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Effect of Double No-till and Permanent Raised Beds on Productivity and Profitability of Maize (*Zea Mays* L.) – wheat (*Triticum Aestivum* (L.) Emend. Flori & Paol) Cropping System under Indo-gangetic Plains of India

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A field experiment was conducted at Indian Agricultural Research Institute, New Delhi on sandy loam soil during 2010 to 2012 to study the effect of tillage and crop establishment techniques, and residue management on maize (Zea mays L.) – wheat (Triticum aestivum (L.) emend. Flori & Paol) cropping system. Results indicated that zero till – raised bed with crop residue retention (ZT-B+R) and conventional till – raised bed with crop residue incorporation (CT–B+R) were found comparable with respect to yield and yield attributes both in maize and wheat. CT–B+R recorded 25.0 and 8.33 % higher grain yield of maize and wheat, respectively compared to conventional till – flat bed (CT–F). Likewise, ZT–B+R gave 25.0 and 28.6 % higher grain yield of maize and wheat, respectively over CT– F. Further, ZT–B+R gave 3.5 % higher system productivity compared to CT–B+R. ZT–B+R gave the highest net returns of maize (39.2 x 10^3 ₹/ha), wheat (50.5 x 10^3 ₹ /ha) and the cropping system (89.7 x 10^3 ₹/ha) followed by CT–B+R and zero till – flat bed (ZT–F).

Keywords: Crop residue management, Flat bed, Maize – wheat system.

1. Introduction

Maize – wheat is the 5th dominant cropping system of India covering 1.8 mha with 2.3% contribution in food basket (Jat et al., 2011). Recently, the growth rate of area

and production of maize has increased by 2.2 and 8.9%, respectively, mainly due to adoption of single cross hybrids and various industrial uses. Further, it is projected that by 2020, the demand for maize in developing countries will surpass the demand for wheat and rice (GOI, 2012-13). Besides this, in Indo-Gangetic Plains (IGP) of India, continuous cultivation of rice – wheat system over the years has resulted in drastic decline of groundwater, deterioration of soil health and yield stagnation. These factors forced to pursue diversified crops and cropping systems, which are not only environmental friendly, but also efficient in conserving natural resource pool (Aulakh and Grant, 2008). Thus, maize – wheat cropping system can be a possible alternative of rice – wheat under IGP tracts of India mainly due to lower water requirement, higher productivity of wheat crop by its timely sowing and better soil health as compared to rice – based cropping system. Generally, farmers intensively ploughed their field to get good seed bed for sowing purpose. This resulted into decline in soil organic matter, deterioration in biological and physical health of soil over the years. In this perspective, conservation agriculture (CA) has drawn considerable attention of researchers as it has potential to improve resource use efficiency, productivity (Nyborg *et al*., 1995) and soil health, besides many environmental benefits (Limon-Ortega *et al*., 2000). Globally, CA occupies 124.79 mha, but in India, area under zero tillage is approximately 2.2 mha and mostly confined to rice-wheat only (FAO, 2013). Minimum mechanical soil disturbance, organic mulch cover and crop diversification constitute the major practices under CA. System productivity and profitability under CA as related to maize – wheat system in sandy loam soil of IGP has not been studied in detail. Therefore, an attempt was made to find out the effect of tillage and crop establishment, and residue management in terms of productivity and profitability under maize – wheat system.

2. Results and Discussion

2.1 Component crop yield and system productivity

Tillage, crop establishment techniques and residue management significantly influenced yield, maize equivalent yield (MEY) and productivity of the maize – wheat cropping system (Table 1). On an average, crop residue retention and crop establishment techniques in zero tillage gave 25.0 and 21.4 % higher grain and stover yield of maize, respectively over zero tillage. Similarly, conventional till – raised bed with crop residue incorporation (CT–B+R) recorded 25.0 and 3.4 % higher grain and stover yield of maize, respectively compared to conventional till–flat bed (CT-F). The zero till – rasied bed with crop residue retention (ZT–B+R) gave statistically highest grain and stover yield of maize over zero till – flat bed (ZT–F) and CT–F, but remained comparable to CT–B+R. Further, CT–B+R was found at par with ZT–F and CT–F in terms of grain and stover yield of maize. In case of wheat, ZT–B+R recorded 28.6 and 22.0 % higher values of grain and straw yield, respectively over ZT–F (Table 1). Likewise, CT–B+R gave 8.33 and 16.4 % higher grain and straw yield of wheat, respectively than CT–F. At par grain yield and straw yield of wheat was obtained with

CT–B+R and ZT–B+R, which remained significantly higher over ZT–F. ZT–B+R and CT–B+R were found comparable to each other in terms of MEY and system productivity, but remained statistically significantly higher over ZT–F. Further, ZT–B+R gave 4.5 and 3.5 % higher MEY and system productivity, respectively compared to CT–B+R. Yield enhancement in zero tillage with residue retention may be linked to subsequent lesser oxidation of organic C over the years. Restriction of tillage under zero tillage improves the structure of soil, especially micro-aggregates, which is active site of holding the labile C for longer periods (Jha et al., 2012). This led to higher labile C formation in soil, which improves acquisition of nutrients to the plant and finally reflected in higher yield (Girma et al., 2012).

2.2 Economics

Net returns and benefit: cost (B:C) ratio of maize, wheat and the system was significantly influenced by tillage and crop establishment techniques and residue management (Table 2). Zero till – rasied bed with crop residue retention (ZT–B+R) gave highest net returns of maize, wheat and system followed by conventional till–raised bed with crop residue incorporation (CT–B+R) and zero till – flat bed (ZT–F). The lowest net returns and B:C ratio were obtained with conventional till-flat bed (CT–F). Furthermore, ZT–B+R increased 27.6 and 27.4 % system net returns and B:C ratio, respectively over CT–F.

Table 1: System productivity and net returns of maize and wheat as influenced by tillage and crop establishment, and residue management practices (mean value of data over two years)

Treatment	Maize yield (t/ha)	Wheat yield (t/ha)	MEY of wheat (t/ha)	MEY of cropping system (t/ha)	Maize	Wheat	Maize-wheat
					Net returns (x 103₹ /ha)	Net return (x103₹ /ha)	Net returns (x103₹ /ha)
CT–F	4.4	4.8	5.69	10.10	27.8	42.6	70.4
CT–B+R	5.4	5.2	6.19	11.59	35.1	46.8	81.9
ZT–F	4.4	4.2	5.02	9.40	29.2	37.7	66.9
ZT–B+R	5.5	5.4	6.47	11.98	39.2	50.6	89.8
SEm+	0.3	0.2	0.22	0.47			
CD (P=0.05)	1.0	0.6	0.76	1.62			

3. Conclusion

On the basis of study, it may be concluded that zero tillage flat bed without crop residue retention in light textured alluvial soil was noticed the poorest method of tillage and crop establishment. Conventional tillage resulted in intermediate yield.

Crop residue retention or incorporation under zero tillage and conventional tillage resulted into higher yield. Overall, zero tillage with crop residue retention found to be a promising technology in maize–wheat cropping system with respect to productivity and profitability.

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