INTERACTIVE EFFECT OF DIFFERENT NITROGEN LEVELS AND SEEDING RATES ON FODDER YIELD AND QUALITY OF PEARL MILLET

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A field experiment to evaluate the effect of 0, 50, 100 and 150 kg N ha^{-1} on pearl millet sown at seeding rate of 10, 15 and 20 kg ha^{-1} was conducted at Agronomic Research area, University of Agriculture, Faisalabad, Pakistan. Nitrogen application significantly increased the green fodder and dry matter yield due to increased plant height, stem diameter and number of leaves per plant. Crude protein and crude fibre contents were also increased due to an increase in nitrogen level. However, increase in nitrogen level decreased the ash percentage. Nitrogen application of 100 and 150 kg ha^{-1} produced statistically similar green fodder yield (79.37 and 79.74 t ha^{-1}, respectively). Increase in seed rate significantly increased the plant density, plant height, green and dry matter yield and dry matter contents but decreased the stem diameter. The number of leaves per plant, crude fibre, crude protein and ash contents were decreased with increased seed rate but not to a significant level. Pear millet sown at seed rate of 20 kg ha^{-1} and receiving 100 kg N ha^{-1} seems to be the best combination for getting higher green fodder yield of "BY-18" under Faisalabad conditions.
Key words: Crude fibre, crude protein, nitrogen, seed rate and fodder yield

INTRODUCTION

Pearl millet commonly known as bajara belongs to family Poaceae. It is a quick growing and short duration crop, grown for both fodder and grain purposes mainly under rain fed conditions because of its high tillering potential, drought and heat tolerance and high dry matter production. It is also grown in mixture with maize and sorghum in irrigated areas. Pakistan possesses animals of very good quality but majority of animals are in very poor conditions due to under feeding and the available fodder supply is 1/3 less than actual need (Younis and Yaqoob, 2005). According to Sial and Aslam (1988) animals in Pakistan are facing a deficiency both in energy and protein by 40 and 60%, respectively. Among various agronomic factors that may affect the yield and quality of millet forage, the application of nitrogen is considered to be the most important (Sharar *et al.* 1988). Sharma *et al.* (1999) reported that the number of effective tillers, ear length and stover yield increased with increasing nitrogen rates. Similarly, Cho *et al*. (2001) also obtained significant increase in plant height, leaf length, leaf width, stem diameter, dry matter and crude protein yield.

Seedling density is another important agronomic factor which greatly influences the micro climate of the field and eventually yield of agricultural crops. It can influence growth, yield and quality parameters (Tomer *et al.,* 1984, Sharma *et al*., 1996 and Ahmad, 2003). Carberry and Campbell (1985) concluded that dry matter accumulation in main axis was unaffected by increased population. Increased population reduced the weight per plant, leaf area and tiller number per plant at 50% anthesis. Similarly, Ayub *et al.*(2002) also reported that increase in seed rate significantly increased the plant density, plant height and yield but significantly decreased the stem diameter, leaf area, crude fibre, crude protein and ash percentage. Information on the interactive effect of nitrogen application and seeding rates on fodder yield and quality of pearl millet is lacking in Pakistan. The present studies were therefore, designed to evaluate the effect of seed rate and nitrogen levels on fodder yield and quality of pearl millet.

MATERIALS AND METHODS

A study pertaining to nitrogen application and seeding rate on fodder yield and quality of pearl millet was carried out at the Agronomic Research area, University of Agriculture, Faisalabad during summer 2003. The experiment was laid out in randomized complete block design with factorial arrangement having three reapplications and a net plot measuring 7m x 1.8m. Millet cultivar BY-18 sown at seed rates of 10 (S_1), 15 (S_2) and 20 (S_3) kg ha^{-1} was given nitrogen at 0 (N_0), 50(N_1), 100(N_2) and 150(N_3) kg ha^{-1}. Full dose of nitrogen in the form of urea and 60 kg phosphorus ha^{-1} in single super phosphate form were broadcasted at sowing. Crop was sown on 20th May in 2003 with single row hand drill on a well prepared seedbed in 30 cm apart rows. All other agronomic practices were kept normal and uniform for all the treatments. Ten mother tillers were selected at random for taking individual plant observations like height, stem diameter, number of leaves and leaf area per tiller. Total dry matter was calculated by taking the random samples of 100 g from chopped millet and it was placed in the oven at 80°C for 72 hours to estimate dry matter percentage and then it was multiplied with respective crop yield to work out total dry matter yield. Quality parameters like dry matter, crude protein, crude fibre and total ash contents were determined using methods given by AOAC (1984). Data was analyzed by using Fisher's analysis of variance technique and the least significant difference test at 5% probability level was used to compare treatment means (Steel *et al.,* 1997).

RESULTS AND DISCUSSION

Yield attributes and yield

Plant density was not influenced significantly by the application of nitrogen fertilizer (Table-2). The results are quite in line to those of Ayub *et al.* (2003). They reported that application of nitrogen fertilizer did not affect the stand density of maize. Plant density was significantly increased with increase in seed rate. It is quite obvious to obtain higher stand densities at higher seed rate provided that seeds have similar viability and 1000-seed weight. These results confirm the findings of Ayub *et al.* (2002 & 2003). The interaction between these two factors was not significant.

Plant height is controlled by the genetic makeup of the species and the environment to which the plants are subjected during the growth and development. The nitrogen application significantly increased the plant height ranging from 160.01 to 229.29 cm. The increase was noted at each increased nitrogen level except nitrogen level of 150 kg ha^{-1} where a significant decrease in plant height was noted (Table-1). This decrease can be attributed to imbalanced nutrient availability in the soil. Increase in plant height with nitrogen application has also been reported by Khateek *et al.* (1999). Plots sown at seed rate of 20 kg ha^{-1} produced significantly taller plants than 10 and 15 kg ha^{-1}, which in turn did not differ significantly from each other. These results are contradictory to those of Sartaj *et al.* (1984). They reported that increased seed rate 10-50 kg ha^{-1} decreased the plant height. These contradictory results can be attributed to differences in climatic conditions and genetic traits of crop plants. The interaction was also significant. The maximum plant height (240.90 cm) was obtained when crop was sown at a seed rate of 20 kg ha^{-1} and received 100 kg N ha^{-1} (N_2 x S_3) but was statistically at par with crop sown using 20 kg seed rate and given 150 kg N ha^{-1} (N_3 x S_3). Significantly minimum plant height was recorded when crop was sown at 15 kg seed rate and given no nitrogen (N_0 x S_2).

Stem diameter was affected significantly by both nitrogen application and seed rate (Table-1). The maximum (0.92 cm) and minimum (0.63 cm) stem diameter was recorded at nitrogen level of 150 kg ha^{-1} and control, respectively. Cho *et al.* (2001) have also reported significant effect of nitrogen application on stem diameter of pearl millet. The stem diameter was decreased with increased seed rate and decrease was significant at each increased seed rate. These results confirm the findings of Sartaj *et al.* (1984), Ayub *et al.* (2003). The interaction was also significant. Plots sown at seed rat of 10 kg ha^{-1} and given 150 kg N ha^{-1} (N_3 x S_1) produced significantly the maximum (1.05cm) stem diameter and was followed by 15 kg seed rate at same fertilizer level (N_3 x S_2). Stem diameter showed a decreasing trend with increase in seed rate at all fertilizer level. The minimum stem diameter was recorded when seeds rate of 20 kg ha^{-1} was used without fertilizer application (N_0 x S_3) and was statistically at par with 15 kg seed rate at same fertilizer level (N_0 x S_2).

Nitrogen application significantly affected the number of leaves $tiller^{-1}$ (Table-2). The nitrogen levels of 100 and 150 kg ha^{-1} produced statistically similar number of leaves $tiller^{-1}$ but significantly higher than control and 50 kg N ha^{-1}. The significant effect of nitrogen application on number of leaves $tiller^{-1}$ has also been reported by Safdar (1997). The effect of seed rate on number of leaves $plant^{-1}$ was not significant. The number of leaves obtained $tiller^{-1}$ were 11.71, 11.49 and 11.19 at seed rate of 10, 15 and 20 kg ha^{-1}, respectively. Interaction between nitrogen and seed rate was not significant.

Leaf area is a measure of size of the assimilatory system of the plant and is the product of leaf length and breadth. The application of nitrogen at the rate of 150 kg ha^{-1} produced significantly more leaf area (1795.0 cm^2) than all other treatments. The Nitrogen levels 50 and 100 kg ha^{-1} also differed significantly from each other and produced higher leaf area over control. The increase in leaf area with nitrogen application has also been reported by Chaudhry and Khade (1991).The leaf area was also influenced significantly by the seed rate. The maximum (1601cm^2) and minimum (1231cm^2) leaf area $tiller^{-1}$ was recorded at seed rate of 10 and 20 kg ha^{-1}, respectively. The decrease in leaf area with increased seed rate might have been due to more competition between plants for light, nutrients and water. The results are in agreement with the findings of Carberry and Campbell (1985).They reported that increased population decreased leaf area $tiller^{-1}$ by 66%.The interaction was also significant. The maximum leaf area $tiller^{-1}$ (2076.30 cm^2) was observed at seed rate of 10 kg ha^{-1} and 150 kg N ha^{-1} (N_3 x S_1) and was followed by seed rate of 10 kg with 100 kg nitrogen application (N_2 x S_1).

Table-1. Effect of nitrogen and seed rate on the plant height, stem diameter, leaf area per tiller and green fodder yield of millet

	Plant height (cm)	Stem diameter (cm)	Leaf area per tiller (cm^{-2})	Green fodder yield (tha^{-1})
Nitrogen levels (kg ha^{-1})				
N_0= 0	160.01 d	0.63 d	805.81 d	51.73 c
N_1= 50	195.02 c	0.75 c	1400.02 c	62.94 b
N_2=100	229.29 a	0.86 b	1745.00 b	79.37 a
N_3=150	223.51 b	0.92 a	1795.00 a	79.74 a
SED	0.891	0.012	0.789	0.264
Seed rate (kg ha^{-1})				
S_1=10	190.22 b	0.86 a	1601.00 a	61.01 c
S_2=15	190.89 b	0.79 b	1477.00 b	67.35 b
S_3=20	224.81 a	0.72 c	1231.00 c	76.99 a
SED	0.772	0.011	0.680	0.231
Interaction				
N_0 x S_1	150.40 g	0.69 g	908.27 i	41.50 k
N_0 x S_2	120.80 h	0.61 h	801.60 j	49.60 j
N_0 x S_3	208.70 e	0.59 h	707.50 k	64.10 h
N_1 x S_1	161.20 f	0.80 ef	1511.80 f	52.82 i
N_1 x S_2	214.40 cd	0.75 f	1445.25 g	63.60 h
N_1 x S_3	209.50 e	0.69 g	1242.75 h	72.40 g
N_2 x S_1	232.10 b	0.89 c	1905.96 b	74.10 f
N_2 x S_2	215.00 d	0.86 cd	1796.75 d	79.25 c
N_2 x S_3	240.90 a	0.82 de	1530.94 e	84.75 b
N_3 x S_1	217.10 c	1.05 a	2076.30 a	75.60 e
N_3 x S_2	213.34 d	0.95 b	1864.10 c	76.93 d
N_3 x S_3	240.00 a	0.76 f	1443.80 g	86.69 a
SED	1.542	0.031	1.362	0.453

Any two means not sharing a letter in common differ significantly at 5% probability level.

At all fertilizer levels each increase in seed rate significantly decreased the stem diameter. The minimum leaf area was recorded in plots where no fertilizer was applied and crop was sown at a seed rate of kg ha^{-1} (N_0 x S_3).

The green fodder yield was significantly increased by increasing the nitrogen rate up to 100 kg ha^{-1} (Table-1). The increase in yield with increased nitrogen rate was mainly associated with more plant height, number of leaves $plant^{-1}$ and stem diameter. Increase in green fodder yield with nitrogen application has also been reported by Tripathi *et al.* (1979) and Sharar *et al*. (1988). Fodder yield was influenced significantly with varied seed rate and all differed significantly from one another. Fodder yield was increased with increase in seed rate. The increase in yield was mainly due to greater plant density. Increase in yield with increased seed rate has also been reported by Tomer *et al.* (1984) and Pena *et al.* (1994). The interaction was also significant and mainly arose due to non-significant differences between plots sown at seed rate of 20 kg ha^{-1} without nitrogen application and sown at seed rate of 15 kg ha^{-1} given 50 kg N ha^{-1}. The significantly maximum green fodder yield (86.69 t ha^{-1}) was obtained at seed rate of 20 kg ha^{-1} and given 150 kg N ha^{-1} (N_3 x S_3). There was a significant increase in the green fodder yield with each increase in seed rate at all the fertilizer levels. The minimum green fodder yield was recorded when the crop was sown at seed rate of 10 kg ha^{-1} and given no nitrogen (N_0 x S_1).

Dry matter yield was significantly affected both by nitrogen levels and seed rate (Table-2). Each nitrogen level gave significantly higher dry matter yield over control and increase was significant at each increased

Table-2. Effect of nitrogen and seed rate on the plat density, number of leaves, dry matter and quality of millet fodder.

	Plant density (m^{-2})	No. of leaves per tiller	Dry matter yield	Dry matter (%)	Crude fibre (%)	Crude protein (%)	Ash (%)
Nitrogen levels (kg ha^{-1})							
N_0= 0	154.60	10.27 b	8.10d	15.57d	35.94c	7.57c	7.49b
N_1= 50	151.95	10.77b	10.59c	16.79c	37.98b	9.29b	8.42b
N_2=100	153.46	12.17a	13.84b	17.43b	40.50a	9.38b	9.61a
N_3=150	153.68	12.65a	14.80a	18.54a	41.34a	10.42a	10.63a
SED	NS	0.392	0.322	0.142	0.649	1.002	0.521
Seed rate (kg ha^{-1})							
S_1=10	108.10c	11.71	10.39c	16.76c	39.27	9.23	9.30
S_2=15	149.51b	11.49	11.61b	17.09b	38.95	9.14	9.09
S_3=20	202.32a	11.19	13.49a	17.40a	38.61	9.09	8.72
SED	1.069	NS	0.281	0.123	NS	NS	NS
Interaction							
	NS	NS	NS	NS	NS	NS	NS

Any two means not sharing a letter in common differ significantly at 5% probability level

nitrogen level. Increase in dry matter yield with nitrogen application has also been reported by Malai *et al.* (1980) and Sharar *et al.* (1988). Dry matter yield was also increased with increased seed rate and increase was significant at each increased seed rate. These results are quite in line with those of Tomer *et al.* (1984) and Pena *et al.* (1994).

Quality parameters

Dry matter percentage was affected significantly by both nitrogen levels and seed rate and each nitrogen level resulted in significantly higher dry matter percentage over control (Table-2). Increase in dry matter percentage with nitrogen application has also been reported by Ayub *et al*. (2002 & 2003) for maize and sorghum fodder, respectively. Dry matter Percentage was also increased with increased seed rate and increase was significant at each increased seed rate. The maximum dry matter percentage (17.40) was noted at seed rate of 20 kg ha^{-1}. The results are quite in line with those of Ayub *et al.* (2002) for maize fodder. The interaction was not significant.

Crude fibre is one of the most important parameter influencing the quality of fodder crops. The crude fibre contents increase with the age of the plant. The higher the crude fibre contents lower will be the digestibility. It is obvious from the date given in table-2 that the effect of nitrogen application on crude fibre content was significant. Crude fibre increased by increasing the nitrogen rate up to 100 kg ha^{-1} whereas, the increase from 100 kg to 150 kg N ha^{-1} could not reach to a significant level. Safdar (1997) have also reported that nitrogen application significantly increased the crude fibre contents. The effect of seed rate on the crude fibre contents was not significant. The maximum (39.27%) and minimum (38.61%) crude fibre contents were noted at seed rate of 10 and 20 kg ha^{-1}, respectively. Non-significantly effect of seed rate on crude fibre has also been reported by Medina *et al.* (1984) and Ayub *et al.* (1999). The interaction was non-significant.

The application of nitrogen fertilizer significantly influenced the crude protein contents (Table-2). All nitrogen levels produced significantly higher crude protein contents than control. The differences between 50 and 100 kg N ha^{-1} were not significant. The increase in crude protein contents with the application of nitrogen fertilizer has also been reported by Malai *et al.* (1980) and Ayub *et al.* (2002). The effect of seed rate on crude protein contents was not significant. The results are similar to those of Medina *et al.* (1984). The interaction was not significant.

The nitrogen levels of 100 and 150 kg ha^{-1} produced statistically similar ash contents but significantly higher than control and 50 kg N ha^{-1} (Table-2). The differences between 50 kg N ha^{-1} and control were not significant. Safdar (1997) and Tariq (1998) have also reported significant effect of nitrogen application on ash contents. The effect of seed rate on ash contents was not significant but decreased with increased seed rate. These results are contradictory to those of Ayub *et al.* (2002). These contradictory results might have been due to species differences. The interaction was also non-significant.

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