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EFFECT OF TILLAGE SYSTEMS ON EARLY SEEDLING GROWTH, FODDER YIELD AND ECONOMICS OF MAIZE

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ABSTRACT

Reduced tillage has become an integral component of sustainable agriculture reducing input costs and soil loss, conserve energy, reduce soil erosion and labor costs, and elimination of extensive land preparation prior to planting. Therefore, in order to investigate the effect of tillage systems on early seedling growth, fodder yield and economic analysis, the experiment was conducted at Agricultural Research Farm of NWFP Agricultural University, Peshawar during spring 2007. The experiment was laid out in randomized complete block design having four replications. The tillage systems consisted of no-till, reduced tillage and deep tillage. The net plot size of 30 m by 20 m was planted at the seed rate of 60 kg ha^{-1} as broadcast. Nitrogen and phosphorus were applied at the rate of 120 and 90 kg ha^{-1}. Deep tillage resulted in greater emergence m^{-2} (134). Reduced tillage produced taller plants (211 cm), more leaves per plant (9.3) and higher fresh and dry fodder yield of maize (130.5 & 48 t ha^{-1}). Similarly, reduced tillage resulted in higher gross income (Rs. 65250) and net income (Rs. 63250). Higher value cost ratio (31.6) was recorded for reduced tillage followed by no-tillage (24.8), whereas deep tillage fetched lowest value cost ratio (11). It was concluded that reduced tillage resulted in higher fodder yield, net income and value cost ratio.

Key-words: Tillage, maize, seedling growth, fodder yield.

INTRODUCTION

Maize (*Zea mays* L.) is a dominant crop in the farming system in Khyber Pukhtoonkhwa and Pakistan because it is a staple food crop for most of the rural population as well as fodder for animals. Maize is cultivated both in spring and summer season as a dual purpose crop. Staggered planting from February to September helps cope with the fodder scarcity problems faced in May-June and October-November (Harris *et al*., 2007). Its nutritious fodder is relished by all kinds of livestock, especially milch animals and exceeds all other summer fodder crops in average yield, dry matter and digestibility (Lakho et al., 2004). The green fodder of maize is rich in vitamin–A and contains 1.56% protein, 0.30% fat, and 5.27% fiber (Chaudhry, 1982). It is a cash crop for growers, as around cities it is widely grown for sale as green fodder.

Tillage is considered the most effective farm activity for developing a desired soil structure. However it has become a controversial practice over the last few decades. For example Patil and Sheelavantar, (2006) and Papini *et al.* (2007) attained better plant growth and performance with deep ploughing. Halvorson *et al.* (2000) and Sainju *et al.* (2006) reported the same results with conventional ploughing while Dolan *et al.*, (2006); Gangwar *et al.*, (2006) and Nakamoto *et al.*, (2006) with no-tillage system. However, other authors have found little or no difference between the various tillage practices (Fischer *et al.,* 2002; Iqbal *et al.*, 2005; Wang and Dalal 2006). Reduced tillage can be efficient in saving more water for crop production (Habtegebrial *et al.,* 2007). It improves productivity and sustainability of arable land in temperate region (Nakamoto *et al.*, 2006). Improvement in soil organic C (Wright and Hons, 2005; Dolan *et al*., 2006), N enrichment (Habtegebrial *et al.*, 2007) and slow release of nutrient upon gradual organic matter decomposition are associated with reduced tillage. However, both deep and reduced tillage have been shown to improve soil porosity and aeration (Hao *et al.*, 2001; Zorita, 2000), preserve greater soil moisture and nutrients for plant and microbes (Lopez-Bellido *et al.*, 2001; Patil and Sheelavantar, 2006) and hence ultimately had increased crop yield (Zorita, 2000).

This study was carried out to asses the financial feasibility of using various tillage systems and its effect on early seedling growth and fodder yield of maize.

MATERIALS AND METHODS

Experimental site

The effects of different tillage systems were assessed on early seedling growth, fodder yield and economic analysis in field experiment on sweet corn. The experiments were carried out at Agricultural Research Farm of KPK

Agricultural University Peshawar Pakistan, during spring 2007. The site was located at 34^o N latitude, 71.3^o E longitude and an altitude of 347 meters above sea level (Khan et al., 2004). The soil of the experimental farm was a clay silt loam, well drained, fine textured derived from piedmont alluvium, deep well developed and belong to Great Group Ustochrept. The experimental site has warm to hot, semi-arid subtropical continental climate with a mean annual rainfall of about 360 mm. The soil is deficient in total N (< 0.5 g kg-1 soil) and AB-DTPA extractable P (< 4.0 mg kg-1 soil), but has adequate AB-DTPA extractable K (> 100 mg kg-1 soil) with a pH of 8.2 and organic matter content <1%. In addition to rainfall, the crop water requirement was fulfilled by supplying water as flood irrigation.

Experimental details

The experiment was laid out in randomized complete block design having four replications. The tillage systems consisted of no-till, reduced tillage and deep tillage. In no-till, the soil was not tilled but the land was leveled with the help of leveler. In reduced tillage, the field was ploughed with cultivator to the depth of about 10-15 cm while in deep tillage the field was ploughed with chisel plough to a depth of about 25-30 cm followed by cultivator with planking. Maize type sweet corn (yellow) was sown on April 23, 2007. The net plot size of 30 m by 20 m was sown at the seed rate of 60 kg ha^{-1} as broadcast. Nitrogen and phosphorus were applied at the rate of 120 and 90 kg ha^{-1}, respectively. Urea and single super phosphate were used as sources of P and N, respectively. All phosphorus and half of nitrogen were applied at the time of sowing, while remaining nitrogen was applied at 4-5 leaf stage. First irrigation was done after two weeks of sowing, and remaining irrigations were applied as and when needed. All other agronomic practices were kept uniform for all the treatments. Data were recorded on emergence m^{-2}, plant height, leaves plant^{-1}, fresh and dry fodder yields. Data on number of leaves, plant height and fodder yield were recorded at start of tasseling. Emergence data were taken by throwing quadrat of one square meter thrice in each plot and then was converted to emergence m^{-2}. Similarly for plant height and leaves plant^{-1}, ten plants were randomly selected in each plot and then was averaged accordingly. Fresh fodder yield was recorded by harvesting one square meter quadrat at three places in each plot and then weighed and was converted to kg ha^{-1}. For economic analysis, the cost incurred tillage operations in term of fuel and time, and income from maize fodder was taken into consideration. The following formulae were employed to find out the economic parameters (CIMMYT, 1988).

Gross income = value of fresh fodder yield of maize crop
Net return (NR) = Value of fodder yield - cost of tillage
Value cost ratio (VCR) = Value of fodder yield / cost on tillage

Statistical Analysis

The data recorded were analyzed statistically using analysis of variance techniques appropriate for randomized complete block design. Means were compared using LSD test at 0.05 level of probability, when the F-values were significant (Steel and Torrie, 1984).

RESULTS AND DISCUSSION

Tillage significantly affected emergence m^{-2}, plant height, number of leaves plant^{-1} and fresh and dry fodder yield of maize. Mean values of data revealed that maximum emergence m^{-2} were recorded at deep tillage (134) followed by reduced tillage (123). Minimum emergence m^{-2} (95) was recorded in no-tillage (Table 1).

Reduced tillage resulted in taller plants (211 cm) followed by deep tillage (190 cm), whereas short stature plants (154 cm) were noted in no-tillage plots (Table 1). Similarly reduced tillage produced higher number of leaves plant^{-1} (9.3), followed by deep tillage (8.1) however, it was at par with by no-tillage (7.9). In case of fodder yield, reduced tillage produced highest fresh fodder yield (130.5 tons ha^{-1}), followed by deep tillage (120 tons ha^{-1}) which were statistically at par with each other. Lower fodder yield (51.5 t ha^{-1}) was recorded for no-tillage. Similarly higher dry fodder yield (48 t ha^{-1}) was recorded by reduced tillage, which was at par with deep tillage (46 t ha^{-1}), whereas lower dry fodder yield was produced by no-tillage (19 t ha^{-1}).

Data regarding economic analysis are shown in Table 2. The variable costs of different tillage operations for all plots received the same amount of seed, fertilizer, and labour, etc. for cultivation practices during the growing period and only differed in term of cost of tillage operations. Different tillage systems fetched significantly different gross incomes. Reduced tillage resulted in higher gross income as compared to no-tillage and deep tillage. Likewise, reduced tillage gave the highest net income followed by deep tillage and no-tillage. The net income for reduced tillage was the highest due to the highest gross income compared with other tillage systems. Reduced resulted in greater value cost ratio (VCR) followed by no-tillage tillage and lower value cost ratio was recorded by deep tillage.

Lowest costs were observed in no-tillage compared with reduced tillage or deep tillage. The lowest total cost in no-tillage was due to the lowest cost of seedbed preparation per hectare. Hence, this comparison showed that reduced tillage with less fuel consumption could be a viable economical alternative when the value cost ratio is taken into account, which was higher for reduced tillage as compared to no-tillage or deep tillage.

Lower number of plants emerged in no-tillage plots which may be due to greater soil compaction, which may have contributed to the delay in seedling emergence (Mehdi et al., 1999). These results are in agreement with Vetsch and Randall (2000) who documented that no-tillage resulted in slower seed emergence and plant development than reduced tillage system. The possible explanation for greater number of leaves per plant under reduced tillage and deep tillage may be due to an initial advantage of higher leaf numbers because of early seedling emergence from better seedbed conditions as compared to no-tillage. Similarly, Vetch and Randall (2002) also reported that plant height was lower in no tillage as compared to reduced tillage. The improved fodder yield may be attributed to more emergence and long stature plants in reduced tillage and deep tillage systems. The higher yield in reduced tillage would be associated with greater preserved soil biota (Nakamoto *et al.*, 2006), higher water retention (Thomas *et al.*, 2007), enhanced soil fertility (Wright and Hons, 2005; Papini *et al.*, 2007), decreased soil compaction (Weisskopf and Anken, 2006), increased nutrient availability (Xiao-Bin *et al.*, 2006) and a reduction in nutrient losses (Saniju *et al.*, 2006) which may have improved individual plant performance. Reduced tillage resulted in better yield, N uptake and N content (Iqbal *et al.*, 2005) when compared to deep tillage. The results are in line with Licht and Al-Kaisi (2005) who attributed better biomass yield with chisel plough and strip tillage systems to better soil conditions early in the season and consequently improved early corn growth compared with no-tillage system.

Reduced tillage resulted in higher gross income as compared to no-tillage and deep tillage Similar results were reported by Ozpinar (2006) who also noted higher gross income and gross margin for reduced tillage. Similarly, Abu-Hamdeh (2003) pointed out that net economic return was lower in mouldboard plough tillage than other reduced tillage systems. Contrary to the findings of this study, Hoffman *et al.*, (1999) found that net economic returns in the mouldboard plough tillage system were higher as compared to reduced and no-tillage systems.

CONCLUSION

It was concluded from the results that reduced tillage performed better than no and deep tillage systems in term of fodder yield, net income and hence fetched higher value cost ratio as compared to deep and no-tillage.

Table I. Emergence, plant height, leaves plant^{-1}, fresh and dry fodder yields (tons ha^{-1}) of sweet corn as affected by tillage systems.

Treatment	No-tillage	Reduced tillage	Deep tillage	LSD	CV (%)
Emergence m^{-2}	95 c	123 b	134 a	11.00	5.46
Plant height (cm)	154 c	211 a	190 b	20.30	6.35
Leaves plant^{-1}	7.9 b	9.3 a	8.1 b	1.06	7.24
Fresh fodder yield (kg ha^{-1})	51.5 b	130.5 a	120.0 a	42.39	12.33
Dry fodder yield (kg ha^{-1})	19 b	48 a	46 a	5.97	9.22

Means in the same column followed by different letters are significantly different from each other at 5 % level of probability.

Table 2. Economic analysis for fodder sweet corn as affected by tillage systems.

Tillage systems	Fodder yield (tons ha^{-1})	Gross income (Rs. ha^{-1})	Tillage cost (Rs. ha^{-1})	Net income (Rs. ha^{-1})	VCR
No tillage	51.5	25750	1000	24750	24.8
Reduced tillage	130.5	65250	2000	63250	31.6
Deep tillage	120	60000	5000	55000	11.0

Fodder value = Rs. 500 ton^{-1}

REFERENCES

Abu-Hamdeh, N.H. (2003). Effect of weed control and tillage system on net returns from bean and barley production in Jordan. Canad. *Biosystems Eng*., 45: 223–228.

Chaudhry, A.R. (1982). *Maize in Pakistan (Maize monograph).* Punjab Agricultural Research Co–ordination Board, University of Agriculture Faisalabad–Pakistan

CIMMYT. (1988). *An economic training manual from agronomic data to farmer recommendations*. Mexico. Pp.1-25.

Dolan, M.S., C.E. Clapp, R.R. Allmaras, J.M. Baker and J.A.E. Molina (2006). Soil organic carbon and nitrogen in a Minnesota soil as related to tillage, residue and N management. *Soil &Tillage Res*., 89 (2):221-231.

Fischer, R.A., F. Santiveri and I.R. Vidal (2002). Crop rotation, tillage and crop residue management for wheat and maize in the sub-humid tropical highlands: I. Wheat and legume performance. *Field Crops Res*., 79:107-122.

Gangwar, K.S., K.K. Singh, S.K. Sharma, and O.K. Tomar (2006). Alternative tillage and crop residue management in wheat after rice in sandy loam soils of Indo-Gangetic plains. *Soil & Tillage Res*., 88:242-252.

Habtegebrial, K., B.R. Singh, and M. Haile (2007). Impact of tillage and nitrogen fertilization on yield, nitrogen use efficiency of tef (Eragrostis tef (Zucc.) Trotter) and soil properties. *Soil & Tillage Res*., 94:55-63.

Halvorson, A.D., A.L. Black, J.M. Krupinsky, S.D. Merril, B.J. Wienhold, and D.L. Tanaka (2000). Spring wheat response to tillage system and nitrogen fertilization within a crop–fallow system. *Agron. J*., 92:288-294.

Hao, X., C. Chang and C.W. Lindwall (2001). Tillage and crop sequence effects on organic carbon and total nitrogen content in an irrigated Alberta soil. *Soil and Tillage Res*., 62:167-169.

Harris, D., A. Rashid, G. Miraj, M. Arif and H. Shah (2007). ‘On-farm’ seed priming with zinc sulphate solution-A cost-effective way to increase the maize yields of resourcepoor farmers. *Field Crops Res*., 102: 119-127.

Hoffman, M.L. D.D., Buhler and D.K. Owen (1999). Weed population and crop yield response to recommendations from weed control decision aid. *Agron. J*., 91: 386–392.

Iqbal, M.M., J. Akhter, W. Mohammad, S.M. Shah, H. Nawaz and K. Mahmood (2005). Effect of tillage and fertilizer levels on wheat yield, nitrogen uptake and their correlation with carbon isotope discrimination under rainfed conditions in north-west Pakistan. *Soil & Tillage Res*., 80:47-57.

Khan, A.Z., P. Shah, S. K .Khalil and B. Ahmad (2004). Yield of soybean cultivars as affected by planting date under Peshawar valley conditions. *The Nucleus*, 41 (1-4): 93-95.

Lakho, A.A., F.C. Oad, A.A. Solangi and M.H. Siddiqui (2004). Economics of maize fodder under organic and inorganic Fertilizers. *Int. J. Agri. Biol*., 6(6): 1172–1173

Licht, M. and M. Al-Kaisi (2005). Strip-tillage effect on seedbed soil temperature and other soil physical properties. *Soil Tillage Res. J*., 80:233-249.

Lopez-Bellido, L., R.J. Lopez-Bellido, J.E. Castillo and F.J. Lopez-Bellido (2001). Effects of long-term tillage, crop rotation and nitrogen fertilization on bread-making quality of hard red spring wheat. *Field Crops Res.*, 72:197-210.

Mehdi, B.B., C.A. Madramootoo and G.R. Mehuys (1999). Yield and nitrogen content of corn under different tillage practices. *Agron. J.,* 91:631-636.

Nakamoto, T., J. Yamagishi and F. Miura (2006). Effect of reduced tillage on weeds and soil organisms in winter wheat and summer maize cropping on Humic Andosols in Central Japan. *Soil & Tillage Res*., 85:94-106.

Ozpinar, S. (2006). Effect of tillage systems on weed population and economics for winter wheat production under the Mediterranean dryland conditions. *Soil Tillage Res*., 87:1-8.

Papini, R., G. Valboa, C. Piovanelli and G. Brandi (2007). Nitrogen and phosphorous in a loam soil of central Italy as affected by 6 years of different tillage system. *Soil &Tillage Res*., 92:175-180.

Patil, S.L. and M.N. Sheelavantar (2006). Soil water conservation and yield of winter sorghum as influenced by tillage, organic materials and nitrogen fertilizer in semi-arid tropical India. *Soil &Tillage Res*., 89:246-257.

Sainju, U.M., W.F. Whitehead, B.P. Singh, and S. Wang (2006). Tillage, cover crops, and nitrogen fertilization effects on soil nitrogen and cotton and sorghum yields. *Europ. J. Agron.*, 25:372-382.

Steel, R.G.D. and J.H. Torrie (1984). *Principles and procedures of statistics*. 2nd ed. McGraw Hill Book Co, Singapore. pp.172-177.

Thomas, G.A., G.W. Titmarsh, D.M. Freebairn and B.J. Radford (2007). No-tillage and conservation farming practices in grain growing areas of Queensland – a review of 40 years of development. *Aust. J. Exp. Agric*., 47:887–898.

Vetsch, J. A. and G. W. Randall (2000). Enhancing no-tillage systems for corn with starter fertilizers, row cleaners, and nitrogen placement method. *Agron. J*., 92:309-315.

Wang, W.J. and R.C. Dalal (2006). Carbon inventory for a cereal cropping system under contrasting tillage, nitrogen fertilization and stubble management practices. *Soil & Tillage Res*., 91:68-74.

Weisskopf, P., and T. Anken (2006). Effects on no-tillage on soil structure. CAB Reviews: Perspectives in Agric. *Vet. Sci. Nutr. and Natural Res*., 1, 051, 11pp.

Wright, A.L. and F.M. Hons (2005). Tillage impacts on soil aggregation and carbon and nitrogen sequestration under wheat cropping sequences. *Soil &Tillage Res*., 84:67-75.

Xiao-Bin, W., C.D. Xiong, W.B. Hoogmoed, O. Oenema and U.D. Perdok (2006). Potential effect of conservation tillage on sustainable land use: a review of global long-term studies. *Pedosphere*., 16:587-595.

Zorita, M.D. (2000). Effect of deep-tillage and nitrogen fertilization interactions on dry land corn productivity. *Soil & Tillage Res*., 54:11-19.

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