Forage Res., **40** (2) : pp. 119-126 (2014) **http://forageresearch.in**

EFFECT OF SODICITY AND NITROGEN LEVELS ON DRY MATTER YIELD, PROTEIN AND NUTRIENT UPTAKE IN TEOSINTE

NIRANJAN SINGH*[1], S. K. SHARMA, RAJPAUL, ROHTAS KUMAR AND ASHWANI KUMAR[2]

Department of Soil Science
CCS Haryana Agricultural University,
Hisar-125 004 (Haryana), India
**(e-mail : nnirajan1234@rediffmail.com)*
(Received : 16 June 2014; Accepted : 25 July 2014)

SUMMARY

The present study was carried out in the Department of Soil Science, CCSHAU, Hisar during **kharif** season in screen house. The experiments were conducted on a sandy loam soil having initial pH (1 : 2) 8.21 and ESP 7.88. Soil of different ESP (15, 30 and 45) was prepared. Observed ESP was 7.88, 13.86, 31.15 and 43.79, respectively. The first experiment was conducted in screen house to study the effect of different ESP levels (control, 15, 30 and 45) on teosinte with fixed 80 kg N/ha dose. In second experiment, different nitrogen levels, 0, 40, 80 amd 120 kg N/ha on pearl millet at an ESP of 45 were studied. The results showed decrease in the dry matter yield of teosinte crop with increasing ESP levels (control, 15, 30 and 45). The maximum (48.18, 45.97, 38.82 and 35.74 g/pot) and minimum (19.78, 25.18, 15.09 and 14.63 g/pot) dry matter yield of teosinte were observed at control and 45 ESP, respectively. The plant height and protein content also decreased with increasing ESP levels. The uptake of N, P, K, Ca, Mg and S decreased with increasing ESP levels. The reduction in N uptake over control was 10.83, 46.77 and 65.22 per cent at 15, 30 and 45 ESP levels, respectively. The uptake of micronutrients (Zn, Cu, Mn and Fe) in teosinte decreased with increasing ESP levels. The maximum uptake was observed at control, whereas minimum at an ESP of 45. The results of experiment conducted on different levels of N (0, 40, 80 and 120 kg/ha) on teosinte forage crop at a constant ESP level (45 ESP) indicated that dry matter yield increased with increasing N levels. The maximum dry matter yield (12.84 g/pot) at 120 kg N/ha and minimum (9.27 g/pot) was obtained at N control in teosinte. The plant height and protein content in these crops also increased with increasing N levels. Effect of different levels of N (0, 40, 80 and 120 kg/ha) on teosinte forage crop at a constant ESP level (45 ESP) indicated that uptake of nutrients N, P, K, Ca, Mg, Na, S, Zn, Cu, Mn and Fe by teosinte increased with increasing N levels.

Key words : ESP, nitrogen, nutrients uptake, dry matter yield, protein content, teosinte

The quality fodder in India is inadequate to meet the requirement of huge livestock population of the country. Low area under forage crops is mainly due to competition among grain and fodder crops and poor yielding ability of fodder crops. So, it is difficult to devote more acreage under fodder crops, and only alternative left to increase the fodder production by growing fodder crops on salt affected soils. Among salt affected soils, sodic soils have prominent place. Excess exchangeable sodium and high pH characteristics of sodic soils are responsible for deterioration in soil physico-chemical characteristics resulting in poor air and water movement in soil (Marlet *et al*., 1998), which ultimately adversely affects growth, yield and chemical composition and nutrient uptake by plants (Singh *et al*., 1980; Singh *et al*., 2014).

The potential of teosinte as an excellent forage crop is well known, particularly in arid and semi-arid regions of the world. It is a multipurpose cereal crop grown for grain, stover and green fodder. With its wide ability to adapt to diverse agro-ecological conditions, it has unique position in the world forage crops. However, yield and quality of fodder teosinte is greatly influenced by soil condition, type and amount of salts present, and agronomic practices including application of fertilizers, irrigation schedules, etc. generally, sodic soils are found deficient in nitrogen. Hence, the requirement

[1]Present Address Asstt. Manager, IFFCO, Fatehabad.
[2]Govt. P. G. College, Jhajhar.

of nitrogen for growing teosinte in these soils is relatively more. The information on effect of sodicity at different nitrogen levels on fodder teosinte is scanty. Therefore, keeping these points in view, present investigation was undertaken.

MATERIALS AND METHODS

The present study was carried out in the Department of Soil Science, CCS Haryana Agricultural University, Hisar during **kharif** season in screen house in the earthen pots. The experiments were conducted on a sandy loam soil having initial pH (1 : 2) 8.21 and ESP 7.88. Soil of different ESP (15, 30 and 45) was prepared adopting the standard procedure given by Bains and Fireman (1964). Observed ESP was 7.88, 13.86, 31.15 and 43.79, respectively. The first experiment was conducted in screen house to study the effect of different ESP levels (control, 15, 30 and 45) on teosinte with fixed 80 kg N/ha dose. In second experiment, different nitrogen levels, 0, 40, 80, 120 kg N/ha on teosinte at an ESP of 45 were studied. Soil samples from each pot were collected after harvest of crop and analyzed for their pH, EC, soluble calcium and magnesium and exchangeable sodium. Effect of different ESP levels was studied on teosinte at 80kgN/pot in three replications in CRD. For data recording above ground plant was harvested at 50 per cent flowering. Analyses of plant and soil samples were carried out as per prescribed laboratory standard procedures.

RESULTS AND DISCUSSION

Effect of ESP Levels on Plant Height, Dry Matter Yield and Protein Content of Teosinte

Data (Table 1 and Fig. 1) reveal that the dry matter yield of teosinte crop decreased significantly with increasing ESP levels. The highest dry matter yield (35.74 g/pot) was observed in control and lowest (14.63 g/pot) at an ESP of 45. The reduction in dry matter yield over control was 38.11 and 59.07 per cent at 30 and 45 ESP levels, respectively. Above findings were supported by Singh *et al.* (1988). Increasing salt levels of the growth caused a marked inhibitory effect on fresh and dry weights and maximum reduction in biomass was observed at highest salt level (Ashraf and Orooj, 2006; Uppadyay *et al*., 2012).

TABLE 1
Effect of ESP levels on dry matter yield, plant height and protein content of teosinte crop

ESP levels	Dry matter yield (g/pot)	Plant height (cm)	Protein content (%)
Control	35.74	140.48	8.50
15	33.30	135.81	8.25
30	22.12	128.89	7.88
45	14.63	119.12	7.44
C. D. (P=0.05)	1.61	2.78	0.18

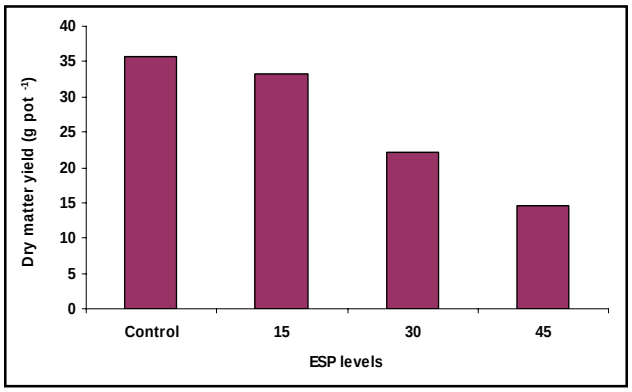

Fig. 1. Effect of ESP levels on dry matter yield of teosinte crop.

The plant height of teosinte crop decreased significantly with the increase in the level of ESP (Table 1). The highest plant height (140.48 cm) was recorded at control soil and lowest (119.12 cm) at 45 ESP. The per cent reduction in plant height was 8.25 and 15.21 at 30 and 45 ESP levels, respectively, as compared to control.

Data in Table 1 reveal that the crude protein content in teosinte decreased significantly with increasing ESP levels. It was found maximum (8.50%) in control soil and minimum (7.44%) at 45 ESP soil. The reduction in crude protein content was 7.29 and 12.47% at 30 and 45 ESP levels, respectively, as compared to control. The

reduction in protein content at high ESP levels may be due to less availability of nitrogen and plant nutrients essential for the protein synthesis (Singh *et al.*, 2014).

Effect of ESP Levels on Nutrient Uptake by Teosinte

Uptake of N, P and K by teosinte decreased with increasing ESP level (Table 2 and Fig. 2). The maximum N (486.06 mg/pot), P (75.05 mg/pot) and K (639.75 mg/pot) uptake was observed at control, whereas minimum N (174.10 mg/pot), P (21.95 mg/pot) and K (209.21 mg/pot) uptake was observed at 45 ESP. The reduction was 42.66 and 64.18 per cent in N uptake, 49.90 and 70.75 per cent in P uptake and 42.26

TABLE 2
Effect of ESP levels on nutrient uptake (mg/pot) by teosinte crop

ESP levels	N	P	K	Ca	Mg	Na	S
Control	486.06	75.05	639.75	203.72	117.94	67.91	142.96
15	439.56	63.27	579.42	179.82	99.90	76.59	123.21
30	278.71	37.60	369.40	108.39	57.51	59.72	75.21
45	174.10	21.95	209.21	64.33	32.16	48.25	42.40
C. D. (P=0.05)	31.30	9.79	37.39	12.56	9.85	13.43	9.21

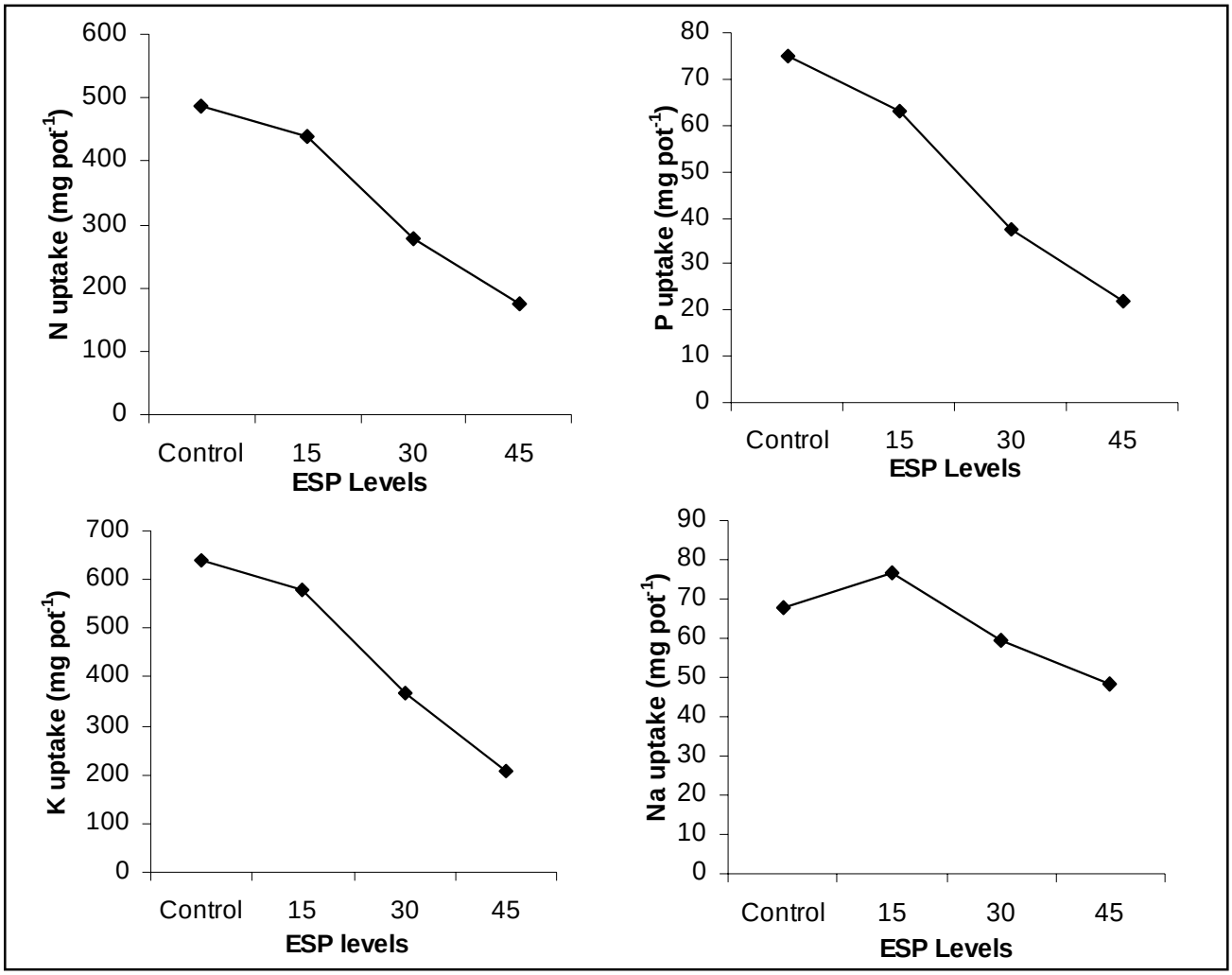

Fig. 2. Effect of ESP levels on uptake of N, P, K and Na by teosinte crop.

and 67.30 per cent in K uptake at 30 and 45 ESP levels, respectively as compared to control. Decrease in nitrogen, phosphorus and potassium uptake with increasing ESP, was also reported by Sarode and Bhalkar (1981) in wheat, Singh and Abrol (1983) in pea and Balak Ram and Misra (2004) in German Chamomile.

Calcium and magnesium uptake by teosinte also decreased with increasing ESP level (Table 2). The maximum Ca (203.72 mg/pot) and Mg (117.94 mg/pot) uptake was observed at control, whereas minimum Ca (64.33 mg/pot) and Mg (32.16 mg/pot) uptake was observed at 45 ESP. The reduction was 46.79 and 68.42 per cent in Ca uptake and 51.24 and 72.73 per cent in Mg uptake at 30 and 45 ESP levels, respectively, as compared to control. The decrease in calcium and magnesium uptake by pearl millet with increasing ESP is in accordance with the findings of Singh *et al*. (2014).

TABLE 3
Effect of ESP levels on micronutrient uptake (mg/pot) by teosinte crop

ESP levels	Zn	Cu	Mn	Fe
Control	0.83	0.17	1.57	5.37
15	0.69	0.15	1.36	4.88
30	0.37	0.08	0.80	3.10
45	0.19	0.05	0.45	1.91
C. D. (P=0.05)	0.05	0.02	0.12	0.31

No significant difference was observed in Na uptake by teosinte within control and 15 ESP treatments, whereas it decreased significantly with further increase

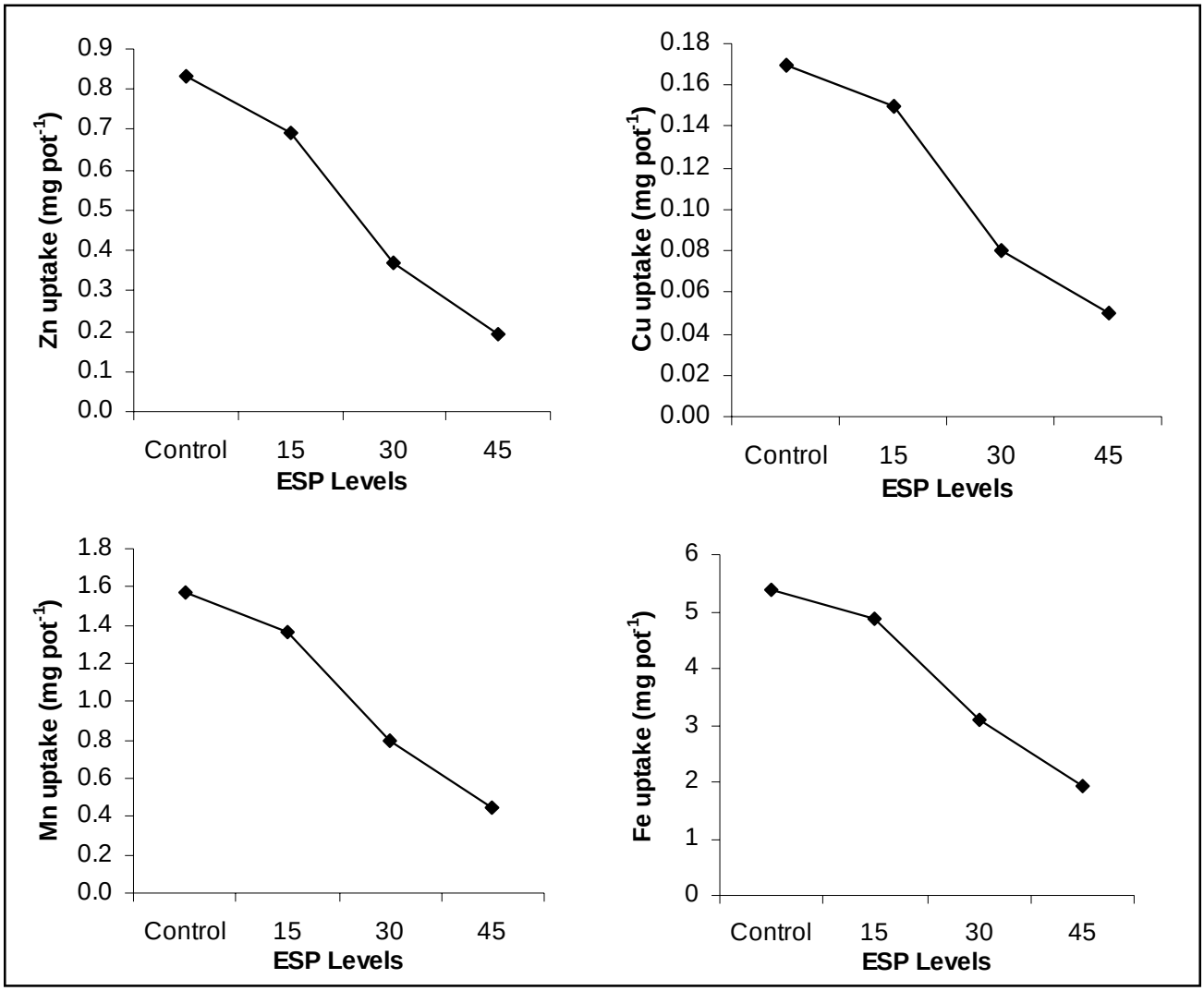

Fig. 3. Effect of ESP levels on uptake of Zn, Cu, Mn and Fe by teosinte crop.

in ESP levels, over 15 ESP (Table 2 and Fig. 2). Sulphur uptake decreased with increasing ESP. The maximum S uptake (142.96 mg/pot) was found in control and minimum (42.40 mg/pot) at 45 ESP (Table 2). The per cent reduction in S uptake over control was 47.39 and 70.34 at 30 and 45 ESP levels, respectively. Singh *et al*. (2014) also observed decrease in sulphate uptake with increasing ESP levels in pearl millet.

Effect of ESP Levels on Micronutrient Uptake by Teosinte

The uptake of Zn, Cu, Mn and Fe by maize decreased significantly with increasing ESP levels (Table 3 and Fig. 3). The maximum Zn uptake (0.83 mg/pot), Cu uptake (0.17 mg/pot), Mn uptake (1.57 mg/pot) and

TABLE 4
Effect of nitrogen levels on dry matter yield, plant height and protein content of forage teosinte crop at 45 ESP

Nitrogen levels (kg/ha)	Dry matter yield (g/pot)	Plant height (cm)	Protein content (%)
0	9.27	110.12	6.75
40	12.84	116.65	7.13
80	14.81	120.16	7.44
120	16.13	123.77	7.69
C. D. (P=0.05)	1.49	2.72	0.20

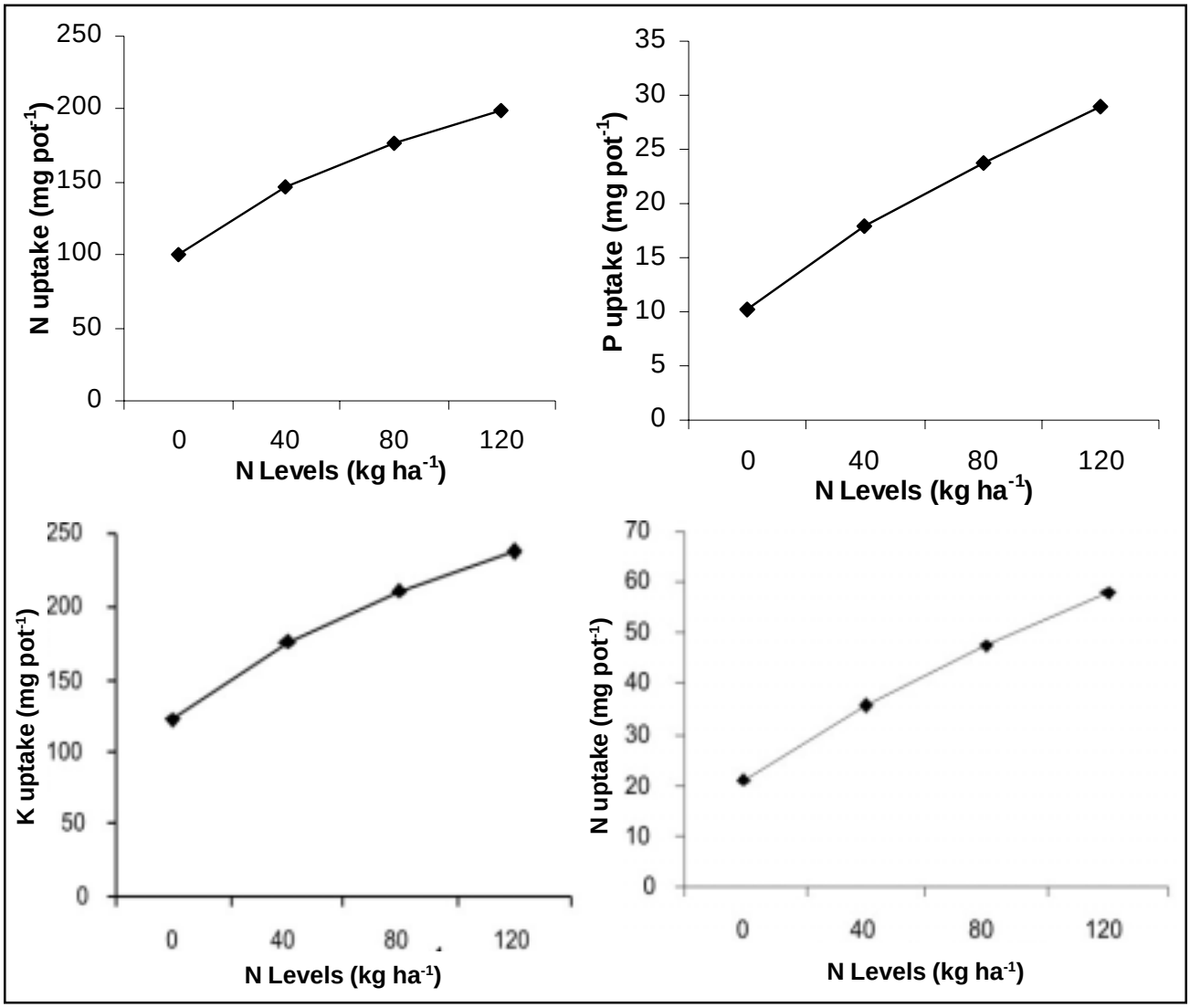

Fig. 4. Effect of nitrogen levels on uptake of N, P, K and Na by teosinte crop at 45 ESP.

Fe uptake (5.37 mg/pot) was observed at control, whereas minimum Zn uptake (0.19 mg/pot), Cu uptake (0.05 mg/pot), Mn uptake (0.45 mg/pot) and Fe uptake (1.91 mg/pot) was observed at 45 ESP. The reduction in uptake over control was 55.42 and 77.10 per cent in Zn, 52.94 and 70.59 per cent in Cu, 49.04 and 71.34 per cent in Mn and 42.27 and 64.43 per cent in Fe at 30 and 45 ESP level, respectively. In maize and beans, the salt treatments lowered the uptake of micro-elements (Kudo *et al*., 2010).

Effect of Nitrogen Levels on Dry Matter Yield, Plant Height and Crude Protein Content

Increasing level of N application from 0 to 40, 80 and 120 kg/ha at 45 ESP increased the dry matter yield of teosinte crop by 38.51, 59.76 and 74.00 per cent, respectively (Table 4). The lowest dry matter yield (9.27 g/pot) was observed at control, whereas highest (16.13 g/pot) at 120 kg N/ha. Nitrogen application at 120 kg N/ha produced significantly higher yield as compared to 80 kg N/ha which is an optimum dose for teosinte in normal soil in this region. This showed that teosinte in sodic soils respond to higher doses of applied N owing to their poor organic matter and available N status. Haggar and Couper (1972) conducted trials in irrigated maize with varying nitrogen levels from 0-160 kg/ha. They concluded that increasing fertilizes rates increased fresh fodder yields. Increase in dry matter yield of teosinte raised in normal soil, with increasing N application also confirmed by Rawal and Relwani (1974) upto 90 kg N/ha and Verma and Joshi (1998) up to 120 kg N/ha. A field experiment on black clay soils at Dharward revealed that the increasing nitrogen levels from 80 to 120 kg/ha produced significantly higher growth and yield in pearl millet (Hegde *et al*., 2004).

Plant height of teosinte crop, grown at 45 ESP, increased significantly with increasing nitrogen levels. It evident from Table 4 that the minimum plant height (110.12 cm) was observed at 0 and maximum (123.77 cm) at 120 kg N/ha. The increase in plant height over control 120 kg N/ha at 45 ESP was reported by Singh *et al.*, (2014) in pearl millet. Each incremental dose of nitrogen contributed significantly in increasing crude protein content of teosinte grown at 45 ESP (Table 4). The minimum crude protein content (6.75%) was observed at 0 and maximum (7.69%) at 120 kg N/ha (Table 4). The application of higher doses of nitrogen levels on pearl millet genotypes produced significantly higher crude protein yield in green forage pearl millet (Kumar *et al*., 2012; Damame *et al*., 2013).

TABLE 5
Effect of nitrogen levels on uptake of nutrient (mg/pot) by teosinte crop at an ESP of 45

Nitrogen levels (kg/ha)	N	P	K	Ca	Mg	Na	S
0	100.12	10.20	122.36	32.45	12.05	21.32	18.54
40	146.38	17.98	175.91	51.36	23.11	35.95	32.10
80	176.24	23.70	210.30	65.16	32.58	47.39	42.95
120	198.40	29.03	237.11	77.42	41.94	58.07	53.23
C. D. (P=0.05)	22.10	5.65	26.26	9.12	9.76	4.70	7.30

TABLE 6
Effect of nitrogen levels on the uptake of micronutrient (mg/pot) by teosinte crop at 45 ESP

Nitrogen levels (kg/ha)	Zn	Cu	Mn	Fe
0	0.08	0.02	0.20	1.12
40	0.14	0.04	0.34	1.62
80	0.19	0.05	0.45	1.93
120	0.25	0.06	0.54	2.15
C. D. (P=0.05)	0.03	0.01	0.06	0.24

Effect of Nitrogen Levels on Nutrient Uptake by Teosinte Crop at an ESP of 45

The N uptake by teosinte increased with increasing N levels (Table 5 and Fig. 4). Increasing level of N application from 0 to 40, 80 and 120 kg/ha increased

the nitrogen uptake by 46.20, 76.03 and 98.16 per cent, respectively.

The P and K uptake also increased with increasing N levels. The minimum P (10.20 mg/pot) and K (122.36 mg/pot) uptake was found at 0 and maximum P (29.03 mg/pot) and K (237.11 mg/pot) uptake was observed at 120 kg N/ha (Table 5 and Fig. 4).

Increasing trends of Ca, Mg, Na and S uptake by teosinte were also observed up to 120 kg N/ha. The minimum uptake was found at control and maximum at 120 kg N ha^{-1} (Table 5 & Fig. 4). The findings of Verma and Joshi (1998) in normal soil, in respect of nitrogen uptake, where nitrogen uptake increased significantly with increase in nitrogen from 0 to 120 kg/ha in teosinte, confirmed the results. Similar findings were reported in pearlmillet (Singh *et al*., 2014).

Effect of Nitrogen Levels on Micronutrient Uptake by Teosinte Crop at 45 ESP.

Uptake of Zn, Cu, Mn and Fe at 45 ESP soil increased with increasing levels of nitrogen (Table 6 and Fig. 5). The minimum Zn (0.08 mg/pot), Cu (0.02 mg/pot), Mn (0.20 mg/pot) and Fe (1.12 mg/pot) uptake

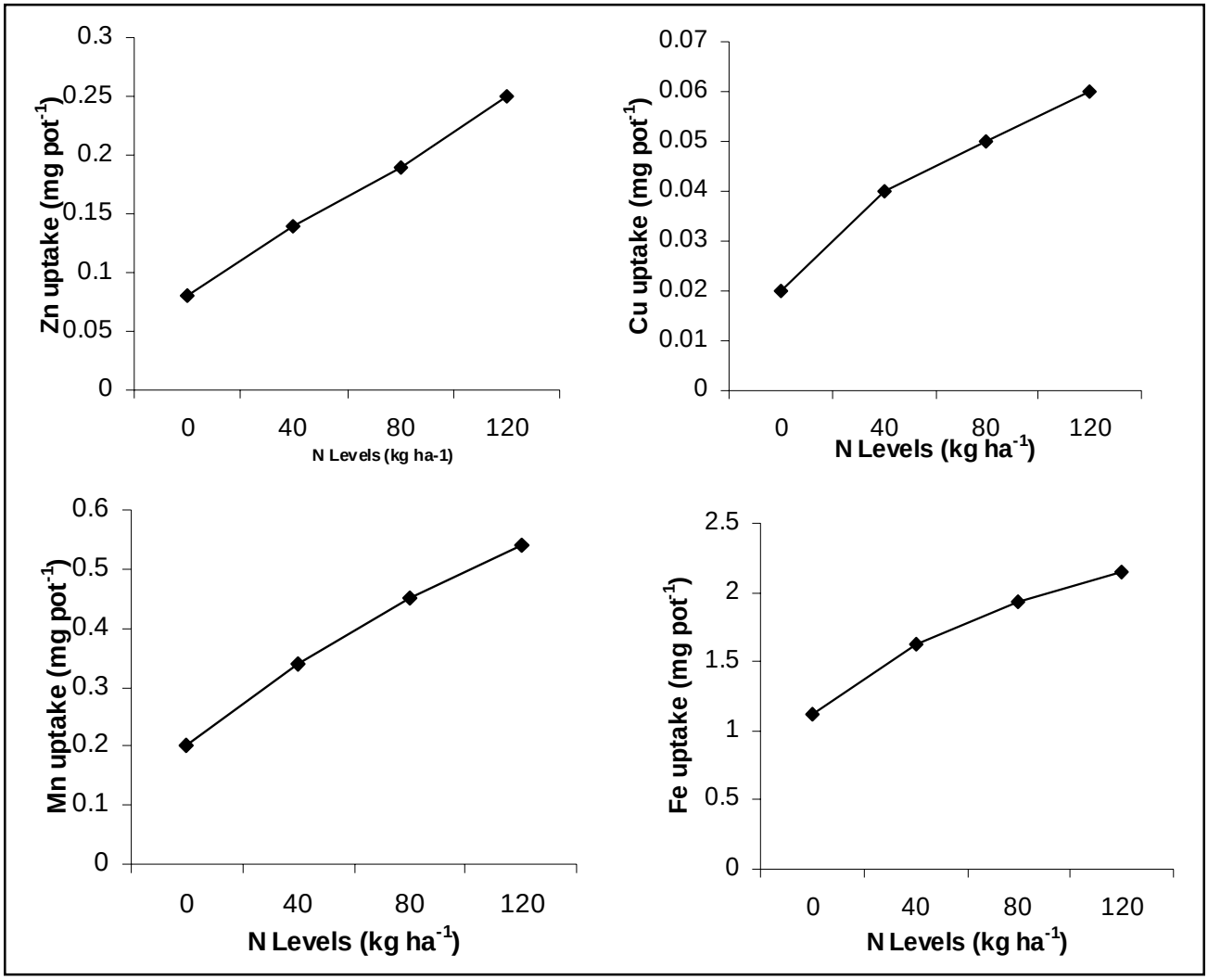

Fig. 5 Effect of nitrogen levels on uptake of Zn, Cu, Mn and Fe by teosinte crop at 45 ESP.

was found at 0 kg N/ha, but the maximum Zn (0.25 mg/pot), Cu (0.06 mg/pot), Mn (0.54 mg/pot) and Fe (2.15 mg/pot) at120 kg Nha^{-1}. Similar trend of results was obtained in pearlmillet (Singh *et al*., 2014).

CONCLUSION

It was concluded that increasing ESP levels reduced the dry matter yield, plant height, protein content

and uptake of macro and micro-nutrients in teosinte. However, increasing N levels increased dry matter yield, plant height, protein content, uptake of macro and micro-nutrients in teosinte.

REFERENCES

Ashraf, M., and A. Orooj, 2006 : Salt stress effect on growth, ion accumulation and seed oil concentration in arid zone traditional medicinal plant ajwain [*Trachyspermum ammi* (L.) Sprague]. *J. Arid Environ.*, **64** : 209-220.

Bains, S. S., and Fireman, M. 1964 : Effect of exchangeable sodium percentage on the growth and absorption of essential nutrients and sodium by five crop plants. *Agron. J.* **56** : 432-435.

Balak Ram, and P. N. Misra, 2004 : Nutrient accumulation and sodicity reclamation potential of German Chamomile (*Chamomilla recutita*) under sodicity and fertility levels. *J. Med. Arom. Pl. Sci*., **26** : 12-16.

Damame, S. V., R. N. Bhingarde, and S. H. Pathan, 2013 : Effect of different nitrogen levels on nutritional quality and nitrate nitrogen accumulation in forage pearl millet genotypes grown under rainfed condition. *Forage Res*., **39** : 93-95.

Haggar, R. J., and Couper, D. C. 1972 : Effect of plant population and fertilizer nitrogen on growth and components of yield of maize grown for silage in Nigeria. *Exptl. Agric*. **8** : 251-263.

Hegde, R., M. Devaraja, and Subhash Gumaste, 2004 : Growth and forage yield of forage pearl millet (*Pennisetum typhoides*) as influenced by stage of harvesting of seed crop, nitrogen and phosphorus levels. *Forage Res*., **30** : 125-127.

Kudo, N., T. Sugino, M. Oka, and H. Fujiyama, 2010 : Sodium tolerance of plants in relation to ionic balance and the absorption ability of micro-elements. *Soil Sci. & Plant Nutr.*, **56** : 225-233.

Kumar, Amit, R. K. Arya, Sunil Kumar, Dharmender Kumar, and Suresh, 2012 : Advances in pearl millet fodder yield and quality improvement through breeding and management practices *Forage Res.*, **38** : 1-14.

Marlet, S., L. Barbiero, and V. Valles, 1998 : Soil alkalization and irrigation in the Sahelian Zone of Niger. II. Agronomic consequences of alkalinity and sodicity. *Arid Soil Res. Rehab*., **12** : 139-152.

Rawal, R., and Relwani, L. L. 1974 : Effect of cutting management and levels of nitrogen on yield and chemical composition of teosinte fodder. National Dairy Research Institute, Karnal, Haryana. Annual Report, 1973.

Sarode, P. V., and D. V. Bhalkar, 1981 : Effect of various levels of exchangeable sodium percentage (ESP) on wheat yield and uptake of nutrients. *PKV Res. J.*, **5** : 57-61.

Singh, K. N., D. K. Sharma, and R. K. Chillar, 1988 : Forage yield and chemical composition of pearl millet (*Pennisetum typhoides*) as influenced by exchangeable sodium. *J. Agric. Sci., UK*, **111** : 465-467.

Singh, N., S. K. Sharma, Rohtas Kumar, Rajpaul, and S. Singh 2014 : Effect of sodicity and nitrogen levels on dry matter yield, protein and nutrient uptake in pearl millet. *Forage Res.*, **40** : 28-35.

Singh, S. B., and I. P. Abrol, 1983 : Effect of exchangeable sodium on the yield of pea and its chemical composition and nutrient uptake. *Indian J. agric. Sci.*, **53** : 686-689.

Singh, S. B., R. Chhabra, and I. P. Abrol, 1980 : Effect of soil sodicity on yield and chemical composition of cowpea grown for fodder. *Indian J. agric. Sci*., **50** : 870-874.

Uppadyay, A., S. Tripathi, and S. N. Panday, 2012 : Effect of soil sodicity on growth, nutrients uptake and bio-chemical response of *Ammi majus* L. *Res. J. Soil Biol*., **4** : 69-80.

Verma, S. K., and Joshi, Y. P. 1998 : Effect of nitrogen and seed rate on leaf area index, nitrogen content, nitrogen uptake and dry matter yield of teosinte (*Euchlaena maxicana* Schrad). *Forage Res*., **24** : 45-47.