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Abhineet
Department of Agronomy, ANDUAT, Ayodhya, Uttar Pradesh, India

BN Singh
Department of Agronomy, ANDUAT, Ayodhya, Uttar Pradesh, India

BN Singh
Department of Agronomy, ANDUAT, Ayodhya, Uttar Pradesh, India

Sudhakar Singh
Department of Agronomy, ANDUAT, Ayodhya, Uttar Pradesh, India

Corresponding Author:
Abhineet
Department of Agronomy, ANDUAT, Ayodhya, Uttar Pradesh, India

Effect of different crop establishment methods with or without residue and fertility levels on late sown wheat after rice crop

Abhineet, BN Singh, RC Tiwari and Sudhakar Singh

Abstract
A field study was carried out at Agronomy research Farm of Acharya Narendra Deva University of Agriculture and Technology, Kumarganj, Ayodhya (U.P.) during *Rabi* season 2018-19 and 2019-20 to evaluate the effect of different crop establishment methods with or without residue and fertility levels on yield and economics of late sown wheat (*Triticum aestivum* L.) after rice crop. The Experiment consist of five Crop establishment methods (CT_B, CT_0, CT_1, ZT_0, ZT_1) and four Fertility levels (F_1, F_2, F_3, F_4) in 20 treatment combination *viz.* CT_BF_1, CT_BF_2, CT_BF_3, CT_BF_4, CT_0F_1, CT_0F_2, CT_0F_3, CT_0F_4, ZT_0F_1, ZT_0F_2, ZT_0F_3, ZT_0F_4, ZT_1F_1, ZT_1F_2, ZT_1F_3, ZT_1F_4. The result revealed that in case of Crop establishment methods maximum grain, straw and biological yield was recorded with ZT_1 (Zero tillage with residue) which is at par with CT_1 (Conventional tillage with residue). Regarding fertility levels, maximum grain, straw and biological yield was recorded with F_4 (100% RDF-IF + 10 t ha^{-1} FYM) which is at par with F_3 (100% RDF-IF + 5 t ha^{-1} FYM) and F_2 (125% RDF-IF). Among all different treatment combinations, ZT_1F_4 treatment recorded maximum grain, straw, biological yield and gave maximum value of gross return. But best net returns and benefit cost ratio was observed in ZT_1F_3 which is closely followed by ZT_1F_2.

Keywords: Crop establishment methods, fertility levels, conventional tillage, zero tillage, net return, gross return, IF-inorganic fertilizer

Introduction
Wheat (*Triticum aestivum* L.) is a major crop supporting food security in South Asia. Around 42% of the wheat in this region is grown following rice (*Oryza sativa*) covering 13.5 million hectares of land. It is grown in the world with an area of 215.45 million hectares, production 730.96 million metric tons with productivity of 3.39 metric tons per hectare. In India, it is grown in an area of 29.65 million hectares, production 99.87 million metric tons with a productivity of 3.37 metric tons per hectare (USDA, 2020) [9]. Uttar Pradesh having first rank in respect to both area (9.75 million hectares) and production (31.88 million tons) with a productivity of 3269 kg/hectare in 2018 (Anonymous, 2018) [2]. Intensive agriculture and excessive use of external inputs lead to degradation of soil, water and genetic resources. Wide-spread soil erosion, nutrient mining, depleting water table, and eroding biodiversity are the global concerns threatening the food security and livelihood opportunities of farmers, especially the poor and under privileged. To cite an example, soil degradation due to erosion and compaction processes is the most serious environmental problem caused by conventional agriculture. This suggests that agricultural systems need a mixture of new technologies which focus more attention on issues of sustainability and conservation agriculture (CA) in intensive production systems. Conservation agriculture is a concept for resource-saving agricultural crop production that strives to achieve acceptable profit together with high and sustained production levels while concurrently conserving the environment (FAO 2007). In the present study an effort is made to compare conservation agriculture and conventional agriculture in different fertility levels to see which one gives higher yields and higher returns.

Materials and Methods
A field experiment was conducted at Agronomy Research farm of A.N.D. University of Agriculture and Technology Kumarganj Ayodhya, UP to evaluate the effect of effect of different crop establishment methods with or without residue and fertility levels on yield and economics of late sown wheat (*Triticum aestivum* L.) after rice crop. The Experiment consist of five Crop establishment methods (CT_B, CT_0, CT_1, ZT_0, ZT_1) and four Fertility levels (F_1, F_2,

F_3, F_4) in 20 treatment combination *viz*. CT_BF_1, CT_BF_2, CT_BF_3, CT_BF_4, CT_0F_1, CT_0F_2, CT_0F_3, CT_0F_4, ZT_0F_1, ZT_0F_2, ZT_0F_3, ZT_0F_4, ZT_1F_1, ZT_1F_2, ZT_1F_3, ZT_1F_4. The total biomass of each plot was threshed and cleaned, the seeds obtained were weighed and converted into q ha^{-1}**,** straw yield was also recorded from each plot by subtraction the grain yield from the total biological yield and expressed in q ha^{-1}. The economics of various treatments was calculated by converting the total yield (grain + straw) into money value. The cost of cultivation was computed on the prevailing market of expenditure. Net income was calculated by the following formulae: Net income (Rs. ha^{-1}) = Gross income (Rs. ha^{-1}) - cost of cultivation (Rs. ha^{-1}). Benefit cost ratio was calculated by dividing net return to the cost of cultivation of the individual treatment combination.

$$\text{BCR} = \frac{\text{Net return (Rs.)}}{\text{Cost of cultivation (Rs.)}}$$

The data recorded on various parameters were subjected to statistical analysis following analysis of variance technique and were tested at 5% level of significance to interpret the significant differences.

Result and Discussion

Grain and straw yield and harvest index

The data with respect to grain yield, straw yield and harvest index as influenced by various treatments have been presented in (Table-1). The maximum grain yield, straw yield and biological yield in different crop establishment methods was recorded with ZT_1 (Zero tillage with residue) which was at par with CT_1 (Conventional tillage with residue) and in case of fertility levels maximum grain yield, straw yield and biological yield was recorded with F_4 (100% RDF-IF + 10 t ha^{-1} FYM) which is at par with F_3 (100% RDF-IF + 5 t ha^{-1} FYM) and F_2 (125% RDF-IF). The minimum grain yield, straw yield and biological yield was recorded with the CT_B (Conventional tillage without residue and sowing by broadcasting) and F_1 (100% RDF-IF). Harvest index do not differ significantly due to different treatments. Grain yield, straw yield and biological yield are the resultant of coordinated inter-play of growth and yield contributing character. The grain yield, straw yield and biological yield differs significantly with different crop establishment methods because of increase in source capacity like plant height, number of tillers (m-2), dry matter accumulation and leaf area index as well as sink capacity like number of effective tillers, number of grains spike-1, Length of spike. The water use efficiency in residue retained soil is good due to which there will be increase in yields These results are in agreement with the findings of earlier research workers, Brar and Walia (2007) [3], Khalid *et al.* (2013) [8], Hossain *et al.* (2020) [6]. In case of fertility levels, grain, straw and biological yields increased with increasing level of fertilizer and manures because balanced nutrition particularly nitrogen which play a vital role in cell division and cell elongation as well as increase in sink size which provide a feedback to sources for production of higher amount of photosynthates. The beneficial effect of organic manures on grain, straw, biological yield and yield attributing characters might be due to the fact that after proper 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. Similar trends were observed by Duhan (2013) [5], Zahoor (2014) [10], Ali *et al.* (2015) [1].

Economics

Data (Table-2) revealed that maximum cost of cultivation (Rs 35723.00 ha^{-1} and Rs 37773.00 ha^{-1}) was computed in CT_B, CT_0 and CT_1 (Conventional tillage treatments) in combination with F_4 (100% RDF-IF + 10 t ha^{-1} FYM during both the years of investigation, while the lowest cost of cultivation of system (Rs 28373.00 ha-1 and Rs 29673.00 ha-1) was computed in ZT_0 and ZT_1 (Zero tillage treatments) in combination with F_1 (100% RDF-IF) during both the years. The maximum gross return (Rs. 76624.00 ha^{-1} and Rs. 82568.00 ha^{-1}) was recorded under the treatment combination ZT_1F_4 (Zero tillage with residue and 100% RDF-IF + 10 t ha^{-1} FYM) followed by CT_1F_4 (Conventional tillage with residue and 100% RDF-IF + 10 t ha^{-1} FYM) during both the years of investigation. The highest net income of (Rs. 44819 ha^{-1} and Rs. 49319 ha^{-1}) was recorded in treatment combination ZT_1F_3 (Zero tillage with residue and 100% RDF-IF + 5 t ha^{-1} FYM) followed by ZT_1F_4 (Zero tillage with residue and 100% RDF-IF + 10 t ha^{-1} FYM) during both years of investigation. Similarly, maximum benefit cost ratio of 1.49 and 1.56 was obtained with treatment combination ZT_1F_3 (Zero tillage with residue and 100% RDF-IF + 5 t ha^{-1} FYM) followed by 1.42 and 1.52 which was obtained with treatment combination ZT_1F_2 (Zero tillage with residue and 125% RDF-IF) during both years of investigation. The treatment giving highest yield is not giving highest net return because of high cost of cultivation incurred in the highest yield giving treatment. These results are in agreement with findings of Chhokar *et al.* (2018) [4] and Kaur *et al.* (2018) [7].

Table 1: Effect of different crop establishment methods with or without residue and fertility levels on grain yield, straw yield, biological yield and harvest index of late sown wheat crop (CTB) Conventional tillage (Broadcasting) (No residue), (CT0) Conventional tillage (Seed cum fertilizer drill) (No residue), (CT1) Conventional tillage (Seed cum fertilizer drill) (Rice residue incorporated), (ZT0) Zero tillage (Zero till drill) (Residue removed), (ZT1)

Treatments	Yield contributing characters							
	Grain yield (q ha^{-1})		Straw yield (q ha^{-1})		Biological yield (q ha^{-1})		Harvest Index	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
(A) Crop Establishment Methods								
CT_B	32.58	35.08	45.35	47.52	77.94	82.60	41.84	42.50
CT_0	34.66	36.82	46.43	48.31	81.09	85.13	42.78	43.30
CT_1	37.02	39.19	50.30	52.28	87.32	91.47	42.36	42.81
ZT_0	34.78	37.11	47.50	49.25	82.28	86.36	42.66	43.32
ZT_1	37.07	39.35	51.20	53.05	88.27	92.40	41.94	42.55
S.Em±	0.14	0.16	1.03	1.06	1.04	1.11	0.67	0.64
CD (P=0.05)	0.45	0.53	3.34	3.47	3.40	3.62	NS	NS
(B) Fertility Levels								

F_1	31.54	33.99	44.51	46.57	76.05	80.55	41.87	42.53
F_2	36.35	38.55	48.66	50.40	85.01	88.95	42.76	43.34
F_3	36.40	38.65	49.10	51.03	85.50	89.68	42.59	43.12
F_4	36.59	38.86	50.37	52.33	86.96	91.19	42.05	42.59
S.Em±	0.10	0.11	0.97	0.95	1.01	0.98	0.61	0.57
CD (P=0.05)	0.30	0.33	2.81	2.74	2.91	2.83	NS	NS

Zero tillage (Zero till drill) (Residue retained), (F1) 100% RDF-IF (120:60:40), (F2) 125% RDF-IF, (F3) 100% RDF-IF + 5 t/ha FYM, (F4) 100% RDF-IF + 10 t/ha FYM

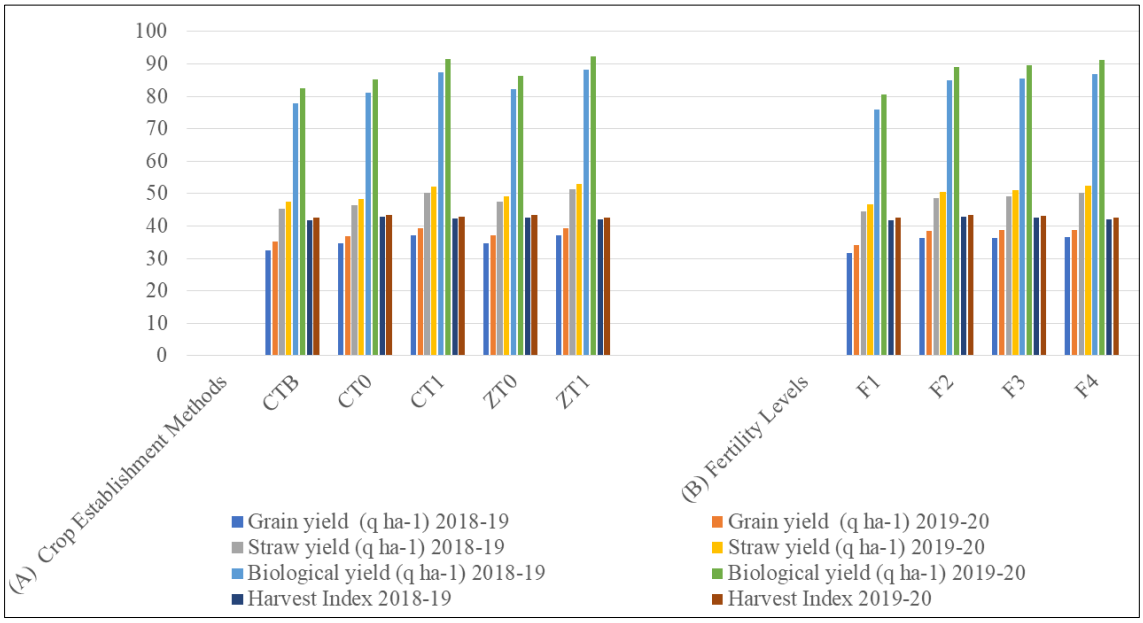

Fig 1: Effect of different crop establishment methods with or without residue and fertility levels on grain yield, straw yield, biological yield and harvest index of late sown wheat crop

Table 2: Economics of various treatment combinations

Treatment combinations	Cost of cultivation (Rs. ha^{-1})		Gross return (Rs. ha^{-1})		Net return (Rs. ha^{-1})		B:C Ratio (Rs. Re^{-1} invested)	
	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20	2018-19	2019-20
CT_B F_1	32223	34073	59106	66274	26883.00	32201.00	0.83	0.95
CT_B F_2	33635	35485	64089	70365	30454.00	34880.00	0.91	0.98
CT_B F_3	33973	35923	64971	71271	30998.00	35348.00	0.91	0.98
CT_B F_4	35723	37773	63640	69906	27917.00	32133.00	0.78	0.85
CT_0F_1	32223	34073	60567	66753	28344.00	32680.00	0.88	0.96
CT_0F_2	33635	35485	73430	78631	39795.00	43146.00	1.18	1.22
CT_0F_3	33973	35923	66771	73116	32798.00	37193.00	0.97	1.04
CT_0F_4	35723	37773	67018	73370	31295.00	35597.00	0.88	0.94
CT_1F_1	32223	34073	62013	67117	29790.00	33044.00	0.92	0.97
CT_1F_2	33635	35485	74575	81124	40940.00	45639.00	1.22	1.29
CT_1F_3	33973	35923	73612	80017	39639.00	44094.00	1.17	1.23
CT_1F_4	35723	37773	75834	82415	40111.00	44642.00	1.12	1.18
ZT_0F_1	28373	29673	60116	66288	31743.00	36615.00	1.12	1.23
ZT_0F_2	29785	31085	67017	73369	37232.00	42284.00	1.25	1.36
ZT_0F_3	30123	31523	71269	77731	41146.00	46208.00	1.37	1.47
ZT_0F_4	31873	33373	70360	76798	38487.00	43425.00	1.21	1.30
ZT_1F_1	28373	29673	62878	70044	34505.00	40371.00	1.22	1.36
ZT_1F_2	29785	31085	72000	78479	42215.00	47394.00	1.42	1.52
ZT_1F_3	30123	31523	74942	80842	44819.00	49319.00	1.49	1.56
ZT_1F_4	31873	33373	76624	82568	44751.00	49195.00	1.40	1.47

Conclusion

On the basis of above discussion, it may be concluded that treatment ZT_1 (Zero tillage with residue) and F_4 (100% RDF-IF + 10 t ha^{-1}) gives higher grain, straw and biological yield. While, in case of net return ZT_1 (Zero tillage with residue) and F_3 (100% RDF-IF + 5 t ha^{-1}) gives higher net return because of low cost of cultivation. So, treatment combination ZT_1F_3 (Zero tillage with residue and 100% RDF-IF + 5 t ha^{-1}) will be suitable for farmers for cultivation of late sown wheat.

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