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Effect of planting density and nutrient management practices on the yield of maize hybrids during *kharif* season

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Abstract
Field experiment was carried out to study the effect of planting density and nutrient management practices on the performance of maize hybrids in acidic soils of Odisha at the Central Research Station, Odisha University of Agriculture and Technology, Bhubaneswar, during 2014 in the coastal ecosystem in *kharif* season. The experiment was laid out in a split-split plot design with three replications. Two hybrids (Hishel and P3441) were allotted to the main-plots, two planting density (high-60 cm x 20 cm, normal-50 cm x 20 cm) to the sub-plots and three nutrient management practices i.e. SSNM (140:41:77 N:P2O5:K2O kg/ha) based on target yield (65.0 q/ha), Soil Test Crop Response (STCR) ((143:15:78) N:P2O5:K2O kg/ha) through fertilizer prescription equation target yield (65.0 q/ha) and RDF (120:60:60 kg N-P-K/ha) to the sub- sub-plots. The Hybrid P3441 influenced higher growth parameters, more plant population, produced maximum grain yield and stover yield to Hishel respectively. Similarly, the high plant geometry significantly yielded highest grain yield and stover yield as compared to normal plant geometry. Likewise, among the three nutrient management practices, STCR significantly resulted in highest grain yield and stover yield over RDF, but it remained at par with SSNM. The increase in grain yield and stover yield of STCR was 21.6% and 4.9% higher over RDF and 31.4% and 4.3% to SSNM.

Keywords: Maize, High plant geometry, Normal plant geometry, STCR, SSNM, RDF

Introduction
Maize is considered as the third most important food crop among the cereals in India that contributed to nearly 9% of the national food security (Jat *et al*., 2013) [4]. During 2015-16, it is cultivated over an area 8.69 million ha with 21.81 million tonnes production having an acreage productivity of 2509 kg/ha (ICAR-IIMR 2016) [2]. However, cereal production in the country increased only five fold, while fertilizer consumption increased 322 times during the 1950–51 to 2007–08 periods, implying very low fertilizer use efficiency. Growing market demand for the feed and starch industry and increase in minimum support price from Rs 5,400/t in the year 2006-07 to Rs 13, 100/t in 2013-14 led to make maize as a more profitable crop and encouraged farmers to grow maize to a large extent (DACNET, 2015) [1]. During *kharif* season, the farmers were facing lot of problem due to erratic monsoon rainfall, non availability of hybrids and high yielding varieties. The use of external inputs enhances maize production and productivity in India but general fertilizer recommendation and current farmers' fertilizer practice are not based on the nutrient requirements of the maize crop and the nutrients available in the soil. The simulated, attainable and actual maize yield gaps due to poor yielding genotypes and crop establishment technique as well as imbalanced nutrient application as 15-45% maize area remains unfertilized (Jat *et al.*, 2011) [3]. The yield potential of maize can be realized only when it is grown with adequate fertilization and optimum plant population (Singh and Singh, 2006) [11]. Due to higher nutrient demand and different plant type the hybrid needs modification in production technology especially for nutrient and plant geometry. So, to achieve higher productivity and resource-use efficiency optimum plant stand is an important factor. Plant density affects growth and developmental patterns, influences carbohydrate production and partition and ultimately the yield of the crop. Even under optimal growth conditions most growth parameters are affected by planting population density, therefore plant population is a measure factor determining the degree of completion between plants (Sangakkara *et al*., 2004) [7].

Many modern maize varieties do not tiller effectively at low plant densities whereas; use of high plant densities increases interplant completion for light, water and nutrients (Sangoi, 2001) [8]. Plant density is one of the most important cultural practices determining grain yield, as well as other important agronomic attributes of this crop. Plant density affects plant architecture, alters growth and developmental patterns and influences carbohydrate production and partition. Maize is more sensitive to variations in plant density than other members of the grass family. Therefore, it is necessary to identify optimum planting densities to facilitate efficient utilization and transformation of the available growth resources into grain production in maize.

Fertilizer is one of the most important agriculture inputs for increasing the crop production. The fertilizer application by the farmers in the field without knowledge of soil fertility status and nutrient requirement of different crops usually leads to adverse effect on soil as well as crops by way of nutrient deficiency or toxicity due to overuse or inadequate use of fertilizers. In regard, targeted yield approach has been found to be beneficial which recommends balanced fertilization considering available nutrient status, in the soil and the crop needs. The concept of fertilizer prescription equation for the desire yield was first given by Troug (1960) [13]. Nutrient requirement of maize varies from field to field due to high variability in soil fertility across farmer's fields and also varies with the yield potential of hybrids. Therefore, single homogeneous nutrient recommendations may not be very useful for improving maize yield. To overcome this problem from adoption of the emerging concept of precision agriculture wherein, the input variables such as fertilizers are applied in the right amount, at the right place and at the time (variable rate application) as per the demand of the crop. It helps to improve input-use-efficiency, economic and ensure sustainable use of natural resources, as it is minimizes wastage.

Site-Specific Nutrient Management (SSNM) approach is one such option which focuses on balanced and crop need-based nutrient approach. It provides an for the timely application of fertilizers at optimal rates to full fill the deficit between the nutrient needs of a high yielding crop and the nutrient supply from naturally occurring indigenous sources, including soil, crop residues, manures and irrigation water. It also works on the 4R principle right method, right amount, right dose and right time. This will help to increase yield and profit by target enabled fertilizer management strategy.

Several approaches used for fertilizer recommendation in maize like, RDF, STCR, SSNM. Among several soil test based fertilizer application technique, STCR and SSNM are plant need based approaches with specific yield target. The aim of SSNM and STCR approaches not only reduce or increase fertilizer use and also cost effective tools for supplying crop nutrient as and when needed to achieve higher yield, besides this they also aims to increase system nutrient use efficiency, leading to more returns per unit of fertilizer invested (Shankar and Umesh, 2008) [12].

The maize crop in *kharif* season requires comparatively less input as compare to most competing paddy crop of the season where farmers are harvesting double yield of maize than rice. The plant geometry and optimum plant population play an important role in plant growth, yield attributing characters and yield of crop. At present there is lack of nutrient recommendation according to area based climatic situation as well as nutrients. This is one of the major reasons for lower production at farmer's field. Without knowing soil fertility status and nutrient requirement of maize hybrids it is not possible to harvest potential yield. Keeping this view in mind, an experiment was undertaken to study the effect of hybrid, plant geometry and levels of nutrients on growth and yield of *kharif* maize.

Materials and Methods

The Field experiment was carried out during 2014 at the Central Research Station, Odisha University of Agriculture and Technology, Bhubaneswar (20^0 26'N, 85^0 81'E, 25.9 m above mean sea level and about 64 km away of the Bay of Bengal), Odisha under the aegis of AICRP on Maize to find out the soil test crop response through fertilizer prescription equations developed assisted SSNM and RDF practices for achieving targeted yield of hybrid maize under precision agriculture. The station comes under the East and South Eastern Coastal Plain Agro-climatic Zone of Odisha and covered under Hot Sub-humid Semi-arid Eco-region with Coastal Alluvium (18-S-7CD2-5) Agro Ecological Region of the country. The place is characterized by warm and moist climate with hot and humid summer and mild winter. The average annual rainfall is 1502 mm of which more than 80% is generally received during the monsoon season (June - October). The average rainfall received during the crop growing period of experiment from July to October was 845.2 mm. The soil of the experimental field was loamy sand in texture, slightly acidic in reaction, low in Organic carbon (0.41%) and available nitrogen (216 kg/ha), medium in available phosphorus (27 kg/ha) and high in available potassium (342 kg/ha).The experiment was laid out in a split-split plot design. The two hybrids were Hishel and P3441, three nutrient management practices wereSSNM (140:41:77 N:P2O5:K2O kg/ha) based on target yield (65.0 q/ha), STCR(143:15:78) N:P2O5:K2O kg/ha) through fertilizer prescription equation target yield (65.0 q/ha) andRDF (120:60:60 kg N-P-K/ha).The crop was sown in the month of July during *kharif* 2014. One third of N and full dose of P and K were applied as basal dose at the time of sowing as urea, single superphosphate and muriate of potash and the remaining 2/3 dose of nitrogen was applied as top dressing in two equal splits, first top dressing at the time of knee high stage and second top dressing at the time of tassling stage of the crop. The Intercultural operations, irrigation and weed control measures were adopted whenever is necessary. Intercultural operations were also done two times during the crop season. The growth parameters were measured at the time of maturity stage and the yield and yield attributing character were recorded after harvesting of the crop. The quantity of nutrient required to achieve target yield was calculated by using the formulae for different technique.

The nutrient requirement is to achieve target yield through Site-Specific Nutrient Management(SSNM) was calculated by using the following formulae.

Where, T = Target yield (t ha^{-1})

EFR = Effective fertilizer rate (if the soil nutrient supply status is low, medium and high applied 20 per cent higher, same and 20 per cent lower than the estimated required quantity of nutrients, respectively).

The STCR equation developed by All India Coordinated Research Project (AICRP) on Soil Test Crop Response (STCR), Bengaluru was used in the study and is as follows:

$FN = 3.45\ T - 0.093\ SN\ (KMnO_4 - N)$

$FP_2O_5 = 2.00\ T - 0.31\ S\ P_2O_5\ (Olsen's - P_2O_5)$

$FK_2O = 1.04\ T - 0.046\ S\ K_2O\ (NH_4OAC - K_2O)$

Where,

T = Target yield (t ha^{-1})
FN= Nitrogen supplied through fertilizer in kg ha^{-1}
FP_2O_5 = Phosphorus supplied through fertilizer in kg ha^{-1}
FK_2O = Potassium supplied through fertilizer in kg ha^{-1} T= Target yield
S N, S P_2O_5, S K_2O = Initial soil test value for available N, P_2O_5 and K_2O (kg ha^{-1}), respectively.

Results and Discussion

Table 1: Effect of planting density and nutrient management practices on growth and yield attributing characters of hybrid maize during kharif season

Treatment	Plant height (cm)	Days to 50% tasseling	Days to 50% silking	Days to maturity	100 grain weight (g)	Stover yield (kg/ha)	Grain yield (kg/ha)
Hybrid							
Hishel	161.5	55.2	58.6	109.1	31.0	16874	5709
P 3441	144.4	53.9	56.9	106.3	31.6	19830	6101
CD (P=0.05)	6.9	1.0	0.5	1.8	NS	791.6	NS
Plant geometry							
60cmx20cm	154.1	54.1	57.4	107.6	30.8	17581	5669
50cmx20cm	151.8	55.0	58.1	107.8	31.8	19122	6140
CD (P=0.05)	NS	0.3	NS	NS	NS	1288.2	201.8
N, P and K (Kg ha^{-1})							
RDF(120:60:60)	145.3	54.1	57.4	107.6	30.4	15406	5249
STCR(143:15:78)	160.3	54.8	58.2	108.3	31.9	20244	6381
SSNM (140:41:77)	153.2	54.8	57.7	107.2	31.6	19406	6085
CD (P=0.05)	3.0	NS	NS	0.9	0.8	815.9	293.1

Effect of maize hybrids

Growth and yield attributes: The experimental data pertaining to growth and yield attributes of hybrid maize during *kharif* 2014 are presented in Table 1. It showed that the Hybrid Hishel significantly influenced the tallest plant height (161.5cm) as compared to hybrid P3441 (144.4 cm). Similarly, the higher days for tasseling (55.2), silking (58.6) and maturity (109.1) were observed in var. Hishel, whereas, lower days were recorded in var. P 3441 (53.9 days, 56.9 days, 106.3 days), respectively. Likewise, the hybrid P3441 measured the higher stover yield (19830 kg/ha) and maximum hundred grain weight (31.6 g) than Hishel (16874 kg/ha and 31.0 g) respectively. The difference between maize hybrids in relation to growth and yield attributes were also reported by Singh *et al.* (2006) [11], Ramchadrappa *et al.* (2007) [5] and Singh *et al.* (2014, 2016) [9].

The normal plant geometry (60 cmx20 cm) influenced taller plant height (154.1 cm) which was remained at par with high plant geometry (50 cmx 20 cm) i. e. 151.8cm. Similarly, higher days for tasseling (55.0), silking (58.1) and maturity (107. 8) were observed under high plant geometry (50 cmx 20 cm) than normal plant geometry (60 cmx20 cm)i. e. 54.1 days, 57.4 days, 107.6 days, respectively. The high row spacing (50 cmx 20 cm) measured the stover yield (19122 kg/ha) and recorded maximum hundred grain weight (31.8 g) as compared to normal row spacing (60 cm x20 cm) i. e. stover yield (17581 kg/ha) and showed minimum hundred grain weight (30.8 g). This might be due to higher plant row 50 cm spacing as compared to normal plant row spacing 60 cm. The plant geometry provides the opportunity for better growth and yield attributes. The findings are in conformity with the result of Sahoo and Chandrappa (2007) [6] and Singh *et al*. (2014) [10] and Singh *et al*. (2016) [9].

The experimental result pertaining to nutrient management practice on growth and yield attributes of hybrid maize in Table 1 revealed that, Soil Test Crop Response (STCR) significantly influenced the tallest plant height (160.3 cm) with higher days for tasseling (54.8), silking (58.2) and maturity (108. 3) as compared to SSNM (153.2 cm, 54.8 days, 57.7days, 107.2 days) and RDF (145.3 cm, 54.1 days, 57.4 days, 107.6 days), respectively. Increase input efficiency improved N, P, K supplying capacity of soil resulting in higher plant height because nitrogen is needed for the formation of chlorophyll, phosphorus for the synthesis of nucleic acids and similarly potassium is important for the growth and elongation probably due to its function as an osmoticum and may react synergistically with indole acetic acid which is responsible for growth and development. Similarly, STCR practice significantly measured the longest stover yield (20244 kg/ha) and recorded maximum hundred grain weight (31.9 g) which was significantly superior to SSNM (19406 kg/ha and 31.6 g) and RDF (15406 kg/ha and 30.4 g), respectively. The findings are in conformity with the result of Sahoo and Chandrappa (2007 [6] and Singh *et al.* (2014) [10] and Singh *et al.* (2016) [9].

Yield: The perusal of data related to yield of hybrid maize during *kharif* 2014 showed that among the two hybrids, higher plant population 86.7 thousand /ha was recorded in var. Hishel while, lower plant population 86.4 thousand /ha was noted under P 3441. Similarly, hybrid P3441 significantly produced maximum grain yield (6101 kg/ha) and stover yield (19830 kg/ha) which was 6.8% and 17.5 higher over Hishel (5709 kg/ha, 16874 kg/ha), respectively. Better vegetative and reproductive growth of maize hybrids contributed towards higher dry matter accumulation resulting in significantly higher grain and stover yield with maize hybrid P 3441.The variation in yield between the two hybrids might be due to genetical potential variation of the hybrid (Singh *et al.* 2014) [10]. Likewise, among the two plant geometry, the high plant geometry (50 cm x20cm) significantly produced maximum grain yield (6140 kg/ha) and stover yield (19122 kg/ha) as compared to normal plant geometry (60 cmx20 cm) i.e. 5669 kg/ha and 17581 kg/ha, respectively. The increase grain yield and stover yield of high row spacing 50 cm x20 cm was 8.3% and 8.8% higher over normal row spacing 60 cmx20 cm. The higher grain and stover yield of maize was mainly due to better translocation of photosynthates from source to sink and higher growth attributing characters. The higher grain yield of P3441 could be mainly attributed to higher grain weight per cob over Hishel.

Similarly, among the three nutrient management practices, Soil Test Crop Response (STCR) significantly resulted in highest grain yield (6381 kg/ha) and stover yield (20244

kg/ha) over RDF (5249 kg/ha and 15406 kg/ha), but it remained at par with SSNM (6085 kg/ha and 19406 kg/ha) respectively. The increase in grain yield and stover yield of STCR was 21.6% and 31.4% higher over RDF and 4.9% and 4.3% as compared to SSNM, respectively. It indicates that the recommendation domain of maize owing to ever declining soil health specially for some of the macro nutrients, increasing level of nutrients probably exerted a positive effect on the development of source and sink strength of the plant which ultimately resulted in higher yield. These findings are in conformity with the findings of Parthipan *et al.* (2003), Sahoo *et al.* (2007) [6], Singh *et al.* (2013) and Singh *et al.* (2016) [9]. Values of plant height and yield attributes were recorded under recommended dose of fertilizers which might be due to low availability of nutrients to the crop for development of height and yield attributes.

Conclusion

On the basis of result, it may be concluded that cultivation of maize hybrids during *Kharif* season responded to high density planting (50 x 20) cm^2 with 8.3% higher yield over normal density (60 x 20) cm^2. Among various nutrient management practices (RDF, STCR & SSNM), STCR exhibited significantly superior (21.6%) higher yield over RDF but, it was at par with SSNM and RDF. Hence, cultivation of maize hybrids with high plant geometry (50 cm x20 cm) along with soil test crop response (STCR) management practice was found to be most effective and suitable technique for enhancing maize productivity at Odisha condition during *Kharif* season.

References

1. DACNET. Directorate of Economics and Statistics. DAC, Ministry of Agriculture, Goverment of India, New Delhi. http://eands.dacnet.nic.in/StateData_13-14Year.htm. 2015.
2. ICAR-IIMR. Annual Report, ICAR- Indian Institute of Maize Research, New Delhi, 2016-17, 3.
3. Jat ML, Saharawat YS, Majumdar L, Gupta R. Addressing climate change effects and meeting maize demand in Asia (In) 11th Asian Maize Conference, Nanning, China, 2011, 370-372.
4. Jat ML, Satyanarayan T, Majumdar K, Parihar CM, Jat SL, Tetarwal JP *et al*. Fertilizer best management practices for maize systems. Indian Journal of Fertilizers. 2013; **9**(4):80-94.
5. Ramachandrappa BK, Nanjappa HV, Soumya TM. Sensory parameters, nutrient contents, yield and yield attributes of baby corn varieties as influenced by stages of harvest. Mysore Journal of Agricultural Sciences. 2007; 41(1):1-7.
6. Sahoo SC, Mahapatra PK. Response of sweet corn (*Zea mays* L.) to plant population and fertility levels during rabi season. Indian Journal of Agricultural Sciences. 2007; 7(7):711-714.
7. Sangakkara UR, Bandaranayake PSRD, Gajanayake JN, Stamp P. Plant population and yield of rainfed maize grown in wet and dry seasons of the tropics. Maydica. 2004; 49:83-88.
8. Sangoi L. Understanding plant density effects on maize growth and development: an important issue to maximize grain yield. Ciencia Rural. 2001; 31:159-168.
9. Singh MV. Effect of planting density and nutrient management on performance of Rabi hybrid maize. Annals of Plant and Soil Research. 2016; 18(3):275-279.
10. Singh MV, Prakash V, Singh B, Shahi HN. Response of maize hybrids to integrated nutrient management. Haryana Journal of Agronomy. 2014; 30(1):65-69.
11. Singh D, Singh SM. Response of early maturing maize (*Zea mays*) hybrids to applied nutrients and plant densities under agro-climatic conditions of Udaipur in Rajsthan. Indian Journal of Agronomy. 2006; 76:372-374.
12. Shankar MA, Umesh MR. Site Specific Nutrient Management (SSNM): An approach and methodology for achieving crop productivity in dryland Alfisols of Karnatak. In:Tec. Bult. Univ. Agric. Sci., Bangalore, 2008.
13. Troug E. Fifty years of Soil Testing. In: 7th Inl. Cong. SoilSc. Wisconsin, USA, 1960, 36-45.