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ALLELOPATHIC EFFECT OF *Brassica* ON WEED CONTROL AND YIELD OF WHEAT

P. K. Biswas, M. M. Morshed, M. J. Ullah and I. J. Irin

Dept. of Agronomy, Sher-e-Bangla Agricultural University, Dhaka
Corresponding author: parimalbiswas@hotmail.com

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Abstract

The experiment was conducted at the Agronomy farm of Sher-e-Bangla Agricultural University to identify the allelopathic effect of *Brassica* species along with their incorporation methods to control weeds in wheat field. The experiment was assigned in a split-plot design where three cultivated *Brassica* spp. were in the main plot and five different ways of green *Brassica* biomass inclusion were in the sub-plot. *Brassica* crops were uprooted at 30 days after sowing (DAS) and incorporated to the soil @ 0.5 kg m^{-2} as per treatment. Wheat seeds were sown on December 04, 2007 using 20 cm line to line distance. Weeds e.g., *Amaranthus spinosus*, *A. viridis, Lindernia procumbens, Heliotropium indicum, Polygonum hydropiper, Celosis argentina, Ageratum conyzoides, Brassica kaber and Digitaria ischaemum* were not found in the wheat field. Significantly the highest weed dry matter (1.72 g m^{-2}) was found in *Brassica juncea* plots at 30 DAS but in *Brassica napus* field (1.44 g m^{-2}) at 50 DAS. The lowest weed dry matter at 30 DAS (0.89 g m^{-2}) was recorded with total incorporation of *Brassica* biomass to the soil but 50% incorporation and 50% spreading at 50 DAS. The *Brassica* biomass spreading above ground, mixed with soil and 50% spreading + 50% mixed with soil resulted positively compared to other ways of biomass incorporation. The highest grain yield (3.83 t ha^{-1}) of wheat was given by *Brassica juncea* when spreaded on the above ground soil.

Introduction

Wheat (*Triticum aestivum* L.) is the most important cereal crop in the world as well as in Bangladesh that provides about 20% of total food calories. Weed is the natural enemy of wheat that reduces its yield if not properly controlled. The yield reduction of wheat by weed is reported to be 20 - 30% (Turk and Tawaha, 2002) and 150% by Peterson (1965). Some crops are specially useful because they have the ability to suppress other plants that attempt to grow around to them.

Allelopathy refers to a plant's ability to chemically inhibit the growth of other plants. Rapeseed and Mustard are reported the most useful allelopathic cover crop that reduced total weed biomass in soybean by 40 - 49% (Krishnan *et al*., 1998). Weed suppression is effective when crop residues left undisturbed on the soil surface but the effect is lost when tilled into the soil (Sheila, 1986). Putnam *et al*. (1983) reported that weeds that were reduced by rye mulch included ragweed (43%), pigweed (95%) and common purslane (100%). Worsham (1991) and Schilling *et al*. (1986) reported 68-80% reduction of broadleaf weeds by rye. Yenish and Worsham (1993) also reported highest weed control by rye application. Anon. (1993) reported allelopathic effect of rapeseed and showed 90% reduction of yellow nutsedge on sweet potatoes. Boydston and Hang (1995) reported that all members of the mustard family (Brassicaceae) contain mustard oils that inhibit plant growth and seed germination. The concentration of allelopathic mustard oils varies with species and variety of mustard. Sullivan (2003) reported that crop residues when left on the soil surface, can be expected to reduce weed emergence by 75 to 90% and when decomposed, weed suppression effect also declined. An attempt was therefore, undertaken to study the allelopathic effect of Rapeseed and Mustard in controlling weeds in Wheat.

Materials and Methods

The experiment was conducted at the Agronomy farm of Sher-e-Bangla Agricultural University, Dhaka-1207, during the period from November 2007 to March 2008 in a silty clay loam soil having low organic matter (0.82%) and slightly acidic soil (pH 5.47-5.63). Three *Brassica* varieties one from *campestris* (BARI Sarisha-15), one from *juncea* (BARI Sarisha-11) and the other from *napus* (BARI Sarisha-13) species were sown on November 02, 2007. The crop was fertilized with 180-100-180-60-10-5 kgha^{-1} of urea, TSP, MoP, Gypsum, Boric acid and Zinc oxide, respectively of which half of urea and the full amount of other fertilizers applied as basal dose. As the crops were uprooted, no additional urea fertilizer was applied. Weeding, mulching and thinning were done at 20 DAS (days after seeding). The *Brassica* crop was uprooted at 30 DAS and the land was then ploughed and cross ploughed, leveled and fertilized as per recommendation of wheat. The experiment was laid out in split-plot design with three replications. Three *Brassica* species was assigned in the main plot and six different ways of biomass incorporation (No biomass application, biomass spreading above the ground, biomass mixed with soil, biomass spreading in lines and 50% biomass as spreading + 50% biomass as mixed with soil) in the sub plot. The wheat variety Shatabdi (BARI Gom21) was sown on 04 December, 2007 maintaining 20 cm line distance. One third urea and the full amount of other fertilizers were applied as basal and the rest urea in two equal splits at CRI stage and before flowering stage. All the intercultural operations were done as and when necessary. Weed data was recorded on 30 and 50 DAS. The yield and other data were recorded using standard procedure. The collected data were analyzed and the mean differences evaluated by least significant difference test (LSD).

Results and Discussion

Weed Species

Twelve weed species belongs to 7 families were found infested in the experimental field of which *Cyperous rotundus*, *Cynodon dactylon*, *Eleusine indica*, *Digitaria sanguinalis*, *Chenopodium album* were found with major population whereas 9 weeds had been found unavailable in wheat field but available to the surrounding areas. The name and family of the weeds are shown in Table 1. The results showed that *Brassica* biomass had allelopathic effect to suppress some weed species in wheat field. Anon. (1993) also reported the suppressive nature of rapeseed to control weeds in sweet potatoes.

Weed density and weight

Inclusion of different *Brassica* biomass had no significant variations on weed population in wheat field at 30 and 50 DAS but the methods of biomass incorporation resulted significant differences of weed population at 30 DAS though no variation was observed at 50 DAS (Table 2). The lowest number of weed population (15.33 m^{-2}) was found in B_4 (spreading in lines) that was similar to B_2 (Spreading above ground) and B_5 (50% spreading + 50% mixed with soil). Sullivan (2003) reported the highest suppressive effect of crop residues when left on the surface than decomposed to the soil. Uremis *et al.* (2009) reported the allelopathic potential of residues of some brassica species suppressed johnsongrass. The result was also in agreement with the findings of Boydston (2008) who reported that Brassicaceae cover crops suppress weeds due to allelopathic substances released during degradation of the cover crop residues.

Table 1. Local name, common name, scientific name, and family of weeds unavailable in *Brassica* biomass treated plots

Local name	Common name	Scientific name	Family
Weeds available in the experimental plot			
Mutha	Nut sedge	*Cyperus rotundus*	Cyperaceae
Chapra	Goose grass	*Eleusine indica*	Gramineae

Local name	Common name	Scientific name	Family
Durba	Bermuda grass	*Cynodon dactylon*	Gramineae
Anguli ghas	Scrab grass	*Digitaria sanguinalis*	Gramineae
Bon mosur	Wild lentil	*Vicia stiva*	Leguminosae
Choto shama	Jungle rice	*Echinochloa colonum*	Gramineae
Bathua	Lambsquarter	*Chenopodium album*	Chenopodiaceae
Tita begun	Tita begun	*Solanum torvum*	Solanaceae
Chatidhara	Flat cyperus	*Cyperus compresus*	Cyperaceae
Shetodron	Leucas	*Leucas aspera*	Labiatae
Malancha	Alligator weed	*Alternanthera philoxeroides*	Amaranthaceae
Bon china	Torpado grass	*Panicum repens*	Gramineae
Weeds unavailable in the experimental plot but available to the adjacent area			
Khet papri	Khet papri	*Lindernia procumbens*	Scrophulariaceae
Hati shur	Wild heliotrop	*Heliotropium indicum*	Boraginaceae
Kata notae	Spiny pig weed	*Amaranthus spinosus*	Amaranthaceae
Shak notae	Pig weed	*Amaranthus viridis*	Amaranthaceae
Bish katali	Smart weed	*Polygonum hydropiper*	Polygonaceae
Shet morog	White cock's comb	*Celosia argentina*	Amaranthaceae
Chagla gacha	Goat weed	*Ageratum conyzoides*	Compositae
Bon sarisha	Wild mustard	*Brassica kaber*	Cruciferae
Choto anguli	Smooth scrab grass	*Digitaria ishchamaemum*	Gramineae

The highest weed dry weight (1.72 g m^{-2}) was recorded in *juncea* plots as compared to *Brassica campestris* (1.16 g m^{-2}) *and Brassica napus* (1.16 g m^{-2}) at 30 DAS but at 50 DAS *Brassica napus* treated plots showed the highest weed dry weight (1.44 g m^{-2}) and the *Brassica juncea* showed the lowest weed dry weight (0.96 g m^{-2}) that was similar to *Brassica campestris* (1.08 g m^{-2}) treated plots (Table 2).

The different ways of biomass incorporation showed significant variations in weed dry weight at 30 DAS and 50 DAS and for both the situation the control (no *Brassica* biomass incorporation) plots had the highest weed dry weight and B_2 at 30 DAS and B_5 at 50 DAS showed the lowest weed dry weight (Table 2). Cheema *et al*. (2008) reported that inclusion of allelopathic crops in rotation systems for weed suppression by early post-emergence application of the mixture of sorghum, sunflower, *Brassica* or mulberry water extracts suppressed total weed dry weight.

The interaction of *Brassica* species and ways of biomass incorporation showed significant variations of weed population in wheat field at 30 DAS and at 50 DAS (Table 3). The highest weed population (37.33 m^{-2}) was recorded in S_2B_1 plots at 30 DAS. The lowest weed population (13.67 m^{-2}) was observed in S_3B_4 at 30 DAS and in S_1B_3 (8.67 m^{-2}) at 50 DAS. The lowest weed dry weight (0.74 g m^{-2}) was found in S_3B_2 at 30 DAS and in S_1B_5 (0.51 g m^{-2}) at 50 DAS.

Table 2. Weed density and weight of wheat as affected by *Brassica* biomass and methods of incorporation

Treatments	Weed density (no. m^{-2})		Weed dry weight (g m^{-2})	
	30 DAS	50 DAS	30 DAS	50 DAS
Brassica species:				
S_1	17.67	14.07	1.16	1.08
S_2	25.60	20.20	1.72	0.96
S_3	22.47	18.80	1.16	1.44
$LSD_{(0.05)}$	NS	NS	0.350	0.208
Incorporation methods:				

B_1	26.78	17.78	1.49	1.66
B_2	17.78	20.11	0.89	1.10
B_3	26.89	20.89	1.59	1.31
B_4	15.33	16.56	1.11	0.93
B_5	22.78	13.11	1.65	0.80
$LSD_{(0.05)}$	9.390	NS	0.534	0.491

S_1 = *B. campestris* S_2 = *B. juncea* S_3 = *B. napus;* B_1 = No biomass B_2 = Spreading above ground B_3 = mixed with soil B_4 = spreading in lines B_5 = 50% spreading + 50% mixed with soil

Table 3. Weed density and weight in wheat as affected by interaction of *Brassica* biomass and methods of incorporation

Treatments	Weed density (no. m^{-2})		Weed dry weight (g m^{-2})	
	30 DAS	50 DAS	30 DAS	50 DAS
S_1 B_1	17.00	19.33	0.91	1.78
S_1 B_2	15.67	17.67	1.01	1.31
S_1 B_3	15.33	8.67	0.93	1.01
S_1 B_4	17.67	15.67	1.13	0.78
S_1 B_5	22.67	9.00	1.80	0.51
S_2 B_1	37.33	22.00	2.31	1.71
S_2 B_2	21.33	29.67	0.92	1.03
S_2 B_3	36.67	14.00	2.68	0.47
S_2 B_4	14.67	19.00	1.26	0.99
S_2 B_5	18.00	16.33	1.44	0.61
S_3 B_1	26.00	12.00	1.26	1.48
S_3 B_2	16.33	13.00	0.74	0.95
S_3 B_3	28.67	40.00	1.16	2.46
S_3 B_4	13.67	15.00	0.93	1.04
S_3 B_5	27.67	14.00	1.72	1.29
$LSD_{(0.05)}$	16.325	22.252	0.925	0.845

S_1 = *B. campestris* S_2 = *B. juncea* S_3 = *B. napus;* B_1 = No biomass B_2 = Spreading above ground B_3 = mixed with soil B_4 = spreading in lines B_5 = 50% spreading + 50% mixed with soil

Wheat yield and other crop characters

Incorporation of *Brassica juncea* biomass to the wheat field showed the maximum 1000-grain weight of wheat (42.13 g) that statistically similar to *Brassica napus* but the lowest grain weight in *Brassica campestris* biomass incorporation. Mansoor *et al*. (2004) stated that water extracts of sorghum, eucalyptus and acacia were significantly affected 1000-grain weight of mungbean. The highest harvest index (48.47%) was given by *Brassica campestris* biomass incorporation that similar to *Brassica juncea* and the lowest in *Brassica napus* (Table 4).

Table 4. Effect of *Brassica* spp. and ways of biomass incorporation on yield and other crop characters of wheat

Treatments	Plant height (cm)	Filled grains spike^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)

Brassica species:						
S_1	84.15	41.32	37.07	3.43	3.64	48.47
S_2	82.53	39.63	42.13	3.52	3.84	47.60
S_3	84.19	45.12	40.38	3.32	3.73	47.27
$LSD_{(0.05)}$	NS	NS	2.883	NS	NS	1.012
Incorporation methods:						
B_1						
B_2	81.74	38.95	39.56	3.54	3.85	47.78
B_3	86.08	43.08	40.84	3.46	3.76	48.11
B_4	84.83	44.32	43.63	3.32	3.84	46.22
B_5	79.96	40.62	37.18	3.37	3.66	47.78
$LSD_{(0.05)}$	85.50	43.16	38.30	3.43	3.56	49.00
	2.340	3.491	3.790	NS	NS	0.972

S_1 = *B. campestris* S_2 = *B. juncea* S_3 = *B. napus;* B_1 = No biomass B_2 = Spreading above ground
B_3 = mixed with soil B_4 = spreading in lines B_5 = 50% spreading + 50% mixed with soil

The tallest plant (86.08 cm) was recorded from B_2 (spreading above ground) that similar to B_5 and B_3 but B_4 produced the shortest plant height (79.96 cm). The maximum number of filled grains spike^{-1} (44.32) was recorded from B_3 (mixed with soil) that similar to B_5 (50% spreading + 50% mixed with soil), B_2 (spreading above the ground) and B_4 (spreading in line) while the minimum (38.95) was found in B_1 (control) plot (Table 4). B_3 treatment showed the highest 1000-grain weight (43.63 g) that similar to B_2 whereas B_4 gave the lowest grain weight (37.18 g) that similar to B_5, B_2 and B_1. The highest harvest index (49.00%) was recorded from B_5 that similar to B_2, B_1 and B_4 while the lowest (46.22%) in B_3.

The combined effect of *Brassica* species and different incorporation methods significantly effect the grain yield and other studied crop characters of wheat where S_2B_2 (*Brassica juncea* spreading above ground) showed the highest grain yield (3.83 t ha^{-1}), straw yield (4.17 t ha^{-1}), superior plant height (85.90 cm) and 1000-grain weight (43.93 g) whereas the lowest grain yield (3.06 t ha^{-1}) was found in S_3B_2 (*Brassica napus* spreading above ground). Baker and Bhowmik (2001) reported that application of imported residues was found more effective in yield enhancement of vegetable cropping systems. The S_3B_5 (*Brassica napus* with 50% spreading + 50% mixed with soil) had the maximum number of filled grains spike^{-1} (47.24) and the minimum (35.87) in S_1B_4 (Table 5).

Table 5. Interaction effect of *Brassica* spp. and ways of biomass incorporation on yield and other crop characters of wheat

Treatments	Plant height (cm)	Filled grains spike^{-1} (no.)	1000-grain weight (g)	Grain yield (t ha^{-1})	Straw yield (t ha^{-1})	Harvest index (%)

$S_1 B_1$	83.20	38.91	38.65	3.61	3.44	51.00
$S_1 B_2$	83.00	44.67	34.97	3.50	3.72	48.67
$S_1 B_3$	88.00	46.40	39.81	3.39	3.95	46.00
$S_1 B_4$	81.13	35.87	33.09	3.39	3.64	48.00
$S_1 B_5$	85.40	40.73	38.49	3.28	3.44	48.67
$S_2 B_1$	79.80	36.07	40.72	3.33	3.83	46.33
$S_2 B_2$	85.90	37.51	43.93	3.83	4.17	47.67
$S_2 B_3$	84.67	43.15	48.77	3.33	3.89	46.00
$S_2 B_4$	79.60	39.76	39.40	3.34	3.69	47.33
$S_2 B_5$	83.07	40.88	37.11	3.75	3.61	51.67
$S_3 B_1$	82.63	41.24	38.67	3.67	4.27	46.00
$S_3 B_2$	89.33	46.19	42.35	3.06	3.40	48.00
$S_3 B_3$	81.83	42.58	42.02	3.23	3.70	46.67
$S_3 B_4$	79.13	46.03	38.52	3.38	3.66	48.00
$S_3 B_5$	88.03	46.69	38.43	3.28	3.61	47.67
$LSD_{(0.05)}$	4.156	6.047	6.564	0.612	0.733	1.684

S_1 = *B. campestris* S_2 = *B. juncea* S_3 = *B. napus;* B_1 = No biomass B_2 = Spreading above ground
B_3 = mixed with soil B_4 = spreading in lines B_5 = 50% spreading + 50% mixed with soil

Conclusion

Irrespective of three studied species, *Brassica* crop has significant role to suppress weed in wheat field. The nature of weed suppression varied among the incorporation methods. The higher grain yield of wheat was found with the incorporation of *Brassica juncea* biomass as spreading above ground. It is necessary to isolate the allelochemical in *Brassica* for implementing such eco-friendly method of weed control.

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