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EFFICACY OF PRE AND POST EMERGENCE HERBICIDES ON WEED CONTROL AND GROWTH OF MUSTARD (*Brassica juncea* L.)

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ABSTRACT

A field experiment was conducted at Agronomy Farm, College of Agriculture, Nagpur during *rabi* season of 2021-22 to evaluate the efficacy of pre and post emergence herbicides on weed control and growth of mustard on clayey and slightly alkaline soil. The experiment was laid out in randomized block design with ten treatments replicated thrice. In the experimental field, predominant weed flora were *Convolvulus arvensis, Alternanthera triandra, Euphorbia hirta, Trigonella foenumgraecum, Parthenium hysterophorus, Euphorbia geniculate, Celosia argentea and Digera arvensis* among the dicot weeds and *Cyperus rotundus, Cynadon dactylon, Dinebra arabica, Cynotis axillaris* and *Poa annua* among the monocot weeds. Results revealed that amongst all the treatments, weed free check treatment (T_2) showed lowest weed count, weed dry matter with highest weed control efficiency. However, in the herbicidal treatments, Pendimethalin 0.75 kg a.i. ha^{-1} PE fb Propaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS (T_5) was found to be effective in controlling weeds across the crop growth period followed by treatment Pendimethalin 0.75 kg a.i. ha^{-1} PE fb 1 hoeing at 35 DAS (T_6). In respect of growth attributes *viz.,* plant height, number of branches, dry matter production plant^{-1} and seed yield plant^{-1} of mustard, recorded significantly higher values with weed free check treatment (T_2) whereas, in herbicidal treatments, the maximum growth attributes were recorded with treatment of Pendimethalin 0.75 kg a.i. ha^{-1} PE fb Propaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS (T_5) followed by treatment Pendimethalin 0.75 kg a.i. ha^{-1} PE fb 1 hoeing at 35 DAS (T_6) which was at par with weed free check treatment (T_2). Herbicidal weed control is a practical and prudent choice for weed management because manual weeding is frequently done but it is costly, labour-intensive and frequently not completed at a key stage due to unfavorable soil and weather conditions and a lack of labour.

(Key words: Mustard, weed, growth, pendimethalin, imazethapyr, WCE, WI)

INTRODUCTION

Weeds reduce crop productivity and quality by competing with crop plants for available nutrients, water, land and light resources. Weeds are no doubt, a major factor that contributes in reducing mustard production. In order to achieve yield potential of mustard, timely weed management is very important. Weed control in mustard can be accomplished by cultural and mechanical methods which reduce the benefit cost ratio. Manual weeding is common in the state but it is expensive, labour-intensive and often not performed at critical stage due to adverse soil and weather conditions. Further, the operation has to be repeated and the paucity of labours, particularly during the peak period makes it further difficult. For overall management of weeds with greater profitability and sustainability, chemical weed management is a viable and wise decision for weed management.

In mustard crop first 20 to 45 days after sowing is considered the most critical period for crop-weed competition and weeds are to be kept under control for optimum yield. One of the reasons for low productivity of mustard is the poor weed control during early period of crop weed competition. Spraying of post emergence herbicides helps to reduce the crop weed competition at critical growth stages resulting higher crop yields. So, crop-weed competition at critical stages is most important for increasing the crop yields (Vanisree *et al.,* 2019). Hand weeding is the most efficient method of weed control. But these operations could not be performed in time due to erratic weather conditions and labour scarcity. The chemical method of weed control can be very effective in killing the weeds before their emergence as well as after emergence. The use of herbicides or chemicals has assumed a great significance, particularly in intensive agriculture due to their ability of providing quick, effective, selective and economical weed management in term of time, money and labour.

MATERIALS AND METHODS

A field experiment was conducted at Agronomy Section Farm, Collage of Agriculture, Nagpur (Maharashtra)

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during *rabi* season of 2021-22. Nagpur is in Central Vidarbha Zone of Maharashtra. The experiment was laid out in RBD with three replications. The ten treatments comprised of Weedy check (T_1), Weed free check (T_2), Pendimethalin 0.75 kg a.i. ha^{-1} PE fb Clodinafop 60 g a.i. ha^{-1} at 35 DAS (T_3), Pendimethalin 0.75 kg a.i. ha^{-1} PE fb Quizalofop 60 g a.i. ha^{-1} at 35 DAS (T_4), Pendimethalin 0.75 kg a.i. ha^{-1} PE fb Propaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS (T_5), Pendimethalin 0.75 kg a.i. ha^{-1} PE fb 1 hoeing at 35 DAS (T_6), Oxyfluorfen 150 g a.i. ha^{-1} PE fb Clodinafop 60 g a.i. ha^{-1} at 35 DAS (T_7), Oxyfluorfen 150 g a.i. ha^{-1} PE fb Quizalofop 60 g a.i. ha^{-1} at 35 DAS (T_8), Oxyfluorfen 150 g a.i. ha^{-1} PE fb Propaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS (T_9), Oxyfluorfen 150 g a.i. ha^{-1} PE fb 1 hoeing at 35 DAS (T_{10}). Spraying was done with the help of manually operated knapsack sprayer fitted with flat fan nozzle using 500 litres of water $hectare^{-1}$. Monocot and dicot weed count (no./m^2) were recorded from places selected at random in each plot at 30 days intervals. A quadrate of (1m x 1m) size was used for recording the weed density and weed dry weight. The weeds within the quadrate were identified and counted and expressed in (no./m^2). After sun drying, weeds were dried in hot air oven at 65°C for 24 hours to obtain constant weight. Weed control efficiency was also calculated on the basis of dry matter production by formula given by Mani and Gautam (1976).

$$\text{Weed control efficiency (\%)} = \frac{\text{DWC - DWT}}{\text{DWC}} \text{ X } 100$$

Where, DWC = Dry weight of weeds in control plots (g)

DWT = Dry weight of weeds in treated plots (g)

Data on growth attributes *viz.*, plant height, number of primary branches, dry matter accumulation and seed yield were determined at harvest. The data were statistically analysed by using statistical procedures and comparisons were made at 5% level of significance (Panse and Sukhatme, 1967). Weed index was calculated by formula given by Gill and Kumar (1969).

$$\text{Weed index (\%)} = \frac{\text{X - Y}}{\text{X}} \text{ X } 100$$

Where, X = Grain yield (kg ha^{-1}) from weed free plot

Y= Grain yield (kg ha^{-1}) from treated plot for which weed index is to be worked out

RESULTS AND DISCUSSION

Weed Flora

Major weed flora observed on weedy plot comprised of *Convolvulus arvensis, Alternanthera triandra, Euphorbia hirta, Trigonella foenumgraecum, Parthenium hysterophorus, Euphorbia geniculate, Celosia argentea and Digera arvensis* among the dicot weeds and *Cyperus rotundus, Cynadon dactylon, Dinebra arabica, Cynotis axillaris* and *Poa annua* among the monocot weeds. Herbicide treatments showed differential influence on weed control in mustard during the year of experimentation.

Effect on weeds

Data pertaining to number of monocots, dicot and total weeds are presented in Table 1. Results showed that the number of monocots, dicot and total weeds was influenced significantly due to the different treatments. Monocot and dicot weed population was reduced significantly due to various weed control treatments. The lowest density of weed was recorded with treatment weed free check (T_2) and was significantly superior amongst all the other treatments. Amongst herbicidal treatments, treatment comprising of Pendimethalin 0.75 kg a.i. ha^{-1} PE fb Propaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS (T_5) recorded significantly lowest weeds m^{-2} than all other treatments. However, it was found at par with treatment of Pendimethalin 0.75 kg a.i. ha^{-1} PE fb 1 hoeing at 35 DAS (T_6) and Oxyfluorfen 150 g a.i. ha^{-1} PE fb Propaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS (T_9). The treatment weedy check (T_1) recorded the highest monocot and dicot weed count m^{-2}. Singh *et al.* (2018) found that application of pendimethalin + imazethapyr (pre-mix) @ 0.75 and 1.0 kg ha^{-1} effectively controlled the weeds at 38 DAS. Singh *et al.* (2019) recorded pre-emergence application of pendimethalin + imazethapyr at 0.75 kg ha^{-1} (pre-mix) effectively reduced the density of weeds. Wadafale *et al.* (2011) reported that lower weed count was obtained with the application of Imazethapyr @ 75 g a.i. ha^{-1} at 15 DAS + 1 hoeing and 1 hand weeding at 35 DAS.

Effect on DMW, WCE (%) and WI (%)

At 60 DAS, the treatment weed free check (T_2) produced significantly lower weed dry matter over rest of the treatments. Regarding the herbicidal treatments, application of Pendimethalin 0.75 kg a.i. ha^{-1} PE fb Propaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS (T_5) recorded significantly less dry matter over all other treatments except treatment Pendimethalin 0.75 kg a.i. ha^{-1} PE fb 1 hoeing at 35 DAS (T_6) and Oxyfluorfen 150 g a.i. ha^{-1} PE fb Propaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS (T_9) which were at par with treatment T_5. The highest weed control efficiency was recorded in treatment weed free check (T_2), because of keeping weed free environment, very less crop-weed competition occured that produced less weed biomass and found superior over rest of all herbicidal treatments. Amongst the various herbicidal treatments, application of Pendimethalin 0.75 kg a.i. ha^{-1} PE fb Propaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS (T_5) recorded maximum weed control efficiency. This might be due to combination of both pre and post emergence herbicides that have longer effect on controlling the monocot as well as dicot weeds population producing less weed biomass and thereby increasing weed control efficiency. Gupta *et al.* (2018) observed that two hand weedings at 25-30 and 40-45 days after sowing recorded minimum mean weed dry weight (39.95 g m^{-2}) and highest weed control efficiency (80.94 %) during both years of study which was statistically

Table 1. Weed density (no./m^2), dry matter of weed (gm/m^2), WCE (%) at 60 DAS and weed index (%), plant height (cm), number of branches plant^{-1}, dry matter accumulation plant^{-1} (g) and seed yield plant^{-1} (g) of mustard at harvest as influenced by different weed management practices

Treatments		Monocot weeds	Dicot weeds	Total weeds	DMW (gm/m^2)	WCE (%)	WI (%)	Plant height (cm)	No. of primary branches plant^{-1}	DMA plant^{-1} (g)	Seed yield plant^{-1} (g)
T_1	Weedy check	4.90(24.00)	6.12(37.00)	7.89(61.00)	4.74(22.17)	-	55.43	163.80	2.73	36.68	8.12
T_2	Weed free check	0.71(0.00)	0.71(0.00)	0.71(0.00)	0.71(0.00)	100	-	176.47	3.60	50.37	12.78
T_3	Pendimethalin 0.75 kg a.i. ha^{-1} PE fbClodinafop 60 g a.i. ha^{-1} at 35 DAS	2.48(5.67)	4.26(17.67)	4.88(23.34)	2.93(8.10)	63.46	29.41	172.73	3.25	44.58	11.23
T_4	Pendimethalin 0.75 kg a.i. ha^{-1} PE fbQuizalofop 60 g a.i. ha^{-1} at 35 DAS	2.54(6.00)	4.74(22.00)	5.34(28.00)	3.00(8.50)	61.66	29.68	172.60	3.23	43.69	11.17
T_5	Pendimethalin 0.75 kg a.i. ha^{-1} PE fbPropaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS	1.68(2.33)	3.46(11.50)	3.79(13.83)	2.13(4.03)	81.82	9.43	175.73	3.53	48.50	12.47
T_6	Pendimethalin 0.75 kg a.i. ha^{-1} PE fb 1 hoeing at 35 DAS	1.77(2.67)	3.50(11.73)	3.86(14.40)	2.35(5.03)	77.31	15.06	174.20	3.48	47.63	11.83
T_7	Oxyfluorfen 150 g a.i. ha^{-1} PE fb Clodinafop 60 g a.i. ha^{-1} at 35 DAS	2.91(8.00)	4.91(23.67)	5.67(31.67)	3.12(9.37)	57.74	36.37	171.87	3.20	42.31	10.69
T_8	Oxyfluorfen 150 g a.i. ha^{-1} PE fbQuizalofop 60 g a.i. ha^{-1} at 35 DAS	2.97(8.33)	5.61(31.00)	6.31(39.33)	3.13(9.63)	56.55	39.14	170.73	2.93	41.22	10.45
T_9	Oxyfluorfen 150 g a.i. ha^{-1} PE fbPropaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS	2.12(4.00)	3.51(12.33)	4.10(16.33)	2.55(6.00)	72.94	23.36	173.40	3.30	46.80	11.46
T_{10}	Oxyfluorfen 150 g a.i. ha^{-1} PE fb 1 hoeing at 35 DAS	2.27(4.67)	4.14(16.67)	4.67(21.34)	2.81(7.50)	66.17	23.87	173.20	3.28	46.72	11.45
	SE (m) ±	0.18	0.17	0.19	0.18	-	-	0.80	0.08	1.10	0.40
	CD at 5%	0.52	0.51	0.56	0.53	-	-	2.37	0.23	3.26	1.20

1. Upper values are transformed values ($\sqrt{X + 0.5}$)

2. Figures indicated in the parenthesis are original values

at par with 1 hand weeding and pre-emergence application of pendimethalin 38.7 CS. Singh *et al.* (2018) recorded pre-emergence application of pendimethalin 30 EC + imazethapyr 2 EC (pre-mix) @ 0.75 kg ha^{-1} and 1.0 kg ha^{-1} significantly reduced the dry weight of weeds (84.9 and 85.3 %, respectively) at harvest than weedy check and also provided highest weed control efficiency. Singh *et al.* (2019) found that highest weed control efficiency was recorded in two hand weedings and was followed by pendimethalin + imazethapyr (pre-mix) 0.75 kg ha^{-1} applied as PE.

Weed index was computed as the yield reduction comparatively to highest yielding treatment T_2 (weed free check). Among the weed management practices, application of Pendimethalin 0.75 kg a.i. ha^{-1} PE fb Propaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS (T_5) showed minimum weed index (9.43) over all the other treatments followed by the application of Pendimethalin 0.75 kg a.i. ha^{-1} PE fb 1 hoeing at 35 DAS (T_6) (15.06). Weedy check treatment (T_1) recorded maximum weed index i.e. (55.43) indicating the reduction in mustard seed yield due to presence of weeds throughout crop growth period. Lower weed index in herbicidal treatments might be due to better weed control which provides favourable condition for crop growth that ultimately increased the seed yield of mustard as compared to weedy check treatment (T_1).

Effect on crop

The periodical data on mean plant height (cm), number of primary branches $plant^{-1}$, dry matter accumulation $plant^{-1}$ (g) and seed yield $plant^{-1}$ (g) of mustard as influenced by different treatments are presented in Table 1. The general mean plant height at harvest was 172.47 cm. Mean plant height was gradually increased with advancement in crop age up to harvest. The rate of increase in plant height was rapid during early vegetative growth stage. The plant height, number of primary branches and dry matter accumulation are important parameters for higher yield of mustard.

The treatment weed free check (T_2) recorded significantly maximum plant height, number of primary branches, dry matter accumulation and seed yield over all other treatments. Amongst various herbicidal treatments, application of Pendimethalin 0.75 kg a.i. ha^{-1} PE fb Propaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS (T_5) and Pendimethalin 0.75 kg a.i. ha^{-1} PE fb 1 hoeing at 35 DAS (T_6) being at par with treatment weed free check and recorded significantly higher plant height, number of primary branches $plant^{-1}$, dry matter accumulation and seed yield over all other herbicidal treatments and when compared with weedy check. This might be due to good aeration of soil and least weed population observed in these treatments which reduced the crop-weed competition for soil moisture, plant nutrients, solar radiation and space during active growth period. Sharma *et al.* (2015) reported that application of Pendimethalin @ 0.9 kg ha^{-1} as pre-emergence + imazethapyr @ 75 g ha^{-1} as post-emergence herbicides at 20 DAS resulted in significantly higher growth attributes, yield attributes and yield.

Based on experimental findings, it can be concluded that application of Pendimethalin 0.75 kg a.i. ha^{-1} PE fb Propaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS (T_5) recorded significantly lowest weed population and dry matter of grassy and broad-leaved weeds followed by Pendimethalin 0.75 kg a.i. ha^{-1} PE fb 1 hoeing at 35 DAS (T_6). Similarly, higher weed control efficiency and lower weed index was recorded by these treatments. Application of Pendimethalin 0.75 kg a.i. ha^{-1} PE fb Propaquizafop + Imazethapyr 60 g a.i. ha^{-1} at 35 DAS (T_5) recorded significantly maximum plant height, number of branches $plant^{-1}$, dry matter $plant^{-1}$ and seed yield $plant^{-1}$ of mustard followed by application of Pendimethalin 0.75 kg a.i. ha^{-1} PE fb 1 hoeing at 35 DAS (T_6). Management of weeds with greater profitability and sustainability, chemical weed management is a viable and wise decision due to non-availability of labour and unfavourable soil and weather conditions at critical periods at reasonable cost.

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