EFFECT OF TILLAGE AND FERTILIZER TREATMENTS ON MAIZE FODDER YIELD UNDER RAINFED CONDITIONS OF PAKISTAN

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ABSTRACT:- The effect of deep and shallow tillage and fertilizer treatments i.e., recommended dose of fertilizer (RF), farm yard manure (FYM) and recommended dose of fertilizer plus farmyard manure (RF+FYM) on maize fodder yield was studied under rainfed conditions of Pakistan. It was observed that the emergence count m^{-2}, maize fodder biomass, plant height, number of leaves per plant and maize fodder yield enhanced, with the application of RF+FYM. However, the effect of FYM+RF and recommended dose of fertilizer was statistically non-significant and on average basis RF+FYM treatment produced higher green fodder (19971.5 kg ha^{-1}) than fodder yield of 18349.1 kg ha^{-1} produced by applying recommended dose of fertilizer. However, green fodder yield produced with these two fertilizer treatments were significantly higher than that of the FYM and control treatments. The FYM treatment gave lowest fodder yield (16997 kg ha^{-1}) and was significantly lower than the fodder yield (17278.7 kg ha^{-1}) obtained in control treatment. The nutrient availability in RF+FYM treatment significantly increased the biomass production, however, application of FYM promoted the weed infestation that reduced the green fodder yield of maize, but it improved the overall forage yield as recorded in RF+FYM treatment. The effect of deep tillage on maize fodder yield was non-significant.

Key Words:Maize; Fodder; Fertilizer Treatments; Farm Yard Manure; Yield Components; Rainfed Conditions; Pakistan.

INTRODUCTION

Maize (*Zea mays L.*) is the third important grain crop after wheat and rice in Pakistan. It is grown on about one million hectare with a total production of 3.6 mt with national average yield of 3.43 tha^{-1} which is very low as compared to yield obtained in other countries advance in agriculture. Increased cropping intensity coupled with the adoption of inefficient crop management techniques has resulted in low crop productivity. The imbalance use of chemical fertilizers and little or no use of organic manures have created soil health problems and drastically lower plant nutrients in the soil. The excessive use of heavy machinery for various crop production operation has caused the development of hardpan in the soil that has aggravated the issue of low crop productivity. The efficient crop management practices provide essential information to obtain the potential yield of rainfed maize fodder on sustainable basis. Studies conducted in the past have revealed the positive impact of deep tillage

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and fertilizer treatments on the yield and yield components of field crops. Ishaque et al. (2002) reported that concentration of NPK were greater in the plough layer than subsoil. Maize fodder yield was significantly negatively correlated with penetration resistance and was positively correlated with soil NPK concentration. In a long term fertilizer trial on maize under non-irrigated conditions in Romania, application of 50 kg N and 40 kg P_2O_5 ha^{-1} during dry years has been recommended (Negrila et al.,1997). In normal and rainy years application of 100-150 kg N and 20 kg P_2O_5 ha^{-1} was recommended to obtain grain yield over 3.8 tha^{-1}. Soon et al. (2001) reported that N uptake by wheat increased with deep tillage than conventional tillage when following a legume crop. Abu-Kreshe et al. (1996) reporting similar results stated that alternate use of deep tillage in legume based cropping system increases the plant nutrient uptake and grain yield of sorghum. Jin et al. (1996) investigated the effect of cattle manure application on yield of maize and soil characteristics. It was observed that cattle manure application resulted in higher maize yield than chemical fertilizer. Suri and Sarita (1996) concluded that addition of FYM reduces the requirement of NPK fertilizer. They reported that FYM lowered NPK fertilizer requirement for maize by 60, 50 and 40% when 10, 7.5 and 5 tha^{-1} FYM was applied to maize fields, respectively.

Sharma and Singh (1996) reported that the application of 10 t ha^{-1} of FYM in conjunction with fertilizer at nutrient levels of 90:45:20 resulted in higher grain production of maize than applying fertilizer and FYM alone. Similarly, Mahajan (1996) conducted an experiment to study the effect of phosphorus and FYM combinations on maize wheat sequence under rainfed conditions. The effect of FYM was useful in increasing the yield of maize and wheat by 27 and 20%, respectively. Suri et al. (1997) carried out a field experiment in India during 1991-92 to evaluate the role of FYM in NPK fertilizer economy in maize-wheat sequence. It was suggested that application of K can be omitted in maize as well as follow-wheat if FYM is applied. Similarly, Chaudhry et al. (1999); Richards et al. (1999) reported that combined application organic and inorganic fertilizers have positive effect on forage yield of maize, however, when the fertilizers were applied individually, these had negative effect on the crop yield.

Mohamed and Aret (1999) conducted a fertilizer trial on maize in Egypt. They concluded that application of 20 kg N+20 m^{-3} FYM produced the highest grain yield, protein contents and 1000-grain weight. Richards et al. (1999) conducted 15 field trials in the UK to evaluate soil mineral N measurement as a means for quantifying the total N supply to forage maize and formed the basis for fertilizer recommendations on a crop specific basis. In every trial 4 rates of cattle manure N and 4 rates of ammonium nitrate were factually combined. Results proved to be useful for N recommendation. They also recommended that soil mineral nitrogen measurement should be taken 7 to 10 weeks after drilling and that if at this stage the amount of mineral nitrogen is less than the expected crop N off take, N fertilizer should be applied. Kagata et al. (1999) grew forage maize with tworowed barley in rotation for 9 successive years with four fertilizer treatments i.e. control, FYM, FYM+NPK and NPK fertilizer. Dry matter yield and harvest index of forage maize were stable and high in FYM and FYM + NPK treatments, but gradually decreased with NPK or without fertilizer. Disease was frequently observed in the 3rd year in NPK but not in FYM or FYM + NPK. Total nitrogen and carbon in soil increased over time in the treatments including FYM. Chemical fertilizer application together with FYM application also positively affected mineral composition of fodder. Sahoo and Panda (1999) studied the maize cultivar Naviot with three fertilizers treatments, i.e., 5 tha^{-1} FYM; 80 kg N + 40 kg P_2O_5 + 40 kg K_2O ha^{-1} and 5 tha^{-1} FYM plus half NPK rates. Grain yield was 442 kg ha^{-1} in control plots and 574, 3682 and 2246 kg ha^{-1} in the three fertilizer treatments, respectively.

Present study was carried out to explore the effect of various tillage practices and fertilizer treatments on rainfed maize fodder yield.

MATERIALS AND METHOD

The experiment was designed during 2000-2002 to study the effect tillage practices viz., deep tillage with moldboard and shallow tillage with cultivator and fertilizer treatments i.e. control (C), recommended fertilizer (RF) @ 100:50 kg NP ha^{-1}, recommended fertilizer with manure (RF+FYM) and manure (FYM) @ 5 tha^{-1} alone on the sustainable maize fodder yield under rainfed conditions at National Agricultural Research Centre, Islamabad. The experiment was laid out in Randomized Complete Block Design (RCBD) and treatments were arranged in split plot fashion with three replications.

Tillage practices were placed in the main plots and fertilizer treatments in the sub plots. The size of sub plots was 17mx6m. Deep tillage was done with moldboard plough once each year before the onset of monsoon rains (in the first week of May) and shallow tillage was done with cultivator at the time of land preparation. Fertilizer doses were randomly applied to each sub plot. The recommended doses of fertilizer for maize fodder crop i.e., 100:50 NP $kgha^{-1}$ and farmyard manure @ 5 t ha^{-1} alone and their mixture were broadcasted in the respective plot at the time of planting. The seed of maize crop was tested in the laboratory for germination potential before planting. Maize variety "Gohar" was planted in mid July during *kharif* 2000 and 2001 for fodder yield that was harvested at 50% silking stage. Data were collected using standard procedures and transferred to computer files for analysis and ANOVA was accompli-shed by using MSTAT (Steel and Torrie, 1980). Treatment means were compared by DMRT.

RESULTS AND DISCUSSION

During both the years of experimentation rainfall was received above normal range hence, non-significant effect on maize fodder yield was recorded due to seasonal variation (Table 1).

Table 1. Seasonal variation of various parameters of maize

Parameter	Year	
	2000	2001
Emergence	51.461 b	52.900 a
Plant height (cm)	117.963 NS	118.877 NS
Number of leaves (m^{-2})	15.054 a	13.355 b
Biomass (g m^{-2})	115.925 NS	131.723 NS
Fodder yield (kg ha^{-1})	17587.458 NS	18510.708 NS

Means followed by same letter (s) do not differ significantly at 0.5% probability level.

Maize Emergence Count

The maize emergence differed significantly among both the years. Significantly higher emergence count of 52.90 m^{-2} was recorded during 2001 than the emergence of 51.461 m^{-2} recorded during 2000 (Table 1). The effect of tillage practices and fertilizer treatments on emergence counts was also significant, however interactive effect was non-significant (Table 3). Significant higher maize emergence count of 52.9 m^{-2} was achieved through moldboard followed by 51.461 emergence m^{-2} cultivator . Highest emergence count of 54.162 m^{-2} was recorded when FYM alone was applied, this was followed by 53.363 emergence m^{-2} achieved when RF+FYM was applied. This may be attributed to better moisture regime when organic matter (FYM) was applied. Similar conductions were developed with deep tillage treatment particularly at emergence stage resulted in fast germination of seed and seedling emergence than shallow tillage. Deep tillage with application of FYM alone gave more emergence of 55.822 m^{-2} followed by the interaction of deep tillage with application of RF+FYM (53.98 m^{-2}). The lowest emergence

Table 2. Effect of tillage practices on maize fodder

Parameter		Tillage Practice	
		Cultivator	Moldboard
Emergence count		51.461 b	52.900 a
Plant height (cm)		114.840 b	122.019 a
Number of leaves (m^{-2})		14.145 NS	14.264
Biomass (gm^{-2})	30 DAS	11.030 NS	10.961
	48 DAS	61.967 NS	61.249
	63 DAS	122.175 NS	125.473
Fodder yield (kg ha^{-1})		18270.400 NS	17827.700

Means followed by same letter (s) do not differ significantly at 0.5% probability level.

count was recorded with the interaction of shallow tillage with check treatment of fertilizer.

Plant Biomass Production

Tillage practices did not show significant effect on biomass production at 33 days after sowing (Table 2). A mixed trend of biomass, production was observed under various fertilizer treatments. Significantly higher biomass of 11.283 and 11.035 g m^{-2} were recorded when RF and FYM alone doses of fertilizer were applied, respectively. This was followed by RF+FYM by producing 10.924 g m^{-2} biomass at 33 days after sowing. The lowest biomass was produced in control treatment. The availability of nutrients enhanced the biomass production. The interactions of tillage with fertilizer treatments were also non-significant.

Maize planted after shallow tillage produced more biomass (61.967 gm^{-2}) compared to biomass produced with deep tillage (61.249 gm^{-2}) (Table 4). Recommended dose of fertilizer produced more biomass (62.90 g m^{-2}) followed by F+FYM (62.35 gm^{-2}) fertilizer dose was applied. The interactions of tillage treatments and fertility levels were also non-significant.

Mixed trend of biomass production was also recorded at 63 days after sowing (Table 3). Statistical analysis of the data indicated that the highest biomass of 131.723 gm^{-2} was produced at 50 % silking stage during 2001 compared to biomass of 115.925 gm^{-2} produced in 2000 (Table 1). However, the difference was non-significant. This was mainly due to uniform rainfall pattern during crop growth period during 2001. Tillage treatments did not affect the biomass production (Table 4). However, on average basis, moldboard produced more biomass (125.473 gm^{-2}) than that of cultivator (122.175 gm^{-2}) (Table 3). The application of RF+FYM and recommended dose of fertilizer produced statistically same level of biomass, however, significantly more biomass of 132.001 and 131.277 gm^{-2}, respec-tively were produced with these as compared to other fertility levels. Application of RF+FYM and RF alone produced similar biomass yield. The interactions of tillage practices and fertilizer treatments were non-significant. Graphic presentation of maize biomass

Table 3. Effect of tillage and fertilizer on maize emergence count

	Tillage practice		
Fertilizer	Cultivator	Moldboard	Means
Control	50.037 NS	51.118	50.577 c
RF	50.560	50.680	50.620 c
FYM	52.502	55.822	54.162 a
RF+FYM	52.747	53.980	53.363 b
Means	51.461 b	52.900 a	-
LSD	-	-	1.937
CV%	-	-	4.54

Means followed by same letter (s) do not differ significantly at 0.5% probability level.

Table 4. Effect of tillage and fertilizer on biomass at 33, 48 and 63 days after sowing

(g)

Fertilizer	33 days			48 days			66 days		
	Tillage practices		Means	Tillage practices		Means	Tillage practices		Means
	Cultivator	Moldboard		Cultivator	Moldboard		Cultivator	Moldboard	
Control	10.762 NS	10.718	10.740 b	60.607 NS	59.480 NS	60.043 NS	111.928 NS	121.243	116.586 b
RF	11.132	11.435	11.283 a	63.107	62.695	62.901	128.698	133.857	131.277 a
FYM	11.240	10.830	11.035 b	60.855	61.422	61.138	116.277	114.585	115.431 b
RF+FYM	10.987	10.862	10.924 b	63.300	61.400	62.350	131.795	132.207	132.001 a
Means	11.030 NS	10.961	-	61.967 NS	61.249	-	122.175 NS	125.473	-
LSD			0.371						4.842
CV%			4.04			5.16			4.69

Means followed by same letter (s) do not differ significantly at 0.5% probability level.

accumulation trend at various interval "days after sowing" during 2000 and 2001 showed that initially increase in dry matter in both the years was similar but afterwards the difference pronounced till maturity (Figure 1). As far as general trend of maize biomass production under different tillage treatments is concerned, corn growth under moldboard treatment was better than cultivator treatment.

Wheat straw from previous crop and addition of fertilizer might have improved the fertility and mulch cover. So this better maize growth was attributed to higher soil moisture under mulch. Similar results were reported by Moddy et al. (1963), they observed that corn growth was higher under mulch treatment than on bare soil. Van Wijk and Burrows (1995) compared the growth of corn under mulch and un-mulch condition and reported similar results. However, no measurement of soil temperature was made in present study. This experiment was probably conducted on a better moisture regime and moldboard treatment resulted in faster germination of seeds and accelerated growth of seedlings than cultivator treatment. This difference between corn growths may be due to better water infiltration in moldboard treated plots, though no water infiltration measurements were taken in this study.

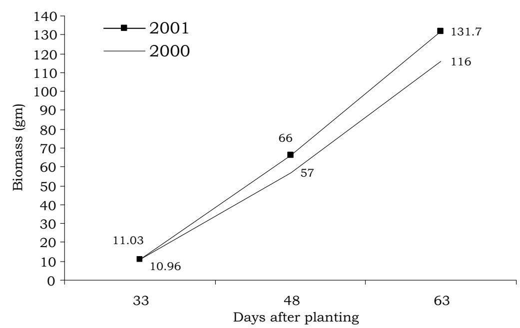

Figure 1. Year-wise biomass production at various growth stages of maize

Plant Height

The data showed that both the tillage and fertilizer treatments significantly affected the plant height of maize (Table 5). However, the difference in plant height due to seasons was non-significant. During 2001 plant height (118.877 cm) (Table 1) was more than it was recorded during 2000 (117.963 cm).

Among the tillage practices, moldboard treatment produced significantly taller plants (122.019 cm) as compared to cultivator treatment (114.84 cm).

Table 5. Effect of tillage and fertilizer treatment on plant height

(cm)

Treatment	Tillage pactices		Means
	Cultivator	Moldboard	
Control	110.882 NS	121.017	115.949 b
RF	118.643	124.432	121.538 a
FYM	110.628	119.932	115.280 b
RF+FYM	119.207	122.697	120.952 a
Means	114.840 b	122.019 a	-
LSD	-	-	3.708
CV %			3.76

Means followed by same letter (s) do not differ significantly at 0.5% probability level.

Among the fertilizer treatments, the plots that received RF alone RF+FYM produced statistically same levels of plant heights but these were significantly taller than other plots. The highest plant height was recorded in RF treatment with average plant height of 121.538 cm followed by treatment RF+FYM (120.952 cm) and these were significantly higher than FYM and control treatments. The FYM plots produced the shortest plants showing 115.28 cm average plant height. The control treatment ranked third for plant height (115.949 cm), but this plant height was statistically non-significant than plant height of FYM alone treatment. The interactive effects of tillage practices with manure treatments were non-significant in plant height that was recorded in these plots. However, deep tillage with recommended dose of fertilizer produced taller plants of 124.432 cm followed by 122.697 cm plant height with deep tillage along with fertilizer dose of RF+FYM. The shortest plant height of 110.628 cm was recorded with shallow tillage along with recommended dose of fertilizer.

It was clear from the results that application of recommended dose of fertilizer significantly increased the plant height. This may be due to better availability of plant nutrients i.e., nitrogen and phosphorus for the vegetative growth of the plant. Deep tillage produced significantly taller plants than the shallow tillage which may be attributed to better growing environment for roots and utilization of resources. These results were in contrast to the findings of Sharma et al. (1988) who reported that no-tillage significantly increased plant height compared to minimum and conventional tillage which might be due to difference in agro-climatic conditions under which maize crops were grown.

Number of Leaves Plant^{-1}

On the basis of seasonal average, markedly higher numbers of leaves (15.054) plant^{-1} were produced during *kharif* 2000 compared with the number of leaves (13.355) plant^{-1}

Table 6. Effect of tillage and fertilizer treatments on number of leaves per plant

Treatment	Tillage practice		Means
	Cultivator	Moldboard	
Control	12.715 NS	13.890	13.303 c
RF	14.542	14.687	14.614 b
FYM	12.205	12.387	12.296 d
RF+FYM	17.117	16.093	16.605 a
Means	14.145 NS	14.264	-
LSD	-	-	0.7927
CV%	-	-	6.69

Means followed by same letter (s) do not differ significantly at 0.5% probability level.

produced in *kharif* 2001 (Table 1). Tillage treatments did not affect significantly number of leaves plant^{-1}. However, deep tillage produced relatively more leaves (14.264) plant^{-1} compared to shallow tillage (14.145 leaves plant^{-1}). This might be due to the effect of deep tillage that facilitated roots to penetrate deep into the soil to get more plant nutrients and moisture and in turn resulted in production of relatively tall plants. It was evident from the data that RF+FYM treatment resulted in the production of significantly more number of leaves (16.605 plant^{-1}) followed by RF treatment producing 14.614 leaves plants^{-1} (Table 6). The application of FYM alone produced significantly less number of leaves (12.296 plant^{-1}) than all fertilizer treatment including control treatment. The interactive effect of tillage with fertilizer treatments were non-significant and statistically same number of leaves plant^{-1} were recorded in these interactions. The lowest numbers of 12.205 leaves plant^{-1} have been recorded by applying shallow tillage along with FYM alone. This was probably due to the effect of manure that provided more plant nutrients during vegetative growth. The application of FYM alone promoted weeds infestation and there might be intensive competition between weeds and maize crop that resulted in production of least number of leaves.

Green Fodder Yield

Fertilizer levels significantly affected green fodder yield of maize. The RF+FYM and recommended dose of fertilizer produced statistically same level of fodder yield. On average basis RF+FYM treatment produced higher green fodder (19971.5 kg ha^{-1}) than fodder yield of 18349.1 kg ha^{-1} produced by applying recommended dose of fertilizer (Table 7). However,

Table 7. Effect of tillage and fertilizer treatment on fodder yield

(kg ha^{-1})

Treatment	Tillage practice		Means
	Cultivator	Moldboard	
Control	17651.0 NS	16906.5	17278.7 b
RF	18180.0	18518.2	18349.1 ab
FYM	17555.7	16438.3	16997.0 b
RF+FYM	19695.2	19447.8	19971.5 a
Means	18270.4 NS	17827.7	-
LSD	-	-	1356.00
CV%	-	-	9.01

Means followed by same letter (s) do not differ significantly at 0.5% probability level.

green fodder yield produced with these two fertilizer levels were significantly higher than that of the FYM and control treatments. The FYM treatment gave lowest fodder yield (16997 kg ha^{-1}) and was significantly lower than the fodder yield (17278.7 kg ha^{-1}) obtained in control treatment. The interaction of tillage practices and fertilizer treatments were non-significant. The lowest green fodder yield of 16438.3 kg ha^{-1} was recorded by in deep tillage along with FYM alone was used. These results clearly indicated the fact that nutrient availability significantly increased the biomass production. However, application of FYM promoted the weed infestation and reduced the green fodder yield of maize, but it improved overall forage yield as in RF+FYM treatment. The interaction of manure with tillage remained non-significant for green fodder yield of maize.

These results coincide with the findings of Lindsay et al. (1983), who concluded that the mean fresh yield of corn from conventional tillage was 40% more than in zero and minimum tillage. Campbell et al. (1984) concluded that autumn sub-soiling increased maize grain yield under both conventional and conservation tillage systems. Similarly Edwards et al. (1988) reported that corn yield with no tillage was 30% lower than from conventional tillage systems.

Above results showed that nitrogen and phosphorus availability significantly increased the biomass production. Tillage system did not affect the fodder yield significantly; however, deep tillage produced slightly more green fodder yield as compared to shallow tillage. These results are contrary to the findings of Lindsay et al. (1983), who reported that mean fresh yield of corn from conventional tillage was 40% more than in zero and minimum tillage.

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