SEED RATE EFFECTS ON FODDER YIELD AND QUALITY ATTRIBUTES OF MAIZE (*Zea mays* L.) VARIETIES SOWN UNDER IRRIGATED CONDITIONS

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A field study to ascertain the seed rate (80, 100,120, 140 kg ha^{-1}) effects on fodder yield and quality attributes of two maize (*Zea mays* L.) varieties, Sadaf and Neelum, was conducted during the year, 2006. Results of the current study described that Sadaf cultivar significantly increased the green fodder (58.91 t ha^{-1}) and dry matter yields (8.18 t ha^{-1}) due to increased plant height (179.69 cm), stem diameter (3.17 cm) and number of leaves per plant (13.04), leaf area per plant (2323.71 cm^2), fresh (289.96 g) and dry weights (31.03 g) per plant parallel to Neelum cultivar (*P*<0.05). Both cultivars (Sadaf and Neelum) produced statistically similar number of plants m^{-2} (28.63 and 28.16, respectively). Crude protein (8.10%), crude fiber (31.19%), ether extractable fat (1.73%) content and ash percentage (7.26%) was also increased in Sadaf cultivar. Higher seed rate significantly increased the plant population (40.16 m^{-2}), plant height (198.90 cm), stem diameter (3.99 cm), green and dry matter yield (65.50 and 8.92 t ha^{-1}, respectively), but decreased the leaf area, fresh and dry matter content while crude protein (7.66%), crude fiber (30.83%), ether extractable fat (1.66%) and ash percentage (6.70%) content was decreased to a significant extent (*P*<0.05). Maximum crude protein, crude fiber, crude fat and ash contents were attained at lower seeding density. The seed rate of 80 and 100 (kg ha^{-1}) remaining at par in relation to protein and fat production. Maize cultivar Sadaf sown at seed rate of 140 kg ha^{-1} was the best combination for getting higher green fodder yield under irrigated conditions.

Keywords: Seed rate, fodder yield, quality attributes, crude protein, ether extractable fat, ash percentage, *Zea mays* L.

INTRODUCTION

Maize (*Zea mays* L.) is one of the leading cereal and fodder crop in the world. Basically it is a tropical plant but at present it is being cultivated extensively with equal success in temperate, tropical and sub-tropical regions of the world (Tahir *et al*., 2009). Due to its high production potential ability, quick growing nature, wider adaptability, excellent fodder quality, succulency, palatability and free from toxicants, it can safely be fed to livestock at any crop growth stage (Mahdi *et al*., 2011).

About 60 percent maize is grown in irrigated and 36 percent in rain fed areas of Pakistan as third most important cereal crop after wheat and rice. It is a short duration crop and is grown twice a year. In Pakistan grain yield of maize is very low contrast to other maize growing countries like Argentina (5650 kg ha^{-1}), China (4570 kg ha^{-1}), Canada (6630 kg ha^{-1}) and Italy producing average maize yield of 9530 kg ha^{-1} (Abuzar *et al*., 2011). At present, in Pakistan maize is cultivated as a fodder crop at an area of 9.39 million ha, while its total fodder production is 3.34 million tons with an average yield of 3264 kg ha^{-1} (Govt. of Pakistan, 2011).

Many environmental, cultural and genetic characters influence on maize forage yield. Fodder scarcity is among the core limiting constraint for flourishing livestock industry in Pakistan. Animals are deficient in protein and energy by 60% and 40%, respectively. Corn is a prime source of energy in dairy industry as produced high yield and high energy forage with lower labor and machinery requirements than other forage types (Sial and Alam, 1988). Although maize is extensively grown in Pakistan as a fodder crop but its yield is very low. Maize hybrid selection and seed rate are important management considerations for successful fodder production in dairy and livestock operations (Ayub *et al*., 1999; Ayub *et al*., 2000). Seedling density is one more imperative agronomic factor that greatly manipulates the micro climate of the field and eventually maize fodder yield through influencing the growth, yield and quality parameters but Sharma *et al*. (1996) and Ahmad (2003) reported that dry matter accumulation in main axis is unaffected by increased population. Increased population reduced the weight per plant, tiller numbers per plant and leaf area at 50% anthesis. Similarly, increase in seed rate significantly improved the plant density, plant height, dry weights, relative growth rate and fodder yield but considerably decreased the quality parameters of forage like stem diameter (cm), leaf area, crude fibre (%), extractable fat (%), crude protein (%) and ash percentage (Ayub *et al*., 2002; Malik *et al*., 2007; Valadabadi and Farhani, 2010). Increasing seed rate from 40 to 80 kg ha^{-1} has registered significantly higher green and dry fodder yield (Tiwana *et al*., 2007; Pradhan *et al*., 2009). Among summer fodders, it is an important quick growing

fodder available throughout the long summer (Ahmed *et al.*, 2001). Since the introduction of spring maize cultivation in Pakistan there has been gradual increase in planting maize during spring season in the irrigated low land areas of Punjab. Maize crop does not have tillering capacity to adjust variations in plant stand, thus good hybrid selection and optimum seed rate for forage production are vital management decisions for booming fodder production (Allen *et al.*, 1997; Njoka *et al.*, 2005).

Keeping in view the above facts, the proposed study was designed to determine the optimum seed rate and suitable variety to obtain maximum maize fodder yield grown under agro-climatic conditions of Faisalabad.

MATERIALS AND METHODS

Site and soil description: The planned study was conducted at the Post-graduate Agriculture Research Station, University of Agriculture, Faisalabad. The experimental site was situated by $73°\ 06^{'}$ E, $31^{0}\ 26^{'}$ N and at altitude of 184.4m above sea level with semi-arid climate. Before sowing the crop the experimental soil was analyzed for their physico-chemical properties (Table 1). Mean monthly rainfall, relative humidity and air temperature was recorded from meteorological observatory in the immediate vicinity of the field during the phase of crop development (Fig. 1).

Table 1. Physico-chemical analysis of experimental site

Properties	Unit	Value
Sand	%	27
Silt	%	38
Clay	%	43
Saturation percentage	%	31.6
Electrical conductivity	dS m^{-1}	1.79
pHs	--	8.5
Organic matter	%	0.95
Total Nitrogen	%	0.23
Available Phosphorus	ppm	1.00
Extractable Potassium	mg kg^{-1}	186

Treatments and experimental design: The experiment was laid out in a randomized complete block design (RCBD) with split plot arrangement in a triplicate run having net plot size of 3m × 6m. The varieties were randomized in main plots while seed rates in sub plots. The experiment comprised of following treatment combinations;

  Varieties: (V$_1$= Sadaf, V$_2$= Neelum)

  Seed rates: (S$_1$= 80, S$_2$=100, S$_3$=120, S$_4$= 140) kg ha^{-1}

Crop husbandry: The crop was sown in August, 2006 on well prepared seedbed in 30 cm apart rows with the help of single row hand drill. The whole of phosphorous and potash along with half dose of nitrogen was applied at the time of sowing and remaining half of nitrogen was applied at knee

height. The crop was thinned out at 3-4 leaf stage in order to maintain the optimum plant population. All other agronomic practices were kept normal and uniform for all treatments except seed rate. The crop was harvested on October 4, 2006 and kept in the respective plots for sun drying. The cobs were removed from the dry stalks, unsheathed and threshed mechanically with the help of corn sheller.
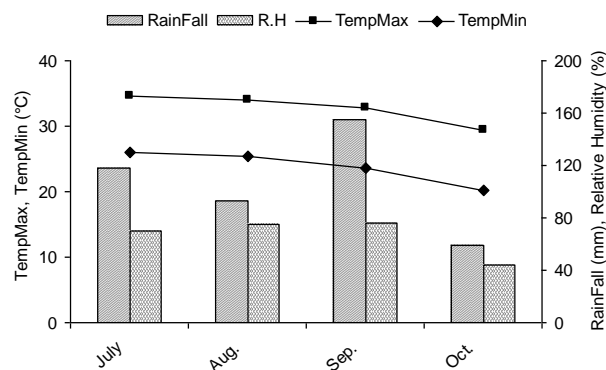

Figure 1. Mean monthly minimum and maximum temperatures, relative humidity and rainfall

Data recording: Pre planned observations on growth and yield parameters of crop as number of plants m^{-2}, plant height (cm), leaves per plant, stem diameter (cm), fresh weight per plant (g), dry weight per plant (g), leaf area, green fodder yield (t ha^{-1}), dry matter yield (t ha^{-1}), crude protein (%), crude fiber (%), ether extractable fat (%) and total ash (%) were recorded using standard procedures.

Procedures for recording quality parameters crude protein (%): 1.0 g of oven dried plant material, 30 ml of concentrated H_2SO_4 and 5 g digestion mixture [K_2SO_4; $CuSO_4$; $FeSO_4$ (100g; 10g; 5g)] was mixed, digested on the gas heater in Kjeldhal digestion flask, cooled and made up the volume to 100 ml. 10ml aliquot was taken out of this for distillation. Nitrogen evolved as ammonia was collected in a receiver containing boric acid (2%) solution and mixed indicator (Bromocresol green and methyl red) and titrated against standard (0.1N) H_2SO_4 The reading obtained after titration against H_2SO_4 was then multiplied by 6.25 to get crude protein percentage. Crude protein percentage was calculated by using the formula:

$$\% \ N = \frac{\text{Vol. of N/10 } H_2SO_4 \text{ used} \times 0.0014 \times 250 \times 100}{\text{Weight of sample} \times 10}$$

  Crude protein (%) = % N × 6.25

Crude fibre (%): 1.0 g of oven dried plant material was put in 250 ml beaker, added 1.25% H_2SO_4 and distilled water and made up the volume to 200 ml. It was heated for 30 minutes and then filtered and washed. Again added 1.25% NaOH and distilled water and made up the volume to 200

ml. Heated again, filtered and washed, dispensed in crucible and placed in oven at 10°C for 24 hours. On drying, it was weighed (W_1) and placed the crucible on flame and ignited. When smoke disappeared it was placed in muffle furnace at 600°C till grey or white ash was obtained. Then it was cooled and weighed (W_2). The crude fiber percentage was calculated by using the formula:

Crude fibre (%) = W_2-W_1/ Sample weight × 100

Ether extractable fat (%): 1.0 g of oven dried plant sample was taken in extraction thimble and plugged it with cotton. Positioned the thimble in Soxhlet (extraction apparatus), consisting of three major parts condenser, jacket containing the sample and flask. Added ether in flask (250 ml or 500 ml flask) and connected condenser in inlet and outlet water tube, and placed the flask on hot plate in order to avoid direct heating. Ether in the flask evaporated at 40-60°C and vapors moved to condenser and condensed there to form ether that felon the sample in the jacket. Ether after extracting fat from the sample fell in the flask through siphon tube. This process continued for 6-8 hours until whole of the fat was extracted. Then detached the flask, added the mixture (ether fat) in reweighed beaker (W_1) and placed in oven. Ether evaporated and fat was left. Ether extractable fat percentage was calculated by using the formula:

W_1= Weight of empty beaker
W_2= Weight of beaker + fat
Ether extractable fat(%)=W_2-W_1/Sample weight (1.0g)×100

Total ash (%): Weighed the empty dry crucible (W_1), added 1.0 g of oven dried sample in crucible, placed it in muffle furnace; heated at 600°C for one hour, cooled and reweighed (W_2). Ash percentage was calculated by using the formula:

Ash (%) = W_2-W_1/ Sample weight × 100

Statistical analysis: Data of various growth and yield parameters were analyzed statistically by using Fisher's analysis of variance techniques and Duncan's New Multiple Range Test (DMRT) at 5% probability level was employed to compare the significance of treatments' means (Steel *et al*., 1997).

RESULTS AND DISCUSSION

Plant population (m^{-2}): Both varieties had statistically similar plant population and the number of plants were (28.63 m^{-2}) and (28.16 m^{-2}) for cultivar Sadaf and Neelum, respectively. The non-significant difference between varieties for plant density might have been due to similar seed size and germination percentage. The plant population was significantly influenced by the seed rates. A progressive and significant increase in plant population was observed with the increase in seed rate (*P*=0.05). The maximum (40.16 m^{-2}) and minimum (17.94 m^{-2}) plant density was observed at 140 kg and 80 kg seed rate per hectare, respectively (Table 2, 3). Interaction between varieties and

seed rates was non-significant. If the seed size is the same then it is quite obvious to get higher plant population at higher seed rate (Rafiq *et al*., 1996).

Plant height (cm): Plant height was not affected significantly by the varieties (Table 2, 3). Cultivars Sadaf and Neelum produced a plant height of 179.69 cm and 176.84 cm, respectively. The minimum plant height (162.2 cm) was recorded at the lowest seed rate (80 kg ha^{-1}) and it was statistically different from 100 kg ha^{-1} and 120 kg ha^{-1}. The maximum significant plant height (198.90 cm) was attained with seed rate (140 kg ha^{-1}) (*P*=0.05). These findings are in confirmation to those of Ayub *et al*. (1998) and Ahmed *et al*. (2001) but are contradictory to the results of Sencor *et al*. (1993), who depicted that contradictory results may be due to variation in soil fertility, environment and genetic makeup of varieties.

Leaves per plant: The data regarding varieties and seed rates showed non-significant effects on number of leaves per plant (Table 2, 3). The maximum leaves per plant (13.31) were acquired in plots where seed rate (120 kg ha^{-1}) was applied (*P*=0.05). Seed rates (80 & 100 kg ha^{-1}) showed statistically similar results in terms of number of leaves per plant (12.74 & 12.85, respectively). The minimum leaves per plant were observed in plots receiving seed rate (140 kg ha^{-1}). Interaction between varieties and seed rates was illustrated non-significant in current study. These results are contradictory with the findings of Khan (1995) and Safdar (1997), who revealed that the highest number of leaves per plant was obtained with highest planting density.

Stem diameter (cm): The data presented in (Table 2, 3) indicated that the difference in stem diameter between varieties was non-significant. This non significant difference between varieties for stem diameter can be attributed to the similar genetic makeup of the varieties. Stem diameter was affected significantly by seed rate treatments (*P*=0.05). A progressive and significant decrease in stem diameter was observed with the decrease in seed rates. Plots sown at seed rate (140 kg ha^{-1}) resulted in significantly higher stem diameter (3.99 cm) than all other seed rates. The minimum stem diameter (2.45 cm) was observed in plots that sown at 80 kg ha^{-1} seed rate. Combined study was also non-significant. These findings are quite in line with Siddique *et al*. (1989).

Fresh and dry weights (g): The maximum fresh weight per plant (348.8 g) was recorded for the lowest seeding density S_1 (80 kg ha^{-1}) and minimum fresh weight per plant (196.70 g) was observed at highest seeding density S_4 (140 kg ha^{-1}). Sadaf cultivar gave maximum fresh weight (289.96 g) contrast to Neelum cultivar (260.81 g). These results are in strong support by Shieh and Lu (1992). The cultivar Sadaf gave significantly higher oven dry weight (31.03 g) than cultivar Neelum (28.26 g). The crop sown at seed rate of 80 kg ha^{-1} produced significantly higher fresh and dry weights (348.80 & 38.52 g, respectively) than all other seed rates and

Table 2. The mean squares of varieties and seed rate treatments on yield attributes of maize (*Zea mays* L.)

Source of Variation	df					Mean square				
		Plants population (m^{-2})	Plant height (cm)	Leaves/ plant	Stem diameter (cm)	Fresh weight per plant (g)	Dry weight per plant (g)	Leaf area per plant (cm^2)	Green fodder yield (t ha^{-1})	Dry matter yield (t ha^{-1})
Replication (r)	2	0.45	6.29	0.54	0.12	15.55	3.48	25749.32	1.53	0.13
Varieties (V)	1	1.32	48.79	0.46	0.29	5098.63**	45.93**	15472.66**	113.40	3.06**
Error a	2	0.33	10.04	0.77	0.42	68.66	1.67	3612.14	6.125	0.16
Seed rate (S)	3	571.14**	1481.94**	0.46	0.78	25964.83**	311.59**	353245.5**	345.17**	4.35**
V × S	3	0.07 NS	6.38 NS	0.25 NS	0.03 NS	79.98 NS	1.01 NS	5526.34 NS	2.64 NS	0.01 NS
Error b	12	0.58	21.54	0.87	0.01	85.59	0.81	9048.63	1.96	0.05

NS= Non-significant; **= Indicates the significance at 5% levels of probability.

Table 3. The response of yield attributes of maize (*Zea mays* L.) varieties to different seed rate treatments

Treatments	Plant population (m^{-2})	Plant height (cm)	Leaves/ plant	Stem diameter (cm)	Fresh weight per plant (g)	Dry weight per plant (g)	Leaf area per plant (cm^2)	Green fodder yield (t ha^{-1})	Dry matter yield (t ha^{-1})
Varieties (V)									
V$_1$= Sadaf	28.63	179.69	13.04	3.17	289.96 a	31.03 a	2323.71	58.91 a	8.18 a
V$_2$= Neelum	28.16	176.84	12.76	2.96	260.81 b	28.26 b	2272.92	54.56 b	7.47 b
LSD (*P*= 0.05)	NS	NS	NS	NS	13.58	1.29	NS	2.89	0.19
Seed rate (S) kg ha^{-1}									
S$_1$= 80	17.94 d	162.20 d	12.74	2.45 c	348.80 a	38.52 a	2576 a	47.46 d	6.90 d
S$_2$= 100	23.44 c	171.10 c	12.85	2.53 b	304.30 b	32.17 b	2413 b	54.81 c	7.50 c
S$_3$= 120	32.05 b	180.90 b	13.31	2.60 b	251.80 c	25.70 c	2169 c	59.18 b	7.97b
S$_4$= 140	40.16 a	198.90 a	12.72	3.99 a	196.70 d	22.22 d	2034 d	65.50 a	8.92 a
LSD (*P*= 0.05)	1.35	6.27	NS	0.12	15.79	1.37	115.7	3.16	0.25
Interaction (V×S)	NS	NS	NS	NS	NS	NS	NS	NS	NS

Any two means not sharing a letter differ significantly at 5% probability level according to (DMR) test.

was followed by seed rate of 100, 120 and 140 kg ha^{-1}, respectively (*P*=0.05). The higher fresh and dry weights at higher seeding densities have been due to higher number of plants (m^{-2}) and plant height (Table 2, 3). These results are in agreement with those of Begna *et al*. (2000). The interaction between varieties and seeding densities was found non-significant. There had been a consistent increase in fresh and dry biomass with the successive increase in planting density.

***Leaf area per plant (cm^2)*:** The leaf area per plant is an important physiological yield determining variable and is influenced differentially by various agronomic practices. The data in respect of leaf area per plant showed that both varieties had statistically similar leaf area per plant and values recorded were 2323.71 cm^2 and 2272.92 cm^2 for Sadaf and Neelum, respectively (Table 2, 3). Comparison of seed rate showed that the lowest seed rate S$_1$ (80 kg ha^{-1}) followed by S$_2$ (100 kg ha^{-1}), S$_3$ (120 kg ha^{-1}) and S$_4$ (140 kg ha^{-1}) produced significantly higher leaf area (2576 cm^2) per plant (*P*=0.05). Minimum leaf area per plant (2034 cm^2) was observed at the highest seeding density S$_4$ (140 kg ha^{-1}). The higher leaf area per plant at low planting density might have been due to less competition for nutrients and sunlight among the plants. These results are contradictory to that of (Cox, 1996). The interaction between seeding densities and varieties was not significant.

***Green fodder yield (t ha^{-1})*:** The statistical analysis along with the summary of treatment means is presented in Table 2 and 3. Both varieties had statistically different green fodder yield and the yields were 58.91 and 54.56 t ha^{-1} for cultivar Sadaf and Neelum, respectively (*P*=0.05). The seeding densities differed significantly for green fodder yield per hectare. Increase in yield was observed with the increase in seed rate. The crop sown at seed rate of 140 kg ha^{-1} produced significantly higher green fodder yield (65.50 t ha^{-1}) than other seed rates and was followed by seed rate of 120, 100 and 80 (kg ha^{-1}) with yield of 59.18, 54.81 and 47.46 (t ha^{-1}), respectively.

The higher seed rates at higher seeding densities have been due to number of plants (m^{-2}) and plant height (cm). These results are in agreement with those of Begna *et al*. (2000) and Ahmed *et al*. (2001). The interaction between varieties

and seeding densities was found non-significant.

***Dry matter yield (t ha^{-1})*:** The data presented in Table 2 & 3 described that cultivar Sadaf produced significantly more dry matter (8.18 t ha^{-1}) than cultivar Neelum (7.47 t ha^{-1}). Significant differences amongst the maize cultivars for dry matter yield have also been reported by Ballard *et al*. (2001). The interaction between varieties and seeding densities was found non-significant. Dry matter yield was also influenced significantly by the seeding densities (*P*=0.05). There had been a consistent increase in dry matter with the successive increase in dry matter with the successive increase in planting density. Maximum dry matter yield (8.92 t ha^{-1}) was recorded for highest seeding density S$_4$ (140 kg ha^{-1}) which was significantly higher than other treatments. Minimum dry matter yield (6.90 t ha^{-1}) was obtained from the plots which were planted at the seed rate of 80 kg ha^{-1}. Similar results are in strong line which have already been reported by Graybill *et al*. (1991) and Cox and Cherney (2001).

Quality attributes:

***Crude protein content (%)*:** Protein content is considered one of the most important parameter affecting the palatability and nutritional value of fodder crop. Both varieties had statistically similar crude protein content (Table 4, 5) and value recorded was 8.10% and 7.92% for Sadaf and Neelum, respectively. These results are quite similar to those of Ayub *et al*. (1998) but are in contradictory to those of Simic *et al*. (2003). Seeding densities affected the crude protein percentage significantly (*P*=0.05). Seeding density of 80 kg ha^{-1} remained at par with 100 kg ha^{-1} than seeding densities of 120 and 140 kg ha^{-1} which gave maximum crude protein content (8.27% and 8.22%, respectively). The difference between seeding densities of 120 and 140 kg ha^{-1} was significant. These results are against the findings of Safdar (1997). The minimum protein content (7.66%) was observed in plots with seeding density of 140 kg ha^{-1}. Similar effect of seeding density on crude protein was observed by Silva (1986). The combined effect between seeding density and cultivars was non-significant.

***Crude fibre content (%)*:** Crude fibre percentage is another attribute that influence the quality of fodder crops. The crude fibre content is lower at early growth stages and gradually

Table 4. The mean squares of varieties and seed rate treatments on quality attributes of maize (*Zea mays* L.)

Source of Variation	df	Mean square			
		Crude protein (%)	Crude fiber (%)	Ether extractable fat (%)	Total ash (%)
Replication (r)	2	0.08	0.04	0.001	0.04
Varieties (V)	1	0.19	0.82	0.023	2.89[**]
Error a	2	0.03	0.04	0.001	0.001
Seed rate (S)	3	0.48[**]	0.41[**]	0.011	0.25[**]
V × S	3	0.06[NS]	0.27[NS]	0.001[NS]	0.08[NS]
Error b	12	0.04	0.13	0.006	0.008

NS= Non-significant; **= Indicates the significance at 5% levels of probability.

Table 5. The response of quality attributes of maize (*Zea mays* L.) varieties to different seed rate treatments

Treatments	Crude protein (%)	Crude fiber (%)	Ether extractable fat (%)	Total ash (%)
Varieties (V)				
V_1= Sadaf	8.10	31.19 a	1.73 a	7.26 a
V_2= Neelum	7.92	30.82 b	1.66 b	6.56 b
LSD (*P*=0.05)	NS	0.33	0.90	0.78
Seed rate (S) kg ha^{-1}				
S_1= 80	8.22 a	33.39 a	1.75	7.16 a
S_2= 100	8.27 a	30.98 ab	1.69	6.99 b
S_3= 120	7.92 b	30.85 b	1.67	6.79 c
S_4= 140	7.66 c	30.83 b	1.66	6.70 c
LSD (*P*=0.05)	0.20	0.50	NS	0.12
Interaction (V × S)	NS	NS	NS	NS

Any two means not sharing a letter differ significantly at 5% probability level according to (DMR) test.

increases with the age of the plant. The more the crude fibre percentage in the feeding material, the more will be its quality. Table 4 & 5 illustrates that neither varieties and nor seeding densities affected the crude fibre percentage to a significant extent. The results are strongly supported by the findings of Cox and Cherney (2002). A slight increase in crude fibre percentage was experienced with the successive increase in seeding density. The maximum crude fibre percentage (33.39%) was observed for S_1 (80 kg ha^{-1}) in contrast to minimum crude fibre percentage (30.83%) for S_4 (140 kg ha^{-1}) as the crude fibre remained higher both for varieties and seeding densities (*P*=0.05). The interaction effect between seeding density and cultivars was non significant. The crude fibre percentage is mainly influenced by growth stage and harvesting time as the plots were sown and harvested on the same day having same growth stage and ultimately containing similar fibre percentage (Nass and Coors, 2003).

***Ether extractable fat (%)*:** The data presented in Table 4 & 5 revealed that ether extractable fat percentage was affected significantly by both varieties and seeding rates (*P*=0.05). Both varieties (Sadaf and Neelum) did not perform similar in terms of fat percentage values. The maximum ether extractable fat percentage (1.73%) was yielded by the Sadaf variety compared to Neelum (1.66%). Comparable results were also reported by Ayub *et al.* (1998). Ether extractable fat percentage was not significantly influenced by the seeding densities as the seed rate of 80 kg ha^{-1} remained at par with 100 kg ha^{-1} and produced almost higher fat percentage (1.75%) than other seed rate treatments. The difference among the seed rates 100, 120 & 140 (kg ha^{-1}) was not statistically significant. The minimum fat value (1.66%) was recorded at the maximum seeding density (140 kg ha^{-1}). The higher fat value at the lowest seeding density might have been due to the reason that plants grown at wider distance exploited more soil and aerial environment resources (Vindis *et al.*, 2010). The combined effect between seeding density and cultivars was no-significant.

***Total ash (%)*:** Significant differences between varieties and seeding densities were observed for total ash percentage (Table 4 & 5). The data depict a clear distinction for total ash percentage accounted in Sadaf (7.26%) and Neelum (6.56%) varieties (*P*=0.05). Kim *et al.* (1992) have also reported the significant differences amongst the maize cultivars for ash content of whole plant. A decrease in ash percentage was observed with increase in seeding density. The difference among the seeding densities was also significant. The maximum (7.16%) and minimum (6.99%) total ash percentage was evidenced at seeding densities of 80 and 100 kg ha^{-1}, respectively. The interaction of seeding density and cultivars was also non-significant. Qureshi (1964) has also stated that a decrease in ash content of maize occurred as a result of increase in plant population but increase could not reach to a significant extent.

CONCLUSIONS

Maize is perhaps the most potential seasonal crop for its higher productivity and diverse uses by virtue of its capability of solar interception. As the green fodder and dry matter yields were increased with increasing seed rates while cultivar Sadaf performed better having more plant height, stem diameter, leaf area per plant (cm^2), leaves per plant, fresh and dry weights per plant. Accordingly, from the above discussion it is quite obvious that maximum fodder can be gained from cultivar Sadaf by sowing at the highest seed rate of 140 kg ha^{-1}.

REFERENCES

Abuzar, M.R., G.U. Sadozai, M.S. Baloch, A.A. Baloch, I.H. Shah, T. Javaid and N. Hussain. 2011. Effect of plant population densities on yield of maize. J. Animal & Plant Sci. 21:692-695.

Ahmed, M., M.S. Shaheen and M.S. Chaudhry. 2001. Effect of different seed rates and fertilizer doses on fodder yield of maize. Pak. J. Agric. Res. 41:23-32.

Ahmad, I. 2003. Influence of seed rate and phosphorus fertilization on growth, fodder yield and nutritive value of pearl millet (*Pennisetum americanum* L.) M.Sc. Thesis, Dept. Agron, Univ. of Agric. Faisalabad, Pakistan.

Allen, M.S., M. Oba, D, Stroke and J.F. Beck. 1997. Effect of brown midrib 3 gene forage quality and yield of corn hybrids. J. Dairy Sci. 80:157.

Ayub, M., R. Mahmood, A. Tanveer and M.S. Sharar. 1998. Effect of seeding density on the fodder yield of two maize varieties. Pak. J. Biol. Sci. 2:664-666.

Ayub, M., R. Mahmood, A. Tanveer and M.S. Sharar. 1999. Effect of seeding density on the fodder yield and quality of two maize varieties. Pak. J. Biol. Sci. 2: 664-666.

Ayub, M., A. Tanveer, R. Ahmad and M. Tariq. 2000. Fodder yield and quality of two maize (*Zea mays* L.) varieties at different nitrogen levels. The Andhra Agric. J. 4:7-11.

Ayub, M., A. Tanveer, S. Ali and M.A. Nadeem. 2002. Effect of different nitrogen levels and seed rates on growth, yield and quality of sorghum (*Sorghum bicolor* L.) fodder. Ind. J. Agric. Sci. 72:648- 656.

Begna, S.H., R.I. Hamilton, L.M. Dwyer, D.W. Stewart and D.L. Smith. 2000. Variability among maize hybrids differing in canopy architecture for above-ground dry matter and grain yield. Maydica 45:135-141.

Ballard, C.S., E.D. Thomas, D.S. Tsang, P. Mandebvu, C.J. Sniffen, M.I. Endres and M.P. Carter. 2001. Effect of corn silage hybrid on dry matter yield, nutrient composition, in vitro digestion, intake by dairy heifers, and milk production by dairy cows. J. Dairy Sci. 84:442-452.

Cox, W.J. 1996. Whole plant physiological and yield responses of maize to plant density. Agron. J. 88:489-496.

Cox, W.J. and D.J.R. Cherney. 2001. Influence of brown midrib, leafy and transgenic hybrids on corn forage production. Agron. J. 93:790-796.

Cox, W.J. and D.J.R. Cherney. 2002. Evaluation of narrow row corn forage in field-scale studies. Agron. J. 94:321-325.

Govt. of Pakistan. 2011. Economic Survey of Pak, 2010-11. Finance Division, Economic Advisor's Wing, Islamabad, Pakistan .

Graybill, J.S., W.J. Cox and D.J. Otis. 1991. Yield and quality of forage maize as influenced by hybrid, planting date and plant density. Agron. J. 83:559-564.

Khan, M.A. 1995. Effect of various levels of irrigation on growth and yield of three fodder crops. M.Sc. (Hons.) Thesis, Dept. Agron, Univ. Agric., Faisalabad, Pakistan.

Kim, D.A. M.H. Jo, C.H. Kwon, K.J. Han and J.K. Kim. 1992. A comparison of agronomic performance of introduced maize hybrids for silage production. J. Korean Soc. Grassland Sci. 12:161-172.

Mahdi, S.S., B. Hasan, R.A. Bhat, M.A. Aziz, L. Singh, Faisul-ur-Rasool, I. Aalum, L. Singh and S. Bashir. 2011. Effect of nitrogen, zinc and seed rate on growth dynamics and yield of fodder maize (*Zea mays* L.) under temperate conditions. Plant Archives 11:965-971.

Malik, M.A., M. Hussain and S.I. Awan. 2007. Yield response of fodder sorghum (*Sorghum bicolor*) to seed rate and row spacing under rain-fed conditions. J. Agri. Soc. Sci. 3:95-97.

Njoka, E.M., M.M. Muraya and M. Okumu. 2005. Plant density and thinning regime effect on maize (*Zea mays* L.) grain and fodder yield. Aust. J. Exp. Agri. 44:1215-1219.

Nass, L.L. and J.G. Coors. 2003. Potential of exotic X adapted maize germplasm for silage. Maydica. 48:197-206.

Pradhan, H.S., P. Khoyumthem, S. Bala and T.K. Basu. 2009. Effect of spacing, seed placement and plant density on yield of baby corn. Envir. Ecology. 27: 173-175.

Qureshi, R.H. 1964. Effect of plant population and fertilizer on the yield and composition of maize grains. M.Sc. Agri. Thesis, Dept. of Agron., W.P.A.U. Lyallpur, Pakistan.

Rafiq, M., M.S. Akhtar and N. Muhammad. 1996. Effect of nitrogen application on fodder yield and quality of maize. J. Agri. Res. 34:107-110.

Sial, M.A. and M.l. Alam. 1988. Livestock feed resources scenario of Pakistan. Paper presented at national seminar on dairy production potential and challenges, held on 29-30 May, 1988, Univ. of Agric. Faisalabad, Pakistan.

Sharma, B.L., P.K. Sharma and S. Kumar. 1996. Effect of nitrogen and seed rate on fodder yield of pearl millet (*Pennisetum glaucum*). Ind. J. Agron. 41:595-597.

Steel, R.G.D., J.H. Torrie and D.A. Dickny. 1997. Principles and Procedures of Statistics, A Biomatrical Approach. 3rd Edition. McGraw Hill Book Co. Inc. New York, USA.

Sencor, O., A. Yildrin and S. Gokmen. 1993. Effect of sowing density on fodder and hay yields of some maize cultivars grown for silage as a second crop. Doga, Turk Tarim, Ve Ormanciki Dergisi. 17:763-773.

Safdar, Z. 1997. Optimization of nitrogen and its effect on yield and quality of maize fodder. M.Sc. (Hons.) Thesis, Dept. Agron, Univ. Agric., Faisalabad, pakistan.

Siddique, M., M.S. Bajwa and M.I. Makhdum. 1989. Yield and quality of maize fodder as influenced by different stages of harvesting and nitrogen rates. Pak. J. Sci. and Ind. Res. 32:766-767.

Shieh, G.T. and H.S. Lu. 1992. Effect of plant density on forage and grain yield of maize with different kernel types. Agri. Rws. China. 41:233-240.

Simic, D., T. Presterl, G. Seitz and H.H. Geiger. 2003. Comparing methods for integrating exotic germplasm into European forage maize breeding programs. Crop Sci. 43:1952-1959.

Silva, P.S.L.E. 1986. Effects of nitrogen levels and plant populations on protein content of green maize. Pesquisa Agropecuaria Brasileira 21:999-1001.

Tahir, M., M.R. Javed, A. Tanveer, M.A. Nadeem, A. Wasaya, S.A.H. Bukhari and J.U. Rehman. 2009. Effect of different herbicides on weeds, growth and yield of spring planted maize (*Zea mays* L.). Pak. J. Life Soc. Sci. 7:168-174.

Tiwana, U.S., K.P. Puri, B.L. Bhardwaj and S. Pritpal. 2007. Effect of seed rates and row spacings on the fodder yield of maize under different sowing dates. Range Manag. Agro Fores. 28:309-310.

Valadabadi, S.A. and H.A. Farhani. 2010. Effects of planting density and pattern on physiological growth indices in maize (*Zea mays* L.) under nitrogenous fertilizer application. J. Agric. Ext. Rural Develop. 2:40-47.

Vindis, P., B. Mursec, M. Janzekovic, D. Stajnko and F. Cus. 2010. Anaerobic digestion of maize hybrids for methane production. J. Achievements Mater. Manufac. Eng. 40:87-94.