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Seed Yield and Economic Profitability Affected by Tillage and Genotypes in Wheat (Triticum Aestivum L.) of Eastern Indo-Gangetic Plains of India

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Abstracts—*Aggravated climate change and natural resource bases depletion are going to become much more of a problem, especially for wheat grown under eastern Indo-Gangetic Plan of South Asia is one of the regions that will be most severely affected by climate change variability. Besides, water scarcity, energy and labour scarcity, increasing cost of production, reducing farm profitability are major constraints for sustainable crop production. Consideration of above facts in views we plan an experiments on wheat for seed production. A field experiment was carried out during the winter (rabi) season of 2013-14 at Directorate of Seed Research, Kushmaur, Mau, Uttar Pradesh to evaluate the effect of conservation tillage and genotypes on growth, seed yield and economics of wheat (Triticum aestivum L.). The eighteen treatments were laid out in a split-plot design, keeping combinations the 3 tillage: Zero tillage (ZT), Conventional tillage (CT) and Raised beds (RB) in main-plots and 6 genotypes (KRL 213, HD 2733, PBW 550, HD 2967, KRL 210 and DBW 39) in sub-plots with 3 replications. There was no strong differences were observed between treatments viz., ZT and CT in terms of seed yield. However, the ZT treatment has showed some tendency to produce higher yield as compared to CT but both the treatments were significantly produce higher seed yield and economic returns over RB system. The magnitude of seed yield increased under ZT over CT and RB were 3.1 and 26.8%, respectively. The net returns are also increased under ZT over CT and RB were 10 151 and 33 383 □ ha^{-1}, respectively.*

1. INTRODUCTION

Wheat "king of cereals" are major food grain of India, during 2013-14 wheat was produced about 95.90 million tonnes from an area of 31.20 million hectare and contributed about 13.5% to the global wheat production [1]. The scenario of rising food demand and production challenges needs for a second Green Revolution to create a much more sustainable and highly productive future. Seed is a vehicle to deliver improved technology and most critical input for sustainable agriculture in a cost effective way. The response of all other inputs depends on quality of seeds to a large extent. It is estimated that the direct contribution of quality seed alone to the total production is about 15–20% depending upon the crop and it can be further raised up to 45% with efficient management of other inputs [9]. Water scarcity, energy and labour scarcity, increasing cost of production, reducing farm profitability and aberrant weather events are major constraints faced by the farmers under conventional rice-wheat system of Indo-Gangetic Plans in Eastern India [6]. The problem of soil degradation is currently a major issue and traditional deep inversion ploughing has been shown to promote the mineralization of soil organic matter (SOM) and thus its loss over time [8 and 3]. Intensive tillage also has negative impacts on soil physical and biological activity [5 and 2]. To mitigate these negative effects, reduced tillage practices (e.g. zero-tillage, reduced tillage, strip tillage, direct seeding) have been adopted and tested in different location in India [6]. Resource conservation technologies (RCTs) likes zero tillage, bed planting and laser land levelling saved substantial quantity of irrigation water, reducing the cost of cultivation in terms of land preparation, timely sowing, decreased seed rate, improved water and nutrient-use efficiency, and left indirect effect on mitigating the adverse effect of climate change. Zero tillage saved 15-20% irrigation water, along with saving about 50-60 litres of diesel per hectares. The Conservation agriculture (CA) is based on three main principles: (1) no or reduced tillage (2) permanent soil cover or residue retention and (3) diversification in crop rotation. Conservation agriculture has been a way to reduce production costs, increase soil organic carbon (SOC) and reduce soil degradation. To assess the advantages and limitation of CA, this paper described the experiences with conservation agriculture from the eastern IGP of India. It focused on agronomic performances and economical viability of different tillage system under seed production systems. However, the CA research is based on no or reduced tillage, permanent soil surface cover and the incorporation of cover crops in the rotations. In real situation at farmers field, most farmers facing technical or socio-economic constraints to apply three principle of CA, and usually applying only 1-2 main principles of conservation agriculture. Therefore, a need to investigation on more fully such partial implementation of conservation agriculture principles on its actual efficiency and assessing the most efficient approaches needed to adapt conservation agriculture principles to local conditions and farming community for seed production of wheat in rice-wheat cropping system (RWCS).

2. METHODOLOGY

The field trial was carried out at Directorate of Seed Research, Mau, and U.P. during the *Rabi* season of 2013-14. The soil of the experimental field was clay loam in texture, alkaline in soil reaction, low in organic carbon (0.30 %) and available N (245 kg/ha), medium in available P (12.50 kg/ha) and available K (165.0 kg/ha). The 18 treatment combinations comprising of 3 tillage systems viz., Zero tillage (ZT), Conventional tillage (CT) and Raised Beds (RB) in main plots while 6 wheat genotypes viz., KRL 213, HD 2733, PBW 550, HD 2967, KRL 210 and DBW 39 were arranged in sub-plots in split plot design with three replications. The wheat was sown under ZT after applied Glyphosate @ 0.5 kg a.i. ha^{-1} before sowing at proper moisture levels, while CT/RB was sown as farmers' practises. CT wheat was sown with a tractor drawn seed drill using a seed rate of 100 kg/ha and a spacing of 20 cm and under RB 75 kg seed rate, 2 rows of wheat (30 cm apart), while under ZT plots, the crop was sown without any preparatory tillage using zero-till seed-cum-fertiliser planter and a seed rate of 100 kg/ha. The recommended dose of N: P: K, 120:60:40 kg/ha was applied through urea, diammonium phosphate and MOP, respectively. Full dose of P and K along with half of N were applied as a basal and remaining N was applied in 2 splits at crown root initiation (CRI) and ear initiation (EI) stages of the crop. The first irrigation was given 20-25 days after sowing and thereafter the plots were irrigated every 15-20 days until the end of the season for a total of four irrigations were given to crops. The data on crop management inputs i.e. number of tillage, irrigation, herbicide application, labour use etc, for each treatment were recorded and seed yield was determined by net area basis after boarder rows removed. The cost of cultivation and net return were calculated by taking into account the prevailing cost of inputs, seed price (minimum support price of grain + 20% extra) and local market price of straw. The analysis of variance (ANOVA) for split plot design was performed using the online software [4]. The treatment means were compared using a LSD test at $P < 0.05$ probability level.

3. RESULTS AND DISCUSSION

In present research findings revealed that tillage and genotypes had significant effect on growth, yield attributes and seed yield of wheat (Table 1). The present finding of results showed that, wheat yield (biological, seed and straw) were highest in ZT followed by CT and RB. The magnitude to increased seed yield in ZT over CT and RB were 3.1 and 26.8%, respectively. Similar trends also recorded in straw and biological yield (Table 1). ZT treatment recorded significantly higher growth and yield attributes (Table 1) as compared to CT and RB because under ZT condition more favourable micro climate for plant growth including better germination and elongated rooting of wheat under ZT thus higher seed yield **[9].** The conservation tillage increases soil porosity, better soil aeration and increases root growth resulted increased soil organic matter strengthens soil structure and gradation, and this, facilitates root growth and development by improving soil aeration support better plant growth **[7].** Amongst the genotypes HD 2967 gave highest seed yield followed by DBW 39, KRL 213, HD 2733, PBW 550 and KRL 210, respectively. The interaction effect on tillage X genotypes were found positive on seed yield of wheat and it was observed that genotypes HD 2967 produced significantly higher yield at all the tillage systems. However, under CT, KRL 213 performed marginally better as compared to other genotypes (Table 2).

Table 1: Effect of different tillage practices and genotypes on growth and yield (qt/ha) of wheat

Treatments	Plant height (cm)	DMA (g m-1 row length)	Tillers (m-2)	Seed yield	Straw yield	Biological yield
Tillage methods						
ZT	89.4	97.7	369.2	48.1	55.2	103.3
CT	91.6	86.0	345.9	46.6	55.6	102.2
RB	93.5	79.1	312.2	35.2	43.9	79.1
SEm±	0.76	0.48	8.49	0.86	1.30	1.29
LSD P=0.05	3.0	1.9	34.2	3.5	5.2	7.0
Genotypes						
KRL 213	89.3	85.0	347.8	44.6	54.2	98.8
HD 2733	91.0	86.9	325.4	42.2	49.9	92.1
PBW 550	92.1	87.7	330.2	42.6	50.3	92.9
HD 2967	98.7	93.1	381.7	48.2	55.4	103.5
KRL 210	85.0	81.9	329.2	36.6	48.0	84.6
DBW 39	92.8	90.8	340.2	45.8	51.5	97.2
SEm±	0.87	1.60	8.03	0.90	1.44	1.44
LSD P=0.05	2.5	4.6	23.2	2.6	4.2	4.2

Table 2: Interaction effect of tillage X genotypes on seed yield (qt/ha) of wheat

Treatments	KRL 213	HD 2733	PBW 550	HD 2967	KRL 210	DBW 39
ZT	47.8	52.2	47.5	55.3	35.3	50.3
CT	49.8	44.7	45.9	49.5	41.0	48.9
RB	36.0	29.8	34.6	39.7	33.4	38.0
			SEm±		LSD (P=0.05)	
Genotypes at different/same levels of tillage			2.17		4.9	
Tillages at different/same levels of genotypes			1.66		5.3	

The net returns and benefit: cost ratio was also affected significantly by tillage and genotypes. The maximum cost of cultivation was recorded under CT followed by RB and lowest in ZT, while net returns and B: C ratio was highest under ZT followed by CT and least under RB (Table 3). The saving in total cost of cultivation due to ZT was ` 7,449 and 4,402/ha as compared to CT and FIRB, respectively. The ZT gave an additional net returns was ` 10,151 and 33,383/ha as compared to CT and RB, respectively (Table 3). The wheat genotype HD 2967 recorded highest gross returns, net returns and B: C ratio as compared to other genotypes. This was due to genotypes HD 2967 performs better under this agro-ecological condition and produced highest seed and straw yield resulted higher economic returns.

Table 3: Effect of different tillage practices and genotypes cost of cultivation and economic returns(` ha^{-1}) of wheat.

Treatments	Cost of cultivation (` ha-1)	Gross return* (` ha-1)	Net return* (` ha-1)	BCR**
Tillage methods				
ZT	23 811	105 986	82 175	3.45
CT	31 260	103 284	72 024	2.30
RB	28 213	77 004	48 792	1.73
Genotypes				
KRL 213	27 761	95 780	68 018	2.51
HD 2733	27 761	94 718	66 957	2.47
PBW 550	27 761	91 680	63 919	2.36
HD 2967	27 761	101 382	73 620	2.71
KRL 210	27 761	91 820	64 059	2.37
DBW 39	27 761	97 168	69 407	2.55

* Gross and net return based on MSP+20% for seed and prevailing market price of straw (` qt^{-1}), ** Benefit cost ratio based on net return basis

4. CONCLUSION

The zero tillage system is pathway for improving wheat productivity, income and food security of Eastern IGP to conventional system. However, further research on management practices in holistic manner for location/site specific conservation agriculture will be essential for RWCS.

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