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Effect of integrated weed management on weed and growth attributing characters of mustard (*Brassica juncea* L.)

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Abstract

Results showed that the minimum weed density and weed dry matter was observed in T_9-Paddy straw mulching @ 5 t/ha followed by T_7- Pendimethalin @ 1 kg/ha+ Clodinofop @ 60 g/ha at all growth stages except 30 DAS. The maximum weed control efficiency and minimum weed index was calculated with application of T_9-Paddy straw mulching @ 5 t/ha followed by T_7- Pendimethalin @ 1 kg/ha+ Clodinofop @ 60 g/ha. The similar results were recorded in respect of growth attributing characters. The crop growth attributing were significantly increased with the application of T_9- Paddy straw mulching @ 5 t/ha followed by T_7- Pendimethalin @ 1 kg/ha+ Clodinofop @ 60 g/ha.

Keywords: *Growth parameters, herbicides, weed index, yield.*

Introduction

Indian mustard (*Brassica juncea* L.) is growing as an oil crop belongs to the family Brassicaceae. Mustard has a large number of alternative uses, mostly related to health. It relieves a sore throat, chest congestion treat fever, flu, calm muscles, treat painful knees, back pain. It contributes 12% of world's total production. The seed meal of rapeseed contains proteins (35-40%), carbohydrates (14-15%), fibre (10-12%), ash (4-6%), minerals and vitamins (1.0-1.5%), glucosinolates (2-3%) tannin (1.6-3.1%), sinapin (1.0-1.5%) and phytic acid (3-6%) (Prasad, 2015). Weed is biotic constrains which complete to crop for natural recourses as well as other inputs. Weed interference is one of the most important limiting factors which decrease crop yields and consequently global food production. Weeds are the most underestimated crop pests in tropical agriculture and cause maximum loss in the yields of crops than other pests and diseases. Approximately, 20-30% yield reduction causes by weeds in rape/mustard crop (Punia *et al.,* 2010). If uncontrolled, the weeds in many fields are capable of reducing yields by more than 80%. The presence of weeds throughout the growing season brought about 24% reductions in crop yield as compared to weed free (Yadav *et al.,* 2017).

Weed management is essential at initial stage of crop to avoid crop weed completion. The most critical period of this crop is varies according to agro-climatic condition varieties nature of weed and density of weed etc. However, the average critical period for crop weed completion is upto 30 DAS (Dashora *et al.* 1990). Weeds can be controlled by several methods. Continuous use of the same method leads to built up of tolerant weeds to particular methods. Therefore it is necessary to combine to other methods of weed control. Due to continuous use of same herbicide with same mode of action weeds become tolerant or resistant to those specific herbicides. Resistance to a particular herbicide develops when the herbicide has a high degree of control of the target species, the weed seed has a short life in the soil seed bank, the herbicide has a long persistence, the herbicide is used frequently, the herbicide has a single site of action and the herbicide rate is high (Reddy and Reddy, 2015). To avoid these problems, integrated weed management practices are used. Integrated weed control is a weed population management system that uses all suitable techniques in a compatible manner to reduce weed population and *maintain* them at levels below those causing economic injury. Application of oxadiargyl at 150 and 180 g/ha alone and tank mixture of oxadiargyl + isoproturon at 90 + 150 g/ha proved very effective in minimizing density and dry weight of *Chenopodium album, Medicago denticulata* and *Melitotus indica* weeds as compared to other treatments and were at par with two hoeing, pendimethalin at 1.0 and 1.5 kg/ha and trifluralin at 1.0 kg/ha (Purna *et al.,* 2006). The lowest weed density, dry weight of total weeds and maximum yield was recorded under application of pendimethalin @ 1.0 kg/ha as pre-emergence + Quizalofop-P-ethyl @ 0.04 kg/ha at 20 days after sowing + Hand-weeding and Inter-cultivation at 40 days after sowing (Jangir *et al.* 2017).

Materials and Methods

The experiment was conducted during 2017 and 2018 at Experimental Farm, Department of Agriculture, Mata Gujri College, Fatehgarh Sahib, Punjab during *Rabi* season. The minimum temperature may go down to 5.3^0 C in January (in 3rd metrological week of 2018) while the maximum temperature may go as high as 34.8^0C in April (in 14th metrological week of 2018). The total rainfall received during the growing season of the crop was 81.3 mm. Evaporation during the cropping season was from 6.2 to 42.2 mm. Maximum relative humidity ranged from 68.9 to 96.0 % and minimum relative humidity ranged from 29.1 to 75.6%. The soil of the experimental field was clay loam texture with pH 8.1. It was moderately fertile, with available nitrogen (271 kg/ha), available phosphorus (24.1 kg/ha), available potassium (198.15 kg/ha) and organic carbon (0.65%). The experimental was laid out in randomised block design with ten treatments *viz.* T_1-Weedy check, T_2-Weed free, T_3-Pendimethalin @ 1.0 kg/ha, T_4- Pendimethalin @ 1.0 kg/ha *fb* Hand hoeing, T_5-Pendimethalin @ 1.0 kg/ha *fb* Isproturon @ 1.0 kg/ha, T_6-Isoproturon @ 1.5 kg/ha, T_7- Pendimethalin @ 1.0 kg/ha *fb* Clodinofop @ 60 g/ha, T_8- Clodinofop @ 60g/ha, T_9-Paddy straw mulching @ 5 t/ha, T_{10}- Paddy straw mulching @ 2.5 t/ha were compared with weedy check and weed free. The treatments were replicated three times. Mustard variety Giriraj (DRMRIJ 32) was sown with seed rate of 4 Kg/ha. The seeds were sown manually with the help of seed drill with spacing 30×10 cm. A recommended dose of 60 kg/ha N, 40 kg/ha P_2O_5, 30 kg/ha K_2O were applied for wheat crop. Half dose of nitrogen and full dose of phosphorus and potassium were applied as basal before sowing. Remaining doses of nitrogen were top dressed. Nitrogen, phosphorus, potassium were applied through urea, single super phosphate and muriate of potash, respectively. Fertilizers were applied after layout of experimental unit. Observations were recorded on total weed population, weed dry matter accumulation and weed index. The weed density, weed dry matter production and weed control efficiency were recorded at 30, 60, 90 DAS and at harvest stage. Weed density and dry weight were square root transformed, before analysis. Plant height were recorded at 30, 60, 90 DAS and at harvest stage. Weed density and weed dry matter was transformed in to square root transformation for statistical analysis. The crop responses to treatments were measured in terms of growth attributes *viz.,* plant height, and No. of secondary branches, crop dry matter accumulation (g/plant) at 30, 60, 90 DAS and at harvest stage except leaf area index. Leaf area index was recorded at 30, 60, 90 DAS. Plant height was measured from soil surface to tip of plant with help of meter scale. Leaf area was measured with help of leaf area meter and then converted in to leaf area index. For crop dry matter samples were dried in hot oven at 60 ± 2°C. The standard statistical procedures were used to analyze the data.

Results and Discussion

Effect on major weed flora, density and dry matter of weed

The important weed flora recorded envisages that crop was infested with grassy, sedges and broad leaved weeds. The important weed species were noticed in crop field *i.e. Avena ludoviciana, Phalaris minor, Chenopodium album, Rumex dentatus, Anagallis arvensis, Convolvulus arvensis, Melilotus indica* and *Cirsium arvense* can be attributed to simultaneous germination of these species along with mustard seeds under favorable soil moisture and temperature. Similar results were reported by Kalita *et al*. (2017) and Yadav *et al.* (2017).

All the weed control treatments reduce the density of weeds and dry matter of weeds comparison to weedy check. The resulted value showed significant difference among the treatments (Table 1). The minimum weed density and dry weight of weeds was recorded in T_3-Pendimethalin @ 1 kg/ha which was at par which T_4-Pendimethalin @ 1 kg/ha *fb* Hand Hoeing (35 DAS), T_5-Pendimethalin @ 1.0 kg/ha *fb* Isoproturon @ 1kg/ha and T_7- Pendimethalin @ 1.0 kg/ha *fb* Clodinofop @ 60 g/ha at 30 DAS and it was recorded as significantly lower to rest of treatments. Pre-emergence application of Pendimethalin @ 1.0 kg/ha reduced the weed density which might be due to effective control of grassy and broad leaf weeds. Pendimethalin inhibits cell division and cell elongation in the root and shoot meristem resulted by inhibition of growth being absorbed through hypocotyls or shoot growth resulted in death of the germinated seedling. Several authors reported that the reduction of weed density, weed dry matter and weed index due to application of pendimethalin (Patel *et al.*, 2013, Kour *et al*., 2014 and Jangir *et al.*, 2017).

At 60, 90 DAS and at harvest, the minimum weed density and weed dry matter was observed in T_9-Paddy straw mulching @ 5 t/ha which was at par with T_7- Pendimethalin @ 1.0 kg/ha+ Clodinofop @ 60 g/ha and T_5- Pendimethalin @ 1.0 kg/ha + Isoproturon @ 1kg/ha. It was significantly inferior to rest of the treatments (Table1). Mulching reduces weed density and its dry matter due to physical hindrance in emerging weeds and reduces solar radiation reaching the weeds because it apply between the rows of crop which cover the space between the rows and due to

Table 1: Effect of integrated weed management on total weed density (m^2) and total weed dry matter accumulation (g/m^2)

Treatments	Total weed density (m^2)				Weed dry matter accumulation (g/m^2)			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1-Weedy check	5.08(25.3)	4.94(24.0)	4.70 (21.6)	4.59 (20.7)	2.98 (8.4)	3.93 (15.0)	5.46 (29.3)	5.56 (30.4)
T_2-Weed free	0.71(0.0)	0.71(0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71 (0.0)	0.71(0.0)	0.71(0.0)
T_3-Pendimethalin @ 1 kg/ha	2.97(8.3)	4.76(22.3)	4.44 (19.3)	4.30 (18.0)	1.28 (1.1)	2.98 (8.4)	4.45 (19.4)	4.56 (20.3)
T_4- Pendimethalin @ 1 kg/ha *fb* hand hoeing (35 DAS)	3.02(8.7)	4.38(18.7)	4.20 (17.3)	3.89 (14.7)	1.29 (1.2)	2.61 (6.3)	3.96 (15.3)	4.11(16.4)
T_5- Pendimethalin @ 1 kg/ha *fb* Isoproturon @ 1kg/ha	3.53(12.0)	4.13(16.7)	3.98 (15.3)	3.62 (12.7)	1.32 (1.3)	2.01 (3.5)	3.57(12.3)	3.66 (13.0)
T_6- Isoproturon @ 1.5 kg/ha	5.05(25.0)	4.56(20.3)	4.37 (18.7)	4.10 (16.3)	2.87 (7.8)	2.83 (7.5)	4.15(16.8)	4.51(19.9)
T_7- Pendimethalin @ 1 kg/ha *fb* Clodinofop @ 60 g/ha	4.49(19.7)	4.02(15.7)	3.76 (13.7)	3.44 (11.3)	1.32 (1.3)	1.88 (3.2)	3.24(10.0)	3.52 (11.9)
T_8- Clodinofop @60g/ha	4.85(23.3)	4.48(19.7)	4.29 (18.0)	4.02 (15.7)	2.78 (7.3)	2.76 (7.2)	4.09(16.4)	4.39 (18.8)
T_9-Paddy straw mulching @ 5 t/ha	4.63(21.0)	3.72(13.3)	3.67 (13.0)	3.37 (11.0)	2.19 (4.3)	1.85 (3.0)	3.19(9.7)	3.24 (10.0)
T_{10}- Paddy straw mulching @ 2.5 t/ha	4.79(22.7)	4.41(19.0)	4.25 (17.7)	3.94 (15.0)	2.70 (6.8)	2.73 (7.0)	4.00(15.7)	4.14 (16.7)
Sem±	0.20	0.18	0.17	0.15	0.10	0.14	0.19	0.13
CD @ 5 %	0.60	0.55	0.50	0.44	0.30	0.40	0.57	0.40

Table 2: Effect of integrated weed management on plant height (cm) and crop dry matter accumulation (g/plant)

Treatments	Plant height (cm)				Crop dry matter accumulation (g/plant)			
	30 DAS	60 DAS	90 DAS	At harvest	30 DAS	60 DAS	90 DAS	At harvest
T_1-Weedy check	10.4	80.7	138.8	153.6	2.8	8.7	17.7	31.3
T_2-Weed free	15.2	97.2	170.0	187.1	3.7	15.3	30.6	40.7
T_3-Pendimethalin @ 1 kg/ha	14.6	83.7	143.4	156.9	3.7	9.7	18.2	32.1
T_4- Pendimethalin @ 1 kg/ha *fb* hand hoeing (35 DAS)	14.6	86.3	148.7	163.2	3.3	10.7	22.1	35.3
T_5- Pendimethalin @ 1 kg/ha *fb* Isoproturon @ 1kg/ha	13.7	90.2	164.4	169.9	3.2	12.4	25.0	36.3
T_6- Isoproturon @ 1.5 kg/ha	10.8	84.1	145.6	157.9	2.8	9.7	20.0	33.1
T_7- Pendimethalin @ 1 kg/ha *fb* Clodinofop @ 60 g/ha	13.1	92.8	165.8	177.5	3.1	13.9	27.6	38.0
T_8- Clodinofop @60g/ha	10.7	84.9	146.3	159.6	2.9	10.0	20.5	34.8
T_9-Paddy straw mulching @ 5 t/ha	12.4	95.8	168.0	183.0	3.1	14.3	28.7	40.0
T_{10}- Paddy straw mulching @ 2.5 t/ha	12.3	85.2	147.8	161.4	2.9	10.1	21.1	35.1
Sem±	0.6	3.1	6.4	6.4	0.2	1.2	2.2	1.4
CD @ 5 %	1.7	9.1	18.9	19.0	0.6	3.6	6.4	4.2

Table 3: Effect of integrated weed management on leaf area index and no. of secondary branches/plant

Treatments	LAI (%)			No. of secondary branches/plant		
	30 DAS	60 DAS	90 DAS	60 DAS	90 DAS	At harvest
T_1-Weedy check	0.15	2.23	3.28	3.30	5.87	6.23
T_2-Weed free	0.37	4.38	5.77	5.27	10.83	11.23
T_3-Pendimethalin @ 1 kg/ha	0.34	2.49	3.57	3.43	6.13	6.47
T_4- Pendimethalin @ 1 kg/ha *fb* hand hoeing (35 DAS)	0.33	3.12	4.78	3.93	8.17	8.57
T_5- Pendimethalin @ 1 kg/ha *fb* Isoproturon @ 1kg/ha	0.28	3.36	4.98	4.07	8.93	9.37
T_6- Isoproturon @ 1.5 kg/ha	0.17	2.68	3.79	3.47	6.87	7.13
T_7- Pendimethalin @ 1 kg/ha *fb* Clodinofop @ 60 g/ha	0.26	3.84	5.15	4.53	9.30	9.77
T_8- Clodinofop @60g/ha	0.19	2.92	4.28	3.57	7.30	7.67
T_9-Paddy straw mulching @ 5 t/ha	0.22	4.15	5.49	4.93	9.93	10.17
T_{10}- Paddy straw mulching @ 2.5 t/ha	0.20	3.04	4.52	3.70	7.63	8.03
Sem ±	0.03	0.27	0.19	0.30	0.44	0.49
CD @ 5 %	0.10	0.81	0.55	0.89	1.31	1.47

absence of light weed growth and development was reduced. It improves the physical condition of soil like increase the moisture conservation, reduce the soil compaction, maintain the soil temperature so crop was well established and suppress the weed growth. Similar results were reported by Jat *et al.* (2017).

Effect on WCE (%) and WI (%)

A perusal of the data presented in Table 4 and revealed that weed control efficiency and weed index was affected to a considerable extent by different treatments. The maximum weed control efficiency was recorded with application of T_3-Pendimethalin @ 1.0 kg/ha followed by T_4- Pendimethalin @ 1.0 kg/ha *fb* hand hoeing (35 DAS), T_5- Pendimethalin @ 1.0 kg/ha *fb* Isoproturon @ 1kg/ha and T_7- Pendimethalin @ 1 kg/ha *fb* Clodinofop @ 60 g/ha. However, the maximum weed control efficiency was found with T_9- Paddy straw mulching @ 5 t/ha followed by T_7- Pendimethalin @ 1.0 kg/ha+ Clodinofop @ 60 g/ha and T_5- Pendimethalin @ 1.0 kg/ha +Isoproturon @ 1.0 kg/ha at 60, 90 and at harvest stage. It may be due to suppressed weed density due to poor germination as well as absence of solar radiation for photosynthesis (Sarangi *et al.,* 2010)

The lowest weed index was recorded with the application of T_9- Paddy straw mulching @ 5 t/h followed by T_7- Pendimethalin @ 1.0 kg/ha+ Clodinofop @ 60 g/ha and T_5- Pendimethalin @ 1.0 kg/ha +Isoproturon @ 1kg/ha. While the highest weed index was recorded in the weedy check and lowest weed index was recorded in the weed free treatments. Similar results were reported by Jat *et al.* (2017).

Effect on growth attributing characters

The growth attributes like plant height, dry matter accumulation (Table 2), leaf area index and No. of secondary branches (Table 3) were influenced significantly by different methods of weed control. These growth parameters showed positive correlation with yield.

The maximum plant height was observed in T_3- Pendimethalin @ 1.0 kg/ha which was at par with T_4- Pendimethalin @ 1.0 kg/ha *fb* Hand Hoeing (35 DAS), T_5- Pendimethalin @ 1.0 kg/ha *fb* Isoproturon @ 1.0 kg/ha and T_7- Pendimethalin @ 1.0 kg/ha *fb* Clodinofop @ 60 g/ha and it was significantly superior over rest of treatments at 30 DAS. Under these treatments it inhibits germination of weeds and toxic effect weeds at initial stages. Similar

Table 4: Effect of integrated weed management on weed control efficiency (%) in mustard

Treatments	Weed control efficiency (%)				Weed
	30 DAS	60 DAS	90 DAS	At harvest	index (%)
T_1-Weedy check	0	0	0	0	39.9
T_2-Weed free	100	100	100	100	0.0
T_3-Pendimethalin @ 1 kg/ha	86.3	43.9	33.9	33.2	36.1
T_4- Pendimethalin @ 1 kg/ha *fb* hand hoeing (35 DAS)	85.7	57.9	47.7	46.0	28.0
T_5- Pendimethalin @ 1 kg/ha *fb* Isoproturon @ 1kg/ha	85.1	76.5	58.2	57.1	17.4
T_6- Isoproturon @ 1.5 kg/ha	7.3	49.8	42.7	34.5	29.9
T_7- Pendimethalin @ 1 kg/ha *fb* Clodinofop @ 60 g/ha	85.0	78.9	65.9	60.8	15.3
T_8- Clodinofop @60g/ha	12.6	51.9	44.2	38.1	31.6
T_9-Paddy straw mulching @ 5 t/ha	48.8	80.2	67.0	67.0	7.1
T_{10}- Paddy straw mulching @ 2.5 t/ha	18.6	53.4	46.4	45.0	30.8

results were found by Mukherjee (2014), Das (2016) and Jangir *et al.* (2017).

At 60, 90 DAS and at harvest, among the different treatments maximum plant height, number of tillers in running meter, leaf area index and dry matter accumulation was observed in T_9-Paddy straw mulching @ 5 t/ha which was at par with T_7- Pendimethalin @ 1.0 kg/ha+ Clodinofop @ 60 g/ha and T_5- Pendimethalin @ 1.0 kg/ha + Isoproturon @ 1.0 kg/ha. It was significantly superior to rest of the treatments. Maximum growth parameters were recorded under T_9-Paddy straw mulching @ 5 t/ha treatment because of low weed density and less crop weed competition at various growth stages. It might to be increase nutrient uptake and better translocation of nutrients to crop. Minimum growth attributes were found in weedy check plot due to high weed density and more crop weed competition. Similar results were found by Regar *et al.* (2009) and Mahanta *et al.* (2019).

Conclusions

On the basis of results summarized above, it can be concluded that application of in T_9- Paddy straw mulching @ 5 t/ha gave best results in respect to all parameters and second best T_7- Pendimethalin @ 1.0 kg/ha+ Clodinofop @ 60 g/ha at different stages of growth stages except 30 DAS.

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