

EFFECT OF WEED MANAGEMENT ON WEED DENSITY AND PRODUCTIVITY OF WHEAT (*TRITICUM AESTIVUM* L.) UNDER LATE SOWN CONDITION

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Abstract: A field experiment was conducted at Crop Research Center, Sardar Patel University of Agriculture & Technology, Meerut, Uttar Pradesh during the *Rabi* season of 2019-20 and 2020-21 under late sown condition to assess the performance of post-emergence application of Pinoxaden, Isoproturon, Metsulfuron, Clodinafop-propargyl, 2,4-D and Iodosulfuron-methyl in combination with pre-emergence application of Pyroxasulfone on wheat (*Triticum aestivum* L.). The experiment laid out in Randomized Block Design (RBD) having three replication. The treatments comprised of Isoproturon @ 1000 g a.i. ha⁻¹+2,4-D @ 500 g a.i. ha⁻¹ as PoE T₁, Pyroxasulfone @ 127 g a.i. ha⁻¹ as PE T₂, Pyroxasulfone @ 127 g a.i. ha⁻¹ as PE + 1 HW T₃, Pyroxasulfone @ 127 g a.i. ha⁻¹ PE *fb* sulfosulfuron + metsulfuron (RM) @ 32 g a.i. ha⁻¹ PoE T₄, Pyroxasulfone @ 127 g a.i. ha⁻¹PE + Pinoxaden @ 40g a.i. ha⁻¹ as PoE T₅, Pinoxaden @ 40g a.i. ha⁻¹ as PoE T₆, Pinoxaden @ 40g a.i. ha⁻¹ as PoE +1 HW T₇, Pinoxaden + clodinafop-propargyl @ 40 g a.i. ha⁻¹ as PoE T₈, Pyroxasulfone @ 127 g a.i. ha⁻¹ as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha⁻¹ PoE T₉, Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha⁻¹ PoE T₁₀, Weed free T₁₁ and Control (Unweeded check) T₁₂. Treatments effects were evaluated in terms of weed density and productivity of wheat. The results revealed that the maximum weed density at 60 and 90 DAS in Pyroxasulfone @ 127 g a.i. ha⁻¹ as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha⁻¹ PoE T₉ was found *at par* with Pyroxasulfone @ 127 g a.i. ha⁻¹ PE *fb* sulfosulfuron + metsulfuron (RM) @ 32 g a.i. ha⁻¹ PoE T₄, Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha⁻¹ PoE T₁₀, Pinoxaden + clodinafop-propargyl @ 40 g a.i. ha⁻¹ as PoE T₈ and Pyroxasulfone @ 127 g a.i. ha⁻¹PE + Pinoxaden @ 40g a.i. ha⁻¹ as PoE T₅ and significantly higher than the rest of treatments during both the year. The results also revealed that among the different weed management treatments the highest grain yield (46.5 & 48.2 q ha⁻¹) was obtained under weed free treatment, which was *at par* with (45.3 & 46.4 q ha⁻¹) with the application of Pyroxasulfone @ 127 g a.i. ha⁻¹ as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha⁻¹ PoE T₉ and Pyroxasulfone @ 127 g a.i. ha⁻¹ PE *fb* sulfosulfuron+metsulfuron (RM) @ 32 g a.i. ha⁻¹ PoE T₄ (43.9 & 45.3 q ha⁻¹) during both the years. Application of Pyroxasulfone @ 127 g a.i. ha⁻¹ as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha⁻¹ PoE found significantly lowest weed density and higher productivity of wheat crop due to non availability of laborers.

Keywords: Wheat, Herbicide, Weed dynamics, Productivity, Profitability

INTRODUCTION

Wheat (*Triticum aestivum* L.) is an important cereal crop for a large number of countries in the world. Wheat is the world's first grain crop in terms of importance, cultivated areas and world production (Kadhum *et al.*, 2021). India accounting for ~13.5% of global wheat production becomes the second largest producer of wheat in the world after China and (Choudhary *et al.*, 2021). Wheat provides 21% of the food calories and 20% of the protein for more than 4.5 billion people in 94 countries. Wheat-based foods supply micronutrients that are fundamental for normal development and also the metabolic functioning, from childhood to adulthood. India has 30.22 mha area under wheat cultivation with production of 93.50 mt (Singh *et al.*, 2019). U.P. occupies about 9.54 m ha area with an average productivity of 34.32 q/ha and total production 32.74 m tones (Sharma *et al.* 2020). By 2050, the world

will require 60% more food than is now available, with around 80% of this growth coming from already cultivated land (Santini *et al.* 2021). Meeting the growing demand for food is a challenging, task because of the fast growing population and possible solution to it is the cereal crops (the main source of nutrients in these countries) which is facing a serious production constraints, mainly due to the competition by weeds, effects of climate change and nutrient management.

Weed management plays an important role in enhancing wheat productivity. Weeds compete with the crop for nutrients, water, light, space etc. resulting in yield reduction. Though being a serious problem in field, many a times this problem remains under-estimated and not given due concern although they lead to higher reduction in economic yield of crops than other factors like pests and diseases. 11-21 days after crop emergence is the critical period of crop weed competition (Kadhum *et al.*, 2021). And

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grain yield reduction in late sown wheat was reported up to 34.3% as a result of mixed weed flora infestation (Meena *et al.*, 2017). Before the advent of herbicides, weeds were managed by number of practices like tillage, manual weeding and diversified crop rotations. Over time, herbicides have become the most preferred method of weed control in most of the countries. Currently, in India, herbicides are effectively used for weed control in number of crops (Kairovin 2021). In wheat, chemical weed control is a preferred practice due to scarce and costly labour as well as lesser feasibility of mechanical or manual weeding. Nowadays there are many good ready-mix combinations of herbicides used for weed control in wheat and they were found effective in controlling broad spectrum weeds in wheat (Deshmukh *et al.*, 2020).

But continuous use of a single site or mode of action herbicide, over the years has led to the problem of herbicide resistance in *Phalaris minor* in the north western plain zone of the country. In order to overcome such problems of herbicide resistance, alternate herbicides and herbicide mixtures are being tried and employed to widen the weed control spectrum. The compatible herbicide mixtures often lower the doses of the component herbicides in the mixture, reduce possibility of development of herbicide resistance and result in synergistic biological activity on weeds. Wheat suffers with mixed weeds flora. The herbicide mixtures controlled mixed stands of broadleaf and grassy weeds with a consequent increase in grain yield (Khan *et al.*, 2021). Herbicide combinations (ready/pre-mix or tank-mix) have been reported to provide better control of weeds compared to single herbicide (Singh *et al.* 2015) besides delaying herbicide resistance. Nowadays there are many good ready-mix combinations of herbicides used for weed control in wheat and they were found effective in controlling broad spectrum weeds in wheat (Deshmukh *et al.*, 2020).

MATERIALS AND METHODS

The field experiment was conducted at CRC farm of the Sardar Vallabhbhai Patel University of Agriculture and Technology, Meerut (U.P.) located in Indo-Gangetic plains of Western Uttar Pradesh. Meerut lies on national highway 58 and is at a distance of 70 km from Delhi. The weekly mean maximum temperature during crop growing period varied between 37.6°C to 15.4°C, whereas the mean minimum temperature was between 5.9 °C to 20.7 °C. The area receives mean annual rainfall of 852 mm, of which more than 80% is in the month of July- September through south-west monsoon. The mean relative humidity during crop period varied between 77.5 to 31.3 per cent. Before sowing of wheat, soil samples to a depth of 0-15 cm were taken randomly from 10 places in the experimental field.

The collected samples were mixed homogeneously and a composite soil sample was drawn, air dried, powdered and allowed to pass through 2 mm sieve for analyses of soil physical and chemical properties. The soil of experimental site was sandy loam in texture, low in available nitrogen and organic carbon, medium in available phosphorus and potassium and slightly alkaline in reaction. The predominant soil at the experimental site is classified with sandy-loam texture having pH 7.4, bulk density 1.49 g/cm³, low organic carbon content (0.42%), Soil samples for 0–15 cm depth at the site were collected and tested prior to applying treatments and the basic properties were low available nitrogen, low organic carbon, available phosphorus, available potassium medium and alkali in reaction. The gross and net plot size were 5.0 x 4.0 m² and 4.0 x 3.2 m², respectively. In order to find out the best weed control treatment in Wheat, field investigation was carried out with twelve herbicides with and without hand weeding, weed free conditions and control (weedy check). Experiment was laid out randomized block design with three replications. Twelve weed management treatments [Isoproturon @ 1000 g a.i. ha⁻¹ as PE+2,4-D @ 500 g a.i. ha⁻¹ as PoE, Pyroxasulfone @ 127 g a.i. ha⁻¹ as PE, Pyroxasulfone @ 127 g a.i. ha⁻¹ as PE + 1 HW, Pyroxasulfone @ 127 g a.i. ha⁻¹ PE fb sulfosulfuron + metsulfuron (RM) @ 32 g a.i. ha⁻¹ PoE, Pyroxasulfone @ 127 g a.i. ha⁻¹PE + Pinoxaden @ 40g a.i. ha⁻¹ as PoE, Pinoxaden @ 40g a.i. ha⁻¹ as PoE, Pinoxaden @ 40g a.i. ha⁻¹ as PoE +1 HW, Pinoxaden + clodinafop-propargyl @ 40 g a.i. ha⁻¹ as PoE, Pyroxasulfone @ 127 g a.i. ha⁻¹ as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha⁻¹ PoE, Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha⁻¹ PoE. Other practices were followed as per recommendation for this region. An iron square of size 0.25 m² (side 0.5 m) was used to take observations on weed population (number per square meter). The total number of weeds were counted species wise in each plot separately and analysed. The Produce of net plot was threshed and grains thus obtained were winnowed, cleaned and weighed. The yield recorded in kg plot⁻¹ and then converted into qha⁻¹. Statistical analysis of the data was done as per the standard analysis of variance technique for the experimental designs following SPSS software based programme, and the treatment means were compared at $P < 0.05$ level of probability using t-test and calculating CD values.

RESULTS AND DISCUSSION

Influence of herbicides on weeds:

Density of total weeds was affected significantly by various treatments involving weed management practices. Among weed control treatments, the highest total weed density (10.8 & 11.6, 10.9 & 11.6 and 10.5 & 11.2 m⁻²) was found under weedy check

treatment, at 30, 60 and 90 DAS during 2019-20 and 2020-21, respectively.

Among all the treatments except weed free, the lowest total weed density was observed (9.4 & 10.2 m^{-2}) in the treatment of Pyroxasulfone @127 g a.i. ha^{-1} as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha^{-1} PoE, at 30 DAS. At 60 and 90 DAS the lowest total weed density (4.4 & 4.9 and 3.9 & 4.3 m^{-2}) was observed with the application of Pyroxasulfone @127 g a.i. ha^{-1} as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha^{-1} PoE followed by Pyroxasulfone @127 g a.i. ha^{-1} PE fb sulfosulfuron + metsulfuron (RM) @ 32 g a.i. ha^{-1} PoE and Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha^{-1} PoE at 60 and 90 DAS during both the years, respectively.

Crop Productivity

Grain yield was affected significantly by various treatments involving weed management practices. Among weed control treatments, the lowest grain yield (27.5 & 28.8 q ha^{-1}) was found in weedy check. The highest grain yield (46.5 & 48.2 q ha^{-1}) was found in weed free during both the years, respectively.

Among the herbicides the significantly highest grain yield (45.3 & 46.4 q ha^{-1}) was recorded with the application of Pyroxasulfone @127 g a.i. ha^{-1} as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha^{-1} PoE, which was statistically *at par* with Pyroxasulfone @127 g a.i. ha^{-1} PE fb sulfosulfuron+metsulfuron (RM) @ 32 g a.i. ha^{-1} PoE, Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha^{-1} PoE and Pinoxaden + clodinafop-propargyl @ 40 g a.i. ha^{-1} as PoE. Pyroxasulfone @127 g a.i. ha^{-1} as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha^{-1} PoE recorded 64.7 & 61.1% more grain yield over weedy check during both the years.

DISCUSSION

Among the herbicides density of narrow, broad and sedges weeds recorded lower weed population in Pyroxasulfone @127 g a.i. ha^{-1} as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha^{-1} PoE treated plots was *at par* with Pyroxasulfone @127 g a.i. ha^{-1} PE fb sulfosulfuron+metsulfuron (RM) @ 32 g a.i. ha^{-1} PoE treatment. Among weed control treatments significantly highest total weed dry weight 5.8 & 6.4, 8.7 & 9.4 and 12.7 & 13.2 g m^{-2} at 30, 60 and 90 DAS respectably was found in weedy check while the lowest dry weight 1.0 & 1.0, 1.0 & 1.0 and 1.0 & 1.0 g m^{-2} in weed free treatment during both the years. This was due to the fact that at later stage most of the weed growth ceased because of leaf

senescence, and thereby resulted in reduction in dry matter accumulation of weeds.

The final yield of the crop was the cumulative effect of yield attributes and the factor which directly effect and or indirectly influenced them. A crop can performed best only when the display of foliage on the ground surface was in such a manner that utilizes maximum natural resources. In our study, grain yield ha^{-1} was significantly influenced by the different weed management practices. Treatment weed free was superior in relation to grain yield ha^{-1} followed by Pyroxasulfone @127 g a.i. ha^{-1} as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha^{-1} PoE. Among the herbicide Pyroxasulfone @127 g a.i. ha^{-1} as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha^{-1} PoE was superior in grain yield ha^{-1} and 64.7 & 61.1% higher grain yield over weedy check. This was might be due to the higher crop growth of wheat in terms of foliage, large amount of photosynthesis, which act as source and helped in developing yield attributes due to low crop weed competition. The minimum grain yield was obtained from un-weeded control due to no control measure was adopted in this plot.

CONCLUSION

Based on the results of experimentation, it can be concluded that all weed control practices proved effective in controlling the weeds in wheat and gave significantly higher grain yield over weedy check. Among the different treatments, manual weeding to keep the plot weed free is the most effective weed control measure to control narrow, broad leaved and sedge weeds and resulted into lower value of total weed density followed by Pyroxasulfone @127 g a.i. ha^{-1} as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha^{-1} PoE and Pyroxasulfone @127 g a.i. ha^{-1} PE fb sulfosulfuron+metsulfuron (RM) @ 32 g a.i. ha^{-1} PoE. Highest yield of wheat was noticed with weed free, which was found statistically *at par* with the application of Pyroxasulfone @127 g a.i. ha^{-1} as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha^{-1} PoE and Pyroxasulfone @127 g a.i. ha^{-1} PE fb sulfosulfuron+metsulfuron (RM) @ 32 g a.i. ha^{-1} PoE. Among weed management treatments. Thus the application of Pyroxasulfone @127 g a.i. ha^{-1} as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha^{-1} PoE seems better for higher productivity of wheat.

Table 1. Weed density (number per m²) and yield (q ha⁻¹) in wheat as influenced by different weed management practices. Original values is parentheses and data subjected to square root ($\sqrt{x+1}$) transformation

Treatment	Density of total weeds (number per m ²)						Grain yield (q ha ⁻¹)	
	30 DAS		60 DAS		90 DAS		2019-20	2020-21
	2019-20	2020-21	2019-20	2020-21	2019-20	2020-21		
T ₁	9.7 (93.6)	10.4 (107.3)	5.4 (28.1)	5.9 (34.3)	4.7 (21.0)	5.2 (25.8)	41.5	42.9
T ₂	10.1 (100.2)	10.8 (114.9)	6.2 (37.0)	6.8 (45.1)	5.4 (28.5)	6.0 (35.0)	35.6	36.8
T ₃	9.9 (97.6)	10.6 (111.8)	5.9 (34.4)	6.5 (41.9)	5.3 (27.0)	5.8 (33.1)	37.2	39.1
T ₄	9.6 (91.2)	10.2 (104.3)	4.9 (23.3)	5.4 (28.4)	4.4 (18.1)	4.8 (22.2)	43.9	45.3
T ₅	9.7 (93.2)	10.4 (106.8)	5.3 (26.9)	5.8 (32.8)	4.6 (20.2)	5.1 (24.7)	42.3	43.8
T ₆	9.9 (96.3)	10.5 (110.3)	5.9 (33.8)	6.5 (41.2)	5.1 (25.4)	5.7 (31.2)	38.2	40.4
T ₇	9.8 (95.1)	10.5 (109.0)	5.6 (30.8)	6.2 (37.6)	4.9 (23.3)	5.4 (28.5)	40.3	41.9
T ₈	9.7 (92.5)	10.3 (106.0)	5.1 (25.0)	5.6 (30.6)	4.5 (19.4)	5.0 (23.8)	42.8	44.3
T ₉	9.4 (88.3)	10.2 (102.5)	4.4 (18.7)	4.9 (22.8)	3.9 (14.3)	4.3 (17.5)	45.3	46.4
T ₁₀	9.5 (90.1)	10.2 (103.2)	5.0 (24.1)	5.5 (29.4)	4.5 (18.9)	4.9 (23.2)	43.4	45.1
T ₁₁	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	1.0 (0.0)	46.5	48.2
T ₁₂	10.8 (115.7)	11.6 (132.6)	10.9 (118.2)	11.6 (133.2)	10.5 (109.6)	11.2 (124.5)	27.5	28.8
SEm(±)	0.33	0.35	0.22	0.24	0.20	0.22	0.9	1.1
C.D. (P=0.05)	0.94	1.01	0.64	0.69	0.59	0.64	2.8	3.2

Isoproturon @ 1000 g a.i. ha⁻¹ as PE+2,4-D @ 500 g a.i. ha⁻¹ as PoE (T₁), Pyroxasulfone @ 127 g a.i. ha⁻¹ as PE (T₂), Pyroxasulfone @ 127 g a.i. ha⁻¹ as PE + 1 HW (T₃), Pyroxasulfone @ 127 g a.i. ha⁻¹ PE fb sulfosulfuron + metsulfuron (RM) @ 32 g a.i. ha⁻¹ PoE (T₄), Pyroxasulfone @ 127 g a.i. ha⁻¹ PE + Pinoxaden @ 40g a.i. ha⁻¹ as PoE (T₅), Pinoxaden @ 40g a.i. ha⁻¹ as PoE (T₆), Pinoxaden @ 40g a.i. ha⁻¹ as PoE +1 HW (T₇), Pinoxaden + clodinafop-propargyl @ 40 g a.i. ha⁻¹ as PoE (T₈), Pyroxasulfone @ 127 g a.i. ha⁻¹ as PE + Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha⁻¹ PoE (T₉), Mesosulfuron-methyl + Iodosulfuron-methyl sodium @ 30+6 gram a.i. ha⁻¹ PoE (T₁₀), Weed free (T₁₁) and Control (Unweeded check) (T₁₂).

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