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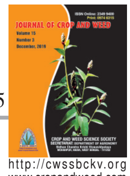

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Integrated weed management in wheat (*Triticum aestivum* L.)

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ABSTRACT

An experiment entitled "Integrated weed management in wheat (Triticum aestivum L.)" was carried out during rabi season of 2020-21 at Agronomy Department Research Farm, College of Agriculture, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.) to determine the effectiveness of various cultural, chemical, physical, and integrated weed management practices on weed flora, growth and yield, as well as the economics of various integrated weed control treatments. Among the treatments of weed management in wheat, the treatment on PE Metribuzine 70% at 0.175 kg a.i ha^{-1} +1 Hand Weeding (T_2) and PE Flumioxazin 50% SC at 125 g a.i ha^{-1} + 1 Hand Weeding (T_4) followed by treatment on closer spacing 15 cm R/R (T_7) were found most effective in controlling weeds and dry weed weight, as well as recorded higher weed control efficiency. These treatments were comparable to weed free and found significantly superior as compared to other treatments. All the yield and yield attributes of wheat was obtained significantly higher in the weed free treatment but statistically at par with PE Metribuzine 70% at 0.175 kg a.i ha^{-1} +1 Hand Weeding (T_2), PE Flumioxazin 50% SC at 125 g a.i ha^{-1} + 1 Hand Weeding (T_4) and closer spacing 15 cm R/R (T_7).

***Keywords*:** Integrated weed management, pre-emergence herbicide, post-emergence herbicides, wheat.

Weeds are one of the most significant variables affecting wheat yield and productivity (Chaudhary *et al.*, 2017). It also deteriorates the grade of farm produce and hence reducing the price on market. Weeds also make the harvesting operation difficult, raise cost for different farm operations, clog water ways and deteriorate quality. Crop losses caused by weed competition are larger than those caused by disease and insects combined. Hence effective weed management is very important for sustaining food grain production to feed increasing population and also ensure food and nutritional security.

The common weeds found to cause drastic reduction in wheat grain yield in India are *Chenopodium album* L., *Convolvulus arvensis, Anagallis arvensis, Rumex retroflex, Melilotus indica, Argemone Mexicana, Brachiaria eruciformis, Fumaria parviflora, Phalaris minor, Avena fatua, Cyperus rotundus, Cynodon dactylon, Parthenium hysterophorous* etc. In crop-weed ecosystem, controlling these weeds in critical period is necessary to inhibit yield losses from weed competition.

Weeds in wheat may be controlled through variety of techniques as a single method of weed control is not sustainable in our country. Integrated Weed Management (IWM) is an ecological weed management strategy that involves integrating various weed management practises, including as agronomic, mechanical, chemical, and biological methods, to reduce dependency on herbicides by understanding weed biology and ecology.

Considering these factors, present experiment was conducted with an objective to investigate efficiency of pre and post emergence herbicide combinations used in sequence or as a pre-mix along with various cultural and physical methods of weed management alone and in combinations, to evaluate their effect on weed control in wheat crop and to assess its efficacy, economic feasibility and impact on grain yield of wheat.

This field trial was conducted during *rabi* 2020-21 at research farm, Department of Agronomy, Vasantrao Naik Marathwada Krishi Vidyapeeth, Parbhani (M.S.) to find out the efficacy of different cultural, chemical, physical and integrated weed management practices on weed flora, yield of wheat, and also to figure out the economics of different integrated weed management treatments. The layout consists of 27 experimental units in 3 replications having 9 units in each replication which was set up in a randomised complete block design. The gross and net plot sizes for each experimental unit were 5.4 m × 4.5 m and 4.5 m x 4.2 m, respectively. The treatments comprised of pre emergence (PE) Flumioxazin 50% at125 g a.i ha^{-1}, PE Metribuzine 70% at 0.175 kg a.i ha^{-1} +1 Hand Weeding , PE Metribuzine at 0.175 kg a.i ha^{-1} + post emergence (PoE) Clodinofop propargyl at 60 g a.i ha^{-1} , PE Flumioxazin 50% SC at125 g a.i ha^{-1} + 1 Hand Weeding , PoE 2,4-D at 0.5-0.84 kg a.i ha^{-1} , PoE Metsulfuron methyl 20% at 4 g a.i ha^{-1}, Closer spacing 15 cm R/R , Weed free and Weedy Check . Sowing was done on 13th November 2020. An area of a quadrate 1 m^2 was fixed in each experimental plot and observations on weed count were recorded at 30, 60, and 90 DAS. These weed samples were sun-dried for three days and then oven dried at 70°C in oven to keep a consistent weight. Before statistical analysis data on

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Table 1 : Mean weed dry weight (g m^{-2}) as influenced by different treatments at 30, 60 and 90 days after sowing

Treatments	30 DAS		60 DAS		90 DAS	
	Monocot	Dicot	Monocot	Dicot	Monocot	Dicot
PE Flumioxazin 50% at125 g a.i ha^{-1}	8.90 (3.14)*	19.60 (4.51)	20.55 (4.64)	30.93 (5.65)	24.78 (5.07)	37.55 (6.20)
PE Metribuzine 70% at 0.175 kg a.i ha^{-1} +1 Hand Weeding	5.48 (2.54)	12.52 (3.67)	8.14 (3.02)	15.48 (4.05)	11.33 (3.51)	20.81 (4.67)
PE Metribuzine at 0.175 kg a.i ha^{-1} + PoE Clodinofop propargyl at 60 g a.i ha^{-1}	13.66 (3.82)	22.04 (4.80)	16.00 (4.12)	26.38 (5.23)	20.23 (4.60)	33.00 (5.83)
PE Flumioxazin 50% SC at 125 g a.i ha^{-1}+ 1 Hand Weeding	6.51 (2.74)	15.56 (4.06)	9.51 (3.24)	19.89 (04.57)	13.74 (3.83)	26.51 (5.24)
PoE 2,4-D at 0.5-0.84 kg a.i ha^{-1}	22.67 (4.86)	28.96 (5.47)	26.62 (5.25)	30.00 (5.56)	31.90 (5.73)	38.33 (6.24)
PoE Metsulfuron methyl 20% at 4 g a.i ha^{-1}	18.96 (4.46)	28.29 (5.41)	19.62 (4.54)	32.71 (5.80)	26.56 (5.24)	41.29 (6.50)
Closer spacing 15 cm R/R	8.83 (3.13)	17.88 (4.34)	11.83 (3.58)	22.21 (4.81)	16.06 (4.13)	28.83 (5.46)
Weed free	3.68 (2.16)	8.66 (3.10)	6.02 (2.64)	11.76 (3.57)	9.60 (3.25)	15.33 (4.04)
Weedy Check	35.44 (6.03)	48.00 (7.00)	68.33 (8.32)	83.85 (9.21)	78.33 (8.90)	98.43 (9.97)
SEm(±)	**1.17**	**1.30**	**2.60**	**1.84**	**1.76**	**3.69**
LSD (0.05)	**3.56**	**3.93**	**7.83**	**5.55**	**5.29**	**11.13**
General mean	**13.79**	**22.36**	**20.73**	**30.33**	**25.83**	**37.75**

*The value in parenthesis are square root transformation by $\sqrt{x+1}$.

Table 2: Yield attributes of wheat as influenced by different weed management practices

Treatments	No. of grains spike^{-1}	Weight of grains spike^{-1} (g)	Weight of grains plant^{-1}(g)	Test weight (g)	Grain yield (tonnes ha^{-1})
PE Flumioxazin 50% at 125 g a.i ha^{-1}	34.43	1.30	10.92	40.85	3.60
PE Metribuzine 70% at 0.175 kg a.i ha^{-1} +1 Hand Weeding	41.26	1.89	13.33	42.01	4.14
PE Metribuzine at 0.175 kg a.i ha^{-1} + PoE Clodinofop propargyl at 60 g a.i ha^{-1}	37.77	1.77	12.15	41.33	3.63
PE Flumioxazin 50% SC at 125 g a.i ha^{-1}+ 1 Hand Weeding	39.32	1.82	13.01	41.51	4.01
PoE 2,4-D at 0.5-0.84 kg a.i ha^{-1}	33.87	1.25	10.82	40.66	3.37
PoE Metsulfuron methyl 20% at 4 g a.i ha^{-1}	34.00	1.28	10.86	40.78	3.41
Closer spacing 15 cm R/R	37.87	1.60	12.20	40.25	4.02
Weed free	41.84	1.92	13.94	42.88	4.36
Weedy Check	29.33	1.03	7.10	40.11	2.20
SEm (±)	**1.30**	**0.11**	**0.56**	**0.98**	**0.20**
LSD(0.05)	**3.93**	**0.35**	**1.70**	**NS**	**0.61**
General mean	**36.63**	**1.54**	**11.59**	**41.15**	**3.81**

Table 3: Gross and net returns of wheat as influenced by different treatments

Treatments	**Gross returns (Rs ha^{-1})**	**Net returns (Rs ha^{-1})**	**Net B : C ratio**
PE Flumioxazin 50% at 125 g a.i ha^{-1}	80143	52808	2.93
PE Metribuzine 70% at 0.175 kg a.i ha^{-1} +1 Hand Weeding	92161	59021	2.80
PE Metribuzine at 0.175 kg a.i ha^{-1} + PoE Clodinofop propargyl at 60 g a.i ha^{-1}	80720	52815	2.89
PE Flumioxazin 50% SC at 125 g a.i ha^{-1}+ 1 Hand Weeding	89251	54936	2.60
PoE 2,4-D at 0.5-0.84 kg a.i ha^{-1}	75806	49894	2.92
PoE Metsulfuron methyl 20% at 4 g a.i ha^{-1}	76698	50808	2.96
Closer spacing 15 cm R/R	89589	61739	3.20
Weed free	96834	57984	2.50
Weedy Check	49569	24719	1.99
SEm (±)	**1715.94**	**1456.15**	**-**
LSD(0.05)	**5165.48**	**4383.44**	**-**
General mean	**81197**	**51636.22**	**2.75**

weed flora and weed dry matter were transformed using the square-root [(x+1)] method (Das, 1999).

Among the weed management treatments, maximum dry weight of weeds was observed with weedy check treatment and lowest weed dry weight for monocot and dicot weeds was recorded with weed free treatment followed by PE Metribuzine 70% at 0.175 kg a.i ha^{-1} + 1 Hand Weeding (T_2), PE Flumioxazin 50% SC at 125 g a.i ha^{-1} + 1 Hand Weeding (T_4) and closer spacing 15 cm R/R at 30, 60 and 90 days after sowing. Dry weed weight for both monocot and dicot weeds were recorded lowest in weed free (T_8) and treatments with pre-emergence herbicides followed by hand weeding and was found to be significantly lower than remaining weed management practices it could be because these treatments provided superior weed control, resulting in lower weed dry weight. Similar findings were also reported by Chaudhari *et al*. (2017).

The treatment weed free check recorded significantly maximum number of grains spike^{-1}, weight of grains spike^{-1}, weight of grains per plant^{-1} and test weight followed by treatment pre-emergence Metribuzine 70% at 0.175 kg a.i ha^{-1} + 1 Hand Weeding (T_2) and pre-emergence Flumioxazin 50% SC at 125 g a.i ha^{-1} + 1 Hand Weeding (T_4).This might be due to reduced crop-weed competition during early growth period which resulted in enhanced growth and development of crop. The lower values for these parameter were recorded in treatment weedy check (T_9).

From the data on grain yield of wheat, it was observed that, among different weed management practices, weed free showed significantly higher grain yield followed by PE Metribuzine 70% at 0.175 kg a.i ha^{-1} + 1 Hand Weeding (T_2) and treatment closer spacing 15 cm R/R (T_7). The minimum grain yield was recorded in weedy check (T_9). The above findings may be due to effective control of weeds which contributed to better vegetative growth coupled with greater yield attributes resulting in higher grain yield over rest of weed management practices. Similar results were reported by Singh *et al.* (2019) and Tomar *et al.* (2020).

As regards to economics of different treatments, weed free recorded maximum gross return (Rs.96834 ha^{-1}) followed by treatment PE Metribuzine 70% at 0.175 kg a.i ha^{-1} + 1 Hand Weeding (T_2) while maximum net returns were recorded with treatment on closer spacing 15 cm R/R (T_7) , PE Metribuzine 70% at 0.175 kg a.i ha^{-1} +1 Hand Weeding (T_2) and weed free (T_8).This might be due to higher cost required for hand weeding in weed free and treatments having herbicide in combination with hand weeding, the cost of treatment increased resulting to lower benefit cost ratio. These results are in line with the results reported by Mongia *et al*. (2005), Tesfay (2014) and Nanher *et al.* (2015).

CONCLUSION

Among the different treatments of weed management in wheat, the treatment PE Metribuzine 70% at 0.175 kg a.i ha^{-1} + 1 Hand Weeding (T_2) and PE Flumioxazin 50% SC at 125 g a.i ha^{-1} + 1 Hand Weeding (T_4) followed by closer spacing 15 cm R/R (T_7) recorded significantly higher values of yield attributes and seed yield with lower dry weight of monocot and dicot weeds due to effective suppression of weeds and found comparable with weed free treatment. As regards to the economic studies, the treatment closer spacing 15 cm R/R (T_7), PE Metribuzine 70% at 0.175 kg a.i ha^{-1} + 1 Hand Weeding (T_2) and PE Flumioxazin 50% SC at 125 g a.i ha^{-1} + 1 Hand Weeding (T_4) were found remunerative as compared to other treatments and found comparable with weed free.

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