Forage Res., **40** (1) : pp. 28-35 (2014) **http://forageresearch.in**

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

NIRANJAN SINGH*[1], S. K. SHARMA, ROHTAS KUMAR, RAJPUL AND SATYENDER SINGH[2]

Department of Soil Science
CCS Haryana Agricultural University,
Hisar-125 004 (Haryana), India
**(e-mail : nnirajan1234@rediffmail.com)*
(Received : 2 June 2014; Accepted : 25 June 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 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 pearl millet (HC-20) with fixed 80 kg N/ha dose. In second experiment, different nitrogen levels 0, 40, 80 and 120 kg N/ha on pearl millet at an ESP of 45 were studied. The results on the studies on different ESP levels revealed that the dry matter yield, plant height, protein content and uptake of nutrients (N, P, K, Ca, Mg and S) decreased with increasing ESP levels. The uptake of micronutrients (Zn, Cu, Mn, and Fe) in pearl millet decreased with increasing ESP levels. However, the studies on different levels of nitrogen at 45 ESP revealed that the dry matter yield, plant height, protein content and uptake of nutrients N, P, K, Ca, Mg, Na, S, Zn, Cu, Mn and Fe by pearl millet increased with increasing nitrogen levels.

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

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).

The potential of pearl millet 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 (Yadav *et al*., 2010). 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 pearl millet are 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 of nitrogen for growing pearl millet in these soils is relatively more. The information on effect of sodicity at different nitrogen levels on fodder pearl millet is scanty. Therefore, keeping the 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 13.86, 31.15 and 43.79, respectively. The first experiment was conducted to study the effect of different ESP levels (control, 15, 30 and 45) on pearl millet (HC-20) with fixed 80 kg N/ha dose. In second experiment, different nitrogen levels 0, 40, 80 and 120 kg N/ha on pearl millet at an ESP of 45 were carried out. Soil samples from each pot were collected after harvest of crop and analyzed for their pH,

[1]Present Address : Asstt. Manager, IFFCO, Fatehabad (Haryana), India.
[2]Department of Maths & Statistics, CCSHAU, Hisar (Haryana), India.

EC, soluble calcium and magnesium and exchangeable sodium.

Each treatment was replicated thrice in a completely randomised design. The pots were irrigated with distilled water through a tube embeded in the pots uniformly, half on the surface and remaining half through centrally embeded tube. 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 Dry Matter Yield, Plant Height and Crude Protein

The data presented in Fig. 1 reveal that the dry matter yield of pearl millet decreased significantly with increasing ESP levels. The maximum dry matter yield (45.97 g/pot) was obtained in control (ESP 7.8) and minimum (25.18 g/pot) at an ESP of 45. The reduction in dry matter yield over control was 17.21 and 45.23 per cent at 30 and 45 ESP, 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).

Similarly, plant height of pearl millet also decreased significantly with increasing ESP levels. It was found maximum (121.2 cm) at an ESP of 7.88 and minimum 104.32 cm at 45 ESP soil. The per cent reduction in plant height was 6.63 and 13.91 at ESP 30 and 45, respectively, as compared with control. Similar findings were also reported in corn and sorghum by Bains and Fireman (1979). The detrimental effects of

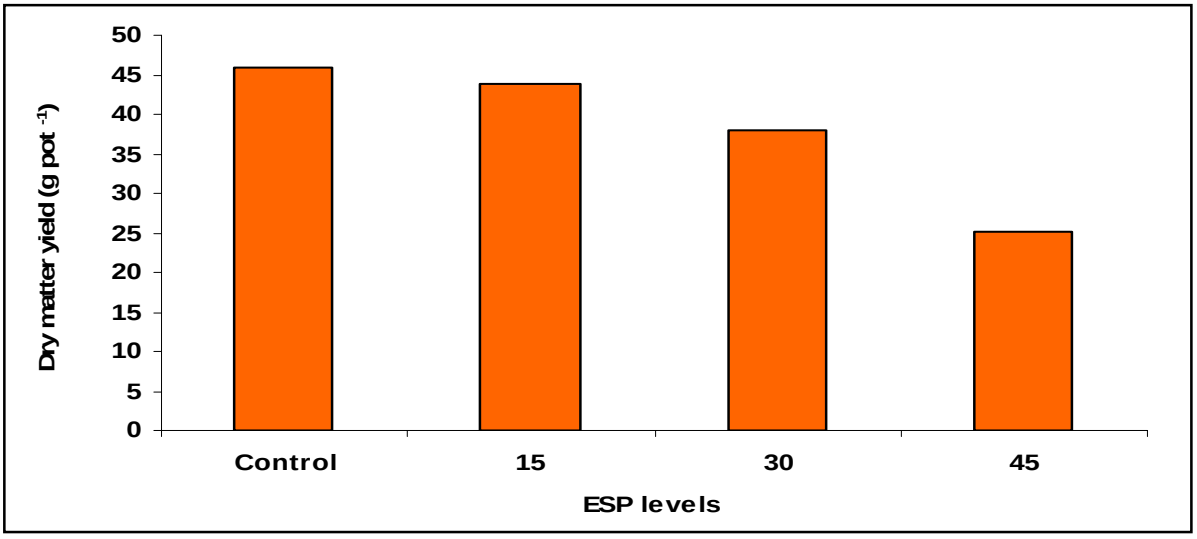

Fig. 1. Effect of ESP levels on dry matter yield of pearl millet crop.

increased ESP levels in sodic soil on plant growth could be attributed to presence of high Na content in soil in available form.

A perusal of data indicates that crude protein content in pearl millet decreased significantly with increasing ESP levels. It was found maximum (9.31%) in control and minimum (7.94%) at 45 ESP level. The per cent decrease in crude protein content as compared with control was 14.72% at 45 ESP level. The reduction in protein content at high ESP levels in pearl millet may be due to less availability of nitrogen and plant nutrients essential for the protein synthesis.

Effect of ESP Levels on Nutrient Uptake

A glance on Fig. 2 shows that uptake of N, P and K by pearl millet decreased with increasing ESP levels. The maximum N uptake (684.95 mg/pot) was observed at control and minimum (319.79 mg/pot) at ESP of 45. The maximum P and K uptake was 91.94 and 979.16 mg/pot, respectively, at control, whereas minimum P (35.25 mg/pot and potassium (465.83 mg/pot) uptake was observed at 45 ESP. The reduction was 23.32 and 53.31 per cent in nitrogen uptake, 33.76 and 61.66 per cent in phosphorus uptake and 21.48 and 52.45 per cent

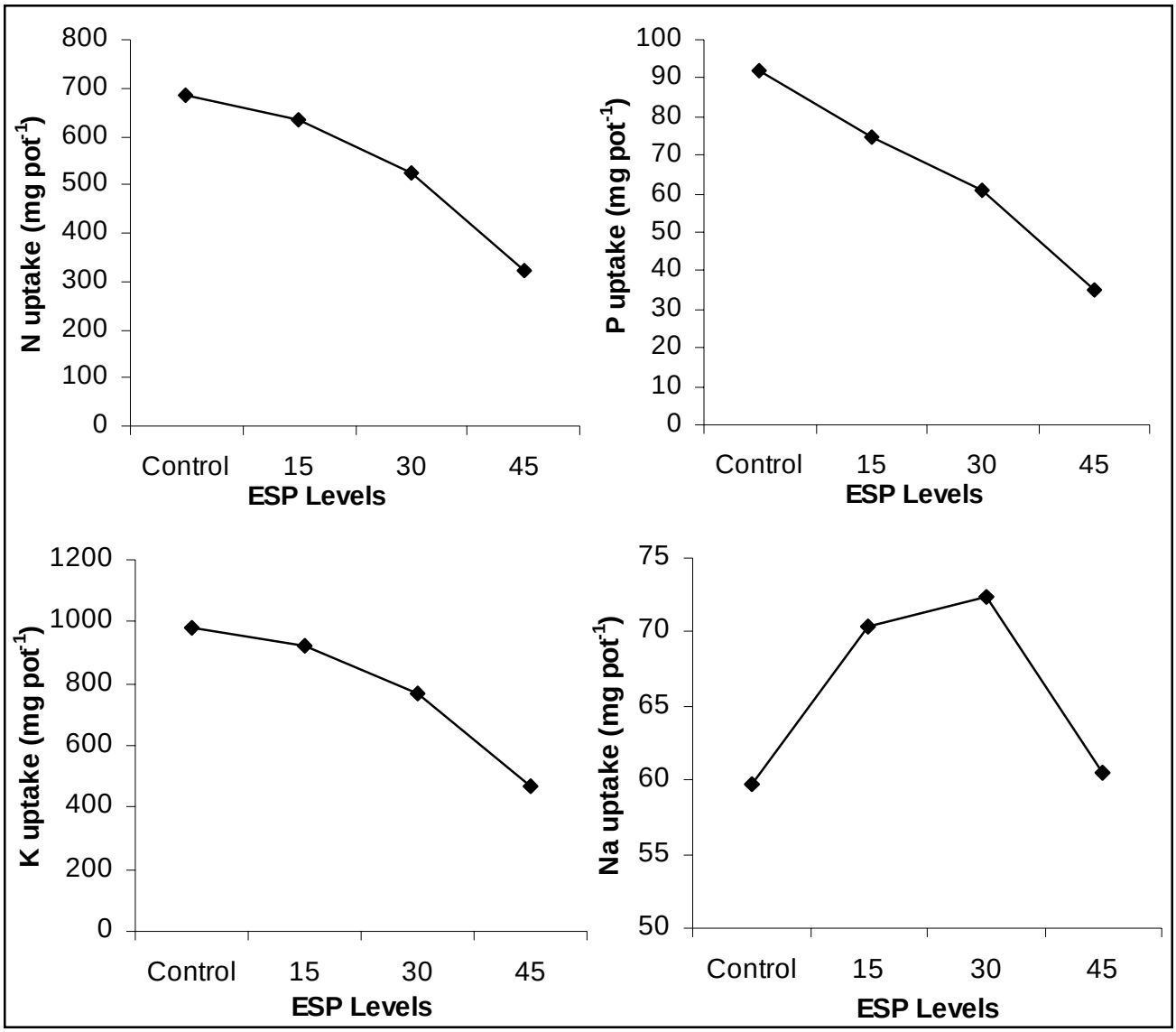

Fig. 2. Effect of ESP levels on uptake of N, P, K and Na by pearl millet crop.

in potassium uptake at 30 and 45 ESP levels, respectively as compared with the control. Decrease was also found decrease in uptake of nitrogen and phosphorus in sorghum. 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 uptake by pearl millet decreased with increasing ESP level. The maximum (160.90 mg/pot) and minimum (57.91 mg/pot) calcium uptake was observed at control and 45 ESP level soil, respectively. The reduction in calcium uptake over control was 12.61, 33.77 and 64.00 per cent at 15, 30 and 45 ESP levels, respectively, as compared to control. There was decrease in calcium uptake by sorghum with increasing ESP.

Magnesium uptake by pearl millet decreased with increasing ESP levels. The maximum (142.51 mg/pot) and minimum (52.88 mg/pot) magnesium uptake was observed at control and 45 ESP level soil, respectively. The decrease in magnesium uptake over control was 13.67, 33.73 and 62.89 per cent at 15, 30 and 45 ESP levels, respectively.

The sodium uptake by pearl millet was statistically non-significant with ESP level treatments. Sulphate uptake by pearl millet decreased with increasing

ESP levels. The maximum (197.67 mg/pot) and minimum (75.54 mg/pot) sulphate uptake was observed at control and 45 ESP level soil, respectively. The reduction in sulphate uptake over control was 13.31, 32.61 and 61.78 per cent at 15, 30 and 45 ESP levels, respectively.

Effect of ESP Levels on Micronutrient Uptake

The uptake of Zn, Cu, Mn and Fe by pearl millet decreased significantly with increasing ESP levels (Fig. 3). The maximum Zn uptake (0.77 mg/pot) Cu uptake (0.24 mg/pot), Mn uptake (2.12 mg/pot), and Fe uptake (6.22 mg/pot) was observed at control but the minimum Zn uptake (0.21 mg/pot), Cu uptake (0.09 mg/pot), Mn uptake (0.86 mg/pot) and Fe uptake (2.92 mg/pot) was observed at 45 ESP level. The reduction in uptake over control was 41.56 and 72.73 per cent in Zn uptake, 33.33 and 62.50 per cent in Cu uptake, 28.77 and 59.43 per cent in Mn uptake and 24.28 and 53.05 per cent in Fe uptake at 30 and 45 ESP levels, respectively. Uppadyay *et al*. (2012) while experimenting on *Ammi majus* reported that the accumulation of Zn and Cu in test plant decreased on increasing ESP levels. 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

It was evident from Fig. 4 that an ESP of 45 dry matter yield of pearl millet increased significantly with the increasing dose of nitrogen. The maximum (27.34 g/pot) and minimum (15.89 g/pot) was observed at 120 kg N/ha and control, respectively. The per cent increase

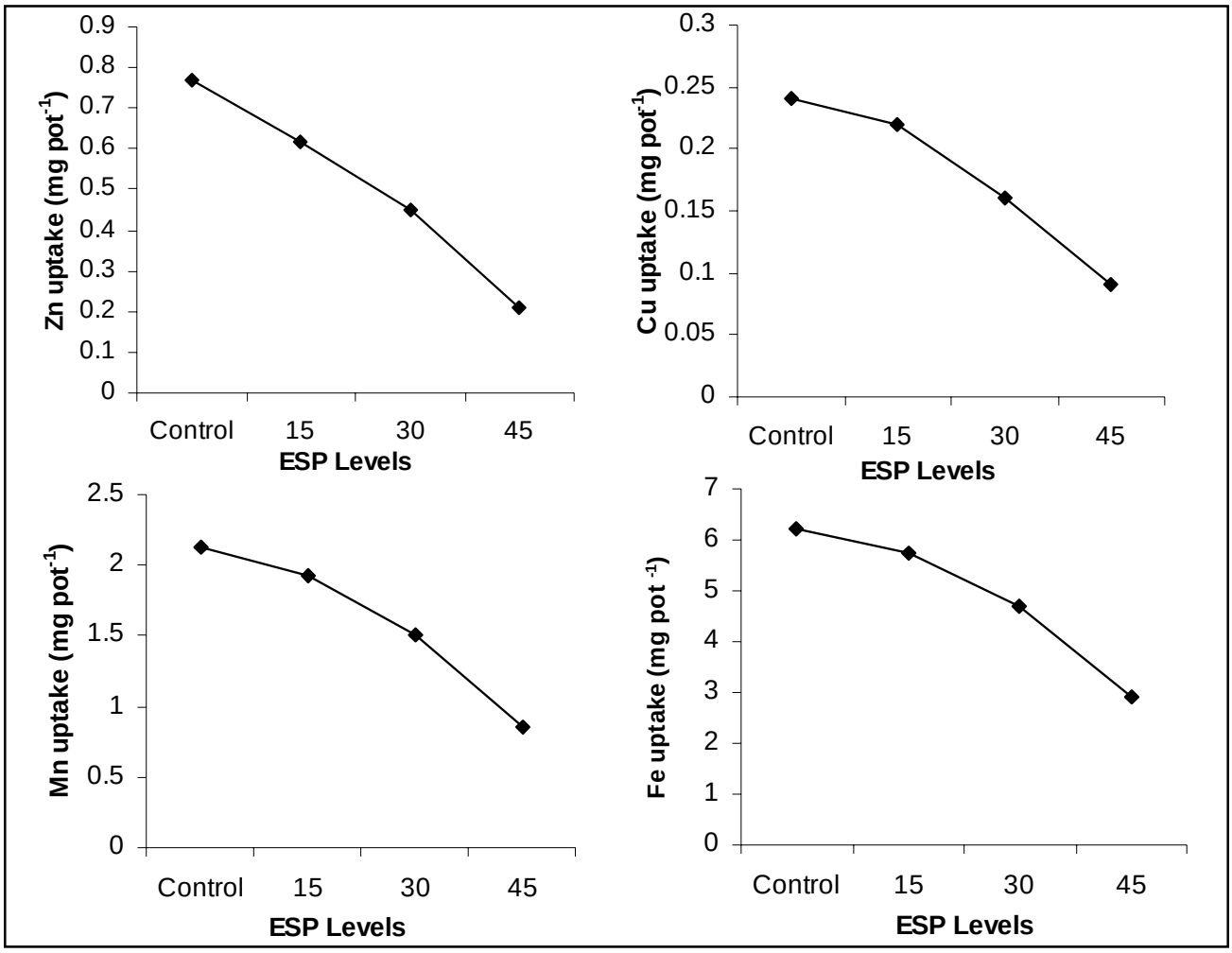

Fig. 3. Effect of ESP levels on uptake of Zn, Cu, Mn and Fe by pearl millet crop.

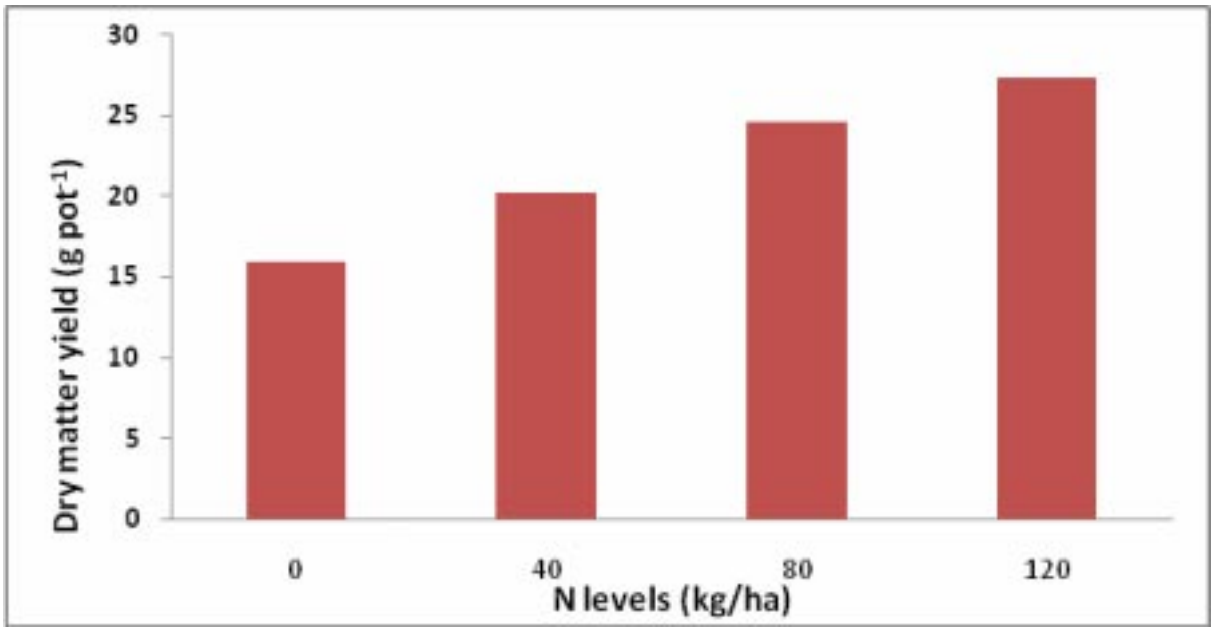

Fig. 4. Effect of nitrogen levels on dry matter yield of pearl millet crop.

in yield as compared to control was 27.00, 54.69 and 72.06 at 40, 80 and 120 kg N/ha, respectively.

Nitrogen at the rate of 120 kg/ha produced significantly higher yield as compared to 80 kg/ha, which is an optimum dose for pearl millet in normal soil in this region. The increase in dry matter yield of pearl millet was reported by various workers (Kumar *et al*., 2012). This showed that pearl millet in sodic soils responded to higher doses of applied nitrogen owing to their poor organic matter and available nitrogen status. Similar findings were also reported by Gautam and Kaushik (1984) and Saini *et al*. (1987) in pearl millet.

Plant height of pearl millet increased significantly with increase in nitrogen from 0 to 120 kg/ha. The highest plant height (92.73 cm) was observed with 120 kg N/ha and this was significantly superior to the lower levels of nitrogen. The increase in plant height over control was 13.43 and 16.99 per cent at 80 and 120 kg N/ha, respectively. Above findings were also supported by Bagada and Patel (1983) and Patel and Parmar (1987) in pearl millet. 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).

Increasing trend of crude protein content was observed with successive increment of nitrogen content than the other levels of nitrogen. Increase in crude protein with each increment in nitrogen dose might be due to increased absorption of nitrogen from the soil. Since nitrogen is main constituent of amino acids, it ultimately increased crude protein content of plants.

The application of higher doses of nitrogen levels on pearl millet genotypes produced significantly higher crude protein yield in green forage pearl millet (Damame *et al*., 2013). The increase in protein of pearl millet was reported by various workers (Kumar *et al*., 2012).

Effect of Nitrogen Levels on Nutrient Uptake

The data (Fig. 5) revealed that uptake of nitrogen by pearl millet at an ESP of 45 increased with increasing levels of nitrogen. The minimum nitrogen uptake (182.74 kg/pot) was observed at control, whereas maximum (360.89 kg/ha) at 120 kg N/ha. The per cent increase in nitrogen uptake over control was 34.73, 70.83 and 97.49 at 40, 80 and 120 kg N/ha, respectively.

The uptake of phosphorus and potassium by pearl millet also showed the same trend as nitrogen uptake. The minimum phosphorus (15.89 mg/pot) and potassium (282.84 mg/pot) uptake was found at control, whereas maximum phosphorus (41.01 mg/pot) and potassium (524.93 mg/pot) uptake was observed at 120 kg N/ha.

Increasing trend of calcium and magnesium uptake by pearl millet was observed up to 120 kg N/ha. The minimum calcium (25.42 mg/pot) and magnesium

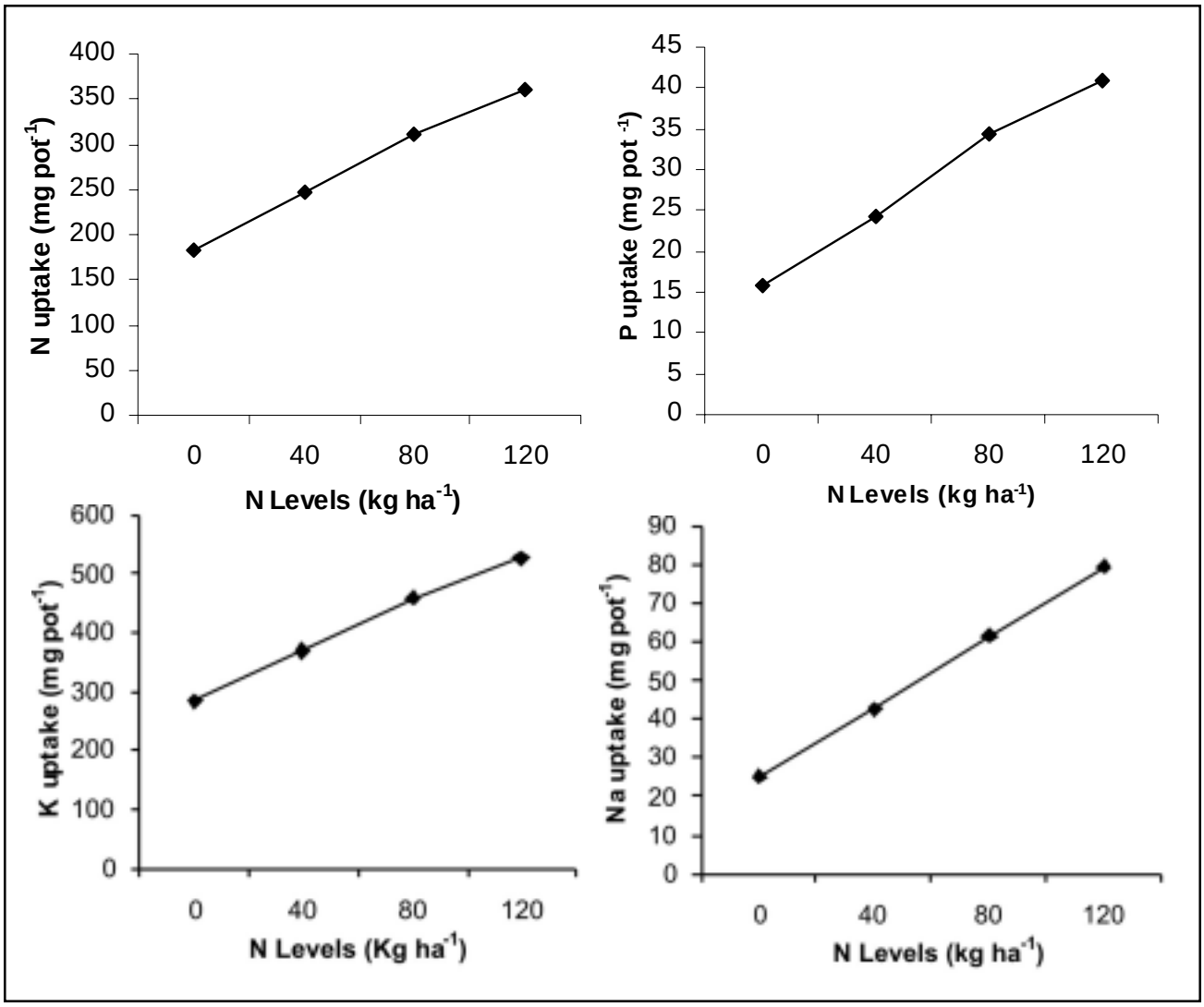

Fig. 5. Effect of nitrogen levels on uptake of N, P, K and Na by pearl millet at 45 ESP.

(19.07 mg/pot) uptake was found at control and maximum calcium (73.82 mg/pot) and magnesium (65.62 mg/pot) uptake was observed at 120 kg N/ha.

Uptake of sodium increased significantly with application of nitrogen up to 120 kg/ha. The minimum uptake (25.42 mg/pot) was observed at 0 kg N/ha, whereas maximum (79.29 mg/pot) at 120 kg N/ha.

At 45 ESP, each incremental dose of nitrogen contributed significantly in increasing uptake of sulphur by pearl millet. Minimum sulphur uptake (33.37 mg/pot) was observed at control, whereas maximum (90.22 mg/pot) at highest nitrogen level.

Effect of Nitrogen Levels on Micronutrient Uptake

Uptake of micronutrients Zn, Cu, Mn, Fe at 45 ESP (Fig. 6) increased significantly with the application of nitrogen up to 120 kg/ha. The minimum Zn (0.07 mg/pot), Cu (0.04 mg/pot), Mn (0.42 mg/pot) and Fe (1.69 mg/pot) uptake was found at 0 kg N/ha, whereas maximum Zn (0.31 mg/pot), Cu (10.10 mg/pot), Mn (1.00 mg/pot) and Fe (3.28 mg/pot) uptake was found at 120 kg N/ha.

CONCLUSIONS

On the basis of studies on different ESP levels, it was concluded that the dry matter yield, plant height, protein content and uptake of nutrients (N, P, K, Ca, Mg and S) decreased with increasing ESP levels. The uptake of micronutrients (Zn, Cu, Mn and Fe) in pearl millet

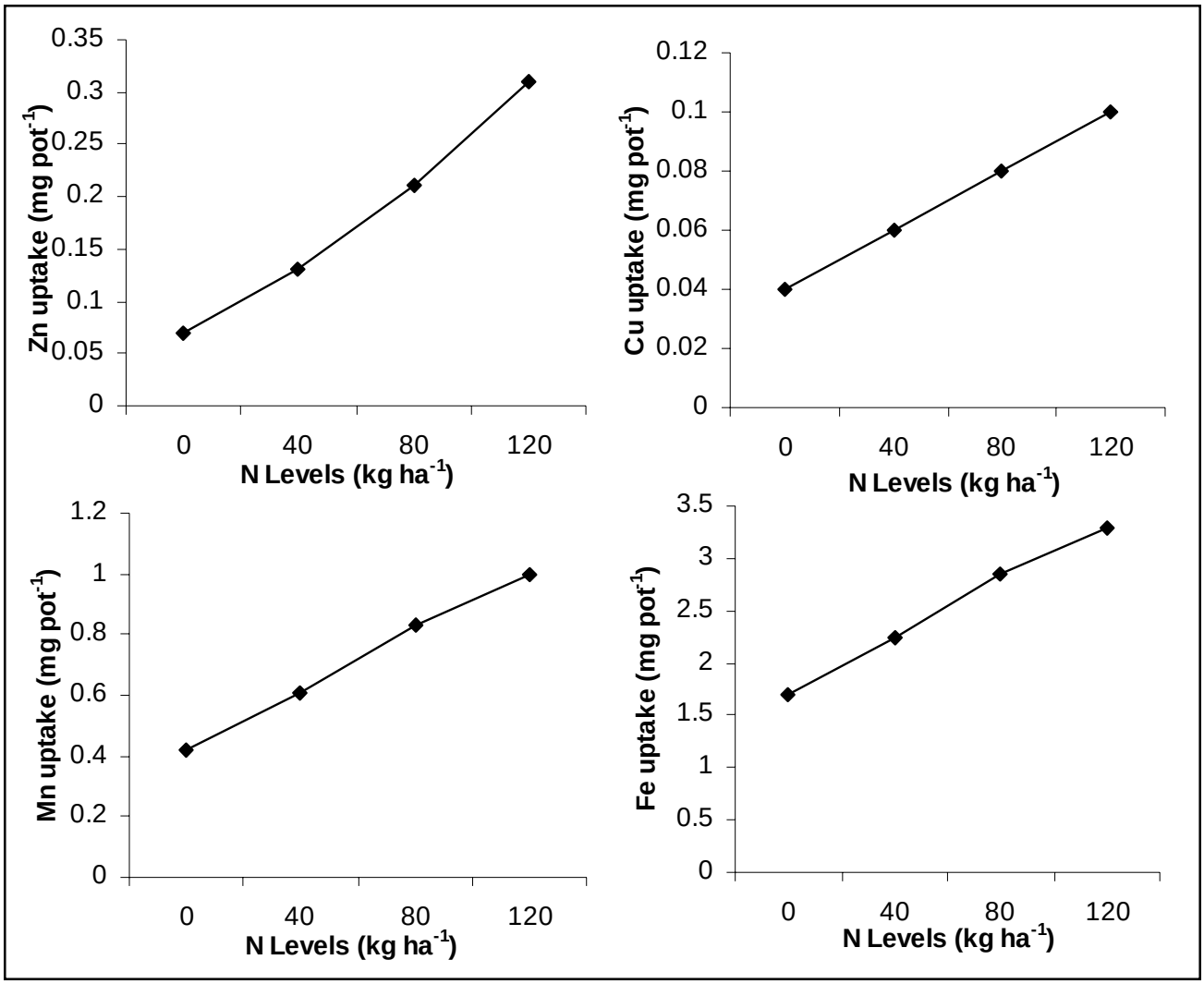

Fig. 6. Effect of nitrogen levels on uptake of Zn, Cu, Mn and Fe by pearl millet crop at 45 ESP.

decreased with increasing ESP levels. On the basis of studies on different levels of nitrogen at 45 ESP, it was concluded that the dry matter yield, plant height, protein content and uptake of nutrients N, P, K, Ca, Mg, Na, S, Zn, Cu, Mn and Fe by pearl millet increased with increasing nitrogen levels.

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.

Bagada, J. P., and R. C. Patel, 1983 : Comparative yield potential of pearl millet hybrid to varying levels of nitrogen. *Indian J. Agron.*, **28** : 309-310.

Bains, S. S., and M. Fireman, 1979 : Effect of exchangeable sodium percentage on growth and absortion of essential nutrients and sodium by five crop plants. *Soil Sci.*, **127** : 242-247.

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.

Gautam, R. C., and S. K. Kaushik, 1984 : Role of split application of nitrogen doses on the growth and yield of pearl millet. *Indian J. Agron.*, **29** : 327-330.

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.

Patel, J. R., and M. T. Parmar, 1987 : Nitrogen fertilization and row spacing studies in hybrid pearl millet. *Indian J. Agron*., **32** : 436-439.

Saini, S. L., K. C. Bishnoi, and P. S. Gill, 1987 : Nutrient use pattern of hybrid and synthetic varieties of pearl millet under nitrogen and phosphorus manuring. *Haryana J. Agron*. **1** : 24-30.

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, 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.

Singh, Y. P., and V. Singh, 1998 : Response on N and Zn levels on biomass, quality and chemical composition of forage sorghum [*Sorghum bicolor* (L.) Moench]. *Forage Res*., **24** : 21-23.

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.

Yadav A. K., M. S. Narwal, and R. K. Arya, 2010 : Stability studies for seedling traits with supra optimal temperature tolerance in pearl millet [*Pennisetum glaucum* (L.) R. Br.]. *Forage Res.,* **36** : 65-70.