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Kovatam Anusha
PG Scholar, Department of
Agronomy, College of Agriculture,
Latur, Vasantrao Naik
Marathwada Krishi Vidyapeeth,
Parbhani, Maharashtra, India

Dr. YM Waghmare
Assistant Professor, College of
Agriculture, Ambajogai, Vasantrao
Naik Marathwada Krishi
Vidyapeeth, Parbhani,
Maharashtra, India

Dr. VP Suryavanshi
Professor, College of Agriculture,
Latur, Vasantrao Naik
Marathwada Krishi Vidyapeeth,
Parbhani, Maharashtra, India

K Praveen Kumar
PG Scholar, Department of
Agronomy, College of Agriculture,
Raichur, University of Agricultural
Sciences, Raichur, Karnataka,
India

Chandana K
PG Scholar, Department of
Agronomy, College of Agriculture,
Latur, Vasantrao Naik
Marathwada Krishi Vidyapeeth,
Parbhani, Maharashtra, India

Corresponding Author:
Kovatam Anusha
PG Scholar, Department of
Agronomy, College of Agriculture,
Latur, Vasantrao Naik
Marathwada Krishi Vidyapeeth,
Parbhani, Maharashtra, India

Effect of integrated nutrient management on growth and yield characters of *kharif* maize (*Zea mays* L. var. 32D55 (Dhanlaxmi))

Kovatam Anusha, YM Waghmare, VP Suryavanshi, K Praveen Kumar and Chandana K

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Abstract

A field experiment entitled "Effect of Integrated Nutrient Management on Growth and Yield characters of *Kharif* Maize (*Zea mays* L. var. 32D55 (Dhanlaxmi))" was conducted during the *Kharif* season of 2025–26 at the Experimental Farm, Department of Agronomy, College of Agriculture, Latur, Maharashtra. The experimental field was laid out in a Randomized Block Design (RBD) with seven treatments replicated three times. The treatments were T₁- Control, T₂- RDF (150:75:75), T₃- RDF + FYM @10tonnes/ha, T₄- RDF + FYM @10tonnes/ha + Multi nutrient grade1 @ 25 kg/ha at 25 DAS, T₅- RDF + FYM @10tonnes/ha + foliar Multi nutrient grade2 @ 0.5% at 30DAS, T₆- RDF + FYM @10tonnes/ha + Znso₄ @20 kg/ha, T₇- RDF + FYM @10tonnes/ha + Spraying of Znso₄ at 45DAS. The results showed that the application of RDF + FYM @ 10t /ha+ Znso₄ @ 20 kg/ha (T₆) showed significantly highest growth attributes viz. The plant height (196.78 cm), number of functional leaves plant⁻¹(15.67), dry matter accumulation plant⁻¹(126 g), leaf area (72.00 dm²) at par with RDF + FYM @10tonnes/ha + Multi nutrient grade1 @ 25 kg/ha at 25 DAS (T₄) and RDF + FYM @10tonnes/ha + Spraying of Znso₄ at 45DAS (T₇) significantly superior over rest of the treatments. While the lowest was observed for treatment control (T₁). Similarly highest seed yield was recorded by application of RDF + FYM @10tonnes/ha + Znso₄ @20 kg/ha (T₆).

Keywords: Integrated nutrient management, maize, FYM, zinc sulphate, growth, yield, and soil fertility

Introduction

Maize (*Zea mays* L.) is the third most important cereal crop after rice and wheat in India. “*zea*” is an ancient Greek word which means “sustaining life” and “*mays*” is a word from Taino language meaning “life giver”. Globally, it is highly valued for its multifarious uses such as food, feed, fodder and raw material for large number of industrial products. The genetic potential of maize is higher than other cereal crops and is called as “Queen of cereals” or “Miracle crop” (Kannan et al., 2013) [10]. Maize belongs to the family “Poaceae” and is a C₄ plant, therefore, has a capacity to efficiently convert solar energy into dry matter. The maize grain is used for consumption by humans and livestock while the stover is solely fed to the livestock. In India, current trends in maize consumption are poultry-pig-fish feed (48%), human diet (25%), cattle feed (11%), seed (1%) and brewery industrial products such as corn sugar, corn oil, corn flour, brewers grit and ethanol.

Maize is an annual, cross-pollinated crop and is grown mainly as *kharif* crop. In India, it is cultivated on an area of 10.04 million hectare with the production of 33.62 million tonnes and productivity of 3.34 t ha⁻¹, which is slightly more than the half of world’s average (5.6 t ha⁻¹) (Anonymous, 2022a) [2]. Currently, 47% of maize produced in India is consumed in feed industry, while 13% goes as animal feed and 14% goes in the starch industry (Anonymous, 2022 b) [3].

The major maize growing states in India are Karnataka, Uttar Pradesh and Bihar. Productivity of maize is higher in Tamil Nadu (4686 kg ha⁻¹). In Maharashtra, maize occupies an area of 8.81 lakh hectares with total production of 2762 kg ha⁻¹ (Anonymous 2012c) [1]. The major growing districts in Maharashtra are Nasik (1.64 lakh ha), Aurangabad (1.38 lakh ha), Jalgoan (0.75 lakh ha), Buldhana (0.66 lakh ha) and Jalna (0.61 lakh ha) as a sole crop but in western Maharashtra, maize

is invariably grown as intercrop in sugarcane, turmeric and to limited extent in drilled paddy. Hence, area under sole maize is very limited. Therefore, there is a great scope for increasing area under sole crop in Maharashtra.

The increasing population has caused an increase in the demand of high-quality food, such as that of maize. Maize being a highly nutritious crop containing 70-80% carbohydrates, 6-13% protein, 4% fat, 1-3% sugar and 2-6% oil. Hence, it continues to be a significant crop to meet out the food and feed security challenges of increasing population. The country needs 65 million tonnes of maize by 2050 (Anonymous, 2022b) [3]. This increase in production should be preferably come from increase in the productivity rather than the area. Higher productivity can be achieved by improving resource use-efficiency, better crop establishment and management of pests. New production technologies provide effective ways of increasing productivity to meet the growing demands of consumers and have favourable impact on the properties of soil (Shisanya *et al.*, 2009) [15].

The continuous use of chemical fertilizers and replacement of organic manures is depleting the soil organic matter and discouraging the activity of soil microbes. Soil fertility is highly imbalanced by the solo application of fertilizers. The addition of organic fertilizers not only supplies the essential nutrients to the plants but also affects the availability of native soil nutrients due to release of organic acids and other products during the decomposition (Chethan *et al.*, 2020) [7]. But this application alone can't meet the crop nutrient requirement because of low nutrient content. The efficacy of organic fertilizers to supply plant nutrients is not as high as mineral fertilizers, but the integrated use of chemical and organic can improve the soil quality and crop productivity on long term basis. Highest productivity of crops in sustainable manner without deteriorating the soil health and environment could be achieved only by applying suitable combinations of different organic manures and inorganic fertilizers.

Maize is being a heavy feeder crop requires large amount of nutrients for its proper growth and high yield. To maintain the nutrient requirement of maize crop, efficient nutrient management strategies are required. The combined application of organic and inorganic fertilizers can provide the solution by providing proper nutrient supply and maintaining soil and improving soil health are three interlinked components of sustainable farming. In this context, the concept of Integrated Nutrient Management (INM) has attained significance.

INM is a holistic approach which provides nutrient balance and sustain soil fertility. INM strategies include the conjunctive use of organic and chemical sources of nutrients to address the depletion of soil health by adding the organic matter directly to the soil. The main components of INM includes organic manures, biofertilizers and chemical fertilizers. Organic manures such as FYM and vermicompost improve soil fertility status, soil aggregation, nutrient use efficiency, etc. The organic manures in addition to nutrients also contain growth promoting substances which improve metabolic activity and provide resistance from diseases and insect pests.

INM nourishes the crop and minimize adverse impacts of fertilizers on the environment (Bajpai *et al.*, 2006) [4]. It enhances the integrity and physico-chemical nature of soil by the judicious use of organic and inorganic nutrient sources. Thus, the basic principle behind increasing the maize crop yield without deteriorating the soil health is to implement the INM strategy so as to replenish the chemical nutrients removed by crop and to maintain soil health concurrently.

Materials and Methods

A field experiment was conducted during the Kharif season of 2024–25 at the Experimental Farm, Department of Agronomy, College of Agriculture, Latur which is situated on an elevation of 631 m above the mean sea level, between 17°52' N to 18°50' N and 76°18' E to 79°12' E- coordinates and comes under semi-arid region of Maharashtra state. The mean maximum temperature during crop growth period is 29.85°C while the mean minimum temperature is 19.86 °C. The soil of experimental plot was clayey in texture with chemical composition such as low in organic carbon (1.28%) available nitrogen (162.01 kg ha⁻¹), medium in available phosphorous (13.95 kg ha⁻¹) and very high in available potassium (373.92 kg ha⁻¹). The soil was slightly alkaline in reaction and having pH 7.64. low in available zinc (0.54 ppm) and boron (0.14 ppm).

The present experiment was laid out in Randomized Complete Block Design with three replications. The allotment of treatments to various plots in each replication was done by randomization. The treatments were T₁- Control, T₂- RDF (150:75:75), T₃- RDF + FYM @10tonnes/ha, T₄- RDF + FYM @10tonnes/ha + Multi nutrient grade1 @ 25 kg/ha at 25 DAS, T₅- RDF + FYM @10tonnes/ha + foliar Multi nutrient grade2 @ 0.5% at 30DAS, T₆- RDF + FYM @10tonnes/ha + Znso4 @20 kg/ha, T₇- RDF + FYM @10tonnes/ha +Spraying of Znso4 at 45DAS.

Sowing was done by dibbling method by using seed rate 15 kg ha⁻¹ with spacing 60 cm x 30 cm. The recommended dose of fertilizer was 150: 75: 75 NPK kg ha⁻¹. The gross plot size of each experimental unit was 5.40 m x 4.50 m and net plot size was 4.20 m x 3.90 m. The recommended dose of fertilizer 150:75:75 NPK kg ha⁻¹, and FYM @10tonnes/ha + Znso4 @20 kg/ha, and multi-nutrient grade1 @ 25 kg/ha at 25 DAS as a top dressing was applied as per treatment. Half dose of nitrogen and full dose of phosphorous and potassium as a basal dose and remaining half dose of nitrogen was applied at 30 DAS as a top dressing. Foliar spray of 0.5% ZnSO₄ at 45DAS and 0.5% foliar multi-nutrient grade2 at 30DAS as per treatment was applied.

The height of plant was measured in cm from base of the plant to the growing tip of plant. Total number of functional leaves present on five sample plants were counted and recorded at different growth stages of crop up to harvest. Leaf area was calculated by using the plant samples labelled for studies from each net plot. Stem diameter was measured by Vernier callipers at different growth stages up to harvest and means were worked out. The cob length and girth of sample plant was measured with the help of scale and recorded at harvest. Dry matter plant⁻¹ was recorded at different growth stages and was computed by oven dry method.

Results and Discussion

Application of RDF + FYM @ 10t /ha+ Znso4 @ 20 kg/ha (T₆) recorded significantly highest plant height, number of leaves plant⁻¹, leaf area plant⁻¹, dry matter plant⁻¹, Length and Girth of cob and seed yield followed by application of RDF + FYM @10tonnes/ha + Multi nutrient grade1 @ 25 kg/ha at 25 DAS (T₄) and RDF + FYM @10tonnes/ha +Spraying of Znso4 at 45DAS (T₇) were also found significantly superior over rest of the treatments. Treatment control (T₁) recorded the lowest values for growth attributing characters at all growth stages of the crop.

Since zinc is necessary for the synthesis of proteins and auxin in plants and as it activates enzymes like proteinase and peptidases, it has a positive impact on plant height, cell elongation and leaf area expansion. An application of RDF + FYM @ 10t /ha+ Znso4 @ 20 kg/ha (T₆) produced significantly taller plants, more leaf area, highest dry matter production at all growth stages of maize

due to more availability of nutrients which has favoured the better absorption of nutrients. These results were in accordance with the

findings of Singh *et al.*, (2017)^[16], Mohammadi *et al.*, (2017)^[14], Mohato *et al.*, (2020) and Chandrawanshi *et al.* (2024)^[6].

Table 1: Mean of growth attributes and yield of maize as influenced by various treatments

Treatments	Plant height(cm) AH	No. of functional leaves plant ⁻¹ AH	Leaf area plant ⁻¹ (dm ²) AH	Total dry matter plant ⁻¹ AH (g)	Length of cob (cm)	Girth of cob (cm)	Cob yield (kg ha ⁻¹)
T ₁ - Control	150.78	12.27	60.23	98.37	24.47	17.04	3934.15
T ₂ - RDF (150:75:75 NPK kg/ha)	154.98	12.33	61.51	102.77	25.59	17.34	5067.15
T ₃ - RDF + FYM @10tonnes/ha	159.49	12.67	62.53	103.21	26.60	18.12	6092.79
T ₄ - T ₃ + multi-nutrient grade1 @ 25 kg/ha at 25 DAS	189.52	15.33	69.33	119.36	30.17	21.28	7226.29
T ₅ - T ₃ + foliar multi-nutrient grade2 @ 0.5% at 30DAS	172.00	13.40	63.14	108.18	27.64	19.22	6754.17
T ₆ - T ₃ + Znso ₄ @20 kg/ha	196.78	15.67	72.00	126.37	32.61	22.81	7794.05
T ₇ - T ₃ +Spraying of Znso ₄ at 45DAS	182.51	13.53	66.81	113.68	29.12	20.29	6931.21
SE ±	8.11	0.69	3.08	5.06	1.35	0.95	283.59
CD @ 5%	24.32	2.11	8.73	15.18	4.05	2.84	850.11

*AH-at harvest *DAS- days after sowing

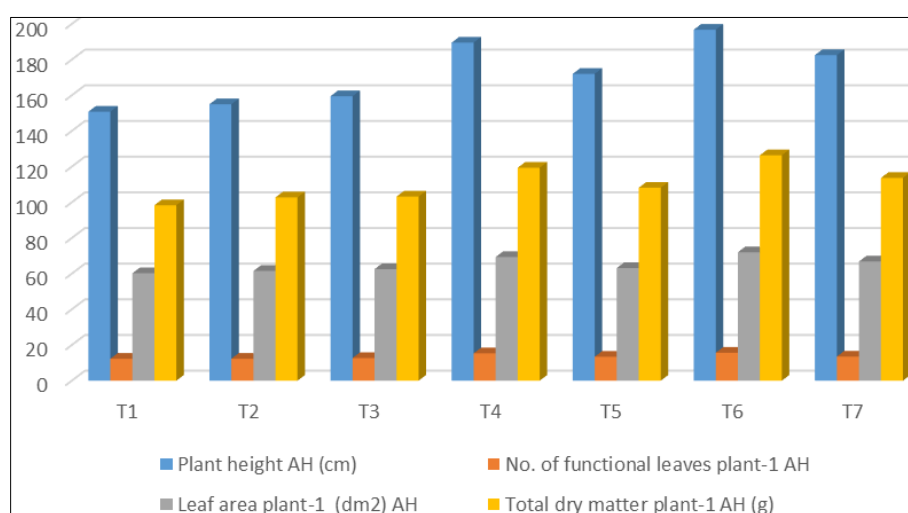


Fig 1: Mean of growth attributes of maize as affected by various treatments

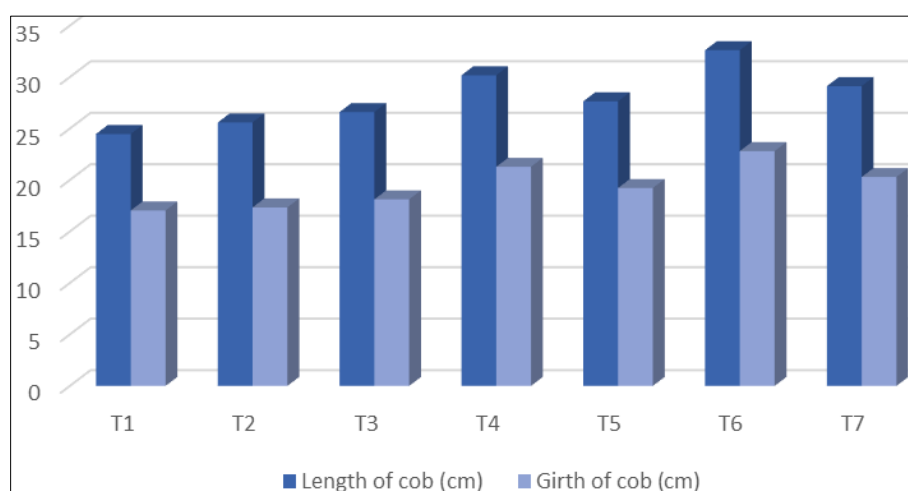


Fig 2: Length of cob and Girth of cob as affected by various treatments

Green cob yield (kg ha⁻¹)

Mean green cob yield (kg ha⁻¹) of maize is 6186.40 kg ha⁻¹. Highest cob yield (7794.05 kg ha⁻¹) was produced by application of RDF + FYM @ 10t /ha+ Znso₄ @ 20 kg/ha (T₆) followed by RDF + FYM @ 10t /ha + multi-nutrient grade1 @ 25 kg/ha at 25 DAS (T₄) which was 7226.29 kg ha⁻¹ and RDF + FYM @10tonnes/ha +Spraying of Znso₄ at 45DAS (T₇) which was

6931.21 kg ha⁻¹ were found superior over rest of treatments. Significantly lowest green cob yield 3439.15 kg ha⁻¹ of maize was obtained from control plot (T₁).

This response is mostly caused by the dominant roles that zinc plays in enhancing the crop's capacity for photosynthetic activity and assimilation through their involvement in a number of enzymatic and other biochemical processes. Improved nitrogen

transfers from source to sink allows for improved yield characteristics and, ultimately, increase in cob yield of maize. Similar results were observed by Khidrapure *et al.*, (2011) ^[12],

Dangariya *et al.*, (2017) ^[8], Ghosh *et al.*, (2019) ^[9], Mohato *et al.*, (2020) and Kayalvizhi *et al.*, (2025) ^[11].

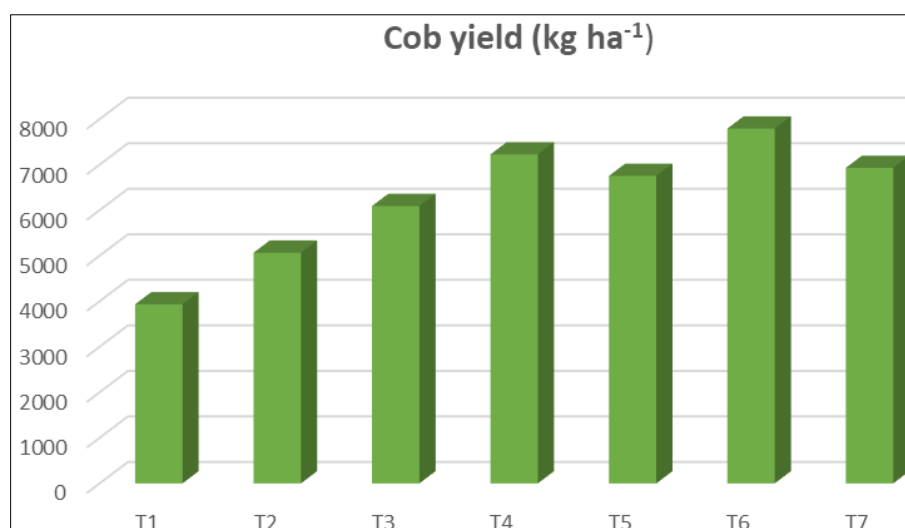


Fig 3: Cob yield of maize as affected by various treatments

Conclusion

The application of RDF + FYM @ 10t /ha+ Znso₄ @ 20 kg/ha (T₆) treatment showed significantly highest growth attributes viz. plant height (196.78 cm), number of functional leaves plant⁻¹(15.67), dry matter accumulation plant⁻¹(126 g), leaf area (72.00 dm²), length of cob (32.61cm), girth of cob (22.81cm), and cob yield (7794.05 kg ha⁻¹) and found superior over rest of treatments.

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