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Effect of Different Nitrogen Rates on Growth, Yield and Quality of Maize

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ABSTRACT

A field trial was conducted to determine the effect of different Nitrogen rates on yield and quality of maize at Agronomy Research Farm (ARF), The University of Agriculture Peshawar-Pakistan during summer 2016. Four nitrogen treatments (70, 130, 160 and 180 kg ha-1) and a control one were studied in this trial. Maximum Growth and yield traits and quality such as plant height (210.23cm), stem diameter (3.68cm), leaf area plant^{-1} (210.5cm^{-2}), chlorophyll content (39.78%), green fodder yield (44.89 ton ha^{-1}), dry matter yield (9.1 ton ha^{-1}), crude protein (10.75%), crude fiber (31.87%) and ash percentage (8.85%) were recorded. It was concluded that increasing nitrogen levels (130, 160, and 180 kg N ha^{-1}) at optimum level can give a maximum growth and yield traits and quality of maize.

Key words: Maize, Nitrogen levels, Growth, yield and Quality

Introduction

Maize is one of the most important cereal crops in the world agricultural economy both as food for man and feed for animals. It is a miracle crop. It has very high yield potential, there is no cereal on the earth which has so immense potentiality and that is why it is called 'King of cereals'. Maize ranks third in the cereals world production after rice and wheat, but in productivity it surpasses all cereals. Among the various factors of production, the nutrient management has been recognized as the most significant factor limiting the yield levels in maize. The productivity of crop decreased in recent years because of decline in soil fertility status. Farmers are facing difficulty in maintaining soil fertility because of shortage of production and availability of Nitrogen. Ensuring balanced quantity of nutrients in a given soil for good plant growth is the greatest challenge of the day as yield potentials vary among soils. For maintaining sustained crop production, balanced manuring is essential to build up soil health (Sharif *et al.,* 2004).

Supply of nutrients at an appropriate amount is always imperative for better growth and development of a crop. However, yield and quality parameters are greatly affected by inadequate availability of plant nutrients. Low yield of fodder maize is due to many constraints but NPK fertilizer application is one of the major factors (Witt *et al.*, 2008). Nitrogen is a component of protoplasm, proteins, nucleic acids, chlorophyll and plays a vital role in vegetative and reproductive phases of crop growth. Higher nitrogen levels are reported to increase plant height, stem thickness, leaf area, leaf area index, dry matter accumulation; net assimilates ratio and yield per hectares (Cheema *et al.*, 2010). Similarly, fodder maize cultivar Akbar received high nitrogen through fertigation produced maximum stem diameter, leaf area index, green fodder yield and total dry matter (Hassan *et al.*, 2010; Iqbal *et al.*, 2006). Reddy and Bhanumurty (2010) reported that applying 240 kg N ha-1 gave significantly higher green fodder yield, dry matter yield and crude protein. Similar findings were obtained by Almodares *et al.* (2009) who reported that fodder maize biomass and crude protein increased with increase in N content. High forage and dry matter yield of maize cultivars LG 2687, PR34N43 and H 2547 was obtained by the application of 300 kg ha-1 N (Karasu *et al.*, 2009)

Similarly, Ayub *et al.* (2003) reported that higher nitrogen application significantly increased plant height, leaf area plant-1, leaf number, stem diameter, green fodder yield, dry matter, crude protein, crude fiber and total ash percent.

Keeping in view the importance of nitrogen, an experiment was designed to determine the effect of different levels of nitrogen on fodder maize yield and quality under the agro-climatic conditions of Peshawar, Pakistan.

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Materials and Methods

Field experiment was conducted at Agronomy Research Farm the University of Agriculture Peshawar, Pakistan during summer 2016. The experiment was laid out on randomized complete block design having four replications with a plot size of 4 m × 3 m. The experiment was consist of four treatments of Nitrogen N1(180 kg ha-1),N2(160 kg ha-1),N3(130 kg ha-1), N4(70 kg ha-1) and Control. Recommended dose of phosphorus (80 kg ha-1) was applied at the time of sowing while nitrogen was applied in three equal splits such as first dose was applied sowing time, second dose was applied 30 days after sowing (DAS) and third dose 40 DAS. All cultural and agronomic practices) were followed accordingly which includes hoeing, weeding, irrigation and insect management).

Procedure for Quality Parameters

Chlorophyll Content

The chlorophyll meter Minolta SPAD-502 (Konica Minolta Inc., Japan) was calibrated using calibration filter to produce a meter reading of 87.1 before estimating chlorophyll content. At harvest (75 DAS), representative samples of 10 plants were selected randomly from each plot and the chlorophyll content was estimated from the upper most leaf which covered 2 × 3 mm leaf area and the average was calculated.

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

Maize crop grown for fodder or forage purpose harvested before the cob maturity called as green maize and used as fresh fodder for animals. It is also called as green fodder yield or vegetative yield. To record this parameter, entire plot (15 m2) of green maize plants harvested on (75 DAS) and the green fodder yield was estimated with the help of manual spring balance (Toolzone, Thornton, CO, USA) and then it was converted to tonnes ha-1 using following formula:
Green fodder yield (t ha-1) = (Green plants yield per plot (kg) x 10,000)/(Plot size (m2) x 1,000).

Dry Matter Yield (t ha^{-1})

Maize crop grown for silage purpose dried under sun and used in autumn or winter when there is limited availability of plant-based food for animals, is called as dry matter yield. After recording green maize yield, plants of each plot were sun dried in the field for 15 days and then the dried plants weighed with the help of manual spring
balance (Toolzone, Thornton, CO, USA). The data were converted in to dry matter yield in tonnes ha‑1 using following formula:

Dry matter yield (t ha-1) = (Sun dried plants yield per plot (kg) × 10,000) / (Plot size (m2) × 1,000)

Fodder quality parameters such as crude protein, crude fiber and ash percentage were determined at Nuclear Institute for Food and Agriculture, Peshawar, Pakistan.

Crude Protein (%)

One gram of oven dried plant material, 30 ml of concentrated H2SO4 and 5 g digestion mixture [K_2SO4 (100g); CuSO4 (10g); FeSO4 (5g)] were added and then digested the material on the gas heater in Kjeldhal digestion flask, cooled it and made up the volume to 100 ml. Ten millilitre aliquot was taken from digestion flask 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) H2SO4. The reading obtained after titration against H2SO4 was then multiplied by 6.25 to get crude protein percentage.
Percent N = (Volume of N/10 H2SO4 used × 0.0014 × 250 × 100) / (Weight of sample × 10) Crude protein (%) = % N × 6.25

Crude Fiber (%)

H2SO4 (1.25%) and distilled water was added into a 250 ml beaker containing 1 g of oven dried plant material and made up the volume to 200 ml. It was then placed on flame for 30 minutes, which was then filtered and washed. NaOH (1.25%) and distilled water added to make up the volume to 200 ml. It was heated, filtered and washed. The sample was put into Gooch crucible and was placed in oven at 10°C for 24 hours. Well dried sample was weighed (W1) and then the crucible was placed on flame and ignited. When smoke disappeared it was placed in muffle furnace at 600°C until grey or white ash was obtained. It was then cooled and weighed (W2). The crude fiber percentage was calculated as:
Crude fiber (%) = (W2 – W1 / Weight of sample) × 100.

Ash Contents (%)

Empty dried Gooch crucible was weighed (W1) and 1g of oven dried sample was put in crucible and then it was placed in muffle furnace and heated at 600°C for 1 hour. It was then cooled at room temperature and reweighed (W2). Ash percentage was calculated as:
Ash (%) = (W2 – W1 / Weight of sample) × 100
Data regarding above-mentioned parameters were analysed through analysis of variance technique of MSTATC software, version 1 (Michigan State University, East Lansing, Michigan, USA) and subsequently least significance test (LSD) was applied for comparing and separation of treatment means (Freed, 1988).

Results and Discussion

Plant height (cm)

Maximum plant height (210.23 cm) was obtained when highest N dose (180 kg ha^{-1}) was applied followed by 160 kg ha-1 (199.78 cm) and 130 kg ha-1 (180.43 cm). However, plant height was minimum (91.04 cm) when no fertilizer was applied followed by minimum (70 kg ha^{-1}) N dose (155.45 cm) as presented in Table (1). The increment in plant height with the rise in N dose indicated that plants used N during active cell division to form building blocks (protein) for cell elongation (Iqbal *et al.*, 2006).

Leaf Area (cm^{-2})

It is revealed from the mean data that fodder maize plants received 180 kg ha-1 N dose produced maximum leaf area plant-1 (210.5 cm^{-2}) followed by 160 kg ha-1 N dose (199.78 cm^{-2}) which was decreased to minimum (125.72 cm^{-2}) in control treatment (Table 1). The enlarged leaf area with increase in N levels could be due to rapid and active cell multiplication within plant leaves resulting larger leaves blades. Like leaf area, LAI was also increased as N level increased (Nadeem *et al.*, 2009).

Chlorophyll content (%)

Mean data of different treatments indicated that maximum chlorophyll content (39.78) was noted in plants received 160 kg N ha-1 followed by 130 kg N ha-1 (33.76) and 180 kg N ha-1 (32.34). However, minimum chlorophyll content (18.69) was recorded in control treatment followed by 70 kg N ha-1 treatments (21.35) as illustrated in Table (1). The escalating trend of chlorophyll content with raising N dose indicated better nitrogen up take by the fodder maize plants, resulting more greenish leaves (Ayub *et al.*, 2007; and Hassan *et al.*, 2010).

Stem Diameter (cm)

Maximum Stem diameter (3.68 cm) was obtained when highest N dose (180 kg ha-1) was applied followed by 160 kg ha-1 (3.51 cm) and 130 kg ha-1 (3.46 cm). However, stem diameter was minimum (2.58 cm) when no fertilizer was applied followed by minimum (70 kg ha-1) N dose (2.89 cm) (Table 1). An increased supply of N concentration might trigger cell division which eventually attributed to steady expansion in stem diameter (Mahdi *et al.*, 2011).

Table 1. Plant height (cm), stem diameter (cm), leaf area plant^{-1} (cm^{-2}), chlorophyll content as affected by different N-levels on growth, yield and quality of fodder maize

Nitrogen Treatments kg ha^{1}	Plant Height (cm)	Leaf Area per plant (cm^{2})	Chlorophyll content	Stem Diameter (cm)
Control	91.04	125.72	18.69	2.58
70	155.45	160.82	21.35	2.89
130	180.43	189.78	33.76	3.46
160	199.78	199.78	39.78	3.51
180	210.23	210.5	32.34	3.68
LSD (0.05)	8.36	36.25	2.99	0.20

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

Plants received the 180 kg N ha-1 produced maximum green fodder yield (41.76 t ha^{-1}) followed 160 and 130 kg N ha^{-1} (44.89 and 39.86 t ha^{-1}, respectively). However, minimum green fodder yield (20.78 t ha^{-1}) was recorded in control treatment followed by 70 (23.78 t ha^{-1}) (Table 2). The reason for higher green fodder yield in plants received higher N may be attributed to the most lucrative consumption of applied nitrogen and other allied environmental resources by the maize crop which resulted in maximum biomass yield (Mukhtar *et al.,* 2011 and Arif *et al.,* 2010).

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

Table 2 shows the plants received the 180 kg N ha-1 produced maximum dry matter fodder yield (41.76 t ha^{-1}) followed 160 and 130 kg N ha^{-1} (44.89 and 39.86 t ha^{-1}, respectively). However, minimum dry matter fodder yield (20.78 t ha^{-1}) was recorded in control treatment followed by 70 (23.78 t ha^{-1}) Increase in nitrogen might have resulted in more active plants growth, which consecutively resulted in more dry matter partitioning. Cerny *et al.* (2012) observed that dry matter yield of fodder maize was linearly increased

Crude protein (%)

Highest crude protein (10.75 and 7.89 %) of fodder maize variety azam was observed when highest N-doses (180 and 160 kg ha-1) were applied. However, minimum crude protein (3.68 %) was estimated in control treatment followed by 70 kg N ha-1 treatment (4.67 %) as shown in Table 2. Plants received 130 kg N ha-1 gave 6.98% crude protein. It is an estimate of the level of protein in the feed based on the amount of nitrogen present (Kebede *et al.*, 2012).

Crude fiber (%)

Highest crude fiber (31.87 and 27.87 %) of fodder maize variety azam was observed when highest N-doses (180 and 160 kg ha-1) were applied. However, minimum crude fiber (22.45 %) was estimated in control treatment followed by 70 kg N ha-1 treatment (23.89 %). Plants received 130 kg N ha-1 gave 25.38% crude fiber (Table 2). The rise in crude fiber percentage with increase in N-levels may be attributed to higher stem diameter and plant height. Similar results were reported by Aslam *et al.* (2011).

Ash content (%)

Plants received higher N content (180 and 160 kg ha-1) produced maximum ash percentage i.e. 8.85 and 6.87%, respectively followed by plants received 130 kg N ha-1 (5.99 %). However, minimum total ash (4.46%) was recorded in control treatment followed by plants received 70 kg N ha-1 (5.28%) Table 2. Present study indicated an increase in total ash percentage with the increase in N-levels which could be due to higher dry matter production in plants that contributed directly or indirectly in biosynthesis of minerals Safdar (1997).Similarly, Ayub *et al.* (2003) also reported that ash percentage was significantly increased with increase in nitrogen.

Table 2. Green Fodder Yield (ton ha^{-1}), Dry Matter Yield (ton ha^{-1}), Crude protein (%), Crude Fiber (%) and Ash (%) as affected by different N-levels on growth, yield and quality of fodder maize

Nitrogen Treatments kg ha^{1}	Green fodder Yield t ha^{1}	Dry matter yield	Crude protein (%)	Crude fiber (%)	Ash (%)
Control	20.78	4.46	3.68	22.45	4.46
70	23.78	6.37	4.67	23.89	5.28
130	39.86	8.65	6.98	25.38	5.99
160	44.89	9.19	7.89	27.87	6.87
180	41.76	9.1	10.75	31.87	8.85
LSD (0.05)	3.16	0.72	0.56	0.49	0.38

Conclusion and Recommendations

It is concluded from the findings of present research that the maize can efficiently serve as forage crop to farm animals as throughout the growth period the increased nitrogen level was beneficial for maintaining and improving the green and dry matter fodder maize yield. Therefore, it is recommended that 180 kg ha-1 nitrogen applications is most economical strategy for obtaining best quality green and dry matter fodder maize yield under the agro-climatic conditions of Peshawar, Pakistan.

References

Almodares, A., M. Jafarinia, and M.R. Hadi. 2009. The effects of nitrogen fertilizer on chemical compositions in corn and sweet sorghum. American- Eurasian J. Agri. Environ. Sci., 6: 441-446.

Arif, M., M.T. Jan, N.U. Khan, H. Akbar, S.A. Khan, M.J. Khan, A. Khan, I. Munir, M. Saeed and A. Iqbal. 2010. Impact of plant populations and nitrogen levels on maize. Pak. J. Bot. 42: 3907-3913.

Aslam, M., A. Iqbal, M.S. Ibni-Zamir, M. Mubeen and M. Amin. 2011. Effect of different nitrogen levels and seed rates on yield and quality of maize fodder. Crop Environ. 2: 47-51.

Ayub, M., M.A. Nadeem, A. Tanveer, M. Tahir and R.M.A. Khan. 2007. Interactive effect of different nitrogen levels and seed rates on fodder yield and quality of pearl millet. Pak. J. Agri. Sci.44: 592-596.

Cerny, J., J. Balik, M. Kulhanek, F. Vašak, L. Peklova, O. Sedlař. 2012. The effect of mineral N fertilizer and sewage sludge on yield and nitrogen efficiency of silage maize. Plant Soil Environ. 58: 76-83.

Cheema, M.A., W. Farhad, M.F. Saleem, H.Z. Khan, A. Munir, M.A. Wahid, F. Rasul and H.M. Hammad. 2010. Nitrogen management strategies for sustainable maize production. Crop Environ. 1: 49-52.

Freed, R.D. 1988. MSTATC. Reference manual. In: Freed RD, Eisensmith SP, Everson EH, Webber M, Paul E, Islieb D (eds) Crop and soil sciences, Department, Michigan State University, East Lansing, USA.

Hassan, S.W., F.C. Oad, S.D. Tunio, A.W. Gandahi, M.H. Siddiqui, S.M. Oad and A.W. Jagirani. 2010. Impact of nitrogen levels and application methods on agronomic, physiological and nutrient uptake traits of maize fodder. Pak. J. Bot. 42: 4095-4101.

Iqbal, A., M. Ayub, H. Zaman and R. Ahmad. 2006. Impact of nutrient management and legume association on agro-qualitative traits of maize forage. Pak. J. Bot. 38: 1079-1084.

Karasu, A., M. Oz, G. Bayram and I. Turgut. 2009. The effect of nitrogen levels on forage yield and some attributes in some hybrid corn (*Zea mays indentata* Sturt.) cultivars sown as second crop for silage corn. Afr. J. Agri. Res. 4: 166-170.

Kebede, S.A., U.G. Girgo, G.D. Jalleta. 2012. The potential of treatment with ash solution in improving degradability of fibrous feeds in Ethiopia. Agri. Sci. Res. J. 2: 100-105.

Mahdi, S.S., B. Hasan, R.A. Bhat, M.A. Aziz, L. Singh, F.U. 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.

Mukhtar, T., M. Arif, S. Hussain, M. Tariq and K. Mehmood. 2011. Effect of different rates of nitrogen and phosphorus fertilizers on growth and yield of maize. J. Agri. Res. 49: 333-339.

Nadeem, M.A., Z. Iqbal, M. Ayub, K. Mubeen and M. Ibrahim. 2009. Effect of nitrogen application on forage yield and quality of maize sown alone and in mixture with legumes. Pak. J. Life Soc. Sci. 7: 161-167.

Reddy, D.M. and V.B. Bhanumurthy. 2010. Fodder, grain yield, nitrogen uptake and crude protein of forage maize as influenced by different nitrogen management practices. Int. J. Bio-Res. Stress Manag. 1: 69-71.

Safdar, Z, 1997. Optimization of nitrogen and its effect on yield and quality of maize fodder. M.Sc. Thesis, Department of Agronomy, University of Agriculture, Faisalabad.

Sharif, M., M. Ahmed, M.S. Sharir and R.A. Khattak. 2004. Effect of organic and inorganic fertilizers on the yield and yield components of maize. Pak. J. Agri. Engg. Vet. Sci. 20(1): 11-15.

Witt, C., J.M.C.A. Pasuquin and A. Dbermann. 2008. Site-specific nutrients management for maize in favorable tropical environments of Saia. Proc. 5th Inter. Crop Sci. Cong., April 13-18, Jeju, Korea, pp: 1-4.