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Unraveling the advantages of site-specific nutrient management in maize (*Zea mays* L.) for enhancing the growth and productivity under varied plant populations in the hot and moist sub-humid region of Odisha

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Abstract

In developing countries like India, a cereal-based cropping system is one of the important practices, having a significant role in food security and the country's economy. Among the cereal crops cultivated in India, maize is one among them having a huge market demand, and yield potential and can perform under various agro climatic conditions. In the cultivation of cereal crops like maize, input optimization and intensification of farming by altering plant population are highly essential for agricultural sustainability as well as crop productivity. Nutrients can be efficiently applied through site site-specific approach by using a decision support system, namely, Nutrient Expert (NE) rather application of a recommended dose for an agro climatic region. Considering the above fact, the research was carried out in the *rabi* season of 2022-2023 at the Post Graduate Research Farm of Centurion University of Technology and Management (23˚38' N latitude and 87˚42' E longitude) in Odisha. The experiment was laid out in a split-plot design with different spacings and NE-based nutrient recommendations. The main factor consisted of 3 different spacings and 4 different nutrient recommendations were considered in sub-plots. The recommended dose of fertilizer for maize was 120-60-60 kg ha^{-1} of N: P_2O_5:K_2O respectively. The results of the experiment revealed that the highest plant height (249 cm), dry matter accumulation (1556 g m^{-2}), leaf area (5674 cm^2 $plant^{-1}$), grain yield (6362 kg ha^{-1}), and stover yield (9334 kg ha^{-1}) were obtained in 60 cm × 15 cm spacing. The NE-based nutrient management for a target yield for 10 t ha^{-1} recorded the highest values in terms of growth attributes, yield attributes, and yield of maize. The experiment concluded that providing fertilizers through NE-based nutrient recommendation for a target yield of 10 t ha^{-1} with a spacing of 60 cm × 15cm can be considered for obtaining better growth, yield attributes, and yield of maize.

Keywords

maize; nutrient expert; plant stand; spacing; yield; yield attributes

Introduction

Cereal crops are the prime source of global food security and supply of dietary energy and nutrients for the majority of the population. Rice, wheat, and maize are the major cereals cultivated across India as well as the world. Maize is a versatile crop having wider compliance under various agroclimatic conditions (1). Maize plays a vital role in meeting world food, feed, and fodder demand. The worldwide production of maize was 1162.3 m t with an average yield of 5.75 t ha^{-1} and the global area under maize production was 201.98 m ha (2). There is a huge demand for the enhancement of maize production in the country as well as in the world. India ranks 4th in the world as a maize-producing country which covered 9.89 million ha, with a production of 31.65 million t and productivity of 3199 kg ha^{-1} (3).

Though Odisha is not a traditional maize-growing state in India, the area under maize cultivation is increasing day by day (4). During the last one and half decades, production of maize has increased by four times in the state, because of the use of hybrids and productivity has also been enhanced by 2.5 times. In Odisha, maize is grown in 2.54 lakh ha with a production and productivity of 7.33 lakh t and 2886 kg ha^{-1} respectively. The productivity of maize in the state is comparatively lower than the national average (3199 kg ha^{-1}) (5).

In countries like India, most of the farmers adopt a rice-based cropping system and the rice-fallow situation is a very common practice. In this scenario, the introduction of *rabi* maize can enhance the cropping intensity of the region (1, 4). However, in the cereal-cereal-based cropping system, proper nutrient management is a vital factor for crop productivity, soil fertility, and agricultural sustainability (6-8). Existing fertilizer recommendations provided by state governments and other competent authorities are for a larger area without considering the site-specific soil, cropping systems adopted by farmers, and weather conditions. This blanket recommendation may result in under-fertilization in regions with low fertile soils and excess fertilization in medium to high fertile soils (9-11). The innovation in modern agriculture has led to the development of various decision-support tools and software for input optimization in agriculture by considering soil and plant-based approaches (12, 13).

There are several precision nutrient management tools such as optical sensors and decision support systems which have been developed for major cereals like rice, wheat, and maize (14, 15). These precision nutrient management tools can analyze the nutrient needs of the crop at different stages as well as site-specific conditions based on which nutrient recommendations will be provided to the requirements of crops (16). However, the optical sensors such as the Soil Plant Analysis Development (SPAD) meter, Chlorophyll Content Meter (CCM), Green-seeker, and Leaf Colour Charts (LCC) are limited to only recommending the site-specific nitrogen requirement (13). In this scenario, Nutrient Expert (NE) for maize can be an efficient software-based decision support system (DSS) for the site-specific recommendation of primary nutrients, namely, nitrogen, phosphorous, and potassium (17, 18).

It was developed by the International Plant Nutrition Institute (IPNI) and the International Maize and Wheat Improvement Center (CIMMYT), Mexico (19). The NE takes into account all field variables such as soil nutrient status, previous crop history, average yield of the field, irrigation, and other important factors affecting nutrient requirement (20). The NE uses an approach for the calibration of information related to a site-specific nutrient management option (21). Apart from proper nutrient management practices, some agronomic practices such as plant population can also play a pivotal role in crop yield. Plant density or plant stand is an important agronomic trait determining crop productivity as well as other important growth parameters of maize (22, 23). Plant stand can affect plant canopy stature, modify growth and developmental designs, and impact assimilates production and partitioning the same to the reproductive parts.

Maize has the sensitivity to plant-stand and hybrids can endure competition to high-density planting, which facilitates higher plant density, leading to a greater biomass production and yield per unit area (24, 25). The progressive farmers adopt innovative approaches in cereal production with various planting methods, plant stands, and nutrient application (26, 27). Thus, adjustment of plant population can be considered an important agronomic management practice for achieving the target yield of maize (28).

Considering the above facts, the present study was designed to determine the optimum plant stand/ spacing for hybrid maize and optimize the recommendation of primary nutrients through a site-specific approach by using NE for maize for a target yield under the hot and moist sub-humid region of Odisha.

Materials and Methods

A field trial was carried out during *rabi* season at the Post Graduate Research Farm of Centurion University of Technology and Management (CUTM) located at 23˚38' N latitude and 87˚43' E longitude) Gajapati district, Odisha. The weather information during the experimentation period was recorded from the Automated Weather Station of CUTM. The daily weather data was converted to standard meteorological week and presented in Table 1. The meteorological data showed that the maximum temperature during the crop period varied from 28.2 °C to 41.0 °C; whereas, the minimum temperature ranged between 12.0 °C and 28.6 °C. The maximum and minimum relative humidity recorded during the crop period was 80.6 % to 97.1 % and 37.4 % to 72.3 % respectively. Further, the crop received 95.7 mm of rainfall between December 2022 to April 2023 and the mean weekly bright sunshine h varied between 4.6 h day^{-1} to 9 h day^{-1}.

Before experimenting, a soil sample was collected from the experimental site as per the standard method. The analyzed composite sample showed that the experimental soil was low in organic carbon (0.32 %), sandy loam, slightly acidic in nature with a pH of 6.68, and the electrical conductivity of the soil was 0.42 dS m^{-1}. The chemical properties of the experimental soil are provided in Table 2. The experiment was carried out in a split-plot design with different spacings and NE-based nutrient recommendations. The main factor consisted of 3 different spacings, namely, S_1: 60 cm × 15 cm (111111 plants ha^{-1}), S_2: 60 cm × 20 cm (83333 plants ha^{-1}) and S_3: 60 cm × 25 cm

Table 1. Meteorological observations during the crop period (December 2022 - April 2023)

Standard week	Temperature (°C)		Relative humidity (%)		Rainfall (mm)	Sunshine (hrs. day^{-1})
	Maximum	Minimum	Maximum	Minimum		
December 2022						
51st	28.2	12.8	96.7	46.4	0	8
52nd	28.4	17.6	95.9	69.8	0	7
January 2023						
1st	28.4	18.1	90.0	68.4	0.0	7
2nd	30.6	13.1	89.0	50.1	0.0	7
3rd	30.0	18.0	89.1	59.7	0.0	8
4th	31.6	13.6	84.9	43.6	0.0	8
5th	32.0	16.6	86.5	48.6	0.0	7
February 2023						
6th	34.0	16.6	87.6	49.9	0.0	8
7th	33.4	16.6	86.0	37.4	0.0	8
8th	34.4	19.4	87.9	49.4	0.0	9
9th	34.8	18.7	83.0	39.6	0.0	8
March 2023						
10th	35.0	18.6	80.6	37.9	0.0	9
11th	34.6	19.3	82.7	43.1	0.0	8
12th	31.7	21.3	85.3	63.0	0.0	9
13th	33.4	23.6	85.9	63.9	17.0	7
April 2023						
14th	34.2	23.3	81.7	47.5	21.2	7
15th	35.1	23.7	81.0	38.9	0.0	8
16th	38.1	28.6	91.0	42.4	0.0	9
17th	41.0	26.6	96.4	60.1	11.0	7
18th	38.7	26.4	97.1	72.3	46.5	8

Source: Agro-meteorological Observatory, Centurion University, Odisha

Table 2. Chemical properties of the soil before the study

Properties	Value	Method
Soil reaction (pH)	6.3	1:2.5 soil water suspension, using glass rod electrode pH meter (29)
Electrical conductivity (dS m^{-1})	0.17	Electrical conductivity (29)
Organic carbon (%)	0.42	Walkley and Black's rapid titration method (30)
Available nitrogen (kg ha^{-1})	231	Alkaline permanganate method (31)
Available phosphorus (kg ha^{-1})	11.8	Bray's method (29)
Available potassium (kg ha^{-1})	131.6	Flame photometric method (29)

(66666 plants ha^{-1}). The subplot consists of 4 different nutrient recommendations comprising of T_1: 100 % Recommended dose of fertilizer (RDF), T_2: NE-based nutrient management for a target productivity for 6 t ha^{-1}, T_3: NE-based nutrient management for a target productivity for 8 t ha^{-1} and T_4: NE-based nutrient management for a target productivity for 10 t ha^{-1}. There was a total of 12 treatment combinations which were replicated 3 times. Each plot was 5 m x 4.2 m. The maize hybrid JKMH-4510 was considered for the research. The recommended dose of fertilizer for maize was T_1(120-60-60 kg ha^{-1}of N: P_2O_5:K_2O). However, for NE-based treatments, there was variation in nutrient doses, such as T_2(120-40-46 kg ha^{-1}of P_2O_5:K_2O), T_3 (140-47-71 kg ha^{-1}of N: P_2O_5:K_2O) and T_4(153-58-79 kg ha^{-1}of N: P_2O_5:K_2O). During the cropping period, 6 irrigations were applied as per the crop needs. To maintain the plots weed-free, atrazine + tembotrione tank mix weedicide was applied at 15 DAS. Further, the crop was infested with fall armyworm and to control the pest incidence, Chlorantraniliprole 18.5 % SC @ 150 mL ha^{-1}was applied during 35 and 70 DAS respectively. There was negligible damage by pests. The growth attributes data such as plant height, dry matter accumulation, stem girth at harvest and leaf area, yield attributes and yield were recorded as per the standard research procedures.

The recorded parameters were analyzed statistically by using analysis of variance (ANOVA), the standard error of means (S. Em. ±), and critical difference at a 5 % probability level of significance (32). Further, the correlation analysis was done between different yield attributes with yield. For all the statistical analysis and correlation, the Microsoft Excel software (Microsoft Office Home and Student version 2019-en-us, Microsoft Inc., Redmond, Washington, USA) was used.

Results

Effect of plant population and nutrient management on growth attributes of maize

The growth attributes of maize showed a significant difference concerning plant population and nutrient doses (Table 3). The highest plant height (249 cm), leaf area (5674 cm^2), and dry matter accumulation (1556g m^{-2}) were obtained with treatment S_1: 60 cm ×15 cm and it remained significantly higher than the other treatments such as S_2: 60 cm × 20 cm and S_3: 60 cm × 25 cm. The treatment S_1: 60 cm × 15 cm (111111 plants ha^{-1}) resulted in taller plants as there was intra-species competition which might cause stem elongation for competition of light and avoidance of shading effect. The same treatment (S_1) recorded the highest dry matter accumulation and leaf area per unit area because of the higher population per unit area. The results are in tune with earlier research where closer

Table 3. Effect of plant population and nutrient management on growth attributes of maize

Treatments	Growth attributes			
	Plant height at harvest (cm)	Dry matter at harvest (g m^{-2})	Leaf area at 60DAS (cm^2 $plant^{-1}$)	Stem girth at harvest (cm)
Spacing				
S_1	249	1556	5674	6.93
S_2	245	1363	5482	7.27
S_3	238	1306	4857	7.68
S. Em. (±)	0.98	6.79	10.18	0.01
CD at 5%	3.86	20.17	39.98	0.03
Nutrient dose				
T_1	240	1295	4925	6.44
T_2	227	1280	4676	6.78
T_3	251	1423	5713	7.87
T_4	258	1635	6038	8.08
S. Em. (±)	3.52	6.79	48.59	0.06
CD at 5%	10.46	20.17	144.35	0.18
Spacing x nutrient dose interaction				
S. Em. (±)	6.10	11.76	84.16	0.10
CD at 5 %	NS	34.94	250.02	NS

* NS: Non-significant; S_1: 60 cm × 15 cm (1,11,111 plants ha^{-1}), S_2: 60 cm × 20 cm (83,333 plants ha^{-1}) and S_3: 60 cm × 25 cm (66666 plants ha^{-1}); N_1: 100 % RDF, T_2: NE-based nutrient management for a target yield for 6 t ha^{-1}, T_3: NE-based nutrient management for a target yield for 8 t ha^{-1} and T_4: NE-based nutrient management for a target yield for 10 t ha^{-1}.

spacing provided higher plant height, dry matter accumulation, and leaf area of maize (22, 33). Unlike the above growth attributes, the highest stem girth was noted with S_3: 60 cm × 25 cm and it remained significantly superior to S_1: 60 cm × 15 cm and S_2: 60 cm × 20 cm. As the treatment S_3 had an optimum plant population (66666 plants ha^{-1}), plants faced comparatively less competition among themselves resulting in proper growth which was reflected in the stem girth of maize. The findings corroborate with the previous research (34, 35).

In the case of the recommended dose of fertilizers, the highest plant height (258 cm), dry matter accumulation (1635 gm m^{-2}), leaf area (6038 cm^2), and stem girth (8.08 cm) were obtained in treatment T_4: NE-based nutrient management for a target yield for 10 t $ha^{-1}$and it remained significantly superior to the remaining nutrient management treatments, namely, T_2: NE-based nutrient management for a target yield for 6 t ha^{-1}, T_3: NE-based nutrient management for a target yield for 8 t ha^{-1}, T_1:100 % RDF. Further, the treatment T_2: NE-based nutrient management for a target yield for 6 t ha^{-1} recorded significantly inferior growth attributes compared to other NE-based treatments (T_3 and T_4) and T_1: 100 % RDF. The treatment T_4: NE-based nutrient management for a target yield of 10 t ha^{-1}probably received the optimum fertilizer dose (153,58, and 79 kg ha^{-1} N, P_2O_5, and K_2O) as it might result in higher nutrient availability to plants which was converted into superior growth attributes in maize (1, 18). The results show a similar trend to the previous findings (36, 37).

The interaction effect between plant population and nutrient dose did not show any significant difference in plant height and stem girth of maize. However, the interactions of dry matter accumulation and leaf area recorded a significant difference among treatment combinations (Fig. 1). The treatment combination of S_3:60 cm × 25 cm (66666 p ha^{-1}) with NE-based nutrient management for a target yield for 10 t ha^{-1} registered the highest dry matter accumulation and leaf area. This treatment combination further remained significantly superior to all other treatment combinations (1).

Effect of plant population and nutrient management on yield attributes of maize

The yield attributes of maize showed a significant difference concerning plant population and nutrient doses (Table 4). In the case of the plant population of maize, the highest number of cobs $plant^{-1}$ (1.79), number of grains cob $^{-1}$ (326), the weight of cob (258 g), and test weight (240 g) were recorded with S_3: 60 cm × 25 cm. This treatment further remained significantly superior to S_1: 60 cm × 15 cm and S_2: 60 cm × 20 cm. The optimum plant stand with S_3:

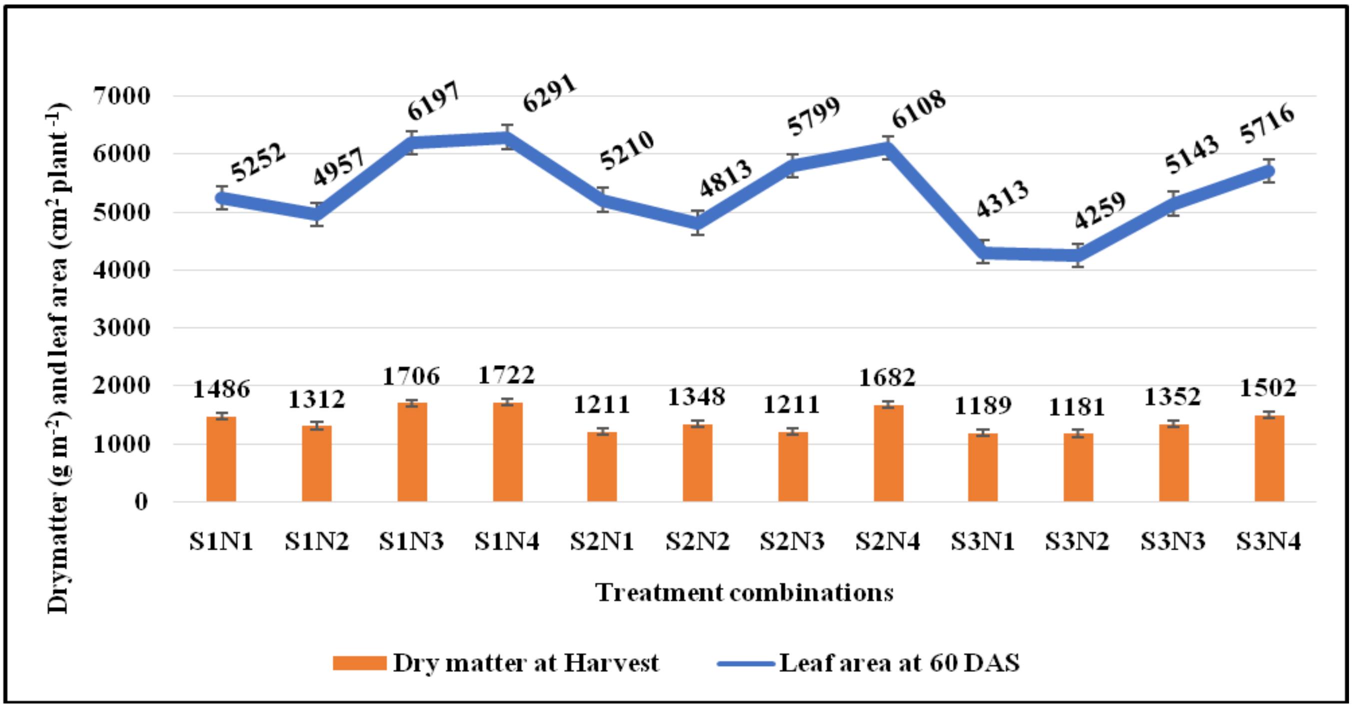

Fig. 1. Interaction effect of plant population and nutrient management on dry matter accumulation and leaf area of maize.

Table 4. Effect of plant population and nutrient management on yield attributes of maize

Treatments	Yield Attributes			
	Number of cobs per Plant	Number of grains per Cob	Test weight (g)	Weight of the cob (g)
Spacing				
S_1	1.68	283	232	232
S_2	1.72	302	236	244
S_3	1.79	326	240	258
S. Em. (±)	0.01	0.83	0.05	0.42
CD at 5 %	0.05	3.27	0.19	1.64
Nutrient dose				
T_1	1.67	277	231	235
T_2	1.63	254	228	222
T_3	1.79	337	241	258
T_4	1.83	346	243	264
S. Em. (±)	0.04	6.36	3.87	3.72
CD at 5 %	0.12	18.89	11.48	11.04
Spacing x nutrient dose interaction				
S. Em. (±)	0.07	11.01	6.70	6.44
CD at 5 %	NS	NS	NS	NS

*NS: Non-significant; for treatment details, Table 3 may be referred.

60 cm × 25 cm (66666 plants ha^{-1}) might facilitate better growth of the crop and result in higher yield attributing characters. Due to close plant spacing in S_2: 83333 plants ha^{-1} and S_1: 111111 plants faced a greater intra-species competition for resources which probably affected the yield attributing characters of maize (38, 39).

In terms of fertilizer doses, the highest number of cobs plant^{-1} (1.83), number of grains cob^{-1} (346), weight of cob (243 g), and test weight (246 g) were obtained in treatment T_4: NE-based nutrient management for a target yield for 10 t ha^{-1}. Further, this treatment remained statistically at par with T_3: NE-based nutrient management for a target yield for 8 t ha^{-1}in the expression of several cobs per plant (1.79), the weight of cob (258.67 gm) and test weight (241.67 gm). The remaining nutrient management treatments, namely, T_2: NE-based nutrient management for a target yield for 6 t ha^{-1} and T_1: 100 % RDF remained significantly inferior to T_4: NE-based nutrient management for a target yield for 10 t ha^{-1}.The application of an ample dose of nutrients through T_4: NE-based nutrient management for a target yield of 10 t increased the dry matter accumulation and leaf area of the maize, which might increase the photosynthate assimilation resulting in better translocation of assimilates to the cob and grain (1, 40). The interaction effect did not show any significant difference concerning cobs per plant, grains per cob, weight of cob, and test weight among the treatment combinations. The above results are in the pipeline with the previous studies of (41).

Effect of plant population and nutrient management on yield of maize

The highest grain yield (6362 kg ha^{-1}), stover yield (9789 kg ha^{-1}), and biological yield (15563 kg ha^{-1}) were recorded with S_1: 60 cm × 15 cm and the treatment remained significantly superior to the remaining treatments such as S_2: 60 cm × 20 cm and S_3: 60 cm × 25 cm (Table 5). The treatment S_3: 60 cm × 25 cm remained significantly inferior to other plant population treatments in the expression of grain, stover, and biological yield of maize. The higher plant population of 111111 plants ha^{-1} (S_1) might result in higher grain, stover, and biological yield of maize as it assimilated higher dry matter (33, 42, 43).

In the case of nutrient management, the maximum grain yield (7065 kg ha^{-1}), stover yield (9334 kg ha^{-1}), and biological yield (16353 kg ha^{-1}) were recorded in the treatment T_4: NE-based nutrient management for a target yield of 10 t ha^{-1} (Table 4). Further, it remained statistically at par with T_3: NE-based nutrient management for a target yield of 8 t ha^{-1} in terms of stover yield (9282 kg ha^{-1}) and harvest index (41.35 %). However, in the expression of grain yield, the treatment T_4: NE-based nutrient management for a target yield of 10 t ha^{-1} remained significantly superior to all other nutrient management treatments. The nutrient management treatments T_2: NE-based nutrient management for a target yield of 6 t ha^{-1} and T_1: 100 % RDF remained significantly inferior to T_4: NE-based nutrient management for a target yield of 10 t ha^{-1} in the expression of grain yield, stover yield, and biological yield. The site-specific application of primary nutrients through NE for a target yield of 10 t ha^{-1} (153: 58:79 kg ha^{-1}of N: P_2O_5:K_2O) might provide a better supply of nutrients with optimum application of nitrogen than RDF which resulted in the highest grain and stover yield of maize (37). The quantitative increase of yield attributes in treatment T_4: NE-based nutrient management for a target yield for 10 t ha^{-1} might support further obtaining maximum yield compared to T_1: 100 % RDF (120: 60:60 kg ha^{-1}of N: P_2O_5:K_2O) (12, 44-46).

The treatment combinations of plant population and recommended dose of fertilizers showed a significant difference in terms of yield of maize (Fig. 2). The highest grain yield and biological yield were registered with T_4: NE-based nutrient management for a target yield for 10 t ha^{-1} with a spacing of S_1: 60 cm × 15 cm. This treatment

Table 5. Effect of plant population and nutrient management on yield of maize

Treatment	Yield (kg ha^{-1})			Harvesting index (%)
	Grain yield	Stover yield	Biological yield	
Spacing				
S_1	6363	9789	15563	40.63
S_2	6062	8629	14592	41.38
S_3	5240	7651	13070	39.42
S. Em. (±)	41.67	52.33	88.24	0.30
CD at 5%	163.58	194.72	346.42	1.18
Nutrient dose				
T_1	5269	8465	13421	39.39
T_2	4780	7680	12348	38.63
T_3	6439	9282	15511	41.35
T_4	7065	9333	16352	42.54
S. Em. (±)	119.93	137.82	159	0.62
CD at 5 %	356.27	390.58	452.84	1.85
Spacing x nutrient dose interaction				
S. Em. (±)	207.72	169.42	221.46	1.43
CD at 5 %	617.08	503.30	657.91	NS

* NS: Non-significant; for treatment details, Table 3 may be referred.

remained on par with T_4: NE-based nutrient management for a target yield of 10 t ha^{-1} with a spacing of S_2: 60 cm × 20 cm and T_3: NE-based nutrient management for a target yield for 8 t ha^{-1} with a spacing of S_1: 60 cm × 15 cm. However, the highest stover yield was recorded with the treatment combination of T_4: NE-based nutrient management for a target yield of 10 t ha^{-1} with a spacing of S_1: 60 cm × 15 cm. This treatment remained on par with T_4: NE-based nutrient management for a target yield of 10 t ha^{-1} with a spacing of S_2: 60 cm × 20 cm. Moreover, the above-mentioned treatment combinations remained significantly superior to all other treatment combinations of plant population and nutrient doses. The lowest values among the interaction treatments were recorded in T_2: NE-based nutrient management for a target yield for 6 t ha^{-1} with a spacing of S_3: 60 cm × 25 cm in an expression of grain yield, stover yield, and biological yield (34, 38, 39, 44).

Regression analysis of growth attributes with yield of maize as influenced by plant population and nutrient management

The regression analysis carried out between the growth attributes and grain yield showed a strong to moderate correlation among the parameters (Fig. 3 and Fig. 4). The regression analysis related to growth attributes, namely, plant height, dry matter accumulation, and leaf area expressed a strong correlation with an R^2 value of 0.933, 0.955 and 0.761 respectively. However, the stem girth was found to be moderately correlated with biological yield by obtaining the R^2 values of 0.592. The regression analysis clearly showed the importance and influence of growth attributes of maize such as plant height, dry matter accumulation, and leaf area to obtain the grain yield of maize (47, 48).

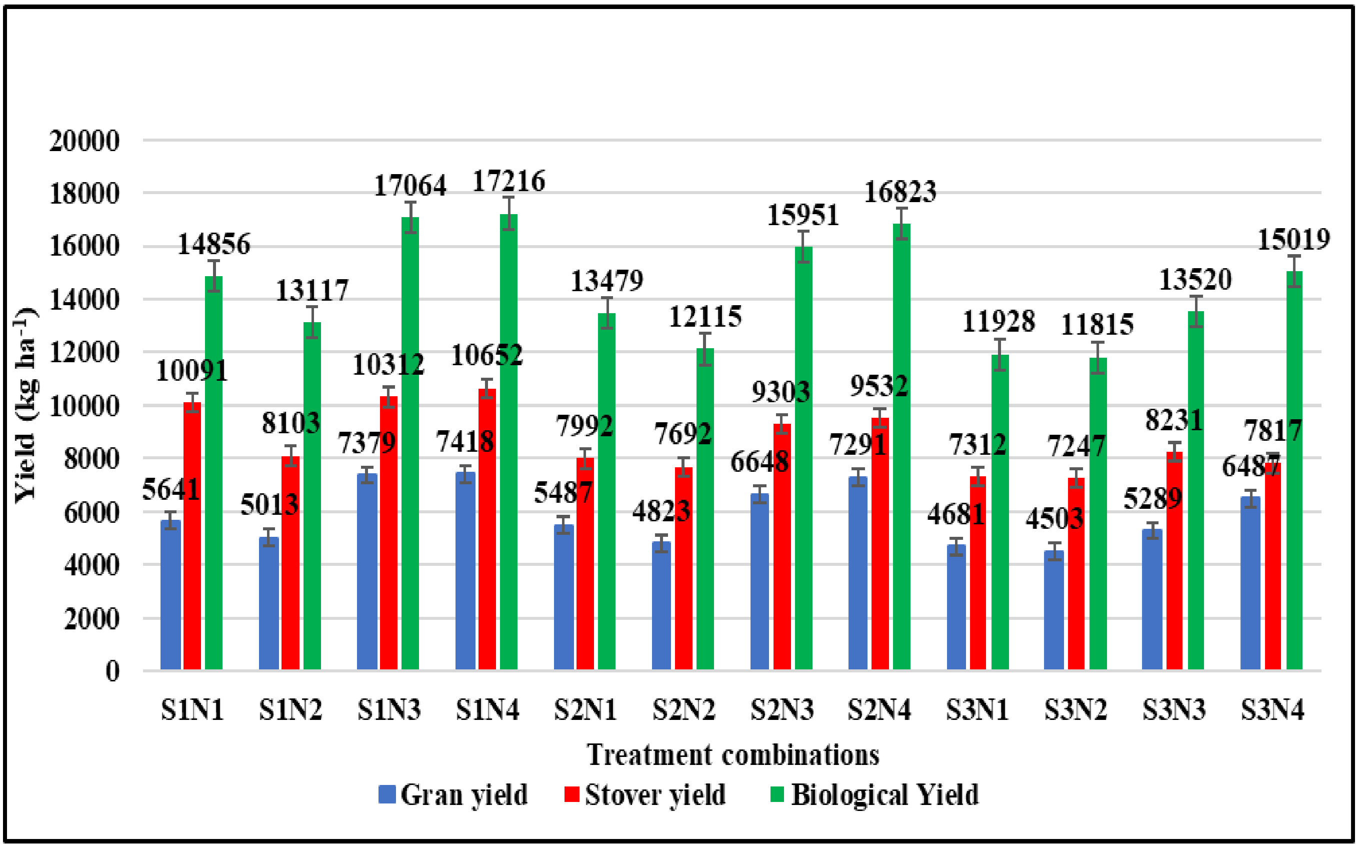

Fig. 2. Interaction effect of plant population and nutrient management on grain yield, stover yield, and biological yield of maize.

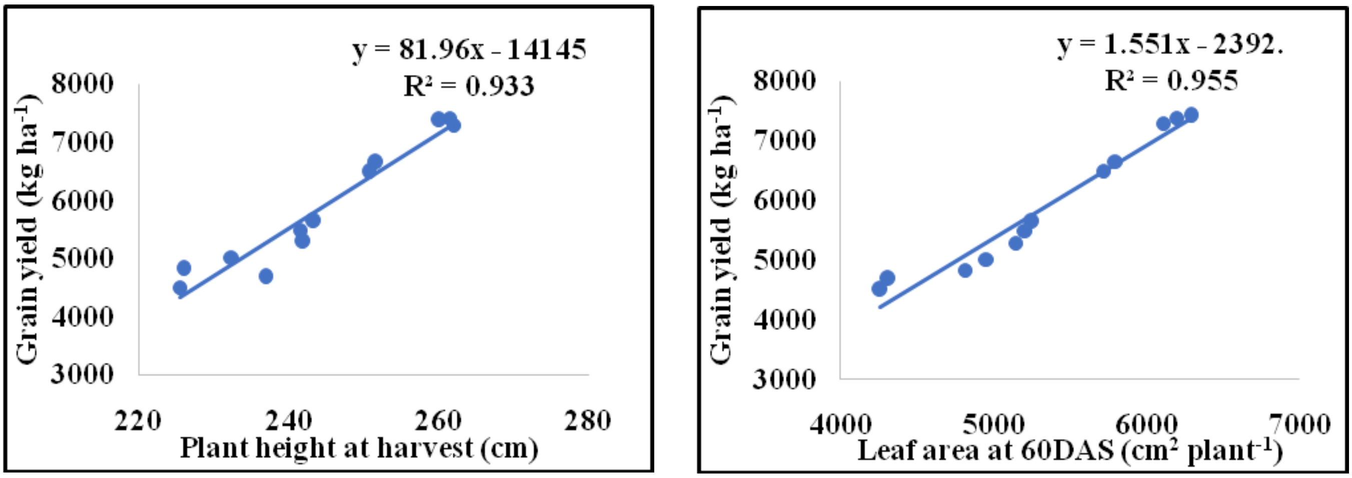

Fig. 2. Interaction effect of plant population and nutrient management on grain yield, stover yield, and biological yield of maize.

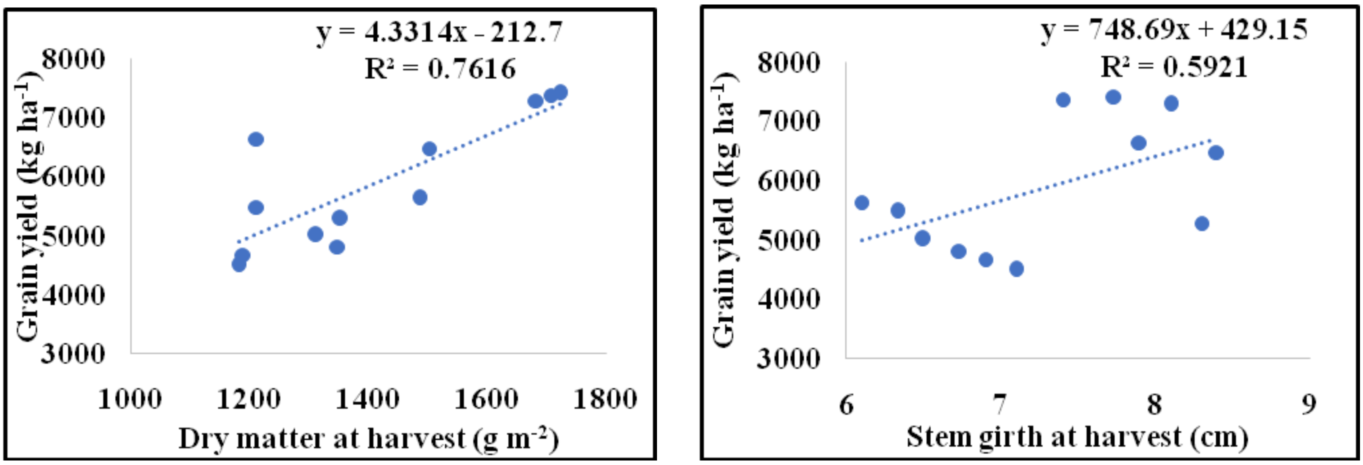

Fig. 4. Regression analysis of dry matter and stem girth with grain yield of maize.

Conclusion

The NE-nutrient management along with varying levels of plant population as well as plant stand showed a significant influence on growth, yield attributes, and yield of maize. The study revealed that the NE-based nutrient management for a target yield for 10 t ha^{-1} can be considered as the best site-specific application of primary nutrients in maize. Further, the highest plant stand by reducing plant-to-plant distance with a plant population of 111111 plants ha^{-1} (60 cm × 15 cm) can be preferred for increasing the productivity of maize. From the study, it may be concluded that the application of nutrients through NE-based nutrient management for a target yield of 10 t ha^{-1} under the plant population of 111111 plants ha^{-1} (with a spacing of 60 cm × 15 cm) should be chosen as the most suitable agronomic practice for improving growth and productivity in maize under the hot and moist sub-humid region of Odisha.

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Authors' contributions

TGK, SM, and MS: A conducted field experiment, collected data, and wrote the manuscript, TGK, SM: Framing out the research work, Designing the experiment, and manuscript drafting. CVR, MS, and TGK: Statistical analysis, SM, MS: Revision of the manuscript.

Compliance with ethical standards

Conflict of interest: Authors declare that they don't have any conflict of interest.

Ethical issues: None.

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