Indian Journal of Agronomy **57** (1): 85–88 (March 2012)

Influence of seed rate, nitrogen and zinc on fodder maize (*Zea mays*) in temperate conditions of western Himalayas

S. SHERAZ MAHDI[1], BADRUL HASAN[2] AND LAL SINGH[3]

Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar, Srinagar, Jammu & Kashmir 191 121

Received : April 2011; Revised accepted : December 2011

ABSTRACT

A field experiment was conducted at Shalimar, Srinagar during 2009 and 2010, to study the effect of seed rate and nitrogen and zinc fertilization on yield and quality of fodder maize (*Zea mays* L.) var. 'J-1006'. Application of N @ 120 kg/ha has resulted significantly higher plant height, leaf area index, green fodder yield, nitrogen content and its uptake, zinc content and its uptake, Ca content and crude protein content. Seed rate of 60 and 80 kg/ha being at par, recorded significantly higher plant height, leaf area index and green fodder yield over 40 kg/ha. Zinc application @ 10 kg/ha, significantly increased plant height, leaf area index and green fodder yield. N and Zn content and their uptake while Ca and crude protein content remain unaffected. Net returns and B:C ratio were recorded highest with 120 kg N/ha, 80 kg seed/ha and 10 kg Zn/ha.

Key words : Crude protein, Ca-concentration, Fodder maize, Net-returns, Nitrogen, Seed rate, Zinc

Maize is an ideal fodder crop because of its high production potential, wider adaptability, quick growing nature, succulency, palatability and excellent fodder quality. Maize fodder is free from toxicants and can be safely fed to animals at any stage of crop growth. Quality fodder production plays an important role in dairy industry. At present, the country faces a net deficit of 62.76% green fodder, 23.46% dry crop residues and 64% feeds (DES, 2008). In India the cropped area under fodder is only 4.2 to 4.4% of the total cultivated area and there is hardly any scope of expansion due to increasing pressure on agricultural land for food and cash crops. The solution therefore, lies in increasing quality fodder production on limited space and time. Maize being highly exhaustive, demands good nutrient management. Among the essential nutrients, nitrogen is the most important limiting factor for plant growth and its application increases the nitrogen, crude protein content and metabolizable energy besides improving succulency, palatability and digestibility of fodder maize (Patel *et al*., 2007). Among the micronutrients, zinc deficiency appears to be the most widespread. Besides improving photosynthesis and regulation of auxin concentration, Zn plays an important role in nitrogen metabolism, protein synthesis (Alloway, 2008). Its application significantly reduces the fiber and soluble carbohydrate content in fodders thereby increases digestibility. Plant population is another important agronomic factor, which greatly influences the micro climate of the field and eventually yield and nutritional status of agricultural crops. (Ahmad, 2003). The present study was therefore, designed to find out the optimum level of nitrogen and plant density to obtain maximum nutritious fodder under the influence of soil applied zinc.

MATERIALS AND METHODS

A experiment was conducted during 2009 and 2010 growing seasons on silty clay loam soil at the research farm, Division of Agronomy, SKUAST-K, Shalimar, Srinagar, which is situated at 34^0 8' N latitude and 74^0 83' E longitudes and altitude of 1587 m above mean sea level. Soil test values indicated a neutral pH (6.9), low in available N (265.0 kg/ha) and Zn (0.51mg/kg) and medium available K (163.9 kg/ha) and P (15.3 kg/ha). Precipitation differed markedly between 2009 and 2010 growing seasons. The Cumulative precipitation was 177.8 mm in 2009 and 249.9 mm during 2010 crop growth period. Minimum temperature during crop growth period (June to September) was from 10-18^{0}C, while the maximum temperature was 25 to 32^{0}C. The treatments consisted of all combinations three nitrogen levels (60, 90 and 120 kg/ha), three seed rates (40, 60 and 80 kg/ha) and two levels of

[1]**Corresponding Author Email:** sheerazsyed@rediffmail.com
[1]Ph.D. Scholar, [2]Dean, [3]Assistant Professor, Division of Agronomy

zinc (0 and 10 kg/ha) and the experiment was laid out in randomized block design (Factorial) with three replications. Half dose of nitrogen and full dose of zinc as per treatment and full dose of P and K was applied as basal dose before sowing in each plot. Remaining half dose of nitrogen was top dressed at knee high stage as per treatment after first irrigation. Pre-soaked maize seed (Variety 'J-1006') was sown manually on 25–26 June at a row spacing of 45 cm. Crop was harvested at 75% silking stage. Plant height of five randomly tagged plants in the penultimate rows of each plot was recorded and averaged to height/plant. Leaf area index was recorded with canopy analyser (Accu PAR Model LP-80). The crop from each net plot (leaving boarder and penultimate rows) was harvested and immediately weighed. It was then allowed to sundry for about a week and weight was recorded in kg and converted to tonne/ha to give the dry weight/ha. Samples of fodder maize collected at harvest were oven dried at 60-65 ^{0}C to a constant weight. The samples were subsequently used for chemical analysis to assess nutritional status of fodder maize. Nitrogen and zinc content of ground samples was estimated by "Modified Kjeldahl's Method" and 'Wet digestion Method' using Atomic Absorption Spectrophotometer, respectively, and their uptake was determined by multiplying their contents with respective dry fodder yield at harvest. The N content of the ground samples determined was multiplied by a factor 6.25 to give the crude protein content. The crude protein yield was determined by multiplying crude protein content with respective dry matter yield at harvest. Calcium content in samples was determined by "Dry Ashing Method". Economics of all treatment combinations was also studied.

RESULTS AND DISCUSSION

Effect of nitrogen

Yield attributes and yield

The study revealed that yield components *viz.,* plant height and leaf area index recorded significant and consistent increase with application of N up to 120 kg/ha (Table 1). These findings may be attributed to the fact that N causes cell elongation, acts as a principal constituent of proteins, enzymes, hormones, vitamins, chlorophyll and thus accelerates the meristematic activity of plant that led to progressive increase in internode length, protein synthesis and photosynthetic area thereby resulted increased plant height, leaf area index (Osman *et al*., 2010). Fresh and dry fodder yield of maize during both the years of study and mean yield over two years recorded significant and consistent increase with increase in N rates from 60 to 120 kg/ha. Eltelib *et al.,* (2006) also reported similar findings.

Nutrient content and uptake

An increase of significant level in the N content and its uptake of fodder maize was noticed with increase in the levels of N up to 120 kg/ha (Table 2). The increase in N content could be attributed to more number of leaves and higher leaf area index at higher levels of N; leaves contains more N than other plant parts. An increase in N uptake with application of higher N rates was due to more dry fodder yield. These results are in conformity with those of Rammu and Reddy (2007). Zn content and its uptake in fodder maize also increased with an increase in N rate. Improvement in Zn content with increased levels of N suggests a synergistic effect of N on Zn uptake. Singh and Singh (1998) also reported similar findings.

Quality

Crude protein content and its yield in fodder maize showed significant increase with an increase in N level from 60 to 120 kg/ha (Table 2). Eltelib *et al.,* (2006) also reported similar findings. Higher dry matter production and higher crude protein content at higher N levels resulted in higher crude protein yield. Singh *et al.,* (2008) have also reported a significant increase in crude protein yield of maize with increase in levels of N up to 120 kg/ha. Calcium content of fodder maize also showed significant increase with increase in N dose up to 90 kg/ha. N promotes the growth of young root tips by enhancing the meristematic activity and Ca^{2+} can be absorbed only by young root tips in which cell walls of the endodermis are still unsuberized. These results are in conformity with the findings of Sujata *et al*., (2008).

Effect of seed rate

Yield attributes and yield

S_{60} and S_{80} being at par, recorded significantly taller plants than S_{40} during both years of study (Table 1). Increase in plant height with higher seed rates may be due to competition for light. Further, auxins have basipetal movement and shading effect causes the auxins to move from illuminated side to shade side and thus the imbalance of auxin causes more elongation of plants in shade. Since auxin is sensitive to light, shading prevents its destruction and thus higher accumulation of auxin in shady plants triggers its growth to height. Joshi and Kumar (2007) reported similar results. Leaf area index showed significant and consistent improvement with an increase in seed rate from 40 to 80 kg/ha, which could be attributed to the effect of high plant population on vegetative and reproductive development. Similar findings have been reportd by Valadabadi and Farahani (2010). However, dry fodder yield recorded significant increase only upto 60 kg seed/ha. Nevertheless the results point out that green fodder ob-

Table 1. Plant height, leaf area index, green and dry fodder yield and economics of fodder maize as affected by levels of nitrogen, seed rate and zinc

Treatment	Plant height (cm)		Leaf area index		Green fodder yield (t/ha)		Mean	Dry fodder yield (t/ha)		Mean	Mean cost of cultivation ×10³₹/ha)	Mean net returns (×10³₹/ha)	B:C ratio
	2009	2010	2009	2010	2009	2010		2009	2010				
N levels (kg/ha)													
60	213.9	214.2	5.26	5.29	40.11	40.09	40.10	10.68	10.69	10.68	18.91	24.62	1.30
90	217.1	217.5	5.90	5.91	43.23	43.30	43.26	11.48	11.43	11.45	19.30	25.99	1.34
120	221.9	222.3	6.30	6.32	44.00	44.18	44.09	11.71	11.84	11.77	19.7	26.80	1.35
SEm±	0.40	0.38	0.12	0.13	0.08	0.09	0.08	0.07	0.08	0.07			
CD(P=0.05)	1.16	1.10	0.36	0.38	0.25	0.26	0.25	0.21	0.24	0.22			
Seed rate (kg/ha)													
40	216.0	217.0	4.48	4.63	40.45	40.52	40.48	10.85	10.86	10.85	18.90	25.38	1.33
60	218.0	218.4	5.85	5.91	43.06	43.14	43.20	11.48	11.53	11.50	19.30	26.31	1.35
80	218.6	218.6	6.86	6.92	43.84	43.93	43.88	11.54	11.58	11.56	19.70	25.89	1.31
SEm±	0.40	0.38	0.14	0.13	0. 08	0.09	0.08	0.07	0.08	0.07			
CD(P=0.05)	1.16	1.10	0.43	0.38	0.25	0.26	0.25	0.21	0.24	0.22			
Zn levels (kg/ha)													
0	216.2	216.6	5.48	5.62	40.72	40.80	40.76	10.93	10.94	10.93	19.03	25.48	1.33
10	218.9	219.6	5.98	6.02	44.18	44.27	44.22	11.64	11.69	11.66	19.58	26.24	1.34
SEm±	0.32	0.31	0.12	0.10	0.07	0.07	0.07	0.07	0.06	0.06			
CD(P=0.05)	0.95	0.90	0.35	0.31	0.20	0.21	0.21	0.20	0.19	0.19			

tained with a high seed rates contained more moisture and was more succulent, which is a good fodder quality.

Nutrient content and uptake

N and Zn content of maize was not affected significantly by different seed rates, however, their uptake recorded at 60 and 80 kg seed rate/ha, being at par, was significantly higher over 40 kg/ha (Table 2). The higher N and Zn uptake with aforesaid treatment might be due to more dry fodder yield (Verma *et al*., (1999). However, Rahmati, (2009) reported significant increase in N content of teosinte with an increase in seed rate.

Quality

Different seed rate could not affect crude protein and calcium content significantly (Table 2), however, crude protein yield recorded at 60 and 80 kg seed rate/ha was significantly higher over 40 kg seed rate/ha. Sikandar *et al*., (2007) also reported similar findings. The increase in crude protein yield at 60 and 80 kg seed rate/ha may be attributed to higher dry matter production.

Effect of zinc

Yield attributes and yield

Yield attributes *viz.*, plant height and leaf area index showed significant increase with application of Zn @ 10 kg/ha over no application. Zn is involved in the protein synthesis, and biosynthesis of Indole 3-acetic acid (a growth hormone, involved in cell division and cell elongation), increased the plant height and leaf area. Earlier Patel *et al*., (2007) have reported similar. As in the case of dry fodder, green fodder yield was significantly increased due to the Zn fertilization. The mean dry fodder yield (11.66 t/ha) recorded over two years exhibited increase of 6.68 per cent over control. These findings are in agreement with those of Patel *et al.*, (2007).

Nutrient content and uptake

Zn application increased both N content and its uptake over control (Table 2). Increase in N content with Zn application could be attributed to synergistic effect between N and Zn. The present findings support the results of Sharifi and Taghizadeh (2009). The results of present study also indicated that Zn content and its uptake increased significantly with Zn application compared to control (Table 2). Higher dry matter productions recorded with Zn application led to higher zinc uptake by the plant. Ashoka *et al*., (2008) also reported that Zn application at 10 mg/kg soil caused significant increase in the Zn content and uptake by sorghum over 5 mg/kg soil applicant and control.

Quality

Crude protein content, its yield and calcium content of fodder maize recorded significant improvement with Zn application over control (Table 2). Jaliya *et al*., (2008) also reported a significant increase in the protein content and yield of maize with Zn application at 30 kg $ZnSO_4$/ha over

Table 2. Nitrogen content, its uptake, zinc content, its uptake, crude protein content, its yield and calcium content of fodder maize as affected by levels of nitrogen, seed rate and zinc

Treatment	Nitrogen content (%)		Nitrogen uptake (kg/ha)		Zinc content (kg/ha)		Zinc uptake (g/ha)		Crude protein content (%)		Crude protein yield (t/ha)		Calcium content (%)	
	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010	2009	2010
N levels (kg/ha)														
60	1.48	1.49	158.16	159.28	20.0	20.0	213.6	213.8	9.25	9.31	0.97	0.98	0.53	0.54
90	1.51	1.51	173.34	172.59	22.0	23.0	252.5	262.9	9.44	9.44	1.06	1.06	0.62	0.63
120	1.54	1.55	180.33	183.52	24.0	25.0	281.0	296.0	9.62	9.69	1.10	1.12	0.64	0.65
SEm±	0.006	0.003	1.70	2.01	0.34	0.62	3.85	5.65	0.05	0.04	0.01	0.08	0.02	0.02
CD (P=0.05)	0.02	0.01	4.9	5.8	0.98	1.80	11.1	16.3	0.16	0.12	0.03	0.02	0.08	0.07
Seed rate (kg/ha)														
40	1.51	1.52	163.83	165.07	22.0	22.0	238.7	238.9	9.44	9.50	1.01	1.01	0.59	0.63
60	1.52	1.52	174.49	175.25	22.0	23.0	252.5	265.2	9.50	9.50	1.06	1.07	0.59	0.61
80	1.51	1.52	174.25	176.01	22.0	23.0	253.0	266.3	9.44	9.50	1.06	1.08	0.61	0.61
SEm±	0.06	0.03	1.70	2.01	0.34	0.62	3.85	5.65	0.05	0.04	0.01	0.08	0.02	0.02
CD (P=0.05)	NS	NS	4.9	5.8	NS	NS	11.1	16.3	NS	NS	0.03	0.24	NS	NS
Zn levels (kg/ha)														
0	1.50	1.51	163.95	165.19	20.0	21.0	218.6	229.7	9.37	9.44	1.02	1.01	0.55	0.56
10	1.53	1.53	178.09	178.85	24.0	24.0	279.3	280.5	9.56	9.56	1.07	1.20	0.62	0.64
SEm±	0.005	0.02	1.39	1.64	0.27	0.51	3.14	4.61	0.04	0.03	0.01	0.06	0.02	0.02
CD (P=0.05)	0.06	0.08	4.00	4.73	0.80	1.47	9.06	13.31	0.13	0.10	0.02	0.18	0.06	0.06

15 kg $ZnSO_4$/ha.

Economics

Response of fodder maize to applied nitrogen up to 120 kg/ha was linear in nature, indicating still higher N need by the crop. The treatment combination '$N_{120}S_{60}Z_{10}$' fetched higher net returns (₹26,460 and benefit cost ratio (1.53) during both the years of experiment. N application caused improvement in net returns and B:C ratio up to 120 kg N/ha while seed rate application positive effect was observed only up to 60 kg/ha. Zn application also caused marked improvement in net returns and B:C ratio (Table 2).

Thus, for realizing nutritious maize fodder under temperate conditions, an application of 120 kg N and 10 kg Zn/ha along with recommended dose of P (60 kg/ha) and K (30 kg/ha) and a seed rate of 60 kg/ha is recommended.

REFERENCES

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,* Department of Agronomy, University of Agriculture, Faisalabad, Pakistan 118 p.

Alloway, B.J. 2008. Zinc in soils and crop nutrition. 2nd edition published by International Zinc Association and International Fertilizer Association, Brussels, Belgium and Paris, France 223–25 pp.

DES. 2008. Digest of Statistics, Directorate of Economics and Statistics, Planning Department. Govt. of Jammu and Kashmir.

Ashoka, P. Mudalagiriyappa, M. Pujari, B.T. Hugar, P.S. and Desai, B.K. 2008. Effect of micronutrients with or without organic manures on yield of baby corn (*Zea mays* L.) chickpea (*Cicer artietinum* L.) sequence. *Karnataka Journal of Agricultural Sciences* **21**(4): 485–87.

Channakeshava, B.C., Ramachandrappa, B.K. and Prasanna, K.P.R. 2007. Influence of micronutrients and plant growth regulator on seed quality parameters in African tall fodder maize. *Current Research* (*University of Bangalore*) **28**: 11–12.

Eltelib, A.H., Hamad, A.M. and Ali, E.E. 2006. Effect of nitrogen and phosphorus fertilization on growth, yield and quality of fodder maize. *Journal of Agronomy* **5**(3): 515–18.

Jaliya, M.M., Falaki, A.M., Mahmud, M. and Sani, Y.A. 2008. Effects of sowing date and NPK fertilizer rate on yield and yield components of quality protein maize (*Zea mays* L.). *ARPN Journal of Agriculture and Biological Science* **3**(2): 22–29.

Joshi, Y.P. and Kumar, K. 2007. Response of forage maize (Zea mays L.) to the levels of nitrogen and seed rates. *Forage Research* **33**(3): 171–73

Osman, S. Abdelsalam, Y. and Abdelsalam, K. 2010. Effect of nitrogen and seed rate on growth and yield of forage sorghum. *Journal of Science and Technology* **11**(2): 123–36.