Effect of pre and post emergence herbicides on growth, yield and economics of wheat

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Abstract

A field experiment was conducted at Research Farm, Department of Agronomy, G.H. Raisoni University, Chhindwara, Madhya Pradesh during Rabi season 2019-20, on effect of pre and post emergence herbicides on growth, yield and economics of wheat. Nine herbicide treatments comprised of post emergence application of Pendimethalin @ 1.0 Kg a.i. ha⁻¹ as pre-emergence 2 DAS, Metsulfuron methyl @ 3 and 4 g a.i. ha⁻¹ POE at 18 DAS, Metribuzin @ 131 and 175 g a.i. ha⁻¹ POE at 18 DAS, 2,4-D @ 563 and 750 g a.i. ha⁻¹ POE at 18 DAS, weed free and weedy check. The experiment was laid out in randomized block design with thrice replication. The experimental results revealed that the growth attributing characters of wheat crop viz., plant height and dry matter accumulation plant⁻¹. Maximum grain yield (47.17 q ha⁻¹), straw yield (69.22 q ha⁻¹), gross monetary returns (95738 Rs. ha⁻¹), net monetary returns (58166 Rs. ha⁻¹) and benefit cost ratio (2.55) were recorded under application of pendimethalin @ 1.0 Kg a.i. ha⁻¹ as pre-emergence at 2 DAS as compared to rest of the treatments.

Keywords: Wheat, growth, yield, economics and herbicide

Introduction

Wheat (Triticum aestivum L.) is the world’s most outstanding crop that excels all other cereals both in area and production known as king of cereals (Costa et al., 2013). It is also one of the most nutritious cereals that contributed to human diet puts it in the first rank to feed the world. The total area under wheat in world during 2018-19 was 221.12 million hectares with an annual production of 697.8 million tonnes and average productivity of 3.16 tonnes ha⁻¹. In India area under wheat was 29.58 million hectares with production of 99.70 million tonnes and average productivity of 3371 kg ha⁻¹ during 2018-19 (Agricultural Statistics at a Glance 2018). Several grassy and broad leaved weeds infest wheat causing severe competition for sunlight, essential nutrients, moisture and space which leads reduction in wheat yield and also its quality (Chopra et al., 2015) [5]. Uncontrolled growth of weeds on an average caused about 7-50% reduction in grain yield of wheat depending upon their density (Jat et al., 2005, Singh et al., 2012) [15]. Weed is one of the major biotic constraints in wheat production as they compete with crop for nutrients, moisture, light and space (Chhokar et al., 2012) [41]. Weed control cost is a major segment of input cost in crop production and herbicides provide a better opportunity to control weeds in close row crops like wheat where manual or mechanical weeding is not possible (Yaduraju and Mishra 2002) [18].

Keeping these problems in view, a field experiment was conducted to study the effect of pre and post emergence herbicides on growth, yield and economics of wheat.

Materials and Methods

The field experiment was conducted at Research Farm, Department of Agronomy, G.H. Raisoni University, Chhindwara, Madhya Pradesh during Rabi season 2019-20. The soil of the experimental field was red in texture, low in available nitrogen (193.00 kg ha⁻¹) medium in available phosphorus (19.89 kg ha⁻¹) potassium (475.78 kg ha⁻¹) and was alkaline in reaction (pH 7.54). Wheat variety Suparsharbat was sown @ 125 kg seed ha⁻¹ at spacing of 22.5 cm between the lines, on 25th November, 2019 and harvested on 14th March, 2020. A full dose of phosphorus and potassium was applied as a basal application. The nitrogen was applied in two splits, half at sowing and at 21 DAS. The optimum plant population was maintained by gap
filling, the crop was irrigated as per the requirements. According to the treatment pre-emergence herbicide i.e. pendimethalin was applied after sowing but before emergence of the crop and post-emergence herbicides were sprayed at 18 DAS through knapsack sprayer with flat fan nozzle using 500 litres of water ha⁻¹. The experiment was laid out in randomized block design with nine treatments and three replications. The gross and net plot size were 4.00 x 3.15m²and3.50 x 2.70 m², respectively. The nine treatment consisted of weedy check, weed free check, pendimethalin @ 1.0 kg a.i. ha⁻¹ as pre-emergence at 2DAS, Metsulfuron-methyl @ 4 g a.i. ha⁻¹ POE at 18 DAS, Metsulfuron methyl @ 3 g a.i. ha⁻¹ POE at 18 DAS at 30 DAS, metsulfuron @ 175 g a.i. ha⁻¹ POE at 18 DAS, metribuzin @ 131 g a.i. ha⁻¹ POE at 18 DAS at 30 DAS, 2,4-D @ 750 g a.i. ha⁻¹ POE at 18 DAS and 2,4-D @ 563 g a.i. ha⁻¹ POE at 30 DAS.

Table 1: Mean plant height plant⁻¹ of wheat as influenced periodically by different treatments

| Treatment                      | Plant height (cm) |
|--------------------------------|-------------------|
|                                | 30 DAS | 60 DAS | 90 DAS | At harvest |
| T₁: Weedy check                | 9.50   | 47.70  | 77.63  | 79.40       |
| T₂: Weed free check hand weeding | 11.20  | 53.63  | 86.80  | 88.76       |
| T₃: Pendimethalin @ 1.0 kg a.i. ha⁻¹ as pre-emergence 2 DAS | 10.63  | 51.63  | 83.00  | 85.50       |
| T₄: Metsulfuron methyl @ 4 g a.i. ha⁻¹ POE at 18 DAS | 10.23  | 49.86  | 79.93  | 81.26       |
| T₅: Metsulfuron methyl @ 3 g a.i. ha⁻¹ POE at 18 DAS | 10.53  | 50.46  | 82.10  | 83.66       |
| T₆: Metribuzin @ 175 g a.i. ha⁻¹ POE at 18 DAS | 10.06  | 49.50  | 79.63  | 80.66       |
| T₇: Metribuzin @ 131 g a.i. ha⁻¹ POE at 18 DAS | 10.40  | 50.00  | 81.00  | 82.90       |
| T₈: 2,4-D @ 750 g a.i. ha⁻¹ POE at 18 DAS | 9.83   | 49.26  | 78.50  | 80.26       |
| T₉: 2,4-D @ 563 g a.i. ha⁻¹ POE at 18 DAS | 10.03  | 49.80  | 80.00  | 81.30       |
| S.E.m±                          | 0.46   | 1.29   | 2.00   | 2.09        |
| C.D. at 5%                      | N.S.   | 3.35   | 5.20   | 5.41        |

Dry matter plant⁻¹
The data in respect of mean dry matter plant⁻¹ of wheat as influenced by different treatments at 60, 90 DAS and at harvest are presented in Table No. 2. Different weed control treatments significantly influenced the dry matter plant⁻¹ at all stages except at 30 days stage, where, it was found none significant. The significantly the highest dry matter plant⁻¹ (53.56 cm) was recorded under weed free check at 60, 90 DAS and at harvest than rest of treatments.

Table 2: Mean dry matter plant⁻¹ of wheat as influenced periodically by different treatments

| Treatment                      | Dry matter plant⁻¹ (g) |
|--------------------------------|------------------------|
|                                | 30 DAS | 60 DAS | 90 DAS | At harvest |
| T₁: Weedy check                | 0.31   | 5.95   | 11.82  | 12.96       |
| T₂: Weed free check hand weeding | 0.38   | 10.3   | 20.09  | 21.62       |
| T₃: Pendimethalin @ 1.0 kg a.i. ha⁻¹ as pre-emergence 2 DAS | 0.35   | 8.91   | 18.01  | 19.73       |
| T₄: Metsulfuron methyl @ 4 g a.i. ha⁻¹ POE at 18 DAS | 0.31   | 6.75   | 14.33  | 16.04       |
| T₅: Metsulfuron methyl @ 3 g a.i. ha⁻¹ POE at 18 DAS | 0.33   | 8.42   | 17.33  | 18.56       |
| T₆: Metribuzin @ 175 g a.i. ha⁻¹ POE at 18 DAS | 0.31   | 6.37   | 13.53  | 15.29       |
| T₇: Metribuzin @ 131 g a. i. ha⁻¹ POE at 18 DAS | 0.32   | 8.14   | 16.53  | 18.42       |
| T₈: 2,4-D @ 750 g a.i. ha⁻¹ POE at 18 DAS | 0.31   | 6.23   | 13.22  | 15.05       |
| T₉: 2,4-D @ 563 g a.i. ha⁻¹ POE at 18 DAS | 0.32   | 8.22   | 16.32  | 18.33       |
| S.E.m±                          | 0.02   | 0.58   | 1.07   | 0.92        |
| C.D. at 5%                      | N.S.   | 2.15   | 3.92   | 3.39        |

Effect on yield
The mean grain yield of wheat differed significantly due to various treatments. It could be seen from the Table No. 3. All the weed control treatments significantly increased the grain and straw yield over weedy check. The highest grain and straw yield recorded in weed free plot while minimum in weedy plot. Among the herbicidal treatments, (T₃) pendimethalin @ 1.0 kg a.i. ha⁻¹ as pre-emergence at 2 DAS, recorded significantly higher grain as well as straw yield (47.17 and 69.22 q ha⁻¹, respectively) and were at par with weed free plot. However, post emergence application of (T₄) Metsulfuron methyl @ 3 g a.i. ha⁻¹ POE at 18 DAS were also statistically at par with (T₃) pendimethalin @ 1.0 kg a.i. ha⁻¹ as pre-emergence at 2 DAS in respect of straw yield kg ha⁻¹

Result and Discussion
Plant height
The data pertaining to the mean plant height of wheat as influenced by different treatments at different growth stages are presented in Table No. 1. Different weed control treatments significantly influenced the plant height at all stages except at 30 days stage, where, it was found none significant. The significantly the highest plant height (53.56 cm) was recorded under weed free check at 60 DAS than rest of treatments. At 90 DAS and at harvest, among the herbicidal treatments, application of pendimethalin @ 1.0 kg a.i. ha⁻¹ as pre-emergence at 2 DAS was recorded significantly higher plant height at all the growth stages except at 30 DAS than remaining treatments and were at par with weed free. Weedy check recorded significantly minimum plant height at all stages of observations. These results were in conformity with Rajpar et al. (2010) [12], and Pisol and Sagarka (2013) [13].
(Table 3). Such superior treatments minimized weed-crop competition and saved more available environmental resources for crop plant that improved growth traits. The superiority of these treatments over weedy check in increasing yield has also been reported by Tiwari and Kewat (2010), Katara et al. (2012), Singh et al. (2012) [15], Kumar et al. (2013) and Singh et al. (2013).

Table 3: Mean grain and straw yields of wheat as influenced by different treatments

| Treatment | Grain (q ha⁻¹) | Straw (q ha⁻¹) |
|-----------|---------------|---------------|
| T₁: Weedy check | 28.93 | 41.08 |
| T₂: Weed free check hand weeding | 50.02 | 75.39 |
| T₃: Pendimethalin @ 1.0 kg a. i. ha⁻¹ as pre-emergence 2 DAS | 47.17 | 69.22 |
| T₄: Metsulfuron methyl @ 4 g a. i. ha⁻¹ POE at 18 DAS | 40.00 | 60.77 |
| T₅: Metsulfuron methyl @ 3 g a. i. ha⁻¹ POE at 18 DAS | 44.80 | 66.37 |
| T₆: Metribuzin @ 175 g a. i. ha⁻¹ POE at 18 DAS | 39.96 | 59.04 |
| T₇: Metribuzin @ 131 g a. i. ha⁻¹ POE at 18 DAS | 44.44 | 63.74 |
| T₈: 2,4-D @ 750 g a. i. ha⁻¹ POE at 18 DAS | 36.60 | 53.46 |
| T₉: 2,4-D @ 563 g a. i. ha⁻¹ POE at 18 DAS | 44.05 | 63.09 |

S.E.± 1.96 | 3.36 |
C.D. at 5% 7.21 | 12.31 |

**Effect on economics**

Data given in Table 4 indicated that effectiveness of any production system is ultimately evaluated on the basis of its economics. Economic analysis is the basic consideration in determining that which treatment gives the highest return while marginal analysis indicates the relative contribution of additional expenditure. All weed control treatments gave higher net benefit over weedy check. Economic analysis promised that maximum net return of (Rs. 58166 ha⁻¹), gross monetary return (Rs. 95738 ha⁻¹), and benefit cost ratio (2.55) was obtained from application of (T₃) Pendimethalin @ 1.0 Kg a.i. ha⁻¹ as pre-emergence 2 DAS. These results were in enclosing conformity with Singh et al., 2013, and Chaudhary et al., 2016, Kumar et al. 2019. The lowest gross return (Rs. 58682 ha⁻¹), net return (Rs 28675 ha⁻¹) and B:C ratio (1.95) was observed with weedy treatment. This is because of more weed - crop competition for light, nutrients, space and moisture in weed control treatment plot as compare to other treatments, which produced higher grain and straw yield.

Table 4: Cost of cultivation, gross and net monetary returns and benefit cost ratio in wheat as influenced by different treatments

| Treatment | Cost of cultivation (Rs. ha⁻¹) | Gross monetary returns (Rs. ha⁻¹) | Net monetary returns (Rs. ha⁻¹) | Benefit cost ratio |
|-----------|-------------------------------|---------------------------------|-------------------------------|-------------------|
| T₁: Weedy check | 30006 | 58682 | 28675 | 1.95 |
| T₂: Weed free check hand weeding | 48976 | 101561 | 52585 | 2.07 |
| T₃: Pendimethalin @ 1.0 kg a. i. ha⁻¹ as pre-emergence 2 DAS | 37572 | 95738 | 58166 | 2.55 |
| T₄: Metsulfuron methyl @ 4 g a. i. ha⁻¹ POE at 18 DAS | 33544 | 81216 | 47681 | 2.42 |
| T₅: Metsulfuron methyl @ 3 g a. i. ha⁻¹ POE at 18 DAS | 36635 | 90941 | 54306 | 2.48 |
| T₆: Metribuzin @ 175 g a. i. ha⁻¹ POE at 18 DAS | 33674 | 81114 | 47440 | 2.41 |
| T₇: Metribuzin @ 131 g a. i. ha⁻¹ POE at 18 DAS | 36739 | 90168 | 54249 | 2.45 |
| T₈: 2,4-D @ 750 g a. i. ha⁻¹ POE at 18 DAS | 33504 | 74276 | 40772 | 2.22 |
| T₉: 2,4-D @ 563 g a. i. ha⁻¹ POE at 18 DAS | 36613 | 89375 | 52762 | 2.44 |

**Conclusion**

On the basis of findings of investigation it can be concluded that weed management practices with the application of Pendimethalin @ 1.0 Kg a. i. ha⁻¹ as pre-emergence 2 DAS should be recommended for the control of complex weed flora in irrigated wheat as these resulted in significantly higher growth and grain yield. However, in monetary terms both the herbicide gave higher net return and B-C ratio.

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