COMPETENCE OF DIFFERENT SELECTIVE HERBICIDES FOR WEED CONTROL AND PRODUCTIVITY OF WHEAT IN CENTRAL TELANGANA ZONE

ABSTRACT

Aim: To study the effectiveness of seven (07) herbicides for the control of weeds in wheat crop.

Study design: Randomized Block Design.

Place and Duration of Study: A field study was executed in the *rabi* seasons, 2014-15 to 2016-17 at Agricultural Research Station, Basanthpur, Telangana.

Methodology: New molecules of herbicides were tested in different combinations and compared with the traditional weed control practice through the weed parameters viz., weed density, weed dry matter, weed index and weed persistence index. The performance of wheat crop in terms of grain yield and cost economics were noted to attest the efficiency of different herbicide treatments.

Results: Based on the results, the pre-emergence application of pendimethalin @ 3.0 l ha^{-1} and a hand weeding at 45 DAS is advised to obtain maximum grain yield while the post emergence application of clodinafop propargyl @ 60 g a.i. ha^{-1} + metsulfuron methyl @ 4 g a.i. ha^{-1} at 3 leaf stage of weed is recommended for higher economic benefits.

Conclusion: Pre-emergence application of pendimethalin @ 3.0 l ha^{-1} followed by a hand weeding at 45 DAS can be recommended for higher wheat crop grain yield. And in case of labour shortage, one post emergence application of Clodinafop propargyl @ 60 g a.i./ha + metsulfuron methyl @ 4g a.i./ha at 3 leaf stage of weed i.e., at 25 DAS of wheat crop can be the cost-effective weed management practice in the wheat crop.

Key words: *Wheat, weed management, herbicide, grain yield, weeds persistence*

1. INTRODUCTION

Wheat crop though not a staple crop of Southern India, it has an important place as cereal food crop in Medak district of Telangana. It occupies an area of 15,400 ha in Telangana with yield and production of 746 kg ac^{-1} and 11,488 MT, respectively [1]. Wheat in this region is mostly grown as rainfed resulting in severe infestation of the crop with both grassy and broad-leaved weeds accounting to around 30-70 percent loss in the grain yield (Chhokar et al., 2012). Also, “the crop is extended in irrigated regions under sprinkler method exposing the crop to more weed competition. This major constraint in wheat production was addressed in various methods, but chemical weed control is most preferred because of its better efficiency along with less cost and time involvement. Wheat crop is generally invaded by both grass and broad-leaved weeds but the major challenge offered is by grass

weeds. This is due to narrow selectivity between grassy weeds and wheat crop being both of grass in nature exhibits similar physiology and reaction to herbicides compared to broad-leaved weeds" (Chhokar et al., 2012). Tank mix application of Isoproturon and 2,4-D has been in practice for the control of mixed weed population in wheat for the last many years (Mathiassen and Kudsk, 1998; Chhokar et al., 2007; Sing Samunder, 2009). But more recently, new herbicides molecules are available for weed control in wheat which are broad spectrum in nature and control both grassy and broad-leaved weeds more effectively. These new herbicides need to be evaluated time and again for their efficiency and economic viability in crops, specifically in wheat as use of less effective herbicides was also considered as a major constraint inhibiting the production as well as profitability of conventional wheat in India (Ajay Singh et al., 2020; Kumar *et al.* 2007 and Ahmed and Sulaiman, 2011) .. Further, wheat in Central Telangana Zone though was grown in pockets earlier, but now the extent is gradually picking up there is a need to provide farmers with best management practices which are efficient and cost effective. In this context,, the present research was conducted to find out suitable herbicide for best weed control in wheat and also the economic viability of different herbicides on wheat productivity.

2. MATERIALS AND METHODS

The crop was sown during the *rabi* seasons of 2014-15, 2015-16 and 2016-17 at Agricultural Research Station, Basanthpur- Mamidigi. NIDW 295 variety of wheat was sown fitting in randomized block design and replicated thrice. The soil of the experimental field was red sandy clay loam, low in available N (232.06 kg ha^{-1}) and medium in organic carbon (0.46 %), medium in available phosphorus (26.35 kg ha^{-1}) and available potassium (182.93 kg ha^{-1}) with neutral pH of 7.02. The experiment comprised of 8 treatments given in Table 1.

Table 1. Treatment Details

T_1 : Weedy
T_2 : Weed free with pre-emergence application of pendimethalin @ 3.0 l ha^{-1} + hand weeding at 45 DAS
T_3 : Isoproturon @ 0.75 kg ha^{-1} + 2, 4 – D Na Salt @ 0.8 kg ha^{-1} (PoE)
T_4 : Diclofop methyl @ 0.75 kg ha^{-1} (PoE)
T_5 : Sulfosulfuron @ 30.0 g a.i. ha^{-1} (PoE)
T_6 : Metribuzin @ 175 g a.i. ha^{-1} (PoE)
T_7 : Metsulfuron methyl @ 4 g a.i. ha^{-1} (PoE)
T_8 : Clodinafop propargyl @ 60 g a.i. ha^{-1} + metsulfuron methyl @ 4 g a.i. ha^{-1} (PoE)

The observations on the number of tillers m^{-2}, plant height and dry matter production were noted at regular intervals (30, 60, 90 and at harvest). Yield attributes viz., no of ears m^{-2}, no of grains ear^{-1}, test weight, grain yield (kg ha^{-1}), straw yield (kg ha^{-1}) were recorded at harvest. Weed density (no. m^{-2}) and weed dry weight (g m^{-2}) were noted at critical period of crop weed competition (45 DAS).

Based on these parameters, weed control efficiency (%) and weed persistence index were derived as follows –

$$\text{Weed Control Efficiency} = \frac{\text{Weed wt./control in control (Unweeded)} - \text{Weed wt. in a treatments}}{\text{Weed wt. in Control}}$$

$$\text{Weed Persistance Index} = \frac{\text{Weed wt. in treated plots x Weed count in control plot}}{\text{Weed wt, in control plot x Weed count in treated plot}}$$

The experimental data was subjected to statistical analysis following the procedure for randomized block design as outlined by [4]. The significance was tested by "F" test at 5 percent level of probability [9]. Critical difference was worked out for the effects which were significant.

3. RESULTS AND DISCUSSION

The weed density and dry matter recorded in response to weed management practices in wheat were significantly lower (27.89 and 20.26 g, respectively) when the crop was maintained weed free with pre-emergence application of pendimethalin @ 3.0 l ha^{-1} followed by a hand weeding at 40 DAS (T_2). The highest values of weed density and dry matter (Table 2) on the other side were noticed when no weed management was practiced (110.25 and 71.22 g, respectively). The benefit of integrated use of chemical and mechanical weed control was also pronounced by Ram et al. (2018). Therefore, it can be inferred that inclusion of herbicides with one pre-emergence application followed by a manual weeding would be an appropriate agronomic measure to minimize crop-weed competition.

Among the different herbicide(s) combinations tested, application of clodinafop propargyl @ 60 g a.i. ha^{-1} + metsulfuron methyl @ 4 g a.i. ha^{-1} registered lower weed density (40.87) and dry matter (27.37 g). The weed density and dry matter registered by this treatment was 11.8 and 9.99 percent higher than the best treatment i.e., pre-emergence application of pendimethalin @ 3.0 l ha^{-1} followed by a hand weeding at 40 DAS (Table 2). Application of other herbicides in treatments, T_3 to T_7 recorded weed density and dry matter percentages in the range of 18.9 to 31.5 and 17.88 to 40.21, respectively higher in comparison to T_2 treatment. Therefore, the regions with shortage in labor may opt for application of cladinofop propargyl @ 50 g a.i. ha^{-1} + metsulfuron methyl @ 4 g a.i. ha^{-1} as post emergence which is phytotoxic enough to bring down the weed population and hence dry matter to less than 50 percent. The results corroborated with the findings of [3] and are in line with [5] who reported the efficacy of 2,4-D Na salt @ 625 g ha^{-1} (PoE), metsulfuron methyl @ 4 g ha^{-1} (PoE), and sulfosulfuron @ 30 g ha^{-1} + metsulfuron methyl @ 2 g ha^{-1} (PoE) in reducing the weed density and dry weight of wheat in comparison to weedy check. Similarly, "studies conducted at Palampur, Himachal Pradesh also documented that application of sulfosulfuron @ 30.0 g a.i. ha^{-1} / sulfosulfuron @ 30.0 g a.i. ha^{-1} + surfactant / sulfosulfuron @ 37.5 g a.i. ha^{-1} with or without surfactant resulted in significantly lower weed dry weight and higher yield attributes and yield of wheat" [8].

The number of ear heads counted per m^2 of wheat was highest when the crop was treated with pre-emergence application of pendimethalin @ 3.0 l ha^{-1} followed by a hand weeding at 45 DAS (228). Application of clodinafop propargyl @ 60 g a.i. ha^{-1} + metsulfuron methyl @ 4 g a.i. ha^{-1} or

metsulfuron methyl @ 4 g a.i. ha^{-1} alone as post emergence with a deviation of 8.3 to 11.4 percent lower than T_2 may be depended in critical situations with respect to ear head count (Table 2). On the other hand, lowest count of ear heads m^{-2} was observed in un weeded (T_1) wheat. The length of the ear head being a genetically determined character remained invariable for all the weed management practices. Un weeded wheat alone varied from the rest of the weed management options with lowest grain number (32) and test weight (32.51 g).

Table 2. Weed performance, yield attributes and yield of wheat in response to weed management practices (Pooled data of three years)

Treatments	Weed density m^{-2}	Weed dry matter (g m^{-2})	No. of ear heads m^{-2}	Length of the ear head (cm)	No. of grains ear^{-1}	Test weight (g)	Grain yield (kg ha^{-1})	Straw yield (kg ha^{-1})
T_1 - Weedy	110.25	71.22	122.89	9.56	31.72	32.51	1464.55	2003.96
T_2 - Weed free with pre-emergence application of pendimethalin @ 3.0 l/ha + hand weeding at 45 DAS	27.89	20.26	227.78	11.22	37.13	40.35	3325.24	4154.21
T_3 - Isoproturon @ 0.75 kg/ha + 2, 4 – D Na Salt @ 0.8 kg/ha	71.44	50.32	149.11	10.08	33.68	34.67	1884.22	2414.65
T_4 - Diclofop methyl @ 0.75 kg/ha.	64.10	44.18	161.62	10.20	35.16	37.73	2249.69	2789.81
T_5 - Sulfosulfuron @ 30.0 gm a.i./ha	59.70	40.59	175.03	10.63	34.88	36.00	2454.18	3227.53
T_6 - Metribuzin @175 g a.i./ha	53.34	35.85	188.54	10.93	35.68	38.94	2668.48	3436.19
T_7 - Metsulfuron methyl @ 4g a.i./ha	48.74	32.99	201.52	11.38	36.21	37.95	2842.81	3651.85
T_8 - Clodinafop propargyl @ 60 g a.i./ha +.metsulfuron methyl @ 4gr a.i./ha	40.87	27.37	209.26	11.11	37.13	37.31	3011.24	3827.19
SEm±	2.59	1.13	6.59	0.67	1.45	1.74	74.29	107.14
C.D. (0.05)	5.55	2.45	14.13	NS	3.12	3.73	159.33	229.79

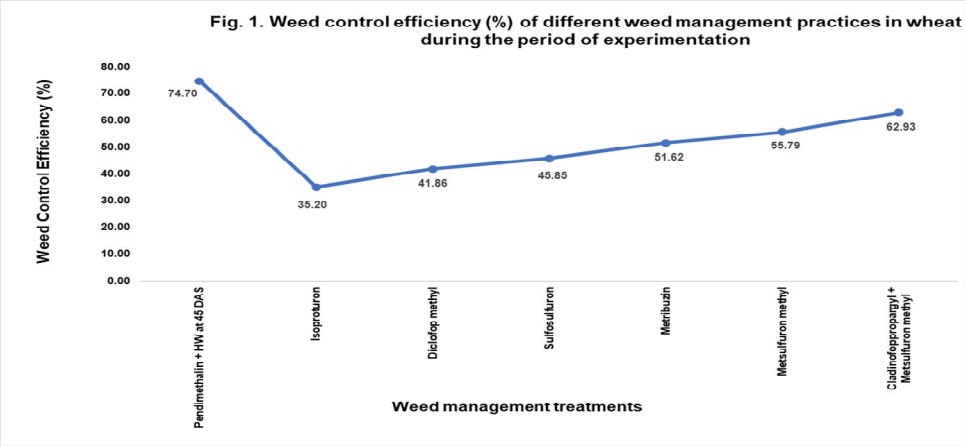
From the above results, it can be inferred that ear head number is the important yield attributing character that determines the wheat yield as both the grain and straw yields were noted to be in line with this parameter reporting highest yields (3325 and 4154 kg ha^{-1}, respectively) from the crop treated with pre-emergence application of pendimethalin @ 3.0 l ha^{-1} followed by a hand weeding at 45 DAS (Table 2). However, considering herbicide application for weed control in case of shortage of labour, application of clodinafop propargyl @ 60 g a.i. ha^{-1} + metsulfuron methyl @ 4 g a.i. ha^{-1} holds promise with yields closer to T_2 with a deviation of 9.4 and 7.9 percent, resepectively for grain and straw yields. Lesser weed competition in view of lesser weed population during the critical period of crop weed competition has established the crop with superior growth visible from higher yield attributing characters and hence yields. However, as an alternative to the traditional practice, application of clodinafop propargyl @ 60 g a.i. ha^{-1} + metsulfuron methyl @ 4 g a.i. ha^{-1} may be considered with a deviation of less than 10 per cent. The research results of [6] corroborated with the above results where the highest grain yield was obtained with the application of pendimethalin + metribuzin followed by clodinafop + metsulfuron-methyl (RM)* treatment (0.53 kg m^{-2}).

Table 3. Cost economics of wheat in response to weed management practices (Pooled mean of three years)

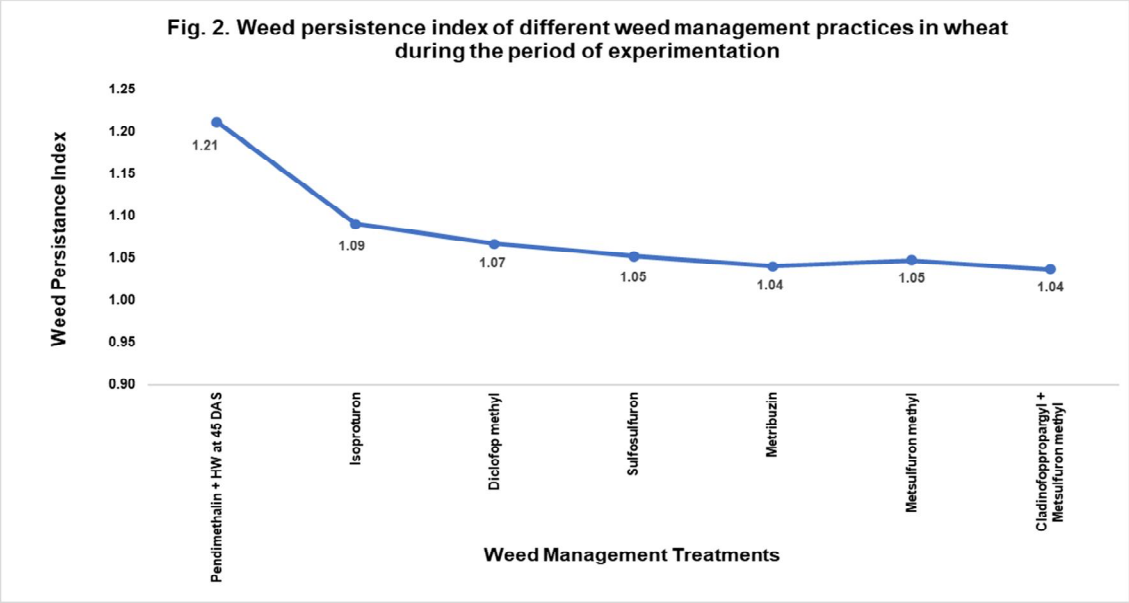
Treatments	Cost of Cultivation (Rs./ha)	Gross returns (Rs./ha)	Net Returns (Rs./ha)	Benefit - Cost ratio
T_1 - Weedy	38550	43937	5387	0.14
T_2 - Weed free with pre-emergence application of pendimethalin @ 3.0 l/ha + hand weeding at 45 DAS	43092	99757	56665	1.31
T_3 - Isoproturon @ 0.75 kg/ha + 2, 4 – D Na Salt @ 0.8 kg/ha	40175	56527	16352	0.41
T_4 - Diclofop methyl @ 0.75 kg/ha.	40925	67491	26566	0.65
T_5 - Sulfosulfuron @ 30.0 gm a.i./ha	40425	73625	33200	0.82
T_6 - Metribuzin @175 g a.i./ha	39925	80054	40129	1.01
T_7 - Metsulfuron methyl @ 4g a.i./ha	40100	85284	45184	1.13
T_8 - Clodinafop propargyl @ 60 g a.i./ha +.metsulfuron methyl @ 4gr a.i./ha	40525	90337	49812	1.23

Among the weed management practices, pre-emergence application of pendimethalin @ 3.0 l ha^{-1} followed by a hand weeding at 45 DAS in spite of higher cost of cultivation (Rs. 43092 ha^{-1}) was found profitable with a benefit of Rs. 1.31 ha^{-1} owing to higher grain yield and hence higher gross and net returns (Table 3). This was followed by clodinafop propargyl @ 60 g a.i. ha^{-1} + metsulfuron methyl @ 4 g a.i. ha^{-1} applied as post emergence with a benefit of Rs. 1.23 ha^{-1}. [10] reported that clodinafop and 2,4-D applied as post-emergence herbicides resulted in significantly lower total weed density (7.8 m^{-2}) and dry weight (5.1 g m^{-2}), which increased grain yield and net

financial returns over isoproturon, clodinafop alone, and weedy check. [2] also reported satisfactory grassy weed control and reduced weed dry matter accumulation with the application of clodinafop @ 75 g ha^{-1} resulting in higher wheat crop yield. It was also superior to hand weeding with effective control of grassy weeds.Weed control efficiency due to pre-emergence application of pendimethalin @ 3.0 l ha^{-1} followed by a hand weeding at 45 DAS was highest (71.71%) over the other treatments. However, among the post emergence herbicides, application of clodinafop propargyl @ 60 g a.i. ha^{-1} + metsulfuron methyl @ 4 g a.i. ha^{-1} closely followed the above treatment with a weed control efficiency of 61.68% (Fig. 1).



Weed persistence index, a measure of relative dry matter accumulation of weeds per count in comparison to control (Fig. 2) was highest (1.2) with pre-emergence application of pendimethalin @ 3.0 l ha^{-1} followed by a hand weeding at 45 DAS indicating resistance of escaped weeds to control measures. Whereas, the weed persistence index values were lowest with application of post emergence herbicides, metribuzin @ 175 g a.i. ha^{-1} (1.04) or clodinafop propargyl @ 60 g a.i. ha^{-1} + metsulfuron methyl @ 4 g a.i. ha^{-1} (1.04) indicating lower persistence of escaped weeds and broad-spectrum effect of those herbicides in controlling the weeds. The results corroborated with those of [7] who reported that “clodinafop + metsulfuron gave the highest net returns due to weed control and marginal benefit-cost ratio. Clodinafop + metsulfuron methyl resulted in highest weed control efficiency (WCE), weed control index (WCI), crop resistance index (CRI), treatment efficiency index, crop intensity index and weed index”.



4. CONCLUSION

Weed management is the biggest constraint in the wheat crop production. The diverse weed flora infesting the crop is reminding us the need for the use of herbicides in combination. The present study concludes that the pre-emergence application of pendimethalin @ 3.0 l ha^{-1} followed by a hand weeding at 45 DAS can be recommended for higher wheat crop grain yield in Central Telangana. And in case of labour shortage, one post emergence application of Clodinafop propargyl @ 60 g a.i./ha + metsulfuron methyl @ 4g a.i./ha at 3 leaf stage of weed can be the cost-effective weed management practice in the wheat crop.

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