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Rama Bharti
Department of Agronomy, Bihar Agricultural University, Sabour, Bhagalpur, India

SK Gupta
Department of Agronomy, Bihar Agricultural University, Sabour, Bhagalpur, India

MK Singh
Department of Agronomy, Bihar Agricultural University, Sabour, Bhagalpur, India

Suborna Roy Choudhury
Department of Agronomy, Bihar Agricultural University, Sabour, Bhagalpur, India

Anshuman Kohli
Department of Soil Science and Agricultural Chemistry, Bihar Agricultural University, Sabour, Bhagalpur, India

Corresponding Author:
Rama Bharti
Department of Agronomy, Bihar Agricultural University, Sabour, Bhagalpur, India

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Effect of plant population and varied nitrogen levels on quality and economics of fodder maize (*Zea mays* L.)

Rama Bharti, SK Gupta, MK Singh, Suborna Roy Choudhury and Anshuman Kohli

Abstract
The present investigation entitled "Effect of plant population and nitrogen levels on fodder maize (*Zea mays* L.)" was conducted during the *kharif* season of 2018 at the Research Farm, Bihar Agricultural University, Sabour, Bhagalpur to find out the effect of plant population and nitrogen levels on the growth parameters, yield attributes, yield, quality parameter and economics of fodder maize. The experiment was laid out in split-plot design with three plant spacing viz. 30cm x 20cm, 40cm x 20cm and 50cm x 15cm in main plots and three nitrogen levels @ 90, 120 and 150 kg ha^{-1}, in sub plots replicated thrice. The experimental plot was sandy loam in texture, slightly alkaline in pH, low in available nitrogen (203.27 kg ha^{-1}), medium in available phosphate and medium in available potash. Quality parameters of fodder maize were highly influenced by adopting different plant population and varied nitrogen levels. Crude protein and ash content were both found significantly higher with 30cm x 20cm plant spacing, whereas, crude fiber content was highest with spacing of 45cm x 20 cm which was at par with S_3 (50cm X 15cm). As higher green fodder yield was obtained with spacing 30cm x 20 cm produced higher gross, net returns and B.C ratio.
Highest green and dry fodder yield (504.5 q ha^{-1} and 126.1 q ha^{-1} respectively) was obtained N application @ 150 kg ha^{-1}. Quality parameters were also significantly influenced by different fertilizer N application levels. Crude protein content was highest (8.3%) with 150 kg N ha^{-1} where as crude fiber was found highest with 90 kg N ha^{-1}. Ash content increased significantly as the nitrogen levels increased from 90 to 150 kg ha^{-1}. Highest gross return, net return and B.C ratio was obtained under 150 kg N ha^{-1} and plant spacing of 30cm x 20cm having higher plant population (1,66,666 plants ha^{-1}). The plant spacing of 30cm x 20cm and nitrogen application @ 150 kg ha^{-1} were found superior over other treatment.

Keywords: Quality Parameters, Net Return, B:C ratio and Fodder Maize

Introduction
Maize is a warm weather plant. It grows from sea level to 3000 metres altitude. It can be grown under diverse climatic conditions also. It is grown in many parts of the country throughout the year. Kharif (monsoon) season is the main growing season in northern India.
At present, the scarcity of green fodder, dry fodder and concentrate feed are about 35.6 per cent, 10.95 per cent and 44 per cent respectively across the country. The demand of dry and green fodder will reach to 631and 1012 million tonnes of by the year 2050. The estimated data shows that there will be deficit in dry (13.2 per cent) and green fodder (18.4 per cent) in the year 2050. Annually about 1.69 per cent forage has to grow for fulfilment of the deficit forage per cent. Therefore, livestock production basically depends upon the availability of quality fodder.

To meet the requirement of current situation there is need to increase the production as well as productivity of fodder maize. Maize is one of the most versatile emerging crops having wider adaptability under varied agro-climatic conditions. As it has yield potential far higher than any other cereal, it is sometimes referred to as the miracle crop or the ‘Queen of Cereals’. The consumption pattern for maize produced in India at present includes poultry feed 52 percent, human food 24 per cent, animal feed 11 per cent and more than 22 per cent going towards industrial processing. With the growing demand of poultry feed the demand for maize is also going up in the country. It is the crop with the highest per day productivity. Some estimates indicate that India may have to produce 55 million tonnes of maize to meet its requirement for human consumption, poultry, piggery and fodder by 2030. (*Vision document -2050, ICAR-IGFRI, Jhansi*). Quantity as well as quality is also a major concern with respect to fodder production. Fodder quality represents a simple concept, yet encompasses much complexity. Though important, forage quality often receives far less consideration than it deserves. Adequate animal nutrition is essential for high rates of gain, ample milk production, efficient reproduction, and for adequate profits. However, forage quality varies greatly among and within forage crops, and nutritional needs vary among and within animal species and classes. Producing suitable quality forage for a given situation requires knowing the factors that affect forage quality, then exercising management accordingly. Analyzing forages for nutrient content can be used to determine whether quality is adequate and to guide proper ration supplementation. Forage quality can be defined as the extent to which forage has the potential to produce a desired animal response such as palatability, digestibility, and nutrient content and animal response. Maize is considered ideal forage because it grows quickly, produces highyields, is palatable, is rich in nutrients, and helps to increase body weight and milk quality in cattle (Sattar et al. 1994) [2]. As fodder for livestock, maize is excellent, highly nutritive and sustainable, Iqbal et al. 2006) [1]. It is commonly grown as a *kharif* fodder in the north western regions of India. Its quality is much better than sorghum and pearl millet, since both sorghum as well as pearl millet possess anti-quality components such as hydrocyanic acid and oxalate, respectively. Among the cultivated non-legume fodders, maize is the most important crop that can be grown round the year under irrigated conditions. It is free from any anti-nutritional components and is considered a valuable fodder crop. It contains high concentrations of protein and minerals and possesses high digestibility. Two maize varieties, namely, J-1006 and African tall, are developed and released for commercial cultivation of fodder in India.

Material and methods

The experiment is being carried out at the research farm of Bihar Agricultural University, Sabour during *Kharif* season, 2018. The research farm falls in the Middle Gangetic plain region of Agro-climatic Zone ш A in Bhagalpur district at 25.50º North latitude and 87.19º East longitudes with and an altitude of 52.73 meters above the mean sea level. The average rainfall is 920 mm. The minimum and maximum day temperature is 18 ºC and 35 ºC during summer season whereas 15 ºC and 25 ºC are the minimum and maximum day temperature during the winter season respectively. The soil of experimental plot was sandy loam in nature having slightly saline pH, low in available nitrogen, medium in phosphorous and potassium. The land was ploughed with tractor drawn cultivator followed by harrowing for fine tilth. The land was labelled and laid out according to the layout was prepared. The experiment was carried out in split-plot design having three plant spacing (30cm x 20cm, 40cm x 20cm, 50cm x 15cm) in main plot and three nitrogen levels (90, 120, and 150 kg ha^{-1}) in sub plot replicated thrice. The application of phosphorous and potassium was applied @ 60 kg ha^{-1} and 40 kg ha^{-1} respectively as a basal dose. Nitrogen was applied in 3 splits *i.e.* 25% N was applied as basal, 50% was applied after 20 DAS and 25% N was applied after 40DAS.

Variety description

African tall variety was taken for the experiment as a test variety for fodder purpose. The variety was released from Mahatma Phule Krishi Vidyapeeth, Rahuri and Maharashtra in 1981. Due to its high palatability and lactoganic effect on milch animals it is famous all around the world. It produces higher no. of leaves per plant, dry matter, more leaf area and crude protein content. It is a short duration variety and can be grown throughout the season having yield potential is 50-60 t ha^{-1}.

Quality studies

To measures the quality parameters such as crude protein, crude fiber and ash percentage five plants were selected to record the observations. The collected plant samples from each treatment were sun dried and further oven dried at 65±5 ºC. The oven dried samples were ground in a Willy grinding mill and used for analysis of quality parameters as recommended by Association of Official Agriculture Chemist.

Crude protein

Modified microkjedhal method was used for the estimation of nitrogen content in plant and expressed in percentage. The crude protein content of plant was estimated by multiplying with factor 6.25 to the nitrogen percentage.

Crude fibre

Acid-alkali digestion method was used for estimation of crude fibre and the whole plant content of crude fiber was expressed in percentage. The formula was

$$\text{CF (\%)} = \frac{\text{Weight before ashing - Weight after ashing}}{\text{Weight of the sample taken}} \times 100$$

Ash content (%)

Ash is an inorganic residue remaining after thermal treatment of organic matter. The ash content is determined by complete oxidation of sample at a high temperature at 500ºC to 600ºC through combustion and volatilization of organic materials. To estimate the ash percentfollowing formula was used and expressed in percentage.

$$\text{Total ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \times 100$$

Economics

Common cost of cultivation was calculated for fodder maize ha^{-1}. Further, variable cost of cultivation was calculated as per treatment ha^{-1} based upon the market price of inputs. Gross returns were calculated by the existing price of fodder in market. Net return was obtained by deducting the cost of cultivation from gross return. For obtaining benefit cost ratio for different treatments the net return were divided by the corresponding cost of cultivation as per treatments. Data obtained from all the parameters were subjected to statistical analysis by means of ANOVA (analysis of variance) outlined by Panse and Sukhatme (1985) [3]. F value was tested at 5 percent level of significance.

Result and discussion

Crude protein

Crude protein was found significantly highest with plant spacing 45cm x 20cm among all the plant spacing was tried. Plant spacing 30cm x 20cm produced lowest crude protein content of fodder maize. Significantly higher crude protein content was obtained with application of nitrogen @ 150 kg ha^{-1} whereas lowest was found with 90 kg N ha^{-1}.There was no significant effect noticed in case of interaction between plant spacing and nitrogen levels. The crude protein was found higher with increased plant spacing and narrow plant density. Therefore, 40 cm x 20 cm spacing produced significantly higher crude protein. As S_2 contains higher number of leaves and sparse plant density might have utilized available nitrogen which in turn enhanced the biochemical activity of fodder maize resulted in higher crude protein content. Similar results were investigated and reported earlier by Patel et al. (2010) [5] and Spandana Bhatt (2012) [10]. Crude protein of fodder maize increased consistently and significantly as nitrogen levels increase from 90 to 150 kg ha^{-1}. Therefore, significantly higher crude protein was recorded with application of nitrogen @ 150 kg ha^{-1}. Application of nitrogen @ 90 kg ha^{-1} produced lower crude protein (Table-1). Nitrogen is a major constitute of amino acid and play an important role in protein synthesis. Many workers reported that there is a linear increase in crude protein as nitrogen level increases constantly, (Muhammad Aslam et al. 2011 and Spandana Bhatt, 2012) [7, 10].

Crude fiber

Crude fiber was found significantly higher with plant spacing 30cm x 20cm which was statically at par with spacing 50cm x 15cm.Lowest crude fiber content was found with spacing 40cm x 20cm.Among the varied nitrogen levels, nitrogen supplied @ 90 kg produced significantly higher crude fiber content of fodder maize while it was found lower crude fiber with application of nitrogen @ 150 kg ha^{-1}.Crude fibre was found lowest with spacing 40cm x 20cm. It was might be due to higher availability and absorption of nitrogen under the lesser plant population. There was a negative relation between crude fiber and nitrogen. Highest crude fibre was obtained with spacing 30cm x 20cm having higher plant population (Table-1). Similar findings were reported by earlier by Syed. Crude fiber and nitrogen show negative linear relation with each other. Therefore, highest and lowest crude fibre was obtained with application of N @ of 90 and 150 kg ha^{-1} respectively. Higher supply of nitrogen creates a greater demand of carbon for protein synthesis which results in low amount of carbohydrate left available for cell wall materials such as pectin cellulose hemi-cellulose which are the major constitute of fiber thus higher dose of nitrogen resulted in formation of low crude fiber of fodder maize. The results found in present investigation are similar with the findings of Muhammad Aslam et al. (2011) [7].

Ash content

Ash content was found significantly higher with plant spacing 40cm x 20cm which was superior over all the plant spacing was tried. Ash content percentage was found significantly improved with increase in nitrogen levels from 90 to 150 kg N ha^{-1}. It was found significantly higher with application of nitrogen @ 150 kg ha^{-1}whereas lowest ash content percentage was obtained with application of nitrogen @ 90 kg ha^{-1}.Ash content percentage was found highest with application of higher dose of nitrogen *i.e.* 150 kg ha^{-1}. Lowest ash percentage was recorded with application of nitrogen @ 90 kg ha^{-1}.Ash content percentage denotes dry matter percent in fodder maize (Table-1). Therefore, high ash content fodder contains less moisture than those having lower ash percentage. As higher dry matter was produced by higher dose of nitrogen resulted in higher ash content percentage, similar findings were reported by Syed Sheraz Mahdi (2011) and Kasinath 2014.

Economics

Economics of fodder maize such as gross return, net return and B.C ratio were found significantly influenced with different plant spacing and varied nitrogen levels.

Gross and net returns (Rs ha^{-1})

Highest gross return was found with plant spacing 30cm x 20cm which was significantly superior over all the plant spacing tried. However, plant spacing 40cm x 20cm gave lowest gross return of fodder maize. Application of nitrogen @ 150 kg ha^{-1} significantly increases the gross return of fodder maize which was found superior over all the nitrogen levels tried. Lowest gross return was recorded with nitrogen applied @ 90 kg ha^{-1}.Among the interaction between plant spacing and nitrogen levels, it was found significantly higher gross return (Table-2) with plant spacing 30cm x 20cm and nitrogen @ 150 kg ha^{-1}. The next best combination was plant spacing 50cm x 15cm along with 150 kg N ha^{-1}. Lowest gross return was recorded with plant spacing 40cm x 20cm with nitrogen @ 90 kg ha^{-1}

Highest net return was found with plant spacing 30cm x 20cm which was significantly superior over all the plant spacing tried. However, plant spacing 40cm x 20cm gave lowest net return of fodder maize. Application of nitrogen @ 150 kg ha^{-1} significantly increases the net return of fodder maize which was found superior over all the nitrogen levels tried. Lowest net return was recorded with nitrogen applied @ 90 kg ha^{-1}.Among the interaction between plant spacing and nitrogen levels, it was found significantly higher net return with plant spacing 30cm x 20cm and nitrogen @ 150 kg ha^{-1}. The next best combination was plant spacing 50cm x 15cm along with 150 kg N ha^{-1}. Lowest net return was recorded with plant spacing 40cm x 20cm with nitrogen @ 90 kg ha^{-1}(Table-3).

Benefit- cost ratio

Highest B: C ratio was found with plant spacing 30cm x 20cm which was significantly superior over all the plant spacing tried. However, plant spacing 40cm x 20cm gave lowest B: C ratio of fodder maize. Application of nitrogen @ 150 kg ha^{-1} significantly increased the B: C ratio of fodder maize which was found superior over all the nitrogen levels applied. Lowest B: C ratio was recorded with nitrogen applied @ 90 kg ha^{-1}.Among the interaction between plant spacing and nitrogen levels, it was found significantly higher B: C ratio with plant spacing 30cm x 20cm and nitrogen @ 150.Gross return, net return and B.C ratio were found significantly highest with application of nitrogen @ 150 kg ha^{-1} and spacing 30 cm x 20 cm having higher plant population (1, 66, 666 plant ha^{-1}). The next best combination was S_3N_3 having higher dose of nitrogen and spacing with 50cm x 15cm. Lowest gross return, net return and B.C ratio were recorded with spacing S_2 (40 cm x 20 cm) with lowest dose of nitrogen *i.e*. 90 kg N ha^{-1}. As closer spacing of plant (30 cm x 20 cm) produced higher no. of plant ha^{-1} resulted in higher yield of green fodder with coupled 150 kg N ha^{-1}. Therefore, treatment combination S_1x N_3 significantly produced higher productivity of fodder maize (Table-4). Similar trends of economics was related to Syed Sheraz Mahdi (2011) and Kasinath 2014.

Conclusion

The study has revealed that adaptation of crop geometry of 30cm x 20cm (1, 66, 666 plants ha^{-1}) and application of nitrogen @ 150 kg ha^{-1} were found significantly higher for achieving higher productivity and profitable returns of fodder maize. Hence, it is concluded that for higher productivity and higher economics return, the closer plant spacing 30cm x 20cm can be adopted along with nitrogen dose @ 150 kg ha^{-1}. For quality fodder production plant spacing 40cm x 20cm is recommended having lower plant density. The spacing of 30 x 20 cm (1, 66, 666 lakhs plants ha^{-1}) along with 150 kg N ha^{-1} may be recommended for higher green fodder yield and net returns.

Table 1: Effect of plant population and nitrogen levels on quality parameters of fodder maize

Treatments	Crude protein (%)	Crude fiber (%)	Ash content (%)
S_1 (30 cm x 20 cm)	7.31	30.08	7.62
S_2 (40 cm x 20 cm)	8.34	24.17	8.80
S_3 (50 cm x 15 cm)	7.71	28.94	8.31
S Em (±)	0.073	0.61	0.092
C.D (p=0.05)	0.287	2.39	0.360
N_1 (90 kg ha^{-1})	7.44	29.47	7.81
N_2 (120 kg ha^{-1})	7.83	26.00	8.17
N_3 (150 kg ha^{-1})	8.08	27.73	8.75
S Em(±)	0.065	0.413	0.087
C.D (p=0.05)	0.203	1.273	0.270
S x N	NS	NS	NS

Table 2: Interaction effect of plant population and nitrogen level on Gross return (Rs ha^{-1}) of fodder maize

Treatments	N_1	N_2	N_3	Mean
S_1	48205	60425	75671	61433.7
S_2	39928	42135	58026	46696.3
S_3	43958	49972	63730	52553.3
Mean	44030	50844	65809	
	S	N	S × N	
S Em (±)	1394.3	656.2	1674.9	
CD (p=0.05)	5474.7	2021.9	5160.9	

Table 3: Interaction effect of plant population and nitrogen level on net return (Rs ha^{-1}) of fodder maize

Treatments	N1	N2	N3	Mean
S_1	24467	36267	51123	37285
S_2	16700	18517	34017	23078
S_3	20640	26264	39631	28845
Mean	20602	27016	41590	
SEm (±)	S	N	S × N	
	1394.3	656.2	1674.9	
CD (p=0.05)	5474.7	2021.9	5160.9	

Table 4: Interaction effect of plant population and nitrogen level on B: C ratio of fodder maize

Treatments	N_1	N_2	N_3	Mean
S_1	1.0	1.5	2.1	1.5
S_2	0.7	0.8	1.4	1.0
S_3	0.9	1.1	1.6	1.2
Mean	0.9	1.1	1.7	
S Em (±)	0.1	0.0	0.1	
CD (p=0.05)	0.2	0.1	0.2	

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