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Effect of Post Emergence Herbicidal Combinations Tank Mixed with Zinc or/and Iron Sulphate on Growth and Straw Yield of Wheat Crop (*Triticum aestivum* L.)

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***Abstract*:** Wheat (*Triticum aestivum*) is an important cereal crop of the world. Its straw is an important livestock feed source. Major biotic stress on wheat crop is the weeds. Wheat growing areas are also now suffering from deficiency of micronutrients. A field experiment was conducted at RRS, Bawal, India during *Rabi* season of 2018-19 to evaluate the post-emergence herbicidal combinations with Zn or/and Fe in wheat crop. Four herbicidal combinations *viz*. clodinafop + metsulfuron @ 60 g/ha, sulfosulfuron + metsulfuron @ 32 g/ha, mesosulfuron + iodosulfuron @ 14.4 g/ha, pinoxaden + carfentrazone @ (50 + 20g/ha) were evaluated with Zn, Fe and with both Zn as well as Fe. Growth parameters *i.e*. plant height, tillers per meter length of wheat and dry matter accumulation per meter row length of wheat increased significantly under the influence of herbicidal treatments over weedy check. Addition of iron and zinc to the herbicidal combinations resulted into increase in growth parameters of wheat. Application of combined (Zn + Fe) with herbicidal combinations enhanced the growth of wheat significantly over application of sole herbicidal combinations. Similar trend in increase in straw yield, biological yield and harvest index of wheat was observed. Highest straw yield, biological yield and harvest index was obtained under the influence of mesosulfuron + iodosulfuron @ 14.4 g/ha + $ZnSO_4$ (0.5 %) + urea (2.5 %) + $FeSO_4$ (0.5 %).

***Keywords*:** Growth parameters, Herbcidal combinations, Iron, Straw yield, Wheat, Zinc

Wheat (*Triticum aestivum* L.) plays very important role in attaining food security and is cultivated on an area of 30 mha in India having production and productivity of 97 mt and 3230 kg/ha, respectively (USDA-FAS 2018). Wheat straw has gained immense importance as livestock feed especially in north western India. Green revolution has caused reduction in production of wheat straw owing to short statured wheat. It has also led complex problem of both grassy and broad leaved weeds. Diverse type of weed flora attacks wheat due to diverse growing conditions and cultivation practices. Weed reduces the wheat yield by 30-40 % if not controlled. Among various weed management methods, chemical weed control is more efficient, less costly and less time consuming. Ready-mix of clodinafop + metsulfuron @ (75 g/ha + 0.2 % surfactant) reduces the grassy and broadleaf weeds density to very low level and results into comparable level of wheat grain yield to sequential application of clodinafop @ 60 g/ha and metsulfuron @ 4 g/ha and weed free without any phytotoxicity symptoms on the crop (Kaur et al2015). Herbicidal combinations (ready mix) of clodinafop + metsulfuron (Vesta), sulfosulfuron + metsulfuron (Total), fenoxaprop + metribuzin (Accord plus) and mesosulfuron + iodosulfuron (Atlantis) are very effective (WCE > 90 %) in wheat (Tiwari et al 2016). So, herbicidal mixtures are very effective in controlling complex weed flora in wheat.Second factor affecting wheat growth and yield is imbalanced fertilization and deficiency of nutrients specially micronutrients. Zn and Fe are essential micronutrients for plants. They play very crucial role in nitrogen fixation, energy transfer and protein synthesis, photosynthesis etc. (Alloway 2008). Foliar application of zinc and iron in wheat significantly increases straw yield of wheat (Zeidan et al 2010). Application of zinc either as seed soaked, soil applied or foliar application increases growth of wheat, straw yield and harvest index of wheat significantly (Mauriya et al 2015). Time of spray of micronutrients in standing field crops mostly coincides with the time of application of post-emergence herbicides. But very less information is available about the compatibility of herbicidal combinations with the zinc and iron sulphate. Keeping in mind the role of these micronutrients, this study was carried out.

MATERIAL AND METHODS

Field experiment was conducted at Choudhary Charan Singh Haryana Agricultural University (CCSHAU), Regional Research Station, Bawal (Rewari), India during *Rabi* season of 2018-19. The experimental soil was alkaline. Soil was low in organic carbon and available nitrogen; medium in available

phosphorous, high in available potash; deficient in available zinc (0.56) and sufficient in available iron (4.51 ppm). Experiment was laid out in Randomized Block having 18 treatments, each replicated thrice. Wheat variety WH 1105 was sown as per recommendations. Crop was raised with recommended package of practices except weed management. Treatments of weed management were applied at 35 days after sowing (DAS) in different plots of size 6.0 m x 2.2 m. Treatments consist of sole application of four herbicidal combinations; as well as tank mixed with zinc or/and iron sulphate along with weedy check and weed free (Table 1). Data of crop growth parameters was recorded at different intervals of crop growth. Five plants were randomly selected and tagged in each plot and their heights were measured with the help of meter scale at 60, 90 and 120 days after sowing. Average of all five observations was calculated. Plant height (cm) was taken as length from ground surface level to the highest point of plant. Plants in 25 cm row length from the 3rd line on either side in every plot were cut close to the ground at 60, 90 and 120 DAS. These samples were initially sun dried and then dried in oven at 65 ± 2^{0}C for 48 hours. After oven drying, the samples were weighted, converted into dry weight per meter row length by multiplying with four. The tillers were counted in one running meter row length measured with meter scale randomly placed at three spots in each plot at 60, 90 and 120 DAS. Both ends of one meter row distance were earmarked with sticks to record effective tillers per meter row length. The grain yield was deducted from biological yield to obtain straw yield and expressed in kg/ha. Before threshing, biological yield was recorded by weighing the crop biomass produced in each plot with the help of portable spring balance. The data was recorded in Kg/plot and converted into Kg/ha. Harvest index is a measure of effectiveness of translocation of carbohydrates from leaves to grains. It was determined using the following formula:-

$$\text{Harvest index (\%)} = \frac{\text{Economic yield}}{\text{Biological yield}} \times 100$$

Statistical analysis: All the experimental data for various crop parameters were statistically analysed by online computer programme OPSTAT (Sheoran et al 1998).

RESULTS AND DISCUSSION

Crop Growth

Plant height: The application of herbicidal treatments alone as well as tank mixed with Zn/Fe increased the plant height of wheat significantly as compared to weedy check. Among various treatments, application of herbicide mixtures with Zn and Fe sulphate results in significant variation in plant height in comparison to application of herbicide mixture alone. The maximum plant height of wheat was observed under mesosulfuron + iodosulfuron (14.4 g/ha) + $ZnSO_4$ (0.5 %) + urea (2.5 %) + $FeSO_4$(0.5 %). The application of herbicide with either Zn or Fe alone could not make a significant improvement in plant height of wheat over treatment with herbicidal combination without Zn or Fe. Simultaneous application of zinc with herbicides improved plant height more than simultaneous application of iron. The possible reason for improvement in plant height with application of herbicides could be enhanced absorption of herbicides which resulted in inhibition of essential enzymes in weeds which caused less competition between crop plants and weeds. Mauriya et al (2015) reported that zinc influences various physiological and biochemical activity of the plant. Higher plant height with the application of zinc might be due to the fact that zinc is a constituent of various metabolites like chlorophyll, enzymes and hormones which affects plant cell enlargement and elongation. Zn and Fe have synergistic effect on plant growth and improved the plant growth as compared to their separate application (Zayed et al 2011). Competitive ability of wheat plants also increased due to application of micronutrients which proved advantageous for wheat plants. Sabeti (2015) reported that application of herbicides with fertilizers improves the wheat growth.

Dry matter accumulation: All the weed control treatments recorded significant increase in dry matter accumulation as compared to weedy check. The separate application of zinc and iron with herbicidal combinations resulted in insignificant improvement in dry matter accumulation but when applied simultaneously along with herbicides led to significant enhancement in dry matter accumulation /m.r.l. over sole application of herbicides. Maximum dry matter accumulation per meter row length was exhibited under the treatment mesosulfuron + iodosulfuron (14.4 g/ha) + $ZnSO_4$ (0.5 %) + urea (2.5 %) + $FeSO_4$ (0.5 %) followed by pinoxaden + carfentrazone (50 + 20 g/ha) + $ZnSO_4$(0.5 %) + urea (2.5 %) + $FeSO_4$ (0.5 %). Among various herbicidal treatments, clodinafop + metsulfuron (60 g/ha) witnessed minimum dry matter accumulation/m.r.l. in wheat.

Weeds are primary competent of wheat for all the essential inputs required for dry matter accumulation. Micronutrients play an important role in crop growth. Zinc is required for formation and utilization of photosynthates and improves the dry matter yield (Sawan et al 2008). Fe is an important element in crops, because it is necessary for chlorophyll synthesis which leads to higher dry matter accumulation. Zinc and iron application at the same time could lead to higher dry matter as compared to using them separately (Kobraee and Shamsi 2011).

Number of tillers/meter row length (m.r.l.) of wheat: After

application of treatments at 35 DAS, the number of tillers per m.r.l. differed significantly among various treatments and were significantly higher in all treatments than weedy check (Table 1). Highest number of tillers per m.r.l. were observed at 60 DAS. Among various herbicidal treatments, mesosulfuron + iodosulfuron (14.4 g/ha) + $ZnSO_4$ (0.5 %) + urea (2.5 %) + $FeSO_4$ (0.5 %) was most effective with maximum number of tillers per m.r.l. Data indicated that treatments of simultaneous application of zinc or iron with herbicidal combinations improved number of tillers per m.r.l. as compared to sole herbicide application; although insignificantly. Combined application of both zinc and iron with herbicidal combinations significantly improved number of tillers per m.r.l. as compared to sole herbicide application.

The application of micronutrients (Fe and Zn) tilted the crop-weed competition in favour of crop, leading to better crop growth and increase in number of tillers per meter row length. Foliar application of zinc and iron in wheat increases the number of tillers by increasing the chlorophyll content which leads to increase in photosynthetic process (Kandoliya et al 2018).Similar increase in number of tillers due to weed control by ready mix herbicidal combinations was reported by Pal et al (2016).

Straw yield, biological yield and harvest index: All weed management treatments employed in the present study exerted significant effect on straw yield of wheat in comparison to weedy check and reaped statistically equal straw yield to weed free. The addition of Zn or Fe individually to the herbicides improved the straw yield over sole application of herbicides. Combined application of herbicides with Zn and Fe (Zn + Fe) further augmented the straw yield. Among herbicides mesosulfuron + iodosulfuron (14.4 g/ha) was most effective and when applied with Zn + Fe attained maximum straw yield followed by pinoxaden + carfentrazone (50 + 20 g/ha) + $ZnSO_4$ (0.5 %) + urea (2.5 %) + $FeSO_4$ (0.5 %). The straw yield achieved under treatment of herbicides with sole application of Zn or Fe was statistically similar to straw yield harvested under herbicides + Zn + Fe. All

Table 1. Effect of herbicidal combinations and their tank mixtures with zinc or/and iron sulphate on crop growth

Treatment	Dose (g/ha)	Plant height			Dry matter			Number of tillers/m.r.l.		
		DAS			DAS			DAS		
		60	90	120	60	90	120	60	90	120
Clodinafop + metsulfuron	60	48.2	79.5	95.0	37.0	136.7	301.0	96.7	90.7	89.6
Sulfosulfuron + metsulfuron	32	48.8	79.8	96.1	37.4	138.1	305.3	98.0	92.3	91.9
Mesosulfuron + iodosulfuron	14.4	49.1	81.3	97.2	38.5	144.2	312.0	100.0	94.8	93.5
Pinoxaden + carfentrazone	50 + 20	47.6	80.1	96.5	37.9	141.0	308.5	98.7	93.7	92.9
Clodinafop + metsulfuron + $ZnSO_4$ + urea	60	49.7	81.3	97.7	38.8	143.3	311.1	100.3	93.1	92.1
Sulfosulfuron + metsulfuron + $ZnSO_4$ + urea	32	50.0	81.9	99.0	39.4	145.9	316.2	101.1	95.3	94.5
Mesosulfuron + iodosulfuron + $ZnSO_4$ + urea	14.4	50.6	83.2	99.5	40.3	149.5	321.2	102.8	97.0	96.2
Pinoxaden + carfentrazone + $ZnSO_4$ + urea	50 + 20	49.0	82.1	99.3	40.0	147.5	319.1	102.0	96.1	95.3
Clodinafop + metsulfuron + $FeSO_4$	60	49.1	80.8	96.6	38.1	140.3	308.4	99.3	93.0	92.1
Sulfosulfuron + metsulfuron + $FeSO_4$	32	49.2	81.2	97.7	38.6	142.3	312.1	100.0	94.8	93.8
Mesosulfuron + iodosulfuron + $FeSO_4$	14.4	49.9	82.4	98.8	40.0	147.8	319.0	102.7	96.0	95.4
Pinoxaden + carfentrazone + $FeSO_4$	50 + 20	48.0	81.7	98.3	39.5	144.0	314.9	101.3	95.7	94.9
Clodinafop + metsulfuron + $ZnSO_4$ + urea + $FeSO_4$	60	51.3	83.4	100.2	40.6	149.8	322.8	103.0	96.0	94.8
Sulfosulfuron + metsulfuron + $ZnSO_4$ + urea + $FeSO_4$	32	51.9	83.7	101.3	41.3	151.7	324.7	103.7	97.8	96.6
Mesosulfuron + iodosulfuron + $ZnSO_4$ + urea + $FeSO_4$	14.4	52.2	85.2	103.0	42.3	155.4	331.2	105.3	99.7	98.5
Pinoxaden + carfentrazone + $ZnSO_4$ + urea + $FeSO_4$	50 + 20	50.7	84.5	102.2	41.8	152.1	328.2	104.3	98.8	97.6
Weedy check	--	42.2	71.1	85.3	32.2	114.7	254.6	84.0	80.3	79.0
Weed free	--	51.3	83.3	99.9	40.6	150.1	322.1	103.3	97.7	96.5
C.D. (p=0.05)		3.0	3.8	4.7	3.1	10.4	16.6	5.1	4.7	4.6

Table 2. Effect of herbicidal combinations and their tank mixtures with zinc or/and iron sulphate on straw, biological yield and harvest index of wheat

Treatment	Dose (g/ha)	Straw yield (kg/ha)	Biological yield (kg/ha)	Harvest index (%)
Clodinafop + metsulfuron	60 g/ha	7918	12900	38.62
Sulfosulfuron + metsulfuron	32 g/ha	8052	13123	38.64
Mesosulfuron + iodosulfuron	14.4 g/ha	8064	13221	39.01
Pinoxaden + carfentrazone	50 + 20 g/ha	8062	13170	38.78
Clodinafop + metsulfuron + $ZnSO_4$ + urea	60 g/ha	8223	13447	38.85
Sulfosulfuron + metsulfuron + $ZnSO_4$ + urea	32 g/ha	8292	13600	39.03
Mesosulfuron + iodosulfuron + $ZnSO_4$ + urea	14.4 g/ha	8353	13731	39.17
Pinoxaden + carfentrazone + $ZnSO_4$ + urea	50 + 20 g/ha	8302	13624	39.06
Clodinafop + metsulfuron + $FeSO_4$	60 g/ha	8176	13347	38.74
Sulfosulfuron + metsulfuron + $FeSO_4$	32 g/ha	8284	13556	38.89
Mesosulfuron + iodosulfuron + $FeSO_4$	14.4 g/ha	8298	13631	39.12
Pinoxaden + carfentrazone + $FeSO_4$	50 + 20 g/ha	8296	13582	38.92
Clodinafop + metsulfuron + $ZnSO_4$ + urea + $FeSO_4$	60 g/ha	8548	14015	39.01
Sulfosulfuron + metsulfuron + $ZnSO_4$ + urea + $FeSO_4$	32 g/ha	8678	14240	39.06
Mesosulfuron + iodosulfuron + $ZnSO_4$ + urea + $FeSO_4$	14.4 g/ha	8705	14360	39.38
Pinoxaden + carfentrazone + $ZnSO_4$ + urea + $FeSO_4$	50 + 20 g/ha	8689	14291	39.20
Weedy check	--	6673	10268	35.01
Weed free	--	8433	13866	39.18
C.D. (p=0.05)		620	993	2.22

herbicidal treatments either alone or in blending with Zn and Fe individually or combined produced significantly more biological yield than weedy check and statistically equal biological yield to weed free. Maximum biological yield was obtained under the treatment of mesosulfuron + iodosulfuron (14.4 g/ha) + $ZnSO_4$ (0.5 %) + urea (2.5 %) + $FeSO_4$ (0.5 %).The harvest index varied from 35.01 per cent under weedy check to 39.38 per cent under the treatment of mesosulfuron + iodosulfuron (14.4 g/ha) + $ZnSO_4$ (0.5 %) + urea (2.5 %) + $FeSO_4$ (0.5 %). Harvest index of 39.18 per cent was attained for weed free.The results are in conformity with the results of Kumar et al (2014) and Punia et al (2017). Similar increase in the yield of wheat were reported by Kaur et al (2007) and Patel et al (2017).

Weeds compete with crop for the applied inputs and space, resulting into significant yield losses. The synergistic effect of tank mixing of herbicidal combinations with Zn and Fe increased yield of wheat. The herbicidal combinations exhibited their worth against weeds through selective mechanism while micronutrients (Zn and Fe) enhanced the efficacy of herbicidal combinations by improving growth of wheat plants directly through their physiological and biochemical action; and improving their competitive ability against weeds. The harvest index also followed same trend. Similar compatibility of herbicides and micronutrients were reported by Sabeti (2015). Martens et al (1978) also reported compatibility of herbicides with liquid fertilizers. Increase in biological yield and straw yield was also due to effect of zinc and iron on biochemical and physiological processes like photosynthesis and consequently growth of wheat (Mauriya et al 2015). Micronutrients especially, zinc and iron plays an important role in translocation of photosynthates which leads to increased grain or economic yield and higher harvest index (Marschner 1997).

CONCLUSION

All the herbicidal combinations recorded significantly higher straw yield and biological yield of wheat over weedy check. Addition of Fe to herbicidal combinations increased the growth and yield of wheat. Addition of Zn to herbicidal combinations further enhanced the growth and yield of wheat. Application of combined (Zn + Fe) to herbicidal combinations recorded significantly higher growth and yield of wheat. Therefore it is concluded that all the herbicidal combinations tested under study were compatible with Zn or/and Fe.

REFERENCES

Alloway BJ 2008. *Zinc in soils and crop nutrition*, 2nd Ed. International Zinc association publications, Brussels, Belgium.

Kandoliya RU, Talaviya BP and Kunjadia B 2018. Effect soil and foliar application of zinc and iron on growth of wheat plant in

calcareous soil of Saurashtra region. *European Journal of Biotechnology and Bioscience* **6**(5): 86-90.

Kaur T, Brar LS and Walia US 2007. Effect of sulfosulfuron and mesosulfuron + iodosulfuron on weeds and wheat yield. *Indian Journal of Weed Science* **39**(1&2): 48-51.

Kaur T, Bhullar MS and Walia US 2015. Bio-efficacy of ready-mix formulation of clodinafop-propargyl + metsulfuron for control of mixed weed flora in wheat. *Indian Journal of Weed Science* **47**(2): 121-124.

Kobraee S and Shamsi K 2011. Determination of zinc, iron and manganese concentration and partitioning during reproductive stages of soybean grown under field conditions. *Research on Crops* **12**(3): 752-760.

Kumar S, Yadav RA, Pal V and Verma S 2014. Bio-efficacy of pinoxaden 5 EC in combination with broad leaf herbicides on weed species with relation to economics of wheat (*Triticum aestivum* L.). *Environment & Ecology* **32**(1): 154-158.

Martens AR, Burnside OC and Cramer GL 1978. Compatibility and phytotoxicity of herbicide-fertilizer combinations. *Agronomy Journal* **70**(6): 1089-1098.

Marschner H 1997. Functions of mineral nutrients. In *Mineral Nutrition of Higher Plants* (pp.313-363). Academic Press, London, UK.

Mauriya AK, Maurya DC, Maurya VK and Verma RK 2015. Effect of zinc application methods on yield attributes, yield and nutrient uptake in wheat (*Triticum aestivum*) varieties under sodic soil. *Indian Journal of Agronomy* **60**(1): 82-86.

Pal S, Sharma R, Sharma HB and Singh R 2016. Influence of different herbicides on weed control, nutrient removal and yield of wheat (*Triticum aestivum*). *Indian Journal of Agronomy* **61**(1): 59-63.

Patel BD, Chaudhari D, Patel VJ, Patel HK, Mishra A and Parmar DJ 2017. Influence of broad spectrum herbicides on yield and complex weed flora of wheat (*Triticum aestivum* L.). *Research on Crops* **18**(3): 433-437.

Punia S, Yadav DB, Kaur M and Sindhu VK 2017. Post-emergence herbicides for the control of resistant little seed canarygrass in wheat. *Indian Journal of Weed Science* **49**(1): 15-19.

Sabeti P 2015. Evaluation the effect of micronutrients on herbicide mixture 2,4-D + MCPA, Bromoxynil + MCPA and Tribenoron-methyl efficacy in wheat (*Triticum aestivum*). *Biological Forum – An International Journal* **7**(1): 1855-1858.

Sawan ZM, Mahmoud MH and El-Guibali AH 2008. Influence of potassium fertilization and foliar application of zinc and phosphorus on growth, yield components, yield and fiber properties of Egyptian cotton (*Gossypium barbadense* L.). *Journal of Plant Ecology* **4**(1): 259-270.

Sheoran OP, Tonk DS, Kaushik LS, Hasija RC and Pannu RS 1998. Statistical Software Package for agricultural research workers. In: *Recent advances in information theory, statistics & computer applications* (pp. 139-143). Department of Mathematics Statistics, CCS HAU, Hisar.

Tiwari A, Verma BK, Tiwari A and Sharma JD 2016. Effect on growth, yield and economics of wheat (*Triticum aestivum* L.) as affected by different herbicides. *Research in Environment and Life Sciences* **9**(4): 490-492

USDA-Foreign Agricultural Service 2018. World Agricultural Production, Circular Series WAP8-18 August, 2018. https://apps.fas.usda.gov/psdonline/circulars/production.pdf.

Zayed BA, Salem AKM and El Sharkawy HM 2011. Effect of different micronutrient treatments on rice (*Oryza sativa*) growth and yield under saline soil conditions. *World Journal of Agricultural Sciences* **7**(2): 179-184.

Zeidan MS, Mohamed MF and Hamouda HA 2010. Effect of foliar fertilization of Fe, Mn and Zn on wheat yield and quality in low sandy soils fertility. *World Journal of Agricultural Sciences* **6**(6): 696-699.

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