The Journal of Animal & Plant Sciences, 22(2): 2012, Page: 318-323
ISSN: 1018-7081

QUALITATIVE AND QUANITATIVE RESPONSE OF FORAGE MAIZE CULTIVARS TO SOWING METHODS UNDER SUBTROPICAL CONDITIONS

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ABSTRACT

Field experiment was conducted at Agronomic Research Area, University of Agriculture, Faisalabad, Pakistan to study the influence of different sowing methods on the growth, yield and quality of different cultivars of forage maize (*Zea mays* L.). The experiment was laid out in randomized complete block design (RCBD) with split arrangement having three replications. The net plot size was 3 m x 6 m. The experiment was comprised of three varieties viz. Neelum, Pakafgoi and Sargodha 2002 and three sowing methods viz. broadcast, 30 cm apart single row and 45 cm apart double row strip. The growth, yield and quality parameters differed significantly among the different cultivars and sowing methods. The results exhibited that the maximum plant height (202.47 cm), number of leaves plant^{-1} (13.5), plant population m^{-2} (44.16) at harvest, , leaf area plant^{-1} (3885 cm^{-2}), fresh weight plant^{-1} (551.67 g), dry weight plant^{-1} (111.63 g), green forage yield (56.65 t ha^{-1}), dry matter yield (10.90 t ha^{-1}), crude protein (8.76%)and crude fibre (30.93%) showed that sowing method S_2, 30 cm apart single row with variety V_2 (Pakafgoi) provided favorable conditions for increasing the growth and yield of maize as compared to other treatments under the environmental conditions of Faisalabad.

Key words: Maize forage, varieties, sowing methods.

INTRODUCTION

Maize (*Zea mays* L.) is a dual purpose crop in Pakistan. It belongs to family Gramineae. It is being used as food and as well as an important kharif fodder grown alone and in mixture in the country (Saleem *et al*., 2003). 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 fodder production and imbalance use of fertilizer (Rashid *et al.,* 2007)

Varietals differences with respect to yield and growth characteristics have been reported by Ayub *et al.,* (1998). But Altin and Hunter (1984) reported non significant differences among the maize cultivars for whole plant dry matter yield and nutritional quality of forage. Whereas, Ayub *et al.,* (2001) observed significant differences for growth parameters, forage yield and crude protein. However, crude fiber and ether extractable fat contents were not influenced significantly. Bertoia *et al.,* (2006) observed significant variation among hybrids for stover yield and whole plant yield. On average commercial hybrids had ear yield greater but lower stover yield than land races and population hybrids. Lambe *et al.,* (1998) reported that irrigation levels and row spacing affected on the yield and growth of maize when maize was grown in 30 cm, 45 cm, and 60 cm apart rows. They concluded that yield was highest at the row spacing of 60cm. The similar results were found by Sahoo and Panda (1999), when sweet corn was planted at the row spacing of 60 × 13 cm, 60 × 16.5 cm, 60 × 20 cm, 40 × 20 cm, 40 × 25 cm and 40 × 30 cm green fodder yield with highest net profits at this spacing (40 × 30 cm).

Thus, there is a need to develop maize cultivar and appropriate sowing methods for high forage production and good quality. Therefore the present study was designed to explore the production of good quality forage and appropriate sowing method under the agro climatic conditions of Faisalabad.

MATERIALS AND METHOD

The study was conducted using a randomized complete block design in split-plot arrangement of the treatment with three replications was carried out at Agronomic Research Area, University of Agriculture, Faisalabad, (31.5°N, 73.09°S) during 2009. Experimental site belongs to Lyallpur soil series. ph of the saturated soil paste was 7.8 and total soluble salts 1.2 dsm^{-1}. The net plot size of 3 m × 6 m. total nitrogen, available phosphorus, organic matter and potassium were 0.075, 12.8 ppm, 0.75 %, 108 ppm respectively. The experiment comprised three cultivars of forage maize namely Neelum**,** Pakafgoi and Sargodha 2002 and three sowing methods viz., Broadcast, 30 cm apart single row and 45 cm apart double row. A basal dose of fertilizer nitrogen is 100 kg ha^{-1} and of phosphorus is 60 kg and 100 kg K_2o ha^{-1} was applied fertilizers used were urea (46 % N), single super phosphate (18 % P, 46 % gypsum) and sulfate of potash (K_20 50 %). Half dose of the nitrogen along with full dose of phosphorus and potash was applied at the time of sowing, while remaining half of nitrogen was top dressed at first irrigation.

Statistical analyses: The data on different agronomic traits, green forage yield, protein content and fiber contents were collected and subjected to analysis of variance according to Steel *et al.* (1997) to sort out significant differences among treatments. Differences among means were compared using LSD at 5% probability level.

RESULTS AND DISCUSSION

Plant population at harvest (m^{-2}): The plant population per unit area at harvest is one of the most important yield contributing factors in fodder crops. The data regarding the plant population m^{-2} as influenced by different varieties and sowing methods are presented in the Table 1. It is evident from the table that the effect of variety on plant population was significant. The effect of sowing methods was also significant. However the interactive effect of both variety and sowing methods (V x S) was non-significant. Maximum plant population (42.53) was found in variety V_2 (Pakafgoi) which was followed by V_1 (Neelum) with a plant population of 41.13 m^{-2} that was at par with V_3 (Sargodha-2002) having plant population of 40.70 m^{-2}. While data regarding sowing methods, reflected that the maximum plant population (43.24) was observed in S_2 (30 cm apart single row) which was followed by S_3 (45 cm apart double row strip) with plant population of 40.66 m^{-2} which was at par with S_1 (broadcast method) with plant population of 40.78 m^{-2}. The variation in plant population may be attributed due to genetic variability, better and efficient utilization of resources like space, air, water and nutrients. These results are in close association with the findings of Niamatullah *et al.* (2011) who reported significant differences regarding plant population of maize.

Plant height (cm): Table 1 showed that the effect of variety on plant height was significant. Similarly the effect of sowing methods was also found significant while the interactive effect of both variety and sowing methods (V x S) was non-significant.

The maximum plant height (199.26 cm) was found in variety V_2 (Pakafgoi) which was followed by V_3 (Sargodha-2002) with a plant height of 178.46 cm. The minimum plant height was found in variety V_1 (Neelum) with a plant height of 160.90 cm. While data regarding sowing methods, reflected that the maximum plant height (182.18 cm) was found in S_2 (30 cm apart single row) which was followed by S_3 (45 cm apart double row strip) with plant height of 178.29 cm and was at par with S_1 (broadcast method) with plant height of 178.14 cm. The results of present study are in accordance with the findings of Rasheed *et al.* (2003) who reported significant variations in plant height among different plantation methods. Hussain *et al.* (2010) and Awan *et al.* (2001) also reported significant variation in plant height among different maize cultivars. Gokmen *et al.* (2001) also reported significant results regarding plant height in response of planting methods.

Number of leaves $plant^{-1}$: In the growth and development of plant the number of leaves $plant^{-1}$ plays an important role because they manufacture and supply food material synthesized during photosynthesis. Resulting an increase or decrease in number of leaves $plant^{-1}$ has a direct effect on the green forage yield of fodder crops. The data for number of leaves $plant^{-1}$ presented in table1.

Statistically the maximum number of leaves $plant^{-1}$ (13.13) found in variety V_2 (Pakafgoi) which was differed by V_3 (Sargodha-2002) with a number of leaves $plant^{-1}$ of 11.32. The minimum number of leaves $plant^{-1}$ were found in variety V_1 (Neelum) with number of leaves $plant^{-1}$ 9.51. While data regarding sowing methods, reflected that the maximum number of leaves $plant^{-1}$ (11.67) were observed in S_2 (30 cm apart single row) that was significantly differed by S_1 (broadcast method) with number of leaves $plant^{-1}$ of 11.28. Minimum number of leaves $plant^{-1}$ (11.01) observed in S_3 (45 cm apart double row strip). These results are in conformity with those reported by Shivay and Singh (2000). Similar results were also reported by Bakht *et al.* (2006) and Memon *et al.* (2007) who found significant effect of planting methods on number of leaves per plant. Iptas and Acar (2003) and Kusaksiz (2010) reported that there were significant differences among the hybrids for number of leaves per plant.

Leaf area $plant^{-1}$ (cm^2): Table 2 showed significant differences among the varieties and sowing methods and interaction of variety and sowing methods. The maximum leaf area $plant^{-1}$ (3845.2 cm^2) was produced in the variety V_2 (Pakafgoi) which was followed by the variety V_3 (Sargodha-2002) with leaf area $plant^{-1}$of 3541.7 cm^2 while the minimum leaf area $plant^{-1}$ was recorded in the variety V_1 (Neelum) that was 2498.3 cm^2. In respect to the sowing methods, the maximum leaf area $plant^{-1}$ (3314.2 cm^2) was recorded in sowing method S_2 (30 cm apart single row) following up the treatment S_2 the sowing method S_1 (broadcast method) produced leaf area plant^{-1}of 3290.4 cm^2 which was also similar to the sowing method S_3 (45 cm apart double row strip) with leaf area plant^{-1} of 3280.6 cm ^{2}. Regarding interaction, all interacted treatments showed significant differences with each other in respect of leaf area plant^{-1}. However, the non-significant differences in respect of the combination of variety and sowing methods were recorded in V_2S_3 (Pakafgoi, sown in 45 cm apart double row strip) and V_1S_1 (Neelum, sown by broadcast method) with leaf area plant^{-1} of 3838.3 cm^2 and 3812.3 cm^2 respectively. The minimum leaf area plant^{-1} was observed in V_1S_1 (Neelum, sown by broadcast method) with leaf area plant^{-1} 2503.3 cm^2 but was statistically at par with V_1S_3 (Neelum, by 45 cm apart double row strip) and V_1S_2 (Neelum, by 30 cm apart single row). Awan *et al.* (2001) reported that leaf area per plant was significantly affected by different maize cultivars. The result of Alias *et al.* (2010) reported that leaf area index was maximum at 75 days after sowing which shows the maximum vegetative growth.

Fresh weight plant^{-1} (g): The reading of Fresh weight plant^{-1} showed in table1 significant differences among the varieties and sowing methods and interaction of variety and sowing methods. The maximum Fresh weight plant^{-1} (521.56 g) was produced in the variety V_2 (Pakafgoi) which was followed by the variety V_3 (Sargodha-2002) with fresh weight plant^{-1}of 447.78 g while the minimum fresh weight plant^{-1} was recorded in the variety V_1 (Neelum) that was 333.56 g. With respect to the sowing methods, the maximum fresh weight plant^{-1} (442.56 g) was recorded in sowing method S_2 (30 cm apart single row) which was similar with sowing method S_1 (broadcast) which was statistically significant than sowing method S_3 (45 cm apart double row strip) with fresh weight plant^{-1} 432.89 g and 427.44 g respectively. Regarding interaction, all interacted treatments showed significant differences with each other in respect of fresh weight plant$^{-1.}$ Similarly non-significant differences in respect of interactive treatments of V x S were also recorded in the combination of V_3S_2 (Sargodha-2002, sown by 30 cm apart single row) that was 442.33 g and (435.67 g) in V_3S_3 (Sargodha-2002, sown by 45 cm apart double row strip). The minimum fresh weight plant^{-1} was observed in V_1S_1 (Neelum, sown by broadcast method) with fresh weight plant^{-1} 332 g but was statistically at par with V_1S_3 (Neelum, by 45 cm apart double row strip) and V_1S_2 (Neelum, by 30 cm apart single row). The results of current study are in accordance with the findings of (Widdicombe and Thelen, 2002) who reported that yield increase of up to 10% with reduced row spacing. While Ramezani *et al.* (2011) have reported contradictory results regarding the effect of row spacing on plant fresh weight of corn forage.

Dry weight plant^{-1} (g): Table 2 showed that the effect of variety on dry weight plant^{-1} was highly significant. The effect of sowing methods was also significant. The interactive effect of both variety and sowing methods (V x S) was non-significant. Statistically maximum dry weight plant^{-1} (109.84 g) was found in variety V_2 (Pakafgoi) which was followed by variety V_3 (Sargodha-2002) with a dry weight plant^{-1}of 92.24 g, minimum dry weight plant^{-1}was found in variety V_1 with a dry weight plant^{-1}of 68.69 g. While data regarding sowing methods, reflected that the maximum dry weight plant^{-1} (91.440 g) was observed in sowing method S_2 (30 cm apart single row) which was followed by sowing method S_3 (45 cm apart double row strip) with dry weight plant^{-1}of 90.450 g. The minimum dry weight plant^{-1} (88.87 g) was observed in sowing method S_1 (broadcast method). The differences in dry weight plant^{-1}among varieties can be accredited to the differences in genetic makeup of crop plants and maximum dry weight plant^{-1}in 30 cm apart single row can be attributed to efficient utilization of resources by crop plants. Decrease in dry weight plant^{-1} in 45 cm apart double row strip can be attributed to greater competition among crop plants. The results are in contradiction with the findings of Ramezani *et al.* (2011) who reported non significant results in respect of dry weight per plant.

Green forage yield (t ha^{-1}): Table-2 showed that the effect of variety on green forage yield t ha^{-1} was highly significant. The effect of sowing methods was also significant. The interactive effect of both variety and sowing methods (V x S) was non-significant.

Maximum green forage yield (54.73 t ha^{-1}) was found in variety V_2 (Pakafgoi) which was followed by variety V_3 (Sargodha-2002) with a green forage yield of 47.20 t ha^{-1}. Statistically the minimum green forage yield was found in variety V_1 (Neelum) with a green forage yield of 39.52 t ha^{-1}. While data regarding sowing methods, reflected that the maximum green forage yield (48.35 t ha^{-1}) was observed in the sowing method S_2 (30 cm apart single row) which was followed by the sowing method S_1 (broadcast method) with green forage yield of 47.14 t ha^{-1} which was statistically at par with the sowing method S_2 (30 cm apart single row) and the sowing method S_3 (45 cm apart double row strip). The minimum green forage yield (45.95 t ha^{-1}) was observed in the sowing method S_3 (45 cm apart double row strip). The variation in green forage yield among varieties can be attributed to the differences in genetic makeup of crop plants and maximum green forage yield in the sowing method 30 cm apart single row can be attributed to efficient utilization of resources by crop plants. Decrease in green forage yield in the sowing method 45 cm apart double row strip can be attributed to greater competition among crop plants. These results are in line with the results found by Awan *et al.* (2001) and Kusaksiz (2010) who reported significant differences for green forage yield and quality among different maize cultivars.

Table 1. Mean values of some traits of maize as affected by different sowing methods and cultivars.

Treatments	Plant Population at Harvest	Plant height(cm)	Number of Leaves plant^{-1}	Leaf Area plant^{-1}	Fresh Weight plant^{-1}	Dry Weight plant^{-1}
A. Variety						
V_1	40.478b	160.90c	9.518c	2498.3c	333.56c	68.69c
V_2	43.244a	199.26	13.13a	3845.2a	521.56	109.84a
V_3	40.644b	178.46b	11.32b	3541.7b	447.78b	92.24b
LSD (0.05)	**1.2189**	**2.9118**	**0.2117**	**17.339**	**11.876**	**1.9359**
B. Sowing Methods						
S_1	41.133b	178.14b	11.28b	3290.4b	432.89ab	88.878b
S_2	42.533a	182.18a	11.67a	3314.2a	442.56a	91.440a
S_3	40.7	178.29b	11.01c	3280.6b	427.44b	90.450ab
LSD (0.05)	**1.2189**	**2.9118**	**0.2117**	**17.339**	**11.876**	**1.9359**
C. interaction						
$S_1 V_1$	40	158.73	9.47	2503.3e	332.00e	68.93
S_1V_2	41.7	197.73	13.16	3812.3b	501.33b	108.72
S_1V_3	39.733	177.97	19.23	3555.7c	465.33c	88.99
S_2V_1	42.867	164.3	9.78	2508.3e	333.67e	68.47
S_2V_2	44.167	202.47	13.5	3885.0a	551.67a	111.63
S_2V_3	42.7	179.77	11.75	3549.3cd	442.33d	94.22
S_3V_1	40.533	159.67	9.3	2483.3e	335.00e	68.66
S_3V_2	41.733	197.57	12.73	3838.3b	511.67b	109.17
S_3V_3	339.667	177.63	11	3520.0d	435.67d	93.52
LSD(0.05)	**NS**	**NS**	**NS**	**30.032**	**20.569**	**NS**

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

Table 2. Mean values of green fodder yield and protein contents as affected by different sowing methods and cultivars.

Treatments	Green forage yield (t ha^{-1})	Dry Matter Yield (t ha^{-1})	Crude Protein (%)	Crude Fiber (%)
A. Variety				
V_1	39.523c	5.69c	7.4b	25.60c
V_2	54.736a	10.45a	8.76a	30.93a
V_3	47.200b	8.33b	7.62b	28.26b
LSD (0.05)	**1.341**	**0.1473**	**0.5903**	**0.8102**
B. Sowing Methods				
S_1	47.149ab	8.07b	7.89a	28.07a
S_2	48.352a	8.54a	7.78a	28.45a
S_3	45.958b	7.86c	7.92a	28.27a
LSD (0.05)	**1.341**	**0.1473**	**0.5903**	**0.8102**
C. interaction				
S_1V_1	39.687	5.72e	7.51	25.43
S_1V_2	54.493	10.22b	8.3	30.52
S_1V_3	47.267	8.26c	7.85	28.26
S_2V_1	40.183	6.25b	7.39	25.61
S_2V_2	56.65	10.90a	8.56	31.64
S_2V_3	48.223	8.48c	7.39	28.12
S_3V_1	38.7	5.10f	6.73	25.76
S_3V_2	53.063	10.22b	9.43	30.64
S_3V_3	46.11	8.26c	7.61	28.41
LSD (0.05)	**NS**	**0.2551**	**NS**	**NS**

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

Dry matter yield (t ha^{-1}): Table-2 Showed significant differences among the varieties and sowing methods and interaction of variety and sowing methods. The maximum dry matter yield (10.45 t ha^{-1}) was obtained in the variety V_2 (Pakafgoi) that was followed by the variety V_3 (Sargodha-2002) with dry matter yield of 8.33 t ha^{-1} while the minimum dry matter yield was recorded in the variety V_1 (Neelum) that was 5.7t ha^{-1}. With respect to the sowing methods, the maximum dry matter yield (8.54 t ha^{-1}) was recorded in sowing method S_2 (30 cm apart single row) as compared to sowing method S_1 (broadcast) that was 8.07 t ha^{-1}. The minimum dry matter yield was obtained in the sowing method S_3 (45 cm apart double row strip) with dry matter yield of 7.86 t ha^{-1}. Regarding interaction, all interacted treatments showed significant differences with each other in respect of dry matter yield. However, the non-significant differences in respect of combination of variety and sowing methods were recorded in V_2S_3 (Pakafgoi, sown by 45 cm apart double row strip) and V_2S_1 (Pakafgoi, sown by broadcast method) with dry matter yield of 10.223 t ha^{-1} and 10.223 t ha^{-1} respectively. Similarly non-significant differences in respect of interactive treatments of V x S were also recorded in the combination of V_3S_1 (Sargodha-2002, sown by broadcast), V_3S_2 (Sargodha-2002, sown by 30 cm apart single row) and V_3S_3 (Sargodha-2002 sown by 45 cm apart double row strip). The minimum dry matter yield (5.7 t ha^{-1}) observed in V_1S_3 (Neelum, sown by 45 cm apart double row strip). The variation in dry matter yield among varieties can be attributed to the differences in genetic makeup of crop plants and maximum dry matter yield in 30 cm apart single row can be attributed to efficient utilization of resources by crop plants. Decrease in dry matter yield in 45 cm apart double row strip can be attributed to greater competition among crop plants. Significant differences among the maize cultivars for dry matter yield had also been reported by Lewis *et al.* (2004) and Turgut *et al.* (2005).

Conclusion: The results of the study indicate that the variety Pakafgoi and sowing method 30 cm apart single row was found to be the most suitable variety and sowing method than all other varieties and sowing methods studied in the experiment for exploiting the forage yield potential of maize under the environmental conditions of Faisalabad Pakistan.

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