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EFFECT OF METRIBUZIN IN COMBINATION WITH POST EMERGENCE HERBICIDE ON WEED AND PRODUCTIVITY OF WHEAT

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ABSTRACT
A field experiment was conducted in wheat during *rabi* season 2011-12 on sandy loam soil at Crop Research Centre, Chirodi of SardarVallabhbhai Patel University of Agriculture & Technology, Meerut (U.P.). The results indicated that chemical methods of weed control Sulfosulfuron+ metribuzin @ 25 + 105 g a.i ha^{-1} (T_7) as post emergence controlled the narrow and broad leaves weeds very effectively and recorded higher value of WCE (89.89%) followed by a combination of sulfosulfuron+ carfentrazone. 25 + 40 g a.i ha^{-1} (T_8), and clodinafop+ metribuzin @ 60 + 122.5 g a.i ha^{-1}(T_5) as post emergence respectively. Highest grain yield (55.13q/ha^{-1}), and straw yield (78.08 q/ha^{-1}), was recorded under sulfosulfuron + metribuzin @ 25 + 105 g a.i ha^{-1}(T_7), maximum net return and B-C ratio was recorded with sulfosulfuron + metribuzin @ 25 + 105 g a.i ha^{-1} (T_7) as post emergence (Rs. 63453.59/ha) and (2.48), followed by clodinafop+ metribuzin @ 60 + 122.5 g ha^{-1} as post emergence ((62820.04/ha) and (2.45) respectively.

INTRODUCTION

Wheat (*Triticum aestivum L.*) is the second most important cereal crop of India next to rice and accounts for 31.5% of the total food grain basket of the country. India is the second largest wheat producing country in the world after China, It covers an area of 29.25 million hectare with total production of 93.90 million tones and average productivity of 30.57 q/ha (Ministry of Agriculture Government of India 2011-12).

The weed in India are causing substantial losses to agriculture production and the annual losses in terms of money come to the Rs. 1650 crores (Joshi, 2002). In agriculture weed causes more damage compared to insects, pests and diseases but due to hidden loss by weed in crop production, it has not drawn much attention of agriculturists (Rao, 2001). The yield losses due to type and intensity of weeds can be as higher as about 65 per cent depending on the crop, degree of weed infestation, weed species and management practices (Yaduraju *et al.*, 2006). In extreme cases, the losses caused by weeds can be up to complete crop failure (Malik and Singh, 1995). The cases of complete crop failure were quite common during late seventies in the absence of effective herbicides and again in mid-nineties due to heavy population of *P. minor* after the evolution of resistance against isoproturon. Under both the situations, some of the farmers were forced to harvest their immature wheat crops as fodder (Malik and Singh, 1993; Chhokar and Malik, 2002). Weed flora of crop differs from area to area and field to field depending on environmental conditions, irrigation, fertilizer use, soil type, weed control practices and cropping sequences (Anderson and Beck, 2007; Chhokar and Malik, 2002; Chhokar *et al.*, 2007 a and b; Dixit *et al.*, 2008 a and b; Froud-Williams *et al.*, 1983). The extent of yield reduction largely depends on growth behaviour of individual weed species in relation to agro-ecological condition (Singh *et al.*, 1997). Among the herbicides, isoproturon and pendimethalin are being used for the last two decades in wheat for management of grassy weeds (Walia et al., 1998 and Chopra *et al.*, 2001). For controlling broadleaved weeds along with grasses, application of isoproturon in combination with 2,4-D and metsulfuron-methyl (MSM) are recommended (Pandey *et al.*, 2006, Singh and Singh, 2002). Singh *et al.* (2004) reported that carfentrazone ethyl at the dose of 20 and 25 g ha^{-1} registered better value of weed control efficiency (90.6 to 100%.) than 2,4-D (500g ha^{-1}) and was comparable with metsulfuron-methyl (4g ha^{-1}). Continuous use of isoproturoned to the development of evolutionary resistant biotype and shift in weed flora (Malik and Singh, 1995). Marczewska and Rola (2003) reported that long-term use of a particular herbicide with incorrect dose and the genetic make-up of the weed contributed to the development of resistance against the active substances containing herbicides. Research was done in objectives study the effects of weed control treatments on crop and associated weeds, study the efficacy of metribuzin in combination with other post emergence herbicides.

MATERIALS AND METHODS

The experiment was conducted at Crop Research Centre of SardarVallabhbhai Patel University of Agriculture and Technology, Meerut, in *rabi* season of 2011-2012. Meerut is located on the Delhi-Dehradun highway. Geographically it is located at 29º402 N latitude and 77º422 E longitude at an altitude of 237 meters above the mean sea level. The area lies in the western Uttar Pradesh. The climate of this region is subtropical and semi-arid the mean maximum temperature of this region is about 43ºC to 45ºC during summer in April, while very low temperature (3ºC) accompanied by frost may be experienced in December-January. The winters are cool frost generally occurs towards the end of December and may continue till the end of January. The monsoon generally begins during the third week of June and continues up to end of September. The total precipitation 800 mm and its distribution in this region various largely, about 80 to 90% of it's received during July to September and few showers are also a common feature during the month of December to January and in late spring season. Total precipitation of 43.4 mm was received during the experimentation period. The maximum temperature being 35.6ºC was recorded in 14th standard week, while the minimum temperature was 2.6ºC in 52th standard week and the Relative Humidity ranged from 29.7 to 88.2% recorded in 21th and 42th week respectively. The soil of experimental field was sandy loam in texture for soil analysis, soil samples was taken from different places at site the experimental field from 0-15 cm depth before application of fertilizers. Composite sample was prepared by mixing all soil samples. Wheat variety DBW-16 was used as seed, Recommended dose of fertilizer NPK as 150:75:60 kg ha^{-1} through source of Urea (46% N), DAP (18% N and 46% P_2O_5) and MOP (60% K_2O) were used as experimental material during the experiment.

The crop response to different treatments application under the present investigation was evaluated on basis of weed studies, growth and yields, in wheat.

Weed studies

The weed counts were taken at 30, 60, 90, DAS and at harvest. The weed counts were taken from the tagged spot of 0.25 m^2in the randomly selected each net plot. The spot was earmarked by iron quadrate having dimension of 0.5 x 0.5 m^2 length and width, respectively.The weeds were air dried completely till they reached to constant weight and finally dry weight of weeds was recorded for each treatment after harvest.The weed control efficiency was calculated by using the following formula (Mani *et al.*, 1981).

$$WCE = \frac{DWC - DWT}{DWC} \times 100$$

Where, WCE = Weed control efficiency

DWT = Dry weight of weeds in treated plot.

DWC = Dry weight of weeds in unweeded control plot.

Growth parameters

The total tillers per 1.0 m row length were recorded at 60, 90 DAS and at harvest stage.The plant height was measured from randomly selected five plants. at 30, 60, 90 DAS and at harvest. Average value for each plot were counted and recorded.

Yield attributes and yeld

The average length of spike was measured by taking length (cm) of five samples and divided by five. The length of year measured from the base of the spike to top of the last spikelet. Five spikes were harvested from the net plot randomly and average number of spikelet's per spike was recorded. The number of grains from 10 spikes from each plot which were selected for length of spike as mentioned above was recorded and later on average number of grains $spike^{-1}$ was worked out. Five plants were harvested from the net plot randomly and allowed to sundry for six days. All the spikes from these plants were threshed and clean manually, weighted and average value of grain weight per plant was recorded for each plot. From bulk produce of each net plot, a representative grain sample was drawn and one thousand seeds were counted randomly. Their weight was recorded as 1000 seed weight. After harvesting, the wheat crop was sun dried up to five days and then weight of net harvested area of wheat in each plot was recorded and converted in to q ha^{-1} the produce of each net plot was threshed and collected separately and grain yield was recorded. The grain yield per net plot was then converted into hectare basis. The straw yield was recorded by subtracting the grain yield from total yield of each net plot and subsequently the values were converted on hectare basis. Harvest index was calculated from economic yield (grain) and biological yield (grain + straw) by using the following formula given by Singh and Staskofif (1971)

$$\text{Harvest index (\%)} = \frac{\text{Economic yield (q ha}^{-1}\text{)}}{\text{Biological yield (q ha}^{-1}\text{)}} \times 100$$

RESULTS AND DISCUSSION

Dry matter of weeds and weed control efficiency

Among different treatments, proved superior to reduce dry weed weight However, rest of the treatments sulfo+metri 25 + 105 g ha^{-1}(T_7), was also found equally effective to restrict dry weight of weeds given in (table1). Significantly the highest dry weight of weeds was observed under weedy treatment. Reduction in dry weight of weeds under sulfo.+metri 25 + 105 g a.i ha^{-1} (T_7), sulfo.+ carfen. 25 + 40 g a.i ha^{-1} (T_8), clodi.+ metri 60 + 122.5 g a.i ha^{-1} (T_5), carfentrazone 50 g a.i ha^{-1} (T_4) and clodi.+ metri 60 + 105 g a.i ha^{-1} (T_6), over weedy treatment were 17.14, 70.00, 99.00, and 90.60 g m^{-2}, at 30, 60, 90 DAS and at harvest, respectively. Reduction in weed biomass was due to lower weed population recorded under these treatments could be attributed to the effective weed

Table 1: Total dry matter weeds (gm^{-2}) as affected by weed management practice in wheat

Treatments	Dry matter accumulation of	weeds 30 DAS	60 DAS	90 DAS	At harvest	W.C.E (%)
T_1	Clodinafop 60 g a.i ha^{-1}	17.45	27.50	44.60	39.20	54.94
T_2	Sulfosulfuron 25 g a.i ha^{-1}	14.93	24.20	31.20	28.40	68.48
T_3	Metribuzin 175 g a.i ha^{-1}	16.29	9.00	18.40	16.30	81.41
T_4	Carfentrazone 50 g a.i ha^{-1}	13.94	19.00	27.10	23.20	72.62
T_5	Clodi.+Metri.60+122.5g a.i ha^{-1}	15.45	6.60	15.00	12.10	84.84
T_6	Clodi.+Metri. 60+105 g a.i ha^{-1}	14.77	9.00	17.60	14.70	82.22
T_7	Sulfo.+ Metri.25+105 g a.i ha^{-1}	15.95	6.00	10.00	9.20	89.89
T_8	Sulfo.+Carfen.25+40 g a.i ha^{-1}	12.91	7.00	13.50	11.50	86.36
T_9	Weed free	0.0	0.0	0.0	0.0	100
T_{10}	Weedy	17.14	70.00	99.00	90.60	0
SEm(±)		0.03	1.96	1.37	1.11	
CD(p=0.05)		0.11	5.82	4.10	4.10	

Table 2: Yield attributes as influenced by different treatments

Treatments		Length of spike (cm)	No of spikelet $spike^{-1}$	No. of grains $spike^{-1}$	1000 grain's weight (g)
T_1	Clodinafop 60 g a.i ha^{-1}	10.97	12.75	42.03	44.11
T_2	Sulfosulfuron 25 g a.i ha^{-1}	11.11	13.21	42.23	44.25
T_3	Metribuzin 175 g a.i ha^{-1}	10.22	12.33	41.15	43.25
T_4	Carfentrazone 50 g a.i ha^{-1}	10.06	12.07	39.15	42.14
T_5	Clodi.+Metri.60+122.5g a.i ha^{-1}	11.36	14.46	44.95	46.22
T_6	Clodi.+Metri. 60+105 g a.i ha^{-1}	11.04	13.45	43.14	45.09
T_7	Sulfo.+ Metri.25+105 g a.i ha^{-1}	11.48	15.35	46.16	48.17
T_8	Sulfo.+Carfen.25+40 g a.i ha^{-1}	11.29	14.06	44.22	45.31
T_9	Weed free	12.14	16.03	48.11	50.05
T_{10}	Weedy	9.15	11.31	34.25	38.11
SEm(±)		0.52	0.11	1.10	1.72
CD(p=0.05)		1.56	0.34	3.29	5.17

Table 3: Yield (q ha^{1}) and harvest index as influenced by different treatment

	Treatments	Biological yield	Grain yield	Straw yield	Harvest Index
T_1	Clodinafop 60 g a.i ha^{-1}	110.98	44.53	66.45	40.12
T_2	Sulfosulfuron 25 g a.i ha^{-1}	117.89	48.06	69.83	40.76
T_3	Metribuzin 175 g a.i ha^{-1}	111.85	46.33	65.52	41.42
T_4	Carfentrazone 50 g a.i ha^{-1}	104.35	42.00	62.35	40.24
T_5	Clodi.+Metri.60+122.5g a.i ha^{-1}	130.55	54.60	75.95	41.82
T_6	Clodi.+Metri. 60+105 g a.i ha^{-1}	125.45	52.33	73.12	41.71
T_7	Sulfo.+ Metri.25+105 g a.i ha^{-1}	133.21	55.13	78.08	41.38
T_8	Sulfo.+Carfen.25+40 g a.i ha^{-1}	125.8	51.73	74.07	41.12
T_9	Weed free	134.45	56.13	78.32	41.74
T_{10}	Weedy	97.25	38.60	58.65	39.69
SEm(±)	1.42	1.04	1.66	0.33	
CD(p=0.05)	4.25	3.16	4.99	1.01	

control. The weedy treatment (T_{10}) recorded significantly the highest dry weight of weeds, might be due to uncontrolled condition favoured luxurious weed growth leading to increased dry matter accumulation. The findings corroborate with those of Sukhadia *et al.* (2000), Chopra *et al.* (2001), Poonia *et al.* (2001), Sardana *et al.* (2001), Singh and Saha (2001), Nayak *et al.* (2003), The highest weed control efficiency (100 %) were registered under weed free (T_9) treatment given in (Table1) and closely followed by treatment Sulfo.+ Metri.25+105 g a.i ha^{-1}(T_7) with (89.89%) and Sulfo.+Carfen. 25+40 g a.i ha^{-1} (T_8) with (86.36%). The lowest weed control efficiency was observed under weedy (T_{10}) treatment.

Yield attribute

The highest spike length (11.48cm) was recorded Sulfo.+ Metri.25+105 g a.i ha^{-1}(T_7), which was at par with Clodi.+Metri.60+122.5 g a.i ha^{-1}(T_5), Sulfo. + Carfen.25+40 g a.i ha^{-1} (T_8), Clodi.+Metri. 60+105 g a.i ha^{-1} (T_6), and Sulfosulfuron 25 g a.i ha^{-1} (T_2), respectively. Lowest spike length (9.15) was observed with weedy (T_{10}), remaining treatments recorded highest spike length than weedy (T_{10}), treatment given in (Table 2). The significantly highest number of spikelet $spike^{-1}$ produce (15.35) was recorded under Sulfo.+ Metri.25+105 g a.i ha^{-1}(T_7), followed by Sulfo. + Carfen.25+40 g a.i ha^{-1} (T_8), Clodi.+ Metri. 60 +122.5g a.i ha^{-1}(T_5), Clodi.+Metri. 60+105 g a.i ha^{-1} (T_6), Sulfosulfuron 25 g a.i ha^{-1} (T_2), Metribuzin 175 g a.i ha^{-1}(T_3), Carfentrazone 50 g a.i ha^{-1}(T_4), and Clodinafop 60 g a.i ha^{-1}(T_1), respectively. The lowest number of spikelet spike^{-1} produce (11.31) under weedy (T_{10}). In general, grains per spike were highest recorded (46.16) in treatments Sulfo.+ Metri. 25 + 105 g a.i ha^{-1}(T_7), followed by Clodi.+ Metri. 60+122.5g a.i ha^{-1}(T_5), Sulfo. + Carfen. 25+40 g a.i ha^{-1} (T_8) and Clodi.+Metri. 60+105 g a.i ha^{-1} (T_6), respectively. Remaining treatments were recorded highest grains per spike than weedy (T_{10}), the lowest grains per spike (34.25) were recorded under weedy (T_{10}), treatment given in (table1).. The highest 1000 grain's weight was recorded (48.17) with Sulfo.+ Metri.25+105 g a.i ha^{-1}(T_7), which was at par with remaining all treatments except weedy (T_{10}), treatment, The lowest test weight observed (38.11) under weedy (T_{10}). Increased values in these yield attributes might have been due to negligible weed crop-competition and increased nutrients and water uptake by the crop leading to increased rate of photosynthesis, supply of photosynthates to various metabolic sinks might have favoured yield attributes and overall improvement in vegetative growth which favorably influenced the tillering, flowering, fruiting and ultimately resulted into increased grain weight and test weight. These findings are in close conformity with those reported by Singh and Saha (2001), Yadav *et al.* (2001) and Jat*et al.* (2003) in respect to number of tillers, Sardana et *al*. (2001), Singh and Saha (2001),

Yield

In herbicidal weed control treatment highest biological yield was observed (133.21q/ha) under Sulfo.+ Metri.25+105 g a.i ha^{-1}(T_7), followed by Clodi.+ Metri. 60+122.5 g a.i ha^{-1}(T_5), statistically at par given in (table 3).. The lowest and highest biological yield was observed (97.25 q/ha^{-1}) and (134.45) under weedy (T_{10}), and weed free (T_9), treatment respectively, Highest grain yield (55.13 q/ha^{-1}) was recorded in herbicidal weed control treatment under Sulfo.+ Metri.25+105 g a.i ha^{-1}(T_7), followed by Clodi. + Metri. 60+122.5 g a.i ha^{-1} (T_5), and Sulfo.+ Carfen. 25 + 40 g a.i ha^{-1} (T_8), being statistically at par respectively. Remaining treatments were observed significantly higher grain yield than weedy (T_{10}), treatment. The highest and lowest grain yield was recorded (56.13 q/ha^{-1}), and (38.60 q/ha^{-1}) was recorded under weed free (T_9), and weedy (T_{10}). Treatment Sulfo.+ Metri. 25 + 105 g a.i ha^{-1} (T_7), was recorded 42.82 % higher grain yield was than weedy (T_{10}) treatment. In herbicidal weed control treatment highest straw yield was observed (78.08 q/ha^{-1}) under Sulfo.+ Metri.25+105 g a.i ha^{-1}(T_7), followed by Sulfo.+ Carfen. 25 + 40 g a.i ha^{-1} (T_8), Clodi.+Metri.60+122.5g a.i ha^{-1}(T_5), and Clodi.+ Metri. 60+105 g a.i ha^{-1} (T_6), which was statistically at par. The lowest and highest straw yield was observed (78.32 q/ha^{-1}) and (58.65 q/ha^{-1}) under weedy (T_{10}), and weed free (T_9), treatment respectively, remaining treatments were recorded significantly higher straw yield than weedy (T_{10}). Treatment Sulfo.+ Metri.25+105 g a.i ha^{-1}(T_7), recorded 33.12 % increased straw yield was than weedy (T_{10}), treatment. No different trend with respect to the effect of weed management on harvest index was obtained. However, the highest harvest index was obtained (41.82 %) under treatment Clodi.+ Metri. 60+122.5g a.i ha^{-1}(T_5), followed by Clodi.+Metri.60+122.5g a.i ha^{-1}(T_6), Sulfo.+ Metri.25+105 g a.i ha^{-1}(T_7), Sulfo.+Carfen. 25 + 40 g a.i ha^{-1}(T_8), and Metribuzin 175 g a.i ha^{-1} (T_3). Remaining treatments were recorded higher harvest index than weedy (T_{10}), treatment. Lowest harvest index was observed (39.69%) under weedy (T_{10}), treatment given in (Table3). The higher yields under these treatments could be ascribed to better control of weeds might have favored higher uptake of nutrients and water, which helped the plant to put optimum growth characters *viz.*, plant height, effective tillers and enhanced photosynthetic activity and partitioning of assimilates, resulting in improved yield attributes like spikelets per spike, grain weight per plant and test weight by virtue of less weed count and dry weight of weeds. These growth and yield attributes evidently reflected in higher grain and straw yields under these treatments. These findings are in close conformity with those reported by Singh (1997) and Nayak *et al.* (2003) who obtained the maximum grain yield with 2 hand weeding. Sukhadia*et al.* (2000) and Singh and Singh (2004)

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