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INFLUENCE OF TILLAGE PRACTICES ON YIELD COMPONENTS AND ECONOMIC ANALYSIS OF MAIZE

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ABSTRACT

An investigation under field condition was carried out to explore the effect of different tillage practices on yield components and economic analysis of maize crop at experimental site of Sindh Agriculture University Tandojam during two growing seasons (2009 and 2010). The tillage treatments include: T_1 (conventional tillage), T_2 (reduced tillage) and T_3 (no tillage). Maximum plant height, cob weight, 1000-grain weight and yield were found under T_1 treatment, followed by T_2 and T_3 treatments during both growing seasons (2009 and 2010). Similarly, the maximum net benefit was also achieved under conventional tillage system, followed by reduced and no tillage treatments during 2009 and 2010; while the maximum marginal rate of return was observed under reduced tillage, followed by conventional tillage system during 2009 and 2010. Therefore, conventional tillage system is recommended to achieve higher maize yield and net benefits.

Keywords: conventional tillage, economic analysis, maize, reduced tillage, yield components

INTRODUCTION

Tillage practices are essential to grow crops as well as improve physical soil environment (Aziz *et al.*, 2009). Appropriate tillage practices reduce and degradation processes and maintain crop productivity as well as soil ecosystem (Lal, 1985; Abbas *et al.,* 2017). On the other hand inappropriate tillage practices cause different soil physical and chemical disorders, such as erosion of soil in rainfed areas, soil carbon depletion and loss of other nutrients, which result in everlasting soil fertility, degradation as well as its productivity (Ramos *et al.*, 2011). Conventional tillage practices are commonly adopted in developing countries, which involve the inversion of soil to the depths of 20-35 cm by mouldboard plough or disc plough (Peigne´ *et al.*, 2007). These tillage practices result in loss of soil fetility, increase in runoff, which ultimately result in the

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shortage of water and nutrients and degrade the soil with low carbon content and a fragile soil physical as well as chemical structure. Due to changes in soil physical and chemical environment, the fertilizer and water use efficiency become low and ultimatly it causes low crop productivity (Zahra *et al.,* 2016). Additionally, the conservative tillage systems influence different soil physical features, especially when thease practices are adopted for longer period of time (Mielke and Wilhelm, 1998). Recently conservation agriculture crop management technologies especially reduced or minimum-tillage are being implemented by progressive growers in intensively cultivated maize production system (Kumara *et al*., 2013). Different tillage practices, such as conventional as well as deep tillage practices provide best chance for decreasing land degradation processes (Parr *et al*., 1990). Moreover, conventional tillage system has good soil aggregate capacities which reduces the soil loss by improving protective crop residue on the surface soil and enhance the soil water conservation by reducing the evaporation losses (Carter, 1991). In this study we explored the economics of different tillage practices for maize production.

MATERIALS AND METHODS

Experimental site

These field investigations were carried out at the research area of Sindh Agriculture University Tandojam during 2009 and 2010. The site is located at 25.42° N latitude and 68.53 °E longitudes at an elevation of about 12 m above the sea level.

Soil sampling and analysis

Soil samples were collected for the determination of some physico-chemical properties. Samples were taken from the depths of 0-21 and 22-42 cm before and after tillage operations (Table 1). Hydrometer method was used for the determination of soil texture (Bouyoucos, 1927). Soil organic matter was measured by Walkley and Black (1934) method, EC (1:5, soil:water) was determined with Systronic Conductivity Meter, soil pH (1:5 soil:water) was measured by digital pH meter, soil phosphorus was determined by Olsen method (Olsen *et al*., 1954) and the soil available potassium was determined by flame photometer (Abbasi and Tahir, 2012).

Table 1. Physical chemical properties of experimental soil

Textural class	**ECe (dS m^{-1})**	**pH**	**Organic matter (%)**	**Total nitrogen (%)**	**Available P (mg kg^{-1})**	**Extractable K (mg kg^{-1})**
Clay loam	1.65	7.9	0.69	0.56	5.58	170

Tillage operations and cultural practices

An investigation was conducted to explore the impact of different tillage treatments on maize yield and its components. Three tillage treatments were arranged under randomized complete block design. Each treatment was repeated thrice. The total nine experimental units were made with size of 20 m × 30 m. The plots under T_1 treatment were plowed to a depth of 25 cm using moldboard plow. In T_2 treatment, plots were tilled to a depth of 15 cm using disc harrow twice. Under T_3 treatment, direct seeding was done during both study years. Weeds were eradicated manually. Maize seed was sown at the end of July during 2009 and 2010. NPK fertilizers were applied at the recommended rate (250, 125 and 125 kg ha^{-1}, respectively). The 1/3rd of N dose was given at the time of sowing, while the remaining dose of N was applied in two equal splits. The phosphorus, in the form of Triple Super Phosphate (TSP), and potassium in the form of Sulphate of Potash (SOP) were applied as a single dose at the time of sowing. The maize cultivar locally known as Akbar was sown at recommended planting distance as well as seed rate of 20 kg $acre^{-1}$. This allowed 40 rows in each plot under each replication. Thinning of extra plants was done after two weeks of sowing to maintain plant population. All other plant measurement practices were kept uniform in each plot. Harvesting was done manually during the first week of November 2009 and 2010.

Yield and yield components

Ten maize plants from each plot were randomly selected to determine the yield components of maize crop. The plant height was measured with the help of measuring tape. Digital weighing balance (0.001g) was used to measure the weight of cobs and grains. Crop was harvested and sun dried for 20 days. After drying, overall biomass yield of each plot was obtained and then converted to dry matter yield. Total grain weight of each plot was recorded and grain yield was calculated on the tons per hectare basis.

Economic analyses

Economic analyses were performed, following the procedures given by Byerlee (1988) formulae:

$$BCR = \frac{\text{Gross income}}{\text{Total cost}}$$

$$\text{Marginal rate of return (\%)} = \frac{\text{Change in net benefit}}{\text{Change in cost}} \times 100$$

The cost of inputs (i.e. seeds and fertilizers) was same under all treatments. Therefore, the cost of tillage treatments was considered in this study.

Statistical analysis

The effects of treatments on the yield components were evaluated by ANOVA using the SAS statistical software (SAS Institute, 2004). The means were compared using least significant difference (LSD) test at 5% probability level.

RESULTS AND DISCUSSION

The investigation results revealed that the plant height, cob weight, 1000-kernel weight, grain yield and total dry matter (TDM) production were significantly (P< 0.5) affected by tillage treatments during the years 2009 and 2010. The supreme plant height was found under T_1 (228 and 233 cm), followed by T_2 (202 and 212 cm) and T_3 (191 and 196 cm), during both growing seasons 2009 and

2010, respectively. The maximum cob weight was measured under T_1 (455 and 463 g), followed by T_2 (408 and 416 g) and T_3 (393 and 400 g) during 2009 and 2010, respectively. The maximum 1000-kernel weight was recorded under T_1 (263 and 274 g), followed by T_2 (246 and 255 g) and T_3 (234 and 240 g) treatments during 2009 and 2010, respectively (Table 2). The maximum dry matter yield was obtained under T_1 (17.9 and 18.2 t ha^{-1}), followed by T_2 (16.3 and 16.7 t ha^{-1}) and T_3 (14.9 and 15.0 t ha^{-1}), respectively (Table 3). Similarly the maximum grain yield was recorded under T_1 (7.2 and 7.4 t ha^{-1}), followed by T_2 (6.9 and 7.1 t ha^{-1}) and T_3 (6.5 and 6.6 t ha^{-1}) during both growing seasons 2009 and 2010, respectively (Table 3). The seasonal comparison indicated that the plant height, cob weight, weight of 1000-kernel, dry matter yield and grain yield during 2010 were relatively greater than that of 2009.

Table 2. Impact of tillage practices on plant height; cob weight and 1000- kernel weight

Tillage treatments	**Plant height (cm)**		**Cob weight (g)**		**1000- kernel weight (g)**	
	2009	**2010**	**2009**	**2010**	**2009**	**2010**
Conventional tillage (T_1)	228 a	233 a	455 a	463 a	263 a	274 a
Reduced tillage (T_2)	202 b	212 ab	408 b	416 b	246 b	255 b
No tillage (T_3)	191 b	196 b	393 b	400 b	234 c	240 c
LSD	25.0	29.4	31.6	37.0	11.3	14.7
Significance	*	*	**	*	**	**

*, ** = Significant at 5%.

Economic analysis

The results of economic analysis showed that the maximum net benefit (Pak Rs. 156, 725, 160, 450 ha^{-1}) was achieved under conventional tillage, followed by reduced (Pak Rs. 151, 950, 155, 450 ha^{-1}) and no tillage (Pak Rs. 145, 350, 148,175 ha^{-1}) during 2009 and 2010, respectively (Tables 4 and 5), while the maximum marginal rate of return (275 and 303%) was observed under reduced tillage, followed by conventional tillage (217 and 227%) during the growing season 2009 and 2010, respectively as depicted in Table 6 and 7. Similar results were found by Anjum *et al.* (2014), who reported that, ridge sowing under conservation cultivation gave high net profit of Pak Rs. 85162 ha^{-1}, while less net profit of Pak Rs. 56984 ha^{-1} was found where broadcast sowing was followed under reduced cultivation and also more BCR of 1.70 was found in ridge sown. Whereas Leghari *et al.* (2015) concluded that the marginal return was greater under reduced tillage (RT) than conventional and no tillage practices. In contrast Ehsanullah *et al.* (2015) obtained maximum marginal rate of return (2232.79%) from ridge sown maize under conventional tillage systems, as compared to minimum and deep tillage practices. These results are in concurrence with those of many past researchers. Feng *et al*. (2010) observed that tillage systems significantly influenced grain yield and yield components of maize crop. This is consistent with Thierfeldera *et al*. (2013), who demonstrated that tillage systems significantly affect yield and yield components of maize for long-term. Similarly, Xu and Pierce (2000) reported substantial increase in maize yield. According to Ahmad *et al*. (2010) the grain yield was greater in conventional tillage system as compared to minimum and no tillage system. In contrast Kutu (2012) reported that minimum and no tillage practices were better for soil health, carbon and grain yield of crops. Moreover, Franchini *et al*. (2012) reported that the conventional soil tillage practices improve soil fertility level.

Table 3. Impact of tillage practices on dry matter production and grain yield

Tillage treatments	**Dry matter yield (t ha^{-1})**		**Grain yield (t ha^{-1})**	
	2009	**2010**	**2009**	**2010**
Conventional tillage (T_1)	17.9 a	18.2 a	7.2 a	7.4 a
Reduced tillage (T_2)	16.3 b	16.7 b	6.9 b	7.1 b
No tillage (T_3)	14.9 c	15.0 c	6.5 c	6.6 c
LSD	0.8	0.6	0.4	0.3
Significance	**	**	**	**

*, ** = Significant at 5%, respectively

Table 4. Economic analysis of tillage treatments on the basis of grain yield produced during 2009

Particulars	**Conventional tillage (T_1)**	**Reduced tillage (T_2)**	**No tillage (T_3)**
Grain yield (tons ha^{-1})	7.2	6.9	6.5
Adjusted yield (to bring at farmer's level 10% decrease)	6.5	6.2	5.9
Grass revenue (Rs. 25000 t^{-1})	162,225	155,250	146,2250
Charges of mouldboard plow + sowing	5500	-	-
Charges of disk harrow + sowing	-	3300	-
Charges of seed sowing	-	-	900
Total price (Pak Rs. ha^{-1})	5500	3300	900
Net profit	156,725	151,950	145,350

Net Income = gross revenue - adjustable cost
The prices of all inputs and outs were included June, 2009 in Pakistan

Table 5. Economic analysis of tillage treatments on the basis of grain yield produced during 2010

Particulars	**Conventional tillage (T_1)**	**Reduced tillage (T_2)**	**No tillage (T_3)**
Grain yield (t ha^{-1})	7.4	7.1	6.6
Adjusted yield (To bring at farmer's level 10% decrease)	6.6	6.4	6.0
Grass revenue (Pak Rs. 25000 t^{-1})	166,050	158,850	149,175
Charges of mouldboard plow + sowing	5600	-	-
Charges of disk harrow + sowing	-	3400	-
Charges of seed sowing	-	-	1000
Total price (Pak Rs. ha^{-1})	5600	3400	1000
Net profit	160,450	155,450	148,175

Net Income = gross revenue - adjustable cost
The prices of all inputs and outs were included June, 2010 in Pakistan

Table 6. Marginal analysis of experimental treatments based on grain yield produced during 2009

Tllage treatments	Net profit (Rs ha^{-1})	Price that differ (Rs ha^{-1})	Variation in price (Rs ha^{-1})	Variation in net profit (Rs ha^{-1})	Marginal return (%)
Conventional tillage (T_1)	156,725	5500	2200	4875	217
Reduced tillage(T_2)	151,950	3300	2400	6600	275
No tillage (T_3)	145,350	900	-	-	-

Table 7. Marginal analysis of experimental treatments based on grain yield produced during 2010

Tllage treatments	Net profit (Rs ha^{-1})	Price that differ (Rs ha^{-1})	Variation in price (Rs ha^{-1})	Variation in net profit (Rs ha^{-1})	Marginal return (%)
Conventional tillage (T_1)	160,450	5600	2200	5000	227
Reduced tillage (T_2)	155,450	3400	2400	7275	303
No tillage (T_3)	148,175	1000	-	-	-

CONCLUSION

The study has shown that conventional tillage practice enhanced maize production and resulted in the higher net benefits as compared to reduced tillage and no tillage practices, while maximum marginal rate of return was obtained under reduced tillage practice. Hence, conventional tillage practice could be adopted to improve yield and achieve net benefits.

REFERENCES

Abbas, F., H. M. Hammad, S. Fahad, A. Cerdà, M. Rizwan, W. Farhad, S. Ehsan and H. F. Bakhat. 2017. Agroforestry: a sustainable environmental practice for carbon sequestration under the climate change scenarios- A review. Environ. Sci. Pollut. Res., 24:11177-11191.

Abbasi, M. K. and M. M. Tahir. 2012. Economizing nitrogen fertilizer in wheat through combinations with organic manures in Kashmir. Pak. Agron. J., 104: 169-77.

Ahmad, I., M. T. Jan and M. Arif. 2010. Tillage and nitrogen management impact on maize. Sarhad J. Agric., 2: 157-167.

Anjum, S. .A., Ehsanullah, U. Ashraf, M. Tanveer, R. Qamar and I. Khan. 2014. Morphological and phenological attributes of maize affected by different tillage practices and varied sowing methods. Am. J. Plant Sci., 5: 1657-1664.

Aziz, I., T. Mahmood, Y. Raut, W. Lewis, R. Islam and R. R. Weil. 2009. Active organic matter as a simple measure of field soil quality. *In:* ASA International Meetings, Pittsburg, PA.

Byerlee, D. 1988. From agronomic data to farmer's recommendation. An Economics Training Manual, CIMMYT, Mexico.

Carter, M. R. 1991. Evaluation of shallow tillage for spring cereals on a fine sandy loam. 1. Growth and yield components, N accumulation and tillage economics. Soil Tillage Res., 21: 23-35.

Ehsanullah, U. Ashraf, S. A. Anjum, F. Ehsan, I. Khan and A. Ghaffar. 2015. Tillage practices and sowing methods affect yield and related attributes of maize. Asian J. Agric. Biol., 3 (1): 8-14.

Feng, F. X., G. B. Huang, Q. Chai and A. Z. Yu. 2010. Tillage and straw management impacts on soil properties, root growth, and grain yield of winter wheat in Northwestern China. Crop Sci., 50:1465-1473.

Franchini, J. C., H. Debiasi, A. A. B. Junior, B. C. Tonon, J. R. B. Farias, M. C. N. Oliveira and E. Torres. 2012. Evolution of crop yields in different tillage and cropping systems over two decades in southern Brazil. Field Crops Res., 137: 178-185.

Kumara, V., S. Yashpal, Saharawatb, K. Mahesh, Gathalac, A. S. Jata, S. K. Singha, N. Chaudhary and M. L. Jat. 2013. Effect of different tillage and seeding methods on energy use efficiency and productivity of wheat in the Indo-Gangetic Plains. Field Crops Res., 142: 1-8.

Kutu, F. R. 2012. Effect of conservation agriculture management treatments on maize productivity and selected soil quality indices under South Africa dryland conditions. Afr. J. Agric. Res., 26: 3839-3846.

Lal, R. 1985. No-till in the lowland humid tropics. *In:* The Rising Hope of our Land, Conference (Georgia, 1985). pp. 235-241.

Leghari, N., M. S. Mirjat, A. Q. Mughal, I. Rajpar and H. Magsi. 2015. Effect of different tillage methods on the growth, development, yield and yield components of bread wheat. Int. J. Agron. Agril. Res., 6 (5): 36-46.

Mielke, L. N. and W. W. Wilhelm. 1998. Comparisons of soil physical characteristics in long-term tillage winter wheat fallow tillage experiments. Soil Tillage Res., 49 (1-2): 29-35.

Olsen, S. R., C. V. Cole, F. S. Watanabe and L. A. Dean. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. USDA Agriculture, United States Department of Agriculture in cooperation with the Colorado Agricultural Experiment Station. Circular, 939: 1-19.

Parr, J. F., R. I. Papendick, S. B. Hornick and R. E. Meyer. 1990. The use of cover crops, mulches and tillage for soil water conservation and weed control. *In:* Organic matter Management and Tillage in Humid and Sub-humid Africa. pp. 246-261.

Peigne´, J., B. C. Ball, J. Roger-Estrade and C. David. 2007. Is conservation tillage suitable for organic farming? A review. Soil Use Manag., 23: 129-144.

Ramos, M. E., A. B. Robles, A. Sanchez-Navarro and J. L. Gonzalez-Rebollar. 2011. Soil responses to different management practices in rainfed orchards in semiarid environments. Soil Tillage Res., 112: 85-91.

SAS, Institute. 2004. SAS/STAT 9.1 User's Guide. SAS Institute, Cary, North Carolina, USA.

Thierfeldera, C., J. L. Chisuib, M. Gamac, S. Cheesmana, Z. D. Jereb, W. T. Bundersonb, N. S. Eashd and L. Rusinamhodz. 2013. Maize-based conservation agriculture systems in Malawi: Long-term trends in productivity. Field Crops Res., 142: 47-57.

Xu, C. G. and F. J. Pierce. 2000. Dry bean and soil response to tillage and row spacing. Agron. J., 90: 393-399.

Zahra, S. I., F. Abbas, W. Ishaq, M. Ibrahim, H. M. Hammad, B. Akram and M. R. Salik. 2016. Carbon sequestration potential of soils under maize production in irrigated agriculture of the Punjab province of Pakistan. J. Animal Pl. Sci. 26: 706-715.

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