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Effect of herbicides on wheat (*Triticum aestivum* L.) productivity and soil fertility status after harvest under different nutrient management practices

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Abstract
A field experiment was carried out at the Crop Research Center, SVPUA&T, Modipuram, Meerut, U.P. during the *Rabi* seasons of 2020-21 and 2021-22 to study the effect of pre and post emergence application of herbicides on wheat under different nutrient management practices. The soil texture of the experimental field was sandy loam, with low organic carbon and available nitrogen, medium available phosphorus and potassium, and slightly alkaline reaction. The treatments comprised of all possible combinations of the two factors, *viz*., Nutrient management (04) and weed control practices (06). Total twenty four treatment combinations were laid out in a factorial Randomized Block Design with three replications. The results indicated that, the nutrient management and weed control practices significantly influenced the yield of wheat and nutrient availability of soil after crop harvest during both the years. The treatment 75% NPK + 25% N through press mud found significantly higher grain and straw yield over the other nutrient management practices, but it was remain at par with 75% NPK + 25% N through FYM. While, significantly nutrient availability was observed with the application of 75% NPK + 25% N through press mud compared to control. Moreover, weed free treatment recorded significantly superior yield of wheat. Among the herbicides, Sulfosulfuron @ 25 g a.i. ha^{-1} PoE gave significantly higher grain and straw yield, while it was remain at par with Pendimethalin @ 1 kg a.i ha^{-1} as PE. Among the weed management practices weedy free treatment found significantly available nutrients compared to Control (Unweedy check), but among herbicides Sulfosulfuron @ 25 g a.i. ha^{-1} PoE observed higher values of nutrient availability. Therefore concluded as among the treatment combinations 75% NPK + 25% N through press mud along with Sulfosulfuron @ 25 g a.i. ha^{-1} PoE found to be beneficial the for productivity of wheat crop and fertility of soil after harvest.

Keywords: Wheat, grain yield, straw yield, available NPK

Introduction
Wheat is one of the world's major staple food crop, consumed by 35% of the human population, contributing to almost 20% of dietary energy and protein in the diet of developing countries. In India, it is a staple food next to rice. Wheat supplies the most calories and proteins to the global population in the form of diverse wheat-based foods.

Ironically, indiscriminate and imbalanced use of these inorganic fertilizers has adversely affected the soil health, human wellbeing besides reducing factor productivity. The application of urea, DAP and MOP have been found to have lower fertilizer efficiency which ranges from 20 to 50% for nitrogen and 10-25% for phosphorus and 70-80% potassium owing to leaching losses besides volatilization and denitrification losses which not only contribute to the greenhouse gases emission but also certain health hazards such as blue baby syndrome as a result of eutrophication and leaching losses of urea. Nutrient management involving combined use of organic and inorganic nutrient sources is important to restore the soil productivity and improve health of arable lands. Integrated use of organic manures and fertilizers besides improving physical condition of soil also provide both major and micro nutrients.

Hand weeding is laborious, time consuming, energy intensive and only possible on small scale and effective on annual weeds. Raising cost of labour and their non-availability lead to the search for alternative methods such as herbicide usage. Herbicides are efficient in controlling weeds especially in large farms (Powles and Shaner, 2001) [10]. Herbicides form potent tools to check the mixed flora of weeds in close row crop like wheat where manual or mechanical weeding is difficult and certain grassy weeds evade farmer hoe because of botanical mimicry at early growth stage.

Keeping in view the foregoing facts the present investigation was carried to study the effect of pre and post emergence application of herbicides yield of wheat crop and nutrient availability of soil under combined application of organic and inorganic sources of nutrients.

Material and Methods

The experiment was carried out at CRC farm of the Sardar Vallabhbhai Patel University of Agriculture & Technology, Meerut, Uttar Pradesh, India, located in Indo-Gangetic plains of Western Uttar Pradesh in Western plains zone. Geographically the farm is situated between 29^0 05' 19" N latitude, 77^0 41' 50" E longitudes and an altitude of 237 meters above the mean sea level. The place is located at National Highway no. 58 Delhi-Dehradun road. The mean annual rainfall is 852 mm of which 80-90% is received from June to September. The mean relative humidity during crop period varied between 94.86 to 19.6 per cent. Maximum and minimum temperature gradually decreased from sowing to growth and after increase to harvest time of wheat crop during Rabi seasons of 2020-21 and 2021-22. Soil samples were collected randomly up to a depth of 0-15 cm from 10 spots representing entire area of the experimental field before application of treatments. The collected samples were mixed homogenously and a composite sample was drawn for analyzing various physico-chemical properties. The soil was sandy loam in texture with pH 7.62 and 7.60, organic carbon 0.42 and 0.44%, Bulk density 1.49 and 1.47 g/cm^3 and available, N, P and K were (235.3 and 236.1 kg ha^{-1}), (15.23 and 15.52 kg ha^{-1}) and (186.5 and 187.3 kg ha^{-1}) kg ha^{-1} during both the years, respectively. The experiment was laid out in Factorial RBD with three replications. There were two factors i.e. first factor nutrient management with four levels *viz*., Control (No NPK), 100% NPK, 75% NPK + 25% N through FYM and 75% NPK + 25% N through press mud and second factor with six weed management practices *viz*., Control (Unweedy check), Weed free, Pyroxasulfone @127 g a.i. ha^{-1} as PE (Pre-emergence), Pendimethalin @ 1 kg a.i ha^{-1} as PE(Pre-emergence), Pinoxaden @ 40g a.i. ha^{-1} as PoE (Post-emergence) and Sulfosulfuron @ 25 g a.i. ha^{-1} PoE (Post-emergence). The gross and net plot size of experiment were 5.0 m x 4.5 m, 4.0 m x 3.15 m, respectively. Wheat variety DBW-222 was sown @ 100 kg ha^{-1} in the first forth night of November in both the years with row spacing of 22.5 cm. FYM and press mud were distributed evenly in the plots according to treatment. N, P, and K (RDF @ NPK - 150:60:60 kg ha^{-1}) were applied through urea, di-ammonium phosphate, and muriate of potash, respectively, as per treatment. Nitrogen was applied in three splits; 1/2 as basal and rest of it was top-dressed in two equal splits at CRI and tillering stages. There was no severe attack of insect and pest on the base of visual observation during crop growth period. Grain and straw yield was recorded at harvest were studied. Available nutrients in soil and nutrient contents in crop were determined as per the standard procedures at harvest and the uptake values were worked out. Statistical analysis of the data was done as per the standard analysis of variance technique for the experimental designs using OPSTAT software, and the treatment means were compared at $p<0.05$ level of probability using t-test.

Yield

Nutrient management and weed control practices of wheat had a significant impact on yield, while harvest index was found non-significant during both years.

Application of 75% NPK + 25% N through press mud observed significantly higher grain, straw and biological yield, which was statistically at par with 75% NPK + 25% N through FYM during both the years and it was observed significantly superior to the remaining treatments during both years. The positive effect of nutrients on grain, straw and biological yield might be assigned to the fact that after decomposition and mineralization, these manures supplied available plant nutrients directly to the plants and also had solubilising effect on fixed forms of nutrients in soil. The higher values of the yield attributes under combined application of inorganic and organic fertilizers resulted into significantly higher grain yield. These results are in line with Chattha *et al*. (2019) [1], Khan *et al*., (2017) [5], Choudhary *et al*. (2022) [2] and Kumar *al*. (2021) [6] and Tanwar *et al*. (2021) [12].

Weed free treatment resulted significantly highest grain, straw and biological yield during the both the years. Among the herbicides significantly higher grain and straw yield was observed under post emergence application of Sulfosulfuron @ 25 g a.i. ha^{-1}, while it was remain at par with Pendimethalin @ 1 kg a.i ha^{-1} as PE. Higher yield might be due to decreased crop weed competition. Similar results were also reported by Pandey and Kumar (2007) [8] Paswan *et al*. (2017) [9] Kaur *et al*. (2018) [4] and Sharma *et al*. (2018) [11].

Available Nutrients

Available N, P and K increased in soil with the application of different nutrient management treatments during both years. Among various treatments significantly higher value for available N, P and K in soils was recorded with 75% NPK + 25% N through press mud, while remaain at par with 75% NPK + 25% N through FYM during both the years during both the years of study. The application of nutrients have been reported not only to improve the nutrient content in the soil but also helps in bringing native nutrients into the available form thus increasing the available nutrient contents in the soil. Moreover, nutrients crates better environment for biological activity in the soil which results into more fixation of N and more solubilising effect on other fixed form of nutrients. Increase in nutrients in soil by the application of nutrients was also reported by Hassan *et al*. (2018) [3] and Chattha *et al*. (2019) [1].

Weed free treatment recorded significantly higher NP and K availability after harvest and it was remain at par with all other weed control treatments except control (Unweedy check). While there is no improvement of available nutrients compared initial soil fertility status. These results are closely related to the findings of Lakra and Husain (2020) [7] who observed that soil nutrient status was unaffected by various cultural and chemical weed control treatments.

Table 1: Effect of different weed and nutrient management on grains, straw, biological yield (q ha^{-1}) and harvest index (%) of wheat

Treatment	Yield (q ha^{-1})						Harvest index (%)	
	Grain		Straw		Biological			
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Nutrient Management								
Control (No NPK)	30.52	31.78	41.21	42.86	71.74	74.64	42.40	42.51
100% NPK	43.80	44.86	59.31	60.76	103.11	105.63	42.43	42.49
75% NPK + 25% N through FYM	45.53	44.86	61.85	62.71	107.38	109.46	42.49	42.65
75% NPK + 25% N through press mud	47.21	49.55	63.63	65.32	110.84	114.87	42.50	42.95
S.Em (±)	1.07	1.27	1.43	1.53	2.18	2.50	0.57	0.62
C.D. (P=0.05)	3.04	3.63	4.09	4.36	6.21	7.13	NS	NS
Weed Management								
Control (Unweedy check)	28.52	29.22	39.23	40.15	67.75	69.37	42.03	42.19
Weed free	50.10	52.70	66.33	68.87	116.43	121.57	42.98	43.43
Pyroxasulfone @127 g a.i. ha^{-1} as PE	41.10	42.29	56.60	57.43	97.70	99.72	42.17	42.22
Pendimethalin @ 1 kg a.i ha^{-1} as PE	44.20	45.70	59.73	61.15	103.93	106.85	42.62	42.73
Pinoxaden @ 40g a.i. ha^{-1} as PoE	40.08	41.10	54.72	55.39	94.80	96.48	42.16	42.31
Sulfosulfuron @ 25 g a.i. ha^{-1} PoE	46.58	48.40	62.40	64.50	108.98	112.90	42.78	43.04
S.Em (±)	1.31	1.56	1.75	1.87	2.66	3.06	0.69	0.75
C.D. (P=0.05)	3.73	4.45	5.00	5.35	7.61	8.74	NS	NS

Table 2: Effect of different nutrient and weed management practices on available N, P, K (kg ha^{-1}) and organic carbon (%) of soil

Treatments	Available nutrients (kg ha^{-1})					
	Nitrogen		Phosphorus		Potassium	
	2020-21	2021-22	2020-21	2021-22	2020-21	2021-22
Nutrient management						
Control (No NPK)	210.85	212.27	12.32	12.53	171.47	171.75
100% NPK	224.91	226.49	13.93	14.28	179.35	180.13
75% NPK + 25% N through FYM	233.41	236.41	15.25	15.53	186.14	189.27
75% NPK + 25% N through press mud	233.41	240.45	15.68	16.06	187.66	190.89
SE(m)±	2.91	2.97	0.20	0.21	2.51	2.58
C.D (P=0.05)	8.32	8.48	0.56	0.60	7.16	7.37
Weed management practices						
Control (Unweedy check)	206.08	208.95	12.27	12.50	170.40	172.53
Weed free	234.89	236.41	15.10	15.42	186.89	188.84
Pyroxasulfone @127 g a.i. ha^{-1} as PE	228.23	230.75	14.57	14.83	181.51	183.51
Pendimethalin @ 1 kg a.i ha^{-1} as PE	230.15	232.54	14.66	14.96	183.66	185.90
Pinoxaden @ 40 ga.i. ha^{-1} as PoE	227.04	229.89	14.43	14.83	179.78	180.47
Sulfosulfuron @ 25 g a.i. ha^{-1} PoE	232.89	234.87	14.77	15.06	184.70	186.82
S.E(m)±	3.57	3.64	0.24	0.26	3.07	3.16
C.D (P=0.05)	10.19	10.38	0.69	0.73	8.77	9.02

Conclusion

The present investigation conclusively inferred that application of 75% NPK + 25% N through press mud along with Sulfosulfuron @ 25 g a.i. ha^{-1} PoE found to be beneficial the for productivity of wheat crop and improved soil fertility status.

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