The Andhra Agric. J 68 (3): 302-307, 2021

Effect of Integrated Nutrient Management on Growth and Yield of Fodder Maize

G Rupa, B Venkateswarlu, P V N Prasad and S Ratna Kumari

Department of Agronomy, Agricultural College, Bapatla

ABSTRACT

The present investigation entitled "Effect of Integrated Nutrient Management on Growth and Yield of Fodder Maize" was carried out during *kharif*, 2021 on sandy loam soil at the Agricultural College Farm, Bapatla. The experiment was laid out in Factorial Randomized Block Design in three replications with two factors each at four levels. Treatments included in factor A: Manures & Fertilizer combinations and factor B: Biofertilizers & Micronutrients combinations. In manures & fertilizer combinations, the highest values of growth parameters *viz.*, plant height, leaf to stem ratio and drymatter accumulation at harvest and green fodder yield was recorded with A_4 treatment (75% inorganic RDN + 25% 'N' through poultry manure) while the lowest growth parameters and green fodder yield were observed in A_1 treatment (100% RDN through inorganic fertilizers). Among biofertilizers and micronutrient combinations, B_4 (Soil treatment with liquid Bio-fertilizer consortia + Foliar spray of 0.2 % $ZnSO_4$ and 0.5 % $FeSO_4$ at 20 & 40 DAS) recorded the highest growth parameters and green fodder yield while the lowest values of these parameters were observed in B_1 (control) treatment.

Key words: *Fodder maize, Manures, Biofertilizers, Micronutrients and Green fodder.*

Livestock production is the backbone of the Indian agriculture contributing 7% to national GDP. India is the largest milk producer with annual production of 198 MT with 535.82 million livestock (DAHD and F, 2019). The human population in India is expected to reach over 1,400 million by 2025. To feed the increasing population there is a need to increase productivity of livestock. The supply of good quality fodder is a prerequisite for the success of dairy industry. In India, the land utilized for growing green fodders hardly exceeds 4.5% of net cultivated area against the required 12%. There is currently a net deficiency of 35.6% green fodder, 10.95% dry fodder and 44% concentrate feed materials in the country (IGFRI Vision, 2050).

Fodder maize (*Zea mays* L.) is one of the most important forage crop in India and it occupies 0.9 million ha area. It is grown in more than 130 countries (Subrahmanya *et al.*, 2019). Among the various cultivated fodder crops, maize is ideal fodder crop because of its high production potential, wider adaptability, palatability, excellent fodder quality and can be grown in all seasons. It is also free from toxicants and can be safely fed to animals at any stage of crop growth. On an average, it contains 9-11% crude protein (CP), 60-64% Neutral Detergent Fiber (NDF), 38-41% Acid Detergent Fiber (ADF), 28-30% cellulose and 23-25% hemi-cellulose at milk to early dough stage. Production potential of forage maize can be altered with changes in agronomic practices. Nutrient management is most important agronomic practice that directly influences the fodder yield and quality.

Maize is an exhaustive crop, requires all macro and micro nutrients for better growth and yield potential. Among the various nutrients, effective supply of nitrogen through inorganic and organic sources may increase the production of maize as well as improve the quality of fodder and soil environment. Application of bio-fertilizers not only fixes the atmospheric nitrogen but also provide favourable environment for root growth by increasing the nutrient availability. Zinc as a co-factor for enzymes and proteins involved in carbohydrate metabolism, protein synthesis, gene expression, auxin (growth regulator) metabolism, pollen formation, maintenance of biological membranes, protection against photo-oxidative damage and heat stress, and resistance to infection by certain pathogens (Alloway, 2008). Iron plays a major role in plant in different biochemical reactions like electron transport, DNA and RNA synthesis and acts as a catalyst in enzymatic processes (Aguado-Santacruz *et al*., 2012). It also helps in synthesis and maintenance of chlorophyll and it is a constituent of nitrogenase. Zn and Fe when applied to fodder maize will boost the fodder yield (Singh *et al*., 2019). In view of the above facts, the present investigation was proposed to study the effect of integrated nutrient management on growth and yield of fodder maize.

MATERIAL AND METHODS

The field experiment was conducted during *kharif* season of 2021 at the Agricultural College Farm, Bapatla, Acharya N.G. Ranga Agricultural University, Andhra Pradesh. The soil of the experimental site was a sandy loam with a pH of 6.83, EC 0.5 ds m^{-1}, low in organic carbon (0.47%), low in available nitrogen (156.8 kg ha^{-1}), medium in available phosphorus (20 kg ha^{-1}) and potassium (236 kg ha^{-1}), low in zinc (0.49 mg kg^{-1}) and iron (2.60 mg kg^{-1}).

The experiment was laid out in Randomized Block Design with factorial concept replicated thrice. The treatments included two factors, of which factor A consisted of four manures & fertilizers levels: A_1: 100% inorganic RDN, A_2: 75% inorganic RDN + 25% 'N' through FYM, A_3: 75% inorganic RDN + 25% 'N' through vermicompost, A_4: 75% inorganic RDN + 25% 'N' through poultry manure and factor B with four biofertilizers & micronutrients levels: B_1:Control (No biofertilizers and micronutrients), B_2: Soil treatment with liquid Bio-fertilizer consortia, B_3: B_2 + Soil application of $ZnSO_4$ @ 25 kg ha^{-1} and $FeSO_4$ @ 10 kg ha^{-1}, B_4: B_2 +Foliar spray of 0.2 % $ZnSO_4$ and 0.5 % $FeSO_4$ at 20 & 40 DAS. The test variety of fodder maize was 'African Tall' was sown on 30-07-2021 and harvested on 30-09-2021.

The growth parameters *viz*., plant height (cm), leaf to stem ratio and drymatter accumulation (g m^{-2}) along with green fodder yield (kg ha^{-1}) were recorded and statistically analyzed by the method of analysis of variance as outlined by Panse and Sukhatme (1985).

RESULTS AND DISCUSSION

Growth parameters

Plant growth parameters *viz*. plant height (cm), leaf to stem ratio and drymatter accumulation (g m^{-2}) were studied during the experimentation (Table 1). All these characters were significantly influenced by both manures & fertilizer combinations and biofertilizer & micronutrient combination but their interaction was found significant in drymatter accumulation at harvest only.

At harvest, significantly the highest growth parameters like plant height (215.17 cm), leaf to stem ratio (1.04) and drymatter accumulation (902.10 g m^{-2}) were registered with 75% inorganic RDN + 25% 'N' through poultry manure treatment (A_4) and it was statistically comparable with 75% inorganic RDN + 25% 'N' through vermicompost treatment (A_3). The 100% inorganic RDN treatment (A_1) registered the lowest plant height (201.50 cm), leaf to stem ratio (0.93) and drymatter accumulation (772.40 g m^{-2}) which was statistically comparable to application of 75% inorganic RDN + 25% 'N' through FYM (A_2).

Increase in the growth parameters might be due to higher nitrogen concentration in poultry manure, which was easily available to the crop as it is having low C:N ratio compared to other manures. By the combined use of organic and inorganic nitrogen, the nitrogen status in the soil might have been maintained throughout the crop's growth, resulting in faster vegetative growth. The current findings are in accordance with the results reported by Sharma *et al*. (2016) and Biswasi *et al*. (2020).

Among biofertilizer and micronutrients combination levels, soil treatment with liquid bio-fertilizer consortia + foliar spray of 0.2% $ZnSO_4$ and 0.5% $FeSO_4$ at 20 & 40 DAS recorded the highest plant height (220.92 cm), leaf to stem ratio (1.09) and drymatter accumulation (970.15 g m^{-2}) at harvest. However, plant height and leaf to stem ratio were statistically on a par with soil treatment of liquid bio-fertilizer consortia + soil application of $ZnSO_4$ @ 25 kg ha^{-1} and $FeSO_4$ @ 10 kg ha^{-1}. The lowest growth parameters were observed in control treatment. The foliar application of zinc and iron was found to be more effective due to its higher uptake efficiency compared to soil application as they help in increased photosynthetic efficiency by delaying leaf senescence. Further, biofertilizer application improves the soil physical properties as well as the chemical properties of the soil. Biofertilizers also helps in converting the unavailable forms of essential nutrients to available form. These findings are supported by previous workers Naidu and Venkateswarlu (2006) and Karrimi *et al*. (2018).

Interaction effect of factor A x factor B with respect to drymatter accumulation was found significant at harvest (Table 2). The treatment combination of A_4B_4 recorded the highest drymatter accumulation (1079 g m^{-2}) and it was significantly superior to other treatment combinations except A_3B_4 and A_4B_3. The lowest drymatter production was recorded under treatment combination A_1B_1 (660.83 g m^{-2}). This was attributed to sufficient plant nutrients supplied by the chemical fertilizers in presence of organic manure and biofertilizer with the supply of zinc and iron to plant through foliar application. Application of biofertilizers might have increased the nutrient availability. The results are in accordance with those reported by Naidu and Venkateswarlu (2006), Rubina *et al*. (2018) and Reddy *et al*. (2020).

Green fodder yield

Data pertaining to green fodder yield of fodder maize was presented in Table.1 reveals that the manures & fertilizers and levels of biofertilizers & micronutrients had a significant effect on yield. There was no significant interaction between manures & fertilizers and biofertilizers & micronutrients levels.

Application of 75% inorganic RDN + 25% 'N' through poultry manure registered significantly the highest green fodder yield (46563 kg ha^{-1}) over A_1 treatment only (100% inorganic RDN) which recorded the lowest green fodder yield (42812 kg ha^{-1}). Treatments A_4, A_3 and A_2 were statistically comparable with one another and significantly superior over A_1 treatment.

The remarkable increase in green fodder yield with the application of 75% inorganic RDN + 25% 'N' through poultry manure (A_4) might be attributed to favorable influence of this treatment on growth parameters *viz*., plant height, leaf: stem ratio and drymatter production. This increase in growth parameters was due to the mineralization of organic

Table 1. Plant height (cm), leaf to stem ratio, drymatter accumulation (g m^{-2}) and green fodder yield (kg ha^{-1}) as influenced by different treatments.

Treatments	Plant height (cm)	Leaf to stem ratio	Drymatter accumulation (g m^{-2})	Green fodder yield (kg ha^{-1})
Manures & fertilizers (A)				
A_1: 100% inorganic RDN	201.5	0.93	772.4	42812
A_2: 75% inorganic RDN + 25% 'N' through FYM	206.08	0.98	801.62	44018
A_3: 75% inorganic RDN + 25% 'N' through vermicompost	211.33	1.01	878.29	45408
A_4: 75% inorganic RDN + 25% 'N' through poultry manure	215.17	1.04	902.10	46563
SEm±	3.18	0.02	14.18	938.8
CD (P=0.05)	9.17	0.06	40.96	2712
Biofertilizers and micronutrients (B)				
B_1: Control (No biofertilizers & micronutrients)	192.75	0.84	689.47	39480
B_2: Soil treatment with liquid Bio-fertilizer consortia	204.33	0.96	775.69	43462
B_3: B_2 +Soil application of $ZnSO_4$@ 25 kg ha^{-1} and $FeSO_4$@ 10 kg ha^{-1}	216.08	1.07	919.1	47194
B_4: B_2 +Foliar spray of 0.2 % $ZnSO_4$ and 0.5 % $FeSO_4$ at 20 & 40 DAS	220.92	1.09	970.15	48665
SEm±	3.18	0.02	14.18	938.8
CD (P=0.05)	9.17	0.06	40.96	2712
Interaction (A x B)				
SEm±	6.35	0.04	28.36	1877.7
CD (P=0.05)	NS	NS	81.91	NS
CV (%)	5.28	7.27	5.86	7.28

Table 2. Interaction effect of different treatments on drymatter accumulation of fodder maize at harvest

Manures & fertilizers	Drymatter accumulation (g m^{-2})			
	Biofertilizers and micronutrients			
	B_1	B_2	B_3	B_4
A_1	660.83	748.33	823.5	856.93
A_2	679	758.65	866.67	902.17
A_3	693.67	793.83	983.17	1042.5
A_4	724.37	801.95	1003.07	1079
SEm±	28.36			
CD (P=0.05)	81.91			

nitrogen from organic manure, which is a slow process and provides nitrogen during the crop requirement and ultimately resulted in higher photosynthetic activities and also in production of more photosynthates. These results are in confirmity with those of Iqbal *et al*. (2014) and Rasool *et al*. (2015).

Among different biofertilizer + micronutrients combinations, soil treatment with liquid bio-fertilizer consortia + foliar spray of 0.2% $ZnSO_4$ and 0.5% $FeSO_4$ at 20 & 40 DAS recorded significantly the highest green fodder yield (48665 kg ha^{-1}) and followed by B_3 treatment i.e. soil treatment with liquid bio-fertilizer consortia +soil application of $ZnSO_4$ @ 25 kg ha^{-1} and $FeSO_4$ @ 10 kg ha^{-1} (47194 kg ha^{-1}) and these two treatments were statistically comparable with one another. Significantly the lowest green fodder yield (39480 kg ha^{-1}) was noticed in control treatment (B_1).

Zinc is essential for several enzyme systems that regulate various metabolic activities in plants. It is involved in auxin production which are growth regulating substances in plants. Zinc is also vital for the oxidation processes in plant cells and helps in the transformation of carbohydrates and regulates sugar in plants. Role of iron is it's catalytic function in biological oxidation and reduction in plants like oxidative photophosphorylation during cell respiration (Tandon, 1995). The beneficial effects of biofertilizer might have been due to the supply of high amount of available nitrogen to the growing tissue and organs by enhancing nitrogen fixing which in turn increases growth and yield. The soil under experiment was initially low in available Zn and Fe, so, application of Zn and Fe might have resulted in improved photosynthesis and nitrogen metabolism. This might be result for increased green fodder yield. These results are in accordance with Karrimi *et al*. (2018) and Asif *et al*. (2020).

CONCLUSION

The present study revealed that superior growth and yield by fodder maize was observed with application of 75% Inorganic RDN + 25% 'N' through poultry manure and soil treatment with liquid biofertilizer consortia + foliar spray of 0.2% $ZnSO_4$ and 0.5 % $FeSO_4$ at 20 & 40 DAS. While, the lowest growth parameters and green fodder yield was obtained in 100% inorganic RDN and control treatments.

LITERATURE CITED

Aguado-Santacruz G A, Moreno-Gomez B, Jimenez-Francisco B, Garcia-Moya E and Preciado-Ortiz R E 2012 Impact of the microbial siderophores and phytosiderophores on the iron assimilation by plants: a synthesis. *Revista fitotecnia Mexicana*. 35 (1): 9-21.

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. 135.

Asif M, Abbas B, Aziz A, Adnan M, Safdar M E and Ali A 2020 Bio-fortification of calcium, zinc and iron improves yield and quality of forage sorghum (*Sorghum bicolor* L.). *Journal of Pure and Applied Agriculture.* 5(3): 74-81.

Biswasi S K, Barik A K, Bastia D K, Dalei B, Nayak L and Ray M 2020 Effect of integrated nutrient management on growth, productivity and economics of hybrid maize in Odisha state. *International Journal of Bio-resource and Stress Management*. 11(5): 465-471.

DAHD and F 2019 20th Livestock Census. Department of Animal Husbandry, Dairy and Fisheries, Government of India.

IGFRI Vision 2050 Indian grassland and fodder research institute. 7– 23.

Iqbal A, Iqbal M A, Raza A, Akbar N, Abbas R N and Khan H Z 2014 Integrated Nitrogen Management Studies in Forage Maize. *American Eurasian Journal Agricultural & Environment Science*. 14(8): 744-747.

Karrimi A S, Reddy A P K, Babazoi F and Kohistani T 2018 Growth, yield and post-harvest soil available nutrients in sweet corn (*Zea mays* L.) as influenced by zinc and iron nutrition. *Journal of Pharmacognosy and Phytochemistry*. 7(4): 2372-2374.

Naidu G S and Venkateswarlu B 2006 Growth, yield and quality of fodder maize as affected by nitrogen, *azotobacter* and zinc. *Journal of Indian Society of Coastal Agriculture Research*. 24 (1): 156-158.

P**anse V G and Sukhatme P V 1985** *Statistical Methods for Agricultural Workers.* ICAR, New Delhi. 100-174.

R**asool S, Kanth R H, Hamid S, Raja W, Alie B A and Dar Z A 2015** Influence of integrated nutrient management on growth and yield of sweet corn (*Zea mays* L. *saccharata*) under temperate conditions of Kashmir valley. *American Journal of Experimental Agriculture*. 7(5): 315-325.

Reddy R U K, Dawson J and Vidya Sagar D R M S 2020 Effect of Zinc, Iron and their Methods of Application on Growth and Yield of Pearlmillet (*Pennisetum glaucum* L.). *International Journal of Current Microbiology and Applied Sciences*. 9(10): 1639-1644.

Rubina G, Prasoon S, Rajesh K and Bijendra K 2018 Effect of Integrated nutrient management on plant growth and yield of rabi maize under irrigated conditions of Ajmer. *International Journal of Current Microbiology and Applied Sciences*. 7(3): 221-225.

Sharma P K, Kalra V K and Tiwana U S 2016 Effect of farmyard manure and nitrogen levels on growth, quality and fodder yield of summer maize (*Zea mays* L.). *Agricultural Research Journal*. 53(3): 355-59.

Singh C, Singh B, Satpal Kumar P, Ankush Gora M K and Kumar A 2019 Micronutrient management for enhancing production of major fodder crops: A review. *Forage Research*. 45(2): 95-102.

Subrahmanya D J, Kumar R, Pyati P S, Ram H., Meena R K and Tamta A 2019 Growth, yield and economics of fodder maize (*Zea mays*) as influenced by plant density and fertility levels. *Forage Research*. 45(2): 128-132.

Tandon H L S 1995 *Methods of analysis of soils, plants, waters, fertilisers & organic manures*. Fertiliser Development and Consultation Organisation, New Delhi, India. 164 + IX.

Received on 21.07.2021 and Accepted on 21.09.2021