The effect of Weed Management Practices on the Growth, Yields and Productivity of Wheat (*Triticum aestivum* L.)

ABSTRACT

A field experiment entitled "Effect of weed management practices on growth, yield and productivity of wheat (*Triticum aestivum* L.)'' was conducted at Agronomy Research Farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (Uttar Pradesh) during *Rabi* season 2018-2019. The experiment was laid out in randomized block design with three replications. There were twelve treatments of weed management practices, namely: T_1 - Sulphosulfuron 25g a.i. ha^{-1}; T_2 - Metsulfuron 4g a.i. ha^{-1}; T_3 - Clodinofop 60g a.i. ha^{-1}; T_4 - Metribuzin 210g a.i. ha^{-1}; T_5 - Sulphosulfuron+Metsulfuron (30+2) 32 g a.i. ha^{-1}; T_6 - Sulphosulfuron+Metribuzin (25+210) 235 g a.i. ha^{-1}; T_7 - Clodinofop+ Metsulfuron (60+4) 64 g a.i. ha^{-1}; T_8 - Fenoxaprop–p–ethyl 120 g a.i. ha^{-1}; T_9 - Fenoxaprop-p-ethyl + Metsulfuron (120+4) 124 g a.i. ha^{-1}; T_{10} - Two hand weeding at 20, 40 DAS; T_{11} - Weedy check; T_{12} - Weed free. From the results, all the growth parameters (or yield attributes) like; higher number of spike (m^{-2}), Length of Spike (cm), number of spikelet $Spike^{-1}$, Grain per ear head (m^{-2}), and Test Weight (g) plus yields of grain and straw, as well as higher harvest index of wheat obtained were significantly higher under weed free treatment of 52.50 qha^{-1} followed by under T_7 - Clodinofop+ Metsulfuron @ (60+4) 64 g a.i. ha^{-1} at an obtained yield of wheat is 51.10 qha^{-1}. The highest net return (81054.50 Rs. ha^{-1}) and benefit cost ratio (2.04) was recorded under T_7 - Clodinofop + Metsulfuron @ (60+4) 64 g a.i. ha^{-1}. Thus it may be recommended for effective control of weeds and higher production of grain and straw yield in wheat crops.

Keywords: *Wheat, Growth, Yields, Productivity, Weed Management, Herbicides.*

1.0 INTRODUCTION

"Wheat (*Triticum aestivum* L.) is the second most important cereal crop next to rice and accounts for 36.01% of total food grain basket of the country" **Anonumous, 2021.** "It is grown under diverse agro climatic conditions while wheat is the backbone of food security of India. It is utilized for bread, cakes, cookies, noodles, petri-products and chapatti etc. Wheat grains contains starch 60-68%, protein 8-15%, fat 1.5-2.0%, cellulose 2.0-2.5%, and minerals 1.5-2.0%" **Rathore,2001.** "The total area of wheat in the world is 217.02 million hectares with production of 764.50 million tonnes and productivity is 35.20 q ha^{-1}. The major producing countries of wheat in the world are the China followed by India, United States of America, Russia, France and Australia" **Anonumous,2019-20.** "In India,having U.P.first rank in production (32.74 million tonnes) and area (9.54 m ha) while in productivity Punjab has first rank with 51.95 q ha^{-1} followed by Haryana, Rajasthan and Uttar Pradesh" **Anonumous,2019-20.** "Weeds are considered as one of the constraints in wheat cultivation. When wheat is infested with a number of weeds, they both compete with the available resources, therefore, decrease in growth, yield attributes and grain yields. The prominent weeds found on wheat farms like *Phalaris minor* of grassy group, *Chenopodium album, Anagallis arvensis, Melilotus alba, Convonvulus arvensis* were of broad leaf group and *Cyperus rotundus* of sedges group. The other less important weeds were *Cynodon dactylon, Vicia hirsuta, Lathyrus aphaca, Avena fatua.* Similar weed flora of wheat crop under normal sown condition have also reported" by **Rahaman and Mukherjee, 2009 and Yadav *et al.* 2022**. The grassy weeds like - *Phalaris minor* and *Avena ludoviciana* are posing great threat to the productivity of wheat crop in last decade in Central Zone also and infestation of these weeds is increasing year to year in newer areas. Other weeds mainly broad leaved weeds notably *Chenopodium album* L., *Melilotus indica*, *Convolvulus arvensis*, *Medicago hispida* etc. *Parthenium hystrophorus* is also infested as a problematic weed in crops as well as non-croplands and spreading every year in newer areas. **Kaur *et al.* 2013.** reported that "Metsulfuron-methyl alone and in combination with Clodinafop, fenoxaprop and Sulfosulfuron provided excellent control of broad leaf weeds, i.e. *C. album, M. indica, R. retroflexus* and *C. didymus* except *C. arvensis* and *L. aphaca"* .**Yadav *et al.* 2022**. "Application of sulfosulfuron + metsulfuron was recorded more effective in controlling

grasses and broad leave weeds followed by mesosulfuron + iodosulfuron as compare to metribuzin while highly infestation of weeds was found under weedy check over rest of the treatments recorded" by **Yadav and Dixit 2014.**

2. MATERIALS' AND METHODS

2.1 Experimental Site

The experiment was carried out during *Rabi* season 2018-19 at Agronomy research farm, Acharya Narendra Deva University of Agriculture and Technology, Narendra Nagar, Kumarganj, Ayodhya (U.P.). The field was well levelled having good soil condition. Study location is situated at 24^0 47' North latitude, 82^0 12' East longitudes with an altitude of 113 meters above mean sea level.

2.2 Geography and Climate

Geographically, the experimental site falls under sub humid, sub-tropical climate of Indo-gigantic plains (IGP) having alluvial calcareous soil. The weekly minimum and maximum temperature during the crop season ranged from 3.5 ^{0}C to 37.5 ^{0}C respectively and the rainfall received during study period was 61.5 mm and average Relative humidity, evaporation and sunshine hours ranged from 53.00 % to 76.6 %, 2.6 to 7.2 mm per day and 3.6 to 9.6 hrs per day respectively.

2.3 Experimental Details

An experiment was laid out in Randomized Block Design (RBD) with twelve treatments and three replications. The treatments comprised of weed management practices under study in wheat crop. All herbicides were used as post emergence at 30 DAS. Treatments are as follows: T_1 - Sulfosulfuron @ 25g a.i. ha^{-1}, T_2 - Metsulfuron @ 4g a.i. ha^{-1}, T_3 - Clodinafop @ 60g a.i. ha^{-1}, T_4 - Metribuzin @ 210g a.i. ha^{-1}, T_5 - Sulfosulfuron + Metsulfuron (30+2) @ 32 g a.i. ha^{-1}, T_6 - Sulfosulfuron + Metribuzin (25+210) @ 235 g a.i. ha^{-1}, T_7 - Clodinafop + Metsulfuron (60+4) @ 64 g a.i. ha^{-1}, T_8 - Fenoxaprop –p – ethyl @ 120 g a.i. ha^{-1} ,T_9 - Fenoxaprop-p-ethyl + Metsulfuron (120+4) @ 124 g a.i. ha^{-1}, T_{10} -Two hand weeding (20 and 40 DAS), T_{11} - Weedy check, T_{12} - Weed free. The size of each plots was (16.90 m^2) 6.5 meter in length and 2.6 meter in width. In experiment total number of plots was 36.

2.4 Agronomic Practices

Pre-sowing irrigation was applied 7-10 days before sowing of wheat crop because, it is necessary to have optimum moisture level for field preparation and to ensure good germination/emergence. Field was harrowed twice followed by cultivator and planking to get well pulverized soil suitable for the sowing and germination of wheat crop.

2.5 Seed and Sowing

Wheat variety PBW-154 was selected for this study. The seed rate used was 100 kg ha^{-1} while healthy and clean seeds were sown at 20 cm rows distance with the help of seed drill. The sowing of all plots was done on November 28, during 2018. And wheat crop was harvested when attained the physical maturity.

2.6 Fertilizers Application

The experimental crop was uniformly fertilized with 120kg N, 60kg P_2O_5 and 40kg K_2O ha^{-1} through urea, Di-ammonium phosphate and murate of potash, respectively. The application of half dose of nitrogen and a full dose of phosphorus and potash were given as basal dose and remaining nitrogen applied as a top dressing in two equal splits; 25% at after first irrigation and 25% at after second irrigation was given.

2.7 Weed Management

Weeds were removed manually in two-hand weeding at 20 and 40 days interval after sowing as per treatments and all the herbicides were applied as post-emergence at 30 DAS of wheat, as per treatments, with the help of a knap-sack sprayer fitted with flat-fan nozzle with a spray volume of 250 L ha^{-1} water.

2.8 Observations Recorded

The observed parameters growth characteristics were: numbers of tillers, plants height; dry matter accumulation; LAI. The observation on yield and yield attributes characteristics were recorded using standard methods as follows; Number of spike, Spike length, Number of spikelet's, Number of grains per spike, Test weight, Grain yield and straw yield. Harvest index had to be determined while the data recorded on different observations were analyzed statistically using the analysis of variance (ANOVA) technique as suggested by Gomez and Gomez (1984). The standard error of mean for different main effects was calculated with the help of the following formula;

$$SEm\pm = \sqrt{2VE/r} \quad \text{.....} \quad (2.8)$$

The treatments mean were compared using the Critical difference at 5 % probability level by Randomized block design (RBD) model as obtained by Co.stat 6.311, 1998-2005 as statistical programme.

3.0 RESULTS' AND DISCUSSIONS

3.1 Growth Characters

3.1.1 Plant Height (cm)

The study result presented in Table 1 indicates that, growth characteristics such as plant height increased significantly by the different weed management practices at 30, 60, 90 day and harvest stage of crop growth. At 30 DAS maximum plant height recorded under weed free being at par with two-hand weeding and significantly higher than herbicidal treatments. This might be due to hand weeding at 20 DAS. Tallest plant (104.50cm) was recorded under weed free which was at par with post emergence application of Clodinafop + Metsulfuron @ 60 +4 g ha^{-1} (102.36 cm) and Sulfosulfuron + Metsulfuron @ 30+2 g ha^{-1}, (101.74cm). "The shortest plants heights (87.40 cm) were observed under weedy check at all growth stages. The increase in plant height was due to greater availability of nutrient which resulted profuse growth of plants at various growth stages" **Pandey and Kumar 2005., Pandey *et al.* 2007., Meena and Singh 2011., Kumar *et al.* 2018.**

3.1.2 Number of Tillers (m^{-2})

The number of tillers m^{-2} increased up to 90th day stage of crop growth and thereafter, it decreased slightly as seen in the data presented in Table 1. The number of tillers m^{-2} increased significantly under various weed management practices as compared to weedy check at all the growth stages except 30 DAS which maximum number of tiller. Weed free treatment recorded significantly higher number of tiller m^{-2} than other weed management practices, being at par with two-hand wedding, post emergence application of Clodinafop + Metsulfuron @ 60 +4 g ha^{-1} and Sulfosulfuron + Metsulfuron @ 30+2 g ha^{-1}, and Fenoxaprop-p-ethyl + Metrubuzin (120 + 210 g ha^{-1}), recorded significantly higher number of tillers. It may be attributed to the fact that there was better availability of nutrients under well managed plots which resulted in better number of tillers m^{-2} than other treatments as equally reported by **Tomar and Vivek 2003., Bibi *et al.* 2008., Kumar *et al.* 2018.**

3.1.3 Dry Matter Accumulation (g m^{-2})

"Dry matter accumulation and the resultant of all the growth and yield attributes viz., plant heights, shoot m^{-2} and leaf area are shown in Table 2. The dry matter accumulation increased significantly with the application of weed management practices at all the growth stages, except at 30 days where dry matter range unaffected. At harvest the highest dry matter accumulation was recorded in weed free (1170.47) which were statistically at par with post emergence application of Clodinafop + Metsulfuron @ 60 +4 g ha^{-1} (1154.30) and Sulfosulfuron + Metsulfuron @ 30+2 g ha^{-1} and two hand weeding. This might be attributed to more synthesis of food materials in plants under less weedy condition". **Paswan *et al.* 2012.**

3.1.4 Leaf Area Index

The leaf area index (Table 2), shows that the leaf area increased with increase in age of crop up to 90th day stage and decline thereafter, mainly due to senescence. The leaf area index increased significantly with various weed management practices recording the highest leaf area index in weed free (4.21) statistically superior over rest treatment while at par with two hand weeding Clodinafop + Metsulfuron @ 60 +4 g ha^{-1} (1154.30) and Sulfosulfuron + Metsulfuron @ 30+2 g ha^{-1}. "The better leaf area index with these treatments might be due to fact that sufficient moisture and nutrient availability due to less weed

density resulted in better growth i.e. leaf number and size leading to increased leaf area and leaf area index. Better LAI with best weed managed reported by plots" **Pandey and Kumar 2005.**

3.2 Yield Attributes

From the yield attributes presented in Table 3, the resultant of all the yield attributes viz. effective tillers m^{-2}, length of spike(cm), number of spikelet $spike^{-1}$ and grain $spike^{-1}$ increased significantly with weed management practices over weed check. The significantly highest values of all the yield contributing characters were recorded with weed free, which were at par with post emergence application of Clodinafop + Metsulfuron @ 60 +4 g ha^{-1} and Sulfosulfuron + Metsulfuron @ 30+2 g ha^{-1}, while significantly higher than the rest of the weed management practices. This might be as a result of better availability of nutrient, moisture, space and light which resulted in better growth and development of plants as in similar finding also represented **singh *et al.* 2011.** Maximum test weight recorded under weed free and Clodinafop + Metsulfuron @ 60 +4 g ha^{-1}, might be due to less competition for different resources resulted more translation of food from source to sink relationship and it is the cumulative function of various growth parameter and yield attribute viz., number of tillers, grain $spike^{-1}$, length of spike and test weight (are the sink components) **Shehzad *et al.* 2012., Singh et al..2017., Ashok *et al.* 2022.**

3.3 Yields

3.3.1 Grain Yield (q ha^{-1})

Table 3 shows the result of Grain yield while the maximum grain yield was recorded at Weed free (52.50 q ha^{-1}) which was at par with post emergence application of Clodinafop + Metsulfuron @ 60 +4 g ha^{-1} (51.10 qha^{-1}) , Sulfosulfuron + Metsulfuron @ 30+2 g ha^{-1} (50.20 qha^{-1}) and two-hand weeding while significantly superior over rest of the weed Management practices. It might be due to the smothering effect of the respective weed management practices which resulted in more translocation of food from source to sink responsibly more yield. Almost similar findings were reported by **Kumari *et al*. 2013., Malik *et al.* 2013., Tomar and Tomar 2014.**, **Singh et al..2017., Sharma *et al.* 2018., Ashok *et al.* 2022.**

3.3.2 Straw Yield (q ha^{-1})

The highest straw yield (see Table 3) of (66.45 qha^{-1}) was recorded in weed free which were statistically at par with post emergence application of Clodinafop + Metsulfuron @ 60 +4 g ha^{-1} (64.10), Sulfosulfuron + Metsulfuron @ 30+2 g ha^{-1}, and two hand weeding while significantly higher than rest of the weed management practices. The above findings may be due to effective control of weeds which contributed to better growth parameters and yield attributes, better vegetative growth coupled with higher yield attributes resulted in higher grain and straw yield over rest of the weed management practices almost similar finding reported by **Malik *et al.* 2013., Tomar and Tomar 2014., Ashok *et al.* 2022.**

3.3.3 Biological Yield (q ha^{-1})

The biological yield (Table-3) is the sum of grain and straw yield. Maximum biological yield recorded under wed free 118.95 q ha^{-1} was at par with post emergence application of of Clodinafop + Metsulfuron @ 60 +4 g ha^{-1} (64.10) (114.70 q ha^{-1}), Sulfosulfuron + Metsulfuron @ 30+2 g ha^{-1}, (114.70 q ha^{-1}). This might be due to the effective weed control, such as to treatment enhancement leading to more growth and development which resulted into more biological yield. Similar finding reported by **Sharma *et al.* 2018,Tomar and Tomar 2014., Ashok *et al.* 2022.**

3.3.4 Harvest Index

Harvest index in wheat exhibited a non-significant influence under various weed management treatments. The highest harvest index was noted in Clodinafop + Metsulfuron @ 60 +4 g ha^{-1} (44.35), closely followed by weed free (44.33) this might be due to the fact that proper weed management increased the proportionate distribution of photosynthetic sink i.e. grain which resulted increase in harvest index. Similar finding was reported by **Choudhary *et al.* 2021**.

Table 1: Effect of Various Weed Management Practices on Plant Height (cm) and Number of Tillers (m^{-2}) of Wheat

Treatments	Plant Height (cm)				Number of Tillers (m^{-2})			
	30 DAS	60 DAS	90 DAS	At Harvest	30 DAS	60 DAS	90 DAS	At Harvest
T_1	28.00	61.65	95.68	97.64	178.32	361.67	366.50	362.48
T_2	27.60	61.59	95.29	97.48	181.59	360.96	364.68	360.00
T_3	28.30	60.42	93.71	95.65	180.12	342.34	361.15	350.81
T_4	25.54	61.14	94.96	96.85	178.47	344.36	362.15	355.15
T_5	28.88	63.36	95.92	101.74	181.84	379.58	401.14	390.49
T_6	28.40	62.50	95.87	97.81	181.23	362.51	378.81	371.19
T_7	28.35	64.15	97.20	102.36	180.89	382.60	404.31	392.88
T_8	26.60	60.68	94.18	94.85	179.54	329.26	348.17	336.99
T_9	29.15	63.10	96.50	99.74	178.99	355.25	381.75	386.12
T_{10}	30.57	65.81	99.70	101.37	183.97	382.15	405.00	388.25
T_{11}	27.50	59.11	85.01	87.4	183.82	273.85	289.56	277.78
T_{12}	31.14	66.96	100.48	104.5	185.98	393.78	415.97	405.47
SEm ±	**0.74**	**1.02**	**1.10**	**1.46**	**2.55**	**10.33**	**10.30**	**6.17**
CD (P ≥0.05)	**2.32**	**3.01**	**3.26**	**4.32**	**NS**	**30.48**	**30.38**	**18.19**

Table 2: Effect of Various Weed Management Practices on Dry Matter Accumulation (g m^{-2}) and Leaf Area Index of Wheat

Treatments	Dry Matter Accumulation (g m^{-2})				Leaf Area Index		
	30 DAS	60 DAS	90 DAS	At Harvest	30 DAS	60 DAS	90 DAS
T_1	94.09	345.20	660.16	1068.66	1.41	3.68	3.75
T_2	93.75	338.60	652.63	1050.20	1.40	3.61	3.71
T_3	93.67	285.90	648.36	1028.67	1.38	3.42	3.58
T_4	94.81	295.50	646.80	1046.54	1.39	3.58	3.67
T_5	95.50	360.95	792.25	1136.91	1.44	3.79	4.13
T_6	94.77	347.40	694.20	1086.21	1.41	3.72	3.77
T_7	94.99	365.60	795.20	1154.31	1.45	3.81	4.14
T_8	93.54	291.70	647.30	1015.39	1.42	3.31	3.54
T_9	94.81	357.50	721.36	1087.81	1.43	3.76	3.95
T_{10}	95.55	366.50	796.00	1132.43	1.43	3.78	4.14
T_{11}	93.42	270.50	556.60	806.42	1.44	2.71	3.14
T_{12}	95.60	370.00	728.50	1170.47	1.46	3.87	4.21
SEm ±	**0.75**	**1.57**	**1.16**	**13.15**	**0.15**	**0.12**	**0.03**
CD (P ≥0.05)	**2.35**	**4.68**	**3.43**	**38.85**	**NS**	**0.34**	**0.08**

Table 3: Effect of Various Weed Management Practices on Yield Attributes and Yields (q ha^{-1}) of Wheat

Treatments	No. of Spike (m^{-2})	Length of Spike (cm)	No. of Spikelets $Spike^{-1}$	Grain per Ear Head (m^{-2})	Test Weight (g)	Grain Yield (q ha^{-1})	Straw Yield (q ha^{-1})	Biological Yield (q ha^{-1})	Harvest Index (%)
T_1	358.72	8.69	14.17	37.40	34.51	46.20	60.45	106.65	39.96
T_2	345.49	8.67	14.10	37.00	34.47	45.80	59.10	104.90	43.66
T_3	335.00	8.51	13.41	36.40	34.47	44.50	58.20	102.70	43.33
T_4	340.25	8.61	13.65	36.51	34.41	45.00	58.75	103.75	43.37
T_5	374.82	9.15	16.00	41.70	35.15	50.20	64.50	114.70	43.76
T_6	362.28	8.87	14.25	38.10	33.43	47.10	61.15	108.25	43.51
T_7	375.00	9.38	16.05	41.41	35.45	51.10	64.10	115.20	44.35
T_8	326.85	8.35	12.70	36.00	34.15	43.18	58.65	101.83	42.40
T_9	375.50	8.90	14.55	38.15	34.97	47.50	61.50	108.65	43.71
T_{10}	367.50	9.45	15.98	38.83	35.05	49.80	64.95	114.75	43.39
T_{11}	260.10	6.74	12.15	34.31	32.80	32.50	47.90	80.40	40.42
T_{12}	379.10	9.73	16.48	43.10	36.32	52.50	66.45	118.95	44.13
SEm ±	**1.5**	**0.41**	**0.65**	**1.60**	**1.06**	**1.33**	**1.03**	**1.48**	**1.19**
CD (P ≥0.05)	**4.45**	**1.21**	**1.90**	**4.69**	**NS**	**3.98**	**2.98**	**4.33**	**NS**

CONCLUSION

On the basis of results summarized above, it can be concluded that, the field experiment on the post emergence application of herbicide Clodinafop + Metsulfuron (60 + 4 g ha^{-1}) gave highest plant height at 60, 90 DAS, at harvest as well as higher number of tillers, dry matter accumulation and leaf area index was recorded at all stages of crop growth. Also recorded were higher number of spike (m^{-2}), Length of Spike (cm), No. of spikelet $Spike^{-1}$, Grain per ear head (m^{-2}), and Test Weight (g). It also produced higher grain yield, straw yield, biological yields and as well as higher harvest index. Due to these results and observations, the post emergence application of herbicide Clodinafop + Metsulfuron (60 + 4 g ha^{-1}) is therefore, recommended for weed management practices and higher production of grain and straw yields in wheat crops.

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