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Effects of various tillage practices on the performance of forage maize (*Zea mays* L.) cutivars

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The sufficient amount and nutritious forage on regular basis is the prerequisite for livestock production to fulfill the requirements for milk, butter and other by-products for human consumption. This study was undertaken to evaluate the effect of various tillage practices on the performance of maize forage viz. Three tillage practices i.e. zero tillage, deep tillage and conventional tillage and four cultivars i.e. Sargodha 2002, Pakafgoi, Sahiwal 2002 and MMRI yellow. Results showed that Pakafgoi enhanced plant height (197.29 cm), stem diameter (1.71 cm), fresh weight (521.06 g), dry weight (104.10 g), grain forage yield (55.18t ha^{-1}) and dry matter yield (9.35t ha^{-1}). And deep tillage had improved plant height (198.18 cm), stem diameter (1.64 cm), fresh weight (522.45 g), dry weight (100.90 g), grain forage yield (53.69 t ha^{-1}) and dry matter yield (8.60). Our results showed that cultivar Pakafgoi and deep tillage improved yield and yield components.

Key words: Tillage, cultivars, growth, forage maize

INTRODUCTION

Forage is the cheapest form of feed for animals but the present forage production in Pakistan does not meet the forage requirement in terms of both quantity and quality, which consequently results in the poor nourishing of animals. There is a lot of scope and potential for increasing the supply of balanced quality forage in the country. Forage crops play a vital role in the economy of a country by providing food for livestock. Livestock is a sub-sector of agriculture in Pakistan and contributed 11.53% to the national GDP during 2011-12 (GOP, 2012). In Pakistan, forage crops are cultivated on 2.23 million hectares. Total annual forage production in Pakistan and Punjab is 49.23 and 41.17 million tons, respectively with national average forage yield of 22.0 tons per hectare (GOP, 2012). The sufficient amount and nutritious forage on regular basis is the prerequisite for livestock production to fulfill the requirements for milk, butter and other by-products for human consumption. Forage scarcity is a major limiting factor for a prosperous livestock industry in Pakistan. The livestock sector is an integral part of agriculture in Pakistan. So growing of forage crops is indeed needed in order to promote livestock production. Among cereals in Pakistan, maize (*Zea mays* L.) is the third momentous crop after wheat and rice. (Chaudhry,1983). Maize being multipurpose crop is used as food and forage in Pakistan. Near big cities, farmers grow maize as cash crop because it is widely grown for sale as green forage (Wolf *et al*., 1993).

It plays a vital role in human diet, animal feed by providing adequate amount of energy and protein. It provides nutritious forage to livestock especially milch animals (Nazir, 1994).

Approximately two third of the total maize produced in world is used for animal feed, starch and commercial oil production. Its forage has greater nutritional value as it contains about0.3% fat 10% protein, 72% starch, 1.7% ash and 5.8% fiber 3% suger and 4.8% oil. However, significant variations exist for nutritional quality attributes of its stem and whole plant forage (Noor *et al.,* 2010).Increased cropping intensity coupled with the adoption of inefficient crop management techniques has resulted in low crop productivity. Due to low yield per hectare and less area under forage crops, the available forage supply is one third less than the requirement and shortage is further being increased due to reduction in area under forage crops by 2% after each decade (Sarwar *et al.,* 2002). The low yield is primarily due to substandard methods of cultivation, poor crop stand, malnutrition, poor plant protection measures and use of low yielding verities. The importance of forage crops in agriculture needs emphasis because of the fact that regular, adequate and nutritious forage is the basic requirement of livestock production to meet the demand of milk, butter and other by products for the human consumption. The yield potential and quality traits of cultivars varied significantly and influenced significantly by the environmental factors (Roth, 1994). The reduction in area and yield is due to growing pressure of human population, shortage of irrigation water, less and erratic rainfall, low priorities to forage production and imbalance use of fertilizer (Rashid *et al.,* 2007). Among the various important crop production factors tillage is an important one which contribute up to 20% in crop production. Subsoil hardening or compaction can reduce the availability and absorption of nutrient and water uptake, and resulted to reduction in yield. Tillage is considered the most effective activity on farm for developing a suitable soil structure. It improves the physical conditions of soil and favours the roots penetration of the plants, which lead to the better nutrient uptake and desired yield of crops. However, research on tillage practices for cultivating forage maize is rare in our country and farmers use conventional tillage practices. Use of excessive and unnecessary tillage operations is harmful to soil and add a lot to cost of production. Intensive conventional tillage usually degrades soil structure (Seibutis*et al*., 2009). There is need to shift from conventional tillage to minimum and zero tillage for the purpose of defending soil degradation, increasing water use efficiency, reducing the cost of production of Kharif crops and improving crop productivity. Conservation tillage (zero tillage and reduced tillage) practices at once conserve the soil and water resources, decrease farm energy usage and increase the crop production. These practices cause the constructive changes in the chemical, biological and physical properties of soil (Bescansa*et al*., 2006). On the other hand cultivars also take a great part in the production of crop. High yielding cultivars should be selected for sowing. If the emphasis is not given to the selection of good cultivars then the problem of poor production remains unsolved.

All developing countries including Pakistan are trying to increase the agricultural production to feed the increasing population. Keeping in view the above discussion, this trial has been planned with objective “To evaluate the effects of different tillage practices on the different forage maize cultivars.”

MATERIALS AND METHODS

The proposed experiment to determine the tillage and cultivars effects on the yield of forage maize *(Zea mays* L.*)* was conducted during Kharif season 2012 at Agronomic Research Area, University of Agriculture Faisalabad, Pakistan. Thee xperiment was carried out in randomized complete block design (RCBD) with split plot arrangement having three replications with net plot size of 7 m × 3 m. Seedbed was prepared by cultivating the field as per requirement of tillage intensities required in different treatments of experiment. Tillage treatments used in experiment were zero tillage, deep tillage (chisel plough followed by planking then seed sowing with manual drill) and conventional tillage (with three ploughing followed by planking then seed sowing with manual drill). Cultivars were Sargodha-2002, Pakafgoi, Sahiwal-2002 and MMRI yellow. Sowing was done with manual drill, maintaining R×R 30 cm. Soil samples were collected up to 30cm depth for soil analysis, prior to planting and after harvesting crop. NPK at recommended dose was applied in such a way that whole of the recommended PK and half of recommended nitrogen (N) was applied at sowing and remaining half dose of nitrogen (N) at the time of first irrigation.

Statistical Analysis

Data regarding all the parameters was collected using standard procedures and analyzed by using Fisher’s analysis of variance technique. LSD test at 5% probability was used to compare the differences among treatment’s means (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

Plant Population

The interaction effects of all treatments Pakafgoi gave the

maximum plant population 43.10 per m^2 under deep tillage conditions and minimum plant population 41.33 per m^2 was observed of Pakafgoi under zero tillage conditions. Similarly Sargodha-2002 produced maximum plant population 42.56 per m^2 under deep tillage conditions and minimum plant population 40.90 per m^2 was observed under zero tillage conditions. MMRI yellow performed better 42.23 per m^2 in deep tillage plots and gave minimum plant population 40.43 per m^2under zero tillage conditions. Sahiwal-2002 also had shown better results 41.76under deep tillage practices but shown poor performance under zero tillage practices mentioned in table 1.0. . Significant differences among the maize cultivars regarding the plant population have also been reported by Ayub *et al.* (1998).

Plant height (cm)

The interaction effects of all treatments Pakafgoi produced maximum plant height 199.43 (cm)under deep tillage, Pakafgoi produced plant height 198.03 (cm) under conventional tillage and minimum plant height 194.40 (cm) was observed of Pakafgoi under zero tillage conditions. Similarly Sargodha-2002 produced maximum plant height 198.03 (cm) under deep tillage conditions, 196.90 (cm) obtained from conventional tillage and minimum plant height 191.50 (cm) was observed under zero tillage conditions. MMRI yellow gave high plant height 197.70 (cm) in deep tillage plots, 194.93 (cm) produced under conventional tillage and gave minimum plant height 189.70 (cm) under zero tillage conditions. Sahiwal-2002 had shown maximum results 197.57 (cm) under deep tillage practices, same cultivar gave 193.70 (cm) plant height under conventional tillage but shown poor performance 188.43 (cm) under zero tillage practices mentioned in table 1.0. Tallest plants were produced under deep tillage conditions might be due to deep penetration of roots and good uptake of nutrients that directly affect on the plant growth. Sencor *et al.* (1993), Ayub *et al.* (1998), Makhabela *et al.* (1992) and Gozubenli *et al.* (2003) have also reported significant differences among the maize cultivars regarding plant height

Number of leaves per plant

Deep tillage shown maximum number of leaves with value 13.80 but conventional tillage gave less number of leaves 13.57 than deep tillage and Zero tillage with gave minimum number of leaves with value 12.94 than deep tillage and conventional tillage. Deep tillage produced plants with high number of leaves and Zero tillage produced minimum number of leaves shown in table 1. In case of cultivars Pakafgoi performed better and produced plants with maximum number of leaves and gave the results 13.78, Sargodha-2002 gave the value 13.56, MMRI yellow 13.25 and Sahiwal-2002 shown poor performance with value 13.15 regarding to the number of leaves per plant. In this manner Pakafgoi produces maximum number of leaves than other cultivars while Sargodha-2002 gave the minimum number of leaves and performed not better mentioned in table 1.0. Interactions between tillage practices and cultivars were non-significant regarding the data of leaves per plant. These results are exactly similar to the finding of the Baloch *et al*. (2006), Altin and Hunter (1984) who reported that there were significant differences among the hybrids of maize for number of leaves $plant^{-1}$

Stem diameter (cm)

Data regarding the interaction effects of all treatments pakafgoi gave the maximum stem diameter (1.74 cm) under deep tillage conditions, 1.72 (cm) obtained from conventional tillage and minimum stem diameter (1.68 cm) was observed of pakafgoi under zero tillage. Sargodha-2002 gave maximum results (1.69 cm) under deep tillage conditions, 1.62 (cm) in conventional tillage system and minimum result (1.59 cm) was observed under zero tillage conditions. MMRI yellow produced maximum thickness 1.60 (cm) under deep tillage system. 1.56 (cm) thickness obtained from conventional tillage with three cultivations followed by planking. MMRI yellow produced minimum thickness 1.50 (cm) in zero tillage plots.Sahiwal-2002 produced maximum results 1.53 (cm) in the deep tillage plots, under conventional tillage 1.51 (cm) stem diameter produced and shown poor results 1.40 (cm) under zero tillage system. These results were in line with the findings of Sakal *et al.* (1999) and Soomro *et al.* (2011).

Fresh weight per plant

Interaction effects of all treatments Pakafgoi produced maximum fresh 531.77 (g) per plan tunder deep tillage, but under conventional tillage Pakafgoi produced 520.77 (g) per plant and minimum fresh weight 510.63 (g) was observed of Pakafgoi under zero tillage conditions where direct sowing was done with the help of hand drill. Similarly Sargodha-2002 produced maximum fresh weight 525.27 (g) per plant under deep tillage conditions, 509.87 (g) fresh weight obtained from conventional tillage system and minimum 500.40 (g) per plant was observed under zero tillage conditions. MMRI yellow gave maximum fresh weight 521.73 (g) per plant in deep tillage plots, 506.27 (g) fresh weight produced under conventional tillage and gave minimum fresh weight 497.63 (g) under zero tillage conditions. Sahiwal-2002

Table No. 1: Effects of various tillage practices on the performance of forage maize (Zea mays L.) cultivars

		Sargodha-2002	Pakafgoi	Sahiwal-2002	MMRI Yellow	Means
Plant population (m^{-2})	Zero Tillage	40.90 ef	41.33 de	38.80 g	40.43 f	40.36 **C**
	Conventional Tillage	41.90 bcd	42.43 abc	41.46 de	41.33 de	41.78 **B**
	Deep Tillage	42.56 ab	43.10 a	41.76 cd	42.23 bc	42.41 **A**
	Means	41.78 **B**	42.28 **A**	40.67 **D**	41.33 **C**	
Plant height (cm)	Zero Tillage	191.50 f	194.40 de	188.43 h	189.70 g	191.01 **C**
	Conventional Tillage	196.90 c	198.03 b	193.70 e	194.93 d	195.89 **B**
	Deep Tillage	198.03 bc	199.43 a	197.57 bc	197.70 bc	198.18 **A**
	Means	195.48 **B**	197.29 **A**	193.23 **D**	194.11 **C**	
Number of leaves $plant^{-1}$	Zero Tillage	13.03	13.36	12.70	12.66	12.94 **B**
	Conventional Tillage	13.76	13.93	13.20	13.40	13.57 **A**
	Deep Tillage	13.90	14.06	13.56	13.70	13.80 **A**
	Means	13.56 **B**	13.78 **A**	13.15 **C**	13.25 **C**	
Stem diameter (cm)	Zero Tillage	1.59 e	1.68 c	1.40 j	1.50 i	1.54 **C**
	Conventional Tillage	1.62 d	1.72 b	1.51 h	1.56 f	1.60 **B**
	Deep Tillage	1.69 c	1.74 a	1.53 g	1.60 e	1.64 **A**
	Means	1.63 **B**	1.71 **A**	1.48 **D**	1.55 **C**	
Fresh weight $plant^{-1}$	Zero Tillage	500.40 h	510.63 ef	487.27 j	497.63 i	498.98 **C**
	Conventional Tillage	509.87 f	520.77 d	500.93 h	506.27 g	509.46 **B**
	Deep Tillage	525.27 b	531.77 a	511.03 e	521.73 c	522.45 **A**
	Means	511.84 **B**	521.06 **A**	499.74 **D**	508.54 **C**	
Dry weight $plant^{-1}$	Zero Tillage	85.37 i	95.53 e	71.80 k	78.50 j	82.80 **C**
	Conventional Tillage	97.50 d	105.13 b	88.70 h	94.37 f	96.42 **B**
	Deep Tillage	101.07 c	111.63 a	93.33 g	97.57 d	100.90 **A**
	Means	94.64 **B**	104.10 **A**	84.61 **D**	90.14 **C**	
Green forage yield t ha^{-1}	Zero Tillage	48.43 g	52.80 c	43.20 j	46.40 i	47.70 **C**
	Conventional Tillage	52.33 cd	55.66 b	47.40 h	49.03 f	51.10 **B**
	Deep Tillage	55.30 b	57.10 a	50.20 e	52.16 d	53.69 **A**
	Means	52.02 **B**	55.18 **A**	46.93 **D**	49.20 **C**	
Dry matter yield t ha^{-1}	Zero Tillage	7.60 e	8.36 d	5.73 i	6.36 g	7.01 **C**
	Conventional Tillage	8.60 c	9.33 b	6.16 h	6.43 g	7.63 **B**
	Deep Tillage	9.23 b	10.36 a	7.06 f	7.73 e	8.60 **A**
	Means	8.47 **B**	9.35 **A**	6.32 **D**	6.84 **C**	

Means not sharing same letter differ significantly using LSD at 5% Probability level.

had shown maximum results 511.03 (g) under deep tillage practices, same cultivar gave 500.93 (g) fresh weight per plant under conventional tillage but shown poor performance 487.27 (g) under zero tillage practices data regarding the interactions between tillage and cultivars mentioned in table 1.0. These results are in line with the results found by Awan (1999) who reported significant differences for fresh weight $plant^{-1}$ among different maize cultivars. The similar results also have been reported by Ayub *et al.* (1998).

Dry weight per plant

The interactions between tillage and cultivars that showed Pakafgoi produced maximum dry matter 111.63 (g) per plant under deep tillage conditions, Pakafgoi produced 105.13 (g) dry matter under conventional and minimum dry weight 95.53 (g) per plant was observed of Pakafgoi under zero tillage conditions. Sargodha-2002 produced maximum dry matter 101.07 (g) per plant under deep tillage conditions, 97.50 (g) was obtained from conventional tillage and minimum dry weight 85.37 (g) per plant was observed under zero tillage conditions.

MMRI yellow gave much dry matter 97.57 (g) per plant in deep tillage plots, 94.37 (g) dry matter was produced under conventional tillage and gave minimum dry weight 78.50 (g) under zero tillage conditions. Sahiwal-2002 produced maximum dry matter 93.33 (g) per plant under deep tillage practices with chisel ploughing, same cultivar gave 88.70 (g) dry matter under conventional tillage but it shown poor performance 71.80 (g) under zero tillage practices mentioned in table 1.0. These results are in consonance with the results of Lee and Estes (1982), Ivakhnenko *et al.* (1991), Lewis *et al.* (2005) and Turgut *et al.* (2005) who found significant variations among different genotypes of maize regarding dry weight plant^{-1}.

Green forage yield (t ha^{-1})

The interaction effects of all treatments Pakafgoi produced maximum green forage yield 57.10 (t ha^{-1}) under deep tillage conditions, Pakafgoi produced 55.66 (t ha^{-1}) forage yield under conventional tillage and minimum yield 52.80 (t ha^{-1})was observed from Pakafgoi under zero tillage conditions. Sargodha-2002 produced maximum forage yield 55.30 (t ha^{-1}) under deep tillage conditions, 52.33 (t ha^{-1}) forage yield was obtained from conventional tillage and minimum yield 48.43 (t ha^{-1}) was observed under zero tillage conditions. MMRI yellow gave high forage yield 52.16 (t ha^{-1}) in deep tillage plots, same cultivar produced 49.03 (t ha^{-1}) under conventional tillage and gave minimum 46.40 (t ha^{-1}) under zero tillage conditions. Sahiwal-2002 had shown maximum results 50.20 (t ha^{-1})under deep tillage practices, same cultivar gave 47.40 (t ha^{-1}) forage yield under conventional tillage but shown poor performance 43.20 (t ha^{-1}) yield under zero tillage practices mentioned in table 1.0. These results were in line with the results found by Ayub *et al*. (1998) and Awan (1999) who reported significant differences for green forage yield and quality among different maize cultivars. Awan *et al*. (2001) and Kusaksiz (2010) also reported significant differences for green forage yield and quality among different maize cultivars.

Dry matter yield (t ha^{-1})

Regarding the interaction effects of all treatments Pakafgoi produced maximum dry matter yield 10.36 (t ha^{-1}) under deep tillage conditions, Pakafgoi produced 9.33 (t ha^{-1}) dry matter yield under conventional tillage and minimum dry matter yield 8.36 (t ha^{-1})was observed from Pakafgoi under zero tillage conditions. Similarly Sargodha-2002 produced maximum dry matter yield 9.23 (t ha^{-1}) under deep tillage conditions, 8.60 (t ha^{-1}) dry matter yield was obtained from conventional tillage and minimum dry matter yield 7.60 (t ha^{-1}) was observed under zero tillage conditions. MMRI yellow gave highest dry matter yield 7.73 (t ha^{-1}) from deep tillage system, same cultivar produced 6.43 (t ha^{-1}) dry matter yield under conventional tillage and gave minimum yield 6.36 (t ha^{-1}) under zero tillage conditions. Sahiwal-2002 had shown maximum results 7.06 (t ha^{-1}) under deep tillage practices, same cultivar gave 6.16 (t ha^{-1}) dry matter yield under conventional tillage but it had shown poor performance 5.73 (t ha^{-1}) under zero tillage practices mentioned in table 1.0. These results are in line with the findings of Soomro *et al.* (2011), Lewis *et al.* (2004) and Turgut *et al.* (2005). They reported significant differences among the maize cultivars for dry matter yield.

CONCLUSION

The results of the study indicate that deep tillage with chisel plough followed by planking and cultivar Pakafgoi were found to be the most suitable tillage practice and cultivar than all other tillage practices and cultivars studied in the experiment for exploiting the forage yield potential of maize under the environmental conditions of Faisalabad, Pakistan.

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