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EFFECT OF TILLAGE AND USE OF ORGANIC AND INORGANIC FERTILIZERS ON GROWTH AND YIELD COMPONENTS OF MAIZE

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ABSTRACT:- Tillage is an important crop production practice which affects crop performance. It was laid out in randomized complete block design (RCBD) with three replications. An experiment was conducted during the spring and autumn crop seasons 2009-2010.The objective of the trial was to compare the effect of three different tillage regimes namely, deep tillage, conventional tillage and zero tillage, and four fertilizer levels. Results showed that plant height, 1000-grain weight, grain yield and dry matter were maximum with deep tillage as compared to conventional and zero tillage. Comparing the seasons, the overall better plant height, 1000-grain weight, grain yield and dry matter were gained during autumn season due to its crop residue effect and supplemental fertilizer. Therefore, considering the environmental conditions, the deep tillage with recommended dose of organic and inorganic fertilizer performed best and provided more vegetative growth, grain yield and dry matter in maize. Residual effects and supplemental fertilizer application in maize production were greater than fresh maize production.

Key Words: Tillage; Organic; Inorganic; Grain Yield; Yield Components; Input-Output; Pakistan.

INTRODUCTION

Tillage management and fertilizer application are among the important factors effecting soil physical properties. Tillage and farm manure often have significant effect on soil bulk density, moisture and porosity. Tillage is a practice which is performed to loosen the soil and to produce a good tilth. Among the crop production practices, tillage contributes up to 20% (Ahmad et al., 1996; Mahajan et al., 1996). Tillage operation affects the sustainable use of soil resource through its influence on soil properties (Hammel, 1989). Deep tillage always breaks up high density soil layers; it improves the movement of water and infiltration in the soil. It also enhances growth of roots and increases crop production (Bennie and Botha, 1986). Deep tillage of the soil resulted in increased maize yield up to 90 cm (Varsa et al., 1997). Zero tillage is also an appropriate method of sowing. On the other hand, soil organic matter is an important com-

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ponent of soil quality which determines soil characteristics i.e., aeration, water uptake, nutrient mineralization, soil aggregate and retention properties. Organic matter not only increases the water holding capacity of the soil but also the portion of water available for plant growth and improves physical properties of soil (Bolan et al., 2004; Sial et al., 2007). Importance of any crop can be judged by its area, production utilization and share in trade. The same criteria can be valid for maize to judge its importance as cereal crop.

Maize is a multipurpose crop grown all over the world; it is adapted to tropical and subtropical regions of the world. As compared to the other crops the unique energy capturing capability made it the basic crop of the world. It also plays an important role as it can grow twice a year, which strengthens, the economy of the country. It is the primary staple food in many developing countries (Morris et al., 1999). It ranks third in Pakistan as well as in world's production following wheat and rice. In Pakistan, maize is the staple food for a large population especially in hilly areas. This crop is capable of producing the largest quantity of grain per unit area (Akbar et al., 2008) and can be grown twice in a year i.e., during spring and summer seasons. This investigation was, therefore, conducted to determine the effect of tillage and uses of organic and inorganic fertilizer for maize crop production.

MATERIALS AND METHOD

Experimental Design and Treatment Applications

The experiment was conducted using randomized complete block design (RCBD) with three replications during spring and autumn seasons 2009-2010. Plots were divided into 7m x 10m sub plots with one-meter path left between each plots. The ploughing of soil was performed with deep tillage (sub-soiler + mould board plow one pass), conventional tillage (disc harrow + cultivator), and zero-tillage (direct drill). All the implements are rated as standard size field tools and were operated according to RNAM (1995) by a diesel engine powered tractor MF-375, with fertilizer rates of control, 10,000 kg ha^{-1} FYM, 100-50-50 NPK kg ha^{-1} and 100-50-50 NPK kg ha^{-1} + 10,000 kg ha^{-1} FYM. During spring sown maize the full dose of fertilizer was applied while in autumn sown maize half dose of fertilizer was applied. Seeds of maize variety, Islamabad Gold, were dibbled 5 cm deep, keeping row to row distance 75 cm and seed to seed distance 20 cm. Maize was sown @ 25 kg ha^{-1} and the complete dose of NPK was applied with sowing. The remaining dose of N was applied in two splits; the farm yard manure was also applied before sowing of maize crop.

Furthermore, before first irrigation thinning process was applied to keep the plants at proper distance and five plants were selected randomly from each plot and tagged. The agronomic observations recorded were: plant height (cm), 1000-grain weight (g), grain yield (kg ha^{-1}) and dry matter (kg ha^{-1}). All the data were subject to analysis of variance (ANOVA) using the analysis of variance procedure (Steel and Torrie, 1980). The treatment means separated using least significant difference (LSD) at 0.05 level of probability.

RESULTS AND DISCUSSION

Tillage Methods

The results revealed that the average depth under sub soiler (27.3 cm) was greater than all other tillage implements used in this study. It was followed by mouldboard plow (21.3 cm), disc harrow (10.8 cm), cultivator (6.9 cm) and zero tillage (drill) (4.7 cm). The results revealed that sub soiler consumed the maximum fuel (24.1 lit ha^{-1}), followed by moldboard plow (21.2 lit ha^{-1}), while cultivator consumed 7.5 lit ha^{-1}, zero tillage (drill) consumed 13.5 lit ha^{-1}), and disc harrow consumed 7.6 lit ha^{-1}.

Plant Height

The effect of tillage as well as fertilizer levels on plant height was recorded maximum in deep tillage as compared to conventional and zero tillage. Gill et al. (1996) observed greater plant height in deep tillage. In spring season the maximum plant height (177 cm) was recorded in deep tillage that received 100-50-50 NPK kg ha^{-1} + 10,000 FYM kg ha^{-1} followed by conventional tillage (173 cm) and zero tillage (169 cm). During autumn season the maximum plant height (189 cm) was recorded in deep tillage with application of half dose 50-25-25 NPK kg ha^{-1} + 5,000 FYM kg ha^{-1}, followed by conventional tillage (187 cm) and zero tillage (182 cm) as compared with application of ½ NPK and ½ FYM alone, respectively. The minimum plant height was recorded in deep tillage (155 cm and 160 cm) in control plots during both seasons (Figure 1). The increase in plant height in response to higher levels of nitrogen has been confirmed by the previous findings (Akbar et al., 2002; Rasheed et al., 2004).

1000-grain Weight

It is evident that significant

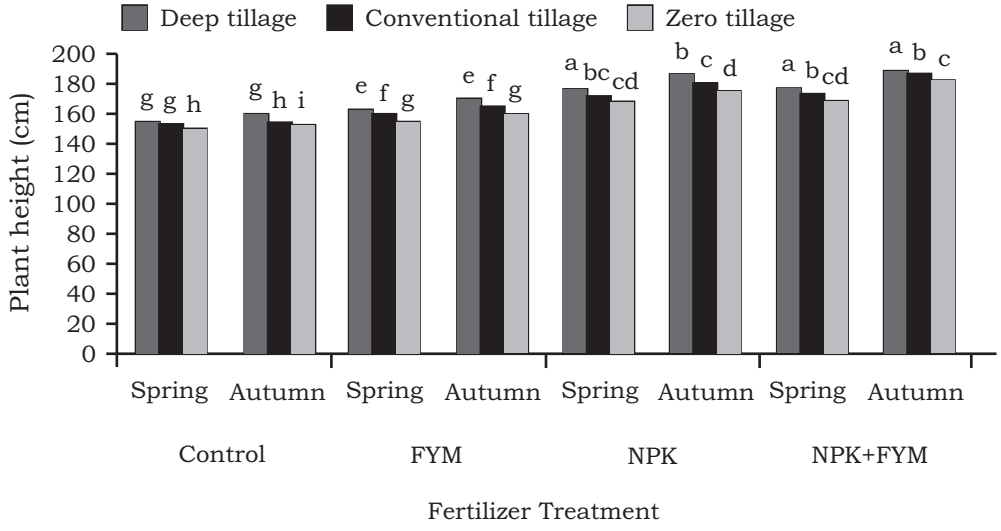

Figure 1. Effect of tillage practices, chemical fertilizer and farmyard manure on plant height using LSD at 5% probability

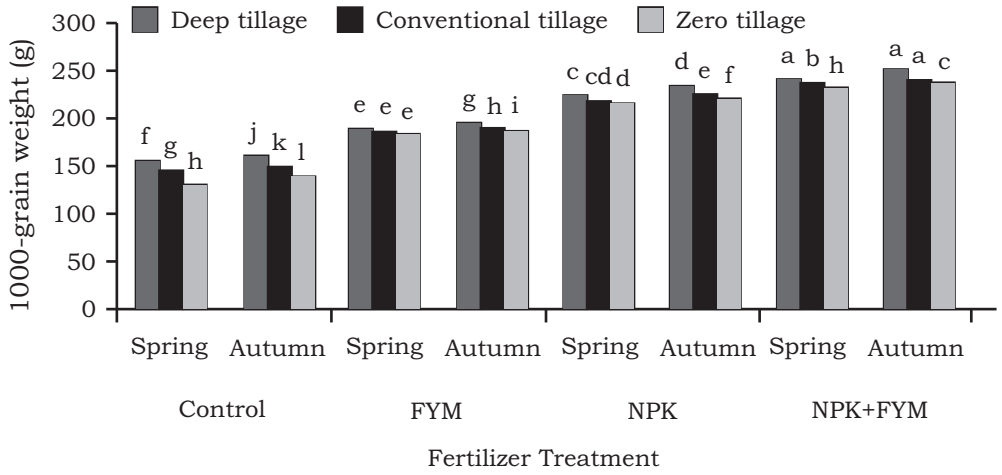

Figure 2. Effect of tillage practices, chemical fertilizer and farmyard manure on 1000-grain weight using LSD at 5% probability

differences in 1000-grain weight were recorded in various tillage methods (Figure 2). The higher 1000-grain weight was found in deep tillage (240 g) followed by conventional tillage (236 g) and minimum was recorded in zero tillage (231 g) with the application of 100-50-50 NPK kg ha^{-1} + 10,000 FYM kg ha^{-1} during spring seasons 2009-2010. During autumn seasons 2009-2010 maximum 1000-grain weight was recorded in deep tillage (250 g) after application of 50-25-25 NPK kg ha^{-1} + 5,000 FYM kg ha^{-1} followed by conventional tillage (240 g) and zero tillage (237 g). The minimum 1000-grain weight (156 g and 160 g) was recorded in control plots during both seasons. When comparing the seasons, overall better 1000-grain weight was found during autumn season as compared to spring season. This might be due to its residual effect and supplemental fertilizer application. These results confirm those of Khaliq et al. (2004) who observed that the use of fertilizer and organic manure gave maximum 1000-grain weight in maize.

Grain Yield

Analysis of variance showed significant difference in maize grain yield between the different tillage practices. The highest grain yield was found in the deep tillage (5185 kg ha^{-1}) followed by conventional tillage (4780 kg ha^{-1}) while the lowest grain yield was observed with zero tillage (4255 kg ha^{-1}) with the application of 100-50-50 NPK kg ha^{-1} + 10,000 FYM kg ha^{-1} during spring season 2009-2010 (Figure 3). During autumn season 2009-2010, maximum grain yield was recorded in deep tillage (5840 kg ha^{-1}) after application of 50-25-25 NPK kg ha^{-1} + 5,000 FYM kg ha^{-1} followed by conventional tillage (5530 kg ha^{-1}) and zero tillage (5370 kg ha^{-1}). However minimum grain yield (3119 kg ha^{-1} and 3286 kg ha^{-1}) was recorded in control plots during both seasons. Better grain yield was obtained during autumn season as compared

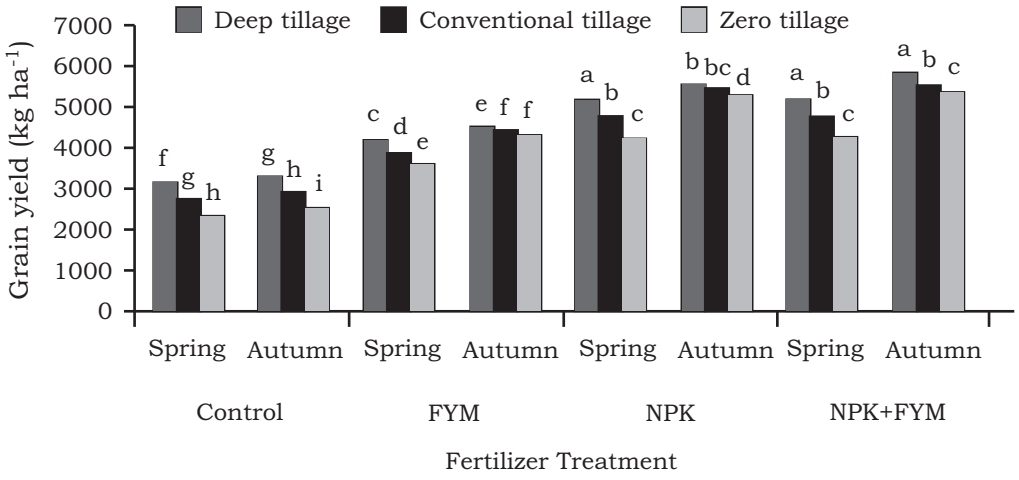

Figure 3. Effect of tillage practices, chemical fertilizer and farmyard manure on grain yield using LSD at 5% probability

to spring season. This might be due to its residual effect and supplemental fertilizer application. These results are in agreement with those of Shata et al. (2007), Sial et al. (2007), Adeniyan and Ojeniyi (2005) who reported that application of chemical and organic manure improved maize grain yield.

Dry Matter

Analysis of variance showed significant difference in maize dry matter between the different tillage practices (Figure 4). The highest dry matter was found in the deep tillage (19665 kg ha^{-1}) followed by conventional tillage (18555 kg ha^{-1}) plots, while the lowest dry matter was observed with zero tillage (17558 kg ha^{-1}) plots with the application of 100-50-50 NPK kg ha^{-1} + 10,000 FYM kg ha^{-1} during spring 2009-2010. During autumn 2009-2010 maximum dry matter was recorded in deep tillage (21205 kg ha^{-1}) after application of 50-25-25 NPK kg ha^{-1} + 5,000 FYM kg ha^{-1} followed by conventional tillage (20136 kg ha^{-1}) and zero tillage (18863 kg ha^{-1}). The minimum dry matter (14214 kg ha^{-1} and 14380 kg ha^{-1}) were recorded in control plots during both seasons. Overall better dry matter was gained during autumn season as compared to spring season. This might be due to its residual effect and supplemental fertilizer application. These results are in agreement with studies conducted by Farhat et al. (2009), Shata et al. (2007) and Chung et al. (2000).

Comparative Analysis of Input and Output of the Tillage Methods

The input and output results revealed that deep tillage exhibited maximum net benefits in all fertilizer treatments, followed by conventional tillage and zero tillage. In spring sown maize, deep tillage with 100-50-50 NPK kg ha^{-1} gave high net benefit (Rs. 130169.1) followed by conventional tillage (Rs. 120740.9) and zero tillage (Rs. 107352.2) (Table 1). The treat-

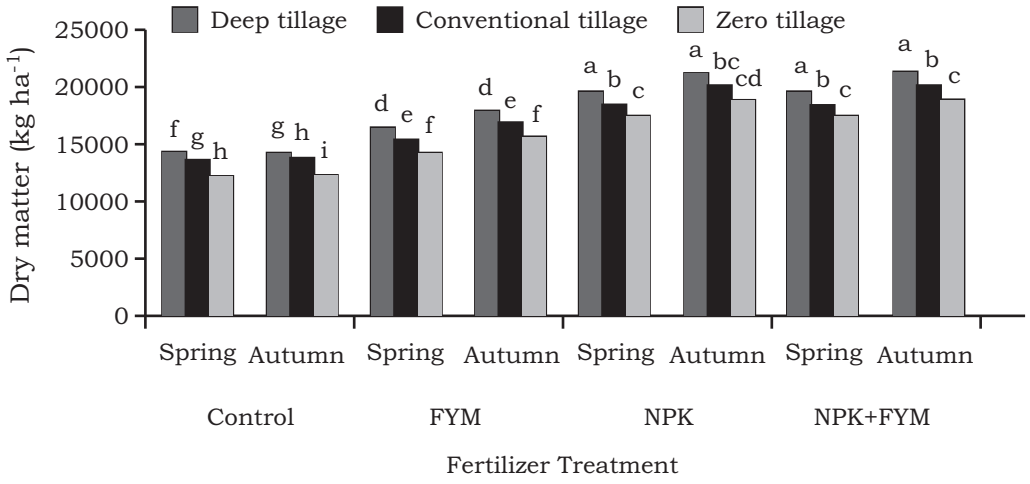

Figure 4. Effect of tillage practice, chemical fertilizer and farmyard manure on dry matter using LSD at 5% probability

ment combinations with organic and inorganic fertilizer are economical due to higher cost that vary and less net benefits, while low benefit in FYM alone and control. Overall maximum net benefits were gained in autumn sown maize with combination of half dose (50-25-25 NPK + 5 t FYM). The maximum net benefit (Rs.171841.6) was in deep tillage, followed by conventional tillage (Rs. 171231.9) and zero tillage (Rs.167523.1). While minimum net benefit was found in FYM alone and the lowest in control. The autumn sown maize gave higher net benefit. This might be due to its residual effect and supplemental fertilizer application. These findings are similar to Nisar et al. (2007) who reported that the residual effect of maize showed positive impacts on yield and yield components of the previous maize crop.

Deep tillage followed by conventional tillage produced tallest plants and more 1000-grain weight and grains and dry matter yields. Zero tillage treatment gave the lowest plant height, 1000-grain weight which ultimately resulted in the lowest yields under this treatment. Overall better plant height, 1000 grain weight, grain yield and dry matter were gained during autumn season as compared to spring season. The mean grain yield increased by about 11.21 % under deep tillage with the application of combined used of fertilizers. Comparison of input and output analysis for two seasons suggested that better net benefits were achieved under deep tillage followed by conventional tillage and lesser benefits were achieved under zero tillage for all fertilizer levels during spring season. While, the highest net benefits were achieved in autumn sown maize as compared to spring sown maize, this might be due to residual effect and supplemental fertilizer and manure applications. When both the organic as well as inorganic fertilizers are available then these should be applied in combination with NPK + FYM fertilizer to get maximum grain and dry matter yields

Table 1. Comparative analysis of input and output of the tillage methods for spring and autumn sown maize

Cost (Rs.)	Deep tillage	Conventional tillage	Zero tillage
Spring Sown			
Fuel consumption @ Rs. 78 lit^{-1}	3540.4	1184.0	1059.4
Lubricant at 15% of diesel cost (Rs.)	531.0	177.6	158.9
Tractor hired @ Rs. 1500 ha^{-1}	1500.0	1500.0	1500.0
Labour cost			
Skilled 10 labour @ Rs. 220 per day for sowing	2200.0	2200.0	-
Skilled 20 labour @ Rs. 220 per day for harvesting	4400.0	4400.0	4400.0
Seed 25 kg ha^{-1} @ Rs. 30 kg^{-1}	750.0	750.0	750.0
Fertilizer inputs cost			
Urea/bag @ Rs. 750/-	3260.8	3260.8	3260.8
DAP/bag @ Rs. 2250/-	4891.5	4891.5	4891.5
MOP/bag @ Rs. 2500/-	4166.6	4166.6	4166.6
FYM 10 tons @ Rs. 6000/-	6000.0	6000.0	6000.0
Total cost of production (a)			
0-0-0 NPK kg ha^{-1}	12921.4	10211.6	7868.3
FYM10,000 kg ha^{-1}	18921.4	16211.6	13868.3
100-50-50 NPK kg ha^{-1}	25239.8	22530.0	20186.7
100-50-50 NPK kg ha^{-1} + FYM10,000 kg ha^{-1}	31239.8	28530.0	26186.7
Gross income (b) sell @ Rs. 30 kg^{-1}			
0-0-0 NPK kg ha^{-1}	93570.0	81960.0	69639.0
FYM10,000 kg ha^{-1}	125091.0	116211.0	107271.0
100-50-50 NPK kg ha^{-1}	155409.0	143271.0	127539.0
100-50-50 NPK kg ha^{-1} + FYM10,000 kg ha^{-1}	155550.0	143400.0	127650.0
Net income (b – a) Rs.			
0-0-0 NPK kg ha^{-1}	80648.5	71748.3	61770.6
FYM10,000 kg ha^{-1}	106169.5	99999.3	93402.6
100-50-50 NPK kg ha^{-1}	130169.1	120740.9	107352.2

(Contd.,)

Cost	Deep tillage	Conventional tillage	Zero tillage
100-50-50 NPK kg ha^{-1} + FYM10,000 kg ha^{-1}	124310.1	114869.9	101463.2
Autumn Sown			
Fuel consumption @ Rs. 88/lit	3983.3	1353.0	1195.3
Lubricant at 15% of diesel cost (Rs.)	597.4	202.9	179.2
Tractor hired @ Rs. 1600 ha^{-1}	1600.0	1600.0	1600.0
Labour cost			
Skilled 10 labour @ Rs. 250 per day for sowing	2500.0	2500.0	-
Skilled 20 labour @ Rs. 250 per day for harvesting	5000.0	5000.0	5000.0
Seed 25 kg ha^{-1} @ Rs. 35 kg^{-1}	875.0	875.0	875.0
Fertilizer inputs cost			
Urea/bag @ Rs. 920/-	1996.4	1996.4	1996.4
DAP/bag @ Rs. 3250/-	3472.0	3472.0	3472.0
MOP/bag @ Rs. 2700/-	2241.0	2241.0	2241.0
FYM 5 tons @ Rs. 3250/ -	3250.0	3250.0	3250.0
Total cost of production (a)			
0-0-0 NPK kg ha^{-1}	14555.8	11531.0	8849.5
FYM 5000 kg ha^{-1}	17805.8	14781.0	12099.5
50-25-25 NPK kg ha^{-1}	22283.1	19258.3	16576.8
50-25-25 NPK kg ha^{-1} + FYM 5000 kg ha^{-1}	25533.1	22508.3	19826.8
Gross income (b) sell @ Rs. 30 kg^{-1}			
0-0-0 NPK kg ha^{-1}	115010.0	101244.5	87045.0
FYM 5000 kg ha^{-1}	158165.0	154350.0	151445.0
50-25-25 NPK kg ha^{-1}	193515.0	191100.0	184100.0
50-25-25 NPK kg ha^{-1} + FYM 5000 kg ha^{-1}	204400.0	193550.0	187950.0
Net income (b – a) Rs.			
0-0-0 NPK kg ha^{-1}	100454.1	89713.4	78195.4
FYM 5000 kg ha^{-1}	140359.1	139568.9	139345.4
50-25-25 NPK kg ha^{-1}	171841.6	171231.9	167523.1
50-25-25 NPK kg ha^{-1} + FYM 5000 kg ha^{-1}	178866.9	171041.6	168123.1

of maize and suggested that crop residue effects be measured and compared in the same year.

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