Indian Journal of Agronomy **59** (3): 471–473 (September 2014)

Research Communication

Effect of nitrogen, phosphorus and zinc on growth, yield and economics of teosinte (*Zea mexicana*) fodder

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Received : December 2013; Revised accepted : August 2014

ABSTRACT

A field experiment was conducted at Karnal during rainy season of 2012 to study the effect of nitrogen, phosphorus and zinc on growth, yield and economics of teosinte (*Zea mexicana* L.) fodder. Plant height, plant girth, number of leaves, leaf area index, number of tillers and branches increased with increase in levels of nitrogen, phosphorus and zinc. Green and dry fodder yield and gross returns, net returns and benefit: cost ratio increased significantly upto 160 kg N/ha, 40 kg P_2O_5/ha and 30 kg Zinc sulphate/ha. The treatment combination of N160 kg/ha, P_2O_5 40kg/ha and Zinc sulphate 30 kg/ha estimated as advantageous for production of teosinte fodder.

Key words: Economics, Nitrogen, Phosphorus, Teosinte, Yield, Zinc

Teosinte is popularly known as '*Makchari*' is a neglected fodder crop. It has not received the attention which it deserves and very little work has been done to explore its yield potentiality and nutritional quality. It is an excellent multicut fodder which gives high yield of nutritious green lush fodder in 65-70 days, with less use of inputs as compared to maize. As a fodder crop, it can be cultivated in any intensive fodder production system on an account of its versatile adaptability and maximum biomass production ability. Teosinte can be fed to animals as green, dry or as conserved fodder in the form of silage and hay. But the main hurdle in the cultivation of teosinte is the lack of production technology. Nutrient deficiency alongwith imbalanced and non-judicious fertilizers use are one of the important yield limiting factor. In India, about 62% and 49% soils are deficient in N and P respectively. Almost 50% of the soils globally used for cereal production are zinc deficient (Gibbson, 2006). Little or no use of zinc alongwith imbalanced fertilization further aggravated the situation. Zinc deficiency in soils resulting in lower zinc content in grains and fodder (Rashid and Ryan, 2004).The antagonism between phosphorus-zinc is observed mainly when both nutrients are deficient. These nutrients are also essential for animals so well nourished crop will also meet the demand of these nutrients specially zinc. Hence there is need to evaluate the level of zinc with other nutrients particularly phosphorus in the soil and plant under specific environment to develop appropriate technology for profitable crop production.

A field experiment was conducted during rainy season of 2012 at research farm of Forage Research and Management Centre, National Dairy Research Institute, Karnal. The soil of the experimental field was clay loam in texture, low in available N (190.5 kg/ha) and organic carbon (0.50%), medium in available phosphorus (19.2 kg/ha) and high in available potassium (270.8 kg/ha) with pH 7.2 and bulk density 1.5 Mg/m^3. Rainfall received during the crop period was 397.7 mm from 12 August to 31 October, 2012 and total evaporation was 303.4 mm. Thirty treatments combinations of 5 levels of nitrogen (0, 40, 80, 120 and 160 kg/ha), 3 levels of phosphorus (0, 20 and 40 kg/ha) and 2 levels of zinc sulphate (0, 30 kg/ha), were laid out 4 times replicated in factorial randomized block design, consisting of 120 plots, each plot of 6 m × 4.5 m size. Half dose of N, full dose of P and Zn was applied as basal dose through urea, single superphosphate and zinc sulphate respectively. The remaining half dose of N was applied in 2 split doses at 30 days after sowing and 45 days after sowing by broadcast after irrigation. Teosinte 'Bihar local' was sown on 12 August 2012 at planting distance of 30 cm × 20 cm by *kera* method. Thinning was done at early stage (25 DAS) of crop. Pre-emergence application of atrazine @ 1.5 kg a.i./ha was applied at 2 days after

Based on a part of M.Sc. thesis of the first author submitted to National Dairy Research Institute (Deemed University), Karnal during 2013 (unpublished)

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sowing followed by one manual weeding at 25 days after sowing for controlling the weeds. Three irrigations at 30, 48 and 65 days after sowing were applied during crop period. Harvesting of green forage was done at 50% flowering; only one cut was taken at 75 days after sowing. The green forage weight per plot was recorded immediately after harvesting by spring balance in the field. Randomly selected 10 plants were tagged for biometric observations viz. plant height plant girth number of branches/plant and number of cobs per plant at harvest. Leaf area index and number of tillers were recorded at 30, 45 DAS and at harvest. Economics was worked out in terms of gross returns, net returns and benefit: cost ratio on per hectare basis. The statistical analysis was done by using standard procedure of variance analysis with the help of statistical software IRRISTAT 4.0 (IRRI, 1999).

The plant height, plant girth, number of branches, number of tillers, number of cobs/plant and leaf area index increased significantly with the successive increase in level of nitrogen application upto 160 kg N/ha at harvesting stage (Table 1). The increase in plant height in response to higher levels of nitrogen has been confirmed by the findings of Shehzad *et al.* (2012). Application of 20 and 40 kg P_2O_5/ha significantly increased plant height at harvest, but no significant difference between 20 kg and 40 kg P_2O_5/ha was noted. Plant height increased significantly upto 40 kg P_2O_5/ha. Roy and Khandekar (2010) reported similar results. Zinc application had no significant effect on plant height at harvesting stage. These results are in conformity with the findings of Mehdi *et al*. (2012). Significant increase in plant girth was recorded up to 120 kg N/ha. Application of 40 kg P_2O_5/ha had significantly higher plant girth than lower levels. The application of 20 kg P_2O_5/ha was at par with control. Zinc application had no significant effect on plant girth of the crop. Effect of N, P and Zn was significant on number of branches/plant and leaf area index (LAI) at different stage of crop. Maximum leaf area index i.e. 6.92, 6.60 and 6.10 was recorded with the application of 160 kg N, 40 kg P_2O_5 and 30 kg $ZnSO_4$/ha respectively (Fig. 1). This is in concurrence with the findings of Shehzad *et al*. (2012).

The number of tillers/plant was significantly affected by N and P application. Increasing levels of phosphorus significantly increased number of tillers/plant at all three stages of crop. Maximum number of tillers (2.0) were recorded with160 kg N/ha at harvest. Increasing trends was shown with phosphorus doses. Zn application had no significant effect on number of tillers/plant (Fig.2). Increasing level of nitrogen upto 160 kg N/ha significantly increased the number of branches at harvesting stage. Maximum number of cobs/plant were recorded with the application of 160 kg N/ha, being on par with 120 kg N/ha. Phosphorus and zinc application had significant effect on number of cobs/plant. The results confirms findings of

Table 1. Effect of nitrogen, phosphorus and zinc application on growth, yield and economics of teosinte fodder at harvest

Treatment	Plant height (cm)	Plant girth (cm)	Branches/ plant	LAI	Tillers/ plant	Cobs/ plant	Green fodder yield (t/ha)	Dry-matter yield (t/ha)	Cost of cultivation (×10^3 ₹/ha)	Net returns (×10^3 ₹/ha)	Benefit: cost ratio
Nitrogen levels (kg/ha)											
0	143.5	4.07	4.1	4.20	1.3	7.4	23.13	5.28	22.9	10.6	0.46
40	155.9	4.39	4.8	5.42	1.6	8.3	31.98	7.41	23.4	23.0	0.98
80	166.0	4.60	4.9	6.06	1.8	10.7	38.75	9.24	23.9	32.3	1.35
120	174.8	4.87	5.8	6.44	1.9	13.2	45.50	11.29	24.5	41.5	1.70
160	180.6	4.89	5.9	6.92	2.0	13.9	49.44	12.22	25.0	46.7	1.87
SEm±	3.8	0.09	0.3	0.35	0.1	0.7	0.52	0.21			
CD (P=0.05)	10.8	0.26	0.8	0.99	0.3	1.9	1.47	0.58			
Phosphorus levels (kg/ha)											
0	156.7	4.34	4.6	5.02	1.6	8.8	33.69	7.88	22.9	25.9	1.13
20	166.4	4.54	5.2	5.81	1.7	10.5	37.90	9.19	23.9	31.1	1.30
40	169.5	4.81	5.6	6.60	1.9	12.8	41.70	10.20	24.9	35.6	1.43
SEm±	3.0	0.07	0.2	0.27	0.1	0.5	0.4	0.16			
CD (P=0.05)	8.4	0.20	0.6	0.77	0.2	1.5	11.4	0.45			
Zinc levels (kg/ha)											
0	163.3	4.51	4.9	5.52	1.7	9.9	36.48	85.8	22.9	30.0	1.31
6	165.0	4.63	5.4	6.10	1.8	11.5	39.05	96.0	24.4	32.3	1.32
SEm±	2.4	0.06	0.2	0.22	0.1	0.4	0.33	0.13			
CD (P=0.05)	NS	NS	0.5	0.63	NS	1.2	0.93	0.37			

Prevailing market price of green fodder @₹1,450/tonne, Urea @₹6/kg, Single Super Phosphate @ ₹8/kg, Zinc sulphate @ ₹57/kg.

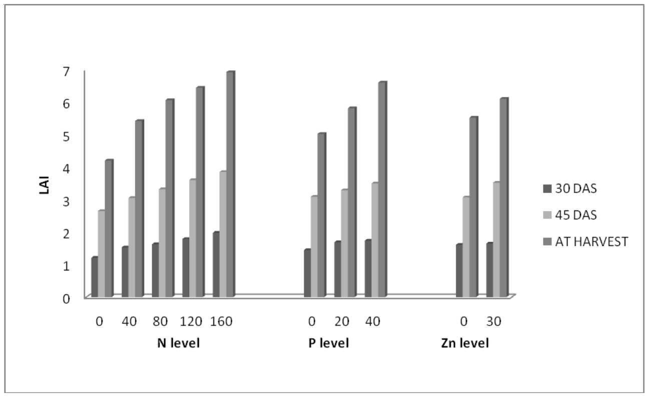

Fig. 1. Effect of N, P and Zn on leaf area index

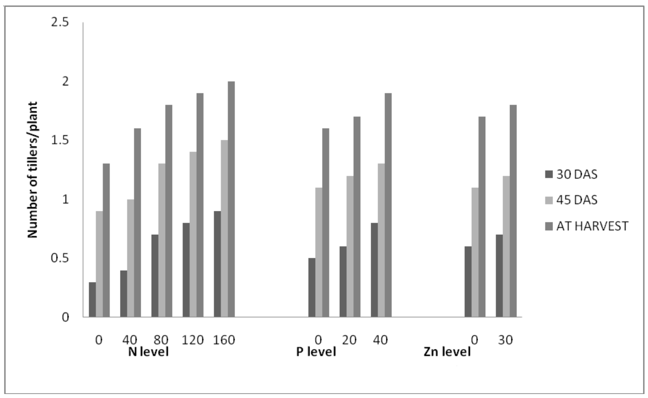

Fig. 2. Effect of N, P and Zn on number of tillers/plant

Sharar *et al*. (2003). Increasing level of N and P significantly increased the green fodder and dry matter yields. Increasing level of phosphorus from 0 to 40 kg P_2O_5/ha produced higher green fodder yield. Application of 30 kg $ZnSO_4$/ha produced significantly higher green fodder yield. Bhagwan *et al.* (1997) reported the similar findings for dry matter yield. Improvement in growth attributes increased the fodder and dry matter yields and utilization of N, P and Zn. Interaction effect N and P on green fodder yield and P and Zn on dry matter yield was found significant (Table 2 and 3).

Increasing level of N, P and Zn increased the gross returns, net returns and benefit: cost ratio of teosinte fodder. The highest net returns (₹46,727) and benefit: cost ratio (1.87) were recorded with application of 160 kg N/ha. Application of 40 kg P_2O_5/ha recorded net returns of ₹35,568 and benefit: cost ratio was increased from 1.13 to 1.43 with increasing the level of phosphorus upto 40 kg/ha. High net returns (₹32,271) and benefit: cost (1.32) were estimated with the application of 30 kg $ZnSO_4$/ha (Table 1).

Based on study, combination of $N_{160}P_{40}Zn_6$ kg/ha was considered economically feasible combination for higher green and dry fodder yield of teosinte fodder.

Table 2. Interaction effect of nitrogen and phosphorus on green fodder yield (t/ha)

Treatment	Phosphorus (kg/ha)		
Nitrogen levels (kg/ha)	0	20	40
0	17.48	24.33	27.56
40	27.67	32.10	36.17
80	35.82	38.98	41.45
120	42.77	45.57	48.16
160	44.66	48.50	55.16
CD (P=0.05)	N×P=2.54		

Table 3. Interaction effect of phosphorus and zinc on dry matter yield (t/ha)

Treatment	Zinc sulphate (kg/ha)	
Phosphorus (kg/ha)	0	30
0	7.45	8.31
20	8.30	10.06
40	9.98	10.41
CD (P=0.05)	P×Zn=0.63	

REFERENCES

Bhagwan, D., Sheoran, R.S. and Das, B. 1997. Effect of phosphorus fertilization on quality and yield of cowpea. *Annals of Biology* **13**(1): 195–96.

Gibbson, R.S. 2006. Zinc: The missing link in combating micronutrient malnutrition in developing countries. (In:) *Proceedings of the Nutrition Society* **65**: 51-60.

IRRI, 1999. IRRISTAT for Windows version 4.0 Biometrics Unit, IRRI, Los Banos, Phillippines.

Krishnamurthy, K., Bommegowda, A., Jagannath, M.K., Venugopal, N., Ranchandra Prasad, T.V., Raghunath,G. and Rajashekaia, B.C. 1974. Relative production of yield by hybrid, composite and local maize as influenced by nitrogen and population levels. *Mysore Journal of Agricultural Science* **8**(4): 500–08.

Mehdi, S.S., Hussain, B., and Singh, L. 2012. Influence of seed rate, nitrogen and zinc on fodder maize (*Zea mays* L.) in temperate conditions of Western Himalayas. *Indian Journal of Agronomy* **57**(1): 85–88.

Rashid, A. and Ryan, J. 2004. Micronutrients constraints to crop production in soils with Mediterranean-type characteristics: A review. *Journal of Plant Nutrition* **27**(6): 959–75.

Roy, P.R.S. and Khandekar, Z.H. 2010. Effect of phosphorus fertilizer on yield and nutritional value of sorghum (*Sorghum bicolor*) fodder at three cuttings. *Bangladesh Journal of Animal Sciences* **39** (1 and 2): 106–15.

Shehzad, M.A., Maqsood, M., Bhatti, M.A., Ahmad, W. and Shahid, M.R. 2012. Effects of nitrogen fertilization rate and harvest time on maize (*Zea mays* L.) fodder yield and its quality attributes. *Asian Journal of Pharmaceutical and Biological Research* **2**(1): 19–26.

Sharar, M.S., Ayub, M., Nadeem, M.A. and Ahmad, N. 2003. Effect of different rates of nitrogen and phosphorus on growth and grain yield of maize (*Zea mays* L.). *Asian Journal of Plant Sciences* **2**(3): 347–49.