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Studies on the allelopathic potential of various crop biomass for controlling weeds in wheat crop

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A field experiment was conducted during *Rabi* season of 2010-11 at Students' Instructional Farm of C.S Azad University of Agriculture and Technology, Kanpur. six crop biomass *viz.*, mustard, field pea, sorghum, maize, rice and wheat straws were incorporated in soil before sowing and their allelopathic potential was compared with weed free and unweeded treatments and analysed on germination and growth of weeds in wheat crop. The crop growth parameters, yield attributes, yield and economics of wheat were also computed. The results obtained shown that mustard straw, sorghum straw and maize straw were more effective to suppress weed germination and growth. The application of mustard straw before sowing registered maximum grain yield of wheat (42.0 q/ha) followed by sorghum straw (41.33 q/ha), maize straw (40.66 q/ha), field pea straw (38.75 q/ha), wheat straw (35.83 q/ha), paddy straw (35.66 q/ha) and minimum grain yield (33.58 q/ha) was noticed in unweeded control treatment. The incorporation of mustard straw, sorghum straw and maize straw registered 25.07 per cent, 23.03 per cent and 21.08 per cent, respectively more grain yield than unweeded control treatment. Allowing weed growth though out crop growth period in unweeded control treatment caused on an average 31.26 per cent reduction in grain yield of wheat *i.e.* 44.08 q/ha of wheat variety UP 2338 in control in plain zone of Uttar Pradesh.

Key words : Allelopathic, Crop biomass, Weeds, Wheat

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INTRODUCTION

In India wheat is the second most important staple food crop, rice being the first. In indogangetic plains wheat crop suffers badly due to weed infestation like, *phalaris minor, chenopodium album, Cyperus rotandus, Convulvolous arvensis* etc. and losses varied generally 24-39 per cent. This is mainly because of repetition of rice-wheat rotation year after year by farmers of this region and some times complete failure of crop may occur due to heavy infestation of associated weeds.

Weed management by different selective herbicides though effective but creates several problems like development of resistance in weeds and destruction of soil microflora etc. Manual weeding is much costly and not feasible in densely populated crop like wheat. Crop allelopathy may be useful to minimise serious weed problems and reduce soil pollution etc. Allelopathic crop like alfalfa, buck wheat, maize, rice, rye, sorghum, sunflower, wheat etc. when used as cover crop, mulch, smother crop, green manure or grown in rotational sequences are helpful in reducing noxious weeds, plant pathogen and improve soil quality as well as crop yield. Allelochemicals from allelopathic crops may aid in development of natural herbicides and pesticides. Keeping above facts, biomass of different crops were in-corporated in soil before sowing of wheat and their allelopathic potential was studied on emergence and growth of weeds and out put interms of grain yield of wheat.

RESEARCH METHODOLOGY

A field experiment was conducted during *Rabi* season of 2010-11, at Students' Instructional Farm of C.S. Azad University of Agriculture and Technology, Kanpur. The experiment was laid out in Randomized Block Design comprising six treatments of crops biomass straw *viz.*, mustard straw field pea straw, sorghum straw, maize straw, rice straw, wheat straw and two treatments weedy and weed free replicated four times. The semi decomposed straw of different crop biomass was incorporated in soil as per

treatment @ 1 kg/m^2 before sowing of crop. The soil of experimental plot was sandy loam in texture, neutral in reaction (pH 7.5), low in available nitrogen 156 kg/ha, medium in available phosphorus 17.8 kg/ha and available potassium 155kg/ha. Wheat verity UP 2338 was sown on 30 Dec. 2010. The crop was fertilized with the recommended dose of fertilizer 120-60-40 kg/ha NPK and irrigated four times at different stages. Under weed free treatment application of isoproturan 75 per cent @ 1 kg/ha + 2-4D @ 6.25 g/ha was sprayed after thirty days after sowing under weedy treatment. No interculture operations and none of any weediside was used in unweeded treatment and weeds let to grow during crop growth period. The data regarding weed germination and growth were recorded in different treatments at 45, 90 days after sowing and at harvesting stage of crop. The data regarding crop growth like plant height, number of tillers and yield attribute like length of spike, number of grain per spike, grain test weight, biological yield and grain yield were recorded treatment wise. The crop was harvested on 24 April 2011.

RESEARCH FINDINGS AND ANALYSIS

The findings of the present study as well as relevant discussion have been presented under following heads :

Weed studies:

The data regarding weed population and dry weight of weeds are summarized in Table 1. It is obvious from the data that among different weeds the population of *Cyperus rotandus* was maximum at 45, 90 DAS and at harvesting stage compound to other weeds like *Chenopodium album* and *Convolvulous arvensis*. The population of these weeds were significantly reduced by the application of different crop straw treatments compared to unweeded control treatment. Among different crop straw treatment mustard straw incorporation reduced the population of *Chenopodium album* 70.58, 62.79, 67.44 per cent, *Convolvulous arvensis* 59.09, 52.38, 60.0 per cent, *Cyperus rotandus* 37.78, 41.67, 42.55 per cent at 45 DAS, 90 DAS harvest stage, respectively compound to unweeded control treatment.

Similarly dry weight of these weeds were also reduced significantly at different stages by the application of different crop straw treatments. The application of mustard straw registered minimum dry weight of weeds *i.e.* 8.12 g, 13.0 g and 21.50 g at 45, 90 DAS and at harvest stage, respectively followed by maize, sorghum and field pea straw which were significantly at par and wheat and rice straw registered significant reduction in dry weight compared to unweeded control treatment which recorded maximum dry weight of weeds *i.e.* 22.50 g, 38.25 g, 67.25 g at 45, 90 DAS and at harvest stage, respectively. The effect of treatments in terms of reduction in dry weight of weeds clearly showed their allelopathic effect of substances released from decayed

Table 1: Weed population/m^2 and dry weight of weed (g) influenced by different crop straw treatments in wheat

Treatments		Weed population at 45 DAS/m^2			Weed dry weight (g)	Weed population at 90 DAS/m^2			Weed dry weight (g)	Weed population at harvest/m^2			Weed dry weight (g)
		Chenopodium album	*Convolvulus arvenses*	*Cyperus rotandus*		*Chenopodium album*	*Convolvulus arvenses*	*Cyperus rotandus*		*Chenopodium album*	*Convolvulus arvenses*	*Cyperus rotandus*	
T_1	Mustard straw	2.50	2.25	7.00	8.12	4.00	2.50	7.00	13.00	3.50	2.50	6.75	21.50
T_2	Field pea Straw	3.25	2.25	7.25	10.25	4.25	2.75	7.75	16.75	4.75	3.00	7.75	25.50
T_3	Sorghum straw	3.50	3.00	7.50	9.75	4.25	3.50	8.00	14.25	4.75	3.50	7.50	24.25
T_4	Maize straw	2.75	3.00	8.25	9.37	3.50	3.25	8.25	14.00	4.00	3.25	8.00	25.25
T_5	Rice straw	4.00	3.00	8.50	13.25	6.75	3.50	9.25	23.00	6.00	4.00	9.50	28.25
T_6	Wheat straw	4.00	3.25	9.00	12.00	6.00	3.25	9.75	20.50	6.50	3.75	9.75	30.75
T_7	Weedy	8.50	5.50	11.25	22.50	10.75	5.25	12.00	38.25	10.75	6.25	11.75	67.25
T_8	Weed free	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil	Nil
	SE ±	0.13	0.13	0.13	0.21	0.17.	0.12	0.14	0.31	0.15	0.13	0.15	0.39
	C.D. (P=0.05)	0.28	0.26	0.27	0.45	0.36	0.25	0.29	0.65	0.32	0.26	0.29	0.81

biomass of different crop which reduced germination, checked growth and hindered dry weight accumulation process of weed species. Similar findings were observed by Ferrero and Reinhardt (2010) and Batish *et al.* (2006).

The data evaluated regarding weed control efficiency and weed index in percentage are summarized in Table 2. The weed control efficiency was evaluated, maximum 63.91 per cent, 66.01 per cent and 68.02 per cent at 45 DAS, 90 DAS and at harvesting stage, respectively by the incorporation of mustard straw and minimum weed control efficiency 46.66 per cent, 47.05 per cent and 50.01 per cent at 45 DAS, 90 DAS and at harvest stage, respectively by the application of wheat straw.

The weed index was registered minimum (4.71 %) in mustard straw treatment followed by sorghum straw (6.23 %). Maize straw (7.75 %), field pea straw (12.09 %), wheat straw (18.71 %), rice straw (19.10 %) and maximum weed index (23.82 %) was evaluated in weedy check treatment.

Crop performance :

The data regarding growth characters, yield attributes, yield and economics of the treatments are summarized in Table 3. the growth parameters like plant height and number of tillers were influenced significantly by different crop biomass treatments compared to weedy check. This shows weed suppression ability of different crop biomass which ultimately leads to better growth of crop plants. The maximum plant height (89.9 cm) was observed in sorghum straw treatment and minimum height (81.10 cm) was recorded in unweeded control treatment. The effective tillers per plant were observed significantly maximum in maize straw (6.48) followed by sorghum and rice straw (6.45), wheat straw (6.42) and lowest effective tillers (6.20) were recorded under unweeded control plot. Other treatments were significantly at par.

The yield attributing characters like ears/plant, length of ear and weight of grains per plant also depicted significant influence by different crop straw treatments compared to weedy treatments. Application of mustard straw showed more number of ears per plant (7.46), more length of ear (8.75 cm) and more grain weight per ear (2.70 g/ear) compared to other crop straw treatments, though the maximum were obtained in weed free treatment *i.e.* 7.51 ears/plant, 9.20 cm length of ear and 2.82 g grain weight/ear. The minimum number of ears per plant (7.0), length of ear (7.72 cm) and grain weight per ear (2.57 g) were recorded in unweeded control treatment.

Among different crop straw treatments the highest increase in biological and grain yield of wheat was observed by mustard straw (86.16 and 42.00 q/ha) followed by sorghum

Table 2 : Weed control efficiency and weed index influenced by different crop straw treatments in wheat

Treatments		WCE (%)			Weed index (%)
		45 DAS	90 DAS	At harvest	
T_1	Mustard straw	63.91	66.01	68.02	4.71
T_2	Field pea straw	54.44	56.21	62.08	12.09
T_3	Sorghum straw	56.66	62.74	63.94	6.23
T_4	Maize straw	58.35	63.39	62.45	7.75
T_5	Rice straw	44.11	39.86	57.99	19.10
T_6	Wheat straw	46.66	47.05	50.01	18.71
T_7	Weedy	-	-	-	23.82
T_8	Weed free	-	-	-	-

Table 3 : Growth, yield attributes, yield and economics of wheat influenced by different treatments

Treatments		Plant height (cm)	No. of effective tillers/plant	No. of ears/ plant	Length of ear (cm)	Weight of grains/ear (g)	Biological yield (q/ha)	Grain yield (q/ha)	Cost of cultivation (Rs./ha)	Net return (Rs./ha)	B:C ratio
T_1	Mustard straw	83.0	6.30	7.46	8.75	2.70	86.16	42.00	30953	25763	1:83
T_2	Field pea straw	82.67	6.20	7.22	7.70	2.62	79.16	38.75	30953	21525	1:69
T_3	Sorghum straw	89.9	6.45	7.45	8.22	2.70	83.33	41.33	30953	24909	1:80
T_4	Maize straw	82.80	6.48	7.35	7.15	2.71	81.66	40.66	30953	23972	1:77
T_5	Rice straw	81.80	6.45	7.15	7.60	2.65	73.33	35.66	30953	17189	1:55
T_6	Wheat straw	82.45	6.42	7.50	7.90	2.66	73.33	35.83	30953	17584	1:56
T_7	Weedy	81.10	6.20	7.00	7.72	2.57	68.33	33.58	28568	16882	1:59
T_8	Weed free	83.45	6.60	7.51	9.20	2.82	90.00	44.08	29681	30011	2:01
	SE ±	0.77	0.08	0.12	0.24	0.08	1.68	0.48	–	–	–
	C.D. (P=0.05)	1.62	0.16	0.24	0.50	0.18	3.50	1.01	–	–	–

straw (83.33 q and 41.33 q/ha), maize straw (81.66 q and 40.66 q/ha), field pea straw (79.16 g and 38.75 q/ha), wheat straw (73.33 q and 35.83 q/ha), rice straw (73.33 q and 35.66 q/ha), respectively. The influence was significant compared to weedy check. The minimum biological yield (68.33 q/ha) and grain yield (33.58 q/ha) was recorded under unweeded control plot. The allellopathic efficiency of different crop straw incorporated in soil effectively controled weed population and boost up grain yield of wheat which was observed 25.07, 23.07, 21.08, 15.39, 6.70 and 6.19 per cent. by mustard straw, sorghum straw, maize straw, pea straw, wheat straw and rice straw, respectively, compared to weedy check. The increase in grain yield of wheat in weed free situation was observed upto 31.26 per cent by application of isoprotureon and 2-4D as post emergence. Several scientist like Singh *et al*. (2000), Sinha *et al.* (2005), Chema *et al.* (2008) reported that grain yield of wheat increased 34-40 per cent by different weed management practices including chemicals as well as incorporation of allellopathic crop residues.

The economic analysis of different treatments also showed the better performance of different crop straw treatment in terms of more net return (Rs./ha) and more B:C ratio compared to weedy check treatment. Among different crop straw treatments maximum net return (Rs. 25763 per hectare) was recorded under mustard straw treatment and minimum net return (Rs. 16882 per hectare) was observed in unweeded control treatment. Though maximum out put interms of net return (Rs. 30011 per ha) was recorded in weed free situation obtained though use of herbicide.

Conclusion :

Application of allelopathic material of different crop straw biomass performed well in suppression of weed population and also led to better growth, maximize yield attributes and yield of wheat crop. It also promoted better soil health. The mustard straw showed better performance among other crop straw treatments.

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