TILLAGE AND NPK EFFECT ON GROWTH AND YIELD OF SPRING MAIZE IN ISLAMABAD, PAKISTAN

Shafique Qadir Memon*, Muhamamd Safar Mirjat, Abdul Quadir Mughal** Nadeem Amjad***, Muhammad Azhar Saeed, Shabbir Kalwar, Asif Ali Mirani and Habib Iqbal Javed****

ABSTRACT:- Tillage is a very important crop production practice which affect crop performance. An experiment was conducted during the spring crop season 2009 to compare the effect of three different tillage regimes i.e. deep, conventional and zero and four fertilizer levels viz., control 100-50-50, 150-75-75 and 200-100-100 NPK kg ha^{-1}. The randomized complete block design was used with three replications. There was significant differences in maize emergence percentage, plant height, grains cob^{-1}, 1000-grain weight and grain yield due to tillage practices and various fertilizer levels, between tillage practices. However, the NPK @ 200-100-100 kg ha^{-1} and deep tillage produced the highest emergence percentage, plant height, grains per cob, 1000-grain weight and grain yield followed by other fertilizer levels and conventional tillage. The zero tillage plots produced the low emergence percentage, plant height, grains cob^{-1}, 1000-grain weight and grain yield. Therefore, considering the environmental conditions, the deep tillage with recommended dose of NPK performed best and provided more vegetative growth and grain yield in maize. However, poor-resource farmers can use the medium level of NPK @ 150-75-75 kg ha^{-1} for getting an economical and successful maize crop.

Key Words: Maize; Grain Yield; Growth; NPK levels; Tillage; Crop Yield; Pakistan.

INTRODUCTION

Soil and climatic conditions of Pakistan are ideal for maize production, its productivity per hectare is very low as compared to other maize growing countries of the world. In Pakistan maize is third important cereal after wheat and rice and 89% of the crop is grown in Punjab and Khyber Pakhtunkhwa Province. Pakistan grows maize on about 1.11 mha with annual production of 4.04 t of grain and average yield of 3.62 tha^{-1} (GoP, 2009). The selection of an appropriate tillage practice for the production of crops is very important for optimum growth and yield. A good soil management programme protects the soil from water and wind erosion, provides weed free seedbed, destroys hardpans that may limit root development and even an increase in organic matter (Wright et al., 2008). Tillage management, fertilizers and organic manure application are important factors effecting soil physical properties, and have significant effect

*Allama Iqbal Open Unviersity, Islamabad.
** Sindh Agriculture University, Tandojam.
*** Pakistan Agricultural Research Council, Islamabad.
****National Agricultural Research Centre, Islamabad.
Corresponding author: shafiq_qm@yahoo.com

on soil bulk density and moisture conservation. Deep tillage break up high-density soil layer, improve the water infiltration and movement in soil, enhance root growth and eventually enhance the crop production (Bennie and Botha, 1986). Deep tillage (up to 90 cm) resulted in significant increase in corn yield (Varsa et al., 1997). Zero tillage is also an appropriate method of sowing, however, has less advantages as compared to deep and conventional tillage in the modern farming. Information regarding appropriate tillage practice and NPK levels is earnestly needed for getting maximum maize grain yield in Islamabad, Pakistan. The present studies were therefore, planned to evaluate the effects of different tillage practices and NPK levels on growth, yield contributing traits and grain yield in spring maize.

MATERIALS AND METHOD

Experimental Procedure

The three tillage systems i.e. deep tillage (DT), conventional tillage (CT) and zero tillage (ZT), and four fertilizer levels viz., control, 100-50-50 NPK kg ha^{-1}, 150-75-75 NPK kg ha^{-1} and 200-100-100 NPK kg ha^{-1} were studied in a randomized complete block design (RCBD) with three replications. The sub-plot size was 7m × 10 m, maize variety "Islamabad Gold" seeds were dibbled at 5 cm depth, with 75 and 20 cm rows and plants spacing, respectively. The maize seed was sown @ 25 kg ha^{-1} and the complete dose of phosphorus, potassium and half dose of nitrogen was applied at sowing time. The remaining half dose of N was applied in two split doses to maize crop. Before first irrigation, the thinning was performed to have required plant spacings. For observations and data recording, the five plants were randomly selected in each plot and tagged. The data were recorded on emergence (%), plant height (cm), grains cob^{-1}, 1000-grain weight (g) and grain yield (kg ha^{-1}).

Tillage Methods

Three tillage methods were: deep tillage (sub soiler + Mould board plow one pass) (DT), conventional tillage (cultivator + disc harrow one pass) (CT) and zero tillage (drill) (ZT). All the implements are rated as standard size field tools and were operated according to RNAM (1995) by a diesel powered tractor MF-375. The results revealed that the average depth under sub soiler (27.35cm) was greater than all other tillage implements used in this study. It was followed by mould-board plow (21.333cm), disc harrow (10.867cm), cultivator (6.917cm) and zero tillage (4.738cm).

Study Location

The present study was conducted at National Agricultural Research Centre (NARC), Islamabad, Pakistan,

Table 1. Physicochemical properties at the experimental site.

Soil property	Soil layers (cm)		
	0-15	15-30	30-45
Sand (%)	39.00	47.00	35.00
Silt (%)	41.00	35.00	40.00
Clay (%)	20.00	18.00	25.00
pH	7.85	7.80	7.82
Organic matter (%)	1.21	0.62	0.57
$CaCO_3$ (%)	5.00	5.50	5.60
NO_3-N (mg kg^{-1})	6.50	4.30	3.50
P (mg kg^{-1})	3.12	2.28	0.51
K (mg kg^{-1})	80.00	62.00	55.00

Table 2. Temperature, rainfall and relative humidity at the experimental site during spring-2009

Month	Temperature (^{0}C)		Rainfall (mm)		Relative humidity (%)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
March	8.0	30.7	0.1	47.0	47	81
April	11.2	35.0	0.1	46.4	40	95
May	14.8	40.8	0.1	11.0	31	85
June	18.0	44.0	0.1	11.0	28	67

during spring crop season 2009. The site is located at Latitude 33^0 40′ North and Longitude 73^0 08′ East. The physicochemical characteristics of the soil at the experimental site revealed that the soil is loamy in texture, soil pH range was 7.80-7.85, indicating that the soil was slightly alkaline in reaction. Organic matter content ranged was 0.569-1.211% indicating that enough amount of organic matter was present in upper layer. Lime content ($CaCO_3$) ranged was 5.00-5.6% indicating that the soil was slightly calcareous (Table 1). Results indicated that NO_3-N and available phosphorus contents were in low concentrations, whereas potassium was marginal in the soil. The climate data is given in Table 2.

Data Analyses

All the data were subject to analysis of variance (ANOVA) using the analysis of variance procedure (Steel and Torrie, 1980). The treatment mean separated using least significant difference (LSD) at 0.05 level of probability.

RESULTS AND DISCUSSION

Emergence

The mean values of the emergence were significantly affected by tillage practices and NPK levels. The maize plots with deep tillage produced the maximum emergence % than that of the other tillage systems (Figure 1). The interactions of tillage × fertilizer, the maximum emergence (91%) was observed in deep tillage with NPK @ 200-100-100 kg ha^{-1} followed by conventional (89%) and zero tillage (85%) regimes. However, the minimum emergence % was in the control plots where no fertilizer were applied. Comparison of various tillage practices by Kersten and Hack (1991) indicated that best results could be achieved by plowing against no till cultivation.

Plant Height

Analysis of variance revealed significant differences in maize plant height among various tillage practices (Figure 2). The tallest plants were found in the deep tillage followed by conventional tillage plots. While the shortest plants were observed in zero tillage plots. The tillage × fertilizer interactions, the maximum plant height (190 cm) was observed in plots of deep tillage where fertilizer was applied NPK @ 200-100-100 kg ha^{-1} followed by conventional tillage (185 cm) and zero tillage (177 cm). However, the least plant height was observed in control plots where no fertilizers were applied. These results

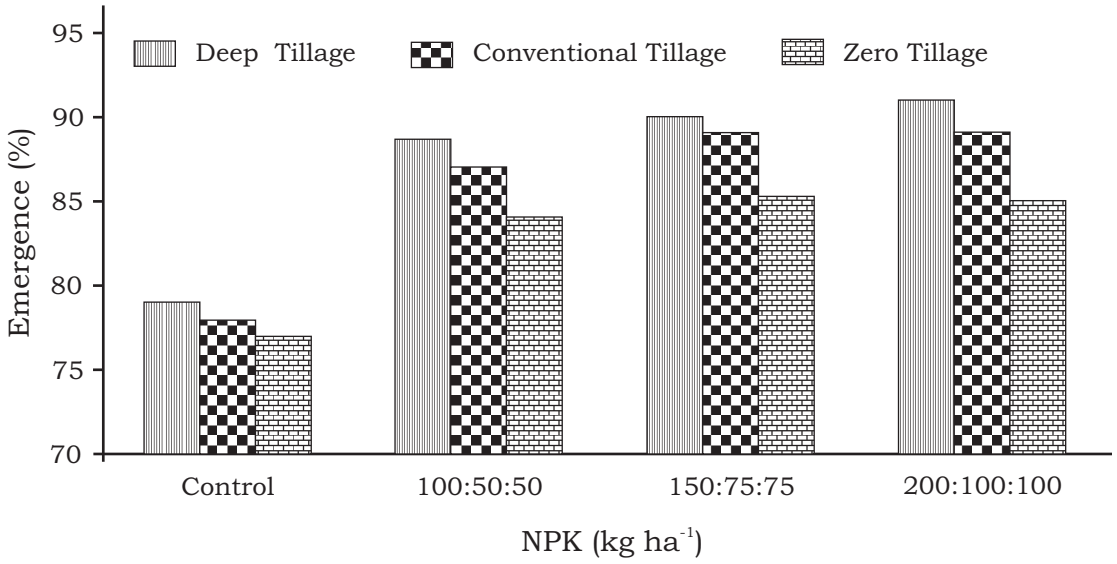

Figure 1. Effect of tillage practice on emergence

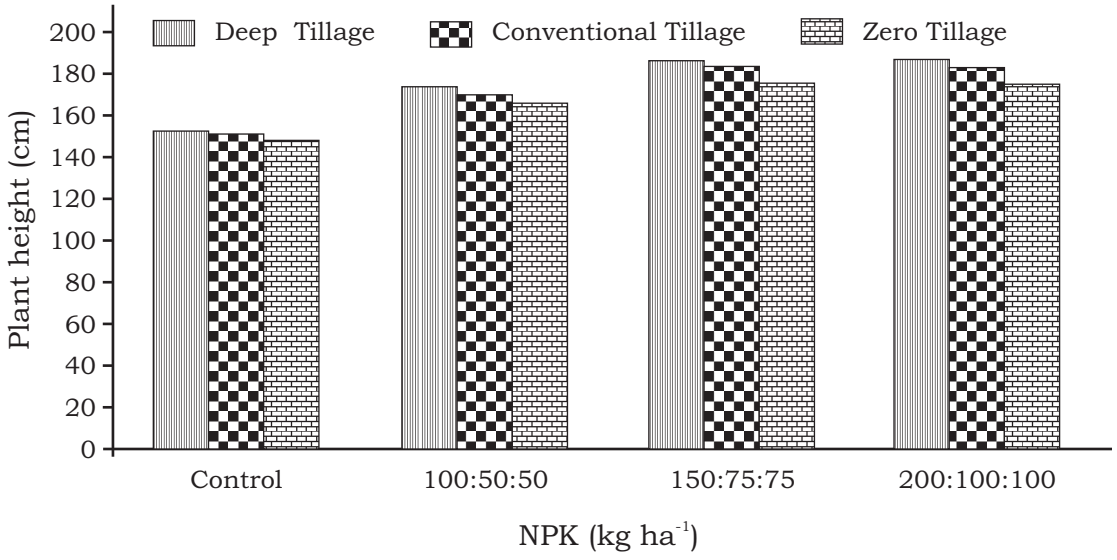

Figure 2. Effect of tillage practice on plant height

were in accordance with findings of Mitchell and Tu (2005). The increase in plant height in response to higher levels of nitrogen has been confirmed by the previous findings of Akbar et al. (2002), and Rasheed et al. (2004).

Grains per Cob

Analysis of variance showed significant differences in grain per cob between the different tillage practices and NPK levels (Figure 3). The maximum grain per cob were

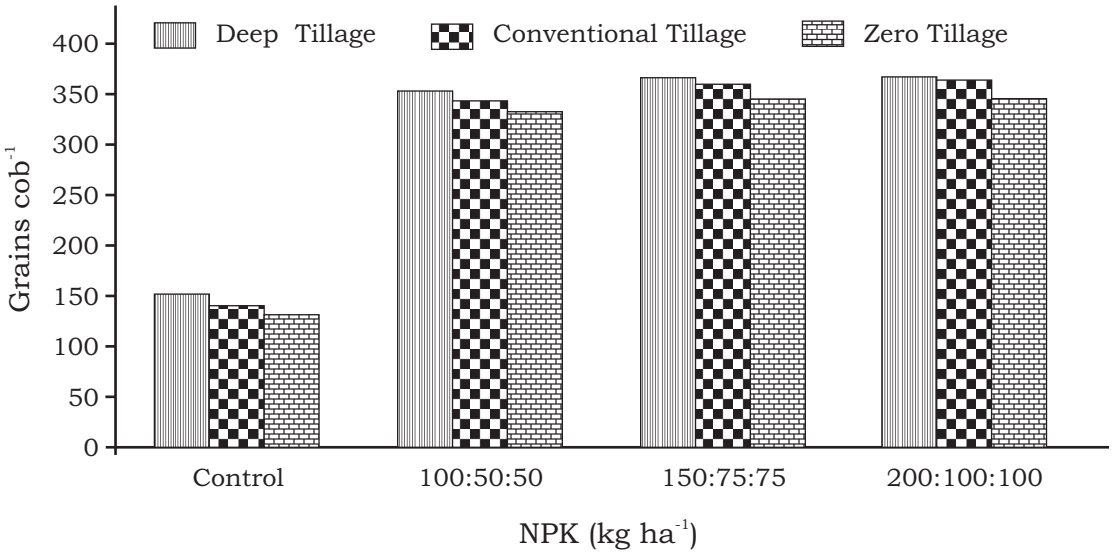

Figure 3. Effect of tillage practice on grain per cob

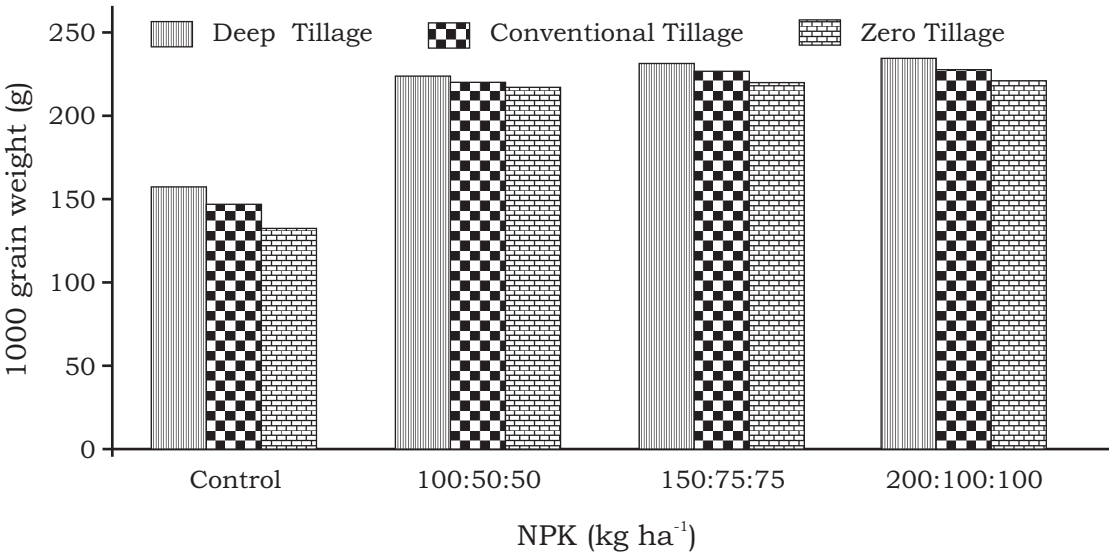

Figure 4. Effect of tillage practice on 1000-grain weight

counted in plots with deep tillage followed by conventional tillage plots. However, the least grain per cob were observed in the plants under zero tillage. The interactions of tillage × fertilizer revealed that highest grain per cob were found in deep tillage (368) where fertilizer was applied @ 200-100-100 kg NPK ha^{-1} followed by conventional tillage (365) and zero tillage (346) as compared to application of NPK @ 150-75-75 kg ha^{-1} and NPK @ 100-50-50 kg ha^{-1}. The least number of grains per cob

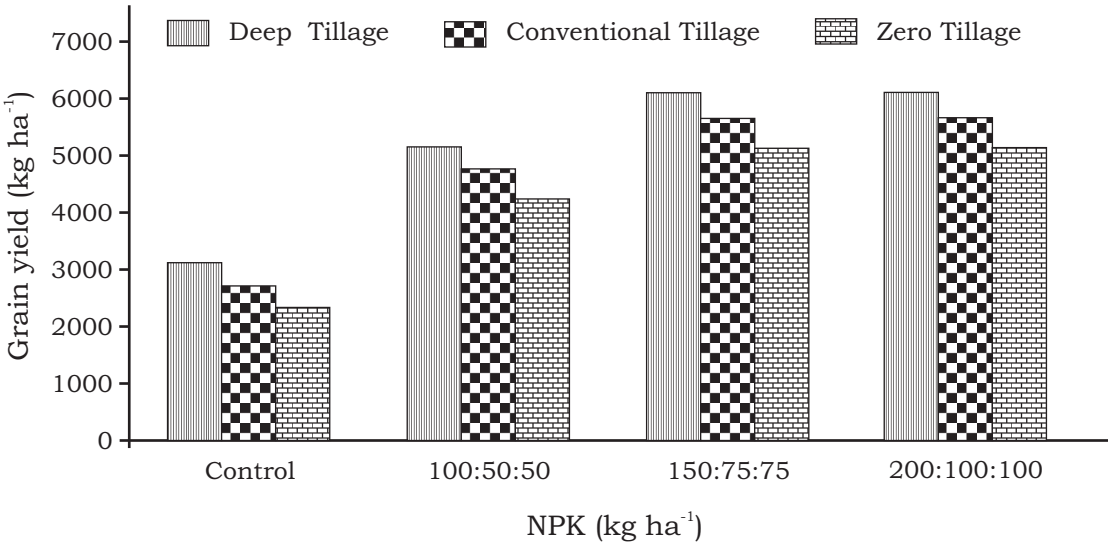

Figure 5. Effect of tillage practice on grain yield

were found in control plots. These results were in line with Maqsood et al. (2001) who reported that high number of grain has been attributed to high levels of nitrogen and phosphorus.

1000-Grain Weight

The tillage practices and NPK levels revealed significant variations through analysis of variance for 1000-grain weight (Figure 4). Maximum 1000-grain weight was observed in the plots with deep tillage followed by conventional tillage plots, while the lowest 1000-grain weight was observed with zero tillage plots. The interactions of tillage × fertilizer revealed that highest 1000-grain weight was exhibited by deep tillage (234 g) where fertilizer NPK was applied @ 200-100-100 kg ha^{-1} followed by conventional tillage (227 g) and zero tillage (220 g) as compared to NPK @ 150-75-75 kg ha^{-1} and NPK @ 100-50-50 kg ha^{-1}. However, the least number of grains per cob were found in control plots. Samad (1992) and Maqsood et al. (2001) reported highest 1000 grain weight in maize with increased levels of nitrogen application.

Grain Yield

Grain yield is a complex trait, and when the yield components affected by various tillage regimes and NPK levels, then eventually will also be effected. Analysis of variance showed significant differences in maize grain yield among different tillage practices and NPK levels (Figure 5). The highest grain yield was produced by maize plots with deep tillage followed by conventional tillage, while the lowest grain yield was observed in zero tillage maize plots. The tillage × fertilizer interactions revealed that highest grain yield was observed in maize plots under deep tillage (6111 kg ha^{-1}) where fertilizer NPK was applied @ 200-100-100 kg ha^{-1} followed by conventional tillage (5654 kg ha^{-1}) and zero tillage (5138 kg ha^{-1})

as compared to NPK @ 150-75-75 kg ha^{-1} and NPK @ 100-50-50 kg ha^{-1}. Nevertheless, the lowest grain yield was found in control plots where no fertilizer was applied. These results are in agreement with previous findings of Koszanski (1993) who reported that increase in nitrogen dose might increase grain and straw yield. Arora et al. (1991) mentioned that deep tillage was beneficial for maize cultivation. Astier et al. (2005) reported that tillage significantly affected the maize grain yield and conventional tillage system exceeded the zero tillage regime for grain yield.

Maize growth, yield and its components were significantly influenced by tillage practices and NPK levels. Deep tillage in interaction with NPK @ 200-100-100 kg ha^{-1} produced maximum emergence %, plant height, grains per cob, 1000-grain weight and grain yield. The zero tillage with all fertilizer levels enunciated the worst growth and yield components. Therefore, the deep tillage with recommended dose of NPK was the best alternative for the highest maize production. However, the farmers who can't afford high cost of fertilizers, they can use the NPK @ 150-75-75 NPK kg ha^{-1} for growing an economical and successful maize crop.

LITERATURE CITED

Akbar, H., M.T. Jan, and J. Amanullah. 2002. Yield potential of sweet corn as influenced by different level of nitrogen and plant population. Asian J. Plant Sci. 16 (1): 631-633.

Arora, V.K., P.R. Gajra, and S.S. Prihar. 1991. Tillage effect on corn in sandy soil relation to water retentivity, nutrient and water management and seasonal evaporability. Soil and Tillage Res. 21(1): 1-21.

Astier, M., J.M. Maass, J.D. Etchevers-Barra, J.J. Pena, and F. Gonzalez. 2006. Short term green manure and tillage management effects on maize yield and soil quality in an Andisol. Soil and Tillage Res. 88 (1): 153-159.

Bennie, A.T.P., and F.J.P. Botha. 1986. Effect of deep tillage and controlled traffic on root growth, water use efficiency and yield of irrigated maize and wheat. Soil and Tillage Res. 7(1): 85-95.

GoP. 2009. Pakistan Economic Survey 2008-09. Ministry of Finance Government of Pakistan. p. 22.

Kersten, M., and F. Hack. 1991. Effect of four tillage methods on growth of maize in Zambia. Agriculture Mechanization in Asia, Africa and Latin America. 22: 34-38.

Koszanski, Z. 1993. Residual effects of irrigation and nitrogen fertilizer application in a crop rotation on yield of spring barley. Zeszyty Naukowe Akademii Rolniczej w Szczecinie, Rolnictwo. 56: 217-223.

Maqsood, M., A.A. Amanat, A. Iqbal, and M.I. Hussain. 2001. Effect of variable rates of nitrogen and phosphorus on growth and yield of maize (Golden). Online J. Biol. Sci. 1 (1): 19-20.

Mitchell, C.C., and S. Tu. 2005. Long term evaluation of poultry litter as a source of nitrogen for cotton and corn. Agron. J. 97: 399-407.

Rasheed, M., T. Mahmood, M.S. Nazir, W.A. Bhutta, and A. Ghaffar. 2004. Nutrient efficiency

and economics of hybrid maize under different planting methods and nutrient levels. Intern. J. Agric. and Biol. 6 (5) : 922-925.

RNAM. 1995. Test code and procedure for farm machinery, Technical series No.12.

Steel, R.G., and J.H. Torrie. 1980. Principles and Procedures of Statistic 2nd edn. New York: Mc Graw-Hill.

Samad, A. 1992. Effect of different combinations of NPK on the grain yield and yield components of maize varieties. Sarhad J. Agric. 8(1): 17-21.

Varsa, E.C., S.K. Chong. J.O. Abolaji, D.A. Farquhar, and F.J. Olsen, 1997. Effect of deep tillage on soil physical characteristics and corn (*Zea mays* L.) root growth and production. Soil and Tillage Res. 43(3): 219-228.

Wright, D., J. Marois, J. Rich, and R. Sprenkel. 2008. Field Corn Production Guide-SS-AGR-85, Available at: http://edis.ifas.ufl.edu/ pdffiles/ AG/ Ag20200.