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STUDIES ON WEED MANAGEMENT PRACTICES IN WHEAT [*TRITICUM AESTIVUM* (L.)]

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Abstract

An investigation on "Effect of Weed Management Practices on Growth and Yield of Wheat [*Triticum aestivum* (L.)]" under adoptic and climatic condition of northern part of Madhya Pradesh was carried out during *Rabi* season 2015-16 at the Research Farm, Directorate of Weed Science Research (DWSR), Centre for College of Agriculture (RVSKVV), Gwalior (M.P.), India. The experiment was laid out in randomized block design replicated three times. The resulted that the wheat variety MP4010 was grown up adopting recommended package of practices except weed control measures. The magnitude of weed competition in wheat and weed control through different combination of herbicides had been critically in present investigation for evaluation of different combination of herbicides were growth, yield and yield attributing characters, weed studies and economics of the treatments. The maximum grain, straw yield (kg/ha) was received in application of treatment $\mathbf{T}_{11}$ (two HW at 30 and 60 DAS). It was followed by treatment $\mathbf{T}_{6}$ (Pendimethalin 1.0 kg/ha *fb* Sulfosulfuron 0.018 kg/ha). Among all treatment, Pendimethalin 1.0 kg/ha *fb* Sulfosulfuron 0.018 kg/ha gave the maximum net return (Rs. 57877/ha) and B:C ratio (2.80) also.

Key words : Growth parameters, yield attributing characters, cultural practice, herbicides.

Introduction

Wheat [*Triticum aestivum* (L.)] is one of the most important cereal crops of India as well as of world. During the green revolution phase of Indian agriculture, there was tremendous increase in area, production and productivity of this crop. It occupies second position both in terms of area and production in our country. It is cultivated in area of 31.19 million hectares with annual production of 95.91 million tonnes and productivity of 3075 kg/ha in 2014-15, whereas, in Madhya Pradesh, it is cultivated in 5.79 million ha land with an annual production of 13.93 million tonnes with productivity of 2405 kg/ha (Anonymous, 2015). Among various factors responsible for low yield, weeds infestation and their management is one of the important factors. Weed competes with crop plants for water, nutrients, space and solar radiation resulting in reduction of yield by 20 to 50% (Bhan, 1998). Hand or manual weeding though very effective and commonly adopted in India is expensive, tedious, time consuming and many a times become uneconomic. Chemical weed control is an important alternative. Herbicide have shown to be beneficial and very effective means of controlling weeds in wheat because they are quite effective and efficient (Azad *et al*., 1997). Clodinafop and sulfosulfuron were recommended as alternative herbicides against isoproturon resistant *Phalaris minor*. But resistance against these herbicides was also reported (Dhawan *et al*., 2009), necessitating the search for new herbicide molecules. Pinoxaden is a new selective post-emergence herbicide belonging to phenyl-pyrazolin group with acetyl-COA-carboxylase (ACCase) has inhibiting action (Hoffer *et al*., 2006) and being developed for the control of annual grassy weeds in cereal crops including wheat and barley. In view of the above facts, the present investigation was conducted to weed management requirement of wheat through hand weeding and chemical weed control under the current scenario.

Materials and Methods

The investigation compiled here was carried out at the Directorate of Weed Science Research (DWSR), Centre for College of Agriculture (RVSKVV), Gwalior (M.P.), India; during the *rabi* season of 2015-2016. The

experiment was laid out in randomized block design with 3 replications. There were 12 treatments, *viz*. namely $\mathbf{T_1}$ (Pendimethalin 0.75 kg/ha), $\mathbf{T_2}$ (Sulfosulfuron 0.025 kg/ha), $\mathbf{T_3}$ (Metribuzin 0.21 kg/ha), $\mathbf{T_4}$ (Clodinafop 0.06 kg/ha), $\mathbf{T_5}$ (Pendimethalin 1.0 kg/ha + Metribuzin 0.175 kg/ha), $\mathbf{T_6}$ (Pendimethalin 1.0 kg/ha + Sulfosulfuron 0.018 kg/ha), $\mathbf{T_7}$ (Sulfosulfuron 0.03 kg/ha + Metsulfuron 0.002 kg/ha), $\mathbf{T_8}$ (Pinoxaden 0.06 kg/ha + Metsulfuron 0.004 kg/ha), $\mathbf{T_9}$ (Mesosulfuron 0.012 kg/ha + Iodosulfuron + 0.0024 kg/ha), $\mathbf{T_{10}}$ (Clodinafop 0.06 kg/ha + Metsulfuron 0.004 kg/ha), $\mathbf{T_{11}}$ (Two hand weeding at 30 and 60 DAS), $\mathbf{T_{12}}$ (Weedy check) wheat variety MP4010 was grown up adopting recommended package of practices except weed control measures which were applied as per treatments. The nutrients were applied @ 120 kg N, 60 kg P_2O_5 and 40 kg K_2O. The nitrogen was applied through urea containing 46 per cent N. The half dose of nitrogen with full dose of P_2O_5 and K_2O were drilled 8 cm deep in the field (at the time of sowing), as a basal dose. The half dose of nitrogen applied after first irrigation. Five wheat plants were randomly sampled from the inner rows of the each plot leaving the border rows. The sampled plants were carefully dunged up, the roots thoroughly washed under running water, put in labelled envelop bags and taken to the laboratory where the growth and yield parameters were recorded. The plant samples were partitioned into various plant fractions and after sun drying sample were subjected to oven-drying at 62°C until a constant weight was attained. Growth parameter and yield attributes were recorded at 30, 60, 90 DAP and harvest. Economics was worked out taking both variable and fixed costs into account. Data were analyzed as per standard procedure with 5% probability level.

Results and Discussion

Growth parameters

The plant stand recorded at initial and harvest stage is presented the results indicated that at both stages the plant population was not affected significantly by different weed control treatments. The plant population ranged between 84.33 to 87.67 and 83.67 to 86.67 at initial and harvest stage (table 1), respectively. Hence, it was evident that the herbicides used in present investigation did not affect the plant population as there was no phyto-toxic effect of herbicides on the crop.

Plant height, a measure of growth was recorded periodically at an interval of 30 days starting from 30th day up to harvest stage. The plant height was found to be influenced significantly due to different treatments of weed control measures at 30 DAS, the treatment $\mathbf{T_{11}}$ [two HW at 30 and 60 DAS] shown significantly maximum height (24.40 cm) being at par with $\mathbf{T_6}$ and $\mathbf{T_1}$ resulted in significantly Increase in plant height over remaining other treatments. The minimum height (21.27 cm) was noted in treatment $\mathbf{T_3}$ (metribuzin @ 0.21 kg/ha). At 60 DAS, the treatment $\mathbf{T_{11}}$ [two HW at 30 and 60 DAS] shown significantly maximum height (61.20 cm) being at par with $\mathbf{T_6}$ and $\mathbf{T_2}$ resulted in significant increase in plant height over remaining other treatments. The minimum height (46.67 cm) was noted in treatment $\mathbf{T_{12}}$ (weedy check). At 90 DAS and harvest the trend of weed control treatments was continued the same as observed at 90 days stage of crop. Maximum plant height was noted under $\mathbf{T_{11}}$ (102.27 cm), which was at par with $\mathbf{T_6}$ and $\mathbf{T_8}$. The treatment $\mathbf{T_{12}}$ (weedy check) resulted significantly in lowest plant height over rest of the treatments (table 1).

The number of tillers per square meter was found to be increase with the advancement in the age of crop plant up to 60th days stage and it remained constant up to 90th days stage and thereafter it decreased considerably up to harvest stage under the effect of all the weed control treatments including weedy check. The results revealed that the number of tillers per square meter was influenced appreciably by the various weed control treatments at all the stages of crop growth except 30 days stages. At 60 DAS, maximum number of tillers (505.33 /m^2) were recorded in treatment $\mathbf{T_{11}}$ (two HW at 30 and 60 DAS), which was significantly more in comparison to $\mathbf{T_{12}}$ and $\mathbf{T_3}$, but at par with other treatments. The minimum number of tillers (344.00/m^2) were observed in weedy check. At 90 DAS, number of tillers per square meter varied from 344.67 to 506.00 per square meter. The maximum tillers were recorded by treatment $\mathbf{T_{11}}$ (two HW at 30 and 60 DAS) while minimum by treatment $\mathbf{T_{12}}$ (weedy check). At harvest, all weed control treatments significantly increased number of tillers per square meter over weedy check. The maximum number of tillers (505.67 /m^2) obtained for treatment $\mathbf{T_{11}}$ (two HW at 30 and 60 DAS) followed by $\mathbf{T_7}$ and $\mathbf{T_4}$ all these treatments were found at par (table 1).

The number of effective tillers per square meter was found to be increase with the advancement in the age of crop plant up to 60th days stage and it remained constant up to 90th days stage and thereafter it decreased considerably up to harvest stage under the effect of all the weed control treatments including weedy check. At 60 DAS, maximum number of effective tillers (505.33 / m^2) were recorded in treatment $\mathbf{T_{11}}$ (two HW at 30 and 60 DAS), which was significantly higher in comparison to $\mathbf{T_{12}}$, $\mathbf{T_3}$, $\mathbf{T_7}$, $\mathbf{T_5}$, $\mathbf{T_2}$, $\mathbf{T_1}$ and $\mathbf{T_9}$ but at par with other treatments. The minimum number of effective tillers (344.00 /m^2) were observed in weedy check. At 90 DAS

and harvest, number of effective tillers per square meter varied from 327.33 to 482.67 per square meter (table 1). The maximum effective tillers were recorded by treatment T_{11} (two HW at 30 and 60 DAS) while minimum by treatment T_{12} (weedy check). The T_{11} (Two HW at 30 and 60 DAS), was found significantly superior to T_{12} and T_3 at par with rest of the treatments.

The number of leaves per plant it remained constant up to 90th day's stage and there after it decreased considerably up to harvest stage under the effect of all the weed control treatments including weedy check. The results revealed that the number of leaves per plant was influenced appreciably by the various weed control treatments at all the stages of crop growth except 30, 60, 90 DAS and harvest stages. At 30 DAS, maximum numbers of leaves (14.07/plant) was recorded in treatment T_9. The minimum number of leaves (13.00/plant) was observed in T_5. At 60 DAS, maximum number of leaves (28.70/plant) was recorded in treatment T_{11}. The minimum number of leaves (24.07/plant) was observed in T_{12}. At 90 DAS, maximum number of leaves (38.00 /plant) was recorded in treatment T_{11}. The minimum number of leaves (32.20 / plant) was observed in T_{12}. At harvest, was found due to all weed control treatments non significantly increase in number of leaves per plant over weedy check (table 2). The maximum number of leaves (33.07/plant) obtained for treatment T_{11} (two HW at 30 and 60 DAS). The minimum number of leaves (28.40/plant) were observed in T_{12} (weedy check).

All growth parameters *viz.*, plant population was non significantly, plant height per plant was significantly and number of leaves per plant, number of tillers/m^2, number of effective tillers/m^2 was significantly influenced by weed control treatments at all crop growth stages except 30 DAS. Combined application of Pendimethalin 1.0 kg/ha + sulfosulfuron 0.018 kg/ha, sulfosulfuron 0.025 kg/ha, clodinafop 0.06 kg/ha +, pendimethalin 1.0 kg/ha + metribuzin 0.175 kg/ha and pinoxaden 0.06 kg/ha + metsulfuron 0.004 kg/ha were found most effective herbicides to enhance the plant height and number of leaves per plant and all these were comparable to Two HW at 30 and 60 DAS treatment having maximum values of these growth parameters studied. This provided better opportunity to the crop to utilize nutrients, moisture, light and space in better way for its proper growth and development. This may also be due to the fact that the plants under less crop-weed competition had more vertical and horizontal growth as a result, these treatments recorded more plant height and number of leaves as compared to other treatments. These all growth parameters results corroborate the findings of Brar and Walia (2010).

Yield attributing characters and yield

The length of ear head differed significantly due to different weed control measures. The treatments T_{11} recorded ear length (11.27 cm), which were significantly higher than T_{12} and T_2 at par with rest of the other treatments. The minimum ear length (9.00 cm) was recorded under weedy check (table 2).

Where, it is observed that number of grains per ear head significantly influenced by different weed control treatments. The maximum number of grains (48.50 /ear head) was noted under two HW at 30 and 60 DAS condition (T_{11}) as well as pendimethalin 1kg/ha + sulfosulfuron 0.018 kg/ha. The treatment T_{12} being at par with T_2 and T_7 resulted significantly in lowest number of grains per ear over rest of the treatments (table 2).

The data pertaining to this study were analyzed statistically and analysis of variance, where it is observed that grain weight per ear head (g) significantly influenced by different weed control treatments.

The grain yield per hectare was significantly influenced by weed control treatment. All weed control treatments increased the grain yield significantly over weedy check. The maximum grain yield of 3810 kg/ha was obtained with treatment T_{11} followed in decreasing order by T_6 (3772 kg/ha). The unchecked weeds of weedy plot reduced the grain yield by 46.36 per cent when compared to yield of T_{12} (Two HW at 30 and 60 DAS) and by 42.40 per cent when compared to yield of T_6 (Pendimethalin 1 kg/ha + sulfosulfuron 0.018 kg/ha). The minimum grain yield (2219 kg/ha) was found under untreated check (T_{12}) (table 2).

It was observed that no significantly maximum straw yield (7121 kg/ha) was recorded in T_{11} being at par with treatment T_6 (6969 kg/ha) and T_3 (6921 kg/ha). The minimum straw yield (5565 kg/ha) was recorded under weedy check (T_{12}), which was significantly inferior to rest of the treatments (table 2).

The data indicates that the maximum harvest index of 35.29 % was observed under T_{11} (two HW at 30 and 60 DAS) (table 2), followed by T_6 and T_1 very closely. Minimum harvest index was computed under weedy check (30.00%).

Yield attributing characters *viz.*, length of ear head, number of grains per ear head and grain weight of ear head were influenced significantly by weed control treatments. All these yield attributing characters were increased over weedy check by all weed control treatments except pendimethalin 1.0 kg/ha + sulfosulfuron 0.018 kg/ha, in case of number of effective tillers/m^2, ear length as

Table 1 : Effect of different weed control measures on growth parameters on wheat.

Treatments	Plant population		Plant Height (cm)			No. of tillers/m^2			No. of effective tillers/m^2		
	Initial	Harvest	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest	30 DAS	60 DAS	90 DAS	Harvest
T_1	87.33	85.67	24.40	57.80	98.47	98.47	90.33	431.00	431.33	430.67	90.33	431.00	412.33	412.33
T_2	86.00	85.00	22.47	59.40	98.33	98.33	89.00	428.67	429.00	429.00	89.00	428.67	408.00	408.00
T_3	84.33	84.33	19.60	55.00	97.27	97.27	87.00	389.33	389.67	390.00	87.00	389.33	362.00	362.00
T_4	87.33	85.67	23.73	58.27	100.40	100.40	91.00	469.67	470.00	470.00	91.00	469.67	440.67	440.67
T_5	84.67	84.67	20.93	53.00	99.87	99.87	88.00	428.00	428.33	428.33	88.00	428.00	405.00	405.00
T_6	87.67	86.33	24.13	60.13	102.13	102.13	90.67	415.00	440.00	415.33	90.67	415.00	385.67	385.67
T_7	87.00	86.00	23.33	57.20	98.00	98.00	91.00	471.67	472.00	472.00	91.00	471.67	476.33	476.33
T_8	87.67	85.67	21.27	59.20	101.47	101.47	91.00	444.67	445.00	445.00	91.00	444.67	425.00	425.00
T_9	87.00	85.00	23.27	56.07	99.00	99.00	89.67	440.67	441.00	441.00	89.67	440.67	420.33	420.33
T_{10}	86.67	84.67	23.20	56.27	97.53	97.53	89.00	445.00	445.33	445.33	89.00	445.00	423.67	423.67
T_{11}	87.33	86.67	23.93	61.20	102.27	102.27	90.33	505.33	506.00	505.67	90.33	505.33	482.67	482.67
T_{12}	87.33	83.67	21.27	46.67	88.93	88.93	91.00	344.00	344.67	344.33	91.00	344.00	327.33	327.33
S.E.(m)±	1.72	1.61	0.62	2.57	1.94	1.94	1.65	16.71	18.12	16.74	1.65	16.71	13.25	13.25
C.D. (at 5%)	NS	NS	1.81	7.53	5.69	5.69	NS	49.02	53.15	49.10	NS	49.02	38.87	38.87

well as number of grains per earhead. The difference between pendimethalin 1.0 kg/ha + metribuzin 0.175 kg/ha, clodinafop 0.06 kg/ha, pinoxaden 0.06 kg/ha + metsulfuron 0.004 kg/ha, and mesosulfuron 0.012 kg/ha + iodosulfuron 0.0024 kg/ha and two HW at 30 and 60 DAS in respect of all yield attributing characters were not significant. This might be due to less population of weeds especially broad and narrow leaf weeds in the plots treated with these herbicides and in two HW at 30 and 60 DAS plots, where there was less competition between crop and weeds plants for moisture, light, space and nutrients utilized provided congenial condition to the crop for proper development of its reproductive phase which resulted in the enhancement of all these yield contributing characters. These results also corroborate with the findings of Jat *et al.* (2003), Malik *et al.* (2007), Upasani *et al.* (2008), Verma *et al.* (2008).

Grain and straw yield

All the weed control treatments significantly increased the grain yield; weed control treatments significantly no increased the straw yield over weedy check. The highest grain and straw yield recorded in two HW at 30 and 60 DAS treatment. Among the herbicides, pendimethalin 1.0 kg/ha + sulfosulfuron 0.018 kg/ha recorded significantly higher grain as well as straw yield and was at par with all combined application of herbicide except sulfosulfuron 0.025 kg/ha and alone application of herbicides *viz*., clodinafop 0.06 kg/ha, pendimethalin 1.0 kg/ha + metribuzin 0.175 kg/ha, metribuzin 2.41 kg/ha, pinoxaden 0.06 kg/ha + metsulfuron 0.004 kg/ha and clodinafop 0.06 kg/ha + metsulfuron 0.004 kg/ha. The highest grain and straw yield were due to effective suppression of weeds in the early stages which was evidenced from maximum growth parameters and yield attributes recorded. Application of pendimethalin 1.0 kg/ha + sulfosulfuron 0.018 kg/ha, clodinafop 0.06 kg/ha + metsulfuron 0.004 kg/ha. The superiority of these treatments over weedy check in increasing yield has also been reported by Malik *et al.* (2007), Triphati *et al.* (2008), Shaban *et al.* (2009), Khokhar and Nepalia (2010), Singh *et al.* (2011), Saini *et al.* (2010).

Economics of treatments

Cost of cultivation of Rs. 29342/ha was common for all the treatments. But the cost of weed control treatment varied from treatment to treatment. The highest cost of cultivation (Rs. 36842/ha) was incurred under two HW at 30 and 60 DAS treatment.

All the weed control treatments resulted more benefit: Cost ratio over weedy check. The maximum benefit cost ratio of 3.02 was recorded with treatment $\mathbf{T_6}$

Table 2 : Effect of different weed control measures on yield attributing characters.

Treatments	Leaves^{-1} plant at harvest	Length of earhead (cm)	Grain weight of earhead (g)	Number of grains/earhead	Grain yield (kg/ha)	Straw yield (kg/ha)	Harvest index (%)
T_1	29.17	10.27	2.00	42.63	3454	6401	35.05
T_2	30.03	10.13	1.87	41.30	3026	5795	34.30
T_3	30.03	10.27	2.06	43.17	2742	6931	28.35
T_4	29.00	10.13	2.00	42.10	3215	6780	32.17
T_5	28.93	10.23	2.03	43.00	2939	5984	32.94
T_6	30.09	11.20	2.07	43.23	3772	6969	35.12
T_7	29.80	11.20	1.93	42.63	3409	6250	34.85
T_8	30.07	10.30	1.93	42.70	2840	6628	30.74
T_9	30.00	10.20	1.93	43.17	3094	6060	33.80
T_{10}	29.30	10.33	1.87	43.17	3189	6060	34.48
T_{11}	33.07	11.27	2.17	48.50	3810	7121	35.29
T_{12}	28.40	9.00	1.80	40.87	2219	5000	30.00
S.E.(m)±	1.35	0.34	0.07	1.20	217.45	354.12	—
C.D. (at 5%)	NS	0.99	0.20	3.52	637.80	1038.66	—

(pendimethalin 1.0 kg/ha + sulfosulfuron 0.018 kg/ha), followed by T_1 (pendimethalin 0.75 kg/ha) the best treatments recording 2.81 while minimum B: C ratio with weedy check (2.10).

Economics

The choice of any weed control method ultimately depends on economics and efficiency in controlling weeds. The cost of chemical weed control is actually less than that of manual weeding. This has been a major incentive to many farmers for switching over to herbicides.

Different weed control treatments, pre emergence application of pendimethalin 1.0 kg/ha + post emergence application of sulfosulfuron 0.018 kg/ha gave highest net return of Rs. 64921/ha, respectively. Minimum net return (Rs. 32271/ha) was received in weedy check. Similarly, pre emergence application of pendimethalin 1.0 kg/ha + post emergence application of sulfosulfuron 0.018 kg/ha performed the highest benefit cost ratio of 3.02, whereas, minimum BCR was obtained in untreated check. Among all treatment, pendimethalin 1.0 kg/ha + sulfosulfuron 0.018 kg/ha was most effective weed control treatment in recorded higher yield and weed control efficiency, also recorded higher benefit cost ratio. Similar finding were also reported by Gopinath *et al.* (2007), Yadav *et al.* (2009) and Sharma and Singh (2011).

Conclusion

It may be concluded from the one year experiment pre-emergence application of pendimethalin @ 1.0 kg/ha with post-emergence application sulfosulfuron @ 0.018 kg/ha and pre-emergence application pendimethalin @ 0.75 kg/ha are most effective weed control measures for controlling grassy and broad leaf weeds in wheat under sandy clay loam soils of Northern Madhya Pradesh.

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