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MICRONUTRIENT CONTENT, FODDER QUALITY AND NITROGEN UPTAKE OF FODDER MAIZE AS INFLUENCED BY FARMYARD MANURE AND NITROGEN LEVELS

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ABSTRACT
A field experiment was conducted during the *Kharif* 2011 to study the effect of farmyard manure and nitrogen levels on quality and micronutrient content of fodder maize. The treatments comprised four nitrogen levels (0, 40, 80 and 120 kg/ha) and three farmyard manure levels (0, 12.5 and 25 t/ha) randomized in a split plot design. Micronutrient contents such as Zinc, Copper, Manganese and Iron content obtained at harvest increased with application of 25 t/ha FYM to the tune of 15.3%, 7.5%, 28.4% and 15.6% over control however decreased with increasing the nitrogen levels. Crude protein yield (kg/ha) increase was 33.78 % and 36.56 % with application of highest level of FYM and nitrogen. Similarly percent increase in total digestible nutrients (kg/ha) content was 18.80 % and 24.00 % over control. Highest nitrogen uptake of 161.7 (kg/ha) was obtained with 120 kg/ha nitrogen application and micronutrient uptake (g/ha) with increasing both farmyard manure and nitrogen levels. Nitrogen content in soil at harvest increased 43.68 % with application of 25 t/ha of FYM over control, 20.08% with 120 kg/ha nitrogen over control. Application of FYM increases all parameters related to fodder quality but application of nitrogen through inorganic fertilizers causes less increase.

INTRODUCTION

Micronutrient malnutrition is a prime concern in developing countries where the deficiency causes widespread illness and diseases (WHO, 2002). In fact, micronutrient deficiency in feed affects the entire food chain. Recently, Prasad (2010) has reported that fodder crops cultivated in deficient soils fed to the cattle causes low birth weight and number of off-springs besides affecting the humans who consume the deficient milk. Micronutrient deficiency can greatly disturb plant yield, quality, and the health of domestic animals and humans (Malakouti, 2007). Micronutrients play an active role in the plant metabolism process starting from cell wall development to respiration, photosynthesis, chlorophyll formation, enzyme activity and nitrogen fixation and reduction. Micronutrients, also known as trace minerals, although are required in extremely small quantities by crops and livestock, however, in no way refers to their role being minor. Their lack can cause serious crop production problems in forages and health disorders in livestock .

The fodder production in the country is insufficient to meet the requirement of livestock in the country. According to planning commission report total deficit in 2015 for green and dry fodder was 63.50 % and 23.56 %. Since feeding alone accounts for two-third of the total cost in animal production and quality green forage availability is the only way to reduce the cost and to increase the returns from livestock. For increasing the production of quality fodder, nutrient management through conjoint use of organic and inorganic plant nutrient sources is very crucial. Many studies have reported the positive effect of both organic and inorganic fertilizers as well as their combinations, in supporting higher growth of maize (Moyin–Jesu El, 2002 and Olayinka, 2009). The use of inorganic fertilizers has not been helpful as it is associated with increased soil acidity and nutrient imbalance. On the other hand, organic fertilizer is slow releasing and could hardly supply the quantity needed by crops (Mando *et al.,* 2005, Bhattachavyya *et al.,* 2008). Application of organic manure not only supply all the various macro and micro-nutrients, although in small quantities also improves the soil physical and biological properties.

However combined application of organic and inorganic fertilizers offers the best advantage because apart from enhancing soil fertility, it also improves soil physical properties (Tiwari *et al.,* 2002). In order to make the soil well supplied with all the plant nutrients in the readily available form and to maintain good soil health, it is necessary to use organic manures in conjunction with inorganic fertilizers to obtain optimum yields (Ramalakshmi *et al.,* 2012, Pathak and Chakraborti, 2014 Choudhari *et al.,* 2015 and Khidrapure *et al.,* 2015) Therefore, the present experiment was undertaken to study the effect of organic and inorganic sources as nitrogen fertilizer on micronutrient concentrations and production of quality fodder in maize.

The objective of this investigation is to discuss forage quality in terms of micronutrient content and nitrogen uptake in fodder maize and to study the complementary and supplementary effects of farm yard manure *vis-a-vis* inorganic nitrogenous fertilizer in quality fodder maize production.

MATERIALS AND METHODS

A field experiment was conducted at Research farm of the Department of Agronomy, Punjab Agricultural University, Ludhiana during *Kharif* season of 2011. The soil was loamy sand in texture, normal in soil reaction (8.0), low in organic carbon (0.33%) and available N (130 kg/ha), high in available of P (28.5 kg/ha) and medium in available K (240 kg/ha). The field experiment comprised twelve treatment combinations viz; three main plots (farmyard manure @ 0, 12.5 and 25 tone/ha) and four nitrogen levels in sub plots (0, 40, 80 and 120 kg/ha).The experiment was laid out in split plot design with four replications.Calculated dose of the farm yard manure was mixed in the main plots with last cultivation.Half nitrogen in the form of urea and full dose of phosphorus (24 kg$P_2O_5$$ha^{-1}$) as single super phosphate and potassium (12 kg K_2O ha^{-1}) as muriate of potash were applied at time of sowing. Maize composite variety J-1006 was sown by *kera* method, on April 11, 2011 using 75 kg seed per hectare at row spacing of 30 cms. Seed was treated with Bavistin @ 3 gram per kilogram of seed**.** Second dose of nitrogen was applied 30 days after sowing. FYM used in the study contained 1.1 % N, 0.49 % P and 2.17 % K.

Micronutrient content

It was determined by taking half-a-gram of the plant samples from each plot at harvesting and digested using 10 ml of di-acid (HNO_3 and $HClO_4$ in the ratio of 3:1). The aliquot was diluted with distilled water to make the volume to 25mL. Then Zn, Cu, Fe and Mn contents were determined by atomic absorption spectrophotometer (Isaac and Johnson, 1975).

Crude protein yield

The crude protein yield of fodder maize was calculated by multiplying the percent protein content in plant with the total dry matter yield and expressed as kg per hectare**.** The crude protein content was calculated by multiplying the nitrogen content % (volume of H_2SO_4 used for absorption of ammonia x 0.00028 x 20 x 100 x 0.50) by factor 6.25**.** The N content (%) was estimated by micro-kjeldahal method (Piper 1966).

Total digestible nutrients

The total digestible nutrients in plant were calculated by multiplying the IVDMD with the total dry matter yield and expressed as kg ha^{-1}. The IVDMD calculations were made using the following formula obtained from Tilley and Terry method 1963.

IVDMD (%) = (Weight of sample taken-weight of undigested sample)/weight of sample taken

Nitrogen and micronutrient uptake

The nitrogen and micronutrient uptake of plant was calculated by multiplying the nutrient content in plant with total dry matter yield and expressed as kg/grams per hectare.

Available nitrogen

After harvest of the crop, soil samples were taken from a depth of 0-15 cm from 3 spots in each plot. The samples taken from all spots were mixed and a composite sample of 100 gram was drawn. Available nitrogen was determined by method described by Subbiah and Asija (1956).

RESULTS AND DISCUSSION

Micronutrient content

Farmyard manure contains all the essential plant nutrients, where as inorganic fertilizer contains one, two or three nutrients. Both farmyard manure and nitrogen significantly influenced the micronutrient content of the fodder. The data presented in the Table 1 reveal that application of FYM produced fodder with significantly higher micronutrients than the control (No FYM).The differences in micronutrient contents in the fodder due to FYM levels were not significant except for iron when F_{25} proved significantly superior over its lower level ($F_{12.5}$).

Improvement in micronutrient content of maize fodder with the application of FYM may be attributed to more availability of nutrients due to improvement in the physico-chemical and microbiological properties of soil (Sharma et *al.,*1987). FYM is considered a store house of essential and non essential plant nutrients. Singh *et al.* (1983) and Ikombo (1984) also reported

Table 1: Effect of farm yard manure and nitrogen on the micronutrient content (ppm) of maize fodder

Treatments	Concentration (ppm)			
	Zinc	Manganese	Copper	Iron
FYM (t/ha)				
F_0	52.94	40.20	3.58	171.07
$F_{12.5}$	60.64	42.58	4.40	177.03
F_{25}	61.07	43.22	4.60	197.79
S.E (d)	1.14	0.44	0.09	3.29
CD(p = 0.05)	3.16	1.22	0.26	9.13
Nitrogen (kg/ha)				
N_0	62.52	44.23	4.53	193.42
N_{40}	59.44	43.10	4.28	184.94
N_{80}	56.72	41.13	4.08	178.22
N_{120}	54.17	39.53	3.86	171.28
S.E (d)	1.37	0.74	0.12	2.57
CD(p = 0.05)	2.88	1.55	0.26	5.39

the improvement in fodder quality with the application of FYM. Sekhon *et al.* (2006) reported that application of FYM resulted in increase and re-distribution of Zn, Fe, Cu and Mn from non-available forms (Carbonates and crystalline iron oxide) to readily available (water-soluble plus exchangeable fraction) and potentially available (Organic fraction, manganese oxides and amorphous iron-oxides) from the soil.

Application of nitrogen through inorganic fertilizer significantly lowered the micronutrient content of maize fodder. Each increment in nitrogen significantly lowered zinc content over its lower level except N_{80} and N_{120}. Application of nitrogen beyond 40 kg significantly lowered the manganese content of fodder maize over its lower level, N_{40} and control being at par. Iron content was significantly lowered by each successive increase in nitrogen level. Various levels of nitrogen had differential effect on copper content of fodder maize. The lowest level of nitrogen (N_{40}) did not bring about significant reduction in copper content over control, which was in turn at par with N_{80}. The highest level of nitrogen (N_{120}) significantly lowered copper content over all the lower levels and control (Table 1).

The increased growth, due to application of graded levels of nitrogen, caused dilution of absorbed micronutrients in the plant. The fall in the micronutrient content of maize fodder by using inorganic fertilizer was arrested with the use of organic manure (FYM).

Crude protein yield

It is evident from the data on crude protein yield presented in the Table 2 that application of FYM at 12.5 t/ha produced 19% more crude protein than that produced by the control (733.86 kg/ha) and further increase to 25 t/ha FYM resulted in an additional yield of 15.7 per cent (1011.14 kg/ha).

Table 2: Effect of farm yard manure and nitrogen on the crude protein yield and total digestible nutrients of maize fodder

Treatment	Crude protein yield (kg/ha)	Total digestible nutrients (kg/ha)
FYM (t/ha)		
F_0	733.86	4929.90
$F_{12.5}$	873.42	5428.52
F_{25}	1011.14	5856.00
Nitrogen (kg/ha)		
N_0	742.48	4830.70
N_{40}	820.78	5196.00
N_{80}	903.85	5554.40
N_{120}	1014.00	5990.20

Application of graded level of nitrogen also improved the crude protein yield. The increase in the crude protein yield with the application of graded levels of nitrogen ranged from 10 to 12.2 per cent than their respective lower level (Table 2). The increased crude protein yield due to application of FYM and nitrogen is due to enhanced crude protein content and dry matter yield. Similar results were reported by Sindhu *et al.*, (2006).

Total digestible nutrients

The data on the TDN yield indicated that production of TDN per unit area was increased with the application of FYM and nitrogen (Table 2). The FYM at 12.5 and 25 t/ha produced 10 per cent (5428.65 kg/ha) and 18.7 per cent (5856 kg/ha) more TDN than the control (F_0) yield (4929.90 kg/ha).

Likewise application of nitrogen produced more TDN over control (Table 2). Application of 40 kg N/ha produced 7.5 per cent more TDN (5196 kg/ha) than the control (4830.7 kg/ha) and 80 kg nitrogen produced 6.8 per cent (5554.4 kg/ha) over the lower level and highest (120 kg) resulted in the production of 7.8 per cent (5993.2 kg/ha) more TDN over N_{80}. Application of 120 kg N/ha produced 24 per cent more TDN than control. The increased in TDN yield with the application of FYM and nitrogen may be due to higher dry matter and better digestibility of fodder.

N and micronutrient uptake

The application of 12.5 and 25 tonnes FYM resulted in 18 per cent and 37 per cent more N uptake over control (117.41 kg/ha) (Table 3). Likewise, application of graded level of N also increased N uptake over control as given in Table 3. Application of 40 kg N/ha increased the N uptake by 10 per cent, whereas 80 kg N/ha resulted 21 per cent increase and 120 kg N/ha 33 per cent higher nitrogen uptake than the control (118.79 kg/ha). The increase in N uptake with the application of FYM and N levels were result of enhanced N content, which was 1.44, 1.59 and 1.75 per cent with the application of no FYM, $F_{12.5}$ and $F_{25.}$ Application of 0, 40, 80 and 120 kg N/ha resulted in 1.49, 1.55, 1.62 and 1.71 per cent N content. The concentration of plant mineral or nutrient in the plant increases as its availability in the nutrient medium increases (Mengel and Kurkby, 1996). Increase in N uptake with increase in FYM and N levels was also reported by Vats *et al.* (2001) and Brar *et al.*, (2001).

Increase in FYM levels increased the micronutrient yield at harvest (Table 3). Application of 25 t/ha FYM resulted in higher micronutrients yield over $F_{12.5}$ which ranged of 6-17

Table 3: Effect of farm yard manure and nitrogen on the nitrogen uptake (kg/ha) and micronutrient uptake (gram/ha) of maize fodder

Treatment	Nitrogen uptake (kg/ha)	Micronutrient uptake			(gram/ha)
		Zn	Mn	Cu	Fe
FYM (t/ha)					
F_0	117.4	431.7	327.8	29.2	1394.9
$F_{12.5}$	139.0	530.2	372.3	38.5	1547.8
F_{25}	161.2	562.4	398.0	42.4	1821.4
Nitrogen (kg/ha)					
N_0	118.7	496.5	351.2	36.0	1535.9
N_{40}	130.6	500.9	363.0	36.1	1557.5
N_{80}	144.3	505.1	366.3	36.3	1587.0
N_{120}	161.7	512.4	373.9	36.5	1620.1

Table 4: Effect of farm yard manure and nitrogen on available nitrogen at harvest (kg/ha)

Treatments	Available nitrogen (kg/ha) YM (t/ha)
F_0	114.66
$F_{12.5}$	144.91
F_{25}	164.75
S.E (d)	3.42
CD(p=0.05)	9.22
Nitrogen (kg/ha)	
N_0	128.88
N_{40}	137.66
N_{80}	144.44
N_{120}	154.77
S.E (d)	4.24
CD(p=0.05)	8.92

per cent. However extent of increase in micronutrient yield with application of 12.5 tonnes farm yard manure was much higher over the control. More availability of nutrients with the addition of FYM might be due to improvement in the physico-chemical and microbiological properties of soil with addition of FYM (Sharma et *al.,* 1987) because FYM proves to be an effective source of nutrients and significantly improves fodder quality (Singh *et al*., 1983).

Likewise, increase in level of nitrogen increased the micronutrient yield of the harvested fodder over the lower levels. With the increase in nitrogen levels (inorganic form) crop growth enhanced resulting in higher dry matter yield without addition of micronutrients in the soil. Though the micronutrient content decreased with increase in nitrogen levels yet increased dry matter yield caused more micronutrients yield from the crop.

Available nitrogen in the soil after harvest

Farmyard manure had significant effect on the residual nutrient status of in soil. Farmyard manure at 25 t/ha had left the soil with significantly higher available nitrogen as compared to $F_{12.5}$ (Table 4). Both the levels of farm yard manure left significantly higher available nitrogen over the control and initial soil nitrogen. It indicates residual effect of FYM on available nutrients status of soil. Similar response of FYM on soil available nutrient status was observed by Khan *et al* (2010), who reported that with the application of FYM at 40 t/ha, there is an increase in organic matter content (%) and NPK concentration in the soil over the control.

Increasing level of nitrogen beyond control improved the available nitrogen content over the initial soil nitrogen (130 kg/ha). Application of 40 kg nitrogen through inorganic fertilizer made the soil richer with available nitrogen, though the magnitude was less (7 kg/ha). Whereas, the higher levels (N_{80} and N_{120}) made the soil richer by 14 and 24 kg/ha. It might be due to application of nitrogen at higher level ($N_{40,}$ N_{80} and N_{120}) was excess of its uptake. Though nitrogen is highly mobile in the soil environment and its long term residual effect on soil fertility is not expected. But experimental crop was of short duration (74 days) and conditions favorable for loss of nitrogen did not prevail during that small span. Therefore, some residual effect of applied nitrogen at higher level could be expected. It clearly indicates that inorganic fertilizer urea having less effect on available nitrogen in soil at harvest as compared to FYM. It might be due to fact that farm yard manure contains nitrogen in organic form which is less susceptible to the loss of leaching.

REFERENCES

Bhattachavyya, R., Kundu, S., Prakash, V. and Chupta, H. S. 2008. Suitability under combined application of mineral and organic fertilizers in a rain fed soyabean- wheat system of the Indian Himalayas. *Eur. J. Agron.* **28:** 33-46.

Brar, B. S., Dhillon, N. S. and China, H. S. 2001. Integrated use of farmyard manure and inorganic fertilizers in maize (*Zea mays* L.) *Indian J. Agric. Sci.* **71:** 605-607.

Choudhari, V. V. and Channappagouda, B. B. 2015. Effect of organics on morpho-physiological traits and grain yield of maize (*Zea mays* L.). *The Bioscan.* **10(1):** 339-341.

Ikombo, B. M.1984. Effect of FYM and fertilizers on maize in semi arid areas of eastern Kenya. *East African Agric. Forestry J.* **44:** 266-74 (Abstr).

Isaac, R. A. and W. C. Johnson, Jr. 1975. Collaborative study of wet and dry ashing techniques for elemental analysis of plant tissue by atomic absorption spectrophotometry. *J. Assoc. Off. Anal. Chem.* **58**: 436-440.

Khan, N. I., Malik, A.U., Umar, F. and Bodla, M. I. 2010. Effect of tillage and farmyard manure on physical properties of soil. *Int. Res. J. Plant Sci.*1**: 75-82.

Khidrapure Gajendra, Uppar, D. S., Maruti, K., Tejagouda, M. B. and Shankrayya. 2015. Effect of integrated nutrient management on plantgrowth and seed yield in hybrid maize (Arjun). *The Bioscan.* **10(1):** 369-371.

Malakouti, M. J. 2007. Zinc is a neglected element in the life cycle of plants: A review. Middle East. *Rus. J. Plant Sci. Biotech*. **1:** 1-12.

Mando, A., Bonzi, M., Wopevels, M. C. S., Lompo, F., Stroosnijder, L. 2005. Long-term effects of mineral and organic fertilization on soil organic matter fraction and sorghum yield under Sudano - Sahelian conditions. *Soil Use Manag.* **21:** 396-401.

Mengel, K. and Kurkby, E. A. 1996. *Principles of plant nutrition.* 6[th]edpp 20. *Panima publishing corporation,* New Delhi.

Moyin-Jesu, EI. 2002. Raising oil palm seedlings in urban cities using sole and amended forms of wood ash and saw dust. *J. Tropical Agric. Sci.* **25(2):** 31-37.

Olayinka, A. 2009. Soil microorganisms, wastes and national food security. Inaugural lecture series 222 Obafemi Awolowo University, Ile - Ife, Nigeria.

Pathak, A. and Chakraborti, S. K. 2014. Impact of bio-fertilizer seed treatment on seed and seedling parameters of maize (*Zea mays L.*). *The Bioscan.* **9(1):** 133-135.

Piper, C. S.1966. Soil and Plant Analysis. *Hans Publishers, Bombay.*

Prasad, R. 2010. Zinc biofortification of food grains in relation to food security and alleviation of zinc. *Current Sci.* **98(10):** 1300-1304.

Ramalakshmi, Ch. S. Rao, P. C., Sreelatha, T., Mahadevi, M., Padmaja, G., Rao, P. V. and Sireesha, A. 2012. Nitrogen use efficiency and production efficiency of rice under rice-pulse cropping system with integrated nutrient management. *J. Rice Res.* **5(1 and 2):** 42-51.

Sekhon, K. S., Singh, J. P. and Mehla, D. S. 2006. Long-term effect of varying nutrient management practices on the distribution of native iron and manganese in various chemical pools under a rice-wheat cropping system. *Arch. Agron. Soil. Sci.* **53:** 253-261.

Sharma, H. L., Singh, C. M. and Modgal, S. C.1987. Use of organics in rice-wheat crop sequence. *Indian J. Agric. Sci.* **57:** 163-168.

Sindhu, V. K., Tiwana, U. S. and Puri, K. P. 2006. Effect of preceding crops on forage quality of maize and pearl millet under different nitrogen levels. *Forage Res.* **32:** 61-63.

Singh, B., Rana, D. S., Kapur, M. L., Sharma, K. N. and Bhandari, A. L. 1983. Evaluation of FYM applied along with fertilizers of maize and wheat . *Indian J. Agron.* **28:** 285-89.

Tilley, J. M. and Terry, R. A. 1963. Methods employed in forage quality evaluation. *J. Br. Grassland Soc.* pp. 108-14.

Tiwari, A., Dwivedi, A. K. and Dikshit, P. R. 2002. Long term influence of organic and inorganic fertilization on soil fertility and productivity of soybean. What system in a vertisol. *J Indian Soc. Soil Sci.* **50:** 472-475.

Vats, M. R., Sehgal, D. K. and Mehta, D. K. 2001. Integrated effect of organic and inorganic manuring of yield sustainability on long term fertilizer experiments. *Indian J. Agric. Res.* **35:** 19-24.

W. H. O. 2002. The World Health Report 2002. Reducing Risks, Promoting Healthy Life. World Health Organization, Geneva, Switzerland, pp. 1-230.