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RESEARCH ARTICLE

Effect of Herbicides on Chlorophyll, Nitrogen, Protein contents and grain yield of Wheat *(Triticum aestivum)*

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ABSTRACT

Herbicidal control of weeds assumes greater significance being efficient and economical method. Field experiments were conducted to study the effect of herbicides (Fenoxaprop-p-ethyl, Metribuzin and Metsulfuron-methyl) on weeds and grain yield of wheat during 2006-07. Weeds like *Avena fatua, chenopodium album, Cynodon dactylon, Melilotus indica,* and *Phalaris minor* dominated the field. *Phalaris minor* is the most troublesome weed affecting wheat production.Significantly higher chlorophyll, nitrogen, protein contents and grain yield of wheat were recorded in fenoxaprop-p-ethyl at 90g a.i./ha as compared to metsulfuron methyl and metribuzin treatments. Fenoxaprop-p-ethyl significantly reduced growth & development of *Phalaris minor* and increased grain yield of wheat. Application of metribuzin at 70g a.i./ha and metsulfuron methyl at 4.0g a.i./ha also increased chlorophyll, nitrogen, protein content and grain yield of wheat as compared to weedy (control). Fenoxaprop-p-ethyl showed the most potent direct effect and caused the maximum decreased in weed population and weed biomass accumulation but had an adverse effect on chlorophyll, nitrogen, protein contents, growth and yield of wheat. All the herbicide resulted in increased chlorophyll, nitrogen, protein contents, growth parameters and yield in wheat.

1) INTRODUCTION

Wheat is major food crop of India occupying second position in area and production of food grains. It is rich in proteins, vitamins and carbohydrates and provides balanced food. Wheat is mainly grown in the northern part of India. Major wheat growing states are Uttar Pradesh, Madhya Pradesh, Punjab, Haryana, Bihar & Bihar. These states contribute almost 80- 85% of wheat area and production. Uttar Pradesh is the leading player in wheat production in India and leads the front with more than 34% share of total wheat production in India. Wheat is grown in more than 96 Lakh hectares out of 168 Lakh hectares of cultivated area. Wheat is mainly grown in three regions in Uttar Pradesh, which include Eastern Uttar Pradesh, Western Uttar Pradesh and Northern Uttar Pradesh. Out of three regions, Eastern Uttar Pradesh is the largest wheat growing region with more than 52 Lakh hectares of land under wheat cultivation. *Triticum aestivum* is the specie of wheat, which is grown in Uttar Pradesh. Also, the yield of wheat production in Uttar Pradesh is more than 3,100 kg per hectare.
Weeds are one of the major factors affecting the productivity, resulting in 30-50 percent losses in crop yield [1] and therefore need immediate attention. It is well known that weeds cause severe loss to yield and deplete soil nutrients considerably. These nutrient losses caused by weeds could be effectively tackled either through the use of effective herbicides or effective weed management treatments. Unwanted plants or weed killing chemicals are called herbicides or weedicides. The use of herbicide offers selective and economic control of weeds right from the beginning, giving crop an advantage of good head start and competitive superiority. Herbicidal control of weeds assumes greater significance being efficient and economical method.
Phalaris minor is the most troublesome weed affecting wheat production. It is an annual grass weed and with the development of resistance against isoproturon [2], it has emerged as the most problematic weed causing yield stagnation of wheat. The infestation of *Phalaris minor* alone can reduce wheat grain yield upto 40 percent . *Phalaris minor* in wheat is dominant weed which pose a serious threat to its successful cultivation. Weed control through herbicides reduces competition with crop for nutrition, light and water. Fenoxaprop-p-ethyl, metsulfuron methyl and metribuzin are main and important chemicals used to reduce the *Phalaris minor* population pressure in order to sustain the productivity of the wheat crop. Due to the morphological similarity, this weed escapes manual weeding and hence its control through herbicides has been a popular option amongst farmers. Keeping these facts in mind, there is urgent need to identify the effective herbicides which may provide wide range of weed control. The present investigation was undertaken to assess the effect of herbicides on chlorophyll, nitrogen, protein contents, growth and yield of wheat.

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2) MATERIALS AND METHOD

The field experiment was conducted during winter season of 2006-07 at Kargaina village, in Bareilly district. The soil of the experiment was sandy clay loam in texture with pH 7.5, organic carbon 0.56%, available P 21.20 kg/ha and available K 224 kg/ha. Sowing of wheat variety PBW 343 was done on 25 November 2006 with row spacing of 20 cm. A constant seed rate per plot @ 100kg/ha was used, crop was raised by applying 120kg N, 60kg P_2O_5 and 40kg K_2O per ha. The experiment was laid out in randomized block design with three replications. Treatments consisted fenoxaprop-p-ethyl at 90 g a.i./ha, metsulfuron methyl at 4.0 g a.i./ha, metribuzin at 70g a.i./ha, weed free and weedy check. All the herbicides were applied 35 days after sowing (DAS) using countineuse sprayer at spray volume of 450 litre water per hectare.

Observations were recorded on total weed population (no. of weeds m^{-2}), total dry weight production of weeds g m^{-2} at 120 DAS. The chlorophyll content (mg g^{-1} fresh weight) was recorded in wheat leaves at 60 DAS. The effect of herbicide weed control treatments on chlorophyll content was determined by the method of Brougham [3]. Chlorophyll content in fresh leaves of wheat was estimated as per formula given by Arnon's [4].

The data on leaf area/plant (cm^2), nitrogen content (%) in leaves and crop dry weight production (g/m^2) were recorded at 90 DAS. The data on plant height, no. of tillers/plant and grain yield (kg/ha) of wheat were recorded at harvest and subjected to statistical analysis. Protein content was analysed in grains of wheat at 120 DAS by a Lowary method [5]. Nitrogen contents was analysed in dried leaves of wheat at 90 DAS by a microkjeldahal method [6]. The total nitrogen uptake (kg/ha) was calculated by multiplying the values of percent nitrogen content in wheat with their respected dry weight. The uptake of nitrogen (kg/ha) was worked out as:

Uptake of nitrogen (kg/ha) = [N (%) in the material X dry weight (kg/ha)]/ 100

3) RESULT AND DISCUSSION

Experimental field was uniformly infested with grassy and non-grassy weeds. The major weed flora at the experimental site comprised grassy weeds *Phalaris minor* (54.96%), *Avean fatua* (11.97%) and non-grassy weeds *Chenopodium album* (13.64%) and *Melilotus indica* (10.33%). Data pertaining to total weed population and total dry weight production of weeds during 2006-07 are presented in table-1, chlorophyll content in table-2, nitrogen content in table-3, Protein content in table-4 and growth parameters of wheat and grain yield are presented in table-5.

Effect of herbicides on weeds:

The data presented in table-1 revealed that the application of fenoxaprop-p-ethyl 90 g a.i. ha^{-1}, metsulfuron-methyl 4.0 g a.i. ha^{-1} and metribuzin 70 g a.i. ha^{-1} significantly reduced the total weed population and total dry weight production of weeds as compared to weedy check. Application of fenoxaprop-p-ethyl 90 g a.i. ha^{-1} recorded significantly lesser number of plants of weed per meter square as compared to other herbicide treatments i.e. metsulfuron methyl 4.0 g a.i. ha^{-1} and metribuzin 70 g a.i. ha^{-1}. Lowest total dry weight production of weeds was also recorded with fenoxaprop-p-ethyl treatment as compared to metsulfuron methyl and metribuzin treatments. Fenoxaprop-p-ethyl at 90g a.i. ha^{-1} was more effective treatment in reducing the population and dry weight production of *P. minor, A. fatua* and ultimately total weeds, which was followed by metribuzin and metsulfuron methyl treatments.

Table 1: Effect of different herbicides on the weed population and dry weight of weeds.

S.No.	Treatment	Dose a.i. g/ha.	Weed population (no. of weeds/m^2)	Dry weight of weeds g/m^2
1	Fenoxaprop-p-ethyl	90	17.00	28.74
2	Metribuzin	70	19.33	31.67
3	Metsulfuron-methyl	4.0	25.00	37.57
4	Weed free	-	0.00	0.00
5	Weedy (control)	-	80.66	158.82
6	C.D. at 5%	-	7.67	7.01

Fenoxaprop-p-ethyl showed the most potent direct effect and caused maximum decrease in *P. minor* population and its dry weight production in comparison to other herbicides as evidenced by its relative population at harvest of the wheat crop due to its selective nature. Fenoxaprop-p-ethyl at 90 g a.i.ha^{-1} was found superior in controlling the population and dry weight production of *P. minor* over metribuzin at 70 g a.i.ha^{-1} and metsulfuron methyl at 4.0 g a.i.ha^{-1} .

Wani et al. [7] reported that fenoxaprop-p-ethyl (80, 100 and 120 g/ha) significantly decreased the population and dry weight of weeds when compared with weedy check. According to Tomer et al. [8] application of fenoxaprop-p-ethyl at 1.50 kg/ha recorded significantly lower weed count at both 40 (24.67 weeds/m^2) and 60 (11.33 weeds/m^2) days after sowing over weedy check. Jat et al. [9] reported that herbicide fenoxaprop at 120g/ha significantly reduced the population of *P. minor* and *A. ludoviciana*. Yadav et al. [10] also reported fenoxaprop at 120g/ha provided 68-72% control of both types of weeds i.e. grassy and broad leaf weeds.

Metribzin at 70 g a.i.ha^{-1} was the second best treatment in reducing the population and dry weight production of *P. minor, A. fatua, C. album, M. indica* and ultimately total weeds. This may be due to broad spectrum effect of metribuzin weedicide. According to Pandey and Verma [11] metribuzin recorded lower population of *P. minor* and other weeds. Canary grass plant after a week of metribuzin spary started withering and died after a month.

Effect of herbicides on growth parameters of wheat:

The plant height, number of tillers and leaf area are important growth characters. The number of tillers/ plant is also yield attributing character because it is helpful in the formation of spikes. According to Malik et al. [12] competitive advantage of various crops to weeds appears to be influenced by crop morphology. Plant height and early ground coverage are positively correlated to competing ability in wheat. Morphological characters like plant height and leaf area have been correlated with weed suppressing abilities in upland rice and beans [13, 14]. Leaf area is an important measures of potential photosynthetic area and thus of the growth capability [15].

The present investigation clearly indicate that all the weed control treatments significantly increased the growth

characters of wheat like plant height, number of tillers/plant, leaf area and crop dry weight production in comparison weedy check. According to Channappagoudar et al. [16] the growth parameters are very much influenced by crop weed competition and herbicides improve these parameters.

Fenoxaprop-p-ethyl at 90g.a.i.ha^{-1} was the best treatment in increasing the growth characters of wheat viz., plant height, number of tillers/plant and leaf area. Fenoxaprop-p-ethyl also produced significantly higher crop dry weight production than other chemicals because of higher plant height, number of tillers and leaf area. This may be due to higher uptake of nitrogen by crop because of consequently better photosynthesis as evidenced by the data recorded on chlorophyll content.

Metribuzin at 70 g.a.i.ha^{-1} was the second best chemical treatment in increasing the growth characters of wheat and followed by metsulfuron-methyl at 4.0 g.a.i.ha^{-1}. Pandey et al., [17] and Pandey et al. [18] stated that the plant height and productive tillers/meter row length of wheat increased significantly by the application of metribuzin.

Effect of herbicides on chlorophyll content:

Fenoxaprop-p-ethyl at 90g a.i.ha^{-1} recorded highest content of total chlorophyll in wheat leaves which was followed by metribuzin at 70g a.i.ha^{-1} and metsulfuron methyl at 4.0g a.i.ha^{-1} . This shows that all the herbicide treatments increased total chlorophyll content in leaves of wheat as compared to weedy check (control).

This may be due to application of herbicides which reduced the population and dry weight of *Phalaris minor* and total other weeds and increased the nitrogen content in wheat, which improved the crop growth characters like plant height, number of tillers, leaf area and dry weight production because of better nitrogen uptake by crop. Thus, better crop growth and nitrogen content increased the Chlorophyll content.

The increase in chlorophyll synthesis resulted in more number of leaves with bigger size and higher chlorophyll content and consequently the higher plant height, dry matter accumulation, number of number of spikes/plant, seed weight/plant and thus the seed yield [19].

Effect of herbicides on nitrogen content:

Fenoxaprop-p-ethyl at 90 g.a.i.ha^{-1} was recorded highest nitrogen content followed by metribuzin at 70 g.a.i.ha^{-1} and metsulfuron methyl at 4.0 g.a.i.ha^{-1}. All the herbicide treatments increased the nitrogen content in the leaves of wheat due to less crop weed competition because of significant control of *Phalaris minor* and total other weeds by herbicides.

Table 2: Effect of different herbicides on Total chlorophyll content of wheat.

S.No.	Treatment	Dose a.i. g/ha.	Total Chlorophyll content (mg/gm f. wt.)
1	Fenoxaprop-p-ethyl	90	2.385
2	Metribuzin	70	2.311
3	Metsulfuron-methyl	4.0	2.298
4	Weed free	-	2.958
5	Weedy (control)	-	1.969
	C.D. at 5%	-	0.244

Table 3: Effect of different herbicides on nitrogen content and nitrogen uptake of wheat.

S.No.	Treatment	Dose a.i. g/ha.	**Nitrogen content (%) 90 DAS**	**Nitrogen uptake by crop (Kg/ha) 90DAS**
1	Fenoxaprop-p-ethyl	90	1.73	137.46
2	Metribuzin	70	1.52	119.11
3	Metsulfuron-methyl	4.0	1.47	114.07
4	Weed free	-	1.88	165.12
5	Weedy (control)	-	1.22	72.54
	C.D. at 5%	-	0.498	41.18

Table 4: Effect of different herbicides on Protein content of wheat.

S.No.	Treatment	Dose a.i. g/ha.	Protein content (%)
1	Fenoxaprop-p-ethyl	90	12.28
2	Metribuzin	70	11.78
3	Metsulfuron-methyl	4.0	11.95
4	Weed free	-	13.36
5	Weedy (control)	-	10.19
	C.D. at 5%	-	1.145

Table 5: Effect of different herbicides on the growth parameters and yields of wheat.

Treatment	Dose a.i. g/ha.	Plant height (cm)	Leaf area (cm^2)	No. of tillers/plant	Dry matter of yield g/m^2	Grain yield Kg/ha
Fenoxaprop-p-ethyl	90	94.16	41.63	5.33	794.66	5052
Metribuzin	70	93.16	38.09	5.23	783.66	4743
Metsulfuron-methyl	4.0	93.25	37.42	5.16	776.00	4655
Weed free	-	95.54	49.96	5.46	878.33	6018
Weedy (control)	-	84.96	31.83	3.76	594.66	3451
C.D. at 5%	-	3.85	3.05	0.70	46.45	695

Nitrogen uptake by crop:

All the herbicide treatments caused higher nitrogen uptake than weedy (control) treatment. Application of fenoxaprop-p-ethyl (90g a.i./ha), metsulfuron methyl (4g a.i./ha) and metribuzin (70g a.i./ha) at applied 35 DAS, resulted in higher nitrogen uptake by crop and differed significantly than weedy treatment. However, metsulfuron methyl and metribuzin were not similar to fenoxaprop-p-ethyl treatment in increasing nitrogen uptake by crop. Application of metribuzin and metsulfuron methyl proved significantly equally effective in reducing the nitrogen uptake by weeds than weedy [20]. The application of fenoxaprop-p-ethyl provided highest nitrogen

uptake (137.46 kg/ha) by crop than other herbicides. This could be attributed to the effective control of *P. minor* by fenoxaprop-p-ethyl application, which checked the nitrogen depletion by *P. minor* to a greater extent.

Effect of herbicides on Protein content:

Fenoxaprop-p-ethyl at 90g a.i.ha^{-1} recorded highest protein content among herbicides. This might be because as it was very effective in controlling *Phalaris minor* and other weeds and increased the nitrogen uptake by crop and ultimately higher protein content in the seeds of wheat. Metribuzin at 70 g a.i.ha^{-1} was the second best herbicide treatment in increasing the protein content followed by metsulfuron methyl at 4.0 g a.i.ha^{-1}. These herbicides significantly reduced the weed population and weed dry weight and increased the nitrogen uptake by crop resulted higher protein content in the grain of wheat over weedy check.

Effect of herbicides on grain yield of wheat:

Applications of fenoxaprop-p-ethyl at 90 g.a.i.ha^{-1} provided highest grain yield (5052 kg/ha) of wheat which was followed by metribuzin at 70 g.a.i.ha^{-1} and metsulfuron-methyl at 4.0 g.a.i.ha^{-1}. It was due to increase in growth parameters, yield attributes of wheat and low weed competition for light, space, moisture and nutrients (nitrogen) because of effective control of *Phalaris minor* and total other weeds under chemical treatments.

Metribuzin was the second best treatment which recorded second highest grain yield of wheat. According to Bisen et al. [21] metribuzin treated plots produced grain yield (4542 kg/ha) significantly higher than weedy check. The higher yield in this treatment was due to lower weed density, weight dry matter production and higher values of yield attributes viz. ear heads/m^2 (212), grains/ear head (43) and 1000 grain weight (42.4gm). According to Pandey et al. [18] application of metribuzin at 230 and 245 gm/ha applied 40 days after sowing, provided higher grain yield of wheat than sulfosulfuron at all doses applied 60 DAS, 2, 4-D 500 g/ha and weedy check. Increase in grain yield in this treatment may be ascribed to the excellent control of weeds and marked improvement in crop growth and yield attributes.

4) CONCLUSION

This study suggests that the reduction in chlorophyll contents may depend on the weed population, weed type, duration and those of herbicide application. The application of fenoxaprop-p-ethyl 90 g a.i. ha^{-1}, methsulfuron-methyl 4.0g a.i. ha^{-1} and metribuzin 70g a.i. ha^{-1} reduced the weed infestation and increased the chlorophyll, nitrogen, Protein content and grain yield of wheat.

REFERENCES

1) Dwivedi, R.K., Bajpai, R.P., Chaudhary, S.K. and Mishra, R.K. (1996). Integrated weed control in wheat in northern hill region of Chhattisgarh, *Indian Journal of Weed Science* **28:** 189-190.
2) Malik, R.K. and Singh, S. (1993). Evolving strategies for herbicide use in wheat. Resistance and integrated weed management proceeding. International symposium on integrated weed management for sustainable agriculture, CCS Haryana Agricultural University, *Hisar, Haryana, India*, 18-20 Nov.
3) Brougham, R.W. (1960) The relationship between the critical leaf area, total chlorophyll content and maximum growth rate of some pasture and crop plant. *Ann Bot.* **24:** 463-473.
4) Arnon, D.I. (1949). Copper enzymes in isolated chlroplasts polyphenol oxidase in Beta vulgaris. *Plant physiol.* **24:** 1-15.
5) Lang, C.A. (1958). Simple microdetermination of Kjeldahal nitrogen in biological materials and chemical, **30:**1692-1694.
6) Lowry, O.H., Rosebrough, N.J., Farr, A.L. and Randall, R.J. 1951. Protein measurement with the Folin Phenol reagent. *J. Biol. Chem*., **193**:265-275.
7) Wani, S., Lone B. A., Haq, S.A. UL. Bahari, F.A., Sofi, K.A. and Sofi, N.A. 2005. Weed management in late sown wheat using different herbicides. Environment & Ecology 23 S (Spl-3), 546-548.
8) Tomer, R.S., Abraham, T. and Jaseph, S.A. 2006-07. Efficacy of different herbicides with and without adjuvant for controlling weeds of wheat (*Triticum aestivum*). Agronomy Digest 6 & 7.
9) Jat, R.K. Punia, S.S. and Malik, R.K. 2006-07. Effect of herbicide-mixture on complex weed flora in wheat *(Triticum aestivum*). Agronomy digest, 6 & 7.
10) Yadav, A.; Malik, R.K.; Banga, R.S.; Dharam Bir; Malik, R.S. and Kumar, V. 2004. Bioefficacy of clodinafop, fenoxaprop, sulfosulfuron, tralkoxydim, dithiopyr and chlrosulfuron alone and in combination against complex flera of weeds in wheat. Indian Journal of Weed Science, 36(1&2), 21-24.
11) Pandey, J. and Verma, A.K. 2005. Effect of low doses of atrazine and metribuzin on *Phalaris minor* and yield of wheat *(Triticum aestivum*). Indian Journal of Agronomy 50(3), 197-199.
12) Malik, R.S.; Yadav, A.; Malik, R.K. and Punia, S.S. 2005. Efficacy of fenoxaprop and competing ability of wheat cultivars against wild vat. Indian Journal of Weed Science, 37(3&4), 256-257.
13) Garrity, D.P., Movillon, M. and moody, K. 1992. Differential weed suppression ability in upland rice cultivars. Agronomy Journal, 84, 586-591.
14) Wortman, C.S. 1993. Contribution of bean morphological characteristics to weed suppression. Agronomy Journal, 85, 840-843.
15) Potter, J.R. and Jones, T.W. 1997. Leaf partitioning as an important factor in growth. Plant physiology, 59, 10-14.
16) Channappagoudar, B.B., Biradar, N.R., Bharmagoudar, T.D. and Koti, R.V. 2007. Influence of herbicides on morpho-physiological growth parameters in potato. Karnataka Journal of Agricultural, Science, 20(3), 487-491.
17) Pandey, J., Gopinath, A.K. and Verma, A.K. 2002. Investigation on low doses of atrazine, Metribuzin Pendimethalin on weeds and yield of wheat. Acta. Agronomica-Hungarica. 50(4), 441-445; 4 ref.
18) Pandey, A.K.; Gopinath, K.A. and Gupta, H.S. 2006. Evaluation of sulfosulfuron and metribuzin for weed control in irrigated wheat (*Triticum aestivum*). Indian Journal of Agronomy, 51(2), 135-138.
19) Dwivedi, S. 2002. Chemical studies on mustard with special reference to Erucic acid and glucosinolate levels as

affected by macro and micro elements. Ph.D. thesis, M.J.P. Rohilkhand Univeristy Bareilly U.P. 155p. India.
20) Bharat, R. and Kachroo, D. 2007. Bio-efficacy of various herbicides and their mixtures on weeds and yield of wheat *(Triticum aestivum)* under subtropical agro-ecosystem. Indian Journal of Agronomy, 52(1), 53-59.
21) Bisen, P.K. Singh, R.K. and Singh, R.P. 2006. Relative composition of weeds and wheat yield as influenced by different weed control and tillage practices. Indian Journal of Weed Science, 38(1&2), 9-11.