

Original Research Article

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Effect of Secondary and Micronutrients on Yield Forming Traits of Maize (*Zea mays* L.)

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ABSTRACT

Keywords

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A field experiment was conducted at Agricultural College Farm, Mahanandi on sandy loam soils to know the response of maize to secondary and micronutrients with pioneer hybrid P3369. The experiment comprised of nine treatments consisting of recommended dose of fertilizer of NPK through soil application and foliar application of secondary and micronutrients at 20 days after sowing (DAS). Foliar application of micronutrients along with RDF recorded significantly highest grain yield of 4702 kg ha⁻¹ and stover yield of 7318 kg ha⁻¹ as compared RDF (3773 and 6430 kg ha⁻¹ of grain and stover yield, respectively). Yield attributes viz., number of cob plant⁻¹, Number of rows cob⁻¹, Number of grains row⁻¹, cob length, cob girth, hundred grain weight were highest with the application of RDF + foliar application of ZnSO₄ @ 0.1per cent (T₇). The highest grain and stover yields was recorded with RDF + foliar application of micronutrient mixture @ 0.2 per cent which was on par with RDF + foliar application of ZnSO₄ @ 0.1per cent (T₇) and superior over recommended dose of fertilizers and control. The treatment with RDF + foliar application of micronutrient mixture @ 0.2 per cent (T₉) recorded the highest gross returns, net returns and B:C ratio.

Introduction

Maize (*Zea mays* L.) is the most important food grain crop next only to rice and wheat in World and India. It is one of the most important cereal crop in the world's agricultural economy, both as a food and feed crop and its value added products have a good export potential. Due to its versatile characteristics of suitability and adaptability to various Agro-climates, maize is gaining popularity among the Indian farmers. It is known as the "Queen of Cereals" due to its

high yielding potential. Globally maize is cultivated in an area of 170.39 Million hectares with a production of 883.46 Million tonnes and productivity of 5.18 tonnes ha⁻¹ (www.indiastat.com). In India, it is grown in an area of 8.55 Million hectares with a production of 21.73 Million tonnes and an average productivity of 2540 kg ha⁻¹. In Andhra Pradesh, it is cultivated in an area of 9.72 lakh hectares with a production of 48.55 lakh tonnes and productivity of 4994 kg ha⁻¹. High yield of maize crops require large quantities of soil nutrients for its growth and

development. Most of the farmers apply only fertilizers that supply major nutrients of N, P and K and less attention is paid to secondary and micro nutrients which led to rapid depletion of secondary and micro nutrients necessity periodic or yearly supply of these nutrients. Although the requirement of secondary and micronutrients is small compared to macronutrients, nevertheless their deficiency can limit the crop growth and production. Furthermore, the adequate supply of these nutrients helps to increase the efficiency of the use of macronutrients. Therefore, field study was undertaken to optimize the nutrient management strategy for higher productivity of maize and evaluating the effects of secondary (Ca, Mg and S) and micronutrients (Fe, Mn, Zn, Cu, B and Mo) with recommended dose of nitrogen, phosphorus and potassium.

Materials and Methods

A field experiment was conducted on maize hybrid P3369, under irrigated conditions during *kharif*, 2015-16 on sandy loam soils of Agricultural College Farm, Mahanandi, Andhra Pradesh. The farm geographically situated at 15°51' N latitude and 78°61' E longitude, with an altitude of 233.48 m above the mean sea level in the scarce rainfall Agro-Climatic Zone of Andhra Pradesh and according to Trolls classification, it falls under Semi-Arid Tropics (SAT). The average minimum and maximum monthly temperature, precipitation, relative humidity and wind speed during the crop period are shown in table.1 The soil of the experimental site was neutral pH (7.58), medium in organic carbon (0.46%), N (287 kg ha⁻¹), P₂O₅ (149 kg ha⁻¹) and high in K₂O (742 kg ha⁻¹). Exchangeable calcium, magnesium (10.41 and 7.22 C mol. (P⁺) kg⁻¹) and available sulphur (13 kg ha⁻¹) were sufficient in availability whereas, micronutrients availability (Fe, Mn, Zn, Cu, B and Mo) was more than their critical limits.

The experiment was laid out in a randomized block design having ten treatments and replicated thrice. The treatments consisting of T₁: Control, T₂: RDF: 250-60-60 kg N-P₂O₅-K₂O ha⁻¹, T₃: RDF + foliar application of one per cent CaNO₃, T₄: RDF+ foliar application of one per cent MgNO₃, T₅: RDF + foliar application of one per cent sulphur, T₆: RDF + foliar application of one per cent each of CaNO₃, MgNO₃ and sulphur, T₇: RDF + foliar application of ZnSO₄ @ 0.2 per cent, T₈: RDF + foliar application of one per cent each of CaNO₃, MgNO₃ and sulphur + foliar application of ZnSO₄ @ 0.2 per cent and T₉: RDF + micronutrient mixture @ 0.2 per cent. Urea, di ammonium phosphate and muriate of potash were used for the supply of NPK and was applied as basal dose at the time of sowing, Whereas secondary nutrients and zinc was supplied through CaNO₃, MgNO₃, wettable sulphur and ZnSO₄ respectively. Micronutrient mixture consists of Boron (B) 1.5%, Copper (Cu) 0.5%, Iron (Fe) 3.4%, Manganese (Mn) 3.2%, Molybdenum (Mo) 0.05% and Zinc (Zn) 4.2%. Foliar spray of secondary and micronutrients was done at 20 DAS. The seeds were sown @ 20 kg ha⁻¹ with a spacing of 75 x 15 cm on second fortnight 2015 and harvested at 23.11.2016 (118 days). The gross and net plot sizes were 15 m X 4.5 m and 12 m X 3.9 m, respectively. Carbofuran 3G granules @ 5 kg ha⁻¹ were applied to control the stem borers. All the cultural practices were taken up as per the recommendations made by ANGRAU.

Results and Discussion

Effect of secondary and micronutrients on yield attributes of maize

The results indicated that different combinations of secondary and micronutrients had significant effect on yield attributes of maize (Table 2). The maximum values of yield attributes like number of rows cob⁻¹ (16.97), number of grains per row (36.99), cob length

(19.86) were recorded with the treatment T₇ (RDF + foliar application of ZnSO₄ @ 0.1 per cent) which was comparable with T₉ (RDF + Foliar application of 0.1 per cent micronutrient mixture). However, highest hundred grain weight was recorded with foliar application of one per cent each of CaNO₃, MgNO₃ and sulphur + ZnSO₄ @ 0.1 per cent with RDF(T₈) which was on par with T₉ (RDF + Foliar application of 0.1 per cent micronutrient mixture). Data on number of cobs per plant and cob girth was not significantly influenced by secondary and micronutrient

In maize, the yield attributes viz. number of grains rows⁻¹, number of rows cob⁻¹, cob length, cob girth and 100-grain weight was influenced by NPK and Zn. A marked increase of these yield attributes were nearly found with T₇ (RDF + foliar application of ZnSO₄ @ 0.1per cent). NPK and Zn are essential nutrients required for the promotion of the meristematic and physiological activities such as leaf spread, root development, plant dry matter production, greater availability of metabolites and nutrients leading to efficient absorption and translocation of water and nutrients and interception of solar radiation. Zinc has control over the synthesis and accumulation of starch in kernals (Guliev 1992). The functional role of Zn includes auxins metabolism, nitrogen metabolism, influence on the activities of enzymes, cytochrome synthesis and stabilization of

ribosomal fractions (Tisdale *et al.*, 1997). Nitrogen in the presence of sufficient zinc shows its optimal performance and promotes higher photosynthetic activities leading to the production of enough assimilates for subsequent translocation to various sinks and there by leading to production of higher sink components like number of cobs plant⁻¹, cob length, cob girth, number of rows cob⁻¹, number of grains row⁻¹ and 100-grain weight. The positive yield forming effect of foliar application of zinc (Wronska *et al.*, 2007; Potrycki 2011). The results are in conformity with the findings of Aruna *et al* (2006), Duraisami *et al.*, (2007), Parasuraman *et al.*, (2008), Meena *et al.*, 2013) and Khan *et al.*, (2014).

Among the secondary nutrients, RDF + foliar application of one per cent MgNO₃ (T₄) had shown profound effect with respect to yield attributes and yield but superior over RDF+ foliar application of one per cent CaNO₃ (T₃) and RDF+ foliar application of one per cent sulphur (T₅). This increment on yield attributes might be due to presence of magnesium, as grain number are direct index of pollen viability and where magnesium is proved to increase the fruit set and pollen viability, and significantly affect the pollen formation (Mahgoub *et al.*,2010 and Siam *et al.*2008). This element will also participate in the transportation of carbohydrates to the sink organs (Barlog and Frckowiak-Pawalak 2008).

Table.1 Average maximum and minimum monthly temperature, rainfall, relative humidity and wind speed during *kharif* – 2015

month	Maximum temperature (°c)	Minimum temperature (°c)	Rainfall (mm)	Relative humidity (%)	Wind speed (km hr ⁻¹)
July	33.7	23.7	2.12	72.55	4.31
August	34.4	24.1	2.38	73.76	4.34
September	32.6	23.6	8.14	76.13	4.02
October	34.1	22.0	1.72	70.18	2.21
November	31.4	20.3	1.67	70.65	3.05

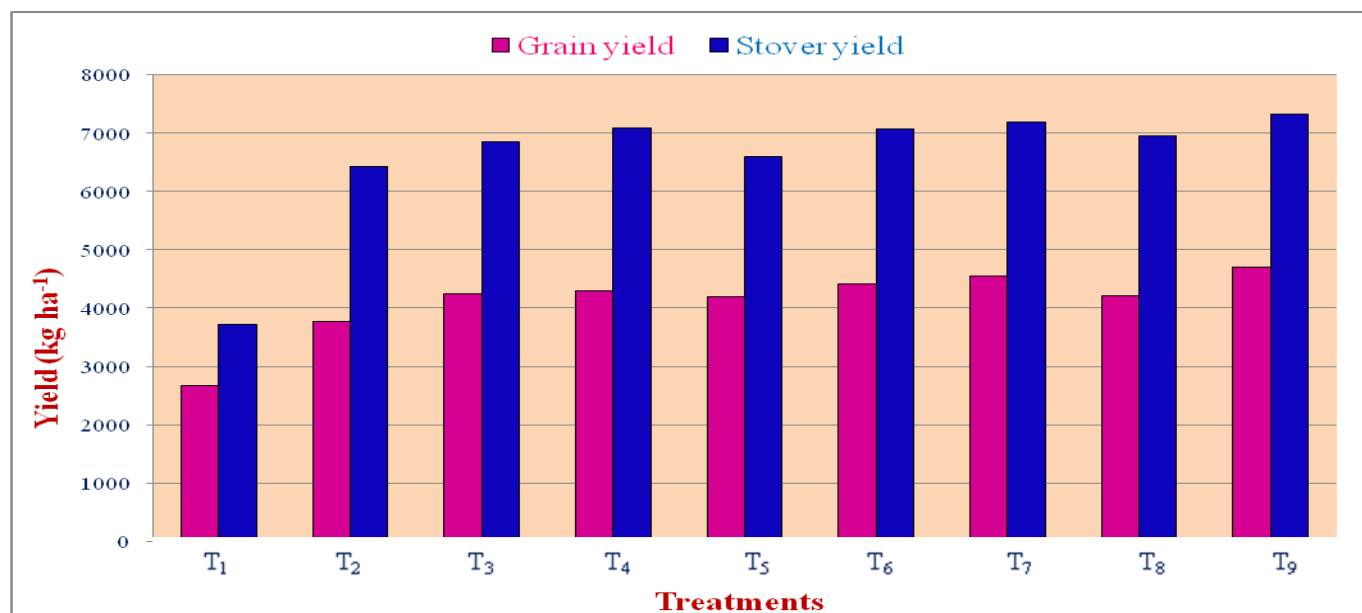
Table.2 Effect of secondary and micronutrients on yield attributes and yield of maize

Treatments	Number of cobs plant ⁻¹	Number of rows cob ⁻¹	Number of grains row ⁻¹	Cob length (cm)	Cob girth (cm)	100-Grain weight (g)
T₁: Control	1.00	12.98	19.99	11.99	11.66	21.76
T₂: 20-40-50 kg N-P₂O₅-K₂O ha⁻¹	1.00	14.11	32.14	17.13	14.25	26.30
T₃: T₂ + foliar application of 1% CaNO₃	1.00	15.12	33.85	18.14	14.81	27.45
T₄: T₂ + foliar application of 1% MgNO₃	1.00	15.66	34.95	17.46	13.89	28.67
T₅: T₂ + foliar application of 1% sulphur	1.06	15.53	33.17	19.04	14.24	28.46
T₆: RDF + foliar application of one per cent each of CaNO₃, MgNO₃ and sulphur	1.00	15.87	35.11	19.09	14.69	29.47
T₇: T₂ + foliar application of ZnSO₄ @ 0.2%	1.06	16.97	36.99	19.86	14.72	29.70
T₈: T₆ + foliar application of ZnSO₄ @ 0.2%	1.00	16.40	34.03	19.14	14.61	31.26
T₉: T₂ + micronutrient mixture @ 0.2%	1.00	15.99	36.09	18.27	14.21	30.53
SEm±	0.03	0.13	0.30	0.19	1.43	0.23
CD (P=0.05)	N.S	0.39	0.92	0.59	N.S.	0.71

Table.3 Effect of secondary and micronutrients on Cost of cultivation, gross returns, net returns (₹ ha⁻¹) and B: C ratio of maize

Treatments	Cost of cultivation(₹ ha ⁻¹)	Gross returns (₹ ha ⁻¹)	Net returns (₹ ha ⁻¹)	B: C ratio
T₁: Control	16270	34667	18397	1.13
T₂: 20-40-50 kg N-P₂O₅-K₂O ha⁻¹	21771	49059	27288	1.25
T₃: T₂ + foliar application of 1% CaNO₃	22421	55081	32695	1.45
T₄: T₂ + foliar application of 1% MgNO₃	22371	55809	33436	1.49
T₅: T₂ + foliar application of 1% sulphur	21871	54454	32583	1.49
T₆: RDF + foliar application of one per cent each of CaNO₃,MgNO₃ and sulphur	24121	54696	30575	1.38
T₇: T₂ +foliar application of ZnSO₄ @ 0.2%	22171	59098	36927	1.59
T₈: T₆ +foliar application of ZnSO₄ @ 0.2%	24521	54678	30157	1.22
T₉: T₂ + micronutrient mixture @ 0.2%	22771	61109	38338	1.68
S.Em±	---	611	607	0.02

Fig.1 Effect of secondary and micronutrients on yield (kg ha⁻¹)of maize



Effect of secondary and micronutrient on grain and stover yield

Data regarding the grain yield and stover yield in Fig.1 showed the treatment with foliar application of 0.2 per cent micronutrient mixture with RDF (T₉) recorded highest grain (4702 kg ha⁻¹) and stover yields (7318 kg ha⁻¹) which was on par with T₇ (RDF + foliar application of 0.1 per cent ZnSO₄), while the lowest grain and stover yields were recorded with T₁ (Control). This increase may be due to the additional availability of micronutrients as foliar application which had beneficial effect on physiological processes, plant metabolism, growth etc. which will directly put forth for higher grain yield. Synergetic role of micronutrients in improving plant growth and other biochemical and physiological activities was given by (Kassab *et. al*, 2004 and Zeiden *et. al*, 2010). The nutrients also enhance the carbohydrates supply to kernels by diverting assimilates from sources, increasing yield components like cob length, cob girth, number of rows cob⁻¹, number of grains row⁻¹ and test weight, which have direct influence on grain yield. Similar results were reported by Aruna *et al.*, (2006), Ghaffari *et al.*, (2011) and Salem *et al.*, (2013).

Economics

The successful adoption of nutrient management practice is finally determined by the net financial gain (Table.3). The best nutrient management practice was foliar application of 0.2 per cent micronutrient mixture with RDF (T₉) attaining 38,338 net field benefits with B:C ratio 1.68 which was comparable with foliar application of 0.1 per cent ZnSO₄ + RDF (T₇) (36,927) and rest of treatments net benefits were low to recommend to farmer.

It could be concluded from the findings that the among the secondary nutrients, foliar

application of magnesium was beneficial in improving yield parameters and yield of maize. With regard to micronutrients, zinc had shown profound effect on growth and yield parameters compared to other micronutrients. So it can be recommended that foliar application of micronutrient mixture along with recommended fertilizer level is feasible for enhancing yield and profitability of maize hybrid pioneer-3369.

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