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EFFECT OF TILLAGE AND CROP ESTABLISHMENT METHODS ON CROP GROWTH, NUTRIENT UPTAKE, QUALITY AND YIELD OF WHEAT GROWN IN RICE-WHEAT CROPPING SYSTEM

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ABSTRACT

An experiment was conducted during *kharif* and *rabi* seasons year 2010-2011 at the Agriculture Research Farm, institute of Agriculture Sciences, Banaras Hindu University, Varanasi (U.P.) in strip-plot design with four tillage and crop establishment methods in rice (Direct seedling by zero till drill, direct seedling of sprouted seeds by drum seeder, manual transplanting and mechanical transplanting by self propelled transplanter) as horizontal strip and tillage and crop establishment methods in wheat (Rotavator till drilling, conventional sowing, strip till drilling and zero till drilling) as vertical strips. The maximum values of growth parameters recorded with zero till drill wheat. Zero till drill sown wheat recorded grain yield and produced protein yield significantly higher over the other crop establishment methods. It was concluded that zero till wheat planting helpful in increasing productivity of wheat in Eastern Indo-Gangetic plains.

KEY WORDS
Crop establishment methods
Nutrient uptake
Protein content
Zero till drill

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INTRODUCTION

Wheat grown area in the world is around 220.88 million ha with a production of 725.47 million tonnes (2014-15). India stands first in area and second in production next to China in the world (2014-15). The India's share in world Wheat area is about 12.40%, whereas it occupies 11.63 % share in the total world Wheat production. There is hardly any scope for expansion of area under Wheat. The main emphasis would be on increasing the productivity of wheat by adopting the improved cultivation practices. In India, rice and wheat covering 44.0 and 30.47 m ha and recorded food grain production of 104.00 and 96.85 m t, respectively during 2014-15 (DAC, 2016). The normal National productivity is about 2708 kg/ha. Among food grains, Wheat stands next to Rice, both in area and production. The share of Wheat in total food grain production is around 35.5% and share in area is about 21.8% of the total area under food grains. Rice-wheat cropping system has substantial role in world food security and provides about 8% staple grain to the world's population (Timsina and Connor, 2001). In South Asia, the area under rice-wheat cropping system is about 13.5 million hectares, which has meaningful role in food self-sufficiency (Saharawat *et al.*, 2010).

Advancing technologies gave us a new tillage technology after zero-tillage *viz*. strip tillage and rotavator tillage. Strip till drill is a nine-row tractor operated rear mounted machine, which prepares 3-inch wide soil strip for placing seed and fertilizer. This machine saves energy and time in the range of 60-70 per cent in comparison to traditional sowing, where five to seven operations are required. The strip till drill sown wheat after paddy in case of manually harvested paddy and after cleaning straw in case of combine harvested paddy. It provides an almost ideal soil seed environment for early germination, crop establishment and growth. Its use increases yield due to timely sowing and lower weed population with saving of Rs. 600 to 700 per acre through diesel and labour cost (Sidhu and Shukla, 2001). However, there is significant interaction exists between environment and technologies for achieving higher yield in crop plants (Jat et al., 2014; Singh and Khind, 2015; Dia *et al.*, 2016). Proper management of all important natural resources, particularly the soil by different manipulations techniques in rice-wheat system can lead to higher productivity of both rice and wheat. Efficient management of costly input like diesel, at present having substantial subsidy can help in reducing the cost of production, and thereby making, the produce more competitive. Moreover, in north eastern plains, especially the

eastern Uttar Pradesh, late wheat is grown in more than 50 per cent of the rice-wheat areas leading to poor productivity. On average delayed wheat sowing reduces crop yield to the tune of 35-40 kg ha^{-1} day^{-1} (Sharma *et al*., 1978). Therefore, advancing the sowing date by reducing turn-around period can help in increasing the productivity of wheat in rice-wheat system (Chauhan *et al*., 2000). Hence, a study was conducted to explore alternate tillage options in wheat for improving productivity, profitability and quality in Eastern Indo-Gangetic plains.

MATERIALS AND METHODS

An investigation was conducted on sandy clay loam soils and a pH of 7.5 at the Agriculture Research Farm, institute of Agriculture Sciences, Banaras Hindu University, Varanasi (U.P.) during *kharif* and *rabi* seasons year 2010-2011. This location has a typical semi-arid and sub-tropical climate characterized by hot dry summers and cool winters. The soils was low in available N (185.6 kg N/ha) and medium in available P (14.5 kg/ha) and rich in K (178.7 kg/ha). The experiment was conducted in strip-plot design with four tillage and crop establishment methods in rice (Direct seedling by zero till drill, direct seedling of sprouted seeds by drum seeder, manual transplanting and mechanical transplanting by self propelled transplanter) as horizontal strip and tillage and crop establishment methods in wheat (Rotavator till drilling, conventional sowing, strip till drilling and zero till drilling) as vertical strips. The total number of treatments combinations was sixteen. The treatments were replicated thrice to avoid any effect of heterogeneity and the treatments were randomly allocated as per standard procedure. Wheat variety HD 2824 (Poorva) was sown at a distance of 20.4 cm on 3rd December, 7th December, 29th November and 26th November of 2010 under Rotavator till drilling, conventional sowing, strip till drilling and zero till drilling with a seed rate of 100 kg/ha respectively. The nutrients were applied @ 120 kg N + 60 kg $P_{-2-}O_5$ + 60 kg K_2O ha^{-1}. Data on various yield attributes, grain and straw yields of rice and economic return were calculated as per the standard procedures.

RESULTS AND DISCUSSION

Growth parameters

The growth parameters *viz*., plant height, number of tillers, green leaves and plant dry matter per meter row length differed by various crop establishment methods applied in wheat. The crop establishment method applied in rice did not influence these growth parameters. The maximum values of all growth parameters were recorded with zero till drill sowing of wheat closely followed by rotavator till drill and conventional sowing than strip till drill. The better in growth parameter of crop in

Table 1: Effect of crop establishment methods on growth and yield attributes of wheat grown after rice

Crop establishment methods	Plant height (cm)	Tillers / meter row length	Green leaves / meter row length	Dry matter accumulation (g/ meter row length)	Spike (m^{-2})	Spike length (cm)	Grains spike $head^{-1}$	Average seed weight (g/m^2)	1000-grains weight (g)
Rice									
Direct dry seeding by zero-till drill	79.44	84.23	464.33	266.83	313.17	12.89	48.94	592.83	38.68
Direct seeding of sprouted seeds by drum seeder	81.05	75.73	449.67	277.92	314.42	12.78	48.08	559.95	37.04
Hand Transplanting	82.19	82.97	447.67	283.67	319.75	12.87	48.25	593.67	38.48
Mechanical Transplanting	82.12	82.37	469.92	282.33	318.58	12.93	49.28	602.55	38.38
SEm±	1.54	3.29	10.09	4.31	13.47	0.13	0.93	18.36	0.52
L.S.D. (P = 0.05)	NS	NS	NS	NS	NS	NS	NS	NS	NS
Wheat									
Rotavator till drilling	81.08	85.20	.83	288.67	319.25	13.01	49.78	605.97	38.13
Conventional sowing	80.68	80.90	460.75	271.83	317.50	12.79	47.83	588.31	38.74
Strip till drilling	75.73	68.47	391.42	252.75	271.42	12.52	46.57	465.15	36.80
Zero till drilling	87.32	90.73	499.58	297.50	357.75	13.15	50.38	701.11	38.90
SEm±	1.98	2.97	17.72	5.21	13.78	0.37	1.94	16.55	0.39
CD at 5%	6.84	10.27	61.34	18.02	47.70	NS	NS	57.28	1.33

Table 2: Effect of crop establishment methods on yield and nutrient uptake of wheat grown after rice

Crop establishment methods	Grainyield (q/ha)	Strawyield (q/ha)	Grain Protein (%)	Protein Yield(kg/ha)	Nutrient Uptake(kg/ha^{-1}) Nitrogen	Phosphors	Potassium
Rice							
Direct dry seeding by zero-till drill	31.9	53.5	9.45	302.7	73.43	14.13	80.17
Direct seeding of sprouted seeds by drum seeder	30.9	51.0	9.76	302.8	72.17	13.72	76.27
Hand Transplanting	29.7	48.9	9.53	282.9	68.59	13.25	73.13
Mechanical Transplanting	30.4	50.9	9.58	291.5	70.49	13.58	76.17
SEm±	1.34	1.59	0.08	13.0	3.18	0.55	2.39
L.S.D. (P = 0.05)	NS	NS	NS	NS	NS	NS	NS
Wheat							
Rotavator till drilling	31.2	53.8	9.61	299.6	72.83	13.54	79.47
Conventional sowing	30.4	58.8	9.59	291.8	74.17	14.11	86.22
Strip till drilling	27.3	49.9	9.33	254.1	63.65	12.49	73.69
Zero till drilling	34.1	41.8	9.80	334.3	74.03	14.54	66.36
SEm±	1.17	2.2	0.05	12.4	2.85	0.50	3.26
CD at 5%	4.05	7.6	0.19	42.8	9.86	1.74	11.28

zero till drill sown plots might be due to timely sowing of wheat in this tillage system, which might have led to early seeds emergence, better root growth and more availability of nutrient in turn bringing more plants height, more no. of tiller/ running meter, maximum green leaves/running meter and plant dry matter production (Table 1). These results are in conformity with the findings of Chhina (2000).

Yield attributes and yield

The crop establishment methods applied in rice could not influenced yield and yield attributes of wheat (Table 1). The crop establishment methods applied in wheat significantly influenced the yield attributes viz. number of spike /m^2, grain weight/m2 and 1000-grain weight, grain and straw yield (q/ ha). The better performance of all the yield attributes were found in zero till drill sown wheat and being at par with rotavator till drill and conventional sowing produced significantly higher grain yield then strip till drill. The higher yield under zero till drill and rotavator till drill is attributed to better performance of growth and yield attributing characters through optimum utilization of resources which had direct bearing on the production of grain yield. Poor performance under strip till drill sowing might attributed to poor plant stand and excessively higher competition with weeds. Bohra and Kumar 2015 has reported the similar results. Conventional sowing of wheat though remained comparable to rotavator till drill produced significantly higher straw yield than strip and zero till drill sown wheat. Rotavator till drilling and strip till drilling also proved significantly superior to zero till drilling. This could be described to the zoom straw left in the field under zero till drilling by Sharma *et al*. (2002) and Bohra *et al*. (2006).

Nutrient uptake and protein content

Conventional sowing of wheat recorded maximum uptake of nitrogen and potassium followed zero till drill and rotavator till drill sowing of wheat/conventional sowing though being comparable to zero till drill sown wheat both recorded significantly higher N uptake than strip till drill sown wheat (Table.2) similar result were obtained for P uptake. This could be ascribed to the better grain yield under zero till drilling and higher straw production under conventional sowing. However, as regards the Potassium uptake; the treatment was CT > RT > ST > ZT. CT being at par with RT resulted in significantly higher K uptake than ST and ZT. Strip till drilling also showed its distinct superiority over ZT. The poor performance of ZT could be attributed to the 20 cm. straw left in the field an the sizable amount of K in wheat is contained in straw. These results are in conformity with the findings of Tripathi and Chauhan (2000); Sharam and Acharya *et al*. (1997). Among the crop establishment methods, zero till drilling estimated higher protein content in seed and seed protein yield as compared with other crop establishment methods. This may be due to higher nitrogen content in seed and higher grain yield in zero till drilling method.

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