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Effects of Tillage Practices on Productivity of Wheat under the Indo-Gangetic Plains

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ABSTRACT

Field experiment was conducted for two consecutive years at the research farm of Baba Raghav Das Post Graduate College, Deoria, Uttar Pradesh, India to evaluate the effect of different tillage practices on soil health and crop productivity of wheat under the rice-wheat cropping system of Indo-Gangetic Plains of India under the irrigated ecosystem. Results revealed that treatment T_3 produced significantly higher yield attributes in terms of number of ear bearing shoots (407)as compared to T_4 (390). However, it was also recorded that the grain weight per spike and test weight were significantly lower in T_3 and T_4over rest of the practices. The similar trends were followed in case of grain yield under the T_3 (45.60) being on a par with T_4 (45.50 but it was recorded significantly superior over rest of the tillage practices. With respect to the soil physical and chemical properties, it was also noticed significantly higher under the treatment T_4 as compared to other treatment.

Key words : Productivity, Tillage, Wheat, Soil health

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the one of most important energy giving food across the globe (Meena *et al*., 2016). Rice-wheat cropping system (RWCS) occupies nearly 13.5 million hectares area in the Indo-Gangetic plains (IGP) of South Asia. Tillage has a long history dating back millennia, and aimed to give soil aeration and to control weeds. However, decline in soil organic matter and crop productivity in rice-wheat cropping system has become a major concern to the researcher.Tillage operations also stimulate N release from SOM (Kumari and Singh, 2016).

At the same time farmers are now interested to use a machinery to facilitate the timely sowing of wheat. Soil tillage system may affect the incorporation of crop residue and influence nutrient dynamics (Kumar *et al.*, 2017). In India, Rice-wheat is an important predominant cropping system in South Asia, which occupies ~13.5 m ha area including 10 m ha in India (Tripathi *et al.*, 2015). In rice-wheat system, rice yield is the final output of the interaction between different methods of rice and wheat establishment, plant population and external environment including soil. The external factors influence directly or indirectly the agronomic operations, package of practices and thereby constitute major constraints and problems in crop production. In this system, rice is taken mainly as manually transplanted crop in puddle soil condition. Rice transplanting in puddled soil is complicated and highly labour intensive. Timely availability of labour for transplanting is big problem in most of areas. Moreover, under puddle soil conditions though rice yield is higher it has its own limitations and ill effect on soil health. Besides sowing of wheat is also delayed that results in linear decline in productivity (Timsina and Conner, 2001). Tillage isagro-technique, influences soil properties, environmental and crop production. Field preparation for wheat sowing after rice crop involves large energy use and modification in tillage system, therefore has an advantage of seeding operation and hence save energy and cost of cultivation (Bohra and Kumar, 2015). Tillage and residue management practices in rice- wheat systems shows that there is a need to study long term effect of different tillage considering crop residue management. Taking consideration of all these aspects, an investigation was carried to find out the effect of different tillage practices on wheat and soil properties, where rice was taken as a preceding crop.

MATERIALS AND METHODS

Field experiments were conducted at Agronomy research farm, Baba Raghav Das Post Graduate College, Deoria (U.P.) during the *rabi*season of two consecutive years of 2010-11 and 2011-12, under rice-wheat cropping system . Soil of experimental field was clay loam in texture with pH 7.2, medium organic carbon (0.45%), phosphorus (19kgha^{-1}), potassium (165kgha^{-1}) and low in available nitrogen (215kgha^{-1}).The treatment consist of five tillage practices i.e. 6 disc harrow + planker (T_1), 1 Mould board plough + 4 Disc harrow + planker (T_2), 1 Standard disc plough + 4 disc harrow + planker (T_3), Zero-till ferti-seed drill sowing (T_4) and Strip-till-drill sowing (T_5) were included in the system for testing the performance of wheat variety PBW-343. The average of rice-residue addition into wheat fields was around 6.5 t/ha. After harvesting of rice through combine, remaining residues on field had an average height of around 31.2 cm. The incorporation of crop residue with tillage treatments were around 91% through mould board plough (T_2) and 80% through standard disc (T_3). The residue remained untouched in case of T_4 and T_5. The length of stubble after operation and

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weight of crop residue left after crop harvest is given in Table1.

Table 1: Residue management under tillage practices

Practices	Treatment				
	T_1	T_2	T_3	T_4	T_5
Depth of cut (cm)	31.4	16.6	8.6	untouched	untouched
Weight residue left (gm^2)	80.0	185.0	180.0	untouched	untouched
Length of stubble (cm)	12.7	17.1	13.7	untouched	untouched

Experiment was laid out in randomized block design in four replications. Grain yield was recorded using the net plot technique. The yield attributing parameters i.e. number of effective tillers was worked out from counting of ear marked two meter row length before harvesting and 10 spikes were randomly selected for measurement of spike length, number of spikelets from spike, grain per spike, grain weight per spike and 1000 grain weight were measured from this and its average was recorded.Pooled data of two years were analyzed by using standard statistical procedure given for randomized block design. The overall significance of treatments' differences was tested by F test compared with critical differences at 5 % of liberty level

RESULTS AND DISCUSSION

Effect of tillage practices on growth and yield attributes

The data on crop performance in terms of yield attributes like ear bearing shootswere found maximum under T_3(407), whichwere significantly higher than T_1(329). Other yield contributing characters such as spike length, grain/spike did not show any significant differences due to tillage practices. Significantly higher value of grain weight per spike was observed in T_1 than T_5, but other tillage practices retained statistically similar grain weight per spike. However test weight was maximum inT_2followed by T_3. Significantly lowest 1000 grain weight was observed in T_1.Azam *et al.* (1991) found an increase in 1000 grain weight of wheat due to incorporation of rice straw. The higher yield attributes under the respective treatments may be owing to better performance of growth and yield attributing characters through optimum utilization of resources which had direct bearing on the production of higher grain yield parameters. Poor performance under direct seeding particularly in zero till drill sowing in attributed to excessively higher competition with weeds. These results are in close conformity with the finding of Bohra and Kumar (2015) in their field investigations.

Table 2 : Effect of tillage practices on yield attributes and economics of wheat

Tillage practices	Effective tillers (no./m^2)	Spike length (cm)	Grains/ spike (no./m^2)	Grains/weight/spike (g)	1000-grain weight (g)	Grain Yield (q/ha)	Biological Yield (q/ha)	Gross Income (Rs/ha)	Net Income (Rs/ha)	Cost: Benefit Ratio
T1	329.0	9.9	42.0	1.87	40.9	42.9	95.8	32707	14817	1.84
T2	395.0	10.3	43.0	1.83	43.3	44.6	99.2	34433	15843	1.85
T3	407.0	10.2	42.5	1.70	43.1	45.6	101.2	36076	16716	1.86
T4	390.0	10.1	42.0	1.80	42.3	45.5	101.0	35510	15883	1.85
T5	365.0	10.1	43.5	1.86	42.1	42.9	95.8	32707	14717	1.84
SE±	3.4	0.3	1.5	0.07	0.8	0.8	1.5	214	210	0.01
CD (*P*=0.05)	6.8	NS	NS	0.15	1.7	1.6	3.1	428	420	0.02

Effect of tillage practices on yield and economics

The data on crop performance showed that grain yield of wheat varied with different tillage practices. T_1 retained the lowest grain yield (42.9 q/ha) while T_4 (45.5 q/ha) and T_3 (45.6q/ha) had maximum grain yield (Table 2). Mean of all the two years revealed the treatment i.e. T_3, T_4 and T_2 gave significantly higher grain yield than other tillage practices .Variation in grain yield and biological yield underthe various tillage practices can be attributed to the ability of crop to produce the dry matter and it's portioning to economically important plant part.

The maximum grain yield of wheat, found in T_3 and T_4, might be due to the higher yield attributes i.e. ear bearing shoots and higher N uptake by wheat crop (Bohra and Kumar 2015). With respect to economics, gross income, net return and C: B ratio under different tillage practices were found similar trend as grain yield. T_3 retained highest gross income (Rs. 36076), net return (Rs. 16716) and C: B (1.86), which was significantly higher than other treatments. This might be due to higher yield was associated with the respective treatments (Kumari and Singh 2016).

Effect of tillage practices on soil properties

Soil physical and chemical parameters were indicator of a healthy soil and play important role by improving their physical environment of rhizosphere for improving the input use efficiency. Reduction in bulk density from field was may be due to mechanical manipulation of soil (Table 3) (Patel *et al.*, 2012).

Table 3: Effect of tillage practices on soil physic-chemical properties after the crop harvest

Tillage practices	Bulk density (g/cc)	Organic carbon (%)	Available N (kg/ha)	Available P (kg/ha)	Available K (kg/ha)
T1	1.22	1.16	242.0	26.2	245.1
T2	1.21	1.13	243.5	31.0	253.0
T3	1.19	1.15	248.3	31.0	254.1
T4	1.35	1.21	255.8	31.5	256.4
T5	1.34	1.20	254.1	31.5	255.9
SE±	0.03	0.01	3.84	0.61	2.75
CD (*P*=0.05)	0.07	0.02	7.68	1.23	5.5

Significant higher value of bulk density was recorded with the treatments i.e. T_4 and T_5 than T_2 and T_3. Significant relationship between bulk density and added of organic matter was reported by Dao (1998). Organic carbon were recorded lowest under T_2 and T_3 and highest under T_4 and T_5. Available nitrogen in soil was found significantly higher in T_4 (255.8 kg/ha) than other treatments. In case of available P and K did not show any significant effect of tillage practices.

CONCLUSION

It may be concluded from the above study that the under rice-wheat cropping system, long term crop residue management practices with zero tillage system improved the crop productivity as well as soil health in wheat in irrigated ecosystem of Indo-Gangetic plains of India.

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