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# Efficacy of weed control methods on weed flora, yield and economics of wheat in *Rabi* season

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**Abstract**
The current investigation was carried out to study the efficacy of different pre and post emergence of herbicides and their combinations along with weeding and hoeing operation to control the weed in wheat at post graduate research farm, R.C.S.M. College of Agriculture, Kolhapur (MS) in randomized block design with eights treatments and three replication during Rabi season of 2016-17 on medium black soil. The weed intensity of weed free check at 42, 56 DAS and at harvest was significantly minimum as compare to rest of all treatments. Weed count and dry matter of weeds at harvest were significantly lowest in weed free check (2.13 m-2) and (0.20 q ha-1), respectively. Among the integrated weed management weeding at 20 DAS and + metasulfuron methyl @ 4 g a.i. ha-1 as PoE at 30 DAS (T5) recorded (7.17 m-2) weed count and (0.54 q ha-1) dry matter of weed and hoeing at 20 DAS + metasulfuron methyl @ 4 g a.i. ha-1 as PoE at 30 DAS (T4) recorded (17.66 m-2) weed count and (1.36 q ha-1) dry matter of weed were comparable with weed free check. The significantly highest weed control efficiency was recorded by weed free check (93.45%) followed by weeding at 20 DAS and + metasulfuron methyl @ 4 g a.i. ha-1 as PoE at 30 DAS (82.23%) and T4 i.e. hoeing at 20 DAS + metasulfuronmethyl @ 4 g a.i. ha-1 as PoE at 30 DAS (55.88%). The integrated weed management practices weeding at 20 DAS and + metasulfuron methyl @ 4 g a.i.ha-1 as PoE at 30 DAS (T5) recorded lowest weed index (3.42%) followed by T4 i.e. hoeing at 20 DAS + metasulfuron methyl @ 4 g a.i. ha-1 as PoE at 30 DAS(6.69%). Weed free check showed lowest species wise weed count over rest of treatments. The more number of monocot and dicot weeds were observed in weedy check over rest of treatments. The comparable results were observed by weeding at 20 DAS and + metasulfuronmethyl @ 4 g a.i. ha-1 as PoE at 30 DAS (T5) and hoeing at 20 DAS + metasulfuron methyl @ 4 g a.i. ha-1 as PoE at 30 DAS (T4), respectively.

**Keywords:** Metribuzin, metasulfuron methyl, integrated weed management

## Introduction
Wheat (*Triticumaestivum* L.) belongs to family "Poaceae" and genus "Triticum". It is a crop of temperate zone with cool winters and hot summers being very conducive for its growth. Among the food crops, wheat is one of the most abundant sources of energy and proteins for the world population and its increased production is essential for food security. It is necessary to sustain the wheat crop production for meet the demand of wheat in India as well as world. Weed infestation during the early stages of crop growth is one of the major factors responsible for low productivity of wheat. The untimely and poor weed management adversely affects proper growth and yield of wheat. Integration of weed controls methods are effective and workable practices that may be used ecologically and economically viable to the farmer. Herbicides have benefited the agricultural community in many ways. However, heavy application of herbicides creates an environment favorable for weed resistance to herbicides, shifts weed flora and off-site movements of herbicides (Rao and Nagmani, 2010) [8]. Under such conditions, integration of hand weeding, hoeing and weed control through herbicides remains the choice for controlling weeds.

Traditional methods of weed control such as crop rotation, manual hoeing or tractor drawn cultivator and costly labour have made the use of herbicides more popular among the Indian farmers. The herbicide like Metribuzine, Metasulfuronmethy reported to be promising against weeds in wheat at different locations in India. However, conclusive information is not available on relative efficacy of such herbicides and economics of different weed control methods such as hand weeding, hoeing etc. in Sub-mountain Zone. Each and every method has advantages and disadvantages by considering these views an experiment was undertaken.

## Materials and methods

The field experiment was conducted at Post Graduate Research Farm, R.C.S.M. College of Agriculture, Kolhapur during *Rabi* 2016. The topography of experimental field was fairly uniform and levelled. The soil was vertisol (medium black) in nature and about one meter deep with good drainage. The soil of experimental field has pH 7.7, EC 0.10 d $Sm^{-1}$, organic carbon 0.57%, available N, $P_2O_5$, $K_2O$ 132.45, 22.34 and 159 kg $ha^{-1}$, respectively. The eight treatments comprising of pre and post emergence herbicides and intercultivation operations viz., hand weedingand hoeing. Application of treatments Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + Hand weeding at 20 DAS ($T_1$), Metribuzine @ 0.175kg a.i. $ha^{-1}$ as PE + Hoeing at 30 DAS ($T_2$), Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + Metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS ($T_3$), Hoeing at 20 DAS + Metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS ($T_4$), Weeding at 20 DAS + Metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS ($T_5$), Hand weeding at 20 DAS + Hoeing at 30 DAS ($T_6$), Weed free check ($T_7$) and Weedy check ($T_8$) and these treatments were replicated three times in randomized block design. Wheat variety 'Phule Samadhan (NIAW-1994)'was grown in the experimental field with recommended package of practices. Fertilizers were applied uniformly at the rate of 120 kg N and 60 kg $P_2O_5$ and 40 kg $K_2O$ $ha^{-1}$. All the herbicides were applied by manually operated sprayer with flat fan nozzle as per treatment.

Weed index was calculated by the formula proposed by Gill and Kumar (1969).

$$WI = \frac{X-Y}{X} X\ 100$$

Where,
WI = Weed index
X= Grain yield from the weed free plot
Y= Grain yield from the treated plot for which weed index is to be worked out

Weed control efficiency of each mechanical and chemical treatment was worked out by using formula proposed by Gautam *et al*. (1975) [10].

$$WCE = \frac{WPC-WPT}{WPC} \times 100$$

Where,
WCE = Weed control efficiency
WPC = Weed population in control plot
WPT = Weed population in treated plot

## Result and discussion

### Weed Count

The weed intensity at 14 DAS was higher as compare to rest of the growth stages except metribuzin treatment. It is because of in most of the treatments the weed control practices were not followed. At this stage the initial weed intensity was minimum in plot treated with metribuzin @ 0.175 kg a.i. $ha^{-1}$ as PE. However, initially in some plot treated with metribuzin show scorching effect and stunted growth of wheat thereafter they could recovered. The weed free plot was recorded significantly the lowest weed intensity as compare to rest of treatments at all growth stages except at 14 DAS. However, the treatments, weeding at 20 DAS + metasulfuron at 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (T5) and hoeing at 20 DAS+ metasulfuron at 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (T4) are comparable with weed free check at different growth stages. Throughout the crop growth period significantly lower weed intensity was observed in weed free check except at 14 DAS as compared to rest of the treatment. This resulted into lower weed intensity and crop weed competition which reflected it to favorable environmental condition for the crop growth and yield. The weedy check recorded significantly highest weed intensity resulted in higher weed crop competition for nutrient, sunlight and water which was hampered crop growth resulted in low yield. These results were inconformity with Kurchania *et al*. (1996) [6], Singh and Ali (2004) [11], Kumar *et al*. (2011) [5] and Paighan *et al*. (2013) [7].

### Species Wise Weed Count

Data on species wise weed count at various growth stages as influenced by different treatments are given in Table4.2which revealed that the minimum number of monocot and dicot weeds were recorded in pre emergence application of metribuzin treatments (T1, T2 and T3) indicating the broad spectrum effect of metribuzin. Similarly the weed free check treatment recordedlowest monocot and dicot weeds at 28, 42, 56 DAS and at harvest as compare to rest of all treatments. However the herbicidal treatments, weeding at 20 DAS + metasulfuron at 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (T5) and hoeing at 20 DAS + metasulfuron at 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (T4) are comparable with weed free check (T8).In general the total number of dicot weeds were more than monocot weeds in successive growth stages.

### Dry Matter of Weeds

The data presented in Table 4.3 and Fig. 4.2 regarding dry matter of weed shows significant effect due to influence of different weed control treatments. The significantly lowest dry matter was recorded in weed free treatment (T7) as compare to rest of treatments which was followed by weeding at 20 DAS + metasulfuron at 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (T5) and hoeing at 20 DAS + metasulfuron at 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (T4), respectively. The significantly highest dry matter was recorded in weedy check (T8), metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + hoeing at 30 DAS (T2), metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + hand weeding at 20 DAS (T1) and metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (T3) over rest of treatments. However, treatments hoeing at 20 DAS + metasulfuronmethyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (T4) and hand weeding at 20 DAS + hoeing at 30 DAS (T6) were at par with each other and significantly superior over T5 and T7.These results were inconformity with Singh *et al.* (2004) [11], Kumar *et al.* (2011) [5] and Paighan *et al.* (2013) [7].

### Weed Control Efficiency

At harvest, significantly highest weed control efficiency was observed in weed free check (93.45%) andweeding at 20 DAS + metasulfuron at 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (82.23%) over rest of treatments. However,hoeing at 20 DAS + metasulfuron at 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (T4) andhand weeding at 20 DAS + hoeing at 30 DAS (T6) were at par with each other and significantly superior over T3, T1, T2 and T8. The significantly lowest weed control efficiency was recorded in weedy check (T8) over rest of treatments.Whereas higher is the weed control efficiency better is the treatment. Similar result were reported by Singh *et al*. (2004) [11], Kumar *et al*. (2011) [5] and Paighan *et al*. (2013) [7].

**Weed Index**

At harvest the significantly highest weed index was recorded in weedy check (41.83%) followed by metribuzine at 0.175 kg a.i. $ha^{-1}$ as PE + metasulfuron at 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (T3), metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + hoeing at 30 DAS and metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + hand weeding at 20 DAS were at par with each other and significantly superior over T6, T4, T5 and T7. The significantly negligible weed index was recorded in weed free check over rest of the treatments. The lower weed index reflected into the higher yield *viz*. weed free check. These results were inconformity with Singh *et al.* (2004) [11], Kumar *et al.* (2011) [5] and Paighan *et al.* (2013) [7].

**Effect of integrated weed management on yield of wheat**

The data presented in Table 3 indicate that the grain yield, straw yield and harvest index was recorded maximum in weed free treatment (52.78 q $ha^{-1}$, 68.45 q $ha^{-1}$ and 43.53%), respectively which was statistically at par with integrated weed management treatment viz. weeding at 20 DAS and + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS and hoeing at 20 DAS + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS but significantly superior over rest of treatments. Effective weed control achieved in these treatments resulted in enhancing various growth and yield contributing characters of wheat and finally gave significantly higher grain yield and straw yield over weedy check. However weedy check recorded significantly lowest grain yield, straw yield and harvest index (30.70 q $ha^{-1}$, 43.93 q $ha^{-1}$ and 41.13%), respectively. Similar findings were recorded by Chopra and Chopra (2010) [2], Katara *et al.* (2012) [4], Vyavahare (2012) [12] and Chaudhari *et al.* (2016) [1].

**Table 1:** Mean weed count $m^{-2}$ as periodically influenced by different treatments

| Treatments | Days After Sowing | | | | At harvest |
|---|---|---|---|---|---|
| | 14 | 28 | 42 | 56 | |
| T1: Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + hand weeding at 20 DAS | 61.13 | 56.13 | 49.70 | 41.46 | 32.88 |
| T2: Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + hoeing at 30 DAS | 65.00 | 59.66 | 54.03 | 44.50 | 38.93 |
| T3: Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS | 70.66 | 63.23 | 25.30 | 14.50 | 13.45 |
| T4: Hoeing at 20 DAS + metasulfuronmethyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS | 137.65 | 47.00 | 29.12 | 19.40 | 17.66 |
| T5: Weeding at 20 DAS and + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS | 138.12 | 44.70 | 23.00 | 12.23 | 7.17 |
| T6: Hand weeding at 20 DAS + Hoeing at 30 DAS | 139.34 | 50.06 | 29.05 | 21.50 | 15.82 |
| T7: Weed free check (minimum competition) | 137.20 | 36.00 | 12.03 | 7.20 | 2.13 |
| T8: Weedy check | 138.45 | 130.50 | 124.06 | 130.50 | 119.46 |
| S.E. m± | 1.07 | 1.00 | 0.93 | 0.58 | 0.79 |
| C.D. at 5% | 3.26 | 3.04 | 2.85 | 1.75 | 2.39 |
| General Mean | 111.69 | 60.91 | 47.16 | 40.79 | 34.04 |

**Table 2:** Species wise number of monocot and dicot weeds $m^{-2}$ as periodically influenced by different treatments

| Treatments | 14 DAS | | | 28DAS | | | 42 DAS | | | 56 DAS | | | At harvest | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | M | D | Total | M | D | Total | M | D | Total | M | D | Total | M | D | Total |
| T1: Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + hand weeding at 20 DAS | 19.3 | 41.83 | 61.13 | 16.3 | 39.83 | 56.13 | 19.5 | 30.2 | 49.7 | 17.6 | 23.86 | 41.46 | 13.5 | 18.93 | 32.43 |
| T2: Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + hoeing at 30 DAS | 18 | 47 | 65 | 16.7 | 42.96 | 59.66 | 21.6 | 32.43 | 54.03 | 21.6 | 22.9 | 44.5 | 17.9 | 21.7 | 39.6 |
| T3: Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + metasulfuron @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS | 21.60 | 49.06 | 70.66 | 16.45 | 46.78 | 63.23 | 9.10 | 16.2 | 25.30 | 6.25 | 8.25 | 14.50 | 6.25 | 7.2 | 13.45 |
| T4: Hoeing at 20 DAS + metasulfuron @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS | 57 | 80.65 | 137.65 | 17.2 | 19.8 | 47 | 11 | 18.12 | 29.12 | 9 | 10.8 | 19.40 | 6.20 | 11.46 | 17.66 |
| T5: Weeding at 20 DAS and + metasulfuron @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS | 51.20 | 86.92 | 138.12 | 16.3 | 28.4 | 44.7 | 9 | 14 | 23 | 4.56 | 7.67 | 12.23 | 2.5 | 4.67 | 7.17 |
| T6: Hand weeding at 20 DAS + Hoeing at 30 DAS | 59 | 80.34 | 139.34 | 17.4 | 32.66 | 50.06 | 8.6 | 20.45 | 29.05 | 8.7 | 12.8 | 21.5 | 6.5 | 9.32 | 15.82 |
| T7: Weed free check (minimum competition) | 55.13 | 82.07 | 137.2 | 13 | 23 | 36 | 4.6 | 7.43 | 12.03 | 2.1 | 5.1 | 7.2 | 1.1 | 1.03 | 2.13 |
| T8: Weedy check | 53.50 | 84.95 | 138.45 | 49.6 | 80.9 | 130.5 | 51.9 | 72.16 | 124.6 | 58.6 | 71.9 | 130.5 | 51.6 | 67.86 | 119.46 |
| Mean | 39.54 | 70.97 | 110.52 | 21.67 | 41.36 | 64.46 | 19.6 | 27.56 | 47.16 | 20.29 | 25.29 | 40.79 | 14.9 | 19.21 | 34.11 |

**Table 3:** Mean weed dry matter, weed control efficiency and weed index of wheat as influenced by different treatments

| Treatments | Dry matter of weed (g $m^{-2}$) | Weed control efficiency (%) | Weed index (%) |
|---|---|---|---|
| T1: Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + hand weeding at 20 DAS | 19.10 | 38.40 | 25.82 |
| T2: Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + hoeing at 30 DAS | 23.07 | 25.60 | 27.60 |
| T3: Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + metasulfuronmethyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS | 14.52 | 53.17 | 31.02 |
| T4: Hoeing at 20 DAS + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS | 13.68 | 55.88 | 6.69 |
| T5: Weeding at 20 DAS and + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS | 5.48 | 82.23 | 3.42 |
| T6: Hand weeding at 20 DAS + Hoeing at 30 DAS | 16.73 | 46.04 | 13.12 |
| T7: Weed free check (minimum competition) | 2.03 | 93.45 | 00.00 |
| T8: Weedy check | 31.01 | 00.00 | 41.83 |
| S.E. m± | 0.71 | 1.95 | 2.48 |
| C.D. at 5% | 2.17 | 5.93 | 7.53 |
| General Mean | 15.78 | 49.10 | 18.69 |

**Table 4:** Effect of integrated weed management on yield and economics of wheat

| Treatments | Grain yield (q $ha^{-1}$) | Straw yield (q $ha^{-1}$) | Harvest index (%) | Net monetary returns (Rs $ha^{-1}$) | B:C ratio |
|---|---|---|---|---|---|
| T1: Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + hand weeding at 20 DAS | 39.15 | 56.05 | 41.20 | 32392 | 1.89 |
| T2: Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + hoeing at 30 DAS | 38.21 | 55.01 | 40.98 | 30905 | 1.85 |
| T3: Metribuzine @ 0.175 kg a.i. $ha^{-1}$ as PE + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS | 36.41 | 52.96 | 40.74 | 28742 | 1.82 |
| T4: Hoeing at 20 DAS + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS | 49.25 | 64.25 | 43.39 | 47555 | 2.23 |
| T5: Weeding at 20 DAS and + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS | 50.97 | 66.26 | 43.47 | 49865 | 2.26 |
| T6: Hand weeding at 20 DAS + Hoeing at 30 DAS | 45.86 | 62.30 | 42.40 | 415a23 | 2.07 |
| T7: Weed free check (minimum competition) | 52.78 | 68.45 | 43.53 | 52033 | 2.29 |
| T8: Weedy check | 30.70 | 43.93 | 41.13 | 22793 | 1.73 |
| S.E. m± | 1.31 | 1.49 | - | - | - |
| C.D. at 5% | 3.97 | 4.52 | - | - | - |
| General Mean | 42.19 | 58.65 | 42.10 | 38226 | 2.01 |

**Effect of integrated weed management on economics of wheat**

Highest net monetary returns were observed in weed free check treatment (Rs.52033 $ha^{-1}$) followed by weeding at 20 DAS and + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (Rs.49865 $ha^{-1}$) and hoeing at 20 DAS + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (Rs.47555 $ha^{-1}$). The lowest net monetary returns was recorded in weedy check (Rs.22793 $ha^{-1}$). These results were in conformity with Chopra *et.al*. (2008), Sharma (2009), Paighan *et al*. (2013) [7], Singh *et al*. (2013), and Chaudhary *et al*. (2016) [1].

The highest benefit cost ratio was obtained in weed free check treatment (2.29) followed by weeding at 20 DAS and + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (2.26) and hoeing at 20 DAS + metasulfuron methyl @ 4 g a.i. $ha^{-1}$ as PoE at 30 DAS (2.23). These results were in conformity with Chopra *et al.* (2008), Sharma (2009), Paighan *et al.* (2013) [7], Singh *et al*. (2013),) and Chaudhary *et al.* (2016) [1].

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