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Effect of weed management practices on yield and economics in Indian mustard

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Abstract
A field experiment was conducted with nine treatments (Weedy check, One hand weeding 30, DAS two hand weeding at 20 & 40 DAS, Pendimethalin (PE) @ 1.00 ai kg/ha, Oxyflorafen (PE) 0.20 ai kg/ha, Isoproturan (PE) 1.00 ai kg/ha, Pendimethalin (PE) @1.00 ai kg/ha+ Hand weeding at 30 DAS, Oxyflorafen (PE) 0.20 ai kg/ha + Hand weeding at 30 DAS, Isoproturan (PE) 1.00 ai kg/h + Hand weeding at 30 DAS) at Ayodhya during 2017-18. Among the different weed management practices maximum number of siliquae plant^{-1}(248.73), Length of siliqua 6.70 cm, Number of seeds siliqua^{-1} 12.01, Test weight 5g, Seed yield 2255 kg ha^{-1}, Stover yield 6063 kgha^{-1},Harvest index 27.10 (%) Oil content 37.95(%), Oil yield 855.81 kg ha^{-1} under Two hand weeding at 20 & 40 DAS followed by treatment having Pendimethalin (PE) @ 1.00 ai kg/ha+ Hand weeding at 30 DAS, similarly maximun net return was obtained under Pendimethalin (PE) @ 1.0 kg ha^{-1} + hand weeding at 30 DAS (Rs. 72862 ha^{-1}) followed by two hand weeding at 20 and 40 DAS (Rs. 71469 ha^{-1}) while maximum gross return was recorded under two hand weeding at 20 and 40 DAS (Rs. 102326 ha^{-1}) followed by Pendimethalin (PE) @ 1.0 kg ha^{-1} + hand weeding at 30 DAS (Rs. 99498 ha^{-1}). Pendimethalin (PE) @ ai 1.0 kg ha^{-1} (2.76) resulted in highest net return per rupee invested on weed control.

Keywords: Weed, pendimethlin, isoproturan, hand weeding

Introduction
Indian mustard (*Brassca juncea* L.) belongs to family Brassicaceae. It is known to Greeks, Romans, Indians and Chinese 2000 years ago. Genus *Brassica* comprises of five cultivated species *viz.*, *Brassica juncea* (Indian mustard), *Brassica campestris* (Toria), *Brassica nigra* (Banarasi rye), *Brassica napus* (Gobhi sarson) and *Brassica carinata* (Abyesinian mustard) predominantly grown in China, India, Canada, Pakistan, USSR and Europe. It is the third major oilseed crop of India, ranking after groundnut and soybean, with around 23 per cent share of total oilseed production (Rajak *et al.*, 2011) [9]. India's rank first in area (20.2%) and second in production (10.7%) after China in rapeseed and mustard growing countries of the world (Annon, 2014) [1]. Oilseed crops occupy an area of 28.2 million hectares with total production of 32.9 million tonnes and productivity 1167 kg ha^{-1} at national level. Mustard alone occupies an area of 6.5 million hectare with the total production of 7.8 million tonnes and productivity of 1208 kg ha^{-1} during 2016-17 among the different oilseed crops (Annonymous, 2016) [2]. Among the various factors, which influence the crop production, weed flora a single negative factor and serious menace, which plays key role for achieving high yield potential in any crop. The weeds cause substantial losses to agricultural production. Estimates showed that in India, weeds cause an annual monetary loss of 1980 million (Mukhopadhyay, 1992) [7]. Weed problem is one of the major barriers which responsible for low productivity of mustard because yields. Weeds compete with the crop for light, nutrient, water and carbon dioxide. Rao (2000) [10] reported that reduction in crop yield has a direct correlation with weed competition. The most common herbicidal weed control measure recommended in Indian mustard is the pre-emergence application of pendimethalin. Farmers and extension functionaries require information on post-emergence herbicidal weed control due to one or other reason, if pre-emergence application of herbicide was not made.

Under situations when weeds are not taken care completely by pre-emergence application of herbicides, post-Emergence herbicides may have an added economic advantage over super imposition of hand weeding. Therefore, it is imperative to find out an alternative weed management strategy for achieving season long weed control in Indian mustard.

Materials and Methods

The file experiment was conducted during *Rabi* season of 2017-18 Ayodhya ($26^0 47^{'}$ N latitude, $82^0 12^{'}$ E longitude and an altitude of 113 meters). The soil of the experimental field was silty loam in texture with low drainage. It was saline-alkaline in reaction, poor in available nitrogen (136.5 kg/ha) as well as phosphorus (14.5 kg/ha) and moderate in potash (248.5 kg/ha). Nine treatments *viz*. Weedy check, One hand weeding 30 DAS, Two hand weeding at 20 & 40 DAS, Pendimethalin (PE) @ 1.00 ai kg/ha, Oxyflorafen (PE) 0.20 ai kg/ha, Isoproturan (PE) 1.00 ai kg/ha, Pendimethalin (PE) @1.00 ai kg/ha+ Hand weeding at 30 DAS, Oxyflorafen (PE) 0.20 ai kg/ha + Hand weeding at 30 DAS, Isoproturan (PE) 1.00 ai kg/h + Hand weeding at 30 DAS. The seeds of mustard variety 'Narendra Rai- 1 (NDR- 8501)' were sown in rows 45 cm apart on November 11, 2017 using 5 kg/ha. The crop was fertilized with 60 kg N, 40 kg P2O5 and 30 kg K2O/ha as basal dose. Required amount of N, P and K was supplied through urea, single super phosphate and muriate of potash, respectively. The recommended cultural practices and plant protection measures were followed to raise the healthy crop. Weeding was done manually with the help of hand tool 'Khunti'. Weed counts was recorded by placing 25 x 25 cm quadrates at two random places in each plot and after drying them in hot air oven (70 ± 10C for 72 h), weed dry weight was recorded. Herbicides were applied with the help of Power Sprayer using flat fan nozzle. Yields were harvested from net plot. Economics of the treatments was computed based on the prevalent market prices.

Result and Discussions

Effect on yield

Yield contributing characters

Yield contributing characters are the resultant of vegetative development of the crop which determine yield. All the yield attributes *viz*., number of siliqua plant-1, length of siliqua, number of seed siliqua-1 and test weight were influenced by various weed management practices.

Number of siliquae plant-1,number of seed siliquae and length of siliquae were recorded maximum in two hand weeding at 20 & 40 DAS being statistically at par with pendimethalin (PE) @ 1.0 kg ha-1 + hand weeding 30 DAS and found superior over rest of the weed management practices. The test weight did not affected significant, due to weed management. The increase in yield attributing characters might be due to the increase in vegetative as well as reproductive attributes under proper nourishment through weed management. In addition the increase in yield attributes was mainly due to increase in photosynthesis activity of leaves, translocation of photosynthates from source to sink and nutrients uptake under higher nutrients availability in weed management. The minimum values of the entire yield attributes were observed in the treatment received lower amount of nutrients in weedy check because plants did not absorbed sufficient amount of nutrients which resulted in poor yield attributes. Similar result were also reported by Jangir *et al.* (2017) [6]. Prakash and (2002) [15] Singh *et al*., (2000)

Seed and stover (kg ha-1)

Yield is the resultant of coordinated interplay of growth characters and yield attributes. Seed and stover yield and influenced significantly by applying various weed management practices.

The maximum seed yield of mustard was recorded with two hand weeding at 20 & 40 DAS which being statistically at par with pendimethalin (PE) @ 1.0 kg ha-1 + hand weeding 30 DAS. More or less similar trend was observed in stover yield and harvest index also. This might be due to adequate nutrient availability and less competition to weeds, which contributed to better growth parameters and yield attributes. Productivity of crop collectively determined by vigor of the vegetative growth and yield attributes which resulted in higher seed and straw yield. The increase in yield was further attributed to better translocation of photosynthates from source to sink due to higher uptake of N which are responsible for quick and easy translocation of photosynthates. Contrary to this, nutrients stress and moisture due to reduced absorbed of nutrients in weedy check provided minimum seed and straw yield due to poor growth and yield attributing characters. The result are in close confirmily weth the findings of Jangir *et al*. (2017) [6] Mukherjee, (2014) [8], Sharma and Singh, (2002) [13-14-15], Chauhan *et al*., (2005) [3] and Degra *et al*. (2006) [4].

Oil content

The oil content in seed was not affected significantly with applying various weed management practices. The maximum oil content in seed was found with Two hand weeding at 20 & 40 DAS and lowest oil content was recorded in the weedy check. This might be due to genetical character of the variety. The result is in confirmation to the finding of Sewak *et al*. (2004) [11], Sharma and Singh, (2002) [13-14-15].

Economics

The cost of cultivation was calculated for all the weed control treatments. The maximum total cost of cultivation (Rs.30927 ha-1) was recorded under the effect of two hand weeding at 20 & 40 DAS for mustard crop. Higher cost of cultivation in this treatment might be due to the huge number of laboures is required for weeding comparison to chemical and other weed management approaches during the present investigation.

The maximum gross return of (Rs.102326 ha-1) and net return of (Rs.72862 ha-1) noted in hand weeding 20 and 40 DAS and pre-emergence application of pendimethalin 1.00 kg ai kg h-1 coupled with one hand weeding at 30 DAS, respectively. The highest net return per rupee investment i.e 2.76 was associated the pre-emergence application of Pendimethalin (PE) @ 1.00 ai kg h-1 alone followed by pre-emergence application of Pendimethalin (PE) @ 1.00 ai kg ha-1 coupled one hand weeding at 30 DAS which recorded net income per rupee investment of Rs. 2.73. This is the matter of fact that pre-emergence application of Pendimethalin (PE) 1.00 ai kg ha-1 coupled with one hand weeding at 30 DAS registered the highest net income ha-1 yet failed to provide the highest net income per rupee investment because of the higher cost of cultivation. Jangir *et al*. (2018) [6] and Mukherjee (2014) [8] reported that Pendimethalin (PE) 1.00 ai kg h-1 alone appeared cheaper in cultivation of indian mustard.

Table 1: Effect of weed management on yield attributes of mustard crop.

Symbols	Treatments	Number of siliquae plant^{-1}	Length of siliqua (cm)	Number of seeds siliqua^{-1}	Test weight (g)
T_1	Weedy check	115.48	3.95	7.53	4.35
T_2	One hand weeding 30 DAS	165.35	4.82	9.34	4.56
T_3	Two hand weeding at 20& 40 DAS	248.73	6.70	12.01	5.01
T_4	Pendimethalin (PE) @ 1.00 ai kg/ha	204.29	5.63	9.68	4.66
T_5	Oxyflorafen (PE) 0.20 ai kg/ha	189.62	5.15	9.55	4.63
T_6	Isoproturan (PE) 1.00 ai kg/ha	170.56	4.95	9.30	4.59
T_7	Pendimethalin (PE) @ 1.00 ai kg/ha+ Hand weeding at 30 DAS	232.64	6.12	11.43	4.86
T_8	Oxyflorafen (PE) 0.20 ai kg/ha + Hand weeding at 30 DAS	212.21	5.90	10.36	4.85
T_9	Isoproturan (PE) 1.00 ai kg/h + Hand weeding at 30 DAS	206.05	5.81	10.24	4.72
SEm±		8.33	0.24	0.31	0.18
CD (P=0.05)		24.98	0.72	0.94	NS

Table 2: Effect of weed management on yield of mustard crop.

Symbols	Treatments	Seed yield (Kg ha^{-1})	Stover yield (Kg ha^{-1})	Harvest index (%)
T_1	Weedy check	1504	4755	24.02
T_2	One hand weeding 30 DAS	1656	5054	24.68
T_3	Two hand weeding at 20& 40 DAS	2255	6063	27.10
T_4	Pendimethalin (PE) @ 1.00 ai kg/ha	1900	5497	25.96
T_5	Oxyflorafen (PE) 0.20 ai kg/ha	1878	5412	25.48
T_6	Isoproturan (PE) 1.00 ai kg/ha	1787	5347	25.04
T_7	Pendimethalin (PE) @ 1.00 ai kg/ha+ Hand weeding at 30 DAS	2187	6009	26.68
T_8	Oxyflorafen (PE) 0.20 ai /ha + Hand weeding at 30 DAS	2000	5516	26.61
T_9	Isoproturan (PE) 1.00 ai kg/h + Hand weeding at 30 DAS	1964	5517	26.24
SEm±		58.76	160.27	1.00
CD (P=0.05)		176.19	480.49	NS

Table 3: Effect of weed management on oil content (%) and oil yield (Kg ha^{-1}) of mustard crop.

Symbols	Treatments	Oil content (%)	Oil yield (Kg ha^{-1})
T_1	Weedy check	35.37	531.91
T_2	One hand weeding 30 DAS	35.80	592.90
T_3	Two hand weeding at 20& 40 DAS	37.95	855.81
T_4	Pendimethalin (PE) @ 1.00 ai kg/ha	36.85	700.26
T_5	Oxyflorafen (PE) 0.20 ai kg/ha	36.60	687.51
T_6	Isoproturan (PE) 1.00 ai kg/ha	35.95	642.35
T_7	Pendimethalin (PE) @1.00 ai kg/ha+ Hand weeding at 30 DAS	37.85	827.86
T_8	Oxyflorafen (PE) 0.20 ai kg/ha + Hand weeding at 30 DAS	37.58	751.66
T_9	Isoproturan (PE) 1.00 ai kg/h + Hand weeding at 30 DAS	37.47	735.77
SEm±		1.10	23.42
CD (P=0.05)		NS	70.24

Table 4: Economic analysis of various treatments combinations

Treatments	Common cost of cultivation (Rs ha^{-1})	Treatments cost (Rs ha^{-1})	Total cost of cultivation (Rs ha^{-1})	Gross return (Rs ha^{-1})	Net return (Rs ha^{-1})	B:C Ratio
T_1	21983	-	21983	69670	47687	2.16
T_2	21983	5324	27307	76348	49041	1.79
T_3	21983	8874	30857	102326	71469	2.31
T_4	21983	1103	23086	86994	63908	2.76
T_5	21983	1041	23024	85944	62920	2.73
T_6	21983	407	22390	82174	59784	2.67
T_7	21983	4653	26636	99498	72862	2.73
T_8	21983	4591	26574	91032	64458	2.42
T_9	21983	3957	25940	89594	63654	2.4

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