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Impact of Farmer Field School on wheat growers of Jabalpur, Madhya Pradesh

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Abstract

Farmer Field School (FFS) is a participatory and interactive approach to social learning. FFS was implemented for wheat management practices in block Sihora, district Jabalpur of Madhya Pradesh to motivate the farmers for adoption of improved wheat production technology and enhance sustainability of the production systems. To assess the impact of FFS on knowledge and adoption of wheat growers, the study was carried out in Sihora block of Jabalpur district. In Sihora block four villages i.e. Khajuri, Khushiyari, Jouly and Bhandhara were selected purposively because maximum number of Farmer Field School under ATMA on wheat crop in last three years has been conducted in the villages last 3 years. Fifty beneficiaries from respective four villages and fifty non beneficiaries from the same villages who were not the member of Farmer Field School were selected randomly. Thus, total sample size comprised of 100 (50 beneficiaries and 50 non-beneficiaries). The results revealed that beneficiaries were having high level of knowledge and medium level of adoption whereas non-beneficiaries were having low level of knowledge and low level of adoption. Beneficiaries fetched higher total mean score of knowledge than non-beneficiaries and higher total mean score of adoption than non-beneficiaries.

Key words: Farmer Field School (FFS), Beneficiaries, Non-beneficiaries

Wheat is the most important staple food grain and third most produced cereal crop in the world has occupied an important place in the agriculture economy of our country. Madhya Pradesh is the second in wheat production according to area with 14.77% share of total area and fourth according to production with share of 9.58% of total wheat production of our country. Average productivity of wheat in Madhya Pradesh is 24.77 q/ha which is low from national average productivity of wheat i.e. 31.18 q/ha (2012-13), (Krishijagran.com). The need for improving wheat production and the productivity in the state is immense. Increasing farm incomes and production requires intellectual innovations, such as rural participation, action oriented research for knowledge generation, mutual sharing, and integration and diversification of the farming systems where necessary. Extension services in the rural areas, which are mostly provided by the government, are generally very limited for a number of reasons, among them inadequate number of extension staff and lack of needed financial support are the most important ones. These days, the emergence of new paradigms and approaches of extension are shifting towards the empowerment of farmers. The Department of Agriculture has recognized the needs for innovation in its extension institutions and since 1980s it has been supporting experimental approaches to meet farmer's needs.

Farmer Field School is a participatory and interactive approach to social learning. It is an approach that puts together set of principles and techniques meant

to systematically enhance farmers` abilities to investigate, analyze, innovate and learn improved farming practices. FFS were conceptualized between 1970s and 1980s and first implemented in Indonesia in 1989 to deal with the wide spread of pest out break in rice that threatened the security of Indonesia's basic food supplies. Farmer Field School came over India in 2004-05. First FFS was seen at Akutotapalli in Anantpur district of Andhra Pradesh. Farmer Field school one of the most effective extension programmes offers community based, non formal education to groups of 25-30 farmers. Farmers Field School (FFS) was implemented for wheat management practices in block Sihora district Jabalpur of Madhya Pradesh to motivate the farmers for adoption of improved wheat production technology and enhance sustainability of the production systems. Keeping this view in mind, the present study the present study was undertaken to assess the Impact of Farmer Field School on wheat growers in terms of level of adoption.

Methodology

The study was conducted in Jabalpur district of Madhya Pradesh in 2015-16. District comprises of seven blocks out of which only one block i.e., Sihora was selected purposively because maximum number of FFS under ATMA on wheat crop has been conducted in last 3 years. The block comprises of 150 villages out of which 4 villages Khajuri, Khushiyari, Jouly and Bhandhara were selected purposively because FFS under ATMA on wheat crop have been conducted in these villages in previous years. The list of FFS beneficiaries from selected 4 villages was obtained from the concerned personnel of Department of Agriculture. Fifty beneficiaries from respective four villages and fifty non beneficiaries from the same villages who were not the member of Farmer Field School were selected randomly. Thus, total sample size comprised of 100 (50 beneficiaries and 50 non- beneficiaries).

Results and Discussion

The term adoption has been applied in present study as "to signify the acceptance and use of improved technology and practices in the field of wheat production". In case of beneficiaries, most of the farmers 38.0 per cent had medium level of adoption in respect of wheat production technology followed by 32.0 per cent farmers had high and 30.00 per cent farmers had low level of adoption respectively. In case of non-beneficiaries, the most of the farmers 42.0 per cent had low level of adoption in respect of wheat production technology followed by 34.0 per cent farmers had medium level of adoption and 24.0 per cent farmers had high level of adoption of respectively. (Table 1)

Table 1: Distribution of the farmers according to adoption level of wheat production technology

Characteristics	**Categories**	**No. of farmers**			
		Beneficiaries	**Percentage**	**Non- beneficiaries**	**Percentage**
Level of Adoption	Low (16-26)	15	30.0	21	42.0
	Medium (27-37)	19	38.0	17	34.0
	High (38-48)	16	32.0	12	24.0
	Total	**50**	**100**	**50**	**100**

Table 2: Impact of FFS in terms of adoption

Adoption category	FFS beneficiaries			Non- beneficiaries			Additional score obtained by beneficiaries over non- beneficiaries		Calculated "Z" value
	(f)	Mean score	Mean	(f)	Mean score	Mean	Absolute	(%)	
Low (16-26)	15	0.30		21	0.42		-0.12	-28.51	
Medium (27-37)	19	0.76	31.10	17	0.68	27.98	0.08	+11.76	**2.056***
High (38-48)	16	0.96		12	0.72		0.24	+33.33	
Total	**50**	**2.02**		**50**	**1.82**		**+0.20**	**+16.58**	

* Significant at 0.05 level of probability

The beneficiary farmers have shown better results over non-beneficiaries in regards of adoption level. The calculated "Z" value 2.104 was higher than table value at 0.05 level of probability and there is clear variation in mean score obtained by beneficiaries and non-beneficiaries in respect of adoption of wheat production technology (Table 2). It is evident that beneficiaries fetched higher total mean score of adoption (2.02) than non-beneficiaries mean score (1.82) and it was due to Farmers Field School.

Table 3: Relationship of attributes of beneficiaries and non-beneficiaries with their level of adoption

Characteristics	Correlation Coefficient	
	Beneficiaries	Non-Beneficiaries
Age	0.028^{NS}	0.051^{NS}
Education	0.380**	0.267*
Disciplinary environment	0.513**	0.407**
Size of land holding	0.398**	0.126^{NS}
Annual Income	0.584**	0.168^{NS}
Material Possession	0.238^{NS}	0.074^{NS}
Extension Participation	0.893**	0.529*
Information seeking behaviour	0.420**	0.770*

*Significant at p= 0.05 and **Significant at p= 0.01 NS = Non significant

Zero order correlation coefficient between socio-personal characters of FFS beneficiaries with level of adoption of wheat production technology were estimated. The results revealed that characteristics namely Education (0.380*), disciplinary environment (0.513**), Size of land holding (0.513**), annual income (0.584**), extension Participation (0.893**) and information seeking behaviour (0.420**) were positively and significantly related to level of adoption of package of practices of wheat crop at 0.01 level of significance. Hence, above mentioned socio- personal, socio- economical and communicational profile of the wheat growers was an important factor for increasing adoption regarding improved wheat production technology. This finding is supported by Patel et al. (2003), Khan (2004), Painkra *et al.* (2005), Chouhan (2007) and Singh (2013).

Zero order correlation coefficient between socio-personal characters of non- beneficiaries with level of adoption of wheat production technology were estimated. The results revealed that characteristics namely disciplinary environment (0.407**), extension participation (0.529**) and information seeking behaviour (0.770**) were positively and significantly correlated at 0.01 level and education (0.276*) at 0.05 level of probability to level of adoption of package of practices of wheat crop.

Conclusion

The beneficiary farmers improve their adoption level through FFS classes. It is clear from the study that there is clear variation in mean score obtained by beneficiaries and non-beneficiaries in respect of adoption of wheat production technology. It may also be concluded from the study that through FFS farmers can strengthen their observation capability and increasing knowledge and adoption level through discovery based learning. FFS is also very helpful in changing deep-rooted beliefs and practices and developing problem-solving capabilities of farmers. Government should support the FFS because it empowers both farmers and extension officers.

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Adoption behaviour of FLD beneficiaries of wheat growers in Jabalpur, Madhya Pradesh

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Abstract

Wheat is the first important and strategic cereal crop for the majority of world's population. Madhya Pradesh is one of the major wheat producing state in India. The main objective of front-line demonstration is to demonstrate newly released crop production and protection technologies and its management practices in the farmers' field under different agro-climatic regions and farming situations. The study was conducted in Jabalpur district of Madhya Pradesh because highest numbers of front-line demonstration on wheat crop with emphasis on new varieties were conducted by Krishi Vigyan Kendra, Jabalpur in the district. Total 125 farmers constitute the sample size and were selected randomly. The maximum number of the respondents had medium adoption behaviour (48.80%) for the recommended package of practices followed by low adoption behaviour (41.60%) and only 9.60 per cent respondents had high adoption behaviour. It is concluded that the adoption behaviour of the recommended package of practices was lower to medium.

Keywords: Wheat, adoption behaviour, frontline demonstration

Wheat (*Tritium aestivum*) is an important and strategic cereal crop for the majority of world's population. It is the most important staple food of about two billion people (36% of the world population). It exceeds in acreage and production of every other grain crop (including rice, maize etc.) and is therefore, the most important cereal grain crop of the world, which is cultivated over a wide range of climatic conditions. Wheat offers ease of grain storage and ease of converting grain into flour for making edible, palatable, interesting and satisfying foods. Wheat is the most important source of carbohydrate in a majority of countries.

India is the second largest producer next to China with maximum area under wheat. However, in terms of productivity, it is ranked thirteenth and marginally less relative to world average. In India, wheat is the second most important crop after rice occupying 29.65 million ha. with a production of 92.46 million tonnes and the average productivity is 3119 kg per ha (DWR, 2013). In Madhya Pradesh area, production and productivity of wheat is 5.30 million hectare, 13.13 million tonnes and 2478 kg per ha. respectively (DWR, 2013).Madhya Pradesh in recent years have shown tremendous potential of producing Quality Wheat with contributing nearly 14.20 percent of total wheat production in the country and emerging as third largest wheat producing state in the country after Uttar Pradesh and Punjab.

Front-Line Demonstration is the concept of field demonstration evolved by the Indian Council of Agricultural Research with the inception of the Technology Mission on Oilseed Crops (TMOs) during mid-eighties.Frontline demonstration is the important mandate of KrishiVigyan Kendra. FLDs educate farmers through results obtained in terms of higher yields and also provide an effective learning situation as farmers see the crops and participate in the discussion for getting maximum production. The main emphasis is to maximize production per unit area by using high yielding

varieties of wheat in conjunction with the package and practices.Large scale adoption of recommended available technologies is essential feature of agriculture development. "Key to agricultural development lies in the mind, heart and hands of farmers". Farmers are ultimate decision makers about an innovation introduced in their systems. Keeping this in mind, the present study on Adoption behaviour of FLD beneficiaries of wheat growers in Jabalpur district of Madhya Pradesh was conducted.

Material and methods

The study was conducted in Jabalpur district of Madhya Pradesh because highest numbers of front-line demonstration on wheat crop with emphasis on new varieties were conducted by KrishiVigyan Kendra, Jabalpur in the district. Jabalpur district comprises of 7 blocks out of which Sihora block was selected purposively for the study. The Sihora block comprise of 149 villages, out of which 5 villages were selected as maximum number FLDs on wheat crop were conducted by KVK, Jabalpur in the selected villages. From each village, 25 wheat growers who were beneficiaries of FLDs on wheat were selected randomly. Total 125 beneficiaries from five villages were selected for the study.

Result

Table 1: Extent of adoption of respondents towards wheat production technology

Improved Technology	Total Obtained score	Mean Score	Rank
Land Preparation	163	1.30	VI
Crop Rotation	138	1.10	XII
Selection of HYV	213	1.70	I
Seed Treatment	158	1.26	VII
Time of Sowing/ Seed Rate	193	1.54	II
Depth of Sowing/ Spacing	107	0.85	XIII
Sowing Method	154	1.23	VIII
Use of Culture	144	1.15	X
Application of Fertilizer	139	1.11	XI
Weed Management	185	1.48	IV
Control of Insect/Pest	188	1.50	III
Disease Management	150	1.20	IX
Time of Harvesting	170	1.36	V

The mean adoption score of different aspects of the FLDs programme as adopted by the respondents. It was found that the selection of suitable HYV (1.70) had highest mean adoption score followed by the time of sowing/ seed rate (1.54), control of insect/ pest (1.50), weed management (1.48), time of harvesting (1.36), land preparation (1.30), seed treatment (1.26), sowing method (1.23), disease management (1.20), use of culture (1.15), application of fertilizer (1.11),and crop rotation (1.10). The adoption behavior of the respondents in the practice, depth of sowing was found minimum. (Table 1).

Table 2: Distribution of the respondents according to their adoption behavior

Categories	Frequency	Percentage
Low (Up to 14 score)	52	41.60
Medium (15 to 29 score)	61	48.80
High (30 to 44 score)	09	09.60
Total	**125**	**100.00**

The data in table 2 shows the percentage distribution of respondents according to their adoption behavior. It is obvious from the table that out of total respondents, 48.80 per cent had medium level of adoption, while 41.60 per cent had low and only 09.60 per cent farmers had high level of adoption (Table 2).

Table 3 : Change in adoption behavior

Adoption Behaviour	Before Adoption		After Adoption		Changes in percentage
	f	%	f	%	
Low (Up to 14 score)	69	55.20	52	41.60	13.60
Medium (15 to 29 score)	46	36.80	61	48.80	12.00
High (30 to 44 score)	10	08.00	12	09.60	01.60
Mean	19.38		23.23		
Variance	57.94		77.21		
t-value (cal)	**9.10**				
t-value 9.10> t-tab 1.97 which is significant at 5% level					

The mean value of adoption behavior was worked out by calculating the impact in terms of before and after intervention of FLD. The data indicates variation between two mean i.e. 19.38 and 23.23 with variance 57.94 and 77.21, respectively. However when the data was subjected to t-test, the calculated value is greater than table value at 5 per cent of significance.

Front line Demonstrations (FLDs) enhanced the yield of crops vertically and ensured rapid spread of technologies horizontally. The FLDs made positive and significant impact on yield enhancement of wheat by adoption of new varieties of wheat. Impact of FLDs on adoption of technologies showed increased trend in adoption of wheatproduction technologies. It was found that FLD is proven extension intervention to demonstrate the production potential of different crops on farmers' field. Therefore, it is recommended that stakeholders who are engaged in transfer and application of agriculture technologies on farmers' field should give priority to organize Front Line Demonstrate extensively in cluster approach for enhancing productivity potential of main crops and to make rapid spread of flagship technologies.

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Profile of pea growers utilizing ICT tools in Jabalpur Madhya Pradesh

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Abstract

Information and communication technology in agriculture offers a wide range of solutions to some agricultural challenges. It is seen as an emerging field focusing on the enhancement of agricultural and rural development through improved information and communication processes. This study was designed to determine the extent to which information and communication technology tools have been utilized for obtaining the recommended technology of pea cultivation. The study was carried out in Patan block of Jabalpur district of Madhya Pradesh having maximum area under pea cultivation. Total 120 pea growers were interviewed. The study revealed that maximum number of pea growers was belonging to middle age group having high school education and medium farming experience. Majority of them were medium farmers in terms of land holding, use high information sources, social participation, extension contact, annual income and achievement motivation. They had low scientific orientation and low level of innovativeness. It was found that maximum pea growers had medium extent of utilization of ICT tools.

Key words- ICT, Extent of utilization, Pea Growers

ICT provides vital access to information, markets by connecting the rural poor and marginalized to the world's information resources and opportunities. The ICTs also provide the flexibility in providing information related to the various modes of farming practices including all the crops, specific commodities and enterprises, price information and all other information and regarding technological advances and tracking global competitiveness. Thus, the ICT play an increasingly important role in linking the research- extension-market continuum towards developing professional competencies and entrepreneurial capabilities among specialists and farming communities respectively.

ICTs can be helpful in providing the interaction among the researchers, extension workers and farmers. ICTs help in providing up to date information services to the farmers such as on package of practices, market information, weather forecasting, the input supply, credit availability etc; can be provided at the earliest possible time.

Material and methods

The study was conducted in Patan block of Jabalpur district of Madhya Pradesh. The area was purposively chosen having larger area under pea cultivation in the district. Total 120 pea growers who were using the ICT tools selected for the study spread over 6 villages. The data were collected through a well-structured and pre-tested interview schedule, which was prepared on the basis of objectives of the study.

Result and discussions

Profile characteristics of the pea growers

The table shows the profile characteristics of the pea grower. It is clear that out of 120 respondents, maximum number of respondents i.e. 45.00 per cent belongs to middle age group followed by 34.17 per cent from young age group and 20.83 per cent were from old age group. Similar result was reported by Natikar (2001).

Table 1 : Profile of pea growers

Attributes	Categories	Frequency	Percentage
Age	Young	41	34.17
	Middle	54	45.00
	Old	25	20.83
Education	Primary	21	17.50
	Middle	29	24.17
	High school	48	40.00
	graduates	22	18.33
Farming experience	Low	30	25.00
	Medium	58	48.33
	High	32	26.67
Land holding	Marginal	28	23.33
	Small	32	26.67
	Medium	40	33.33
	Large	20	16.67
Information Source	Low	28	23.33
	Medium	36	30.00
	High	56	46.67
Social Participation	Low	33	27.50
	Medium	56	46.67
	High	31	25.83
Extension Contact	Low	32	23.66
	Medium	53	44.17
	High	35	29.17
Annual Income	Low	35	29.17
	Medium	61	50.83
	High	24	20.00
Achievement Motivation	Low	34	28.33
	Medium	51	42.50
	High	35	29.17
Scientific Orientation	Low	52	43.33
	Medium	37	30.84
	High	31	25.83
Innovativeness	Low	59	49.17
	Medium	34	28.33
	High	27	22.50

Maximum farmers i.e. 40.00 per cent were found to be educated up to high school, 24.17 per cent had middle

medium and 23.33 per cent had low information source. This finding is in line with the Vijay Kumar (2001). Most of the respondent i.e.46.67 per cent had medium social participation, followed by low and high (27.50 per cent and 25.83 per cent) respectively. Maximum i.e.44.17 per cent respondents had medium extension contact, followed by high and low extension contact respectively.

The data of Table reveals that more than 50 percent of the respondent, had medium annual income followed by 29.17 per cent had low annual income, while 20.00 per cent showed high annual income. Similar result was reported by Kumar et.al (2011) and Sunil Kumar (2004)

Table1 indicates that 42.50 per cent respondents had medium achievement motivation, 29.17 per cent had high while only 28.33 percent showed low achievement motivation. It is observed from the table that maximum respondents i.e. 43.33 per cent had low scientific orientation, followed by medium (30.84%) and remaining 25.83 per cent had high scientific orientation Similar result was reported by Ram (2005). Approximately 50 per cent farmers had low innovativeness, followed by medium and high innovativeness respectively.

Conclusion

It is concluded that maximum pea growers were belong to middle age group having high school education and medium farming experience, majority of them were medium farmers in terms of land holding, use high information sources, social participation, extension contact, annual income and achievement motivation. They had low scientific orientation and low level of innovativeness. The major ICT tools used by pea growers are radio, TV, mobile phone, internet etc. In specific, the findings of the study would help planners and policy makers to apply appropriate strategy and specific actions while formulating ICT projects so as to achieve greater participation of the farmers in utilizing information technology in rural areas.

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Effect of different weed control treatments on yield attributes and yield of transplanted rice

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Abstract

A field experiment entitled "Effect of different weed control treatments on yield attributes and yield of transplanted rice" was conducted during Kharif season of 2017. The ten treatments comprising of doses of pyribenzoxim @ 25 to 60 g ha^{-1}, alone application of fenoxaprop- p-ethyl 56.95 g ha^{-1}, and oxadiargyl 100 g ha^{-1} as post-emergence, hand weeding twice at 20 and 40 DAT including weedy check, were laid out in randomized block design with 3 replications. All the herbicidal treatments were applied 15 DAT. In the experimental field, *Alternanthera sessilis* (24.58%) was rampant weed followed by *Cyperus irriya* (20.52 %). However, other weeds like *Cyperus rotundus*, *Echinochloa colona*. and *Cynodon dactylon* were also present in less numbers with rice in weedy check plots. Data on yield attributes (effective tillers m^{-2}, test weight(g), both grain and straw yield were significantly higher under hand weeding. pyribenzoxim @ 45 g ha^{-1} recorded higher yield attributes, grain and straw yield compared to pyribenzoxim applied at different rates and alone application of fenoxaprop- p-ethyl and oxadiargyl.

Keywords : Upland transplanted rice, yield attributes and yield

Rice (*Oryza sativa L.*) is the plant belonging to the family Poaceae. India is the 2nd largest producer and consumer of rice in the world. Based on the hydrology and topography of land, the rice area is divided into various ecologies viz., Rainfed upland (16%), irrigated land (45%) and rainfed low land (39%). Rice plays a significant role in the economy of India and hence, occupies a central position in national agricultural policy and food security. In Madhya Pradesh, rice is grown in about 2.02 million hectares area with the production of 3.58 million tonnes and productivity is 1768 $kgha^{-1}$ (Agriculture Statistics at a glance, 2016).

Control of weeds by herbicides is although quite effective but needs proper skill and fidelity. Generally pre emergence herbicides like pretachlor, butachlor, anilophos and post emergence herbicides like 2,4-D, and Almix are used frequently to control grassy and broad leaved weed in transplanted rice. Continuous application of the herbicides may also results weed flora shift and development of herbicide resistance in weeds. Hence, there is a need to develop appropriate weed management practices through the new and alternate herbicides to overcome the problem of herbicidal resistance in weeds. Therefore, the present investigation entitled "Effect of different weed control treatments on yield attributes and yield of transplanted rice" has been conducted to see the effect of weed control treatments on on yield attributes and yield of transplanted rice

Material and methods

The field experiment was conducted in Kharif season of 2017 at, College of Agriculture, Krishi Nagar Research Farm, Jabalpur (M.P.) under All India Coordinated Rice Improvement Project. The experimental field was sandy clay loam in texture. It was just below neutral in reaction (pH 7.5) with normal electrical conductivity (0.32 dS/m). The organic carbon content was low (0.62 %) while

medium in available NPK contents 282.34,20.51 and 271.14 kg/ha, respectively.

The experiment was laid out in randomized block design with three replications. The treatments comprised of transplanting dates 19th Jul in main plots and variety Kranti. The uniform dose of fertilizers (100 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha) were applied in all the treatments. The crops were grown under recommended package of practices. In the experimental field, *Alternanthera sessilis* (24.58%) was rampant weed followed by *Cyperus irriya* (20.52 %). However, other weeds like *Cyperus rotundus, Echinochloa colona. and Cynodon dactylon* were also present in less numbers with rice in weedy check plots. Various observations were recorded periodically in relation to growth and yield attributing characters and finally, economics of the treatments was calculated.

Results and discussion

In the experimental field, *Alternanthera sessilis* (24.58%) was rampant weed followed by *Cyperus irriya* (20.52 %). However, other weeds like *Cyperus rotundus*, *Echinochloa colona*. and *Cynodon dactylon* were also present in less numbers with rice in weedy check plots. Appreciably lowest effective tillers m^{-2} and panicle length were noted under weedy check plots (Table 1). Heavy weed competition hampered the supply of growth resources below the demand resulting in poor vegetative growth and reduced assimilatory area per unit of ground area. The effective tillers m^{-2} were increased markedly with corresponding increase in the doses pyribenzoxim being higher when it was applied 45 g a.i. ha^{-1} (175.96 m^{-2}). The effective tillers were significantly more with hand weeding twice (182.92 m^{-2}) in comparison to rest of the treatments. This was attributed to weed free environment throughout the critical period which resulted in better growth and development of foliage and finally more effective tillers. These findings are in conformity to those of Chandra and Solanki (2003) and Chauhan *et al*. (2013).

In the present investigation the sterility percentage was lowest (25.57 %) under hand weeding twice and highest (44.91 %) in weedy check plots. Pyribenzoxim as post-emergence @ 45 and 40 g a.i. ha^{-1} had almost similar sterility and both the doses were significant over its lower doses (25) g a.i. $ha^{-1)}$. The lowest sterility in case of hand weeding was owing to weed free condition which possibly enhanced the utilization of more photosynthatase towards sink and finally reduced the sterility. Similar reduction in sterility was also reported by Chander and Pandey (1996).

The 1000 grains weight (g) was not significantly differed under various weed control treatments. The possible reason for non-significant differences in test weight under the treatments was due to similarity in size and shape of individual grains. (Chauhan *et al*., 2013).

In the present study the lowest grain and straw yields (Table 1) were noted under weedy check plots in which weeds were allowed to grow throughout the crop season. This resulted in severe crop-weed competition for available growth resources which resulted in the inferior yield attributing characters as well as effective tillers which resulted in the lowest yields. Significant increase in yields (grain and straw) were observed with the different doses of pyribenzoxim when applied as post-emergence @ 25, 30, 35, 40, 45 and 60 g a.i. ha^{-1} being highest (4351 and 6879 kg ha^{-1}) at 45 g a.i. ha^{-1}. The grain and straw yields noted under hand weeding twice were appreciably more (5054 and 7506 kg ha^{-1}) over all the treatments. The enhanced yields under these treatments was because of elimination of weeds which helped in enhancing the availability of nutrients, space, sunlight and water resulting in better growth and development of crop plants. This caused better yield attributing characters (Table1) and ultimately the highest yields. These results are in collaboration with the findings of, Chauhan and Opena (2013) and Kumar *et al*. (2014).

Table 1. Effect of different weed control treatments on yield attributes and yield of transplanted rice

Treatments	Dose (g a.i./ha)	Effective tillers (m^{-2})	Sterility (%)	Test weight (g)	Grain yield (Kg/ha)	Straw yield (Kg/ha)
Pyribenzoxim	25	140.46	42.97	24.25	2396	5875
Pyribenzoxim	30	175.90	32.45	24.72	4332	6860
Pyribenzoxim	35	175.92	31.41	24.73	4335	6864
Pyribenzoxim	40	175.94	32.32	24.74	4347	6875
Pyribenzoxim	45	175.96	32.31	24.74	4351	6879
Pyribenzoxim	60	168.07	37.18	24.72	3900	6757
Fenoxaprop-p-ethyl 6.7% EC	56.95	145.95	40.02	24.37	2725	6452
Oxadiargyl 80% WP	100	165.02	35.92	24.58	3804	6760
Hand Weeding	20 and 40 DAT	182.92	25.57	24.94	5054	7506
Weedy check		136.27	44.91	24.03	2119	5597
SEm±		1.35	-	0.17	59.13	69.13
CD (P=0.05)		4.06	-	0.51	177.4	207.4

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Evaluation of economical viability of different weed control treatments on rice crop under transplanted condition

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Abstract

A field experiment entitled "Evaluation of economical viability of different weed control treatments on rice crop under transplanted condition" was conducted during Kharif season of 2017. The ten treatments comprising of doses of pyribenzoxim @ 25 to 60 g ha^{-1}, alone application of fenoxaprop- p-ethyl 56.95 g ha^{-1} and oxadiargyl 100 g ha^{-1} as post-emergence, hand weeding twice at 20 and 40 DAT including weedy check, were laid out in randomized block design with 3 replications.All the herbicidal treatments were applied at 15 DAT. In the experimental field, *Alternanthera sessilis* (24.58%) was rampant weed followed by *Cyperus irriya* (20.52 %). However, other weeds like *Cyperus rotundus, Echinochloa colona*. and *Cynodon dactylon* were also present in less numbers with rice in weedy check plots. Data on both grain and straw yield were significantly higher under hand weeding. pyribenzoxim @ 45 g ha^{-1} recorded higher grain and straw yield compared to pyribenzoxim applied at different rates and alone application of fenoxaprop- p-ethyl and oxadiargyl. Hand weeding needed an investment of Rs 12000 ha^{-1} to control of weeds while expenditure incurred under herbicidal treatments ranged from Rs 1150 to 2200. Maximum gross monetary return (Rs 85849 ha^{-1}) was fetched with hand weeding twice followed by application of pyribenzoxim @ 30 g ha^{-1} (Rs 40165 ha^{-1}) closely followed by @ 35 g ha^{-1} (Rs 40073 ha^{-1}). Though the gross monetary returns was maximum in hand weeding treatment among all the treatments and same trend follow in net monetary returns, but the B:C ratio was the highest under pyribenzoxim at 30 g ha^{-1} closely followed by pyribenzoxim at 35 g a.i. ha^{-1} as post emergence to rice.

Keywords : Upland transplanted rice, yield and economics

Introduction

Rice (*Oryza sativa* L.) is the plant belonging to the family Poaceae. India is the 2nd largest producer and consumer of rice in the world. Based on the hydrology and topography of land, the rice area is divided into various ecologies viz., Rainfed upland (16%), irrigated land (45%) and rainfed low land (39%). Rice plays a significant role in the economy of India and hence, occupies a central position in national agricultural policy and food security. In Madhya Pradesh, rice is grown in about 2.02 million hectares area with the production of 3.58 million tonnes and productivity is 1768 kgha^{-1} .

Control of weeds by herbicides is although quite effective but needs proper skill and fidelity. Generally pre emergence herbicides like pretachlor, butachlor, anilophos and post emergence herbicides like 2,4-D, and Almix are used frequently to control grassy and broad leaved weed in transplanted rice. Continuous application of the herbicides may also results weed flora shift and development of herbicide resistance in weeds. Hence, there is a need

to develop appropriate weed management practices through the new and alternate herbicides to overcome the problem of herbicidal resistance in weeds.

Therefore, the present investigation entitled "Evaluation of economical viability of different weed control treatments on rice crop under transplanted condition" has been conducted to work out the economics of weed control treatments.

Material and methods

The field experiment was conducted in Kharif season of 2017 at, College of Agriculture, Krishi Nagar Research Farm, Jabalpur (M.P.) under All India Coordinated Rice Improvement Project. The experimental field was sandy clay loam in texture. It was just below neutral in reaction (pH 7.58) with normal electrical conductivity (0.32 dS/m). The organic carbon content was low (0.62 %) while medium in available N.P.K. contents 282.34, 20.51 and 271.14 kg/ha, respectively.

The experiment was laid out in randomized block design with three replications. The treatments comprised of transplanting dates 19th July in main plots and variety Kranti.

The uniform dose of fertilizers (100 kg N, 60 kg P_2O_5 and 40 kg K_2O/ha) were applied in all the treatments. The crops were grown under recommended package of practices. In the experimental field, *Alternanthera sessilis* (24.58%) was rampant weed followed by *Cyperus irriya* (20.52 %). However, other weeds like *Cyperus rotundus, Echinochloa colona*. and *Cynodon dactylon* were also present in less numbers with rice in weedy check plots. Various observations were recorded periodically in relation to growth and yield attributing characters and finally, economics of the treatments was calculated.

Results and discussion

In the experimental field, *Alternanthera sessilis* (24.58%) was rampant weed followed by *Cyperus irriya* (20.52 %). However, other weeds like *Cyperus rotundus, Echinochloa colona*. and *Cynodon dactylon* were also present in less numbers with rice in weedy check plots. Economic evaluation of the treatments is also important to know the practical utility of a treatment to the farmers. The cost of cultivation was maximum under hand weeding twice owing to an additional expenditure of Rs 12000 ha^{-1} on weeding. This in general, is not feasible to farmers due to high investment and also unavailability of adequate laborers at peak period of demand. The different doses of pyribenzoxim required lesser investment as compared to hand weeding twice.

The values of Gross monetary returns were minimum (Rs 38411 ha^{-1}) in weedy check plot and maximum (Rs 85849 ha^{-1}) under hand weeding twice. It was noticed that application of pyribenzoxim @ 45 g a.i. ha-1 could not compensate the GMR's as obtained with hand weeding twice but the later treatment (i.e. hand weeding twice) had the higher investment. These variations were due to differences in economical yield (grain and straw) under the treatments.

The net monetary returns (NMR's) was also minimum (Rs 6026 ha^{-1}) under weedy check, which increased to the range of Rs 9484 to 40165 ha^{-1} under those treatments where weeds were controlled by herbicides. The NMR under pyribenzoxim @ 30 g a.i. ha^{-1} was Rs 40165 ha^{-1}, which was followed by pyribenzoxim @ 35 g a.i. ha^{-1} Rs 40073 ha^{-1}. It is noteworthy that although the hand weeding fetched the highest GMR's and the NMR (Rs 41464 ha^{-1}), because of higher grain yield. Similar results were also reported by Sah *et al*. (2012).

It represents the profitability or monetary gain under a particular treatment with each rupee of investment. The ratio was minimal (1.18) under weedy check plots. It is higher (2.18) when pyribenzoxim @ 30 g a.i. ha^{-1} followed by pyribenzoxim @ 35 g a.i. ha^{-1}due to proportionate increase in economical yield because of effective

control of weeds. But B:C ratio under hand weeding twice was less than pyribenzoxim @ 30 g a.i. ha^{-1} because of high cost of cultivation under hand weeding. Similar results were also reported by Jacob *et al*. (2014) and Sah *et al*. (2012). However pyribenzoxim applied @ 60 g a.i. ha^{-1} was more effective to control weeds but simultaneously its phytotoxic effect on crop was found so ultimately yield losses took place and economically not found suitable.

Table 1. Economics of different weed control treatments under transplanted rice

Treatments	Dose (g a.i./ha)	Grain yield (kg/ha)	Straw yield (kg/ha)	Net income (Rs./ha)	B : C ratio
Pyribenzoxim	25	2396	5875	9484	1.28
Pyribenzoxim	30	4332	6860	40165	2.18
Pyribenzoxim	35	4335	6864	40073	2.17
Pyribenzoxim	40	4347	6875	40116	2.17
Pyribenzoxim	45	4351	6879	39728	2.14
Pyribenzoxim	60	3900	6757	33523	1.99
Fenoxapropp-ethyl 6.7% EC	56.95	2725	6452	14839	1.43
Oxadiargyl 80% WP	100	3804	6760	31934	1.94
Hand Weeding	20 and 40 DAT	5054	7506	41464	1.93
Weedy check		2119	5597	6026	1.18
SEm±		59.13	69.13	9484	1.28
CD (P=0.05)		177.4	207.4	40165	2.18

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Development of manually operated seedling planter for horticultural crops with mechanical considerations

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Abstract

A low cost manually operated single row vegetable seedling planter was developed for transplanting of plug and pot type vegetable seedlings on ridges and mulch beds. It consisted of jaw assembly, delivery pipe, lever, handle and spacing marker. Operating principle of the developed transplanter involves the raising the transplanter up to one feet height and allow to free fall in the soil, dropping the seedling in the seedling delivery tube, pressing the lever in upward direction which enable the jaw to open the soil and seedling was placed in the soil by gravity and lifting the transplanter with open jaw and close the after raising the transplanter by one feet height. It was evaluated for inter and intra-row spacings of 45×45 cm. Manual transplanting on plastic mulch beds (MTP) were compared with developed transplanter on plastic mulch beds (MOTP). The transplanting rate using single labour was found to be 5 and 12 seedlings /min for MTP and MOTP respectively. The field capacity was calculated as 0.0031 and 0.0166 for MTPand MOTP. Similarly, field efficiency was 21-28% and 42-57%. Moreover, cost of operation (Rs/ha) in was found to be 9218 and 1753Rs/ha. The time saving over manual transplanting is 80.96 % by using seedling planter. Weight of developed transplanter is 2.4 kg and cost are Rs. 500. It is completely made up of stainless steel Developed vegetable transplanter found more suitable for vegetable transplanting as compare to traditional method of manual transplanting.

Keywords : Manual seedling planter, single row, vegetable seedlings, ridges, mulch bed.

Introduction

Vegetables play an important role in human nutrition and vegetable production is essentially a small-farm venture that benefits thousands of families in urban and rural areas. Growing vegetables in the country, offers self-employment to families who are engaged in different aspects: crop-cultivation, harvesting, transporting, preparation for the market and selling for about 175 types of vegetables. According to Horticultural Statistics at a Glance, total vegetable production in India in the year 2014-15 was 168.30 million tonnes grown over an area of 9.54 million hectares with an average yield of 17.64 tonnes/ha. in 2016-17 production of vegetables is estimated to be around 168.6 million tonnes which is marginally lower by 0.3% than the previous year. It is estimated that the per capita fruits and vegetables availability in India is less than 190 to 200 g per day, which is far below the recommended quantity of 230 g per capita per day. On other side, growth in the vegetable and fruit sectors offers considerable opportunities for increased diversification of agricultural income and nutrition in the future in Indian farming conditions. The estimated demand of vegetables in India by the end of 2020 is 220 million metric tons and this can be achieved by increasing the area under vegetable cultivation and mechanised operation of vegetable seedlings cultivation. In the past one decade, the change in cropping pattern is more towards the horticulture sector and commercial crops.

Presently at most of the area is covered by hybrid seeds for vegetable cultivation, seeds are costly but gives higher yield and quality produce. Indian farmers allocate relatively small proportion of their land. Two techniques are followed in vegetable transplanting viz., raised bed and flat planting. In raised bed, the nursery bed seedlings are transferred manually in rows at recommended spacing in the raised bed and soil is placed around the seedling and compacted. The raised seed-bed (90 to 120 cm), ridges and furrows (10-15 cm wide and 15-30 cm high) prepared manually, bullock and by tractor-drawn implements. Whereas, in case of flat planting, seedlings are transferred manually in rows, covered, compacted with soil. Suitable soil working component used in vegetable transplanter with reduced draft to be selected. Three types of seedlings are transplanted in the field bare root, plug and pot/soil block seedlings. In small scale vegetable gardening, holes dug by hand at desired spacing and seedling placed and packed with soil or soil with manure. In case of medium to large scale farming system, the furrows are opened using bullock or tractor-drawn implements and seedlings are planted in furrows by hand. The acceptable limit of soil coverage is near about 100%.

These series of operations are not affordable for large-scale operation, difficult to timely operation and often results in non-uniform plant distribution. It is time consuming, tedious, labour-intensive and expensive operation. Mechanical transplanters such as semiautomatic transplanter were developed. The soil is opened by mechanical means and seedlings are fed to the metering mechanism by labourer. About 15-72 seedlings per minute have been reported by various researchers. However, these transplanter cost is very high and operated by power tillers/tractors, not feasible for small farms. Presently, most of the operations under vegetable cultivation are accomplished manually. These operations are accomplished in kneeing posture or squatting posture. Therefore, they are more tedious, uncomfortable, tiresome and drudgery prone. Raised bed planting type traditional method of vegetable seedling transplanting requires 185 man-hours/ha for onion. While, flat planting method requires about 260 man-hours/ha for transplanting tomato. Since the majority of Indian farmers having small land holdings, they are unable to procure high cost machinery for vegetable cultivation. The cheaper technologies which can be beneficial over the traditional cultivation practices are the current need of vegetable farming.

Materials and Methods

The stainless steel manually operated single row vegetable seedling planter consists with simple jaw type mechanism mounted at bottom and operated by lever with thin stainless-steel wire. The jaw mechanism is developed with combination of spring, Hexagonal bolt, frame support. Other parts are handle, seedling feeding pipe, lever, marker holder and marker pointer. The overall weight of seedling planter is 2.41 kg. A CAD drawing of the manually operated single row vegetable seedling planter is shown in figure 1.

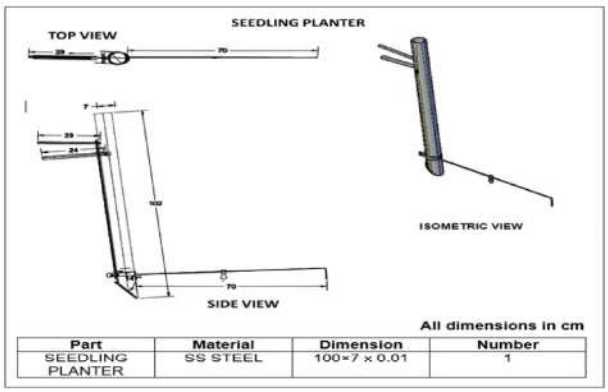

Fig. 1: Manually operated single row vegetable seedling planter

The details of the different components of the developed transplanter are explained below.

Seedling feeding pipe

The seedling feeding pipe was made up of stainless

steel and the diameter measured was 65mm, which was calculated as approximately 1.5 times the root media maximum dimension (plug/pot seedlings) when the plant in upright condition i.e., 30 to 40 mm. The height of pipe was set as 1000mm which was lower than 5th percentile value of standing elbow height of Indian farmer worker (i.e., 1000mm) for easiness in operation for easy operation of transplaning the handle was arranged as per the elbow angle of worker i.e. 150 to 170°.

Handle

The handle was mounted at top of the seedling feeding pipe, made of stainless steel pipe and opposite to movable jaw which was at the bottom of pipe. It was used to control, hold and penetrate the jaw in the soil bed. The height of handle from ground was fixed on the basis of average standing elbow height of operator i.e. 900 mm and diameter of 25mm was decided on the basis of average hand grip of human and length of handle was kept 200mm.

Jaw assembly

It is a soil engaging part of equipment, which makes opening for placing the seedling. The jaw was fabricated with two sections, one section is end of the seedling feeding pipe and other one was movable against the axis provided at top of jaw. This movable section of the jaw was fitted with stud and spring mounted at one end to regain its closed position against stainless steel wire. The angle between the two sections of the jaw was kept 215.5^{o} for easy operation. The complementary angle to this, sometimes named as apex angle 2θ , which is inclined angle formed between the two edges, ranges from 36 to 60° for proper penetration of implement into the soil; therefore, apex angle of jaw was taken as 47.26^{o}.

Lever

The lever was used to operate the jaw, which was made up of stainless steel pipe. The length of lever is 200mm, width was 20mm and the thickness of lever was 2mm. A wire is provided to give leverage to open the soil by jaw.

Marker

The marker was provided in order to indicate the location of seedling to be transplanted. In the present equipment, there was provision to mark laterally as well as longitudinally. This can be adjusted as per the spacings of crop. The maximum and minimum spacings which can maintain in marker is 300 mm to 750 mm respectively.

The technical specifications of the manually operated single row transplanter are given in table 1.

Table 1:Technical specifications of the manually operated single row seedling planter

Parameter of transplanter	Details
Length of the transplanter, mm	1000
Diameter of seedling feeding pipe, mm	65
Diameter of hole punched in soil, mm	70
Depth of operation, mm	75
Height of handle from ground, mm	900
Diameter of handle, mm	25
Types of clutch used	Lever type
Overall weight, kg	2.410
Adjustment of plant spacing, mm	300 - 750

Work quality

The formation of dug and hole in the plastic mulch is tedious job. Manual transplanting by traditional method a labourer has of carry the seedling tray along with him and needs more time in manoeuvrability. Developed machine provided the combination of operation at a time such as formation of hole, pacing

of seedling, covering the soil, marking for transplanting, carrying the ability of portray having provision of to place the seedling on the developed prototype. The hole prepared by jaw is of uniform in size and depth. It facilitate the hole formation, putting of seedling in the hole, covering the soil, carrying the seedling along with machine, and spacing marking operation in standing posture and help to increase the forward speed of operation which results in higher capacity and increase the efficiency of the labour at reduced efforts. Developed machine always plant the seedling in the centre of punch.

Working principle of the machine is one has to hold the prototype in vertical position with handle and as the jaw in a closed position to the height of 15-30 cm and allow to fall or press it to penetrate into soil bed, one seedling has to be picked up from tray and put it in to the seedling feeding pipe, it will be dropped and held into the jaw from inside. Then, pulling the lever towards handle to open the jaw inside the soil and the moment the jaw is opened the seedling resting inside the jaw will drop by gravity into the pit/hole made by jaw. Lift the transplanter lever in pressed position (jaw open) and the soil accumulated at periphery of jaw roll back towards the root zone of seedling thus stabilizing the seedling in the pit/hole and covering the seedling root zone by soil. The different components were designed based on the seedling characteristics (*viz*.,Dimension of seedlings, soil-root containment), human subject strength, reach, clearance limits (*viz.* Operating force requirement, diameter and clearance between handle and lever, height of equipment), working environment (soil cone index, raised bed /ridge/ mulch).

Field performance evaluation

Testing of the developed transplanter was evaluated in research farm of Horticulture, JNKVV, Jabalpur. Ridges and furrows were made by manually operated plastic mulch laying machine. Height and top width of ridge was 20 cm and 90cm. The length of ridge was 35 m length. Moisture content of the soil was 17-18% (db) soil type is vertisol. Plastic mulch on ridges was covered by manually operated plastic mulch laying machine and plastic mulch as time taken for number of seedlings transplanted were recorded by stop watch and transplanting rate, field capacity, field efficiency, labour requirement, cost of operation and saving in labour and cost was calculated by standard formula and methods [25]. The developed machine was tested in 35 x 9.5m area for each method and tomato seedlings of 20 days old raised in 104 cell portray were used. Average seedling height was 150 mm. Portrays were irrigated one day before the transplanting. Formulae used to evaluate the performance of the vegetable seedling planter are as follows

Seedlings delivered

The seedlings delivered per minute were calculated by observing the average time required for transplanting two seedlings in second, the formula of which is given as

$$\text{Seedlings delivered/min} = 60/t$$

Where, t= average time required for transplanting one seedling, s

Speed

The effect of field condition on speed of operation of transplanter was observed by following relation for both plant spacing.

$$\text{Speed}_{45}, \text{km/h} = 0.45 / t \times 3.6$$

Actual field capacity

The actual field capacity of the transplanter was calculated by using following relation.

Actual field capacity, ha/h, = (N×W×S) / 10

Where, N= number of rows covered in single pass; W= distance between two rows, m; S= Speed of operation, km/h

Field efficiency

Field efficiency in percentage was calculated by taking the ratio of actual field capacity to theoretical field capacity. The theoretical speed of operation was considered as 0.7 km/h.

Labour required

Labour required was calculated in terms of the man hours required for transplanting in one hectare area by taking inverse of actual field capacity

Cost of operation

The labour charges were considered as Rs. 25 /h. Hence the labour cost required (Rs.) for one hectare transplanting was calculated by multiplying man hours required for transplanting in one hectare area with 25.

Time saving over manual transplanting

The time saving over manual transplanting in terms of percentage was calculated using following ratio.

TS_{MT} = Manhours required using developed transplanter / Manhours required by conventional method.

Where, TS_{MT} = Time saving over manual transplanting

Developed one row transplanter was compared with manual transplanting by both methods

Results and discussions

Conventional method of making holes on mulch sheet and planting seedlings by carrying seedling tray with hands

The conventional method of making holes on mulch sheet and planting seedlings manually is the most time consume the most time consuming and labour consuming process than planting seedlings with the help of seedling planter and tray holding bag. Making holes manually the uneconomical steps which are following by the farmers are :

a. Marking at the sides of the mulch sheet for proper maintenance of plant to plant and row to row distance which requires 6 minutes for three persons to cover 35 m length bed of 1 m width.

b. Pointing the plant to plant distance of required length with sharp end wooden stick which requires 6 minutes for 1 person to cover 35 m length bed of 1 m width.

c. Making holes on the markings with the help of steel glass which has sharp edge with the impact force by stones which requires 15 minutes for 2 persons to cover 35 m length bed of 1 m width.

d. Planting the seedlings with hand by carrying the trays while planting which takes 50.4 minutes for 1 person to cover 35 m length bed of 1 m width.

The manually making holes on mulch sheet and transplanting the seedlings requires 80.96% more time i.e. 316.45 h/ha than the seedling planter i.e. 60.24 h/ha. Conventional method also required 295 man - h/ha whereas for seedling planter it requires 56.1 man - h/ha. It was also observed that by using seedling planter and tray holding bag the drudgery obtained was less than manually transplanter due to posture of subjects (Table 2).

Table 2: Field performance parameters of developed single row vegetable seedling planter

Parameters	(T3)	(T4)
Plant to plant spacing, mm	300	300
Seedlings/min	5	12
Speed, km/h	0.072	0.198
Actual field capacity, ha/h	0.0031	0.0166
Field efficiency, %	21-28	42-57
Labour required, man-h/ha	295	56.1
Cost of operation, Rs/ha	9218.75	1753.125
Saving cost, %	—	80.98
Time required for 1 hec, h/ha	316.455	60.240
Time saving over conventional method of planting seedlings, %	—	80.96

Plate 1 and 2 shows the above four methods for conventional planting of seedlings.

Plate 1: Conventional method of marking and pointing on mulch sheet

Plate 2: Conventional method of making holes on mulch sheet and planting seedlings

Planting seedlings with the help of developed seedling planter

Ridges and furrows were made by manually and with developed mulch machine. Height and top width of ridge was 20 cm and 90 cm. The length and width of ridge was 35 m and 1 m respectively. Soil type was vertisol. Plastic mulch on some ridges was covered manually and some ridges with developed mulch and drip laying machine. Time taken for number of seedlings transplanted were recorded by stop watch and transplanting rate, field capacity, field efficiency, labour requirement, cost of operation and saving in labour and cost was calculated.

The developed machine was tested in 35 x 9.5 m area for transplanting of tomato seedlings. The 20 day aged seedlings were used for transplanting and is kept in the 98 cell seedling tray. Average seedling height was 150 mm. seedling trays were irrigated one day before the transplanting. The spacing between plant to plant is taken as 300mm. It has been observed that it requires 20 min to plant seedlings in 35 m length bed of 1 m width which includes two rows at 600mm distance. The actual field capacity obtained is 0.0166 ha/h.Plate 3 shows the Planting seedlings with developed seedling planter in field condition (Table 2).

Plate 3: Planting seedlings on mulch sheet with developed transplanter

Conclusions

- Transplanting rate with hand held transplanter was found to be 12 seedlings/min against 5 seedlings/min in case of manual transplanting for plastic mulch bed.
- The field capacity was calculated as 0.003ha/h and 0.016 for manual transplanting plastic mulch beds (MTP), by hand held transplanter on plastic mulch beds (MOTP).
- Moreover, cost of operation in was found to be 9218 and 1753 Rs/ha. The time saving over manual transplanting is 80.96%.
- Weight of transplanter is 2.4 kg and cost Rs. 500/-. It is simple, light weight, low cost and found suitable for transplanting of vegetable seedlings.

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Investigation on water table behaviour in Tikamgarh, Madhya Pradesh

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Abstract

The present study investigates behaviour of pre monsoon and post monsoon groundwater levels in all blocks of Tikamgarh district, Madhya Pradesh, which faces severe water scarcity due to the declining groundwater levels. Here pre monsoon and post monsoon data has been analysed for detection of the water level pattern. The analysis indicates the average rate of water level in pre monsoon and post monsoon level was decreasing with 0.102 m/yr and 0.308 m/yr during year 1997-2006. Also it was observed that rate of water level after the construction of soil and water conservation structures, pre monsoon and post monsoon level was increasing 0.101 m/yr and 0.056 m/yr during 2007-2016.

Keywords: Groundwater, Water table fluctuation, Tikamgarh.

Groundwater recharge is the downward flow of surface water joining the water table and thereby adding an additional amount of water to groundwater reservoir. Groundwater recharge may be natural or artificial. Natural recharge takes place naturally without any intervention and human effort. Artificial recharge systems are the engineered systems where surface water is put on or in the ground for infiltration and subsequent movement to aquifers to augment groundwater resources (Bouwer, 2002). Tikamgarh district suffers from low rain fall, meteorological drought, soil erosion, poor agriculture, lack of education and poverty are the main abstracts for its development. So, the Tikamgarh district of Madhya Pradesh was selected for groundwater trend analysis.

Material and methods

Study area

Tikamgarh district lies between 78°26' and 79°21' E longitude and 24°26' and 25°34' N latitudes having a geographical area of 5048 Sq. km. The area is influenced by southwest monsoon and the mean annual rainfall is 1057 mm. The major part of the study area is comprised of granite rocks and soils are classified as black humus granitic and yellowish grey colour with kankar soils. The entire district comes under Betwa sub basin of Ganga basin. The groundwater in the area generally occurs under water table conditions. The precipitation and influent seepage are the main source of natural recharge to groundwater.

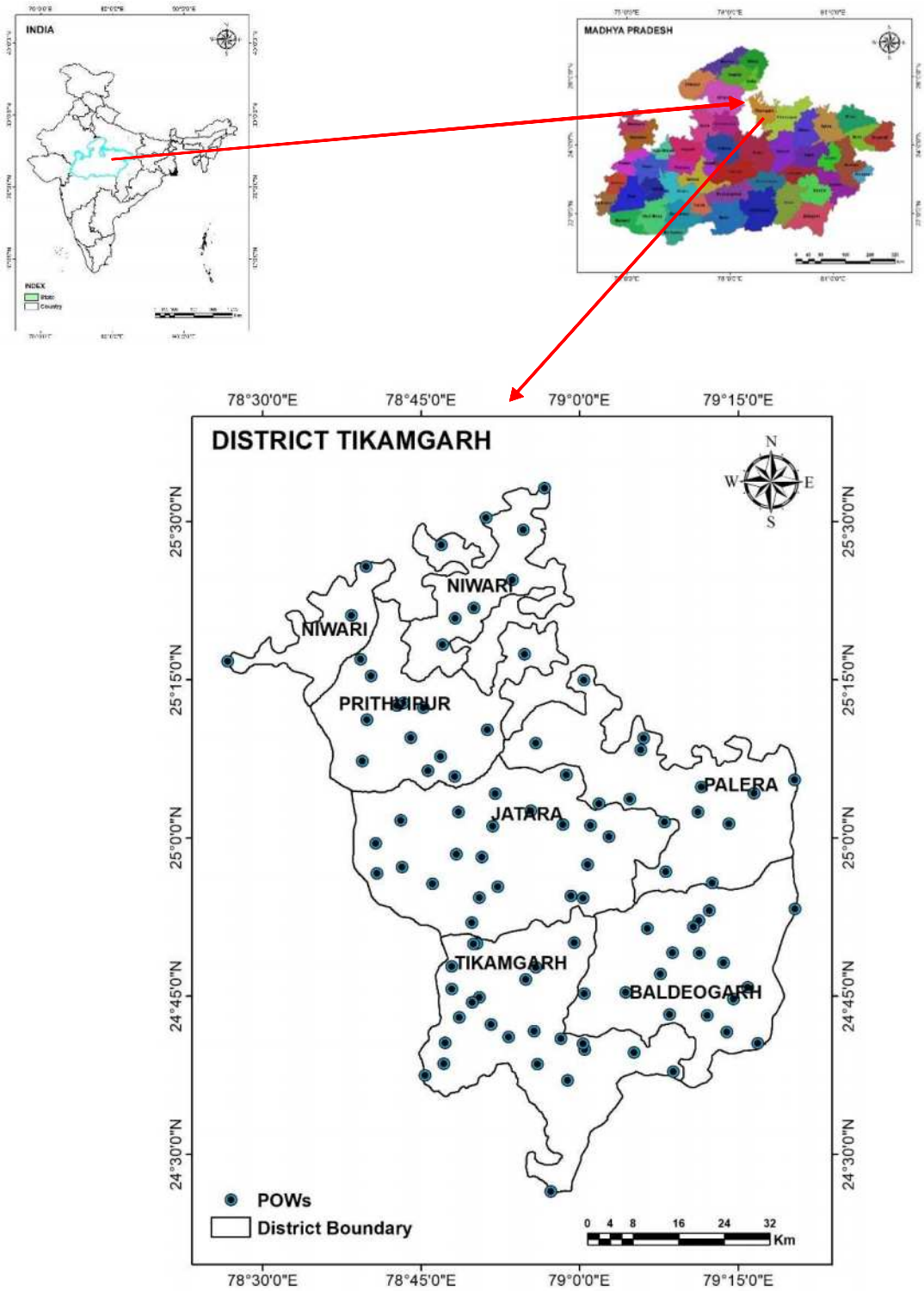

Fig.1. Location map of permanent observation wells in all blocks of Tikamgarh

Data used

The groundwater level data for all blocks of Tikamgarh, Madhya Pradesh district during the post monsoon rabi, pre monsoon, rainy monsoon and post monsoon kharif seasons for a period of 20 years have been used in the analysis and the data is given in **Table 1.**

Table.1. Data availability in all blocks of Tikamgarh, Madhya Pradesh

Name of blocks	No. of observation wells	Periods of analysis
Tikamgarh	23	1997 to 2016
Baldeogarh	17	1997 to 2016
Jatara	20	1997 to 2016
Palera	15	1997 to 2016
Prithvipur	10	1997 to 2016
Niwari	15	1997 to 2016

Methodology

Analysis of pre monsoon and post monsoon water level data of two decades was carried out. It was found that the average water level depth in first decade (1997-2006) in various blocks of Tikamgarh District. Estimated the average water level depth in second decade after the construction of soil and water conservation structures (2007-2016). The Water Table Fluctuation method can be employed for checking the presence of behaviour in the time series. Estimating Δh can be problematic because rainfall is not the only factor that can cause the water table to rise. All other causes of the water table rising need to be filtered out to prevent an overestimation of the recharge.

Results

The plot showing the declining groundwater scenario at Tikamgarh is given in Figs.2, whereas the declining scenario during 1997 to 2006.Then rising of groundwater levels scenario at Tikamgarh is given in Figs.3, during the year 2007 to 2016.

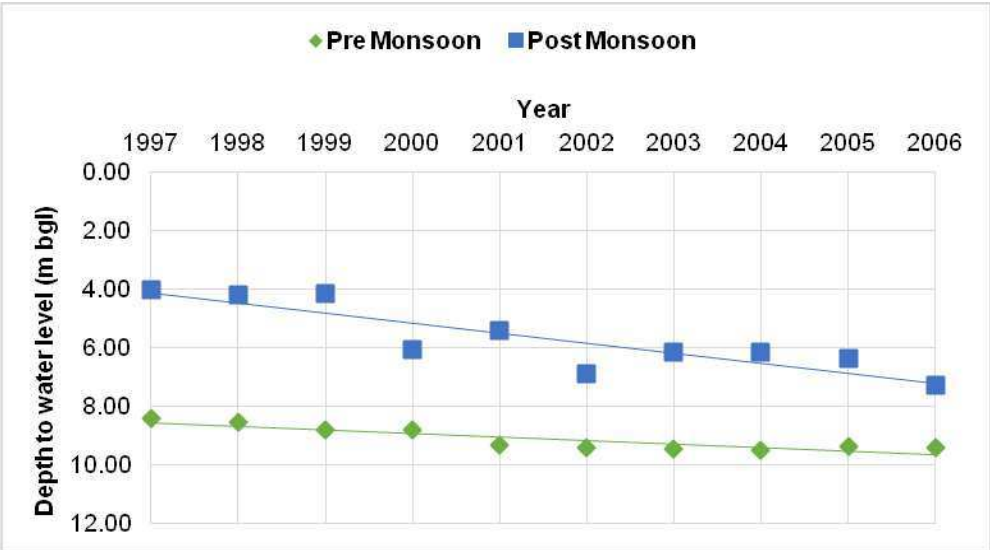

Fig.2. Declining groundwater levels at Tikamgarh district

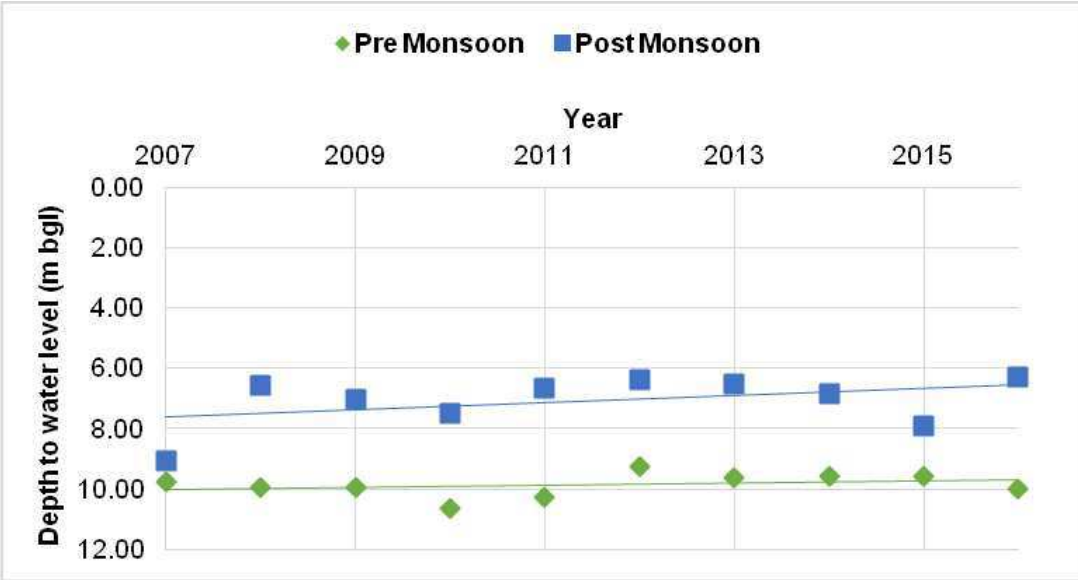

Fig.3. Rising groundwater levels at Tikamgarh district

The reasons for the declining trend in these blocks during 1997 to 2006, may be due to the overexploitation and dependence of groundwater for irrigated agriculture and domestic uses. The analysis of the groundwater levels at various blocks in Tikamgarh district has helped to identify the critical blocks. The groundwater needs to be exploited in a sustainable manner particularly in the blocks of Tikamgarh District, Madhya Pradesh. Then the rising of groundwater levels scenario from 2007 to 20016 at Tikamgarh district due to the construction of soil and water conservation structures.

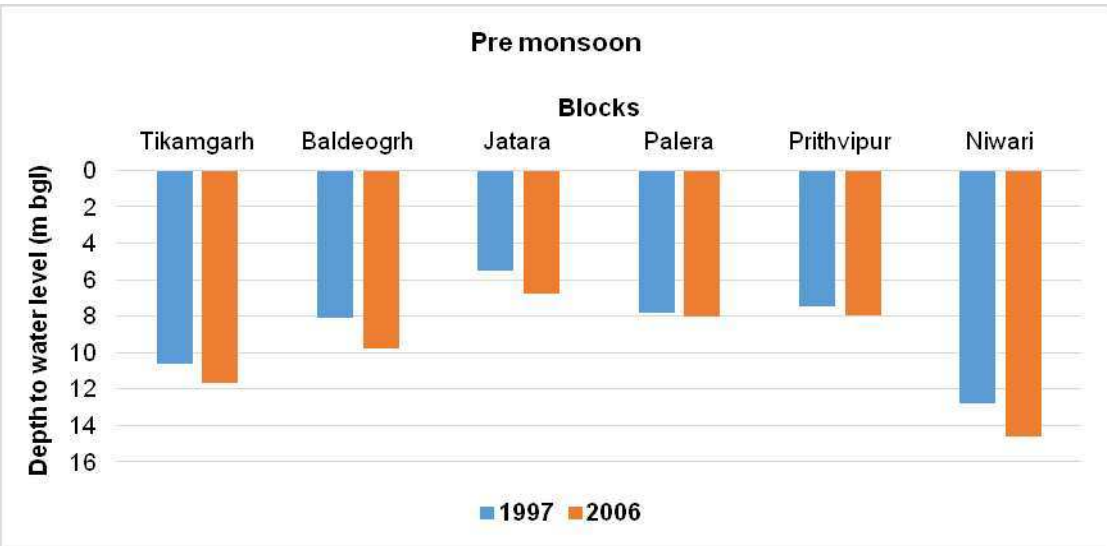

Fig. 4 Change in average water table in various blocks of Tikamgarh in First Decade

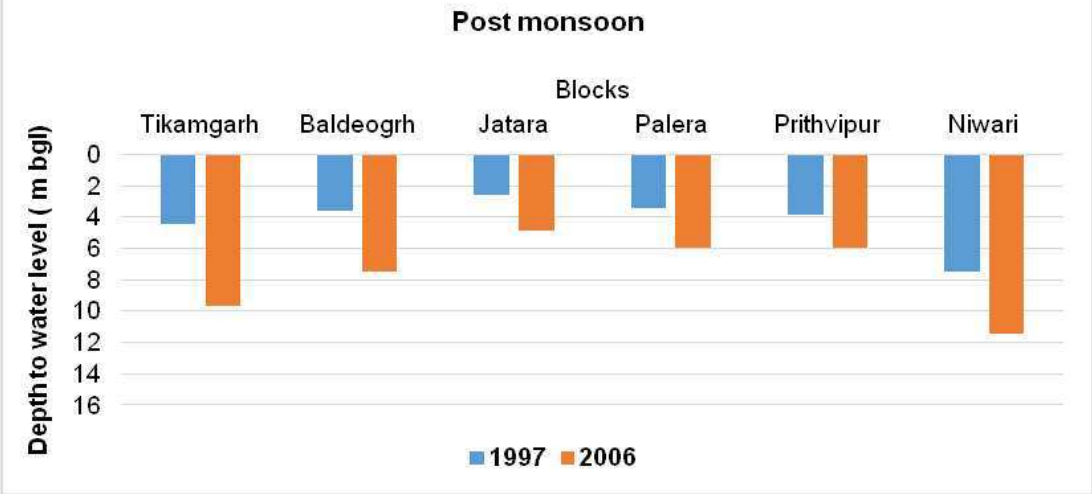

Fig. 5 Change in average water table in various blocks of Tikamgarh in First Decade

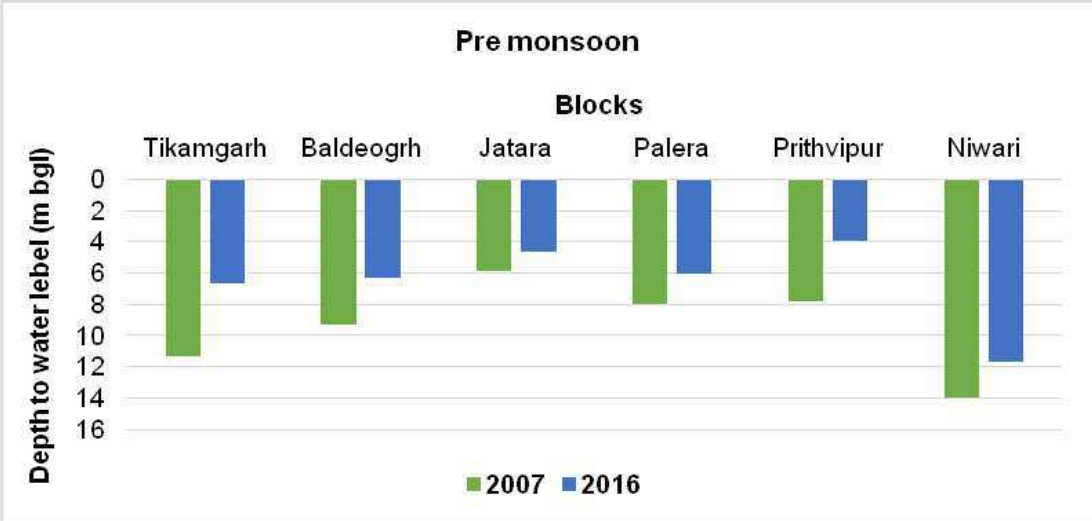

Fig. 6 Change in average water table in various blocks of Tikamgarh in Second Decade

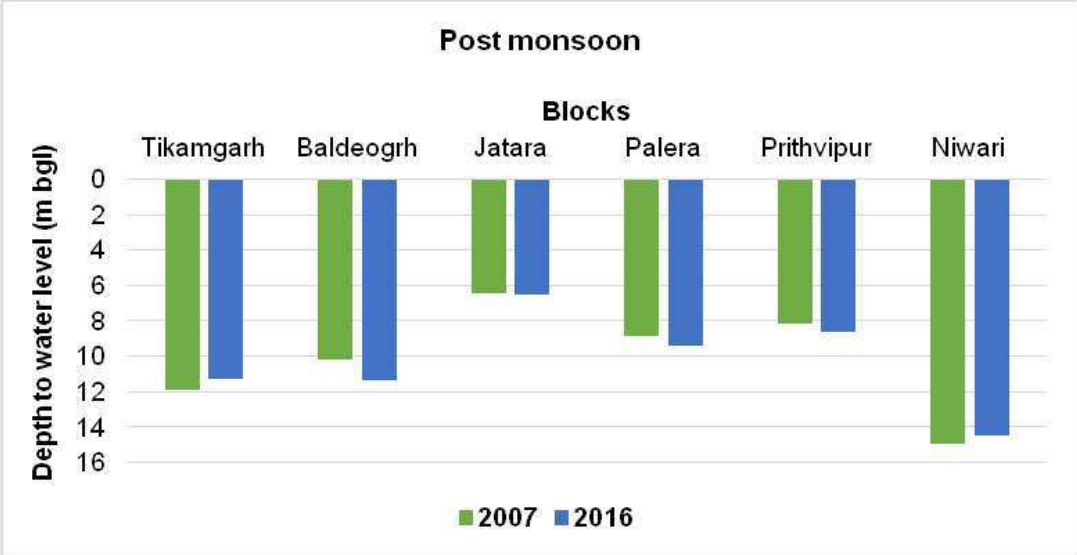

Fig. 7 Change in average water table in various blocks of Tikamgarh in Second Decade

Conclusion

Groundwater level fluctuations and trends can be used to estimate changes in aquifer storage resulting from the effects of groundwater withdrawal and recharge. These data can be used to address water management needs and to evaluate the effects of management and conservation programs. In first decade (1997-2006) or before the construction of soil and water conservation structures the ground water level was decreasing. But after the construction of soil and water conservation structures (in second decade), the water level is rising during the year 2007 to 2016. Efforts should be directed towards identifying suitable artificial recharge zones in these blocks, so as to recharge the depleted aquifers and the exploitation should be limited within the dynamic recharge zone. Conjunctive use studies should be planned for the judicious use of the surface and groundwater, so that the groundwater system can be relieved of the additional stress conditions.

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Assessment of water resources and water demand of an area

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Abstract
Socio economic changes, climate change and droughts focus attention on sustainability of water supplies and consumption of water to meet levels of services. Water resources are the prime input for the growth and prosperity of the nation. A need for assessment of water availability in the Narmada river basin is frequent topic of discussions. In the Upper Narmada Basin, some block are under water stress, thus it is necessary for water resources to evaluate it. The main objective of this review study to highlight the demand generated in different sectors and availability of water resources, thus a proper management plan can be proposed against the water scarcity in the blocks of basin.

Keywords: water resources, assessment, supply, water demand.

Water resource assessment provide a means for evaluating the sustainable availability and water demand. A climate variability and poses risk to basin water scarcity through altered drought, variation in trend of water demand and per capita availability of water. For a sustainable development of water resources, it is imperative to make a quantitative estimation of available water resources. For this task would be to make a realistic assessment of surface and ground water resources and then plan their use in such a way that full crop water requirement are met and there is neither water -logging nor excessive lowering of ground water table. The average annual water availability of the country is assessed as 1869 billion cubic meters (BCM). Of this, total utilizable water resources is assessed as 1123 BCM surface water 690 BCM and ground water as 433 BCM (MoWRD, GOI, 2002). At present, India has the ultimate irrigation potential of 140 M ha and the total area equipped for irrigation was 66.3 M ha (FAO, 2008).

This paper reviews methods of estimation of water availability and demand generated and forecasting with particular reference to the blocks of basin. Water budget is a demand and supply analysis of water resources. Water demand of a single district is computed by adding water consumed by different sectors viz. agriculture, domestic, livestock and industrial. A study shows that the water demand towards domestic use and for livestock is much less than the water required towards crops. About 80% of utilizable water is consumed by the agriculture sectors. Water adequacy aims towards optimum use of water to get maximum production and maximum net return with available land resources.

Analysis of Meteorological Data

Rainfall

Analysis of the rainfall record for 1973-1992 for palampur, Kangra District, revealed that the probability of getting adequate rain for a good Kharif crop of maize was very high in July and August when excess rain water can be stored in the soil profile and tanks.

Verma *et al.* (1994) in their study on rainfall analysis for rainfed crop planning in mid-hills of H.P observed that analysis of the lowest assured weekly rainfall at different probability levels using the incomplete

Gamma distribution was found suitable for planning rainfed crop and related rainwater conservation measure for hilly regions of Himachal Pradesh. They noted that annual, seasonal and monthly rainfall analysis was not adequate for planning rainfed farming

India-WRIS Web GIS (2014) Rainfall is heavy in the upper hilly and upper plains areas of the basin. It is gradually decreases towards a lower plains and lower hilly areas. In upper hilly areas, the annual rainfall is more than 1400 mm but it goes up to 1650mm in some part. In the upper plains, near Jabalpur to near punasa dam site rainfall deceases from 1400mm to 1000mm with high rainfall zone around panchmarhi where the annual rainfall exceeds 1800 mm.From the data of 30 years on intensity of rainfall during 24 hours period as complied by MPWRD, Bhopal and concluded that the most intense rain occurred in southern section of Upper Narmada Basin.

Thomas ***et al.*** (2015) analysed the monsoon rainfall variability over Narmada basin in central India. The trend analysis of the 1-day maximum rainfall series showed a significant positive trend at 95% significance level with the Mann-Kendall test statistic value of z ¼ 3.66 over the entire basin. The analysis further suggested that there has been an increasing trend in the magnitude of 1-day maximum rainfall over the basin with more areas in the basin experiencing high intensity storms, which was more prominent in the most recent 20 years. The analysis also suggested that appropriate measures may be proposed for better management of the water resources in the basin.

Crop water requirement

FAO-24 Radiation method ranked first and the other methods ranked in decreasing order were 1982 Kimberly-Penman, Hargreaves, Turc Radiation, Priestley-Taylor and FAO-24 Penman. Of all the methods evaluated, the Kimberly-Penman predicted Penman-Monteith ETo more closely for Bellary station. For Bombay the FAO-24 radiation method ranked the first based on the SEE. The 1982 Kimberly-Penman method has the lowest SEE and ranked as first for the Kharagpur station.

Tyagi *et al* (2000) conducted study to measure the daily, weekly, and seasonal crop evapotranspiration of wheat and sorghum directly from sensitive weighing-lysimeter. The estimated values of crop coefficient for wheat by Penman-Monteith at the crop growth stages (initial, crop development, reproductive and maturity) were 0.5, 1.36, 1.24, and 0.2, respectively, and for sorghum the crop coefficient values were 0.53, 0.82, 1.24 and 0.85, respectively. In the case of these two crops actual crop coefficient were found significantly different from those suggested by Allen *et.al* (1998). It is therefore, necessary that the crop coefficient values should be developed in a particular region for accurate estimation of evapotranspiration of crops.

Daniel *et al.* (2003) reported that the estimation of crop water requirement to make suitable irrigation planning. Adoption of such practices improved the overall water productive efficiency of system. Generally the water requirement of crops was followed with the help of climatology parameter and lysimetric studies.

Al-Naja (2011) determined irrigation water requirement of Gaza strip, by using FAO-CROPWAT model. The result shows that the reference evapotranspiration accounts for 145 ±5 mm/year in average for citrus , almonds, date, palm, grapes respectively.

Kumar *et al.* (2012) estimated the irrigated reference crop evapotranspiration, Solan, HP. Mathematical models are useful tools to estimate the evapotranspiration and water requirement of crops, which is one of the essential information required to design or choose best water management practices.

Gorge and Raghuwanshi (2012) evaluated empirical methods for calculating ET using meteorological data

from four climatological stations. For Jagdalpur station (humid region), the performance of the FAO-24 Radiation method was in close agreement with the FAO-56 Penman-Monteith method.

Mehta (2015) calculated the reference evapotranspiration and determine the crop water requirement of major crops of Gujarat using FAO Penman-Monteith (FAO 56 P-M) method. Kc values given by FAO was corrected for different selected crops of Gujarat using climatic variables (RH and wind speed) at different stations. The value of Kc varies with growth stages including initial (with 10% canopy cover), developmental (70-80% groundcover), and midseason (discoloring of leaves as in beans or falling of leaves as in cotton) and late season (start of maturity to harvest or full senescence) and crop to crop.

Assessment of water resources

Singh *et al.* (1999) presented a water resource assessment approach based on water balance analysis of huruluwewa watershed, Srilanka. Watershed based water management approach was found to be feasible option to alleviate the problem of water scarcity. They concluded that water resource planning is strongly linked to land use planning.

Khare *et al.* (2006) assessed surface and ground water resource availability for irrigation in Sapon irrigation command area, Indonesia. The ground water availability was estimated on pre and post monsoon water level fluctuation method. Because of the simplicity of the method and wide availability of water-level hydrographs from observation wells, the Water Table Fluctuation (WTF) method has been used.

Jat *et al.* (2009) developed a water management plan for Rajasthan, a water deficit state and stated that a comprehensive and integrated planning of development of surface and ground water is needed. Strategies to bridge the gap between the available and what can be used are given as a conjunctive use of surface and ground water increasing the water use efficiency , planning of water resources based on water basin.

Kumar (2012) pointed out that water balance technique have been extensively used to make quantitative estimates of water resources. It is possible to make a quantitative evaluation of water resources and its dynamic behavior under the incidence of means activities.

Bhatt (2014) analyzed the of demand and supply of water in India. Although India has sizeable water resources, the country faces huge challenges in the water sector as the distribution of water varies widely by season and region. The objective of this paper is to highlights the demand and supply of water in India, and the estimated water in major basins in India. It has been found that the demand for water is increasing substantially due to increasing population, growing urbanization, and rapid industrialization combined with the need for raising agricultural production. The supply of water is inadequate compared to its growing demand in our country.

The per capita availability of water is also continuously decreasing. Therefore Sustainable development and efficient management of water is an increasingly complex challenge to India.

Shriadhionakar (2015) conducted the water resource assessment at basin level using water balance approach and remote sensing approach.in order to develop and rationally manage the water resource an assessment of quantity of water resource is necessary. This study includes hydrological model selection and its parameterization. Water budget approach was adopted for this assessment study.

Surface and Ground water resources

National Commission on Agriculture (2002) has laid down norms for water budgeting of an area and as per its estimate the losses of water as evaporation, surface water flow out of the area is calculated in

present estimation. Similarly, addition of water into the area as runoff generated from the block. The immediate evaporation losses that occurs during the rainfall is taken as 17.5% of total rainfall 28.7% rainfall converts into surface flow. Ground water also adds to the surface flow and it is taken as 23.739% of surface flow. Utilizable surface and ground water flow is 48.639 %of total surface water and 31.625 % of total ground water flow generated respectively. Utilization of water takes place in four major categories. These are domestic and animal water needs, crop water requirement and for industrial and recreation purpose. The industrial demand is computed as 6 %(vary 3- 6%) of available fresh water.

Anonymous (2002) had laid down norms for water budgeting(demand and supply) of an area and as per its estimate the losses of water as evaporation, surface water flow and ground water flow out of the area is calculated in present estimation.

McKenzie and Ray (2009) in their paper on, urban water supply in India, noted that large number of households in cities around the developing world do not have access to and safe drinking water. India experienced the problem of access to water in urban area and various option available for reform. A review of these ongoing reforms illustrate some political economy challenges involved in reforming the water sector

Shriadhionakar (2015) conducted the water resource assessment at basin level using water balance approach and remote sensing approach.in order to develop and rationally manage the water resource an assessment of quantity of water resource is necessary. This study includes hydrological model selection and its parameterization. Water budget approach was adopted for this assessment study.

Awasthi *et al.* (2018) presented the Agro-climatic zone wise Water Budgeting of Madhya Pradesh. They had quantified the total water availability in different agro- climatic zones of M.P. This Budget also contains demand generated through the different sectors viz. Agriculture, Domestic, Livestock, Industry and water excess or deficit. A clear scenario was presented in the technical bulletin A Water Budget has been prepared for 11 agro-climatic zones of Madhya Pradesh.

Ekta (2018) estimated the demand and supply of water resources using curve number method and CGWB guide line of 51 districts of Madhya Pradesh. She also suggested the water utilization plan for district of Madhya Pradesh.

Study conducted on the blocks of Upper Narmada Basin highlighted the water stress problem generate d due to improper management of water resources. We have reviewed the methods of demand and supply estimation with reference to National commission on Agriculture. These measures of demand and supply estimation may adopted for entire basin. Study reveals that there is large gap between demand and supply, but proper management can be settle the entire problem using different tool, techniques or schemes. Proper monitoring of generated runoff may be a good step behind the efficient water utilization.

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Effect of moisture pretreatments on performance of soybean dehuller

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Abstract

A soybean dehuller for such applications was developed by CIAE, its dehulling efficiency was evaluated under present study. Soybean samples of 5 kg each was prepared at different moisture content, the moisture level was increased by addition of measured amount of water and conditioning for 24 to 60 hr. The five moisture levels selected 9, 11, 13, 15, 17 and 19% (w b). It was observed that dal recovery increased with increase in moisture content. The mass of soybean passing out unhusked through the dehuller increased with increase in moisture content. This increase was very sharp after 15%(w.b) moisture content. The dehulling efficiency decreased with increase in moisture content. The rate of decrease becomes steeper after 15% moisture content (w b). The capacity of machine was found to be highest i.e. 96.2 kg/hr at 9% moisture level, and it decreased with increase in moisture content. The mathematical models were also developed to predict the correlation between different variables under study within the range of recorded observations.

Key Words: Soybean dehuller, dehulling efficiency, moisture conditioning, broken grains, unhusked grains, medicinal benefits.

Introduction

Soybean offers number of reasons to be one of the most economical and valuable agricultural products. It has unique chemical composition of 40% protein and 20% oil, its protein has higher proportion of unsaturated fatty acids; it has several health benefits. Its hull although contains very good quality dietary fibers but it needs to be recovered for its use as soy dal or for preparation of milk and milk products from soybean. The machine used to remove the hull is called soybean dehuller. Such a soybean dehuller was designed and developed by CIAE Bhopal. Therefore, in the light of above facts it was decided to test the performance of CIAE soybean dehuller.

Material and methods

The soybean was procured from research farm of College of Agriculture, Jabalpur. Samples of 5 kg was prepared at different moisture content whenever necessary the moisture level was increased by addition measured amount of water and conditioning for 24 to 60 hrs. The five moisture levels selected 9, 11, 13, 15, 17 and 19% (wb).

Experimental Design

The details of various parameters are given below

Parameters		No. of Levels	Value
Independent	Dependent		
Moisture content (wb)	--	6	9,11,13,15, 17 & 19

Procedure

Every day a 5 kg sample of soybean was prepared and its moisture was determined. As per the requirement measuring amount of water was added and the soybean were conditioned to attain the design moisture levels at certain intervals the moisture was sorted and as soon as the designed moisture level was reached the soybeans were subjected to dehulling and the data were recorded. The data so obtained were utilized for calculation of feed rate, capacity and dehulling efficiency. The dehulling efficiency was calculated using following equation

$$= \left(1 - \frac{Mb}{Mt}\right)\left(1 - \frac{Muh}{Mt}\right) \times 100$$

When, = dehulling efficiency

Mt = Mass of total grains

Mb = Mass of broken grain

Muh = Mass of unhusked grains.

Result and discussion

Performance evaluation of soybean dehuller developed in CIAE Bhopal was the objective of this experiment. To evaluate the performance the moisture content of the Soybean was taken as the independent variable. Based upon preliminary observation it was decided to go for dehulling operations at six moisture levels of Soybean mainly 9%, 11%, 13%, 15%, 17% and 19% wb. Also based upon the preliminary observations it was decided to fix the sample size at 5 kg of whole Soybean.

After finalizing the experimental setup the required sample of 5 kg of conditioned Soybean was fed into the hopper of Soybean dehuller and the machine was started. The stopwatch used for calculation of feed rate was started simultaneously with the opening of feed shutter fixed at the bottom of the hopper.

The various dehulled component were collected from their respective outlets. Various data recorded were analyzed and discussed to obtain the different indicators of machine performance, results are as below:

Recovery of Soy Dal

Recovery of soy dal was found to be maximum at 9%, moisture content of whole soybean (i.e. 4059) and it decreased with increase in moisture content of soybean (Fig. 1). This trend was same for all the five replications of observation. Lowest value of dal recovery (i.e. 2100.7) was observed at the highest moisture level (i.e. 19% moisture content w.b.). It can be seen from fig 8,9,10,11, and 12 that with increase in moisture content decrease in dal recovery is mainly due to short increase in the mass of unhusked soybean coming out of the dehuller.

The data obtained were analyzed statistically to give the coefficient of correlation between the dal recovery and moisture content; the data obtained are representative of a very strong negative association between the moisture content and dal recovery i.e. with increase in moisture content the dal recovery decreases. A second order polynomial

was also developed based upon the method of least sum of squares using MS Excel of MS Office 2000. The equation and R^2 values for the average value of all the five replication is tabulated:

Replication	Second Polynomial	R^2 Value
Average	$Y = -22.109 X^2 + 444.32X + 1807.4$	0.9952

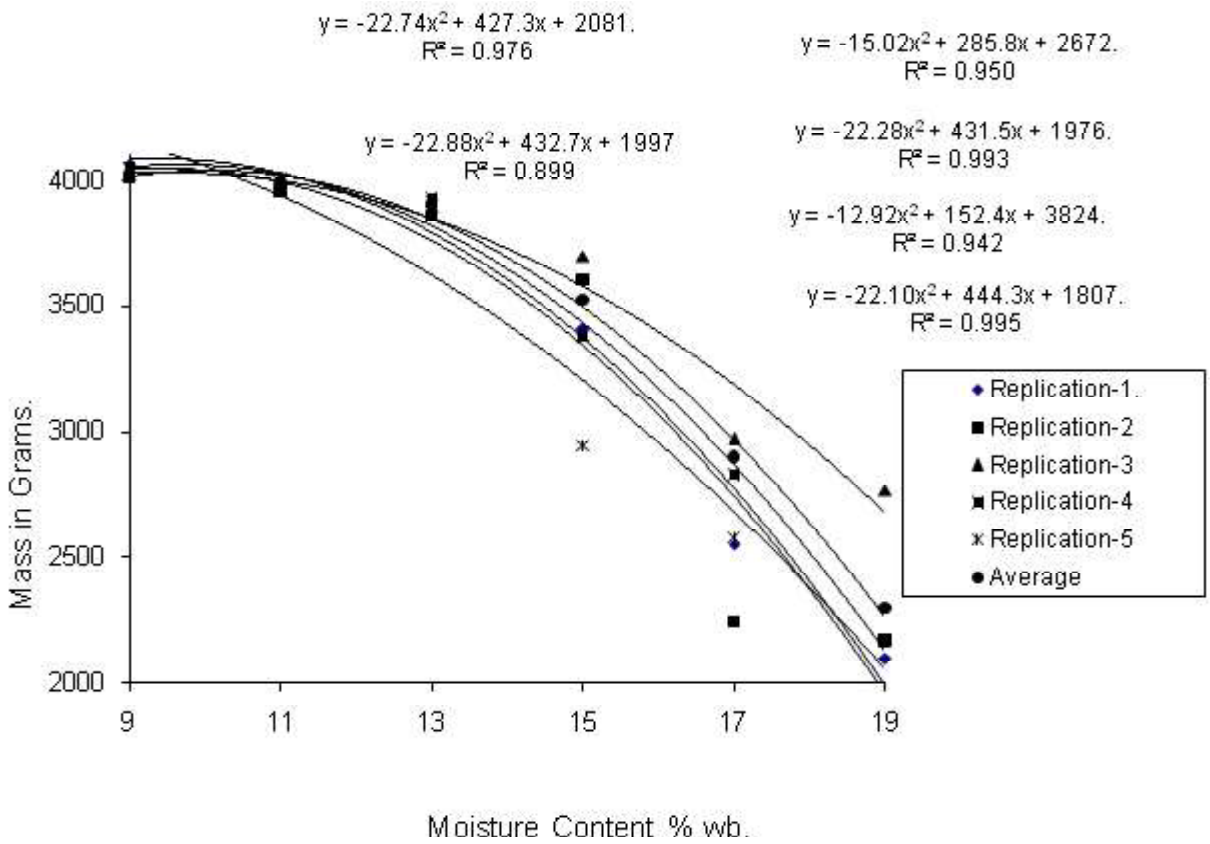

Fig. 1 : Variation inRecovery of Dal with Moisture Content of Soybean

Recovery of Mealy Waste and Broken

Mealy waste consists of fine broken and germs where as the broken consists of soy dal, broken in to size less than % of its original size. The recovery of mealy waste and broken is although not very significant but it is one of the major parameter used in calculation of dehulling efficiency. The variation in mealy waste and broken has a strong positive association with moisture content of whole soybean i.e. with increase in moisture content the amount of mealy waste and broken increases (Fig. 2). This is also confirmed by the strong positive coefficient of correlation obtained between the two variables. The second order polynomial obtained for the average value is tabulated as below:

Replication No	Second Polynomial	R^2 Value
Average	$Y = 0.0263 X^2 + 10.685X + 159.54$	0.9891

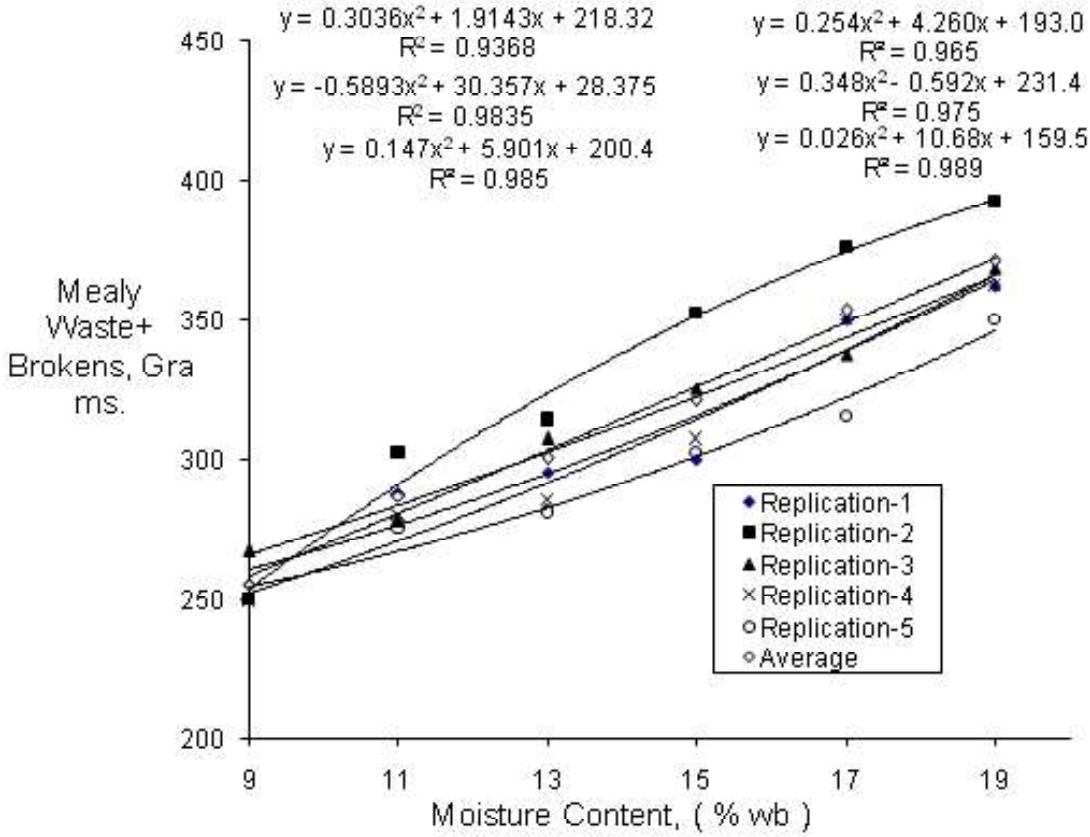

Fig. 2 : Variation in Mealy Waste and Brokens with Moisture Content of Soybean

Recovery of Unhusked Soybean

The increase in amount of unhusked soybean follows the exponential growth in amount of unhusked mass with increase in moisture content (Fig. 3). The unhusked soybean which was initially at 57 gm corresponding to 9% moisture content of soybean finally increases to approximately 1550 to 2200 gm. It can be seen from Fig. 3 that after the 15% moisture content its growth shoots up very fast. However, the growth trend always follows the exponential asocial and coefficient of correlation also shows are very strong positive associations. The data obtained were analyzed based upon the method least sum of square and the regression equation of unhusked soybean on moisture content were developed based upon the method of least sum of square. The equations is tabulated

Replication	No Second Polynomial	R^2 Value
Average	$Y = 1.9529e^{0.3751x}$	0.9886

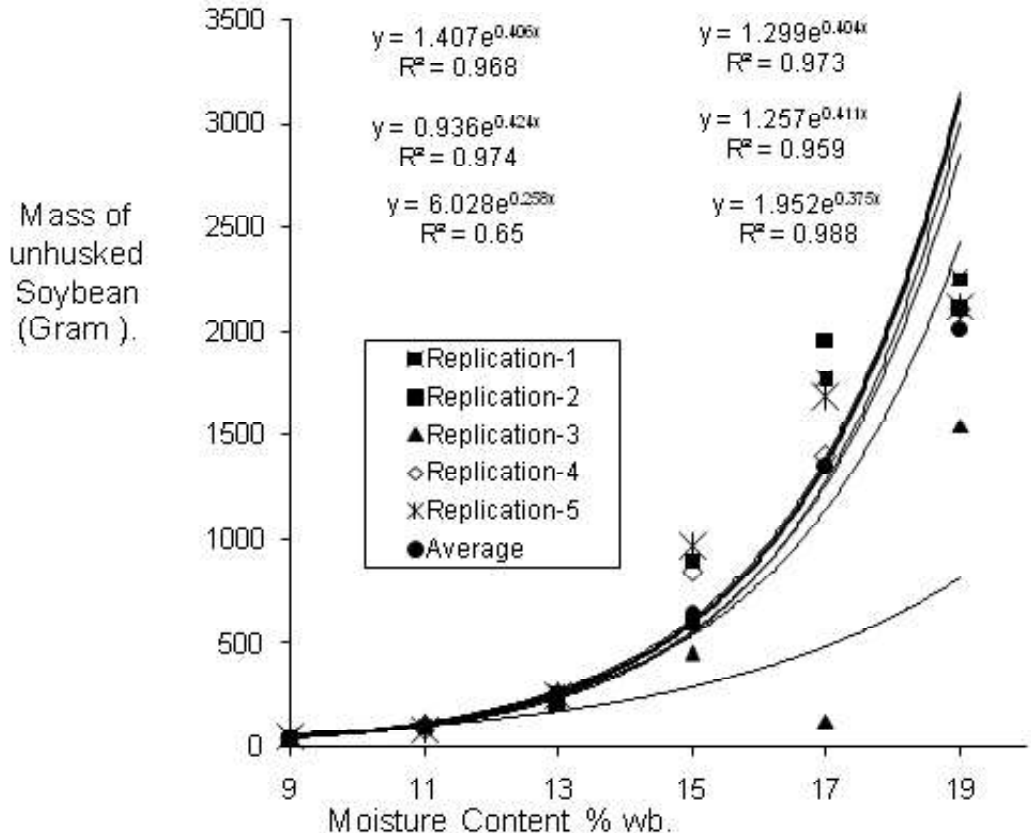

Fig. 3 : Variation in unhusked Soybean with Moisture Content % wb

Variation in Husk Recovery

Amount of husk coming out of the dehuller is a direct function of mass of soybean dehulled. Because the husk constitutes 10 to 12% of the mass of soybean, therefore, more the soybean is dehulled the higher will be husk recovery and vice versa. The maximum value of husk recovered is approximately 700 gm (replication 2) and the minimum value of husk recovered is approximately 287 gm (replication 1). The amount of husk recovery decreases with increase in moisture content (Fig. 4). Although the husk recovery is not a function of moisture content but the decrease in husk recovery with increase in moisture content is mainly because of the fact that with increase in moisture content the amount of soybean passing out undehulled through the dehuller increases sharply and the amount of soybean dehulled decreases with increases in moisture content. Therefore the amount of husk recovery also decreases with increases in moisture content.

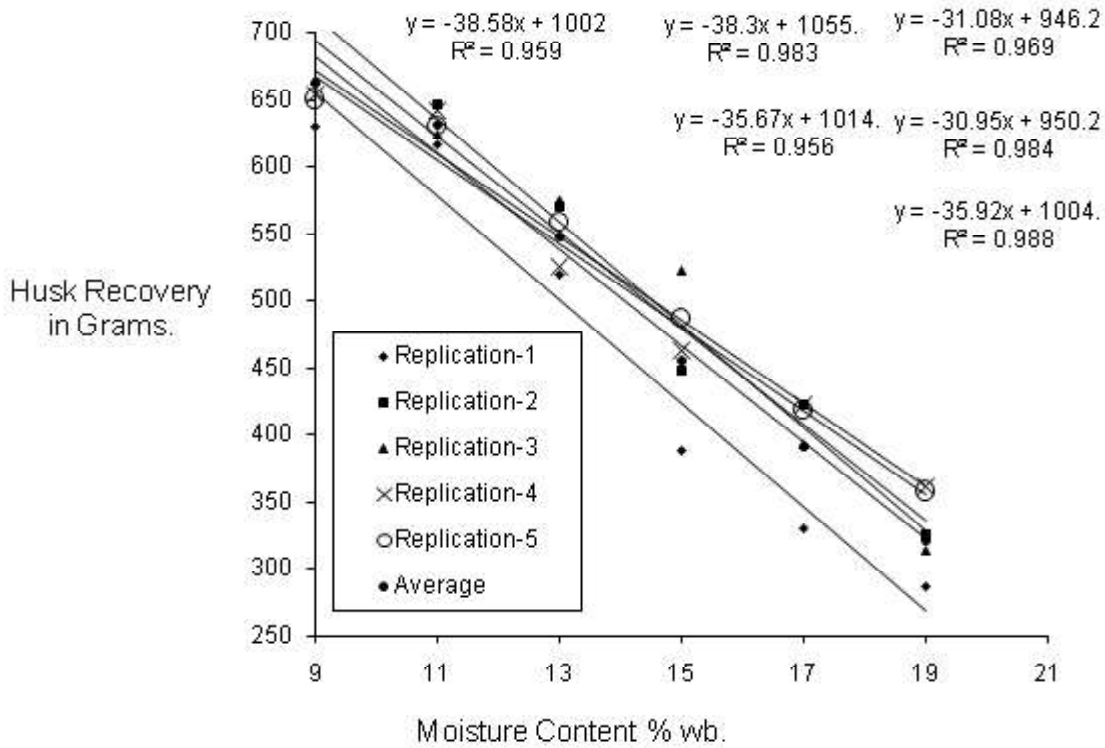

Fig. 4 : Variation in Husk Recovery with Moisture Content of Soybean

Dehulling Efficiency

Dehulling efficiency is the parameter which is directly a measure of performance of the machine.

It is calculating using the following equation.

$$N = \left(1 - \frac{M_b}{M_t}\right)\left(1 - \frac{M_{uh}}{M_t}\right) \times 100$$

The dehulling efficiency has got reverse association with mass of broken and mass of unhusked soybean coming out of the dehuller. Dehulling efficiency has the highest value of 94% at 9% moisture content and the lowest value of 53% at 19% moisture content. The decrease in the dehulling efficiency is mainly due to increase in the mass of unhusked soybean coming out of dehuller.

The dehulling efficiency has got a strong negative association with the moisture content of soybean. The strong association is conform by a high correlation coefficient between the dehulling efficiency and the moisture content of soybean (Fig. 5). A second order polynomial was also developed by the method of least sum of square using MS Excel and MS office 2000. The second order polynomial and R^2 value for the average of 5 replication is tabulated:-

Replication No	Second Polynomial	R^2 Value
Average	$Y = 0.4464 X^2 + 8.5486X + 52.595$	0.9931

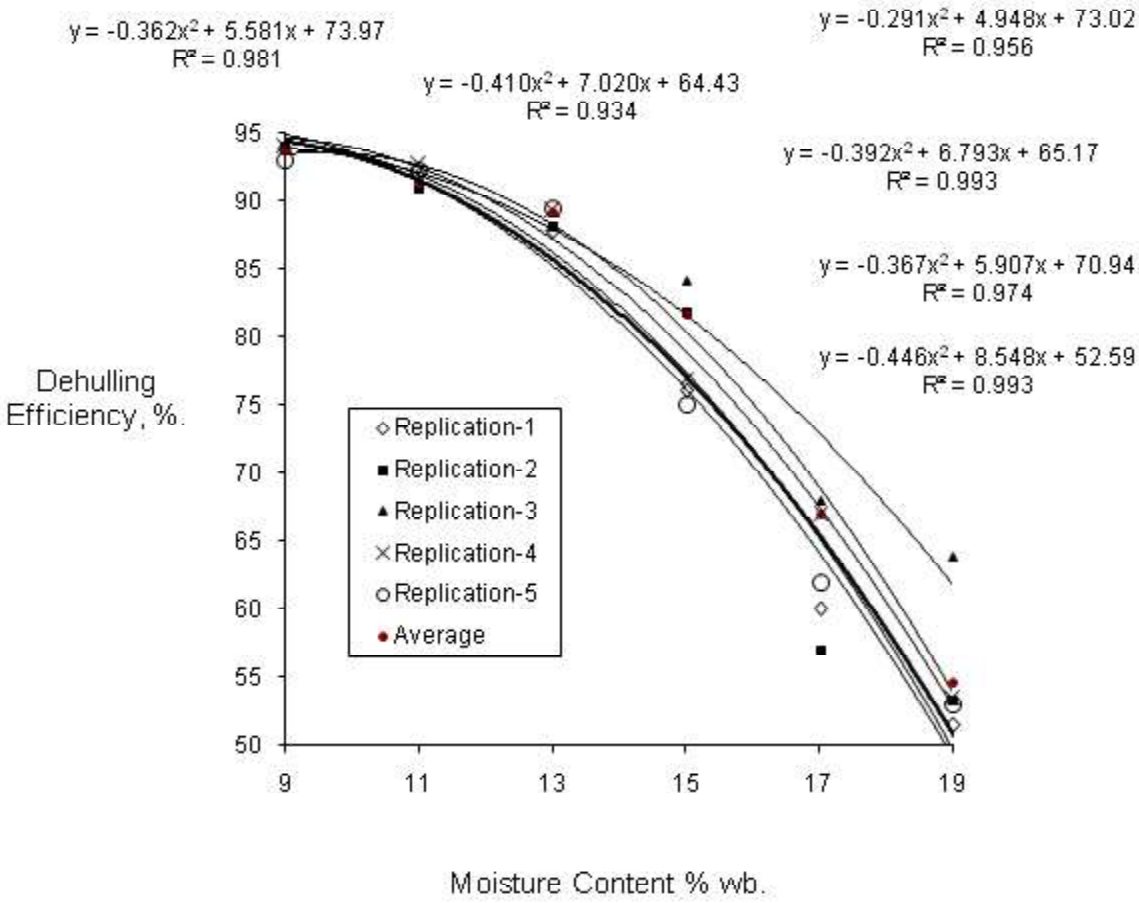

Fig.5 : Variation in Dehulling Efficiency with Moisture Content of Soybean

Capacity

The capacity of the soybean dehuller was calculated based upon the time taken by the machine to dehull the 2 kg of whole soybean. The feed rate of the machine obtain for 2 kg of soybean when express in terms of amount of soybean dehulled per unit of time in kg/hr gave the capacity of machine. The maximum capacity of machine was found approximately 96 kg/hr at 9% moisture content and minimum capacity was found to be about 19 kg/hr at 19% moisture content. This sharp decrease in capacity was mainly due to the fact that at higher moisture content. The feed rate was maintained at very low level because even a slight increase in feed rate resulted in the choking of the machine. This choking during dehulling at higher moisture content was mainly due to greater toughness, flexibility and fibrousness of the hull at high moisture content.

The feed rate has a strong negative association with the moisture content of soybean i.e. with the increase in moisture content feed rate decreases (Fig. 6). The second order polynomial shows the regression equation of feed rate on moisture content was calculated based on the method of least sum of squares using MS Excel and MS Office 2000. The Regression equation and R^2 value for different replication are tabulated

Replication No	Second Polynomial	R^2 Value

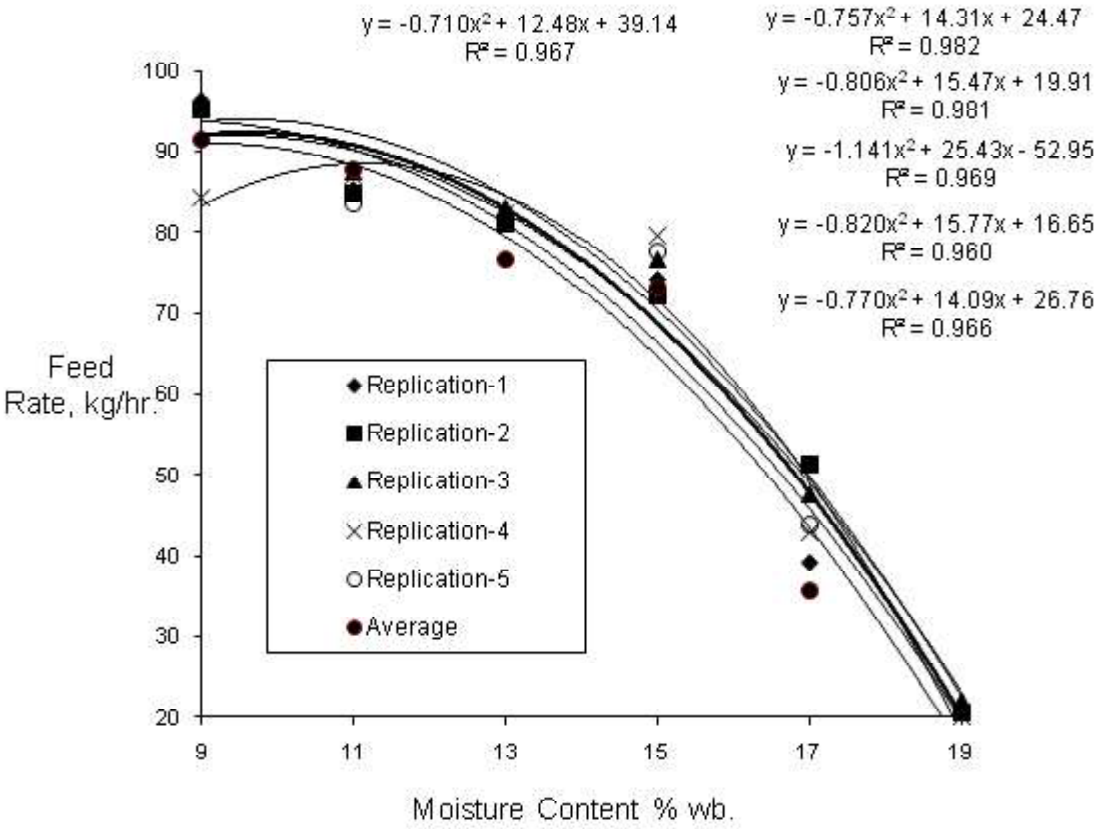

Fig. 6 : Variation in Feed Rate with Moisture Content

Soybean Samples of 5 kg each was prepared at different moisture content, the moisture level was increased by addition of measured amount of water and conditioning for 24 to 60 hrs. The five moisture levels selected 9, 11, 13, 15, 17 and 19% (w b). It was found that dal recovery increased with increase in moisture content. The mass of soybean passing out unhusked through the dehuller increased with increase in moisture content. This increase was very sharp after 15%(w.b) moisture content. The dehulling efficiency decreased with increase in moisture content. The rate of decrease becomes steeper after 15% moisture content (w b). The capacity of machine was found to be highest i.e. 96.2 kg/hr at 9% moisture level, and it decreased with increase in moisture content. The mathematical models were also developed to predict the correlation between different variables under study within the range of recorded observations.

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Physico-chemical evaluation of soy fortified vegetable warri based on blackgram and greengram

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Abstract

The present investigations were carried out in the Department of Food Science and Technology, College of Agriculture, JNKVV, Jabalpur (MP) during the year 2015-16. Soy fortified vegetable warri with blackgram and greengram contain good amount of protein, fiber and carbohydrate. Traditional food products are consumed and relished by all individuals in our country. Therefore, the present study was conducted on development of vegetables warri using various vegetables, soybean, black gram and green gram. SBP (soybean + blackgram + meshed potato) at the ratio of (48:32:20) was found to be the best formulated vegetables warri, rich in nutrients and had excellent consumer acceptability. Soy blended warri had higher amount of protein as compared to other vegetables supplemented warri. In case of nutrients without supplementation of vegetables. SB (soybean 40% + black gram 60%) was found o be more nutritious as compared to other formulated warri. The formulation of 20% vegetables shreds in warri had more overall acceptability and high fiber content than other formulated warri.

Kewords: Soy, warri, blend, organoleptic, sensory evaluation.

Warri a partially fermented legume based ready to fry product is manufactured on cottage scale. It is a legume savory, prepared from black gram or green gram dhal (Pruthi et al., 1983). Traditionally prepared wadi is relished in the form of curry. Very low moisture in instant vegetable warries off flavour emanating from oxidative degradation of lipids is major cause of reduced acceptability during storage. It is a hollow, brittle, ball or cone shaped popular traditional legume-based product of many countries in the Indian Subcontinent.

Blackgram (*Vigna mungo L*) is a pulse commonly used in Indian cuisine. It is mostly consumed as pulse and in preparation of typical Indian dishes like papad, idli, dosa and warri. Green gram is an excellent source of carbohydrates, proteins and minerals and its protein quality is similar to or better than other legumes, such as chickpea, blackgram, peas, pigeon pea (Jood el al., 1986). Vegetables contain high amount of known antioxidants such as polyphenols, vitamin C, vitamin E, carotene, and lycopene. The consumption of vegetables has been inversely associated with morbidity and mortality from degenerative disease. It is not known which dietary constituents are responsible for this association but antioxidants appear to play a major role in the protective effect of plant foods.

Ash gourd (*Benincasa hispida*) fruit is used in variety of Indian cuisines including the traditional sweet dish

'Petha' (Anonymous, 1962). Similarly, different parts of this fruit are extensively used in traditional Indian medicines for the treatment of insanity, epilepsy and such other nervous disorders. Further, it is also widely used for the treatment of diabetes, piles, dyspepsia etc (Nadkarni, 1982). Brinjal (*Solanum melongena L*) is highly productive and usually find its place as poor man's crop. Brinjal fruits are fairly good source of Ca, P, Fe, and vitamins particularly 'B' group. It is reported to stimulate the intrapeptic metabolism of blood cholesterol. Dry fruits are reported to contain goitrogenic principle. It has also got much potential as raw material in pickle making and dehydration Industries. Potato (*Solanum tuberosum L*) is a nutritious food. It contains practically all the essential dietary constituents, such as carbohydrate (22.6 g/100 g of edible portion), protein (1.6 g/100 g of edible portion) and minerals like calcium, phosphorus, iron and vitamins (B_1, B_2, B_6, and C). About 50% of the potato produced in the world is utilized as human food (Shekhawat, 2001). Soybean (*Glycine max*) is one of the important crops. It contains about 20 percent oil and 40 percent high quality protein (Gopalan *et al.*, 1996). It also contains a good amount of minerals and vitamins. It is used for making high protein food for children (American Soybean Association, 2004)

Supply of fresh vegetable to defense personnel in high altitude, snow bound areas during winter months is logistically difficult. Therefore easy to cook instant spiced vegetable warri may be useful for providing variety in the diet of troops deployed in these areas. Therefore it was thought to formulate and develop soy fortified vegetables warries made from pulses, soy flour, various vegetables and combination having good quality characteristics than other warri. Thus, the present investigation was planned to develop and evaluate soya fortified blackgram and greengram vegetable worries.

Material and methods

Food Commodities

Blackgram, greengram, soybean dal and vegetables (Ash gourd, potatoes and brinjal) were purchased from the J.N.K.V.V. farm Jabalpur.

Cleaning and grading- Firstly cleaned the pulses to remove the stones, dust particles and any other foreign materials from the grains.

Preparation of warri- Warries were prepared in the laboratory from soybean and blackgram and greengram which was soaked in excess of tap water for 6-12 hr at room temperature. The soaked splited grains were washed with water 3 times to remove frothing and ground in wet grinder to smooth paste. Soy paste, spices and freshly comminuted ash gourd, potato, and brinjal shreds were mixed thoroughly and small round 3-8 cm diameter warri were made and then placed directly on an oil smeared enameled tray at a distance of about 1-2 inches from one another and sun dried for 4-6 days. Dried warries were packed in packaging materials at ambient temperature (30± 2 °C RH 70%).

Development and standardization of soy fortified vegetable warri

Preliminary studies were conducted to standardize the formulation for the development of the different pulses and vegetable based warri. Fortified warries were prepared from different splits of soy, black gram, greengram and vegetable (ash gourd, potato, brinjal) using different combination (Table 1). Developed warries were subjected to sensory evaluations. On the basis of sensory analysis best combination of greengram and blackgram at the ratio of (48:32:20) was e best formulated vegetables warries had excellent consumer acceptability (Joshi *et al.*, 2017). Best formulations were subjected to various physical, functional and chemical analysis.

Table 1. Different combinations for preparation of soy fortified vegetable warri based on blackgram and greengram

Combinations	Soybean %	Blackgram %	Ash gourd shreds	Potato	Brinjal shreds
Soy fortified Ash gourd Warri					
SB (Control)	40	60	-	-	-
SBA-1	32	48	20	-	-
SBA-2	28	42	30	-	-
SBA-3	24	36	40	-	-
SBA-4	20	30	50	-	-
SBA-5	16	24	60	-	-
Soya fortified Potato warri					
SBP-1	32	48	-	20	-
SBP-2	28	42	-	30	-
SBP-3	24	36	-	40	-
SBP-4	20	30	-	50	-
SBP-5	16	24	-	60	-
Soy fortified Brinjal warri					
SBB-1	32	48	-	-	20
SBB-2	28	42	-	-	30
SBB-3	24	36	-	-	40
SBB-4	20	30	-	-	50
SBB-5	16	24	-	-	60

Physical and functional properties

Bulk Density: Bulk density was measured in triplicate by the method of Kinsella (1979).

Water absorption capacity (WAC): WAC was determined by the method given by Sosulski *et al.* (1976).

Cooking time: Cooking time was determined by the method given by Sharma *et al*. (1996).

Proximate analysis

Various chemical constituents such as moisture, crude protein, crude fat, crude fibre, carbohydrates and ash contents in the processed products were estimated by AOAC (1995) methods.

Estimation of Minerals

Mineral contents of warries were obtained by calculation using table values (Gopalan *et al.*, 1996). In this case, percentage mineral content was calculated based on the mineral content of different ingredients used in the development of the warri.

Results and Discussion

Physical and functional properties of soy fortified vegetables warri based on pulses

Bulk Density

The result of bulk density of soy fortified vegetables based on pulses (green and blackgram) made by supplementation of different blend of ash guard shreds, mesh potato and brinjal shreds in warri have given in table 2. Maximum bulk density was found in SBB (1.42 gm/ml) followed by SGP (1.28 gm/ml), whereas minimum was found in control SG (1.10 gm/ml) and SB (1.18 gm/ml). The data showed that the increased fortification ratio of soybean, green gram, black gram and shreds of ash guard, mesh potato and brinjal shreds increased the bulk density of warri. Although Kinsella (1976) reported the higher bulk density with processing treatments as compared to present finding.

Water absorption capacity

Water binding capacity plays an important role during reconstitution into the blend before consumption. Water binding capacity depends on the availability of hydrophilic groups that bind water molecules and on the gel forming capacity of macromolecules. It is evident from the tables 2 that maximum water absorption capacity was found in SBA (250 %) followed by control SB (240 %), whereas minimum was found in SGP (200 %). Water absorption capacity increased with increasing the blend ratio of pulses and vegetables. This might be due to incorporation of fiber or supplement of vegetables and pulses in soy fortified vegetables warri. These findings have been supported by Nicole *et al.* (2010) in soy and wheat flour based product.

Fat absorption capacity

The data presented in table revealed that the maximum fat absorption capacity was found in control SG (48 %) followed by SB (45 %) and SGA (43 %), whereas minimum fat absorption capacity was in SBP (35 %). The data showed that fat absorption capacity decreased with increasing the blend ratio of pulses and vegetables in soy fortified vegetables warri. This might be due to supplementation and denaturation of protein in warri. These finding have been supported by Kinsella (1976).

Cooking time

From the table 2, it was found that the maximum cooking time was observed in SGB (23 min) followed by SGA (22 min) whereas minimum cooking time observed in control SB (15 min) and SG (18 min). Soy fortified black gram brinjal warri samples had higher cooking time, which might be due to hardness and high fibre content of fortified warri. With increase in supplementation of vegetables the cooking time of the warri was increased, whereas increasing the supplementation ratio of cooked and meshed potato there was decrease in the cooking time. A similar finding have been reported by Sharma *et al.* (1996).

Table 2. Physical and functional attributes of soy fortified vegetable warri based on blackgram and greengram

Warri type	Treatment	Combi-nation	Bulk density (g/ml)	Water absorption capacity (%)	Fat abso-rption capacity (%)	Cooking time (minute)
Control	SB	40:60:00	1.18	240	45	15
	SG	40:60:00	1.10	210	48	18
Ash gourd warri	SBA	32:48:20	1.25	250	39	21
	SGA	32:48:20	1.18	230	43	22
Potato warri	SBP	32:48:20	1.26	220	35	18
	SGP	32:48:20	1.28	200	36	20
Brinjal warri	SBB	32:48:20	1.42	230	40	20
	SGB	32:48:20	1.20	220	38	23

Quality attributes

Moisture

As per the data obtained, maximum moisture content was found in SGA (11.63 %) followed by SGB (11.46 %), where as minimum moisture content was found in SBP (10.97 %) followed by control SB (11.14 %). The data showed that moisture content was increased with increasing the blend ratio of vegetables in all soy fortified warries. The moisture content increased due to high fibre content in soy fortified vegetables warri. Similar findings have been supported by Sharma *et al*. (1996)

Protein

Protein content decreased with increase in addition of different vegetables shreds in soy fortified warri. The table 3 showed that maximum protein content was found in control SG (33.60 %) followed by SB (30.37 %) whereas minimum protein content was found in SBP (25.74 %) followed by SBA (26.60 %). Protein content decreased with increase in supplementation of different vegetables shreds in warri. This could be due to the supplementation of vegetable shreds in soy fortified pulses based warries. These results are close agreement with Kulkarni *et al.* (1997) on storage of black and green gram warries.

Fat

The fat content in soy fortified warri was found maximum in SG (12.22 %) followed by SGB (10.50 %) whereas minimum fat content was found in SBP (6.98 %) followed by SBA (7.41 %). Fat content decreased with increase in the supplementation of vegetables in soy fortified vegetable pulses based warri. This may be due to supplementation of high fiber vegetables shreds. Similar findings have been supported by Sangeeta and Grewal (2006)

Ash

The maximum ash content of soy fortified warries was found in SBA (4.81 %) followed by SGA (4.11 %) whereas minimum ash content was found in SGP (3.04 %). The data showed that the ash content was increased with increase in the blend ratio of vegetables shreds. This might be due to supplementation of high fiber vegetables shreds. Similar findings have been supported by Akubour (2005).

Carbohydrate

The data showed that maximum carbohydrate content was found in SBP (50.43 %) followed by SGP (45.24 %) whereas minimum carbohydrate content was found in SG (36.50 %). The data showed that carbohydrate content decreased with increase in supplementation of ash guard and brinjal shred but in case of soy fortified potato warries carbohydrate content increased with increase in the blend ratio of mesh potato. This might be due to supplementation of vegetables in soy fortified warri. Similar findings have been supported by Umar *et al.* (2009)

Fibre

The data obtained showed that the fibre content was increased with increase in supplementation of different vegetables in soy fortified warri. Maximum fibre content was found in SGA (6.41 %) followed by SBA (5.87 %) whereas minimum fibre content was found in SBP (2.15 %). This might due to supplementation of vegetables in soy fortified warri. Similar findings have been supported by (Tandon and Singh, 1987)

Table 3. Quality attributes of soy fortified vegetable warri based on blackgram and greengram

Warri type	Treatment	Combination	Moisture	Protein	Fat	Ash	Carbohydrate	Fiber
Control	SB	40:60:00	11.14	30.76	8.64	4.14	42.98	2.34
	SG	40:60:00	11.36	33.60	12.22	3.27	36.50	3.02
Ash gourd	SBA	32:48:20	11.43	26.60	7.41	4.81	43.88	5.87
warri	SGA	32:48:20	11.63	28.88	10.27	4.11	38.70	6.41
Potato	SBP	32:48:20	10.97	25.74	6.98	3.73	50.43	2.15
warri	SGP	32:48:20	11.17	28.01	9.84	3.04	45.24	2.70
Brinjal	SBB	32:48:20	11.28	27.99	7.63	4.03	44.06	5.01
warri	SGB	32:48:20	11.46	30.26	10.50	3.34	38.88	5.56

Minerals

It is observed from the tables that soy formulated vegetables warri had different effect on the minerals content of supplementation of vegetables as compared to without supplemented vegetables.

Calcium

The calcium content of all control soy fortified black gram warri was found maximum SB (188.40 mg/ 100gm) followed by SG (174.00 mg/100gm) whereas minimum calcium content was found in SGP (141.20 mg/100gm). Calcium content decreased with increase in supplementation of vegetables in soy fortification. This may be due to supplementation of high fiber vegetables shreds. Similar findings have been supported by Dagadkhair *et al.* (2009).

Phosphorus

The phosphorus content decreased with increase in incorporation of different vegetables shreds in soy fortified warri. The table showed that maximum phosphorus content was found in all control soy fortified warries based on green gram SG (576.40 mg/ 100gm) followed by SB (507.00 mg/100gm) whereas minimum phosphorus content was found in SBA (409.00 mg/100gm) soy fortified ash guard based black gram warri. Phosphorus content decreased with supplementation of different vegetables shreds

in warri. This could be due to the supplementation of vegetables shreds in soy fortified pulses based warri. These results are closed by Visalakshi and Mohansundari (2002).

Iron

The maximum iron content was found in all control soy fortified green gram warri SG (7.80 mg/100gm) followed by SB (6.44 mg/100gm) whereas minimum iron content was found in SBB (5.22 mg/100gm). The data showed that iron content was decreased with increase in the blend ratio of vegetables in all soy fortified warri. The iron content decreased due to high fibre content in soy fortified vegetables warri. Similar finding have been supported by Semwal *et al.* (2000).

The data showed that the K, Na, Cu, Zn and Mg contents in general decreased in all the developed soy fortified vegetables warri. Mineral composition of developed soy fortified vegetables warri based on pulses indicated that fortification of vegetables shreds with different supplements at different levels decreased the mineral content in developed warri.

Table 4. Mineral content of soy fortified vegetable warri based on blackgram and greengram

Warri type	Treat ment	Combi-nation	Calcium	Phosphorus	Minerals mg /100g warri (dry weight)					
					Iron	Potassium	Sodium	Copper	Zinc	Magnesium
Control	SB	40:60:00	188.40	507.00	6.44	480.00	23.88	1.11	3.56	148.00
	SG	40:60:00	174.00	576.00	7.80	460.00	10.88	0.98	3.76	153.80
Ash gourd warri	SBA	32:48:20	156.72	409.60	5.31	384.00	19.10	0.88	2.84	118.40
	SGA	32:48:20	145.20	464.80	6.40	368.00	8.70	0.78	3.00	123.04
Potato warri	SBP	32:48:20	152.72	413.60	5.24	433.40	21.30	0.92	2.95	124.40
	SGP	32:48:20	141.20	417.40	468.80	10.90	6.33	0.81	3.11	129.04
Brinjal warri	SBB	32:48:20	154.32	424.00	415.00	19.70	5.22	0.91	2.89	121.40
	SGB	32:48:20	142.80	408.00	470.20	9.30	6.31	0.81	3.05	126.04

Conclusion

On the basis of findings it was concluded that soy fortified 20% (mesh potato) vegetables warri based on pulses could be considered the best from both nutritional and sensory quality point of view. The soy fortified vegetables warri at ratio of 32:48:20 with soybean + pulses (black gram and green gram) +vegetables (ash guard, potato, brinjal) were found good is term of organoleptic properties. Supplementation of soybean and pulses increased the amount of nutrient in warries. Hence it was concluded that low cost high fiber nutritious warries could be developed.

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Quality attributes of instant upma mix from foxtail millet semolina and soy grits

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Abstract

The present work is designed to study the physicochemical, functional and shelf life studies of instant upma mix. The developed upma mix exhibited moisture 7.22 to 8.40%, protein 11.24 to 13.24%, fat 7.26 to 8.50%, crude fibre 1.50 to 7.65%, ash 2.12 to 3.98%, carbohydrate 59.83 to 69.48% and energy value 367.10 to 388.22 Kcal/100 g. The calcium content in instant upma mix varied from 26.85 to 41.00 mg / 100g, phosphorus 130.85 to 295 mg/100g and iron 1.91 to 2.89 mg/100g. All instant upma mix prepared from foxtail millet semolina and soy grits were nutritionally superior in terms of protein, fibre, ash and minerals i.e., calcium, phosphorus and iron. Bulk density was increased from 0.74 to 0.80 g/ml in instant upma mixes. In Hunter colour analysis the L* value was decreased with increased level of foxtail millet semolina. The functional attributes i.e, the water absorption capacity was increased from 222 to 234 ml/100 g and fat absorption capacity increased from 198 to 228 ml/100 g with increased level of foxtail millet. Best accepted instant upma mix along with control sample were stored in LDPE, PP and aluminium foil pouches and evaluated for shelf life. These samples are found stable for 2 months at ambient conditions in aluminium foil pouches as compare to LDPE and polypropylene.

Key words: Foxtail millet semolina, Soy grits, Instant upma mix, Proximate composition, Physical attributes, Functional attributes, Storage studies.

Upma is a traditional Indian breakfast dish, cooked as a thick porridge from dry roasted semolina. Various seasonings and vegetables are often added during cooking depending on individual preferences. Semolina is a gritty, coarse particle of wheat obtained after bolting the flour. Because of its versatility, semolina is a popular ingredient both in Asian and Western cuisines. Semolina from foxtail millet could be a new product from small millets, which can offer inherent health benefits associated with foxtail millet for the consumer and can also open up better avenues for utilization of millet products (Dharmaraj et al., 2016).

Foxtail millet (Setaria italica) is cheaper and nutritional comparable or even superior of major cereals, especially with respect to protective nutrient. It is a good source of protein (12.3 g/100 g), dietary fibre (14 g/100 g), moderate carbohydrate (60.9 g/100 g), rich in minerals (3 g/100 g) and ß carotene (126-191 μg/100 g) (Goudar et al., 2011). Apart from the major nutrients, it is a good source of tocopherols and exhibits good antioxidant potential (Chandrasekhara and Shahidi, 2012).

Soybean is significantly known not only for its nutrient content but also for its health related benefits and it is usually identified as a 'Miracle golden bean'. On average, dry soybean contains roughly 40% protein, 20% oil, 35% soluble (sucrose, raffinose, stachyose, etc.) and insoluble carbohydrate, dietary fibre and 5.0% ash (Liu, 2004).

Foxtail millet has not exploited for the preparation for semolina and its utilization in the preparation of instant upma mix. Therefore, the

present investigation was undertaken to develop instant upma mix by incorporating soybean and foxtail millet and analyze its various quality parameters.

Materials and methods

Foxtail millet (*Seteria italica*) procured from Regional Agricultural Research Station, All India Coordinated Research Project on Small Millets, College of Agriculture, Rewa. Wheat semolina and soybean (*Glycine max*) were procured from the local market of Adhartal, Jabalpur.

Preparation of foxtail millet semolina

The de-husked foxtail millet was converted into semolina (grits) using a flour mill by adjusting clearance between the rotating discs and the obtained semolina was passed through flour sieve to get flour free semolina of uniform size.

Preparation of soy grits

Soybean grains were thoroughly cleaned to remove the dust and other foreign materials. The cleaned grains were soaked in water for 6-8 hours and autoclaved for 20 minutes to remove the beany flavour and as well as to enhance easy de-hulling. The autoclaved beans were cooled and dried at 60^0C for about 24 hours. The dried beans were milled to make soy grits and sieved through 80 - 100 mesh sieve to separate soy flour (Ajibola and Filani, 2015).

Drying of spices

The fresh coriander and curry leaves were washed under tap water and dried in hot air oven at 65°C for 6-7 hrs. Fresh green chilli and ginger were also washed, chopped into small pieces and dried in oven at 65°C.

Different formulations of instant upma mix

Instant upma mixes prepared by substituting foxtail millet by replacing wheat semolina and black gram by soy in different proportion of foxtail millet, wheat semolina and soy (UM2-75:20:5, UM3-65:30:5, UM4-55:40:5, UM5- 45:50:5, UM6-95:0:5) respectively. The control sample was prepared by using 95% semolina and 5% black gram dal (UM1).

Preparation of instant upma mix:

In this method, the foxtail millet semolina, soy grits and wheat semolina were roasted separately in non-stick pan on slow flame with constant stirring till it started to give characteristic aroma and colour of a cooked product. All ingredients were mixed properly, then oil (10 ml) was heated in a pan and mustard seeds (0.50 g) were fried, after that roasted ingredients were added in a pan and mixed properly with oil. Salt (3 g), citric acid (0.10 g), tartaric acid (0.10 g), dried green chilies (0.50 g), curry leaves (0.30 g), ginger (2 g), coriander leaves (0.20 g) were also added to the pan. The samples were cooled and packed in polyethylene pouches and stored at ambient condition.

Physical attributes of instant upma mix

Colour measurement of different instant upma mixes as well as upma prepared from it was done by using a Hunter colour measuring system and expressed in terms of L*, a*, b*, according to the CIE method (1976). L* represents the brightness from white (100) to black (0). Red to green colour component was indicated by the a* values and yellow to blue colour components were indicated by the b* values. The apparent (bulk) density was calculated and expressed in g/ml as per method of Jones *et al.* (2000).

Proximate composition of instant upma mix

The moisture content of the sample was determined using moisture meter, protein content by conventional Micro-Kjeldhal digestion and distillation procedure as given in AOAC (2007) using Pelican's Kel Plus digestion and distillation assembly. The fat, ash and crude fibre content of the sample was determined by the procedure as described in AOAC (2007) using Sox plus automatic fat analysis system, Muffle furnace & automatic fibre analysis

system (Make-Pelican) respectively. Total carbohydrate was estimated by subtracting the sum of moisture, protein, fat, ash and crude fibre from 100 (Merrill and Watt, 1973). The total energy value (Kcal) was calculated by using the Atwater factor method [(9 x fat) + (4 x carbohydrate) + (4 x protein)] as described by Nwabueze (2007). Mineral contents of different upma mixes were obtained by calculation using table values (Gopalan *et al.,* 1996).

Functional attributes of instant upma mix

Fat absorption capacity was measured by the method of Sosulski et al. (1976) and water absorption capacity was measured by the method of Sosulski *et al.* (1962).

Statistical analysis

The data obtained from various experiments were statistically analyzed. A complete randomized design was adopted for statistical analysis of data by following the procedure as described by Panse and Sukhatme (1963).

Storage studies

The storage stability of instant upma mix was carried out using low density polyethylene (LDPE), polypropylene (PP) and aluminium foil pouches for a period of 2 months at ambient conditions. All samples were drawn periodically after 0, 30, 60 days and analyzed for overall acceptability, moisture, free fatty acid and peroxide value. Free fatty acid was determined as per the method of AOAC (2007) and peroxide value in stored samples was estimated by the method of Ranganna (1986).

Results and Discussion

Physical attributes of instant upma mix

Bulk Density

The bulk density of instant mixes ranged from 0.74 to 0.80 g/ml. Significantly lower bulk density was observed in UM1 whereas highest was observed in UM6 of instant upma mix. Bulk density of instant upma mix was increased as compared to control sample. Similar result reported by Adegunwa *et al.* (2014) in millet-wheat composite chinchin, Nazni and shobana (2016) reported that 0.53 g/ml bulk density for roasted foxtail millet.

Hunter colour analysis of instant upma mix

Colour of the food is the first parameter of quality evaluated by consumers. In instant upma mix showed in Table -1, the highest value of lightness (66.71) in UM1 while the lowest value (61.83) was obtained from UM6. The highest a* (5.18) and b* (28.17) values of upma obtained from UM5 and UM1 respectively and lowest from UM3 (3.26, 23.80) respectively.

Table 1: Physical attributes of instant upma mix

Formula-tions	Hunter Colour Analysis			Bulk Density (g/ml)
	L*	a*	b*	
UM1	66.71	5.11	28.17	0.74
UM2	63.21	4.06	24.79	0.79
UM3	64.21	3.26	23.80	0.77
UM4	64.84	3.86	24.74	0.75
UM5	65.72	5.18	26.94	0.76
UM6	61.83	4.61	25.62	0.80

Functional attributes of instant upma mix

Water absorption capacity

As can be depicted from the Table - 2, that in instant upma mix the WAC ranged from 222 to 234 ml/100 g. The water absorption capacity was found to be maximum in formulation UM6 containing higher amount of foxtail millet i.e., 95%. Similar, results were reported by Adegunwa *et al.* (2014) in millet-wheat composite chinchin. Higher water absorption by the millet flour compared to control (refined wheat flour) can be related to the high water absorption capacity of millets as reported by Karuppasamy *et al.* (2013).

Fat absorption capacity

The value of fat absorption capacity in instant upma mix ranged from 198 to 228 ml/100 g. Increased in foxtail millet semolina in instant upma mix shows the decrease in fat absorption capacity. The similar result was reported by Thilagavathi *et al.* (2015) for millets and contrast result reported by Kamara *et al.* (2009) with regards to defatted foxtail millet flour. Variation in fat absorption may be due to the variation in protein concentration, degree of interaction with water and oil and conformational characteristics (Bhatt and Batool, 2010).

Table 2: Functional attributes of instant upma mix

Formulations	Water absorption capacity (ml/100 g)	Fat absorption capacity (ml/100 g)
UM1	225	228
UM2	230	218
UM3	228	220
UM4	224	222
UM5	222	226
UM6	234	210

Proximate analysis of instant upma mix

The proximate composition of instant upma mix was showed in Table - 3. Moisture content varied from 7.22 to 8.40, protein 11.24 to 13.24 percent, fat 7.26 to 8.50 percent, crude fibre 1.50 to 7.65 percent, ash 2.12 to 3.98 percent, carbohydrate 59.83 to 69.48 percent. The range of energy value was found to be 367.10 to 388.22 Kcal/100 g. The fibre content was increased with increased supplementation of foxtail millet. Similar findings were reported by Poongodi *et al.* (2010) with regard to millet flour blend. The fat content was increased with increased supplementation of soy grits as well as addition of oil used for the preparation of instant upma mix. The overall nutritional quality of instant upma mix with substitutions of foxtail millet semolina was higher than control sample. Similar results were reported by Sambavi *et al.* (2015) who developed cookies using a combination of foxtail millet and wheat flour and Punia *et al.* (2003) prepared ladoo and shankarpara from foxtail millet. Chithra and Sathiya (2008) reported remarkable increase of protein and fibre content in soy incorporated adai, oothapam, pancake, vermicelli upma and vegetable biryani. The moisture content was decreases as the rate of millet substitution increases.

Table 3: Proximate analysis of instant upma mix

Formula-tions	Moisture (%)	Ash (%)	Crude fibre (%)	Protein (%)	Fat (%)	Carbohydrate (%)	Energy value (Kcal/100)
UM1	8.40	2.12	1.50	11.24	7.26	69.48	388.22
UM2	7.65	3.82	6.24	13.24	8.40	60.65	371.16
UM3	7.68	3.74	5.32	12.55	8.36	62.35	374..84
UM4	7.74	3.68	4.52	12.50	7.60	63.96	374.24
UM5	8.15	3.56	3.80	12.41	7.32	64.76	374.36
UM6	7.22	3.98	7.65	12.82	8.50	59.83	367.10
SEM	0.025	0.010	0.034	0.048	0.041	0.020	0.025
CD at 5%	0.081	0.034	0.109	0.151	0.131	0.044	0.079

Mineral analysis

As can be seen from the Table - 4, the calcium content in instant upma mix varied from 26.85 to 41.00 mg/100g, phosphorus 130.85 to 295 mg/100g and iron 1.91 to 2.89 mg/100g. An appreciable amount of calcium, iron and phosphorus content were found in all instant mixes. The supplementation of foxtail millet semolina and soy grits increases the phosphorus, calcium and iron content in instant mixes. This is in close agreement with a previous study by Ravindran (1991), Karuppasamy *et al.* (2013) and Reema *et al.* (2006) with regards to studies on millets, quality characteristics of bread from kodo, little and foxtail millets and germinated cereals and legumes respectively. Bhag *et al.* (2010) reported that millets are nutritionally characterized by high micronutrient content, particularly calcium and iron than all other major cereals.

Table 4: Mineral composition of instant upma mix (mg/100 g)

Formulations	Calcium	Phosphorus	Iron
UM1	26.85	130.85	1.91
UM2	38.30	267.65	2.87
UM3	35.25	250.23	2.73
UM4	34.52	233.71	2.6
UM5	33.40	218	2.58
UM6	41.00	295	2.89

Storage studies

Moisture

The moisture found to be 8.40 at initial stage and further increased up to 8.50 in P1UM1, 8.48 in P2UM1 and 8.55 in P3UM1. In modified instant upma mix initially it was 7.68 and increased up to 7.73 (P1UM3), 7.72 (P2UM3) and 7.74 (P3UM3). The selection of packaging materials and storage conditions are thus justified as aluminium foil had better result as compare to low density polyethylene and polypropylene for moisture content of the product. Moisture pick up at higher relative humidity has been reported by (Tiwari *et al.*, 2009) for rice based snack product.

Free fatty acid of instant upma mix

The initial value of free fatty acid in instant upma mix (control) was 0.26 and increased up to 0.35 for P1UM1, 0.33 for P2UM1 and 0.35 for P2UM1 whereas in modified instant upma mix it was 0.29 to 0.32 for P1UM3, 0.30 for P2UM3 and 0.34 for P3UM3 at the end of storage. All the packaging materials showed increase in free fatty acid during the storage period but the highest increase was observed in low density polyethylene and polypropylene while the lowest increase was observed in aluminium foil pouches. Contrast result reported by Balasubramanian et al. (2014) with regard to upma mix prepared using pearl millet semolina.

Peroxide value of instant upma mix

The peroxide value of instant upma mix (control) was from 3.7 meq/kg to 8.90 meq/kg in P1UM1, 8.50 meq/kg in P2UM1 and 9.10 meq/kg in P3UM1 for whereas in modified upma mix it increased from 3.4 meq/kg to 10.25 meq/kg in P1UM3, 10.20 meq/kg in P2UM3 and 11.00 meq/kg in P3UM3 at the end of storage. The rate of increase in peroxide value during storage was lower in aluminium foil pouches when compared to low density polyethylene and polypropylene. The low PV observed in aluminium foil indicates that it could be used better by limiting fat peroxidation. Food with high PV could be harmful to human health due to the free radicals that can be generated in the oxidative process (Tagoe *et al.*, 2012). Similar results were found by Lohekar *et al.* (2014) in instant dhokla mix stored in laminated aluminium pouch. Peroxide value was significantly increased after storage period.

Overall acceptability of instant upma mix

The overall acceptability was decreased from 8.9 to 8.70 for P1UM1, 8.78 for P2UM1 and 8.75 for P3UM1. The overall acceptability for best formulation in sensory

analysis mix was decreased from 8.20 to 8.12 for P1UM3, 8.14 for P2UM3 and 8.10 for P3UM3 on 60th day of storage. Instant mix stored in aluminum foil had better result with regards to overall acceptability as compared to low density polyethylene and polypropylene. The highest mean scores for overall acceptability was found in aluminum foil on 60th day of storage.

Table 5: Shelf life of instant upma mix

Parameters	Formulations	0 days	30 days	60 days
Moisture %	P1UM1	8.40	8.45	8.50
	P2UM1	8.40	8.42	8.48
	P3UM1	8.40	8.52	8.55
	P1UM3	7.68	7.70	7.73
	P2UM3	7.68	7.69	7.72
	P3UM3	7.68	7.70	7.74
Free fatty acid (%Oleic Acid)	P1UM1	0.26	0.32	0.35
	P2UM1	0.26	0.30	0.33
	P3UM1	0.26	0.33	0.35
	P1UM3	0.29	0.31	0.32
	P2UM3	0.29	0.30	0.30
	P3UM3	0.29	0.33	0.34
PV (meq. of O2/kg Fat)	P1UM1	3.7	5.5	8.90
	P2UM1	3.7	4.5	8.50
	P3UM1	3.7	5.6	9.10
	P1UM3	3.4	8.5	10.25
	P2UM3	3.4	7.9	10.20
	P3UM3	3.4	8.8	11.00
Overall acceptability	P1UM1	8.90	8.80	8.70
	P2UM1	8.90	8.85	8.78
	P3UM1	8.90	8.83	8.75
	P1UM3	8.20	8.15	8.12
	P2UM3	8.20	8.15	8.14
	P3UM3	8.20	8.11	8.10

P1- Low Density Polyethylene, P2-Aluminium foil pouches, P3- Polypropylene

Control- UM1 Best formulation in sensory analysis- UM3

Conclusion

Foxtail millet semolina and soy grits can be successfully utilized to prepare several ready-to-eat use and ready-to-cook food products. The fibre, protein, ash, calcium and iron content of modified upma were higher than control samples (wheat semolina+black gram). The shelf life studies indicated that the instant upma mixes were acceptable up to 2 months of storage at ambient condition in aluminium foil packaging.

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Production and utilization of microbial pigments in processed food

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Abstract

The present investigation was conducted with the objectives of optimization of blending carbon and nitrogen sources for maximum yield of microbial pigments, sensory quality evaluation of the processed products incorporated with synthesized pigments and shelf life quality assessment of value added processed food products under varied storage conditions. The findings regarding sensory quality evaluation of the processed products (jellies and sugar candies) incorporated with synthesized microbial pigments, both the processed food products (jellies and sugar candies) were found to be acceptable with respect to their colour, flavour, texture, taste and overall acceptability. Regarding shelf life quality assessment of value added processed food products jellies and sugar candies incorporated with synthesized microbial pigment, This investigation revealed that both processed products viz. jellies and sugar candies did not show any adverse effect and found acceptable throughout the storage period, irrespective of the storage conditions and type of containers used for packaging. Between the two packages processed products packed in glass containers were slightly superior to those packed in PVC containers.

Key Words : Microbial Pigments, Processed Food, *Monascus purpureus,* Fungi, Shelf life

In food processing industry, the attractive colorants are usually used to increase the food consumption (Babitha *et al.*, 2006). But with increasing health and environment concerns, colours from natural sources are preferred over synthetic colours. Natural pigments and colorants are extracted from plants, animals, and microorganisms. Microbial pigments have an advantage over other sources as it can be produced rapidly under controlled physico-chemical conditions (Carvalho *et al.*, 2007). Many microorganisms have the ability to produce pigments, including species of the genera *Monascus, Cordyceps, Streptomyces, Phattia, Torula* and *Penicillium* (Gunasekaran and Poorniammal, 2008). *Monascus* pigments are used as food colorants and flavouring agents (Hajjaj *et al.*, 2003). Monascus is able to produce strong red pigment including some useful primary metabolites such as ethyl alcohol, acids, esters, and other flavouring compounds and secondary metabolites i.e. pigments, lovastatin (monacolin), and antimicrobial agents (Hsu et al., 2010; Kono and Himeno, 1999). *Monascus* pigments are safe as well as preferable due to their high affinity towards proteins, thermal stability and stability over a wide range of pH (Zhou *et al.*, 2008).

Colour of food is a vital visual parameters used for assessing quality of food. Bright and appealing colour of processed food product leads to development of temptation for consumption of food, whereas dull and poor colouration of food products leads to feeling that food may not have been properly processed or it may have spoiled. Hence, in order to make food product more attractive and appealing, food colourants are used on large scale in industrial as well as in home made foodstuffs. These food colourants are mostly synthetic in nature. Synthetic food colourants like

sunset yellow, orange, lemon yellow, rasberry red etc. are the blends of chemicals like tartrazine, carmosine, sodium chloride, sodium sulphate etc. However, these permitted synthetic colourants have shown to cause allergies. Moreover, these synthetic dyes are also reported to have potential carcinogenicity and teratogenicity (Babitha *et al.* 2009). Since many kind of synthetic dye stuffs have been found to be hazardous to human health, only a limited kind of such dye stuffs are permitted to be used in many countries and therefore, there is a need to develop alternative sources of natural colourants . Natural colourants can be obtained from plants and microbial sources. The colourants obtained by microbial species provide advantage over colourants obtained by plant sources as they are stable under varied conditions of pH, temperature, duration of storage etc.

Pigments extracted from *Monascus purpureus,* a xerophillic fungi, seems to be promising alternative to synthetic colours. *Monascus* species have been used in East Asian countries like China, Japan, Thailand etc. for making red coloured fermented rice called "angkak' which is further used in making red wine, red soya, cheese for over a long time ago. New food applications like colouration of processed meat (Sausages, Ham), marine products like fish paste, surimi have also been reported (Fabre *et al.* 1993). Pigments extracted from *Monascus purpureus,* a xerophillic fungi, seems to be promising alternative to synthetic colours. *Monascus* species have been used in East Asian countries like China, Japan, Thailand etc. for making red coloured fermented rice called "angkak' which is further used in making red wine, red soya, cheese for over a long time ago. New food applications like colouration of processed meat (Sausages, Ham), marine products like fish paste, surimi have also been reported (Fabre *et al.* 1993). Pigments produced from Monascus fungi can be distinguished into atleast six different pigment groups : two yellow coloured, (ankaflavin and monacin) : two orange coloured (rubropunctatin and monascorubrine) and two red coloured (rubropunctamine and monascorubramine).

The production of pigments from *Monascus purpureus* can be achieved by two methods - submerged fermentation and solid state fermentation (Hammano and Kilikian, 2006). Keeping in view the above fact this research work was planned with the objectives to Optimization of blending carbon and nitrogen sources for maximum yield of microbial pigment., Sensory quality evaluation of processed food products incorporated with synthesized pigments and Shelf life quality assessment of value added processed food product under varied storage conditions. *Monascus* pigment is also reported for antibacterial activity (Neeraja *et al.,* 2017) Microbial pigments are preferred as natural colour source by persons (Tuli *et al.,* 2015)

Materials and methods

The present investigation entitled "Production and utilization of mircobial pigments in processed foods " was conducted in the Fermentation Technology Laboratory of Biotechnology Centre, JNKVV, Jabalpur, with the objectives of optimization of blending carbon and nitrogen sources for maximum yield of microbial pigments, sensory quality evaluation of the processed products incorporated with synthesized pigments and shelf life quality assessment of value added processed food products under varied storage conditions. In the first part of this investigation on optimization of blending carbon and nitrogen sources for the maximum yield of microbial pigments, various combinations viz. RB : CSOC, RB : MOC, WB : CSOC and WB : MOC in different ratios (1 : 1 and 2 : 1) were analysed in order to know the best substrate combination for obtaining maximum yield of microbial pigments. In the second part of this investigation on sensory quality evaluation of the processed products (jellies and sugar candies) incorporated with synthesized microbial pigments, the most efficient blend of carbon and nitrogen

sources was used for fermentation using *Monascus purpureus* so as to obtain maximum yield of pigments. In the last part of the investigation on shelf life quality assessment of value added processed food products, jellies and sugar candies incorporated with synthesized microbial pigment were packed in two different types of packaging materials namely glass containers and PVC containers.

Rice Bran (RB), Wheat Bran (WB), Mustard Oil Cake (MOC) and Cotton Seed Oil Cake (CSOC) were used as substrate and procured from local market of Jabalpur city. Mustard Oil Cake (MOC), Cotton Seed Oil Cake (CSOC) was ground to fine powder using an electrical grinder to pass through 40 mesh size sieve. The substrates were later packed in air tight glass bottles and stored at room temperature condition. The substrates were further used as carbon and nitrogen sources as and when required for conducting experiments. The microbial pigment producing micro-organism (strain) *Monascus purpureus* MTCC 410 (Fig.01) was obtained from Institute of Microbial Technology (IMTECH), Chandigarh, Punjab.

Results and Discussion

Data presented in Table 01 showed that among all the combinations, blending of RB : CSOC in 2 : 1 ratio, resulted in the highest total pigment yield of 117.6 OD units/g dry mouldy biomass, comprising of 39.2 for yellow, 38.4 for orange and 40.0 OD units/g dry biomass for red pigment. However, the same combination of RB : CSOC in 1:1 ratio showed the total pigment yield of 77.0 OD units/g dry weight of mouldy biomass comprising of 40.7 for yellow, 19.8 for orange and 16.50 OD units/g dry mouldy biomass for red pigment fraction.Different observations made on yield of microbial pigments obtained from blending different combinations of carbon and nitrogen rich sources viz. RB : CSOC, RB : MOC, WB : CSOC and WB : MOC in the ratio of 1 : 1 and 2 : 1 . Data obtained from observations showed that among all the combinations, blend of RB : CSOC in ratio 1 : 1 gave the maximum total pigment yield of 572.9 OD units/g dry biomass, comprising of 178.1 for yellow, 175.6 for orange and 174.6 OD units/g dry biomass for red pigment fraction as extracellular pigments, whereas for intracellular pigments yield comprised of 35.4 for yellow, 5.0 for orange and 4.2 OD units/ gm dry biomass for red pigment. Some reports have also published in the literature showing additional carbon sources increased the pigment production (Wong *et al.*, 1981).

The observations on the mean score values of various sensory quality attributes for jellies and has been presented in Table 02 It is evident from the data that jellies prepared by incorporating red pigment were found acceptable with mean score values ranging from 8.3 to 8.6. The mean score values for jellies made by incorporating yellow pigment were 8.3, 8.4, 8.2, 8.1 and 8.2 for colour, flavour, texture, taste and overall acceptability. In a study conducted by Fabre *et al.* (1993), the sensory profiles based on sensory evaluation conducted on meat products incorporated with *Monascus* extracts showed that product with *Monascus* colourants enhanced flavour according to the amount of colourant extract incorporated. It was reported that the flavour enhancing may be due to precursors linked with glutamate which is a flavour enhancer. In addition to the possibility of increasing flavours, Sensory characteristics viz. colour, flavour, texture, taste and overall acceptability of sugar candies prepared from incorporation of microbial pigments were assessed by a panel of judges. The observations on the mean score values of various sensory quality attributes for sugar candies has been presented in Table 03 From the recorded observations, it is clear that sugar candies prepared from yellow pigment were found acceptable with the mean of overall acceptability of 8.3. The data on mean score values of overall acceptability of differently packed (glass containers and PVC containers) sugar candies incorporated with

synthesized microbial pigments stored for a period of 4 weeks under two different storage conditions (room condition and refrigerated condition) have been presented in Table 04 and 05 . The data recorded showed that the mean score values were slightly decreased with the advancement in storage period, although the sugar candies did not show any adverse effect and were found acceptable irrespective of the storage conditions and type of packages used in the experiment. It is clear from the recorded observations (Table 06 &07) that the values of 'L' (lightness) and 'b' (brightness) of differently packed and stored jellies showed increasing trend in values with the advancement in storage period. On the other hand, the observations on parameter 'a' (Absorbance) indicated that the values were recorded in decreasing order with the advancement in storage period of 4 weeks. The observations also revealed that the trends of parameters L, a, and b during the storage period were found t be the same irrespective of the storage condition, type of packages and pigment type. Data presented in Table 08 & 09 obtained by recording the observations of pigment incorporated sugar candies on Hunter Lab. (Colour spectrophotometer revealed that the lightness (L) and brightness (b) value of the stored product increased with the increase in storage period. However, the obserbance ('a') values were found to decrease with the advancement in storage period of the differently packed and stored products. The findings recorded in these experiments also revealed that the trends of L, a and b values during the storage of 4 weeks were found to be similar irrespective of the storage conditions, type of packages and pigment type. Various other workers have also reported the similar findings on the stability of pigments in other products (Fabre *et al.*, 1993, Ng *et al.* 2004, Boranova *et al.*, 2008).

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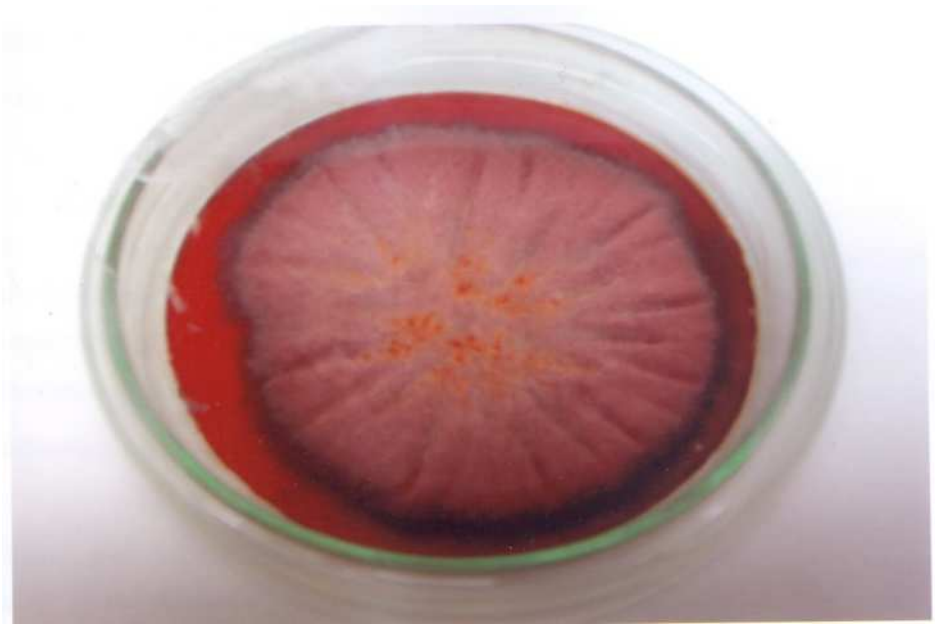

Fig: 01: Culture Plate of Strain Monascus purpureus MTCC 410

Table 01: Optimization of blending different carbon and nitrogen sources for maximum yield* of microbial pigments in solid state fermentation (SSF)

Combination of Substrates	Ratio of Combination	Yield of Pigment (O.D. Unit/g of dry mouldy biomass)			Total Yield of Pigments (O.D. Unit/g dry mouldy biomass)
		375 nm (Yellow)	475 nm (Orange)	500 nm (Red)	
RB : CSOC	1 : 1	40.7	19.8	16.5	77.0
	2 : 1	39.2	38.4	40.0	117.6**
RB : MOC	1 : 1	36.0	17.8	14.4	68.2
	2 : 1	36.9	17.4	17.9	72.2
WB : CSOC	1 : 1	27.3	14.7	11.0	53.0
	2 : 1	29.6	5.2	3.7	38.5
WB : MOC	1 : 1	30.0	18.5	13.3	61.8
	2 : 1	29.3	6.7	5.3	41.5

* Values are average of triplicates.

** Highest value

Initial moisture: 55%, Incubation temperature: 30° C, Incubation period: 12 days (288 hrs)

Table 02: Mean score values of sensory characteristics of jellies incorporated with different extracted pigments (yellow, orange and red).

Type of pigment used	Colour	Flavour	Texture	Taste	Overall acceptability
Yellow	8.3	8.2	8.2	8.1	8.2
Orange	8.4	8.1	8.4	8.5	8.4
Red	8.6	8.3	8.3	8.4	8.5
SEm ±	0.05	0.06	0.05	0.06	0.04
C.D. 5%	0.11	0.13	0.11	0.12	0.09

Table 03: Mean score values of sensory characteristics of sugar candies incorporated with different extracted pigments (yellow, orange and red).

Type of pigment used	Colour	Flavour	Texture	Taste	Overall acceptability
Yellow	8.4	8.3	8.2	8.1	8.3
Orange	8.5	8.3	8.4	8.3	8.4
Red	8.6	8.5	8.5	8.6	8.6
SEm ±	0.03	0.04	0.09	0.06	0.05
C.D. 5%	0.07	0.09	0.11	0.12	0.11

Table 04: Mean score values of the overall acceptability of differently packed jellies incorporated with synthesized microbial pigments stored for period of 4 weeks under room condition (30-40^0 C)

Jellies incorporated with pigment packed by containers	Storage period (Weeks)				
	0	Ist week	2nd week	3rd week	4th week
Glass Container					
Yellow	8.2	8.2	8.1	8.1	8.1
Orange	8.4	8.3	8.3	8.3	8.3
Red	8.5	8.5	8.4	8.4	8.4
SEm ±	0.04	0.04	0.03	0.03	0.03
C.D. 5%	0.09	0.10	0.07	0.07	0.07
PVC Containers					
Yellow	8.2	8.2	8.1	8.1	8.0
Orange	8.4	8.3	8.2	8.2	8.1
Red	8.5	8.4	8.3	8.3	8.4
SEm ±	0.04	0.05	0.04	0.06	0.03
C.D. 5%	0.09	0.11	0.08	0.13	0.08

Table 05:Mean score values of the overall acceptability of differently packed jellies incorporated with synthesized microbial pigments stored for period of 4 weeks under refrigerated condition

Jellies incorporated with pigment packed in containers	Storage period (Weeks)				
Glass Container	0	Ist week	2nd week	3rd week	4th week
Yellow	8.2	8.2	8.2	8.1	8.1
Orange	8.4	8.4	8.3	8.3	8.3
Red	8.5	8.5	8.5	8.4	8.4
SEm ±	0.01	0.04	0.04	0.03	0.03
C.D. 5%	0.09	0.09	0.10	0.07	0.07
PVC Containers					
Yellow	8.2	8.2	8.2	8.1	8.1
Orange	8.4	8.4	8.4	8.3	8.3
Red	8.5	8.5	8.4	8.4	8.4
SEm ±	0.04	0.04	0.05	0.03	0.03
C.D. 5%	0.09	0.09	0.10	0.07	0.07

Table 06:Mean score values of the overall acceptability of differently packed sugar candies incorporated with synthesized microbial pigments stored for period of 4 weeks under room condition (30-40^{0}C)

Sugar candies incorporated with pigment packed by containers	Storage period (Weeks)				
Glass Container	0	I	II	III	IV
Yellow	8.3	8.3	8.2	8.1	8.1
Orange	8.4	8.4	8.3	8.3	8.2
Red	8.6	8.6	8.5	8.4	8.4
SEm ±	0.05	0.05	0.04	0.03	0.059
C.D. 5%	0.11	0.11	0.10	0.07	0.123
PVC Containers					
Yellow	8.3	8.3	8.2	8.1	8.0
Orange	8.4	8.4	8.2	8.2	8.1
Red	8.6	8.6	8.4	8.3	8.3
SEm ±	0.06	0.06	0.05	0.06	0.56
C.D. 5%	0.11	0.11	0.10	0.13	1.17

Table 07:Mean score values of the overall acceptability of differently packed sugar candies incorporated with synthesized microbial pigments stored for period of 4 weeks under room condition (4^0 C)

Sugar candies incorporated with pigment packed by containers	Storage period (Weeks)				
Glass Container	0	I	II	III	IV
Yellow	8.3	8.3	8.3	8.2	8.2
Orange	8.4	8.4	8.3	8.3	8.3
Red	8.6	8.6	8.5	8.5	8.5
SEm ±	0.05	0.05	0.04	0.04	0.04
C.D. 5%	0.11	0.11	0.09	0.10	0.10
PVC Containers					
Yellow	8.3	8.3	8.2	8.2	8.1
Orange	8.4	8.4	8.3	8.3	8.3
Red	8.6	8.6	8.5	8.4	8.4
SEm ±	0.05	0.05	0.04	0.05	0.03
C.D. 5%	0.11	0.11	0.10	0.11	0.07

Table 08: Instrumental colour measurement of jellies packed in glass container and stored for a period of 4 weeks under different storage conditions.

Jellies incorporated with microbial pigments	Parameters of Hunter colour Lab	Storage period (Weeks)				
		0	I	II	III	IV
Room Condition						
Yellow	L	25.7	26.1	26.6	27.1	27.7
	a	2.6	2.4	2.3	2.3	2.2
	b	12.0	12.4	12.7	12.9	11.8
Orange	L	22.3	22.9	23.3	23.8	24.5
	a	5.0	4.9	4.8	4.7	4.6
	b	9.5	10.1	10.3	10.6	11.0
Red	L	19.8	19.8	20.2	20.6	21.2
	a	6.9	6.9	6.8	6.7	6.6
	b	6.7	7.1	7.2	7.4	7.6

Refrigerated conditions						
Yellow	L	25.7	26.5	26.9	27.4	27.9
	a	2.6	2.5	2.4	2.3	2.3
	b	12.0	12.7	12.9	13.4	13.5
Orange	L	22.3	23.3	24.7	25.2	25.2
	a	5.0	5.0	4.8	4.7	4.6
	b	9.5	9.9	10.2	10.4	10.6
Red	L	19.0	20.6	20.9	21.3	21.7
	a	6.9	6.8	6.7	6.5	6.4
	b	6.7	7.2	7.4	7.5	7.6

Table 09: Instrumental colour measurement of jellies packed in PVC container and stored for a period of 4 weeks under different storage conditions.

Jellies incorporated with microbial pigments	**Parameters of Hunter colour Lab.**	**Storage period (Weeks)**				
		0	I	II	III	IV
Room Condition						
Yellow	L	25.7	26.4	27.6	28.1	28.7
	a	2.6	2.5	2.4	2.3	2.3
	b	12.0	12.5	12.8	13.1	13.3
Orange	L	22.3	23.6	24.3	25.1	25.4
	a	5.0	4.9	4.8	4.6	4.6
	b	9.5	9.8	10.0	10.2	10.4
Red	L	19.8	20.9	21.9	22.3	22.9
	a	6.9	6.8	6.6	6.5	6.4
	b	6.7	6.9	7.0	7.1	7.3
Refrigerated conditions						
Yellow	L	25.7	26.2	26.7	27.2	28.2
	a	2.6	2.5	2.3	2.2	2.2
	b	12.0	12.1	12.4	12.6	12.9
Orange	L	22.3	22.7	23.1	23.6	24.3
	a	5.0	4.9	4.8	4.7	4.6
	b	9.5	9.8	10.0	10.2	10.4
Red	L	19.8	20.3	20.6	21.3	21.8
	a	6.9	6.7	6.5	6.3	6.2
	b	6.7	7.0	7.2	7.3	7.4

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Evaluation of genetic diversity in medicinally important endangered spices *Commiphora wightii* using RAPD markers

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Abstract

Randomly amplified polymorphic DNA (RAPD) analysis was conducted to find the genetic variation among 21 accessions of *Commiphora wightii* collected from Rajasthan, Madhya Pradesh, and Gujarat. Seven RAPD markers were screened which showing clear banding patterns and resolution in the accessions of *C. wightii*. These 7 molecular markers produced 30 amplified loci ranging between 250 to 2000 bp. 28 loci (93.33%) were found polymorphic in 21 accessions. Cluster analysis was performed based on Jaccard's similarity coefficient matrices and a dendrogram generated. Based on phylogenetic analysis 21 accessions of *C. wightii* were classified into two major cluster with two sub-clusters (A and B) having 10 and 11 accessions. Genetic diversity among 21 accessions of C. wightii observed using RAPD markers and the information derived in this study will certainly help in identification of diverse parents for crop improvement.

Key words: RAPD molecular marker, *Commiphora wightii,* Genetic diversity.

Guggul plant is small, thorny, and has trifoliate leaves. It is a perennial herb grows up to maximum 4m height. Guggal is a pharmacologically, economically and ecologically important species. It is found in wild form in western India and eastern Himalayas and grow abundantly in Karnataka, Gujarat and Rajasthan. It is listed in IUCN's red data book of threatened plants (Natesh and Mohanram, 1999).

Presence of steroidal compound guggulsterone (forms e and z) in the oleo-gum resin, it has been used in treating various disorders since ancient times. The guggulosterones present in the guggul gum of C. wightii plants have antioxidant activity. The Guggulipids from the resin have been reported to be effective as anti-inflammatory, anti-bacterial, antimicrobial, anti-oxidant, anti-arthritic, anti-malarial, antimycobacterial, anti-schistomal, hepatoprotective, muscle relaxant, larvicidal, and molluscicidal (Sahni *et al.* 2005). Studies have reported the antidiabetic, cardiac and neuronal protective activity of guggulsterone, which is used for prevention of cancer. The exudates of the plant are a complex mixture of resin (61%), gum (29.3%) and other bio chemicals (6.1%). More than 150 compounds have been reported and new compounds continue to be reported (Fatope *et al.* 2003). The guggal plant produce a dense oily resin identified as guggal gum. It is a pale yellow or brown in colour and aromatic complex mixture of steroids, diterpenoid, aliphatic ester, carbohydrate and varieties of inorganic ions (Pullaiah, 2006).

The assessment of the genetic diversity in germplasm of such endangered plant species is a prerequisite and an incredibly important input for any systematic conservation program and their sustainable management and utilization. DNA markers have been used to evaluate genetic diversity in different crop species. Genetic diversity analysis is possible using various molecular markers such as RAPD (Dawson et al. 1993). Results greatly depend upon type of markers used, their distribution in the

genome, loci they amplified, level of polymorphism and reproducibility. DNA-based molecular markers are widely used in many population genetic studies on plant species. Randomly Amplified Polymorphic DNA (RAPD) markers are efficient to assess genetic variation and have been used extensively to evaluate natural genetic diversity in plant populations.

Materials and Methods

During the present study, genomic DNA was isolated from young leaf samples of 21 accessions of *C. wightii* (Table-1) using CTAB method (Saghai-Maroof et al. 1984) with minor modifications. The procedure is applicable to fresh leaves of *C. wightii*. This modified CTAB (2%) protocol include the use of 1.4M NaCl, 1% ß-mercapto-ethanol and 100% ethanol in the extraction as well as increasing the centrifugation duration while separation and precipitation of the DNA, 12K rpm for 15 min. The isolated DNA proved amenable to PCR amplification. The yield and purity of isolated DNA were determined using spectrophotometer at the wavelength of 230 nm for the carbohydrates or polyphenols, 260 nm for the DNA and 280 nm for proteins. Concentration of DNA was recorded 50ng/µl while the purity of the extracted DNA was calculated as the OD ratio of 260/ 280. The presence of proteins, carbohydrates and polyphenol contaminations was determined by measuring the UV absorbance ratio of A260/280 and A260/230, respectively. The purified DNA, approximately 50 ng/µl, was used for amplification with RAPD (OPERON series) markers in polymerase chain reaction (PCR). Amplification was carried out in a 20µl reaction mixture (containing 1X taq buffer, 1.5 mM of $MgCl_2$, 0.2 mM of dNTPs, 0.4 µM of RAPD primer and 1.0 U of Taq DNA polymerase). PCR cycling conditions for amplification of RAPD consisted of an initial denaturation at 94°C for 4 min followed by 45 cycles consisting of 1 min denaturation at 94°C, 1 min annealing at 37°C and 1 min elongation at 72°C, and finally single extension cycle of 5 min at 72°C. The amplified PCR products were analyzed by electrophoresis in a 2 % agarose gel with 1X TAE buffer. DNA fingerprints on RAPD gels were scored for the presence (1) or absence (0) of bands of molecular weight size in the form of binary matrix for all the accessions studied. Data were analyzed to obtain Jaccard's coefficients among the isolates by using NTSYS-PC Version 2.02e software (Rohlf, 1998). The SIMQUAL program was used to calculate the Jaccard's coefficients as following formula:

Jaccard's coefficient = *NAB / (NAB + NA + NB)*

Where *NAB* is the number of bands shared by samples,

NA represents amplified fragments in sample A,

NB represents fragments in sample B.

Similarity matrices based on these indices were calculated. A dendrogram was constructed using UPGMA (unweighted pair-group method with arithmetic averages) with the SAHN (sequential, agglomerative, hierarchical, and nested clustering) routine. The dendrogram was generated from similarity matrix data by cluster analysis using unweighted pair group method for arithmetic mean (UPGMA).

Table-1 Twenty one accessions of *C. wightii* used in the present study

Collection Site	Name of Accessions
CAZRI Jodhapur Rajasthan	CW-1 to CW-8
Anand Gujarat	CW-9 to CW-17
Murena Madhya Pradesh	CW-18 to CW-21

Results and Discussion

Out of 12, only seven RAPD markers were screened (Table-2) which showing clear banding patterns and resolution of amplified product in the gel (Fig. 1 and 2). These seven primers amplified 30 loci ranging between 250 to 2000 bp. Among these primers OPJ-17 was exhibited maximum 85.17% polymorphism with the band size ranging between 250-1500bp of 7 loci.

Table-2 RAPD Primers and their sequences used in the investigation

Primer	Sequences 5 -3	GC content
OPA-1	CAGGCCCTTC	60
OPA-3	AGTCAGCCAC	60
OPJ-1	CCCGGCATAA	60
OPJ-17	ACGCCAGTTC	70
OPJ-18	TGGTCGCAGA	60
OPH-18	GAATCGGCCA	60
OPAA-1	AGACGGCTCC	70

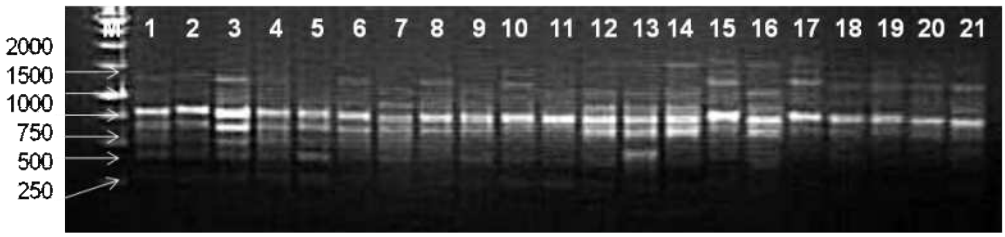

Fig-1 RAPD amplification using OPJ-17 primer in 21 accessions of *C. wightii* (Lane M= 1 Kb Ladder, Lane 1 to 21 RAPD amplified product)

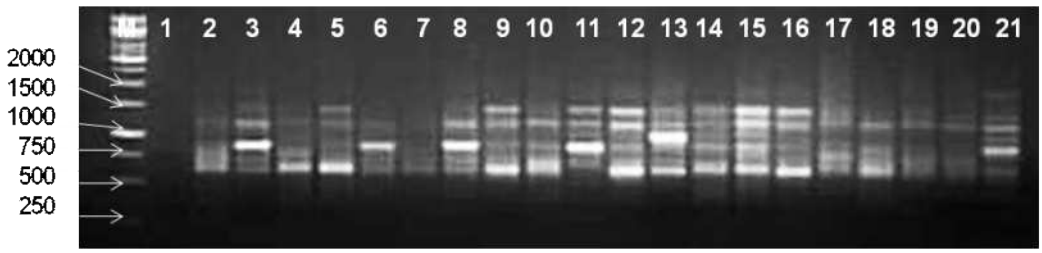

Fig-2 RAPD amplification using OPJ-18 primer in 21 accessions of *C. wightii* (Lane M= 1 Kb Ladder, Lane 1 to 21 RAPD amplified product)

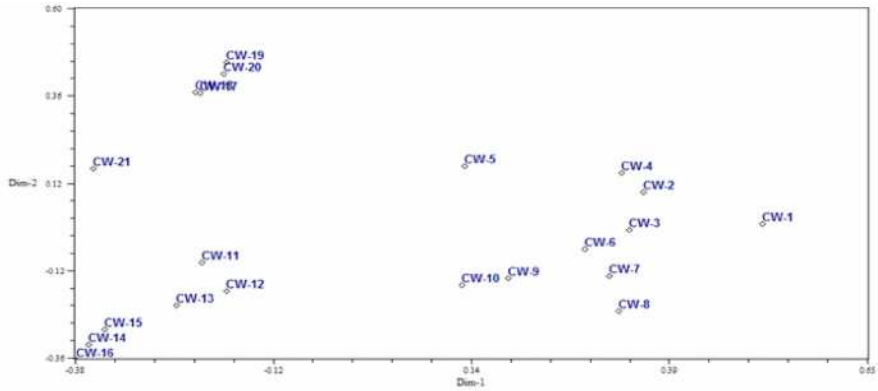

Fig-3 Two dimensional scaling of 21 accessions of *C. wightii* by Principal Component Analysis (PCA) using RAPD marker

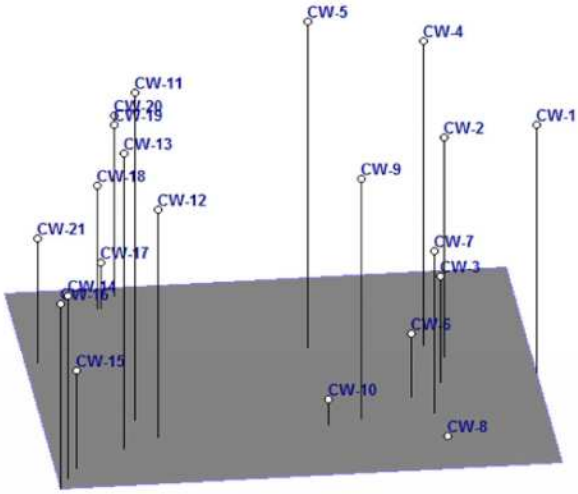

Fig-4 Three dimensional scaling of 21 accessions of *C. wightii* by Principal Component Analysis (PCA) using RAPD markers

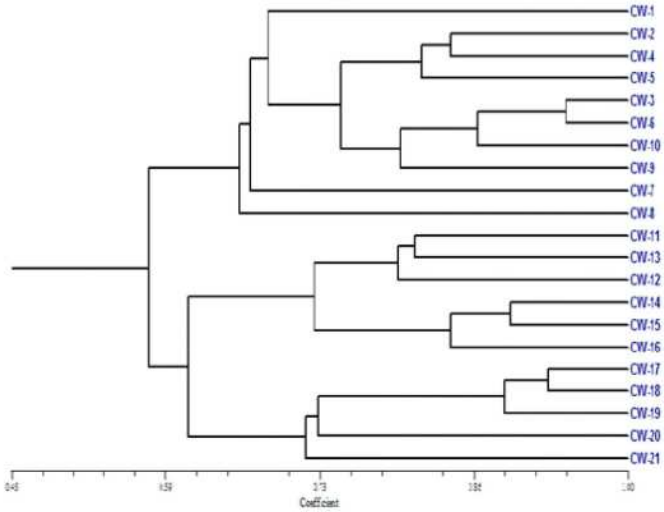

Fig-5 Dendrogram Generated using UPGMA analysis showing relationship among 21 accessions of *C. wightii* using RAPD markers

The average percentage of polymorphic loci was found 4% through RAPD marker. The RAPD markers analysis, it was found that 28% bands showed polymorphism while 2% bands showed monomorphic. Out of 30, 28 loci (93.33%) were found to be polymorphic in the present study (Table-3). Similar results also reported by Krishnamurthy et al. (2015) and they detected 54.50% of polymorphism in 13 accessions of *C. wightii.* Suthar *et al.* (2008) also observed 83.08% polymorphism among *C. wightii* accessions. The PIC (polymorphism information content) PIC values between 0.4 to 0.6. Highest PIC value 0.61 found with OPJ-17 RAPD markers. Principle components analysis of 21 accessions of *C. wightii* was carried out according to the similarity coefficient. Group I consists of CW-1, to CW-8, and CW-9, CW-10 accessions. Among all 21 accessions CW-1 and CW-21 found to be highly diverse from each other (Fig 3, 4). Cluster analysis was performed based on Jaccard's similarity coefficient matrices and dendrogram generated (Fig 5). Dendrogram grouped these accessions into two major clusters A and B. The cluster A contains 10 accessions CW-1 to CW-8 collect from Jodhpur, Rajasthan and accessions CW-9 and CW-10 from Anand, Gujrat.

Table-3 Polymorphism revealed by RAPD marker assay of 7 primers

Primer bands	Total bands	Monomorphic bands	Polymorphic Polymorphism	Percentage of Value	PIC
OPA-1	3	1	2	66.66	0.47
OPA-3	3	0	3	100	0.51
OPJ-1	4	0	4	100	0.49
OPJ-17	7	1	6	85.71	0.61
OPJ-18	6	0	6	100	0.52
OPH-18	3	0	3	100	0 .48
OPAA-1	4	0	4	100	0.54
	30	2	28	93.33	

The cluster B contains 11 accessions CW-11 to CW-17 from Gujarat and CW-18 to CW-21 collect from Murena Madhya Pradesh. The cluster B divided into two sub-groups, group one is contains CW-17, CW-18, CW-19, CW-20, CW-21 collect from Murena Madhya grouped together and group second contain was CW-11, CW-12, CW-13, CW-14, CW-15, CW-16 and CW-17 grouped together collect from Gujarat. The maximum similarity was obtained from CW-3 and CW-6 (95%) followed by CW-17 and CW-18 (90%) and 85% between CW-14 and CW-15. Similar results showing a high degree of genetic similarity existing among *C. wightii* accessions were also reported between the accessions collected from Rajasthan using RAPD markers by Suthar et al. (2008). Vyas and Joshi (2015) used 11 RAPD markers for diversity analysis of *C. wightii.* The RAPD analysis revealed a high degree of genetic diversity among the accessions used in this study. The overall genetic diversity of a taxon has great implications for its long-term survival and evolution.

Conclusion

Analysis of genetic relationships among *C. wightii* is an important component of crop improvement program and determination of relationship among

individuals and populations are important considerations for genetic conservation and utilization of plant genetic resources. Genetic diversity observed among the *C. wightii* accessions tested using RAPD markers and the information derived in this study will certainly help in identification of diverse parents for crop improvement.

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Integration of bioagents and fungicides for management of sesame diseases

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Abstract

Field trials conducted on integrated disease management practices to combat major diseases and to increase the seed yield of sesame during *kharif* revealed that soil application of neem cake (250 kg/ha) along with seed treatment (2.5 kg/ha) of *Trichoderma viride* followed by foliar spray of saaf @ 2g/L, first spray at the appearance of diseases and second at 15 days after first spray (Module 3) was found to be significantly effective by recording minimum disease incidence coupled with maximum seed yield with higher cost benefit (C:B) followed by $\mathbf{M_4}$-Soil application of neem cake (250 kg/ha) + seed treatment with *T. viride* (0.4%) + soil application of *T. viride* (2.5 kg/ha) + spray of Azadirachtin 0.03%, first spray at the initial appearance of the disease and second at 15 days after first spray . Though module $\mathbf{M_2}$ and $\mathbf{M_1}$ ranked next to $\mathbf{M_4}$ with statistically on par in reducing the diseases, enhancing seed yield and C: B ratio. All the modules were superior over farmer's practices (without any treatment)

Key words: Azadirachtin, Saaf, IDM module, neem cake, sesame, *Trichoderma viride.*

Sesame (*Sesamum indicum* L.) is the important edible oilseed crop of *Kharif* season. It is called "The queen of oilseed crops" by virtue of the quality of oil it produces. India contributes the highest sesame acreage of above 18 lakh hectare. The low productivity (321.3 kg/ha) is attributed to poor crop management and exposure of the crop to a number of biotic and abiotic stresses. Among fungal diseases, Phytophthora blight caused by *Phytophthora nicotianae* var. *parasitica* f sp. *sesami,* stem/root rot caused by *Macrophomina phaseolina*, Alternaria leaf blight caused by *Alternaria sesami* and Cercospora leaf spot caused by *Cercospora sesami* are the most important diseases causing severe yield losses when there are heavy and continuous rains coupled with high humidity. Now these diseases become major biotic constraint for sesame production in Madhya Pradesh. At present chemical fungicides are the first choice for the farmers to combat diseases because of their easy adaptability and immediate therapy. Due to health risk and pollution hazards by use of chemical fungicides in plant disease control, it is considered appropriate to minimize their use. Since sesame seed and oil are in high demand for export due to their high unsaturated fat and methionine content, focus has been shifted out safer alternatives to chemical fungicides in recent years. Biological control had attained importance in modern agriculture to reduce the hazards of intensive use of fungicides for control of soil borne diseases. Since the efficacy of biocontrol agents in disease management has been inconsistent due to their inability to maintain a critical threshold population necessary for sustained biocontrol activity, biocontrol with antagonistic microorganisms alone could not be a complete replacement for management strategies currently employed. The activities and population of introduced antagonist generally decrease with time after their application and thus making the beneficial effect of short duration. To enhance and extend the desired

responses, the surrounding environment needs to be altered which favours the activities of the introduced biocontrol agent and this can be overcome by the organic amendments which are utilized selectively by the introduced microbe employed as biocontrol agent (Paulitz, 2000). Therefore Integrated Disease Management (IDM) that consists the biocontrol agents, botanicals and organic amendments would reduce the amount of fungicide used per season in addition to combat diseases in an economically viable and ecologically safe proportion. Soil amendments are known to improve the nutrient status and tilth of the soil in addition to increase the microbial activity and to suppress pathogens; biocontrol agents can grow, proliferate, colonize and protect the newly formed plant parts to which they are not applied; phytopesticide materials range from whole fresh plants to their formulations are known to inhibit pathogens and hence they are considered as attractive supplements to the conventional methods for plant disease management. These diseases spread through seed, soil and air hence, an attempt was made to assess the effect of IDM modules with chemicals, botanicals, organic amendments and biocontrol agents on disease incidence and yield of sesame in comparison with farmer's practices.

Materials and Methods

An experiment was conducted at JNKVV research farm Jabalpur during *kharif* season to evaluate the efficacy of integrated disease management modules. Five modules were tested in randomized block design and replicated four times using the variety JTS-8. The modules are $\mathbf{M_1}$- Soil application of neem cake 250 kg/ha + seed treatment with Thiram (0.2%) and Carbendazim 50 WP (0.1%) + spray of Mancozeb (0.25%) and Quinalphos (0.05%) first spray at the initial appearance of the disease and second at 15 days after first spray; $\mathbf{M_2}$ -,Soil application of neem cake 250 kg/ha + seed treatment with Carbendazim 50 WP(0.2%)+ spray of Saaf (Carbendazim + Mancozeb 0.2%) and Imidaclorprid 17.8 SL (0.25 ml/ l),first spray at the initial appearance of the disease and second at 15 days after first spray; $\mathbf{M_3}$ - Seed treatment with *Tricodermaviride*(0.4%)+ soil application of *T.viride* 2.5 kg/ha + spray of saaf (Carbendazim +Mancozeb 0.2%) and Imidachloprid 17.8 SL (0.25 ml/l), first spray at the initial appearance of the disease and second at 15 days after first spray; $\mathbf{M_4}$ - Soil application of neem cake (250 kg/ha) + seed treatment with *T. viride* (0.4%) + soil application of *T. viride* (2.5 kg/ha) + spray of Azadirachtin 0.03%, first spray at the initial appearance of the disease and second at 15 days after first spray; $\mathbf{M_5}$- Farmer's practice. The seed treatment with chemicals and *T. viride* were done individually 24 hrs prior to sowing. Neem cake and *T. viride* (TNAU commercial talc formulation) were applied to the soil individually a week before sowing. The crop was raised as per the agronomic practices given in the Crop Production Guide and observations of disease incidence were recorded one week after the last foliar spray. Phytophthora blight and Alternaria/ Cercospora leaf spot incidences were scored by following 0-5 scale (Anonymous, 2008) and Percent Disease Index (PDI) was worked out. The incidence of *Macrophomina* root rot was recorded individually by counting the number of affected and healthy plants at random quadrate selection in each plot and the Percent Incidence (PI) was calculated. The seed yield was recorded and B:C ratio was worked out. Data were analyzed statistically.

Results

All the four modules were found significantly superior to reduce incidence of diseases and increasing seed yield over Farmer's practice. The least incidence of Phytophthora blight (5.1 PDI) was recorded in IDM module $\mathbf{M_3}$ coupled with highest seed yield of 865 kg/ha and high BC ratio of 3.3. The module also registered the highest plant height, number of branches, capsule/ plant and 1000 seed weight (Table 1). IDM module $\mathbf{M_4}$ including the soil application of neem cake (250 kg/ha) along with seed treatment and soil application (2.5 kg/ha) of *T. viride* followed by foliar spray of azadirachtin @ 3 mL/L, first spray at the initial appearance of the disease and second at 15 days after first spray was found to be significantly effective by recording the minimum

incidence of root rot. This was in agreement with the findings of Rajpurohit and Nema (2012), who has reported that soil application of neem cake along with seed treatment and soil application of *T. viride* reduces the root rot significantly than seed and soil application of *T.viridealone*. Addition of neem cake promotes biological activity in soil by providing nutrients and favorable conditions for the antagonists besides enhancing plant growth and vigor was documented by Mallesh *et al.* (2008). The results of the present study also confirm that soil application of *T. viride* and neem cake exhibited maximum disease suppression when applied in combination than alone. Regarding seed treatment, the modules $\mathbf{M_3}$ and $\mathbf{M_4}$ with *T. viride* seed treatment recorded significantly lesser incidence of root rot than $\mathbf{M_1}$ and $\mathbf{M_2}$ with chemical seed treatment. From this, it was inferred that seed treatment with biocontrol agents provide longer protection than chemicals which suppress the seed and soil-borne pathogens only in early stage of the crop growth, besides stimulating germination and lysis of sclerotia of *M. phaseolina.* The present investigation is in line with the report of Rao (2009). Module $\mathbf{M_2}$ consisting of two foliar sprays of saaf (0.2%) is the most effective for management of Alternaria and Cercospora leaf spot both. Rajpurohit and Nema (2013) also reported the efficacy of saaf against Alternaria leaf spot of sesame.

Table1. Incidence of diseases and seed yield of sesame under integrated disease management practice

S. No.	Module	Disease incidence (%)	Percent Disease Index			Seed Yield	BC Ratio
		MSR	Phytophthora Blight	Alternaria Leaf Spot	Cercospora Leaf Spot	(kg/ha)	
M1	Soil application of neem cake 250 kg/ha + seed treatment With Thiram (0.2%) and Carbendazim 50 WP (0.1%) + spray of Mancozeb (0.25%) and Quinalphos (0.05%),first spray at the initial appearance of the disease and second at 15 days after first spray.	25.7 (30.45)	15.08 (22.82)	2.8 (9.63)	10.8 (19.15)	722	2.36
M2	Soil application of neem cake 250 kg/ha + seed treatment with Carbendazim 50 WP (0.2%)+ spray of saaf (0.2%) and Imidachl oprid 17.8 SL (0.25 ml/l),first spray at the initial appearance of the disease and second at 15 days after first spray.	24.1 (29.40)	14.50 (22.36)	2.4 (8.86)	8.9 (17.32)	740	2.22

Thiram

M3	Seed treatment with *Trichoderma* viride (0.4%)+ soil application of *T.viride* 2.5 kg/ha + spray of saaf (0.2%) and Imidachloprid 17.8 SL (0.25 ml/l),first spray at the initial appearance of the disease and second at 15 days after first spray.	16.38 (23.86)	5.1 (13.00)	3.0 (10.00)	9.8 (18.21)	865	3.30
M4	Soil application of neem cake 250 kg/ha + seed treatment with T. viride (0.4%) + soil application of T. viride (2.5 kg/ha)+ spray of Azadirachtin 0.03%, first spray at the initial appearance of the disease and second at 15 days after first spray.	13.55 (21.57)	21.73 (27.77)	9.3 (17.81)	15.4 (23.09)	851	2.7
M5	Farmer's practice	34.18 (35.77)	32.75 (34.90)	18.2 (25.24)	20.6 (26.98)	486	
	SEm±	0.64	0.58		0.49	0.76	19.80
	CD (P=0.05)	1.98	1.78		1.50	2.35	61.09
	CV	4.56	4.79		6.8	7.27	5.40

*Figures in parentheses are angular transformed values;MSR- Macrophomina stem/root rot
MSR=Macrophomina stem/root rot

Table 2. Effect of integrated disease management modules on yield attributing characters of sesame

Module	Plant height (cm)	No. of branches /plant	No. of capsule/ Plant	1000 seed weight
M1	95.3	3.9	56	3.2
M2	100	4.1	59	3.5
M3	112	4.7	88	3.8
M4	108	4.5	72	3.5
M5	90	3.0	48	2.8

With respect to grain yield, all IDM modules recorded significantly higher seed yield and B:C than farmer's practices. Among them, M3 ranked first by recording the highest seed yield (865 Kg/ha) and B:C (3.3:1) ratio followed by M2. Our results are in confirmatory with those of Harman *et al.* (2004) and Haikal (2008) who also observed similar effects of *T. viride*

in different crops. Papavizas and Lumsden (1980) opined that changes in soil reaction due to increased activity of introduced *Trichoderma* species might be one among the reasons for the increased seedling growth beside production of growth regulating substances by the antagonists. The highest seed yield and B:C ratio of M3 may be attributed due to the nutrient content of the neem cake and increased nutrient uptake through enhance root growth by *Trichoderma* and inclusion of only cheap and easily available biopesticides for managing diseases.From the study, it is concluded that IDM module M3including soil application of neem cake (250 kg/ ha) along with seed treatment (2.5 kg/ha) of *Trichoderma viride* followed by foliar spray of saaf @ 2g/L, first spray at the appearance of diseases and second at 15 days after first spraywas found to be superior in reducing the diseases and increasing the seed yield coupled with higher cost benefit ratio.

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Distribution of phylloplane fungi and its utilization as organic management tool against Alternaria leaf spot disease of *Withania somnifera* (L.) Dunal

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Abstract

In an attempts to get organic solution for medicinal plant disease management, an investigation on maximization of isolation of phylloplane fungi from medicinal plant on standard media, phylloplane fungal community composition on plant sprayed without and with different chemicals at different intervals of time and antagonistic potential of dominant phylloplane fungi against *Alternaria alternata* under ***in-vitro*** conditions have been made. Among the eight different media, the maximum (44.60) frequency percentage of *T.harzianum* was recorded on PDA medium followed by *Withania* leaf extract medium 1 (43.34) of *A. niger*. Among the six different fungicides applications, the maximum (53.49%) frequency percentage of *A. niger* was recorded with Azoxystrobin followed by *T.harzianum* (43.78%) with Mancozeb. There was change in frequency percentage of dominant mycoflora after 15 days of fungicides spray, the maximum frequency percentage (25.79 %) of A. niger of was recorded with Chlorothalonil followed by *T. flavus* (20.95%). Frequency percentage distribution of dominant mycoflora isolated on PDA media mixed with fungicides showed the maximum (50.0%) frequency percentage of *T. flavus*. However, the change in dominant mycoflora sprayed with fungicides 15 days before isolation on fungicide mixed PDA recorded the highest (60.00 %) frequency percentage of *T.harzianum* on Mancozeb followed by Hexaconazole (55.55 %).

All four Aspergillus species and three *Trichoderma harzianum* isolates exhibited growth suppressing ability against *Alternaria alternata*. The *Aspergillus terreus* was found the most effective antagonist against Alternaria alternata in suppressing the growth and statistically superior to other tested *Aspergillus* species. The minimum growth (45.66 mm) was attained by *A. alternata* in co-culture with *A. terreus* followed by *T. harzianum* 2 (48.0 mm), *T. harzianum3* (49.0mm), *A.niger*1 (50.33mm), *A.niger*3 (50.66mm),*T. harzianum* 1 (50.66mm) and *A. niger*2 (52.0mm). The effect of culture filtrate of fungal antagonist on the growth of *A. alternata* was found statistically significant. The maximum inhibition of mycelial growth of test pathogen was observed with culture filtrate of *T. flavus* that accounted to 35.39 percent of inhibition.

Key words: Bioagents, dominant mycoflora, media, phylloplane fungal community,

Ashwagandha (*Withania somnifera* L. Dunal.) is commonly used in Ayurveda and other traditional systems of medicine (Bhargava and Singh, 1978). Ashwagandha roots are prescribed for hiccup, gynaecological disorders, cough, rheumatism and dropsy. Bark decoction is taken for asthma and applied locally to bed sores. Withaferin-A is therapeutically active withanolide reported to be present in leaves. Therefore, leaves and leaf juice are useful for curing inflammation, swellings, curing cough, cold, conjunctivitis etc. *Withania somnifera* is prone to several diseases and pest (Gupta *et al.*, 1993; Nagraj and Reddy 1985) but leaf spot caused by *Alternaria alternata* (Fr.) Keissler is widely prevalent under all cultivated conditions. The attack of pathogen not only reduces the chlorophyll and

reducing sugar content but also brings about decrease in withaferin A and withanolites contents (Pati *et al*., 2008) that confers immense therapeutic value to the crop. *Alternaria* is known to produce mycotoxin and these *Alternaria* toxins are connected to certain health disorders (Woody and Chu, 1992).

The phyllosphere is considered as hostile environment because it experience daily and seasonal changes in terms of availability, incident irradiation and nutrient availability (Lindow *et al*., 2002). Seasonal changes alter leaf morphology, and leaf surface biochemistry has been seen to affect the community composition and magnitude of phylloplane microbial populations (Hirano *et al*., 2000; Yadav *et al.,* 2005). Antagonistic effects of saprophytic microorganisms were reported by Goswami and Islam (2002). However, fewer attempts have been made on maximization of isolation of phylloplane fungi on standard media and their utilization as biocontrol agent compared to endophytes, saprobes against pathogenic fungi. Considering the importance of phylloplane fungi and their probable role in restricting the growth and multiplication of Alternaria alternata causing leaf spot of Ashwagandha, the present investigation was taken as an alternate management tool for biological control.

Materials and Methods

Sources of materials

The leaf samples were collected from the *Withania somnifera*, grown on research field of AICRP on Medicinal and Aromatic Plants and Betelvine at Jawaharlal Nehru Krishi Vishwa Vidyalaya (22°49'- 220 80'N; 78°21'- 80°58'E), Jabalpur during 2014-15. The samples were collected from the ten places of individual plant and were mixed together to form the composite sample. The leaf samples were collected (a) thirty days old plant leaves, (b) leaves at anthesis stage and (c) mature plants leaves. Leaves were also collected from plants under different fungicidal treatments such as Mancozeb, Copper oxychloride, Pyrrostrobulin, Azoxystrobulin, Hexaconazole and Chlorothalonil.

Isolation, purification and quantification of phylloplane fungi from Ashwagandha leaves

The diseased leaves of Ashwagandha were collected from the field showing typical *Alternaria* symptoms and were cut into pieces. These pieces were put on the transferred to the Petriplates containing 15 ml Potato Dextrose Agar (PDA) medium and incubated at 25± 1^0 C. As soon as the fungal hypha grew in the Petri-dishes, it was transfers on to PDA slants. Single spore isolation method (Choi *et al*., 1999) was used for purification of pathogen.

Leaf wash method was used to estimate total fungal count of phylloplane fungi of *Withania somnifera*. The suspension of 1 ml (=10-4) solution of microorganisms prepared was transferred into Petri-dishes containing different media viz., PDA (Potato dextrose agar), MEA (Malt extract agar), Rose Bengal agar (RBA),V-8 Juice Agar, Carrot Agar (CA) and Withania leaf extract Agar(WLA) medium supplemented with streptomycin. Plates with different media were added with and incubated at 22 ± 20C for 7-9 days. Three replications for each treatment were maintained and the experiment was repeated twice.

An experiment was conducted under field conditions, following randomized block design with seven treatments with plot size of 1x1 m2. Five fungicides along with their recommended dose were sprayed on plant against the *Alternaria* disease. The solution/suspension of each of the fungicide was prepared and sprayed on 90 days old Aswagandha (*Withania somnifera*) plants. The plot sprayed with sterilized water served as control.

Table 1: Fungicides with common, trade and chemical names, their concentration used

Common Name	Trade Name	Chemical Name	Concentration	Dose
Mancozeb 75 WP	Hyzeb M-45 bis di thio carbamate	Manganese-ethylene	0.3%	1.5-2.0 g/L
Chlorothalonil	Chlorothalonil 80 WP	2,4,5,6-Tetrachloro isophtnalonitrile	0.2%	2.0 g/L
Copper oxychloride	Copper oxychloride oxychloride 50 WP	Copper oxychloride	0.3%	2.5 g/L
Azoxystrobulin	Heritage	Strobilurin	0.11%	0.11 kg a.il/ha
Pyrostrobulin	Headline	Strobilurin	0.11%	168 gm/ha
Nembicidine Control	Nembicidine	Azadirachtin 3000 ppm	0.15%	0.03%

The leaves were collected for dominant fungal count after three days and 15 days of fungicide spraying on ashwagandha plants. Leaf wash method was used to estimate total and dominant fungal count. In another experiment, the fungicides were added in the PDA medium and 1 ml (=10^{-4}) leaf wash solution was added to it. The plates were incubated at 22 ± 2^{0}C for 7-9 days for final data recording. Three replications for each treatment were maintained and the experiment was repeated twice.

Total isolation frequency (Fr) of genera was calculated according to

$$\textbf{Frequency (\%)} = \frac{\text{Number of sample with Genus}}{\text{Total number of samples}} \text{X100}$$

Shannon-Wiener diversity index (H'):

$$H = -\sum_{i=1} P_i \,.\, \log_2 (P_i)$$

Where Pi is the proportion of ith Genera that contribute to total diversity.

Investigation on interaction of phylloplane fungi with *Alternaria alternata*

Mycofloral interactions of Alternaria alternata with dominant phylloplane fungi has done by dual culture technique (Dikinson *et al.*, 1971). The effect of non-volatile metabolites of dominant fungi was studied by culture filtrate method. The culture filtrate of dominant fungal flora on growth of A. alternata was studied by poison food technique.

Antagonistic efficacy for each antagonist against the pathogen was worked out and expressed as percentage of inhibition of radial growth of test pathogen by following formula:

$$\text{Percentage of inhibition} = \frac{R1 - R2}{R1} \times 100$$

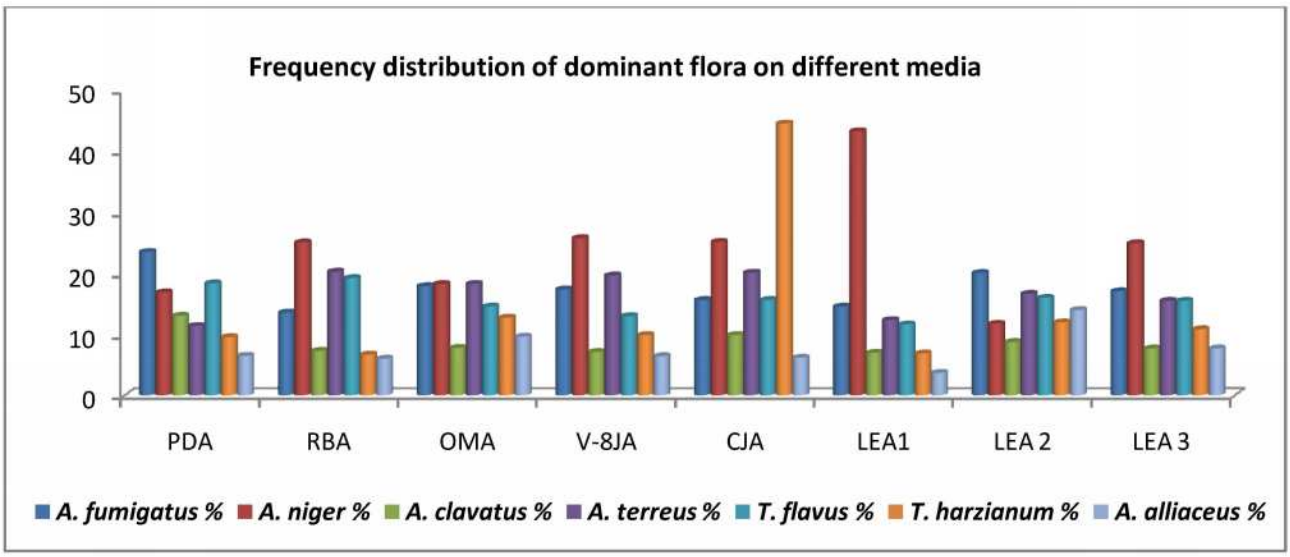
R1-Radius of the radial growth of Alternaria alternata

R2-Radius of the radial growth of the antagonist in test plate

Results and Discussion

Dominance and diversity of mycoflora on different media

Eight media were used for isolation and quantification of fungi from phylloplane of *Withania somnifera*. The PDA medium supported the highest (23.59%) frequency of *Aspergillus fumigatus* followed by *Talaromyces flavus, Aspergillus niger, Aspergillus clavatus, Aspergillus terreus* and *Trichoderma harzianum*. The Rose bengal agar medium was highly (25.15) supportive for isolation of *Aspergillus niger* followed by *Aspergillus terreus*. Oat meal agar medium promoted almost similar and higher isolation frequency of *Aspergillus niger* (18.39), *Aspergillus terreus* (18.39) and *Aspergillus fumigatus* (18.01). It was also found to be supportive for *Talaromyces flavus* and Trichoderma harzianum. The highest (44.6%) frequency of *Trichoderma harzianum* was recorded on Carrot juice agar medium. The Leaf extract agar 1 medium supported the highest (43.34%) percent of *Aspergillus niger* while Leaf extract medium 2 was promotive towards *Aspergillus fumigatus*. Leaf extract 3 medium supported the highest (25.02%) frequency of *Aspergillus niger* and equally (15.63%) to *Aspergillus terreus* and *Talaromyces flavus* (Fig. 1).



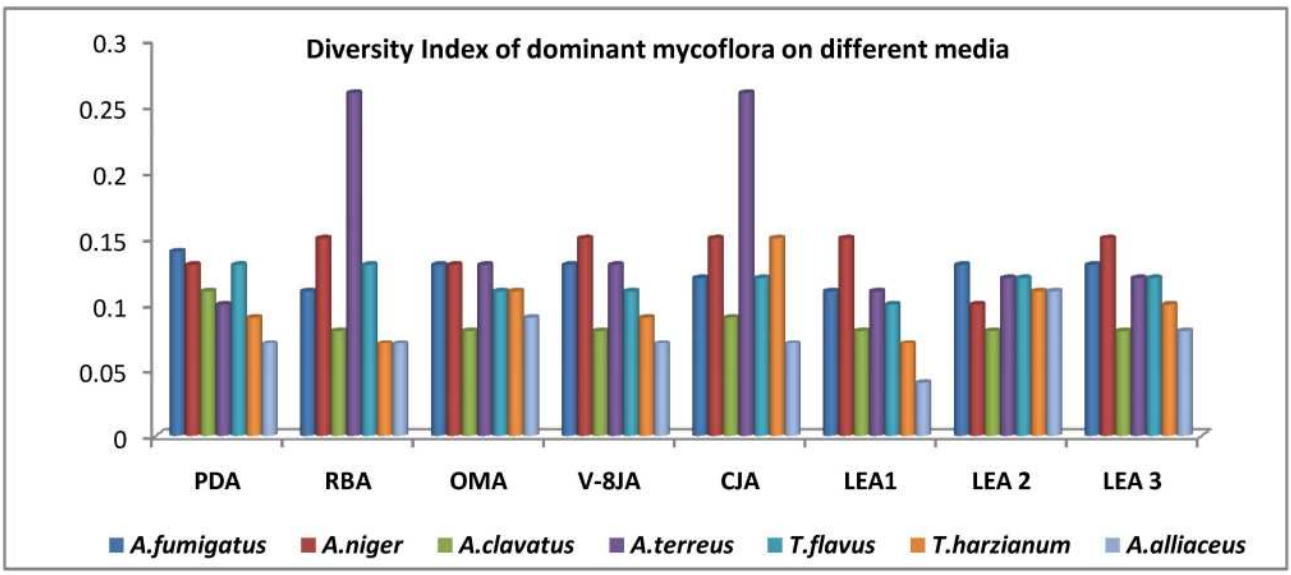


fig.1: Dominance and diversity of mycoflora on different media

The diversity index of different fungi varied in different media. The range of diversity index was recorded from 0.07 to 0.14 in PDA. Least (0.07) and similar diversity index of *T. harzianum* and *A.alliaceus* was recorded on Rose bengal agar while the highest (0.26) of *A. terreus*. Except *A. clavatus* and *A. alliaceus* the higher diversity index of dominant mycoflora was recorded on Oat meal agar medium (Fig 1). Diversity index of *A. niger* (0.15), *A. terreus* (0.13) and *A. fumigatus* (0.13) was noticeable on V-8 juice agar medium. The highest diversity index of *A. terreus* (0.26) was recorded on carrot juice agar medium. On Leaf extract medium1, the diversity index (0.15) of *A. niger* was the highest whereas the diversity index of *A.fumigatus* was the highest (0.13) on Leaf extract agar medium2. The highest diversity index of *A. niger* (0.15) was recorded on Leaf extract agar medium3. The changes in resources and competition between organisms dictate the actual community composition (Lindow *et al.*, 2002), leading to composition of specific fungal communities and microbial processes.

Dominance and diversity of mycoflora under different fungicide spray

Six different fungicides were sprayed on *W. somnifera* plant to assess their effect on distribution of dominant mycoflora. Azoxystrobin supported the highest (53.49%) frequency of *A. niger* followed by *T. harzianum* and *A. fumigatus*. Mancozeb was also highly (47.74) supportive for *A. niger* followed by *T.harzianum* (19.08). Copper oxychloride promoted higher frequency of *T. harzianum* (43.78) followed by *A. niger* (25.01). The highest frequency of *A.niger* (45.65) was recorded with Pyraclostrobin (44.6%). Hexaconazole supported the highest (32.01%) percent of *T. harzianum* while Chlorothalonil was promotive towards *A. niger* (40.01).

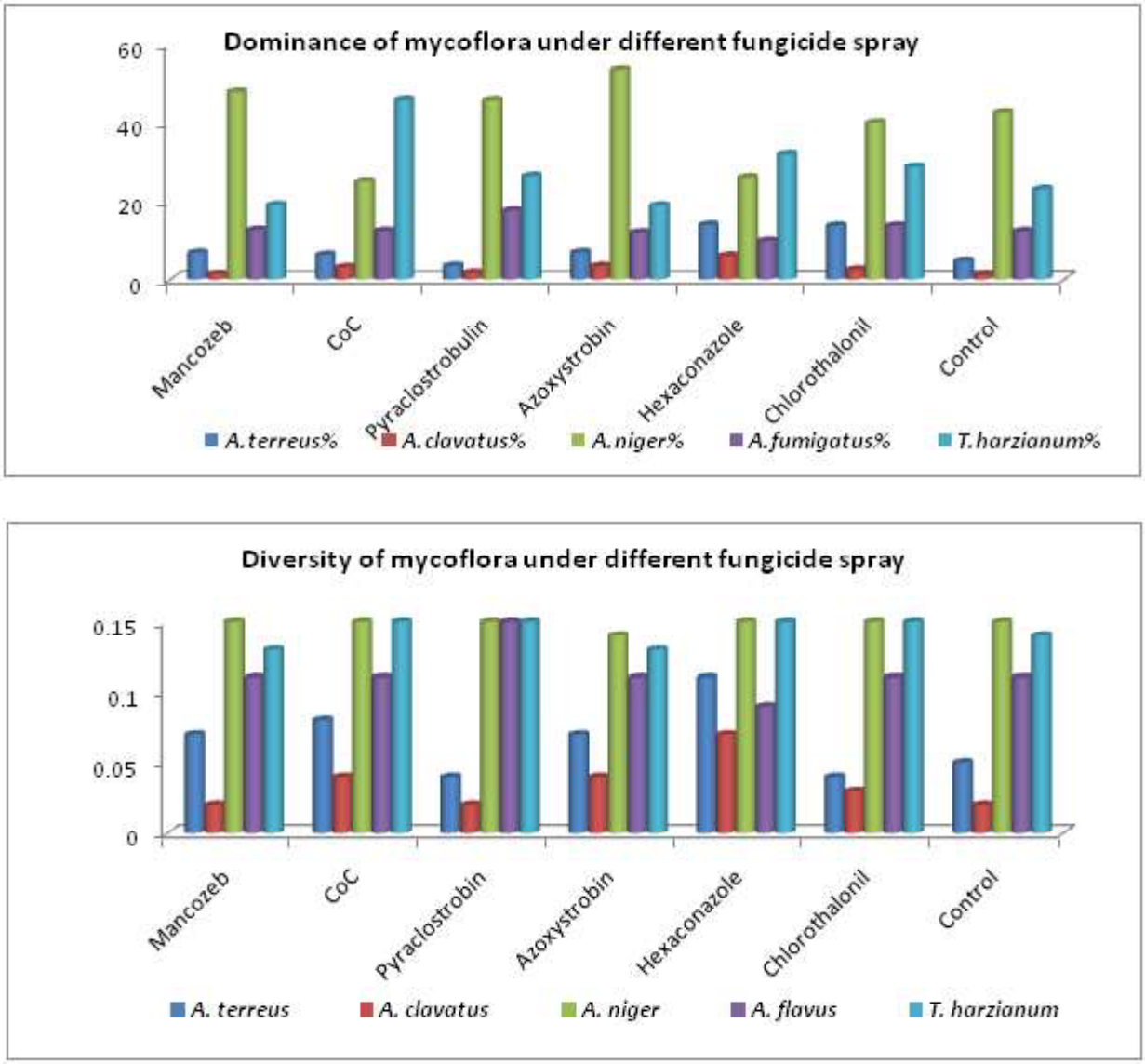


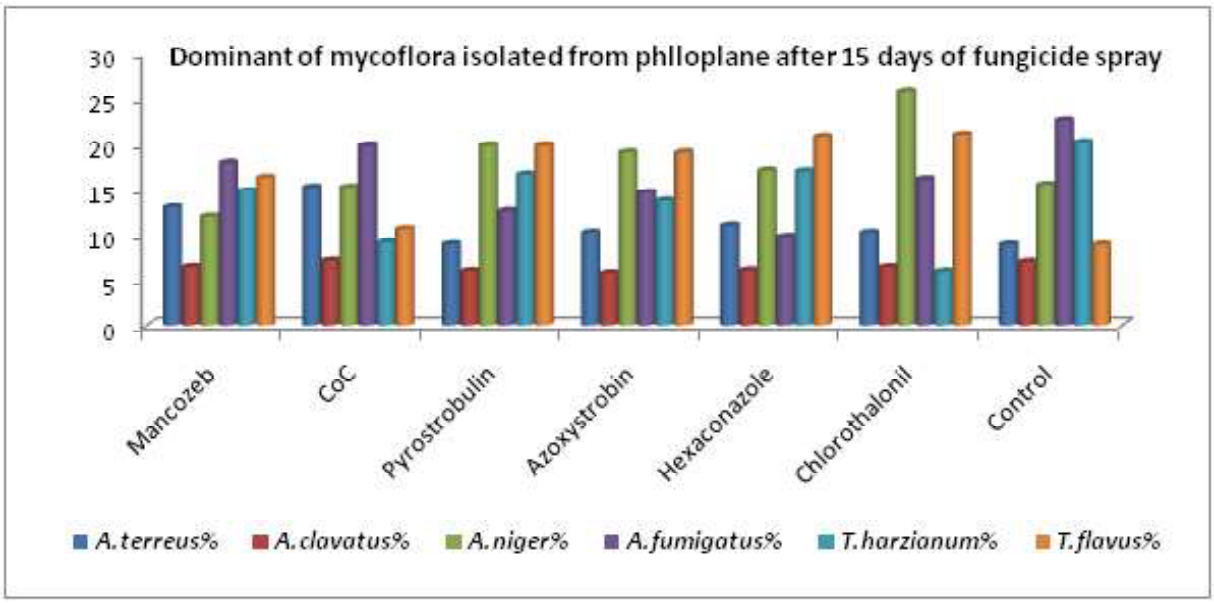
Fig 2: Dominance and diversity of mycoflora under different fungicide spray

Control was supportive to the highest (42.64%) frequency of *A. niger.* The diversity index of *A. terreus* (0.11) and *A.clavatus* (0.07) was the highest in hexaconazole treatment over the rest of treatments. However, the diversity index of *A. niger* was almost equal in all treatments. Equal diversity of *A. fumigatus* was recorded on Mancozeb, Copper oxychloride, Azoxystrobin, Chlorothalonil and Control treatments. The diversity index of *T. harzianum* (0.15) has not varied in Copper oxychloride, Pyraclostrobin, Hexaconazole and Chlorothalonil treatments (Fig.2). Differential effect of fungicides on different dominant mycoflora may be attributed such result. De Jager et al. (2001) proposed that the cultivated crops are influenced by management practices, such as the application of pesticides and fungicides that further alter phylloplane communities.

Dominant and diversity of mycoflora isolated from phlloplane after 15 days of fungicide spray

The effect of fungicides treatment after 15 days on

fungal dominance varied within themselves. The Mancozeb supported the highest dominance of *A.fumigatus* followed by *T. flavus* and *T. harzianum*. Although the dominance of *A. terreus* and *A. niger* was equal with Copper oxychloride treatment but the highest (0.19) *A.niger* was recorded with same treatment. The highest (0.19) dominance of *A. niger* and *T. flavus* was recorded with Pyraclostrobin treatment followed by *T. harzianum* (Fig 3). The same fungi *A. niger* and *T. flavus* were more dominant in Azoxystrobin treatment too. The hexaconazole treatment supported maximum dominance of *T. flavus* followed by *A. niger* and *T. harzianum*. The Chlorothalonil treatment promoted the maximum dominance of *A. niger* and also *T. harzianum* and *T. flavus* that were but the former were next to *A. niger*. In Control the maximum dominance of *A. fumigatus* was recorded followed by *T. harzianum* and *A. niger.*



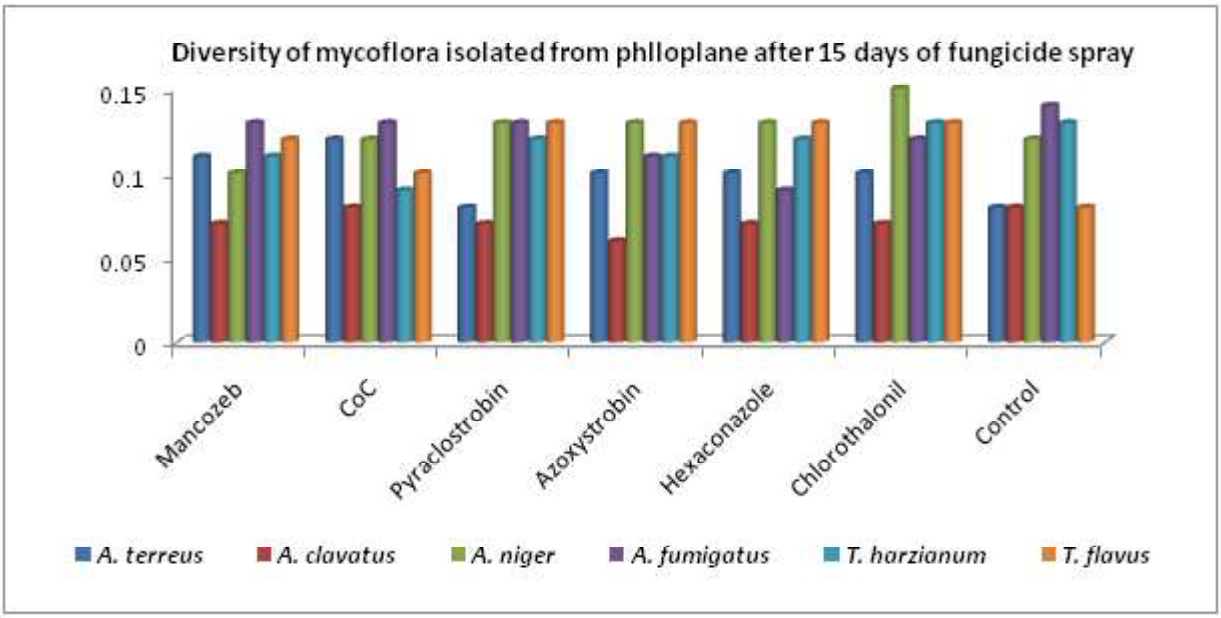


Fig3: Dominance and diversity of mycoflora isolated from phlloplane after 15 days of fungicide spray

The diversity index of *A. niger* (0.15) was the highest in Chlorothalonil treatment over the rest of treatments. The diversity index of *A. clavatus* was almost equal in all treatments. Mancozeb, Copper oxychloride, Azoxystrobin, chlorothalonil and Control supported equal diversity of *A. terreus, A. clavatus* and *T. flavus* (0.08). The diversity index of *T. flavus* (0.13) has not varied in Pyraclostrobin, Azoxystrobin, Hexaconazole and Chlorothalonil treatments.

The six different fungicides were used for study of distribution of phyllolane fungi of *W. Somnifera* leaves. Hexaconazole supported the highest (42.42%) frequency of *A. niger*. However, the Mancozeb was equally (33.33%) supportive for *A. niger,T. harzianum* and *T. flavus* (Fig 3). Copper oxychloride and Pyraclostrobin promoted higher frequency of *T.flavus* (50%). Pyraclostrobin was also supportive for higher frequency distribution of *T. harzianum* (41.17). Higher frequency of *T. flavus* (36.53%) was also recorded with Azoxystobulin. Chlorothalonil was equally supportive toward *A.niger* (40.00) and *T. harzianum* (40.00). Without chemical amendment (control) supported the highest (39.13%) frequency of *T. flavus*. Presence of heavy metals in the fungicides and modification of phylloplane environment owing to their action could be the reason for such change. Ruscoe *et al*. (1971) has studied that the environmental acidifying pollutants and ozone have been shown to affect phylloplane fungal communities. The presence of zinc, lead and cadmium reduced phyllosphere microbial abundance and diversity of cabbages and pine saplings when compared with their non-contaminated

Frequency distribution of dominant mycoflora isolated on PDA media mixed with fungicides

It was recorded that the distribution of fungus varied on different fungicides mixed with PDA. Mancozeb treatment (0.33) equally supported the dominance of *A. niger, T. harzianum* and *T. flavus*. The Copper oxychloride and Pyraclostrobin treatments recorded the highest dominance of *T. flavus* (0.50). Pyraclostrobin supported the maximum dominance of *T. harzianum* followed by Chlorothalonil. The dominance of *T. flavus* was maximum (0.42) in Hexaconazole treatment. Moreover, the dominance of *A. niger* (0.40) and *T. harzianum* (0.4) was equal in Chlorothalonil treatment. As the leaf aged, new chemical resources (Yadav *et al.*, 2005) became available and physical spaces formed that allow fungi to compete, exploit and dominate their particular new niche.

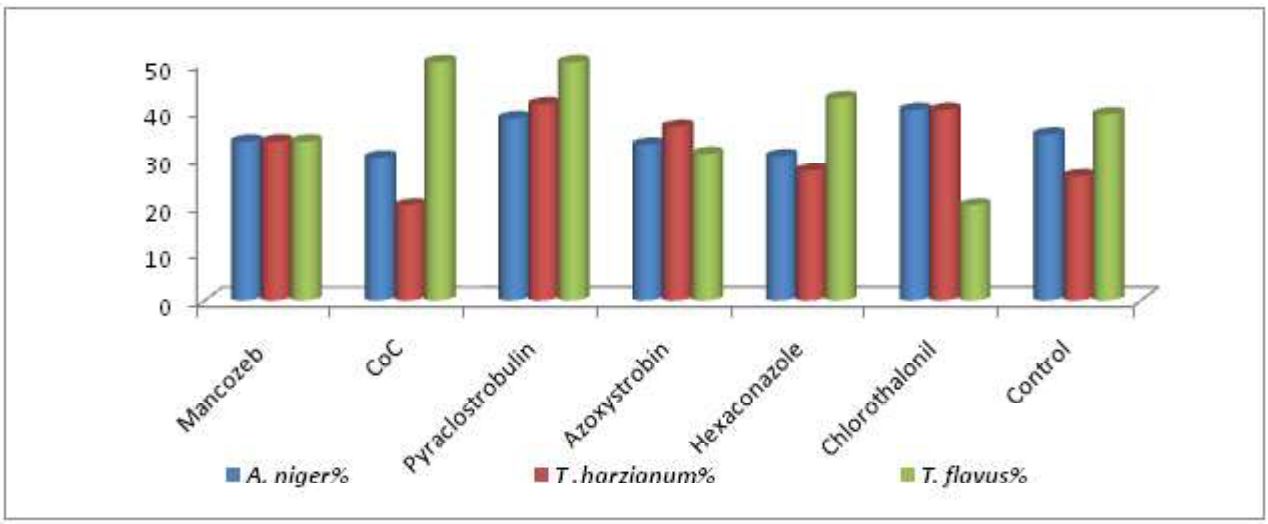


Fig4: Frequency percentage distribution of dominant mycoflora isolated on PDA media mixed with fungicides

Antagonistic potential of dominant phylloplane fungi against *A. alternata*

All the four Aspergillus species and three *T.harzianum* isolates exhibited growth suppressing ability against *A. alternata* (Table 2). A. terreus was found the most effective antagonist against *A. alternata* in suppressing the mycelial growth and was statistically superior to other *Aspergillus species*. The minimum growth (45.66 mm) was attained by *Alternaria alternata* in co-culture with *A. terreus* followed by *T.harzianum* 2 (48.0 mm), *T.harzianum* 3 (49.0mm), *A. niger* 1 (50.33mm), *A. niger* 3 (50.66mm), *T.harzianum* 1 (50.66mm), *A. niger* 2 (52.0mm).This result indicates that *A. terreus* is the best biocontrol agent against A.alternata. The work of Hu *et al*. (2013) clearly demonstrated that the mycoparasite characteristics of *Aspergillus* sp. ASP- 4 may be enhanced through its ability to produce a range of extracellular enzymes, such as chitinases and other antifungal extrolites which help in colonization of *S. slerotiorum* sclerotia; the same may be thought to be the mode of action of *A. terreus*.

Table 2: Screening of antagonistic potential of dominant phylloplane fungi against *A. alternata* through dual culture method

Fungus	Growth inhibition of A.alternata (mm)			Inhibition (%)
	72 hr	96 hr	120 hr	
A.niger1	31.00	43.33	50.33	43.33
A.niger2	36.00	43.66	52.00	41.25
A.niger3	41.00	49.66	50.66	40.40
T.harzianum1	38.00	32.66	50.66	40.40
T.harzianum 2	33.66	42.00	48.00	43.52
T.harzianum 3	33.33	46.33	49.00	42.35
A.terreus	22.33	30.33	45.66	46.28
Control	55.00	66.33	85.00	
C.D.	3.23	4.02	3.65	
C.V.	5.15	5.25	3.91	

Table 3: Inhibition of mycelial growth of Alternaria alternata by culture filtrates of dominant mycoflora

Metabolites	Growth inhibition of *A. alternata* (mm)			Inhibition(%)
	72hr	96hr	120hr	
T.harzianum1	29.66	39.00	60.00	25.30
A.alliaceus	31.00	39.00	60.66	24.48
T. harzianum3	33.66	46.00	84.16	4.76
A.niger	32.00	27.33	52.33	34.85
A.clavatus	31.00	38.00	66.66	17.01
T.flavus	27.66	22.33	51.66	35.39
A.fumigatus	28.66	38.00	57.50	28.42
A.terreus	28.66	27.33	53.33	33.61
Control	46.33	62.33	80.33	
C.D.	3.18	3.89	5.55	
C.V.	5.79	6.01	5.14	

The effect of culture filtrate of fungal antagonist on the growth of *A. alternata* was found statistically significant (Table 3). The maximum inhibition of mycelial growth of test pathogen was observed with culture filtrate of T. flavus that accounted to 35.39 percent of inhibition. Culture filtrate of *T. harzianum*1, *A. alliaceus*, *T. harzianum*3, *A.niger, A.clavatus, A. flavus, A. fumigatus, A. terreus* inhibited the radial growth of *A. alternata* by 60.0, 60.66, 84.16, 52.33, 66.66, 51.66, 57.50, 53.33 mm, respectively. Presence of several antifungal compounds in the culture filtrate of the *T. flavus* could be the reason for such inhibition. Gams *et al*. (2004) reported that *Talaromyces flavus* is an aggressive parasite of many kinds of sclerotia and one of the most successful biocontrol agents of *Sclerotium rolfsii* and *Verticillium dahlia*.

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Rhizosphere driven soil fungal diversity in medicinal plants root zone

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Abstract

The distribution of fungal population in medicinal plant rhizosphere of vertisol was studied during 2013-14. Rhizosphere soil of six medicinal plants viz., *Asparagus racemosus, Rauvolfia serpentina, Withania somnifera, Plumbago zeylanica, Commiphora wightii and Ocimum sanctum* was collected and distribution of fungal propagules was compared by dilution plate technique. The highest (30.66× 10^4cfu/g soil) total population was recorded in O. sanctum while lowest (6.74 × 10^4cfu/g soil) in *C. wightii* rhizosphere. The study reveals that the medicinal plants whose roots have medicinal value harbour more mycoflora than that of having stem as medicinal value but less than that of having entire plant as therapeutic value. Frequency of *Aspergillus* and *Penicillium* genera was observed more in comparison to *Cladosporium, Fusarium* and *Trichoderma*. The higher number of *Trichoderma* was recorded in *P. zeylanica* while no population was recorded in *A. racemosus*. Similarly, the community structure analysis of different medicinal plants differed greatly in fungal genera distribution except *C. wightii,* where low but constant distribution was recorded. The study reflects that the fungal colonization is subjected to variation due to secretion of different metabolites or organic compounds by the plant. This study also opens the avenue of getting noble microbes from medicinal plants' rhizosphere.

Key words: F*requency distribution, fungal diversity, medicinal plants' rhizosphere, species diversity, dominance.*

Introduction

Plants are considered as one of the most important sources of medicine and are used for curing several human ailments since long back. In India, the use of plants for medicine purpose is well documented in *Rigveda* that was written between 3500-1600 BC. The ethnic and tribal communities of India have preserved the knowledge of medicinal use of plants and still relying on it for curing several diseases (Bhattacharya and Borah, 2008). The agro-climatic zone of Madhya Pradesh is the most suitable for cultivation and growth of medicinal and aromatic plants. The production of medicinal plants in state in 2004-05 was 20,000 tones and is estimated to rise 1.04 lakh tones by now (MP Govt. report, 2013), in the vertisol of the state. Vertisol are the group of heavy textured soils commonly known as dark textured soil. The major factor contributing to vertisol in semi-arid environments is their higher water holding capacity; in areas of uncertain and variable rainfall, sometimes too much and often too little, the ability of soil to store sufficient water to carry crops through drought periods is of great importance (Virmani *et al*., 1982) for herbal medicine cultivation. The studies of rhizosphere effect describe the phenomenon that the biomass and activity of microorganisms is enhanced as a result of exudation of compounds by the root, in comparison to bulk soil (Sørensen, 1997, Raaijmakers *et al*., 2009).

Most of the medicinal plants are generally less attracted by the disease causing pathogen because of beneficial interaction of plant-microbes in their rhizosphere. Jeffries *et al*., (2003) reported that the beneficial plant-microbe interactions in the rhizosphere are the determinants of plant health and soil fertility. An understanding of population dynamics of the fungi in different medicinal plant rhizosphere is critical for its domestication and disease free cultivation in new agro-ecosystem. Comparisons of fungal diversity in different plant rhizosphere will be helpful to assess the influence of plant rhizosphere system on fungal colonization. Earlier papers have compared the diversity in widely cultivated crops. This paper extends these comparisons to medicinal plants. Therefore, the present study was undertaken to evaluate the effect of high alkaloid containing medicinal plants with differential medicinal properties affects the distribution and diversity of dominant mycoflora inhabiting rhizosphere of these medicinal plants.

Moreover, the medicinal plants are used by 80% of the world population as only available medicine especially in developing countries (Pattanayak *et al*., 2010) and traditional practitioners treat about 80% of patient in India, 85% in Burma and 90% in Bangladesh by this traditional system of medicine (Siddiqi, 1993). Plant based natural constituents or herbal medicine are gaining importance in both developing and developed countries because the development of resistance of pathogens against antibiotics has become a difficult issue to deal with the indiscriminate use of modern antibiotics (Okemo *et al*., 2003; Arya *et al*., 2010 and Mamun-OR-Rashid *et al*., 2012). Hence, the important advantages of medicinal plants in various treatments are their safety besides being less expensive, efficacy and availability throughout the world (Ahmed *et al*., 2002). In India, root of *Asparagus racemosus, Rauvolfia serpentina, Withania somnifera and Plumbago zeylanica*; stem of *Commiphora wightii* and entire plant of *Ocimum sanctum* are widely used for curing several human diseases.

Materials and Methods

Sample Collection and isolation

The soil samples were collected from the rhizosphere of six medicinal plants viz., *Ocimum sanctum, Asparagus racemosus, Rauvolfia serpentina, Withania somnifera, Plumbago zeylanica* and *Commiphora wightii* grown in medicinal plant garden and research field of AICRP on Medicinal and Aromatic Plants and Betelvine at Jawaharlal Nehru Krishi Vishwa Vidyalaya (22°49'- 220 80'N; 78°21'-80°58'E), Jabalpur in the Central India during 2013-14. The soil is vertisol with pH 6.7, organic carbon 0.98 per cent, available N 204 kg/ha, available P 8.6 kg/ha and available K 410 kg/ha. The samples were collected from the ten places of individual plant's root zone and were mixed together to form the composite sample and air dried for 1-2 days at 25-30^{0}C.

Fungal isolation

Dilution plate method was used to estimate total fungal count in soil samples of medicinal plant rhizosphere on two different media such as MEA (Malt extract agar) and Rose Bengal agar. Plates with different media were added with 0.1 ml (=10^{-4}) of suspension and incubated at 22 ± 2^{0}C for 15 days. The colonies were transferred to test tubes containing Potato dextrose agar (PDA) medium. Microscopic examination of fungal colonies that resembled *Aspergillus* and *Penicillium* species were subcultured on malt extract agar (MEA) for further identification. *Fusarium* was subcultured on dichloran-chloramphenicol-peptone agar (DCPA), *Cladosporium* on PDA and *Trichoderma* on *Trichoderma* semi-selective medium. The fungi were identified on the basis of their cultural and morphological characters and confirmed with the help of available literature (Thom and Raper 1945; Ellis 1971 ; Nelson *et al* 1983).

Data analysis

The following indicators were used to measure the diversity which is an important tool for biologist to quantify the micro-organisms.

Total isolation frequency (Fr) of genera was calculated according to Gonzalez et al (1995)

$$\textbf{Frequency (\%)} = \frac{\text{Number of sample with Genus}}{\text{Total number of samples}}$$

(equation No. 1)

Species Richness (S): The total number of species in the community.

Simpson's dominance index (D):

$$\mathbf{D} = \frac{1}{\sum_{i=1}^{s} P_i^2}$$ (equation No. 2)

Where the proportion of species (i) is relative to the total number of species (P_i) is calculated and squared. The squared proportions for all the species are summed and the reciprocal is taken.

Shannon's diversity index (H'):

$$H = -\sum_{i=1}^{S} Pi.\log_2 (P_i)$$ (equation No. 3)

Where P_i is the proportion of ith genera that contribute to total diversity.

Sorensen's similarity index (SI) = 2j/(a+b)

(equation No. 4)

Where j is number of genera common to both the crops/sample type and a is the number of genera in crop type I/ sample type A, b being the number of species in crop type II/ sample type B

Results and Discussion

Total fungal population

This study compared the fungal population at genera level in the rhizosphere of six medicinal plants having different medicinal values in the vertisol using community structure analysis. The total mycofloral population varies from 6.74 to 30.66 × 10^4 cfu/g soil. The highest (30.66× 10^4 cfu/g soil) total population was recorded in *O. sanctum* while lowest (6.74 × 10^4 cfu/g soil) in *C. wightii rhizosphere* (Fig. 1). However, the total fungal population in *R. serpentina* (16.00× 10^4 cfu/g soil) and in *P. zeylanica* (15.66 × 10^4 cfu/g soil) was almost similar. Similarly, the variation in fungal population *A. racemosus* (12.33 × 104 cfu/g soil) was not much higher than that of *W. somnifera* (11.00× 10^4 cfu/g soil). The result clearly indicates that the medicinal plants whose roots have medicinal value harbour more mycoflora than that of having stem as medicinal value but less than that of having entire plant as therapeutic value. Five principal genera isolated from rhizopshere of six medicinal plants were represented by percentage of samples in which each genus was present (Fig. 2). There was drastic decline in *Aspergillus* population from *O. sanctum* to other medicinal plant. Although, less variation in *Aspergillus* population (2.77, 2.17, 2.13× 10^4 cfu/g soil) was recorded in *P. zeylanica, W. somnifera* and *A. racemosus*, respectively but its least population was found in *C. wightii*. A wide variation in *Penicillium* population that ranged between 6.52 to 0.99× 10^4 cfu/g soil was recorded in different medicinal plants. Moreover, difference in colony count of genus *Cladosporium* was found in different medicinal plants but was not much in *A. racemosus* (3.11× 10^4 cfu/g soil), *P. zeylanica* (2.91× 10^4 cfu/g soil) and *W. somnifera* (2.18× 10^4 cfu/g soil) respectively. In comparison to other genera, the population of *Fusarium* was less and ranged between 1.11 to 0.08 × 10^4 cfu/g soils. The higher population of *Trichoderma* was recorded in *P. zeylanica* while it was negligible in *A. racemosus*. This study will probably be the first report on the fungal population

in the rhizosphere of medicinal plant from India. The principal genera isolated from the soil were *Aspergillus, Penicillium, Cladosporium, Fusarium* and *Trichoderma* are commonly found due to their production of different structures such as conidiophores, chlamydospores etc. Dominance of such genera was also reported by Vibha *et al*., (2010) in rice-wheat cropping system. Abundance of beneficial *Pseudomonas* spp. with antagonistic activity against *F. oxysporum* was lower in extended monoculture soils. Phenolic acid mixture at a ratio similar to that found in the rhizosphere could promote mycelial growth, sporulation, and toxin (3-Acetyldeoxynivalenol, 15-O-Acetyl-4-deoxynivalenol) production of pathogenic *F. oxysporum* while inhibiting growth of the beneficial *Pseudomonas* sp. W12 (Wu *et al*., 2015).

Frequency Distribution

The most frequent genera have been observed viz., *Aspergillus, Penicillium, Cladosporium, Fusarium* and *Trichoderma* isolated from medicinal plant rhizosphere (Fig. 2). *Aspergillus* was isolated in 42.66% soil samples of *O. sanctum* and its frequency decreased up to 17.27% in *A. racemosus.* Genus *Penicillium* was isolated with more frequency in *R. serpentina* (40.75%), *W. somnifera* (30.64%) and *A. racemosus* (33.25%), respectively. Although, the frequency of *Cladosporium* ranged between 16.54 to 25.22% in most of the studied medicinal plant's root zone but was exceptionally low (7.50%) in *R. serpentina* rhizosphere. In contrast to it, frequency of genus *Fusarium* was even less than 1% in *R. serpentina, P. zeylanica and W. somnifera* (0.69%, 0.70% and 0.73%) but was higher and almost equal in *O. sanctum* (3.62%) and *C. wightii* (3.40%). The frequency of *Trichoderma* reached 13.54% in *P. zeylanica* but was zero in *A. racemosus*. The results clearly propose that the frequency of six principal studied genera differ greatly in the rhizosphere of medicinal plants due to presence and secretion of alkaloid and other organic compounds by these plants. The abundance of microbial flora in soil rhizosphere is subjected to type of root system, its secretion and colonization capacity of microbes. Most rhizosphere microorganisms are saprophytes, but all their relations to plants are not incidental because some microorganisms live on the root surface, whereas other penetrate the root (Storkey, 1958), However, the survival time of microbes differs considerably. The highest population was recorded in *O. sanctum* followed by medicinal plants whose roots have medicinal value. This may possibly be due to the effect of the allelopathic or beneficial secretion of primary or secondary metabolites from the root zone. The ability to secrete a vast array of compounds into the rhizosphere is one of the most remarkable metabolic features of plant roots, with nearly 5% and 21% of all photo-synthetically fixed carbon being transferred to the rhizosphere through root exudates (Marschner, 1955). This drives the dense population in rhizosphere area due to easy availability of abundant source of organic material for feeding for soil microbes (Ryan and Delhaize, 2001).

Species diversity, dominance and similarity

The diversity, dominance, evenness and similarity index of fungal genera isolated from medicinal plant is presented in Fig. 3. The highest (0.89) dominance was recorded in *P. zeylanica* followed by *C. wightii, W. somnifera* and *A. racemosus*. However, the dominance index of *O. sanctum* (0.74) and *R. serpentina* (0.67) was less in comparison to other crops but their richness index was higher except *P. zeylanica*. The diversity index ranged in between 0.79 to 0.89. The highest (0.89) diversity was recorded in *P. zeylanica* followed by *R. serpentina* (0.89), *A. racemosus* (0.88), respectively. Equal diversity index was recorded in *O. sanctum* (0.81) and *C. wightii* (0.81) while least (0.79) in *W. somnifera*. Similarity index calculated for different genera between different medicinal plants was done to find some trend in occurrence of the studied genera. It was recorded that the similarity between *Aspergillus* was the highest (1.49) between *R. serpentine* and *A.*

racemosus while least (0.22) between *C. wightii* and *O. sanctum*. Although, genus *Penicillium* had maximum (1.54) similarity index between *W. somnifera* and *C. wightii* but contrast (0.32) between *C. wightii* and *O. sanctum*. Similarity index of *Cladosporium* genera had not varied much (1.03 to 1.32) in *W. somnifera, P. zeylanica* and *A. racemosus* but conspicuous variation was recorded in *O. sanctum* (1.70) and *C. wightii* (0.34) with their corresponding crops. Genus *Fusarium* had maximum (1.81) similarity index with *O. sanctum* and *R. serpentine* while minimum (0.30) with *R. serpentina* and *A. racemosus*. *Trichoderma* isolated from all medicinal plants had more or less similarity with each other but was almost zero between R. serpentina and A. racemosus. The similarity index of all the genera in different medicinal plant has distinct variation with each other except *C. wightii*, where low but constant similarity index of isolated genera was found between *C. wightii* and *O. sanctum*.

Higher population of *Aspergillus* and *Penicillium* may be attributed to production of several enzymes and metabolites by these fungi. Mrozik and Seget (2010) reported that these microorganisms are metabolically versatile and are capable of degrading a wide spectrum of substrates. Hence, are the most abundant soil mycoflora of all soil types. The author observed the greater numbers of these two genera in root zone of those medicinal plants whose root have high medicinal value. This indicates that they might have facilitated better in phosphorus solublization that is absorbed and distributed in plant by root system and resulted in better growth. Species belonging to genera *Penicillium* and *Aspergillus* possess ability to bring insoluble soil phosphate into soluble form and their beneficial effect on various crop has already been documented (Rudresh *et al* 2005). All the medicinal plants rhizosphere supported the growth of *Trichoderma* except *A. racemosus*. This result could be due to the presence of alkaloids in the root/ root exudates that may not support the growth and multiplication of Trichoderma spp. The anti-oxidant properties in *A. racemosus* is found due to the presence of isoflavons especially racemofuran, asparagamine A and racemosol in root (Wipoonpun *et al*., 2004). The results of Tolly and Rippel-Baldes (1958) indicate that the effect of roots on spore germination are selective in that spore of fungi isolated from roots of cereal plants germinated in the rhizosphere of cereals but not in rhizosphere of unrelated plants or in soil.

Diversity and dominance of fungal flora in *P. zeylanica* was the highest while richness was lower than *O. sanctum*. Similarly, the diversity and richness of *R. serpentina* was higher than *W. somonifera* but dominance was lower than the same. Such change in diversity and dominance of mycoflora could be either due to the storage or secretion of different enzymes or metabolites by these plants. Paul and Yuvaraj (2013) reported that *P. zeylanica* have some powerful enzymes in its root which act as gastro-intestinal flora normaliser. The complexity and biodiversity of underground micro-organism are directly related to the chemicals secreted by the rhizosphere as attractants or repellants in narrow zone of rhizosphere rather passive target for such organisms.

Acknowledgements

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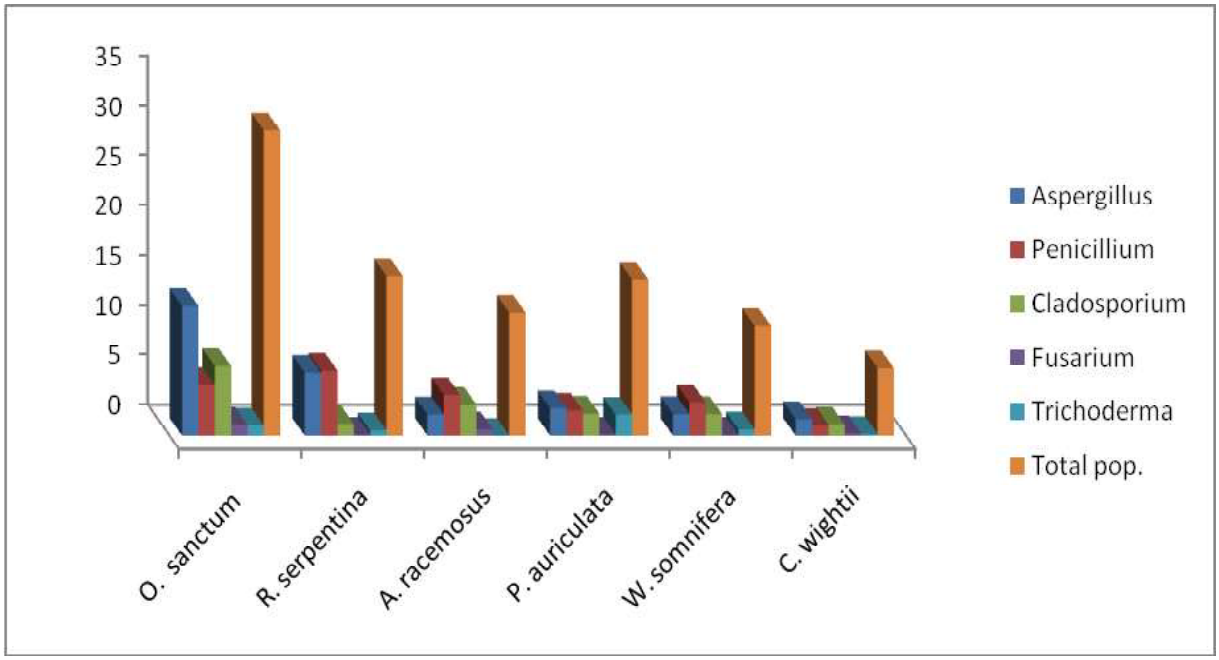

Figure 1: Fungal population isolated (cfu/gm) from rhizospere of different medicinal plants

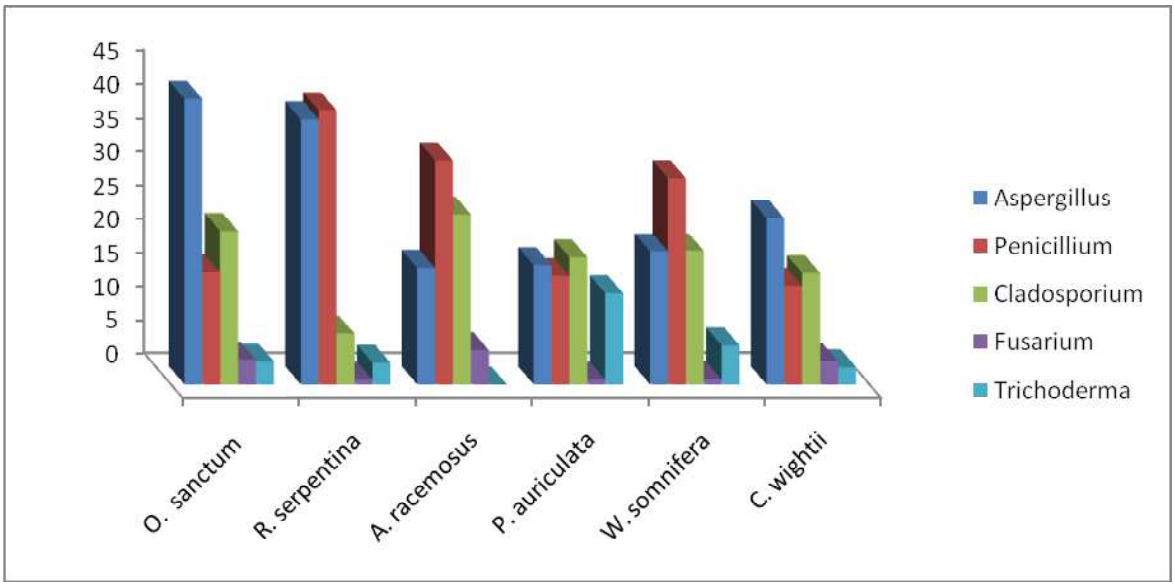

Figure 2: Frequency distribution of dominant fungal genera isolated from the medicinal plant rhizopshere

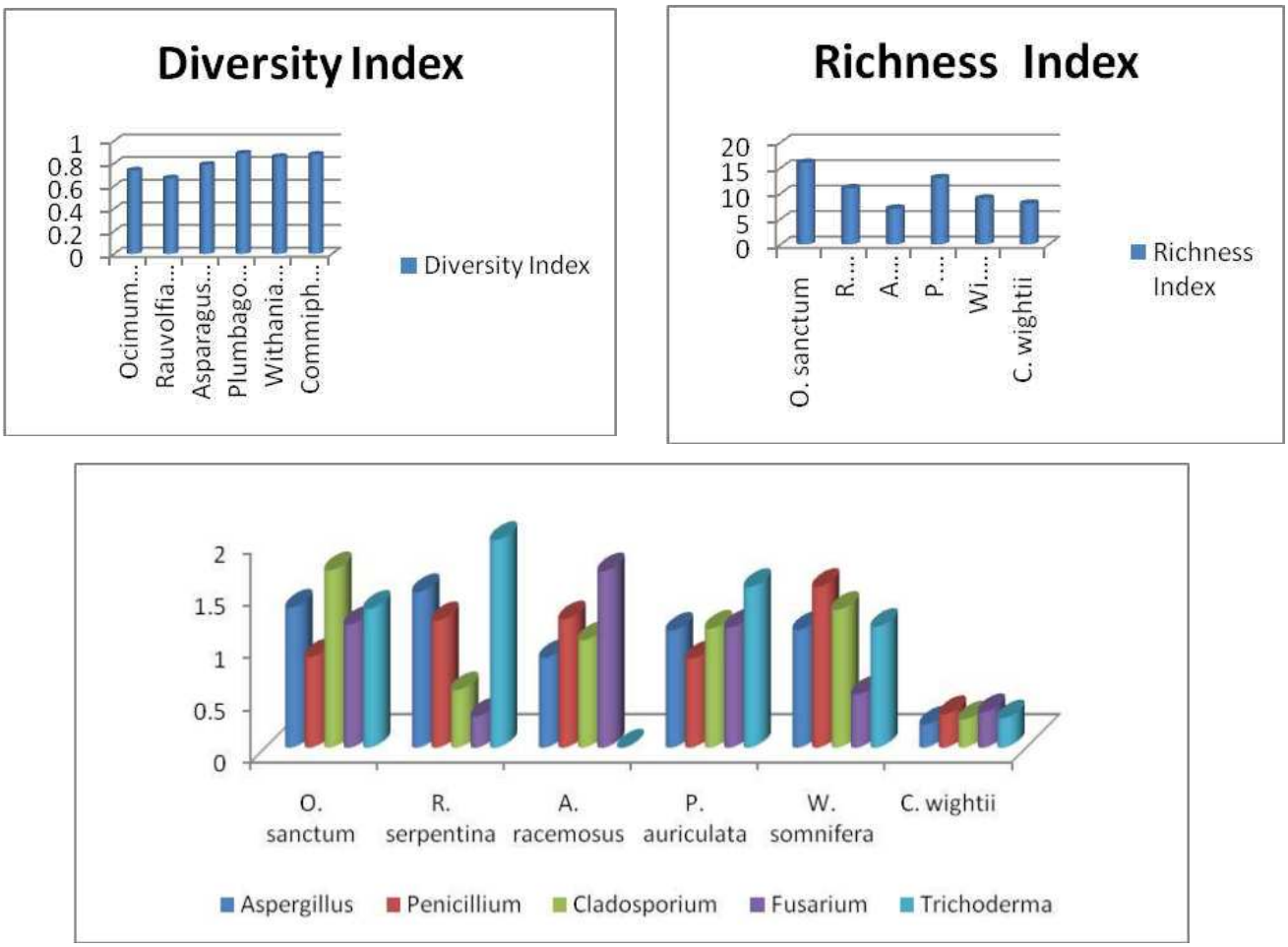

Figure 3: Diversity, Richness and Similarity indices of isolated genera under different medicinal plants

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Association of delayed leaf senescence rate with post anthesis drought tolerance in wheat

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Abstract

The adverse effect of drought on crop photosynthesis, growth and yield has been documented in numerous studies over the last few decades, but little information exists on how staygreen (SG) wheat germplasm respond to drought. An experiment was conducted to determine the association between SG traits and drought tolerance in thirty five wheat genotypes under pot culture conditions from various sources, including Indian and CIMMYT.Drought stress was imposed by stopping irrigation at anthesis for 8 days (RWC 65-70%). The SG traits was assessed at anthesis by visual scoring (0-10 scale), SCMR (SPAD chlorophyll meter reading), photosynthesis rate (Pn) and yield. There was decline in SCMR and Pn, whereas increase in leaf senescence rate (LSR) under moisture deficit stress in all the germplasm studied. However, the decline was relatively less in SG genotypes compared to the non-staygreen (NSG) ones. Germplasm CHIRYA 7 registered lesser reduction in all the above mentioned traits in response to water deficit stress indicating that the drought tolerance mechanism exist in CHIRYA 7 owing to its better management under limited water supply particularly at anthesis in comparison to other germplasm. The data suggested that SG traits are pivotal for regulating LSR and yield formation during moisture deficit stress condition and could be used as a physiological marker in wheat for drought tolerance.

Keywords: Staygreen, Photosynthesis rate; SCMR (SPAD chlorophyll meter reading); Drought Tolerance Efficiency; Leaf Senescence Rate

The world population is projected to grow to 8.2 billion by 2030 and 9.2 billion by 2050. Problem of increasing food production is only magnified in situations of extreme changes in weather patterns. Therefore issue of food security need to be addressed through innovations in crop production (Gepstein *et al.*, 2013). Among the crop plants, wheat (*Triticum aestivum* L.) is a staple food for more than 35% of the world population with 30% of the world's cereal area, and over 220 million ha, often under abiotic stress which consequently lowers its yield. (Cossani *et al.*, 2012). Thus, Improvement of wheat productivity for drought tolerance is a major objective in plant breeding programs.

Functional SG is a beneficial trait that may increase grain yield by maintaining photosynthesis in many crops and can be studied at the physiological level. SG genotypes have been used successfully in sorghum for yield stability and promises as a selection tool in wheat (Christopher *et al.*, 2008). Visual rating for the SG traits was used for screening under drought stress (Adu *et al.*, 2011). After scoring for the SG traits, total leaf chlorophyll contents were measured using Minolta Chlorophyll Meter SPAD-502 (Minolta Camera Co., Ltd, Japan). Higher the SPAD values represent higher total chlorophyll content. The relationship of visual stay green ratings with SPAD values indicated that it was a reliable indication

of leaf senescence and should be used in evaluating genotypes for drought tolerance (Xu *et al.*, 2000).

DSI is considered to be the most effective selection criteria to assess drought tolerance. Most of the drought tolerant genotypes shows lowest DSI and minimum reduction in seed yield due to stress which clearly indicated that improvement in drought tolerance is possible through simple selection (Bahar *et al.*, 2010). Although association between SG traits and yield stability is reported in many crops but published studies on a possible association between them are scare (Kumari *et al.*, 2013). Therefore, present investigation was planned to study the association between SG traits and yield attributes under moisture deficit condition and whether the regulatory mechanisms controlling SG traits is necessary for improving drought tolerance which may facilitate the screening and selection of wheat germplasm for drought tolerance.

Material and Methods

A pot culture experiment was conducted during *rabi* season on thirty five wheat germplasm showing diversity for SG traits with recommended package of practices for wheat. Plants were subjected to water deficit stress for 8 days after anthesis by withholding irrigation (RWC 65-70%), while in irrigated plants RWC ranged from 80-85%. The response of plants in terms of growth and physiological traits were studied in upper most fully expanded flag leaf at 50% anthesis stage.

The rate of photosynthesis (Pn) was measured using portable Infrared Gas Analyser (IRGA), LI-6400XT Model (Li-COR Ltd., Lincoln, Nebraska, USA) by operating the IRGA in the closed mode between 10.00-11.00 a.m. when relative humidity, temperature, photosynthetic photon flux density and CO2 conc. ranged from 50-60%, 30 to 35°C, 1200 µmol $m^{-2}s^{-1}$ and 350 to 360 µmol mol-1, respectively.Soil and plant analyser development (SPAD) values were measured in the middle part of flag leaves using portable Minolta SPAD-502 chlorophyll meter (Minolta camera Co. Ltd., Osaka, Japan)after flowering at the end of stress period for 8 days. The average readings of 10 leaves per pot was recorded and used in analysis. Phenotyping for leaf senescence was done visually and degree of senescenced part of flag leaf was scored using a scale from 0 to 10, dividing the percentage of estimate area that is dead by time duration in days as per Lu *et al*. (2011).

After 20 days of moisture deficit stress at 50% anthesis, LSR was scored 6 times after every 4 day interval.

$$\text{LSR} = \frac{\text{Change in the degree of senescence at two ferent time interval}}{\text{Total time duration (days)}}$$

Grain yield was recorded at physiological maturity stage, when 90% of seed changed colour from green to yellowish and stopped photosynthetic activity. The plants were harvested separately from control and water stressed pots. Measurements on grain yield per plant were recorded as economic yield. The harvest index was calculated as the ratio of the economic yield to biological yield and was expressed in percentage

HI (%) = [Economic yield/Biological yield]*100.

The drought susceptibility index was calculated using the formulae of (Fischer and Maurer, 1978). The data obtained was pooled and subjected to analysis of variance appropriate to the experimental design. F-test was carried out to test the significance of the treatment differences and the least significant difference (CRD) was computed to test the significance of different treatments at 5 % level of probability by the SPSS 10.0.

Results and Discussion

Effect of water deficit stress on SCMR and Pn of flag leaves

Plants under drought stress develop several mechanisms, which enable them to survive and

reproduce under conditions of water scarcity (Budak *et al*., 2013). Under drought stress, the primary response is inhibition of growth and acceleration of senescence process (Gepstein *et al*., 2013). SG (staygreen) lines have the ability to remain green for longer time than the NSG (non-staygreen) lines, thereby contributing to photosynthates for a longer period towards grain development under harsh environmental conditions (Reynold *et al*., 2002). Both the SCMR value and Pn decreased as the moisture deficit stress progressed in all the germplasm. The germplasm HW 4024, CHIRYA 7 and HW 2061 always exhibited higher SCMR values under moisture deficit stress condition whereas, HW 2033, CBW 38, HW 2027 and PBW 373 showed greater decline (Fig. 2). Similarly, the leaf Pn decreases significantly in all germplasm under moisture deficit stress conditions. Maximum reduction in Pn was in HW 2033, HW 4009 and SHANGHAI-1 while HW 2085, HW 4050 and CHIRYA 7 showed minimum reduction at anthesis stage (Fig. 1). Plants with SG traits showed lesser reduction in greenness index (GI) and Pn in comparison to plants with NSG traits under moisture deficit stress condition. Significant differences were observed in GI and Pn among the genotypes differing in SG traits more under water deficit stress as compared to the non-stressed wheat plants.Thus, drought induced senescence leads to a reduction in Pn and GI which was found to be more in NSG germplasm as compared to SG ones. Similar results were obtained by Gupta *et al*. (2001), where they reported that, water stress invariably reduced chlorophyll content but its reduction was lower in tolerant wheat genotypes as compared to susceptible ones. From the data, it is inferred that a better stability in the level of SCMR values under water deficit stress might be the reason for high yield stability of CHIRYA 7 under water deficit condition.

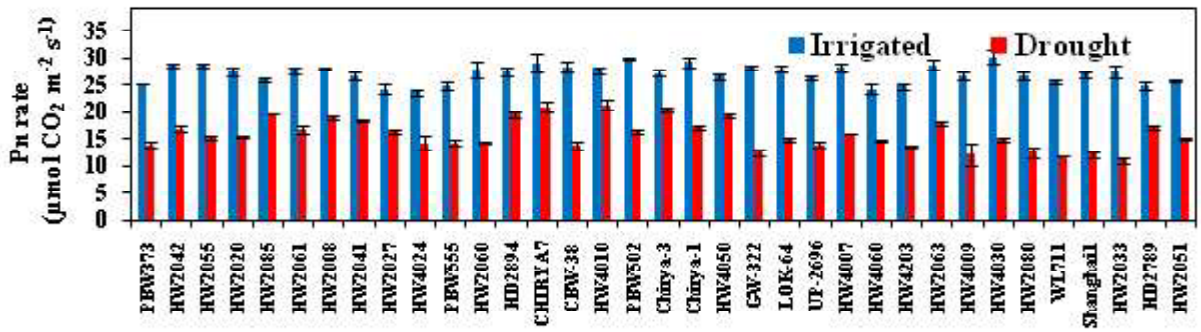

Fig 1. Effect of water deficit stress on Photosynthesis rate in wheat germplasm

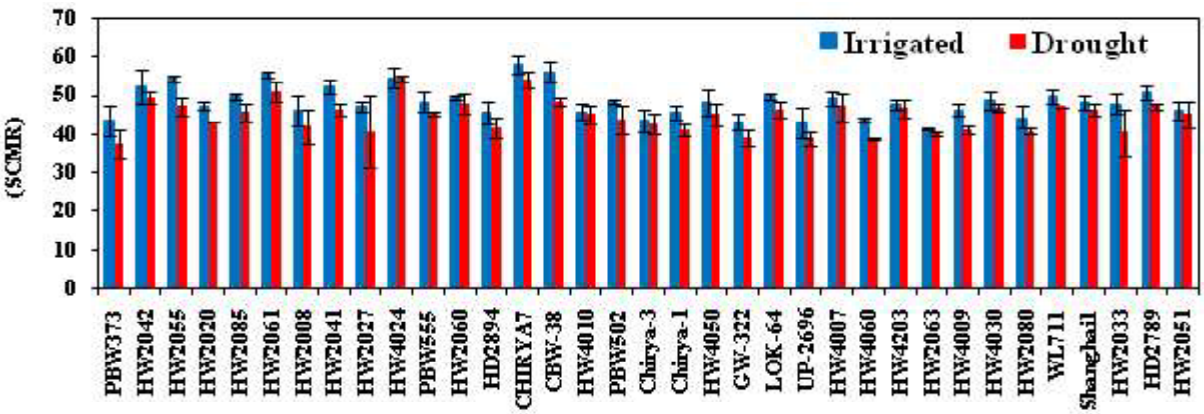

Fig 2. Effect of water deficit stress on SPAD Chlorophyll meter reading in wheat germplasm

Effect of water deficit stress on Leaf senescence rate of flag leaves

LSR was low in CHIRYA 7 followed by HW 2041, HW 2085 and HW 2061 whereas HW2033, HW 2051 and SHANGHAI 1 shows fastest LSR under moisture deficit stress condition (Fig. 3). SG germplasm displayed lesser LSR as compared to NSG germplasm and they continued to maintain their superiority under moisture deficit stress conditions. In this study we report that LSR was slow in CHIRYA 7 whereas, CBW 38 shows fastest LSR under moisture deficit stress condition. Similar findings of Muchero *et al*. (2013) suggested a robust association of the stay-green traits with grain and biomass yield under drought stress and for using delayed senescence as a rapid screening tool for post-flowering drought tolerance in cowpea breeding, specially for large number of samples in breeding programs targeting improved drought tolerance.

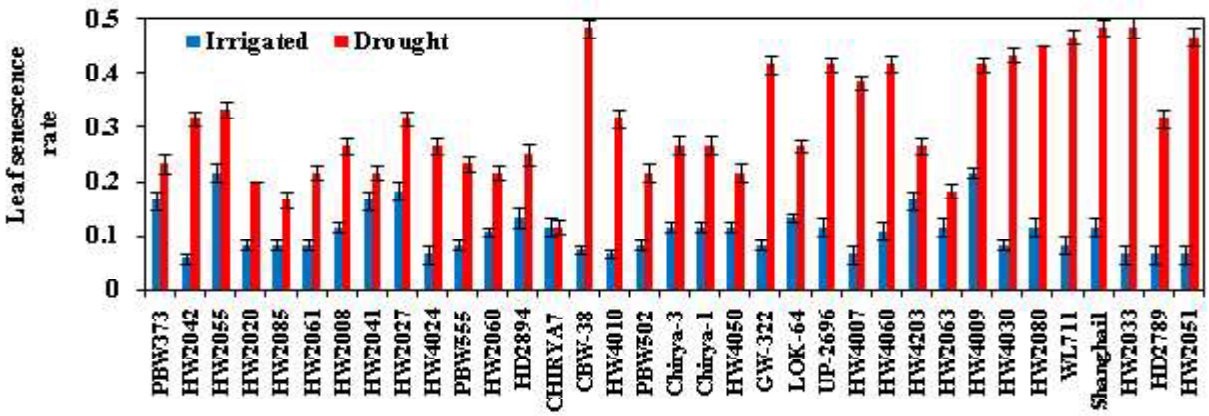

Fig 3. Effect of water deficit stress on leaf senescence rate in wheat germplasm

Effect of water deficit stress on Drought susceptibility index of yield

There were significant decrease in yield attributes viz., HI under water deficit stress in all the germplasm. While germplasm with SG traits were observed with higher yield attributes under irrigated as well as stressed condition. Highest value for HI were recorded in CHIRYA 7 followed by HW 2063 and HW 2041; whereas it is lowest in PBW 555, SHANGHAI 1, CBW 38 and GW 322 under moisture deficit stress condition. Significant differences were recorded among the germplasm on the basis of DSI. HW 2063 shows highest DSI value as compared to all other germplasm while, CHIRYA 7 show lowest DSI values (Fig. 4). Grain yield is frequently used in crops such as wheat as the main criteria for drought tolerance and selection typically involves evaluating genotypes for either high yield potential or stable performance under varying degrees of water stress as per Ahmad *et al*, (2003). The present study, showed a general reduction in yield on account of water deficit stress in all germplasm. Significant variations were observed among germplasm for yield, HI and DSI .Results of this study have showed parallelism with Mohammadi *et al*. (2011) that minimum yield reduction was realized in the genotypes which had the highest DSI values in stressed environments. Similarly, high HI in wheat genotype under moisture deficit stress is due to improved resistance to drought was reported by Austin *et al*. (1994). Similar findings by Jordan *et al*. (2012) that in sorghum hybrid cultivars, SG traits was observed to have significant yield advantages under post anthesis drought compared to control hybrid lines. As reported by Messmer *et al*. (2011) in maize

line CML444 under drought stress at flowering stage, delayed LSR can be positively correlated with higher grain yield.Thus, it is concluded that higher yield of CHIRYA 7 and other drought tolerant germplasm might be on account of its higher yield potential and functional SG traits that can be utilized for increasing yield potential through the improved dry matter production during anthesis under water limited conditions.

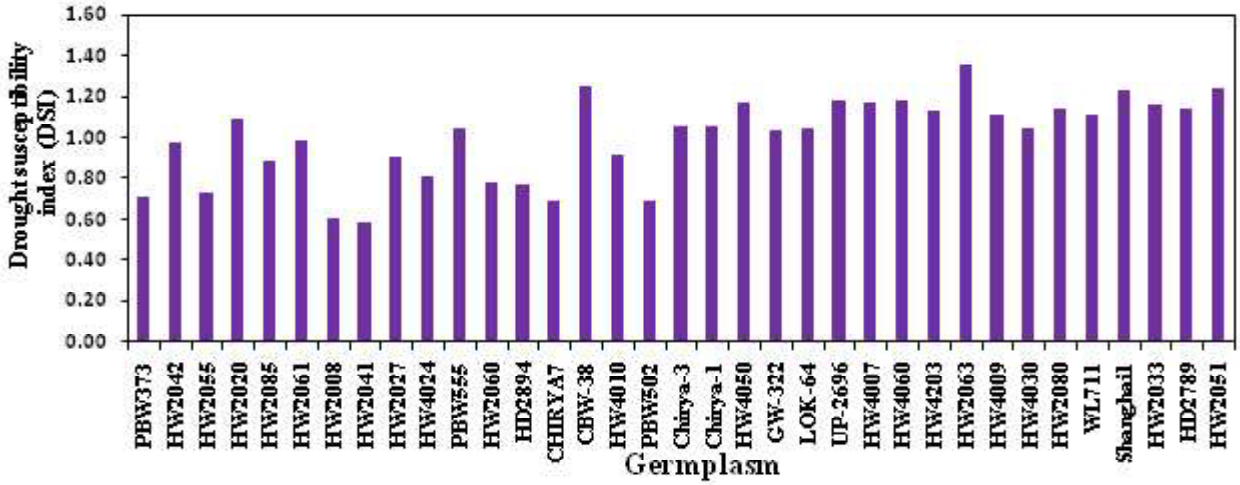

Fig 4. Effect of water deficit stress on drought susceptible index in wheat germplasm

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"Influence of water stress on productivity and biochemical constituents of Shankhpushpi (*Convolvulus pluricaulis Choisy*)

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Abstract

Water availability is one of the most limiting environmental factors affecting crop productivity. It is practically axiomatic that, crop growth is frequently subjected to water stress during the course of its life time. Stress imposed during juvenile stage drastically affects crop growth, ultimately leading to a massive loss in yield and quality. The present investigation comprised of four water stress regimes, T_1- 100% (Field Capacity), T_2- 80% water stress, T_3- 60% water stress ,T_4- 40% water stress and five replications. Shankhpushpi a potential important medicinal plant used in memory enhancer activity. It was obrserved that the plant growth was reduced under water stress but the active ingredient content was increased. Out of four water stress levels the maximum fat content was recorded in T_1 Control condition (6.23) at and minimum was estimated in T_4 - 40% water stress (4.59). Maximum crude fibre content was recorded in T_1 100% (8.02) and minimum recorded in T_3 60%(5.89).The various water stress levels significantly affected the moisture content. Maximum moisture content was recorded in T_1 100% (7.27) and minimum was recorded in T_4 40 % (4.22). The different water stress levels significantly affected the ash content. Maximum ash content was recorded in T_1 100% (7.23) and minimum was recorded in T_4 40 % (5.25). Maximum nitrogen content was recorded in T_1 100% (3.16) and minimum was recorded in T_4 (0.64). The different water stress levels significantly affected the protein (%). Maximum protein was recorded in T_1 100% (10.83) and minimum was noted in T_4 40 % (3.51). Maximum chlorophyll 'a' content was recorded in T_1 100% (0.66) and minimum was estimated in T_4 40 % (0.37). The different water stress levels affect the chlorophyll 'b' content in leaves significantly. Maximum chlorophyll 'b' content was recorded in T_1 100% (0.44) and minimum was estimated in T_4 40 % (0.26). The different water stress levels affect the carotenoids content in leaves significantly. Maximum carotenoids content was recorded in T_1 100% (0.48) and minimum was estimated in T_4 40 % (0.32). Maximum proline content was recorded in T1 100% (151) followed by T_3 60 % (166.05) and minimum proline was recorded in T_4 (105.352). Maximum scopoletin content was recorded in T_4 40 % (0.0837%) followed T_3 60% (0.0517%) and minimum was estimated in T_1 100% (0.0268%)

Keywords: Water stress, scopoletin, *Convolvulus pluricaulis*, Memory enhancer.

Medicinal plants are among the major and important group of crops (Rehm and Espig, 1991) which has been traditionally used for prevention and treatment of diseases as herbal medicines (Williamson, 2003). Shankhpushpi (*Convolvulus pluricaulis*) is commonly found in India (plains of Punjab, Uttar Pradesh, Haryana, Rajasthan, Bihar and Chota Nagpur) and Burma (Sethiya and Mishra 2010). It is one of the most prominent natural medicine, which helps in improving memory, improves complexion, increase appetite, useful in bronchitis, biliousness, epilepsy and teething troubles of infants eliminate nervous disorders and to treat hypertension (Bala and Manyam 1999); It is also used as anti-helmintic, good

in dysentery control , hair tonic, cures skin ailments (Rai 1987). It is considered to be one of the best Medhya Rasyana (Nervine tonic) in comparison to other rasyanas of ayurveda. The whole plant of *Convolvulus pluricaulis* has been reported for its use as brain tonic, memory enhancer, hair tonic, sedative,antiinflammatory,antistressand hypolipidemic agent. There are reports of secondary metabolite level increase in some plants from previous literature cited but information related to drought mediated increase in secondary metabolite level in sankhpushpi is meager. The commercial medicinal values of aromatic plants rely on the presence of different phytochemical secondary metabolites components such as tannins, alkaloids, terpenoids, and phenolic compounds that cause particular physiological effects on the human body. Indeed, water supply is one of the most determinative cultivation conditions, which essentially affect the yield and oil content of herb crops .The objective of this study was to investigate the impact of varying levels of soil moisture stress on the biochemical constituents of Shankhpushpi.

Material and methods

The experiment was conducted in the Herbal Garden of Medicinal and Aromatic Plants under the Department of Plant Physiology, College of Agriculture, JNKVV, Jabalpur during Kharif season (2016-17).The effect of water stress was assessed through a pot experiment in complete randomized design with four water stress regimes T_1- 100% (Control), T_2- 80%,T_3- 60% ,T_4- 40% .and five replications. The soil moisture content was expressed by weight as the ratio of the mass of water present to the dry weight of the soil sample, or by volume as ratio of volume of water to the total volume of the soil sample. The ratios for a particular soil sample,was determined by drying the soil to constant weight and measuring the soil sample mass before and after drying. The weight was the difference between the weights of the wet and oven dry samples. The criterion for a dry soil sample was the soil sample that had been dried to constant weight in oven at temperature between 100 - 110 °C (105 °C is typical).Forster (1995).The nitrogen and protein content was estimated by microkjeldhal distillation methods , fat,content by AOAC,1980 . Crude fiber and ash percent was estimated through the method as described by Sadasivam and Manickam (1992)., The Chlorophyll a & chlorophyll b, carotinoide,content was estimated by acetone extraction method (Yoshida *et al*. 1972) and proline content(Bates *et al*, 1972) were measured by UV spectrophotometer. The scopoletine was estimated by HPTLC methods .

Result and Discussion

The biochemical parameters were significantly affected various treatments had significant influence on proximate parameters and active ingredient content. The different water stress levels significantly affected the fat content. Maximum fat content was recorded in T_1 100% Field Capacity (6.23) at and minimum was estimated in T_4(4.59). Onwugbuta-Enyi(2004),Marting- Junior *et al*. (2008) reported that the water stress caused significant reduction ($P<0.05$) in crude fat content of leaves of O.gratissimum and G. latifolium The reduction in the crude fate content of leaves in response to water stress might be caused by breakdown of fats to form highly osmotic materials to aid the plants to with stand the stress. Research reports revealed that water stress caused reduction of fats in plants.The different water stress levels significantly affected the crude fibre content. Maximum crude fibre content was recorded in T_1 100% (8.02) and minimum recorded in T_3 (5.89).The various water stress levels significantly affected the moisture content. Maximum moisture content was recorded in $T_1$100% (7.27) and minimum was recorded in T_4 (4.22). The different water stress levels significantly affected the ash content. Maximum ash content was recorded in $T_1$100% (7.23) and minimum was recorded in

T_4 (5.25). Other researchers reported that a range of ash contents in different wheat cultivars under normal irrigation conditions from 0.50-0.45 (Raymond,1993), 0.48 (Nadeem *et al*.,2004)and 0.80 (Rehman *et al*.,2007).

The different water stress levels significantly affected the nitrogen content. Maximum nitrogen content was recorded in T_1 100% (3.16) and minimum was recorded in T_4 (0.64). The different water stress levels significantly affected the protein (%). Maximum protein was recorded in T_1 100% (10.83) and minimum was noted in T_4 (3.51). Bidwell (1979)and Hale and Orcutt (1987) observed that plants synthesize special high molecular proteins during water stress to assist them in resisting the effect of water stress. Singh *et al* (2008) and Naseri *et al*.(2010) Who revealed that with the effect of water stress the protein content in wheat increased protein contents by 10.3 -13.2% while Seleiman *et al*.(2011) reported that less irrigation and water stress increased protein content. Ghorbani Javid and colleagues (2007) reported that concentrations of soluble proteins at different levels of drought stress in the tolerant genotypes of alfalfa is almost constant that see mingly has been favorable maintaining the structure of the plant and plant activities, while in sensitive genotype with increasing stress, the concentration of soluble proteins decreased that can be caused by decreased the frequency of precursors producing protein (Substrates) and a decrease in gene expression or manifestation of their origin.

Table: 1 Effect of water stress levels on biochemical parameters of Shankhpushpi

Treatment- Water stress levels (% FC)	Fat (%)	Fiber (%)	Ash (%)	Moisture (%)	Nitrogen (%)	Protein (%)
T1- 100% FC (Control)	6.23	8.02	7.73	7.27	3.16	10.83
T2- 80% FC	5.82	7.47	6.56	6.36	2.18	8.16
T3- 60% FC	5.16	5.89	5.42	5.35	1.31	6.87
T4- 40% FC	4.59	6.00	5.25	4.22	0.64	3.51
Mean	5.45	6.84	6.24	5.80	1.82	7.34
SEm±	0.17	0.14	0.09	0.11	0.10	1.22
CD5%	0.51	0.43	0.28	0.34	0.32	3.77

The chlorophyll content of leaves and their corresponding rates of photosynthesis expressed the assimilatory rate of tissues of their leaf chlorophyll contents, which related to the synthesis of assimilates and ultimate the dry matter production .The different water stress levels affect the chlorophyll 'a' content significantly. Maximum chlorophyll 'a' content was recorded in T_1 (0.66) and minimum was estimated in T_4 40%(0.37). The different water stress levels affect the chlorophyll 'b' content in leaves significantly. Maximum chlorophyll 'b' content was recorded in T_1 100% (0.44) and minimum was estimated in T_4 (0.26). The different water stress levels affect the carotenoids content in leaves significantly. Maximum carotenoids content was recorded in T_1 100% (0.48) and minimum was estimated in T_4 (0.32). Kirnak *et al*., 2001 reported that water stress significantly decreases leaf chlorophyll (chlorophyll a, b and total chlorophyll) concentrations. Chlorophyll content

was reduced at high water stress (W1, water excess and W4, water deficit) as compared to well irrigated plants (W2 and W3).The water stress resulted in significant decreases in chlorophyll content and the leaf relative water content. Total chlorophyll content in high water stress was reduced by 55% compared to the control. The adverse effect of water stress on chlorophyll concentration has previously been shown for young peach trees by Steinberg *et al*. (1990). Kirnak *et al*. (2001), Dhindsa *et al*. (1981), Chen *et al*. (1991) have associated the increased electrolyte leakage to reductions in chlorophyll concentrations due to leaf senescence. H. Lessani and M. Mojtahedi, reported that the drought stress has been to reduce both chlorophyll content and biosynthes is. C. H. Foyer *et al*.,1994. reported that the reason for chlorophyll content reduction is that drought stress enhances the production of reactive oxygen species (ROS) such as O_2 ? and H_2O_2 that can lead to lipid peroxidation and, consequently, chlorophyll degradation.

Table:2 Effect of water stress levels on biochemical content of Shankhpushpi

Treatment- Water stress levels (% FC)	Chlorophyll a (mg/g fresh leaf weight)	Chlorophyll b (mg/g fresh leaf weight)	Carotenoids (mg/g fresh leaf weight)
T1- 100% FC (Control)	0.66	0.44	0.48
T2- 80% FC	0.64	0.35	0.42
T3- 60% FC	0.57	0.27	0.37
T4- 40% FC	0.37	0.26	0.32
Mean	0.56	0.33	0.40
SEm±	0.012	0.008	0.007
CD5%	0.037	0.026	0.022

The various water stress significantly affected the proline content. Maximum proline content was recorded in T_1 (151) followed by T_3 (166.05) and minimum proline was recorded in T_4 (105.352) Griffin and colleagues (2004) in their study on Judas tree and Mehrabi (2009) on sesame reported proline increased under drought stress. Akhondi and colleagues (2007) and Kydamby and colleagues 1990) in their experiments on the alfalfa reported the effect of drought stress on proline. Maximum scopoletin content was recorded in T_4 (0.0837%) followed T_3 (0.0517%) and minimum was estimated in T_1 (0.0268%) Nogués *et al.* (1998), who reported a significant increase in the concentration of phenolic compounds in stressed pea (*Pisum sativum*). Manukyan (2011), who detected only a slight drought stress-related increase in monoterpene concentration (terpenes g^{-1} biomass) in catmint and lemon balm plants, calculated and reported a stress-related decrease in the total content of terpenoids per plant in *Melissa officinalis, Nepeta catariaand Salvia officinalis*.

Table:3 Effect of water stress levels on proline and scopoletin content of Shankhpushpi

Treatment- Water stress levels (% FC)	Proline (mol/g)	Scopoletin (%)
T1- 100% FC (Control)	105.35	0.0268
T2- 80% FC	117.69	0.0385
T3- 60% FC	121.47	0.0517
T4- 40% FC	151.47	0.0837
Mean	123.99	0.0502
SEm±	0.08	0.0002
CD5%	0.24	0.0006

CONCLUSIONS

Water availability is considered as a determinant factor that affects plant growth and development. Water of heaving herbs stress on the medicinal plants positively affects active substances (constituents). Shankhpushpi (*Convolvulus pluricaulis* Choisy) rich in secondary metabolites which are potential sources of drugs and essential oils. Increasing levels of water stress progressively increased proline content along with active ingredient.The reduction in chlorophyll a, chlorophyll b, carotenoids, fat, fiber, ash, moisture, nitrogen, protein with the increase in proline & scopoletin content when the water content of soil was reduced to 40% from 100% i.e. control.

Acknowledgement

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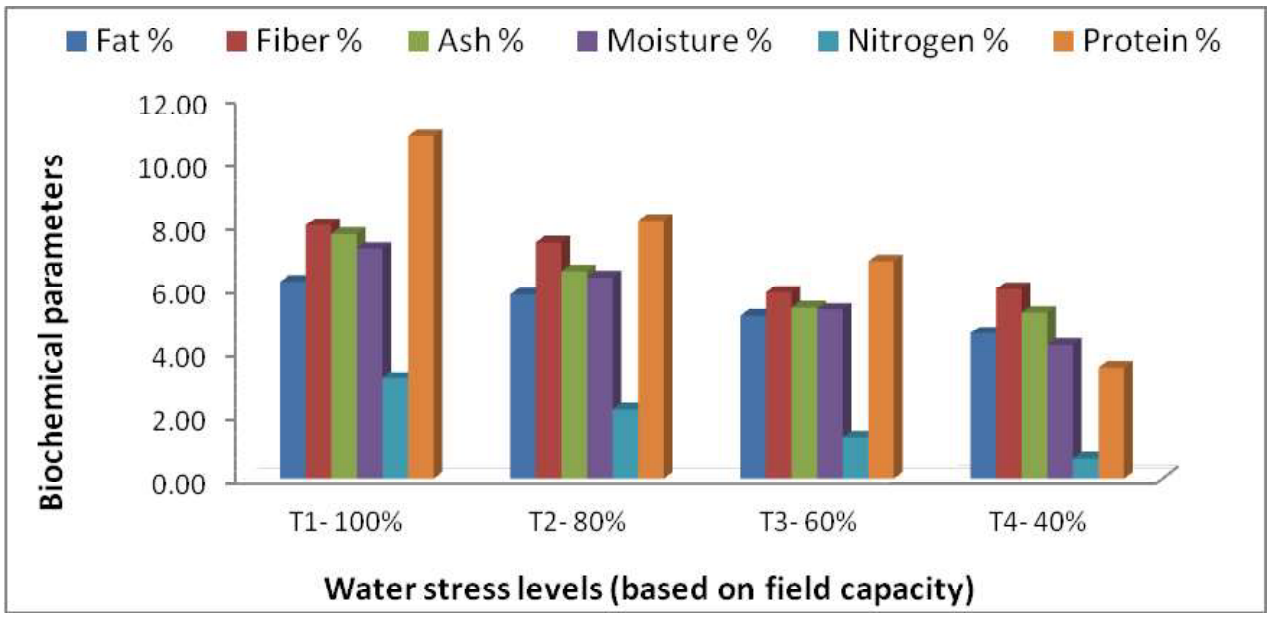

Fig : 1 Effect of water stress levels on biochemical parameters of Shankhpushpi.

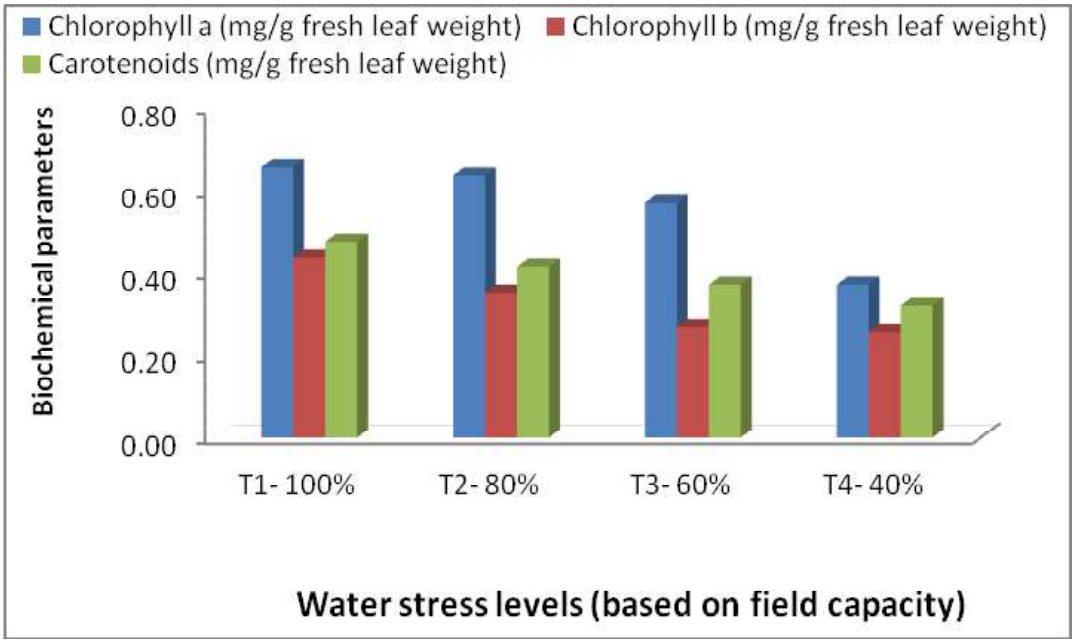

Fig 2: Effect of water stress levels on biochemical content of Shankhpushpi

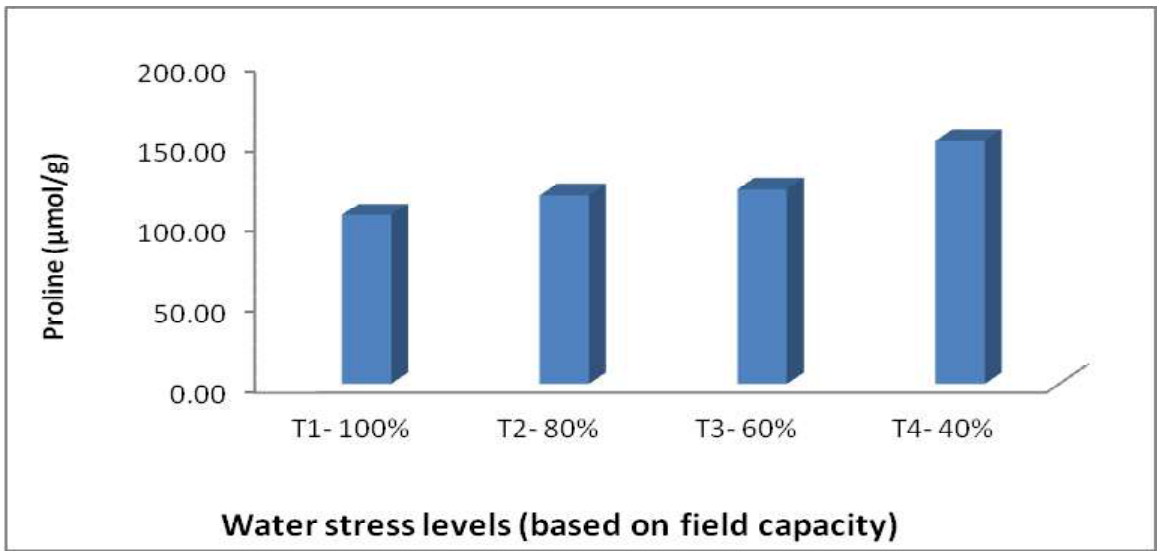

Fig 3: Effect of water stress levels on proline content of Shankhpushpi

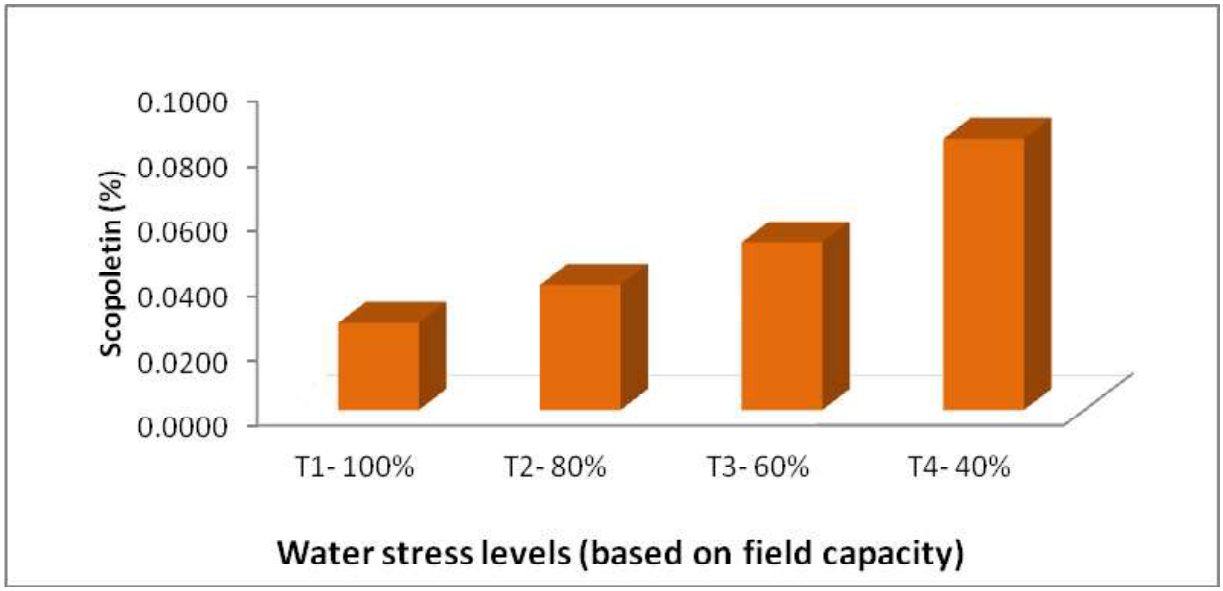

Fig 4: Effect of water stress levels on Scopoletin content of Shankhpushpi

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Production Potential of wheat under pruning intensities of *Dalbergia sissoo Roxb*. and Agronomical management: An Agroforestry Approach

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Abstract

The study was undertaken to find out the growth characters of wheat crop under Dalbergia sissoo based agro forestry, during the year 2016-17, in 20 years old *D. sissoo* plantation, planted at a distance of 5 m X 5 m. Wheat variety GW-173 was sown @ 80 Kg/ha at 20 cm apart. The soil of the experimental field was clay loam in texture and almost neutral in reaction. The available NPK content in the soil were 288 (medium), 20 (medium) and 170 (very low) kg/ha, respectively. Agroforestry is one of the best option to increase the tree cover outside the forest. The need of Agro Forestry has been necessitated in many parts of the country. This will help to get potential returns from wheat based Agroforestry system.

The results revealed that significantly maximum grain and straw yield were recorded under open conditions (27.3, 41.8 q/ha, respectively). The reduction in grain and straw yield due to shade was 39.92 % and 20.81 %, respectively. Among the different pruning intensities, 75% pruning produced the maximum grain (24.4 q/ha) and straw (40.69 q/ha) yield. The percent reduction in great yield under no pruning, 25% pruning, 50% pruning and 75% pruning was 39.92 %, 30.40%, 21.61% and 10.62 %, respectively. In Agronomical management, 25% more nitrogen than recommended dose gave significantly higher grain yield (24.8 q/ha) as compared to recommended dose of nitrogen and seed rate (21.7 q/ha). Wheat with *D. sissoo* in 25% pruning intensity, with 25% more nitrogen than recommended dose, produced the maximum economic return, as compared to crop alone and tree alone.

Key words: Growth characters, Pruning intensity, Agronomical management, Yield, Economic return.

Introduction

In the State of Madhya Pradesh, as traditional agroforestry system, tree legumes namely, *Acacia nilotica, Butea monosperma and Dalbergia sissoo* are found growing, respectively for fuel, fodder and small timber purpose in both extensive grazing system and in association with field crop. The most suitable trees for agroforestry systems are those having less spread canopy, fast growth, clean bole, nitrogen fixing capacity and protein rich fodder. Dalbergia sissoo is one of the moderately fast growing and nitrogen fixing tree, has an advantage to include in agro forestry system. In India, wheat is grown in an area of about 31.2 m. ha with production of 95.9 m. tons and productivity, 3075 kg per ha. Wheat can be grown successfully in open conditions and in association with *Dalbergia sissoo*.

As the tree grows, they produce shading effect on associated crop reduce yield because of insufficient penetration of light to the crop under the tree. Silviculture management like thinning, pruning, etc. can reduce shedding effect to some extent. Pruning provides woody biomass for the fire wood and leaf biomass for fodder. In pruning the removal of some part of the tree or crown will obviously reduce the competition ability of tree because crown management will facilitate more light to underneath crops and reduce demand of moisture and nutrients.

Beside these, some agronomical management like

increasing fertilizer dose, seed rate etc. also helpful in increasing the crop yield. Higher yields can be achieved by adjusting plant population based on higher seed rate. Management practices are very necessary to get optimum production from an agroforestry system. Pruning reduced the competitive ability of the trees, which allow the crop to take advantage of higher nutrient availability and facilitated penetration of sunlight. Light is a critical factor affecting the performance of field crops under agro forestry interventions.

Dalbergia sissoo is a tropical leguminous tree, which is most widely cultivated and economically important tree species. It is an important timber tree, and also known for the production of firewood, shade, shelter and fodder (Tewari, 1994). Pruning is being used as a cheap and effective cultural technique for regulating the cropping pattern, yield and quality. However, severe pruning should be avoided because it affects the growth and yield adversely. (Singh and Sandhu, 1984)

Keeping the above facts in view, the present investigation was undertaken.

Material and methods

The study was initiated to find out the growth characters of wheat crop under *Dalbergia sissoo Roxb*. based agrisilviculture system of Agro-forestry during the year 2016-17 in 20 years old *Dalbergia sissoo* plantation, planted at a distance of 5 m X 5 m. The soil of the experimental field was clay loam in texture and almost neutral in reaction. The available nitrogen, phosphorus and potash in the soil were 288 (medium), 20 (medium) and 170 (very low) kg/ ha, respectively. Jabalpur is situated at $23^0$3" North Latitude and 79.5^o5" East Longitude with an altitude of 411.78 m above mean sea level. It comes under the Agro climatic regions classified as Kymore Plateau and Satpura Hills and is broadly known as Rice-Wheat Crop Zone of Madhya Pradesh. The climate of the region is sub-tropical with hot dry summer and cold dry winter. The mean annual rainfall of Jabalpur is 1250 to 1400 mm mostly received between mid of June to September with occasional rains during winter. The mean monthly temperature reaches as high as 45 ^{0}C during summer. The field experiment was conducted in Strip Plot Design, with 5 replications, keeping the pruning intensities in main treatment, i.e. Po - No Pruning, P1 = 25% pruning, P2 = 50% Pruning and P3 = 75% Pruning, compared with open conditions and agronomical management, i.e. F1 - Recommended dose of fertilizer (120: 60: 40 NPK Kg/ha) + seed rate (100 kg/ha), F2 - F1 + 25% more nitrogen than recommended dose and F3 - F1 + 25% more seed rate than recommended dose. Wheat variety GW173 was sown @ 80 kg/ha, with 20 cm rows apart. The study was initiated on these aspects: - Plant height (cm) at different growth stages, Number of tillers per m row length at different growth stages, Fresh weight of wheat plant (g), Dry weight of wheat plant (g),Crop shoot biomass (q/ha), Grain yield (q/ha), Straw yield (q/ha), Harvest index (%), 1000 grain weight (g) and Economics of the treatment (Rs./ha).

Result and discussion

Effect of Pruning Intensity

Plant height

Effect of different pruning intensities on plant height was found significant in all successive observation recorded at crown root initiation, late tillering, late jointing, flowering, milk and dough stages (Table 1). Observations recorded at different growth stages i.e. crown root initiation, late tillering, late jointing, flowering, milk, dough stages showed that open condition recorded significantly higher plant height (9.4, 40.6, 63.2, 67.0, 64.2 and 63.9 cm) whereas no pruning recorded significantly lowest plant height (7.3, 34.1, 60.3, 61.3, 60.9 and 61.9 cm) respectively. Increase in pruning intensities, increased the plant height hence 75% pruning recorded significantly higher plant height closely followed by 50 % pruning and was superior to no pruning. This was found in all the observation recorded at crown root initiation,

late tillering, late jointing, flowering, milk and dough stages. At harvest open condition recorded significantly higher plant height (64.0 cm) closely followed by 75% pruning (63.0 cm) and 50% pruning (62.3 cm). This was significantly superior to 25% pruning (61.8 cm) No pruning recorded the lowest plant height (61.6 cm).

Effect of Agronomical Management

Agronomical management showed significant effect on plant height at different growth stages i.e. crown root initiation, late tillering, late jointing, flowering, milk and dough stages (Table 1).Treatment F2 - F1+ 25% higher nitrogen level than recommended dose recorded significantly higher plant height (9.4, 39.0, 63.3, 66.0, 64.2 and 63.8 cm) which was at par with F3 - F1+ 25% more seed rate than normal (8.2, 37.9, 61.7, 65.3, 61.8 and 62.7cm) and both were significantly superior to control F1 - recommended dose of fertilizer and seed rate produced the plant height of 7.6, 36.0, 60.2, 64.1, 61.3 and 61.3 cm at crown root initiation, late tillering, late jointing, flowering, milk and dough stages respectively. At harvest F2 recorded significantly higher plant height (63.9 cm) which is superior to F1 (61.1cm).

Table 1. Effect of different treatments on plant height (cm) at different growth stages

	Growth stages of wheat						
Treatment	**CRI**	**LT**	**LJ**	**F**	**M**	**Dough**	**At harvest**
Pruning Intensity							
P0 - No pruning	7.3	34.1	60.3	61.3	60.9	61.9	61.6
P1 - 25% pruning	8.3	36.5	61.4	64.7	61.8	62.1	61.8
P2 - 50% pruning	8.4	37.9	61.7	66.2	62.0	62.2	62.3
P3- 75% pruning	8.7	39.0	62.1	66.4	63.0	62.9	63.0
Open - No tree	9.4	40.6	63.2	67.0	64.2	63.9	64.0
SEm±	0.2	0.5	1.0	0.7	1.0	1.0	1.1
CD (P = 0.05)	0.5	1.7	3.0	2.0	3.0	3.0	3.3
Agronomical management							
F1 - [Recommended dose of SR and FD (control)	7.6	36.0	60.2	64.1	61.3	61.3	61.1
F2 - [F1+25% more nitrogen than recommended dose	9.4	39.0	63.3	66.0	64.2	63.8	63.9
F3- [F1+25% more seed Rate than recommended dose]	8.2	37.9	61.7	65.3	61.8	62.7	62.6
SEm±	0.4	0.7	0.9	0.6	0.7	0.9	0.9
CD (P = 0.05)	1.3	2.4	3.0	2.0	2.4	3.1	2.6
Interaction (Main × Sub)							
SEm±	0.7	1.0	1.3	0.8	1.4	1.6	1.5
CD (P = 0.05)	2.2	3.0	3.8	2.4	4.0	4.6	4.2

SR - Seed rate, FD - Fertilizer dose

Number of tillers per meter row length

Different pruning intensities showed significant effect on number of tillers/MRL was found significant in all

successive observation recorded at late tillering, late jointing, flowering, milk, and dough stages (Table 2). Observation recorded at late tillering, late jointing, flowering, milk, and dough stages showed that open condition recorded significantlyhigher number of tillers/MRL (88.1, 95.1, 94.5, 95.9 and 96.5) closely followed by 75% pruning (87.1, 91.3, 92.3, 91.1 and 90.9) followed by 50% pruning (85.7, 89.8, 91.6, 89.5 and 90.3) whereas, no pruning recorded significantly lowest number of tillers/MRL(75, 79.9, 83.5, 81.2 and81.8)and superior to no pruning. This was found in all the observation recorded at late tillering, late jointing, flowering, milk, and dough stages. At harvest 75% pruning recorded significantly higher number of tillers/MRL(90.6) than 50% pruning (89.4) and 25% pruning (87.3) and recorded significantly higher number of tillers/MRL than no pruning (80.9). These findings are also collaborated with the findings Puri et al. 2001.

Effect of Agronomical Management

The fertilizer doses and seed rate showed significant effect on number of tillers/MRL at late tillering, late jointing, flowering, milk, and dough stages (Table 2). Treatment - F1 + 25% more nitrogen than recommended dose of fertilizer and seed rate recorded significantly higher number of tillers/MRL at late tillering (84.9), late jointing (91.8), flowering (92.2), milk (92.1) and dough (93.5) at par with F3. F1 - Recommended dose of seed rate and fertilizer dose which recorded significantly lowest number of tillers/meter row length at late tillering (81.6), late jointing (86.4) flowering (88.2), milk (86.2) and dough (87.1).Similar result was also recorded at harvest stage. These findings are similar as reported by Singh *et. al.* 1993.

Table 2. Effect of different treatments on number of tillers/meter row length at different growth stages

	Growth stages of wheat					
Treatment	**LT**	**LJ**	**F**	**M**	**Dough**	**At harvest**
Pruning Intensity						
P0 - No pruning	75.0	79.9	83.5	81.2	81.8	80.9
P1 - 25% pruning	83.0	88.5	89.7	86.8	89.1	87.3
P2 - 50% pruning	85.7	89.8	91.6	89.5	90.3	89.4
P3- 75% pruning	87.1	91.3	92.3	91.1	91.9	90.6
Open - No tree	88.1	95.1	94.5	95.9	96.5	95.1
SEm±	1.1	1.7	1.2	1.5	1.2	1.2
CD (P = 0.05)	3.2	5.0	3.5	4.4	3.8	3.7
Agronomical management						
F1 - [Recommended dose of SR and FD (control)	81.6	86.4	88.2	86.2	87.1	85.9
F2 - [F1+25%more nitrogen than recommended dose	84.9	91.8	92.2	92.1	93.5	92.5
F3 - [F1+25% more seed rate than recommended dose	84.7	88.6	90.6	88.4	89.2	87.6
SEm±	1.2	1.6	1.2	1.6	1.5	1.6
CD (P = 0.05)	3.8	5.7	4.1	5.3	5.0	5.1
Interaction(Main × Sub)						
SEm±	1.7	2.9	2.0	2.8	2.7	3.0
CD (P = 0.05)	4.8	8.5	5.7	8.0	7.7	8.6

SR - Seed rate, FD - Fertilizer dose

Effect of Pruning intensity

Fresh weight

At grain formation stage

Different pruning intensities showed significant effect on fresh weight of wheat. Open condition recorded significantly highest fresh weight of wheat crop (6.6 g) than the pruning treatments (Table 3). Among different pruning intensities 50 % pruning showed significant effect (6.3 g) than to 75% pruningand 25% pruningbut significantlysuperior tono pruning. No pruning recorded significantly lowest fresh weight (5.4 g) at par with 25% pruning (5.6 g).

At harvest

Different pruning intensities showed significant effect on fresh weight of wheat (Table 3).Open condition recorded significantly highest fresh weight of wheat crop (11.6 g) than the pruning treatments. Among different pruning intensities 50 % pruning showed significant effect (11.3 g) than to 75% pruning (11.0g)and 25% pruningbut significantly superior to no pruning. No pruning recorded significantly lowest fresh weight (10.6 g) at par with 25% pruning (10.7 g).

Oven dry weight

At grain formation stage

Different pruning intensities showed significant effect on oven dry weight of wheat crop (Table 4.3). Open condition recorded significantly highest fresh weight of wheat (2.1g) than the pruning treatments. Among different pruning intensities 75 % pruning showed significant effect (2.0 g) at par with 50% pruning (1.9 g) but significantly superior to no pruning and 25% pruning. No pruning recorded significantly lowest oven dry weight (1.7 g) at par with 25% pruning (1.8 g).

At harvest

Different pruning intensities showed significant effect on oven dry weight of wheat crop (Table 3). Open condition recorded significantly highest fresh weight of wheat (4.4 g) than the pruning treatments. Among different pruning intensities 75 % pruning showed significant effect (4.0 g) at par with 50% pruning (3.8 g) but significantly superior to no pruning and 25% pruning. No pruning recorded significantly lowest oven dry weight (3.5 g) at par with 25% pruning (3.7 g).

1000 grain weight

Pruning intensities shows significant effect on 1000 grain weight. Open condition recorded higher 1000 grain weight (30.9 g), which was at par with 75% pruning (29.9 g). Among different pruning intensities 75% pruning recorded highest test weight. No pruning recorded significantly the lowest test weight (26.5 g). Agronomical management showed no significant effect on 1000 grain weight.

Effect of Agronomical Management

Fresh weight

At grain formation stage

Agronomical management level of fertilizer doses and seed rate showed significant effect on fresh weight of wheat crop (Table 3). F2 - F1 + 25% more nitrogen than recommended dose recorded highest fresh weight of wheat crop (6.6 g)significantly superior to F3 - F1+ 25% more seed rate than recommended dose (6.0 g) and F1- Recommended dose of seed rate and fertilizer dose (5.5g).

At harvest

Agronomical management fertilizer doses and seed rate showed significant effect on fresh weight of wheat crop (Table 3). F2 - F1 + 25% more nitrogen than recommended dose recorded highest fresh weight of wheat crop (11.6 g) at par with F3 - F1+ 25% more seed rate than recommended dose but significantly superior to F1- Recommended dose of seed rate and fertilizer dose (10.4 g).

Oven dry weight

At grain formation stage

Agronomical management levels offertilizer dose and seed rate showed significant effect on oven dry weight of wheat crop (Table 3). F3 -F1+ 25% more seed rate than recommended dose recorded highest oven dry weight of wheat crop (2.1 g) at par with F2 - F1 + 25% more nitrogen than recommended dose but significantly superior to F1- Recommended dose of seed rate and fertilizer dose (1.6 g).

At harvest

Agronomical management levels of fertilizer dose and seed rate showed significant effect on oven dry weight of wheat crop (Table 3). F3 -F1+ 25% more seed rate than recommended dose recorded highest oven dry weight of wheat crop (4.1 g) at par with F2 - F1 + 25% more nitrogen than recommended dose but significantly superior to F1- Recommended dose of seed rateand fertilizer dose (3.5 g).

Table 3. Effect of different treatment on fresh and oven dry weight of wheat at different growth stages

Treatment	Fresh weight (g)		Oven dry weight (g)		1000 grain weight (g)
	Grain formation stage	At harvest	Grain formation stage	At harvest	
Pruning Intensity					
P0 - No pruning	5.4	10.6	1.7	3.5	26.5
P1- 25% pruning	5.6	10.7	1.8	3.7	27.2
P2- 50% pruning	6.3	11.3	1.9	3.8	27.9
P3- 75% pruning	6.2	11.0	2.0	4.0	29.9
Open(crop alone)	6.6	11.6	2.1	4.4	30.9
SEm±	0.1	0.2	0.1	0.1	0.8
CD (P = 0.05)	0.4	0.7	0.2	0.2	2.4
Agronomical management					
F1- [Recommended dose of SR and FD (control)]	5.5	10.4	1.6	3.5	28.0
F2-[F1+25%more nitrogen than recommended dose]	6.6	11.6	2.0	4.0	28.4
F3- [F1+25% more SD than recommended dose]	6.0	11.1	2.1	4.1	29.1
SEm±	0.1	0.4	0.2	0.1	0.7
CD (P=0.05)	0.5	1.1	0.4	0.3	NS
Interaction (Main × Sub)					
SEm±	0.3 0.6	0.1	0.1		
CD (P = 0.05)	0.8 1.6	0.3	0.4		

SR - Seed rate, FD - Fertilizer dose

Grain Yield (Q/ha)

Effect of Pruning intensity

Significantly maximum grain yield was recorded under open conditions (27.3 q/ha), which in turn was superior to all pruning treatments. Among the different pruning intensities, 75% pruning recorded the maximum grain yield (24.4 q/ha), as compared to 50% pruning (21.4 q/ha) and 25% (19.0 q/ha). No pruning recorded the lowest grain yield (16.4 q/ha). The percent reduction in grain yield under no pruning, 25%, 50% and 75% pruning, as compared to open condition was 39.92 %, 30.40%, 21.61% and 10.62%, respectively. (Table 4). The similar results has been documented earlier by Newaj *et. al*. 2010.

Effect of Agronomical Management

Under Agronomical management, 25% more nitrogen than recommend dose gave significantly higher grain yield, (24.8 q/ha) as compared to 25% more seed rate than recommended dose (21.7 q/ha). The recommended dose of seed rate and fertilizer, recorded the lowest grain yield (19.1 q/ha). The percent increase in yield by increasing 25% more nitrogen than recommended dose of fertilizer and seed rate and 25% more seed rate than recommended seed rate and fertilizer dose as compared to recommended dose of seed rate and fertilizer.(Table 4)

Table 4. Grain yield, straw yield and harvest index of wheat as influenced by different pruning intensities and agronomical management in agroforestry

Treatments (qha^{-1})	Grain yield (qha^{-1})	Straw yield	Harvest Index (%)	
Pruning intensities				
P0 - No pruning	16.4	33.1	33.1	
P1 - 25% pruning	19.0	34.1	35.7	
P2 - 50% pruning	21.4	37.5	36.3	
P3 - 75% pruning	24.4	40.6	37.5	
Open (crop alone)	27.3	41.8	39.5	
SEm +-	0.8	2.4	2.5	
CD (P= 0.05)	2.3	7.3	NS	
Agronomical management				
T1 - [Recommended dose of SR and FD (control)]	19.1	36.4	34.4	
T2 - [T1 + 25% more nitrogen than recommended dose]	24.8	39.1	40.3	
T3 - [T1 + 25% more seed rate than recommended dose]		21.7	36.7	35.6
SEm +-		1.0	1.5	1.5
CD (P = 0.05)		3.3	NS	4.9

Net Monetary Return

Different pruning treatments showed significant effect on net monetary return. 25% pruning recorded significantly higher monetary return, as compared to 50% pruning and 75% pruning. Under managed Agro Forestry system, i.e. wheat + sissooin 25% pruning recorded higher monetary return (Rs. 89382 q/ha) when 25% more nitrogen than recommended dose was applied, as compared to crop alone, tree alone and unmanaged Agro Forestry system, i.e. no pruning (Table 5). The results were also confirm by Chaturvedi 1991 and Mishra 2014.

Benefit Cost Ratio

In Agro Forestry system, the maximum B : C ratio was recorded in no pruning (5.80) as compared to 25% pruning, (4.46). Significantly the lowest B : C ratio was recorded with 75% pruning (2.62), which was at par with open conditions. (Table 5)

Table 5. : Economic analysis of different treatments on per hectare area basis

Treatments	Cost of cultivation (Rs / ha)	Gross monetary return (Rs / ha)	Net monetary return (Rs / ha)	Benefit Cost Ratio
No pruning + T1	13000	71035	58035	4.46
No pruning + T2	13000	88500	75500	5.8
No pruning + T3	13000	81985	68985	5.3
Tree alone (No crop)	5000	42665	34665	4.33
25% pruning + T1	20000	93812	73812	3.69
25% pruning + T2	20000	109382	89382	4.46
25% pruning + T3	20000	95069	75069	3.75
Tree alone (No crop)	10000	63946	53946	5.39
50% pruning + T1	22000	95355	73355	3.33
50% pruning + T2	22000	98489	76489	3.47
50% pruning + T3	22000	96175	74175	3.37
Tree alone (No crop)	10000	56176	46176	4.61
75% pruning + T1	24000	81110	57110	2.37
75% pruning + T2	24000	86932	62932	2.62
75% pruning + T3	24000	83419	59419	2.47
Tree alone (No crop)	10000	32198	22198	2.21
Open crop only T1	15000	50410	35410	2.36
Open crop only T2	15000	58777	43777	2.91
Open crop only T3	15000	54955	39955	2.66

" Sale rate of wheat, pruned biomass and tree biomass as fuel @ Rs. 15, 3 and 5 per Kg, respectively.

" Cost of cultivation of wheat, *Dalbergia sissoo* was Rs. 15645/ha and Rs. 5000/ha per year, respectively.

Conclusion

From the above findings, it may be concluded that among the different pruning intensities, 75% pruning produced the maximum grain (24.4 q/ha) and straw (40.69 q/ha) yield. The percent reduction in grain yield under no pruning, 25% pruning, 50% pruning and 75% pruning was 39.92 %, 30.40%, 21.61% and 10.62 %, respectively. In Agronomical management, 25% more nitrogen than recommended dose gave significantly higher grain yield (24.8 q/ha) as compared to recommended dose of nitrogen and seed rate (21.7 q/ha). Wheat with *D.sissoo* in 25% pruning intensity, with 25% more nitrogen than recommended dose, produced the maximum economic return, as compared to crop alone and tree alone.

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Use of Geographical Information System for estimation of rainfall erosivity factor (R) of universal soil loss equation for soil erosion modelling in Banjar River watershed

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Abstract

The present paper contributes to the quantitative assessment of Universal Soil Loss Equation's Rainfall Erosivity (R) from average annual rainfall depth in a data scarce region of Banjar River Watershed. Rainfall erosivity, considering rainfall amount and intensity, is an important parameter for soil erosion risk assessment under future land use and climate change. Despite its importance, rainfall erosivity is usually implemented in models with a low spatial and temporal resolution. This study is concentrated on Banjar River watershed which lies in Narmada Basin in Balaghat and Mandala districts of Madhya Pradesh, India. It covers a total geographical area of 240423 ha with annual rainfall of watershed is 1300 mm. Rainfall depth from three raingauge locations in the watershed was collected and a simple model was employed for rainfall erosivity estimation. The main objective of this study was to estimate rainfall erosivity factor (R) values for the study area. The R map of the area was prepared with the help of thiessen polygon technique by using ArcGIS software. The final rainfall erosivity factor (R) map was generated using the empirical equation in Spatial Analyst tool of ArcGIS 9.3 software. It was found that R factor value of the study area varies between 362.89 and 792.59.

Keywords : Universal soil loss equation, Rainfall erosivity, Banjar River, ArcGIS

Rainfall drives the process of soil erosion by water (Petrovsek and Mikos, 2004). The parameter that is often used to describe rainfall in the process of soil erosion is the USLE's R factor. Climate change may lead to changes in rainfall characteristics and is thus a major concern to soil conservation. The relation between rainfall and sediment yield is given by the rainfall erosivity, which quantifies the kinetic energy of raindrop impact. The rainfall erosivity factor (R) in the Universal Soil Loss Equation (USLE) is generally recognized as one of the governing parameters for the prediction of the erosive potential of raindrop impact (Loureiro and Coutinho, 2001).The original method to calculate the erosivity values for a storm event requires pluviographic records (Wischmeier and Smith, 1978). Due to limited availability of long precipitation time series with a high temporal resolution, several alternative strategies have been deployed based on the rainfall volume (instead of intensity) for R-factor estimation (Meusburger *et al*. 2012). Hence it is important to accurately determine

spatial distribution of rainfall erosivity for quantitative estimation of soil erosion. Universal Soil Loss Equation (USLE) was designed to predict longtime average soil losses by runoff from specific field areas in specified cropping and management systems. The USLE (Wischmeier and Smith, 1978) estimates the average annual soil loss from:

$$A = R.K.LS.C.P$$

Where, A is the estimated soil loss per year, R is the runoff factor, K is the soil erodibility factor, LS is the slope length and steepness factor, C is the cover and management factor and P is the support practice factor (Wischmeier and Smith, 1978). The R factor expresses the erosive power of rainfall corresponding to the amount and intensity of rainfall over the year (erosivity index unit) at a particular location. An increase in the intensity and amount of rainfall results in an increase in the value of R. The K factor expresses inherent erodibility of the soil or surface material. The value of "K" is defined as a function of the particle-size distribution, organic-matter content, structure, and permeability of the soil or surface topography, specifically hill-slope length and steepness, on soil erosion. An increase in hill-slope length and steepness results in an increase in the LS factor. The C cover-management factor is used to express the effect of plants and soil cover. Plants can reduce the runoff velocity and protect surface pores. The C-factor measures the combined effect of all interrelated cover and management variables, and it is the factor that is most readily changed by human activities. The P factor is the support practice factor. It expresses the effects of supporting conservation practices, such as contouring, buffer strips of close growing vegetation, and terracing on soil loss at a particular site. A good conservation practice will result in reduced runoff volume, velocity and less soil erosion. The USLE concept has more recently been modified and adapted by a large number of researchers by including additional data and incorporating research results. One of the most important parameters in USLE is the rainfall erosivity factor (R) that represents/describes the potential for soil to be washed off from disturbed, unvegetated areas into surface waters during a storm. The R factor reflects the effect of intensity of the rainfall event on the soil erosion rate. The R factor indicates how rainfall distribution affects the average annual soil loss and how that soil-loss potential will be distributed in space during different seasons and cover conditions (Van der Knijff *et al*. 2000). Vegetation cover protects the soil by dissipating the raindrop energy before reaching the soil surface. As such, soil erosion can be effectively limited with proper management of vegetation, plant residue, and tillage (Lee 2004). In USLE the R factor is computed using an empirical equation that

requires intensity data (Wischmeier and Smith, 1978; Renard *et a*l. 1997).However, the erosivity estimation relationships for specific locations remain still difficult to be developed on homogeneous bases of data over broad areas where spatial-time variability of climatic variables is high. There have been few attempts to assess rainfall erosivity at large spatial scales. At global scale, Yang *et al*. (2003) identified alternate power and polynomial relationships between annual values of rainfall erosivity and precipitation. In Indian context, Babu *et al*. (2004) established linear relationships between average annual and seasonal rainfall to compute rainfall erosivity. This study aimed to evaluate the spatial distribution of rainfall and to produce rainfall erosivity map for the considered watershed. In present study estimation of rainfall erosivity was carried out for 5 years (2011-2015) and with 30 m × 30 m cell size for the preparation of the R-thematic maps of the area.

Study area

The present study has been carried out in a watershed (Banjar river watershed) of Narmada basin (Fig 1) lies in between Balaghat and Mandla districts of Madhya Pradesh, geographically located

between 22^{0}05'N to 23^{0}29'N latitudes and 80^{0}22'E to 81^{0}00'E longitudes. The watershed covers total geographical area of 240423 ha up to gauging point. It is situated in the eastern part of Madhya Pradesh. Climate of the area is tropical with moderate winter and severe summers and well distributed rainfall received from southwest monsoon. However due to higher general elevation and abundance of forests, summer temperature do not rise as much as in other areas. The normal annual rainfall of the Banjar river watershed is 1300 mm. Soils of the area are characterized by black grey, red and yellow colours, often mixed with red and black alluvium and ferruginous red gravel or lateritic soils. These soils are commonly known as black soils. In most parts of the study watershed, topsoil is loamy and the subsoil is sandy clay loam except in alluvial deposits that have relatively heavy texture of clay. In barren areas where soil is shallow, fine platy structure surface soil and compressed blocky structure subsurface soils are visible.

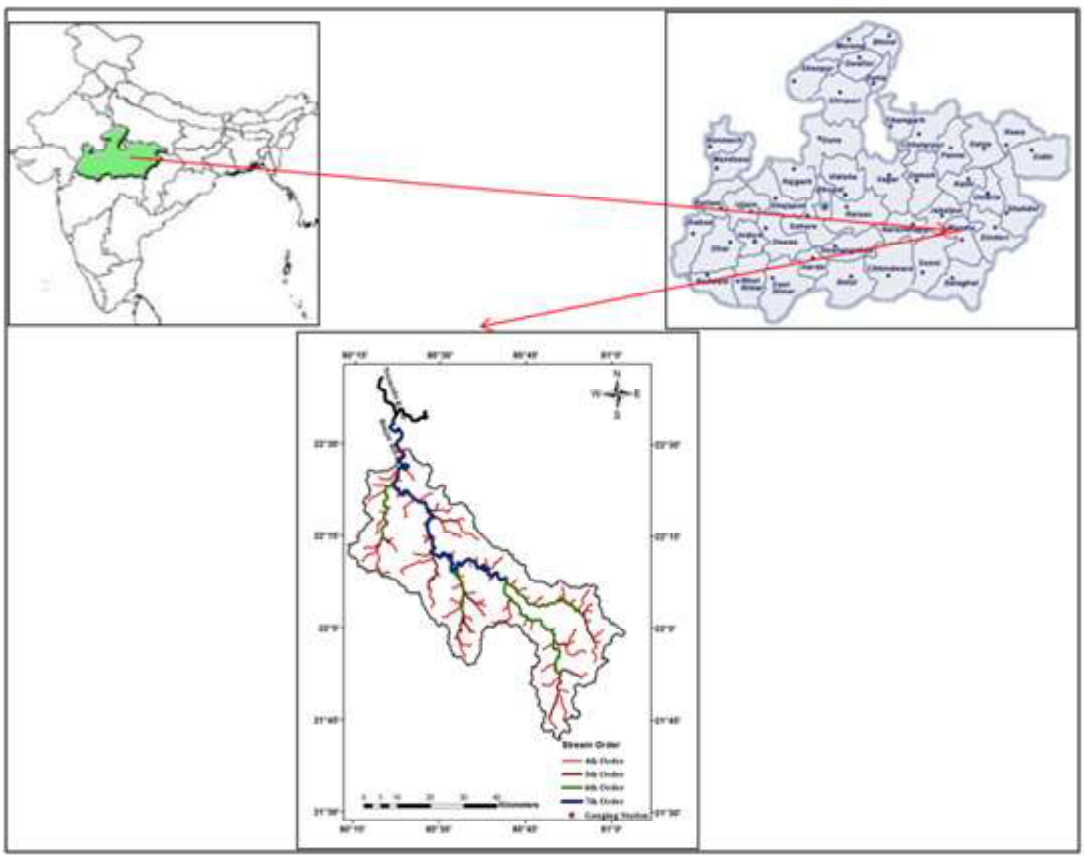

Fig 1. Location map of study area

Materials and Methods

Rainfall erosivity factor (R) is the basic and important factor in the assessment of soil erosion in the mathematical model, Universal Soil Loss Equation (USLE) and its revised form RUSLE (Elangovan and Seetharaman, 2011). Erosivity is the potential capacity of the raindrops to cause detachment of the soil particles from its location and it depends on rainfall intensity its recurrence. Therefore, it is important to accurately estimate the erosivity for quantitative estimation of soil erosion. The R-factor is defined as the mean annual sum of individual storm erosion index values, EI_{30}, where E is the total storm kinetic energy and

I30 is the maximum rainfall intensity in 30 minutes.

Mathematically,

$$EI30 = \frac{KE \times I30}{100} \quad ...1$$

where,

KE = Kinetic energy of the storm. The KE in metric tones/ha-cm and expressed as

$$KE = 210.3 + 89 \log I \quad ...2$$

where,

I = rainfall intensity in cm/h and

I_{30} = maximum 30 minutes rainfall intensity of the storm

$$R = \text{Erosion index } KE = I \sum_{i=1}^{n} (KE \times I_{30})$$

$$i = 1 \quad ...3$$

where,

KE = Kinetic energy of the storm (MJ/ha)

Computation of R-Factor

Vegetation cover, soil infiltration, erodibility and rainfall erosivity are the major factors governing soil erosion. Of all, rainfall erosivity is particularly difficult to predict and control. However, is considered one of the determining parameters in the universal soil loss equation. Rainfall erosivity is the potential ability for rainfall to cause soil loss (Silva, 2004). Numerous studies have assessed the relationship between conventional rainfall characteristics and soil detachment (Arnoldus, 1977; Hudson, 1971; Wischmeier and Smith, 1978). The original method requires high resolution rainfall data with continuous pluviographic records; however, these are rarely available in many parts of the world (Aronica and Ferro, 1997; Diodato, 2005; Silva, 2004). Thus several models, based on correlations between the measured R-factor and the available rainfall, have been developed to estimate the rainfall R-factor from daily, monthly, or yearly rainfall (Ferro *et al*. 1999; Zhang *et al*. 2002). To compute storm KI_{30}, continuous rainfall data is needed. For Indian conditions, a linear relationship was developed by Babu *et al*. (2004) between average annual & seasonal (June - September) rainfall and rainfall erosivity factor (R). They used 123 rain gauge stations situated in various parts of India. Derived relationships are as follow:

Annual relationship:

$$R = 81.5 + 0.38Rn (340 \text{ Rn } 3500 \text{ mm}) \quad ....4$$

Seasonal relationship:

$$R = 71.9 + 0.361 \text{ Rs } (293 \text{ Rs } 3190 \text{ mm}) \quad ....5$$

where,

R is the average annual / seasonal erosion index,

Rn is the average annual rainfall (mm) and

Rs is the average seasonal rainfall (mm).

In the present study, equation 4 was used to calculate annual values of R factor by replacing Rs with actual observed rainfall in a year. The thematic map of rainfall erosivity factor (R) was developed in the GIS platform. The thiessen polygon of the study area was prepared using spatial analyst toolbox of the ArcGIS 9.3 considering three rain gauge stations namely,Parswara, Baihar and Jamuniya and is presented in Fig.2. Thiessen polygon gives fair distribution of rainfall in the surrounding area of the rain gauge station (Aggarwal *et al*. 2000). After attributing estimated R factor values to the Thiessen polygons, raster maps of R factor for individual years were prepared using Conversion tool box of ArcGIS 9.3.

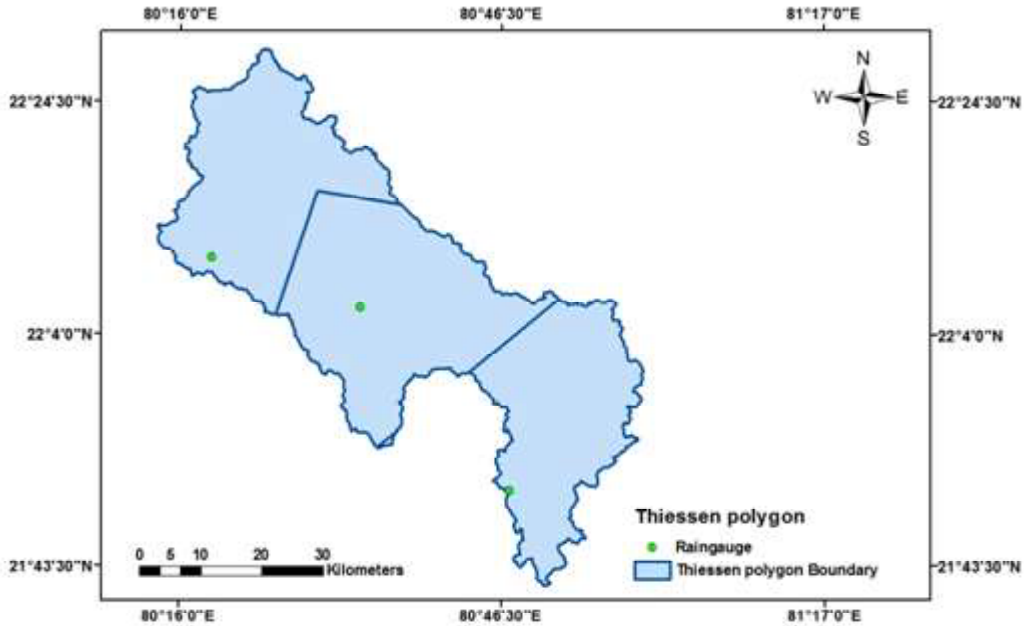

Fig 2. Thiessen polygon map of study area

Result and discussion

Banjar River watershed has R factor values ranges from 362.89 to 792.59. The R map of the area was prepared in ArcGIS 9.3 software using thiessen polygon technique. The spatial distribution of R-factor map is shown in Fig 3. Higher rainfall erosivity was observed in the middle of watershed decreasing towards the lower part of study area. The estimated values of R factor are presented in Table 1.

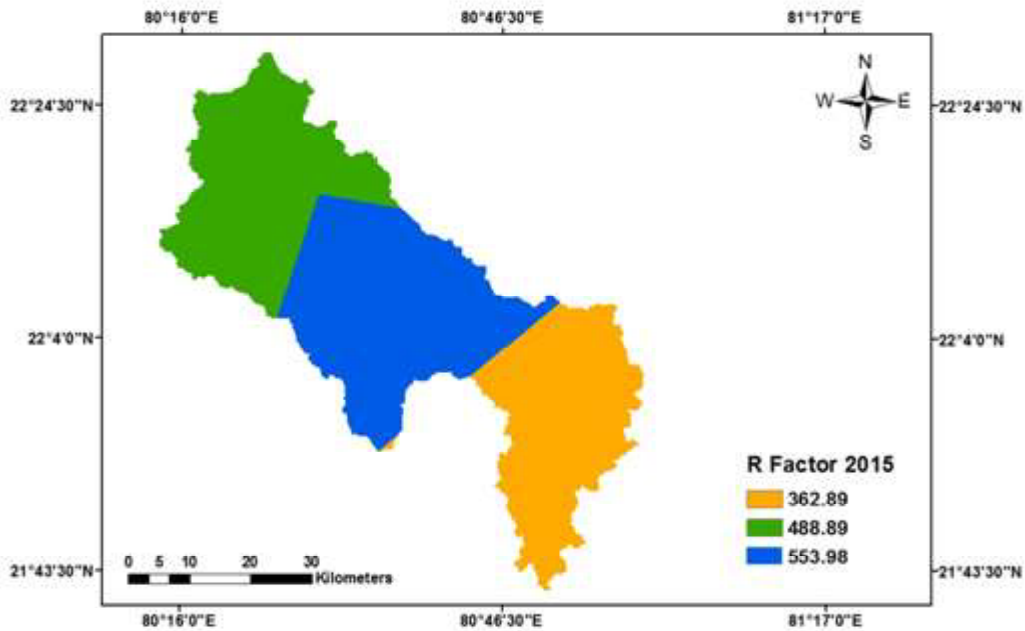

Fig 3. R-map of study area

Table 1 Annual rainfall and annual rainfall erosivity factor (R)

	Annual rainfall (mm) at			Annual rainfall erosivity factor (R) at		
Year	**Paraswara**	**Baihar**	**Jamuniya**	**Paraswara**	**Baihar**	**Jamuniya**
2011	1220.20	1265.50	1190.80	545.17	562.39	534.00
2012	857.90	1490.00	1401.90	407.50	647.70	614.22
2013	829.80	1871.30	1417.20	396.82	792.59	620.03
2014	1219.80	1322.40	924.50	545.02	584.01	432.81
2015	1072.10	1243.40	740.50	488.89	553.99	362.89
Average	1039.96	1438.52	1134.98	476.68	628.13	512.79

According to the individual stations, yearly R factor was calculated (Table 1) and it can be seen that for every station rainfall erosivity has increases with the increase in the annual rainfall. If only rainfall erosivity factor is considered separately, then the middle and upper part of watershed will be more affected by soil erosion hazard due to higher R factor.

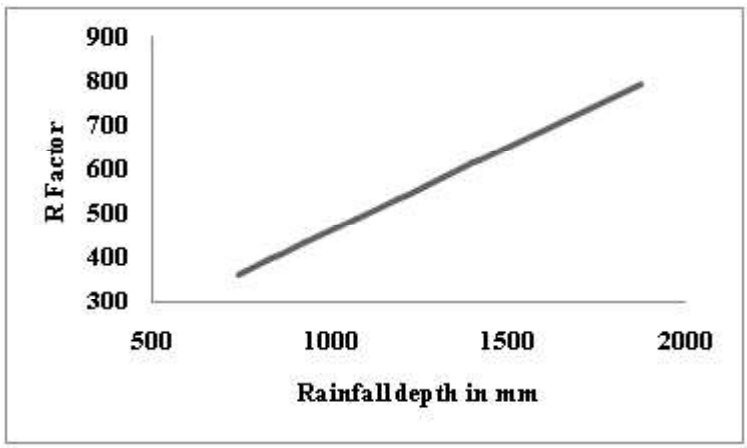

Fig 4. Relation between rainfall depth and R-factor

The basic relation between rainfall and R factor is presented in Fig. 4. This shows that possibility of higher risk of erosivity is associated with higher amount of rainfall which can contribute to the degree the soil erosion. This method clearly shows the significant strong correlation of rainfall with R factor.

Conclusion

An attempt has been made to estimate R factor values with empirical equation for modelling soil erosion using ArcGIS 9.3 software. R factor values were assigned to pixels of different polygons created through ArcGIS within the study area. Based on the assumption, thiessen polygon gives fair distribution of rainfall in the surrounding area of the rain gauge station, the R factor map of Banjar river watershed was produced to

use in soil erosion methods such as USLE. It should be noted that R factor values can be precisely estimated using high resolution temporal rainfall data. In this particular study GIS techniques are used as it offers an optimal method to estimate Rainfall erosivity factor (R) values of large areas in a short time.

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Seed associated mycoflora of tomato and its management

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Abstract

During the investigation, at seed level *Fusarium oxysporum*, *Alternaria alternata, Aspergillus niger and Aspergillus flavus* were found associated with tomato seeds from farmers and commercial nurseries. In all 12 seed sample from farmers of 6 villages and 18 seed sample from commercial nurseries were analyzed by standard blotter method. Association of *Fusarium oxysporum* was observed in the range of 1.0-19.0%, *Alternaria alternata* (2.0-12.0%), *Aspergillus niger* (6.0-19.0%) and *Aspergillus flavus* (6.0-14.8%). Seed germination ranged from (40-67%).

Influence of seed treatment with 3 bio-pesticide and 6 chemical fungicides was determined on the association of mycoflora using a pre-tested seed sample with maximum natural infection (19.0%) of *Fusarium oxysporum, Alternaria alternata* (12.0%). Efficacy of Carboxin + Thirum (0.2%), Carbendazim + Mancozeb (0.25%) and Copper oxychloride (0.25%) was recorded among the chemical fungicide whereas *Trichoderma viride* and *Trichoderma harzianum* exhibited about 50.0 % efficacy. Seed treatment with chemical fungicides and bio-pesticides enhanced tomato seed germination.

Key words : Tomato seedborne fungi, biopesticides

Tomato (*Solanum lycopersicum* L. = *Lycopersicon esculentum* Mill) is one of the most popular and widely grown vegetable crops, in India.It is grown for its edible fruits, which are consumed either fresh or it can be processed to several products like puree, paste, soup, juices, ketchup, whole canned fruits. The pulp and juice are digestable, promoter of gastric secretion and blood purifier. Tomato is a valuable source of vitamin A and C as well as several essential minerals (Kaur and Kapoor, 2008) including calcium, iron, manganese, and particularly potassium (Naika *et al*., 2005). It also contains lycopene which is a carotenoid that gives red coloring to tomatoes (Kelley and Boyhan, 2010). The attractive red colour of fruit is due to lycopene and yellow colour is due to carotenes. Tomatoes are called as "Poor man's apple" (Roopa, 2012).

In Madhya Pradesh, the total tomato production area is 73.70 thousand ha with production of 2285.90 tones and with productivity of 31.0 tones/ha (Horticultural Statistics at a Glance 2015, 2016).

Many factors operate in successful cultivation as well as marketing of quality tomato, of which diseases play an important role. Tomato crop is prone to various types of diseases such as seedborne, soilborne as well as airborne. Number of pathogens have been reported to be seedborne in nature(Jones *et al*., 1991), that affect the plant stand thereby reduce the yield, hence this investigation was undertaken to determine the seed associated mycoflora and their control through fungicide and bio-pesticides.

Material and methods

Collection of seeds

Tomato seeds were directly obtained from the farmers of 6 villages covering 12 nurseries and 6 locations of commercial nurseries located in the vicinity of Jabalpur, Madhya Pradesh (between 22°49' and 22°80' North latitude and 78°21' and 80°58' East longitude at an attitude of 411.78 meter above the mean sea level).

Analysis and identification of associated mycoflora

The collected seed samples were tested by Standard Blotter Method (ISTA, 2010) and associated mycoflora were identified under stereo binocular microscope after the incubation of 6 days with 12 hr light and 12 hr dark period in the grow chamber, with the help of available identification key.

Influence of seed treatment

The effect of seed treatment with fungicides and bio-pesticides on the associated mycoflora and seed emergence was determined by sowing the seeds in soil .

Results and discussion

Detection of seed associated mycoflora

Detection of seed associated fungal flora with tomato seed was determined by employing standard blotter method (ISTA, 2010). In all 12 seed sample of tomato were obtained from farmers of 6 villages. Similarly, 18 seed samples were obtained from commercial nurseries for the analysis.

Farmers saved seeds

Seven-day incubated seeds exhibited the association of four major mycoflora that were identified under stereoscopic binocular microscope on the basis of habit character. Association of *Fusarium oxysporum* ranged from 1.0-19.0%, and more than 10.0% association were recorded in 8 seed sample. Sample from Gwarighat exhibited higher association (18.0-19.0%) whereas seed sample from farmers of Gohalpur exhibited lesser association (5.0-6.0%). Under stereoscopic binocular microscope white cottony growth of *Fusarium oxysporum* covered the entire seed surface. Association of *Alternaria alternata* ranged from 2.0-12.0% and practically all the seed sample exhibited the association. Black-brown beaded mycelium was the chief characteristic of *Alternaria alternata*. The association of *Aspergillus flavus* and *Aspergillusniger* was in the range of 6.0-19.0 and 6.0-14.0%, respectively. The colonies of *Aspergillus flavus* were white initially and later changed into green colour whereas the colonies of *Aspergillusniger* were coke-brown in colour (Table 01).

Seeds from commercial nurseries

Tomato seed obtained from six commercial nurseries exhibited in the association of Fusarium oxysporum in the range of 3.0-19.0%, *Alternaria alternata* 2.0-16.0%, *Aspergillus flavus* 3.0-16.0% and *Aspergillusniger* 6.0-21.0%. Maximum infection of *Fusarium oxysporum* was recorded in a seed sample from Gwarighat, while maximum association of *Alternaria alternata* (16.0%) in Maharajpur. Seed samples from Katangi had higher association of *Aspergillus flavus* and *Aspergillusniger*, 16.0% and 20.0%, respectively (Table 02).

Management

Use of bio pesticide and chemicals

Management of seed associated Fusarium oxysporum

Influenceof seed treatment by 3 biopesticide and 6 chemical fungicides was determined on the association of mycoflora. Pretested seed sample with maximum natural infection (19%) of *Fusarium oxysporum* was used as check (Control). The treated seed were placed on top of the blotter as in Standard

Blotter method. Observation was recorded on 7th day of incubation. it was recorded that Carboxin+Thirum, Carbendazim+Mancozeb, and Copper oxychloride practically eliminated the association while only 2.0% association of *Fusarium oxysporum* was recorded as compared to 19.0% in untreated control. Among the bio pesticide association of *Fusarium oxysporumranged* between 8.0-9.0% and seed germination 48.0-50.0% with overall range of germination48.0-60.0% 58-60% as compared to 52% in untreated seed sample (Table 03).

Management of seed associated Alternaria alternata

The similar trend of efficacy and seed treatment with Carboxin+Thirum (0.2%),Carbendazim+Mancozeb (0.2%), and Copper oxychloride (0.25%) exhibited lesser association of *Alternaria alternata* as compared to 10% in untreated seeds. Seed sample with maximum natural infection of *Alternaria alternata* (12.0%) obtained from Gohalpur was used. Seed treatment with bio pesticide had comparatively lesser association (4.0-8.0%). Seed treatment with chemical fungicide enhanced the seed germination (Table 04).

Effect of seed treatment on seed emergence

Management of seed associated Fusarium oxysporum

Seed sample with natural infection of *Fusarium oxysporum* obtained from the farmers was used. Seeds were treated with bio pesticide and chemical fungicides sown in sterile soil kept in plastic pots that were placed in the laboratory. Seed emergence was counted after 10 days of sowing in sterile soil whereas disease incidence was observed after 20 days of sowing. A similar trend was observed and no incidence of disease was recorded after 21 days were as the seed treated with bio pesticide have shown 3% disease as compared 6.0% as 19.0% in control. Enhanced seed germination percent was recorded in the range of 62% in fungicides treated seed as compare to 50% emergence in untreated naturally infected seeds (Table 05).

Management of seed associated Alternaria alternata

A seed sample with maximum natural field condition of *Alternaria alternata* (12.0%)was used and seeds were treated with bio pesticides and chemical fungicides. treated and untreated seed were sown in sterile soil filled in plastic pots that were placed in the laboratory. No disease incidence was recorded in seeds treated with Carboxin+Thirum (2%) and Copper oxychloride (0.25%). Seed treated with Carbendazim+Mancozeb (0.25%), exhibited 1.0% mortality as compared to 11.0%naturally infected seeds. Seed treated with *Trichoderma viride* and *Trichodermaharzianum* were equally effective and after 21 days only 1.0% infection was recorded. Bacterial biopesticide (*Pseudomonas florescence*) @ 10 g/kg and Tebuconazole @ 1.5g/kg seed recorded 5.0% mortality as compared to 11.0% in untreated seeds. Seed treated with biopesticide and chemical fungicides exhibited higher seed emergence as compared to untreated seed. Seed treated with Carboxin+Thirum exhibited (4%) seed emergence treated) as compare to untreated seeds (51.0%) (Table 06).

Efficacy of Carboxin + Thirum (0.2%), Carbendazim + Mancozeb (0.25%) and Copper oxychloride (0.25%) was recorded among the chemical fungicide whereas *Trichoderma viride* and *Trichoderma harzianum* exhibited about 50% efficacy. Seed treatment with chemical fungicides and bio-pesticides enhanced tomato seed germination. Application of bio-pesticide and chemical was attempted for the management of early blight pathogen. Efficacy of Copper oxychloride, Mancozeb, Carbendazim, Tebuconazole and *Trichoderma harzianum* is reported stated by Rani *et al*. (2017); Gondal *et al*. (2012); Thakur *et al.* (2017).

Table.01. Association of mycoflora with tomato seeds obtained from Farmers and tested by standard blotter method (ISTA, 2010)

Location	percent seed association				percent seed germination
	FO	AA	AF	AN	
Gohalpur					
Sample.1.	5.0	12.0	11.0	12.0	42.0
Sample.2.	6.0	9.0	10.0	10.0	49.0
Amkhera					
Sample.1.	12.0	6.0	11.0	6.0	64.0
Sample.2.	10.0	4.0	19.0	7.0	67.0
Gwarighat					
Sample.1.	19.0	6.0	19.0	11.0	61.0
Sample.2.	18.0	6.0	12.0	9.0	62.0
Maharajpur					
Sample.1.	15.0	11.0	15.0	14.0	50.0
Sample.2.	11.0	2.0	9.0	6.0	52.0
Patan					
Sample.1.	10.0	7.0	7.0	12.0	55.0
Sample.2.	7.0	4.0	6.0	10.0	56.0
Katangi					
Sample.1.	0.0	5.3	11.0	13.0	52.0
Sample.2.	10.0	5.0	14.0	10.0	54.0
Range	1-19.0	2-12.0	6-19.0	6.0-14.0	42-67.0

FO: *Fusarium oxysporum;* AA: *Alternaria alternata;* AF: *Aspergillus flavus;* AN *Aspergillus niger.*

Table.02. Association of mycoflora with tomato seeds obtained from Commercial Nursery and tested by standard blotter method (ISTA, 1996)

Location	percent seed association				percent seed germination
	FO	AA	AF	AN	
Gohalpur					
Sample.1.	14.0	11.0	10.0	11.0	45.0
Sample.2.	10.0	15.0	9.0	10.0	60.0
Sample.3.	7.0	12.0	13.0	10.0	63.0
Amkhera					
Sample.1.	16.0	9.0	12.0	11.0	60.0
Sample.2.	13.0	6.0	10.0	12.0	59.0
Sample.3.	6.0	4.0	3.0	9.0	59.0
Gwarighat					
Sample.1.	19.0	8.0	5.0	7.0	60.0
Sample.2.	16.0	9.0	14.0	11.0	63.0
Sample.3.	15.0	15.0	9.0	13.0	66.0
Maharajpur					
Sample.1.	9.0	16.0	6.0	10.0	66.0
Sample.2.	11.0	5.0	11.0	6.0	63.0
Sample.3.	6.0	12.0	9.0	13.0	64.0
Patan					
Sample.1.	6.0	6.0	7.0	15.0	64.0
Sample.2.	11.0	6.0	7.0	11.0	63.0
Sample.3.	10.0	11.0	6.0	9.0	56.0
Katangi					
Sample.1.	10.0	3.0	16.0	21.0	57.0
Sample.2.	11.0	7.0	16.0	11.0	58.0
Sample.3.	17.0	12.0	5.0	10.0	59.0
Range	3-17.0	2-16.0	3-16.0	6-21.0	45.0-66.0

FO: *Fusarium oxysporum;* AA: *Alternaria alternata;* AF: *Aspergillus flavus;* AN: *Aspergillus niger.*

Table.03. Effect of seed treatment on mycoflora associated with tomato seeds

Bio-pesticide / Fungicide	Dose gm /Kg seed	Percent association	Percent seed Germination
Trichoderma viride	10.0	9.0	50.0
Trichoderma harzianum	10.0	8.0	49.0
Pseudomonas fluorescence	10.0	8.0	48.0
Carboxin + Thirum	2.0	0.0	60.0
Carbendazim + Mancozeb	2.5	0.0	59.0
Copper oxychloride	2.5	0.0	58.0
Tebuconazole	1.5	2.0	57.0
Control	0.0	19.0	52.0
Seed sample with *Fusarium oxysporum*	-	19.0	-

Table.04.Effect of seed treatment on mycoflora associated with tomato seeds

Bio-pesticide / Fungicide	Dose gm /Kg seed	Percent association	Percent seed Germination
Trichoderma viride	10.0	4.0	58.0
Trichoderma harzianum	10.0	6.0	57.0
Pseudomonas fluorescence	10.0	8.0	52.0
Carboxin + Thirum	2.0	0.0	59.0
Carbendazim + Mancozeb	2.5	0.0	58.0
Copper oxychloride	2.5	0.0	58.0
Tebuconazole	1.5	2.0	58.0
Control	0.0	10.0	53.0
Seed sample with *Alternaria solani*	-	12.0	-

Table.05. Effect of seed treatment on tomato seed emergence

Bio-pesticide / Fungicide	Dose gm/Kg seed	Seeds sown in sterile soil in pots	
		Disease incidence after 21 days	Percent seed emergence after 10 days
Trichoderma viride	10.0	3.0	55.0
Trichoderma harzianum	10.0	3.0	53.0
Pseudomonas fluorescence	10.0	6.0	48.0
Carboxin + Thiram	2.0	0.0	62.0
Carbendazim + Mancozeb	2.5	0.0	61.0
Copper oxychloride	2.5	0.0	60.0
Tebuconazole	1.5	2.0	60.0
Control	0.0	19.0	50.0
Seed sample with *Fusarium oxysporum*	-	19.0	-

Table.06. Effect of seed treatment on mycoflora associated with tomato seeds

Bio-pesticide / Fungicide	Dose gm/Kg seed	Seeds sown in sterile soil in pots	
		Disease incidence after 21 days	Percent seed emergence after 10 days
Trichoderma viride	10.0	1.0	58.0
Trichoderma harzianum	10.0	1.0	56.0
Pseudomonas fluorescence	10.0	5.0	53.0
Carboxin + Thiram	2.0	0.0	63.0
Carbendazim+ Mancozeb	2.5	1.0	62.0
Copper oxychloride	2.5	0.0	61.0
Tebuconazole	1.5	5.0	61.0
Control	0.0	11.0	51.0
Seed sample with *Alternaria solani*	-	12.0	-

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