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

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Abstract
A field experiment was carried out 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) [4]. 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 (193.00kg ha^{-1}) medium in available phosphorus (19.89kg ha^{-1}) potassium (475.78kg ha^{-1}) and was alkaline in reaction (pH 7.54).Wheat variety Suparsharbati was sown @ 125 kg seed ha^{-1} at spacing of 22.5 cm between the lines, on 25rd November, 2019 and harvested on 14nd 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 3.15m^2and3.50 x 2.70 m^2, 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, metribuzin @ 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 @ 750g *a.i.* ha^{-1} POE at 18 DAS and 2,4-D @ 563 g *a.i.* ha^{-1} POE at 18 DAS at 30 DAS.

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 Pisal and Sagarka (2013) [13].

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
T_1: Weedy check	9.50	47.70	77.63	79.40
T_2: Weed free check hand weeding	11.20	53.63	86.80	88.76
T_3: Pendimethalin @1.0 kg *a. i.* ha^{-1} as pre-emergence 2 DAS	10.63	51.63	83.00	85.50
T_4: Metsulfuron methyl @ 4 g *a. i.* ha^{-1} POE at 18 DAS	10.23	49.86	79.93	81.26
T_5: Metsulfuron methyl @ 3 g *a. i.* ha^{-1} POE at 18 DAS	10.53	50.46	82.10	83.66
T_6: Metribuzin @ 175 g *a. i.* ha^{-1} POE at 18 DAS	10.06	49.50	79.63	80.66
T_7: Metribuzin @ 131 g *a. i.* ha^{-1} POE at 18 DAS	10.40	50.00	81.00	82.90
T_8: 2,4-D @ 750 g *a. i.* ha^{-1} POE at 18 DAS	9.83	49.26	78.50	80.26
T_9: 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. Among the herbicidal treatments, application of pendimethalin @ 1.0 Kg *a.i.* ha^{-1}as pre-emergence at 2 DAS was recorded significantly higher dry matter $plant^{-1}$ 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 Kumar and Agarwal (2010) [8]. and Singh *et al.* (2011)

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
T_1: Weedy check	0.31	5.95	11.82	12.96
T_2: Weed free check hand weeding	0.38	10.3	20.09	21.62
T_3: Pendimethalin @1.0 kg *a. i.* ha^{-1} as pre-emergence 2 DAS	0.35	8.91	18.01	19.73
T_4: Metsulfuron methyl @ 4 g *a. i.* ha^{-1} POE at 18 DAS	0.31	6.75	14.33	16.04
T_5: Metsulfuron methyl @ 3 g *a. i.* ha^{-1} POE at 18 DAS	0.33	8.42	17.33	18.56
T_6: Metribuzin @ 175 g *a. i.* ha^{-1} POE at 18 DAS	0.31	6.37	13.53	15.29
T_7: Metribuzin @ 131 g *a. i.* ha^{-1} POE at 18 DAS	0.32	8.14	16.53	18.42
T_8: 2,4-D @ 750 g *a. i.* ha^{-1} POE at 18 DAS	0.31	6.23	13.22	15.05
T_9: 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, (T_3) 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 (T_5) metsulfuron methyl @ 3 g *a.i.* ha^{-1} POE at 18 DAS were also statistically at par with (T_3) pendimethalin @ 1.0 kg *a.i.* ha^{-1} as pre-emergence at 2 DASin respect of straw yield kg ha^{-1}

(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	Yield (q ha^{-1})	
	Grain	Straw
T_1: Weedy check	28.93	41.08
T_2: Weed free check hand weeding	50.02	75.39
T_3: Pendimethalin @1.0 kg *a. i.* ha^{-1} as pre-emergence 2 DAS	47.17	69.22
T_4: Metsulfuron methyl @ 4 g *a. i.* ha^{-1} POE at 18 DAS	40.00	60.77
T_5: Metsulfuron methyl @ 3 g *a. i.* ha^{-1} POE at 18 DAS	44.80	66.37
T_6: Metribuzin @ 175 g *a. i.* ha^{-1} POE at 18 DAS	39.96	59.04
T_7: Metribuzin @ 131 g *a. i.* ha^{-1} POE at 18 DAS	44.44	63.74
T_8: 2,4-D @ 750 g *a. i.* ha^{-1} POE at 18 DAS	36.60	53.46
T_9: 2,4-D @ 563 g *a. i.* ha^{-1} POE at 18 DAS	44.05	63.09
S.E.m±	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 (T_3) 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 ration (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
T_1: Weedy check	30006	58682	28675	1.95
T_2: Weed free check hand weeding	48976	101561	52585	2.07
T_3: Pendimethalin @1.0 kg *a. i.* ha^{-1} as pre-emergence 2 DAS	37572	95738	58166	2.55
T_4: Metsulfuron methyl @ 4 g *a. i.* ha^{-1} POE at 18 DAS	33534	81216	47681	2.42
T_5: Metsulfuron methyl @ 3 g *a. i.* ha^{-1} POE at 18 DAS	36635	90941	54306	2.48
T_6: Metribuzin @ 175 g *a. i.* ha^{-1} POE at 18 DAS	33674	81114	47440	2.41
T_7: Metribuzin @ 131 g *a. i.* ha^{-1} POE at 18 DAS	36739	90168	53429	2.45
T_8: 2,4-D @ 750 g *a. i.* ha^{-1} POE at 18 DAS	33504	74276	40772	2.22
T_9: 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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