# Yield attributes and yield of (hybrid) Maize (Zea mays L.) as influenced by plant densities and level of nitrogen

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***ABSTRACT:*** ***The field experiment were conducted in two seasons (summer and Kharif, 2012) at Annamalai University Experimental Farm, Annamalainagar in search of an yield improvement in maize hybrid through plant densities and level of nitrogen. Split plot designs with two factors are used. The experiments consisted of twelve treatments and were replicated thrice. The results showed that plant spacing of 60×20 cm and N level of 225 kg N ha$^{-1}$ recorded maximum values for yield components viz., cob length, cob diameter, grain number cob$^{-1}$ and hundred grain weight on maize. The control ($D_2N_0$) treatment recorded minimum values of the growth and yield components of maize. The benefit cost ratio was also higher in plant spacing of 60×20 cm and N level of 225 kg N ha$^{-1}$.***

***Keywords:*** ***Maize, N level, plant density, yield and yield attributes.***

## INTRODUCTION

Maize (*Zea mays* L.) is the third important cereal after wheat and rice in cultivation. Among, agronomic crops, maize is the third most versatile one as it has great nutritive value with 72% starch, 10% protein, 4.8% oil, 8.5% fiber, 3% sugar and 17% ash. It is relatively as short duration cereal crop capable of utilizing the solar energy more efficiently. It attains great priority in the area of high altitude where chilling conditions and snow fall limits growing period of other cereals. Increasing maize production became one of the most important goals in Indian agriculture to face human and animal demends. This could be achieved through following the proper management systems which could lead to maximize its productivity.

Plant density is an important factor in crop production that can significantly affect the grain yield. One of the main tasks in maize production is finding the optimum plant density where the negative effects of competition between plants will not result in significant yield reduction. Optimum plant density ensure the plants to grow properly both in the aerial and underground parts through different utilization of solar radiation and nutrition. Higher plant density than optimum level, resulted in severe competition among plants for light above ground or for nutrients below the ground, consequently the plant growth slows down and the grain yield decreases. Modern hybrids are highly dependent upon plant density, because they can produce the maximum yield only in a small range due to the high number of plants. Plant density has s decisive effect on yield with increasing plant density, the yield per plant decreases, but the yield per unit area increases until the optimal number of plants ha$^{-1}$ is reached (Sarvari, 2005).

Nitrogen fertilizer is a major nutrient for maize production. Nitrogen is a component of protein and nucleic acids and its deficiency reduce the growth and yield. Ideal N management optimizes grain yield, farm profit and N use efficiency, while it minimizes the potential for leaching of N beyond the crop rooting zone. Ali *et al*., (2002) concluded that N had a significant effect on grain yield, nitrogen uptake at tasseling, maturity and in grain. Mohammadian *et al*., (2010) showed that yield reduction in corn due to nitrogen deficiency is higher than of other elements deficiency. There are many reasons of low productivity. Among them plant density and mismanagement of plant nutrition is considered to be the major one. Hence there is need to improve this major component of the production technology for getting higher maize production of better quality. With this objectives the experiment was to conducted study the effect of different plant density and various N levels on yield and yield components of maize.

## MATERIALS AND METHODS

### Experiment location

Field experiments were conducted at the Experimental Farm, Department of Agronomy, Annamalai University during 2011-2012 to study the "Yield attributes and yield of Maize hybrid (*Zea mays* L.) as influenced by plant densities and level of nitrogen". The study was conducted in two seasons during Rabi (January-April, 2012) and Kharif (June-September, 2012). The experimental farm is geographically situated at 11°24' N latitude and 79°44' E longitude at an altitude of + 5.79 m above mean sea level. The weather of experimental farm is moderately warm with hot summer. The maximum temperature of this locality ranges from 30.4 to 38.9°C with a mean of 35.06°C. The minimum temperature ranges from 22.7 to 28.3°C with a mean 25.12°C. The relative humidity ranges from 80 to 90 per cent with a mean of 85 per cent. The mean annual rainfall is 1500 mm. The soil type of the experimental field was moderately clay loam with pH of 7.2. The soil was low in available nitrogen (236.0 kg ha$^{-1}$), medium in available phosphorus (20.8 kg ha$^{-1}$) and high in available potassium (285.0 kg ha$^{-1}$).

### Experimental design and treatments

The experiment was conducted in split plot arrangements. Treatments were replicated thrice. The main plot treatments were *viz.*, (plant density) $D_1$-60×25 cm (66000 plants ha$^{-1}$) ,$D_2$- 60×20 cm (83000 plants ha$^{-1}$) , $D_3$ -60×30 cm (55000 plants ha$^{-1}$) Sub-plot treatments,$N_0$- 0 kg N ,$N_1$- 75 kg N ha$^{-1}$ ,$N_2$- 150 kg N ha$^{-1}$ and $N_3$- 225 kg N ha$^{-1}$ . The plot size was kept at 5m × 4m. Maize hybrid Pioneer 3052 was used in this experiment. The entire dose of phosphorus and potassium were applied basally. Half dose of nitrogen was applied at the time of sowing and the remaining half was applied when the crop was at knee high stage. Irrigation and all other agronomic practices were carried out uniformly throughout the growing season.

**Statistical analysis**

Data on yield components were collected using standard procedures and were analysed statistically by using ANOVA table. Critical difference of 5 per cent was employed to test the significance of treatments means.

## RESULTS AND DISCUSSION

### Growth attributes

### Cob length

There was significant interaction between plant density and nitrogen practices on the cob length of maize. The treatment of 60×20 cm spacing with 225 kg of nitrogen $ha^{-1}$ ($D_2N_3$) recorded the highest cob length of 25.66 cm and 26.40 cm during Summer and Kharif 2012, respectively. The least cob length was recorded in $D_2N_0$ (60×20 cm spacing with no fertilizer application) 13.60 cm and 14.40 cm during Summer and Kharif 2012, respectively. Gokmen *et al*., (2000) concluded that, increase in N levels also increased cob length.

### Grain number $cob^{-1}$

There was significant interaction between plant density and nitrogen practices on the grain number $cob^{-1}$of maize. The treatment of

**Table -1. Effect of plant density and N level on yield components of maize**

| Treatments | Yield components | | | |
|---|---|---|---|---|
| | Summer | | Kharif | |
| | Cob length | No.of grains $cob^{-1}$ | Cob length | No.of grains $cob^{-1}$ |
| Plant density | | | | |
| $D_1$ | 18.96 | 257.64 | 20.44 | 269.88 |
| $D_2$ | 20.03 | 280.03 | 21.06 | 279.72 |
| $D_3$ | 18.15 | 239.78 | 19.76 | 259.31 |
| S.Ed | 0.44 | 0.93 | 0.36 | 1.07 |
| CD(P=0.05) | 0.89 | 1.86 | 0.74 | 2.14 |
| Nitrogen level | | | | |
| $N_0$ | 15.30 | 197.11 | 16.01 | 212.66 |
| $N_1$ | 17.41 | 221.56 | 18.66 | 247.12 |
| $N_2$ | 20.89 | 287.22 | 22.51 | 296.06 |
| $N_3$ | 22.58 | 330.70 | 24.49 | 322.72 |
| S.Ed | 0.05 | 0.92 | 0.07 | 1.17 |
| CD(P=0.05) | 0.10 | 1.85 | 0.17 | 2.35 |
| D X N | | | | |
| S.Ed | 0.39 | 1.36 | 0.24 | 3.14 |
| CD(P=0.05) | 0.79 | 2.72 | 0.49 | 6.28 |
| N X D | | | | |
| S.Ed | 1.23 | 3.11 | 1.12 | 3.14 |
| CD(P=0.05) | 2.47 | 6.22 | 2.24 | 6.29 |

60×20 cm spacing and 225 kg of nitrogen $ha^{-1}$ ($D_2N_3$) recorded the highest grain numbers $cob^{-1}$ of 385.07 and 348.40 during Summer and Kharif seasons of 2012, respectively. The least grain numbers $cob^{-1}$ was recorded in $D_2N_0$ (no fertilizer application) 187.36 and 201.58 during Summer and Kharif seasons 2012, respectively. Younas *et al*., (2002) reported that high level of nitrogen enhanced the grain yield on account of increased number of grains $cob^{-1}$.

### Yield

### Grain yield

There was significant interaction between plant density and nitrogen practices on the grain yield of maize. The treatment of 60×20 cm spacing along with 225 kg of nitrogen $ha^{-1}$ ($D_2N_3$) recorded the highest grain yield of 6792 kg $ha^{-1}$during Summer, 2012 and 6918 kg $ha^{-1}$ during Kharif, 2012, respectively. The least grain yield was recorded in $D_2N_0$ (60×20 cm spacing with no fertilizer application) 3502 kg $ha^{-1}$ and 3342 kg $ha^{-1}$ during Summer and Kharif seasons of 2012, respectively. Mekdad (2015) reported that increase in yield as a result of increasing N fertilizer levels may be due to the importance of N as one of the macronutrient elements for plant nutrition and its role in increasing vegetative growth through enhancing leaf initiation, increment chlorophyll concentration in leaves which may reflected in improving photosynthesis process.

### Stover yield

There was significant interaction between plant density and nitrogen practices on the Stover yield of maize. The treatment of 60×20 cm spacing along with application of 225 kg of nitrogen $ha^{-1}$ ($D_2N_3$) recorded the highest Stover yield of 10480 kg $ha^{-1}$ and 10255 kg $ha^{-1}$ during Summer and Kharif seasons, 2012, respectively. The least Stover yield was recorded in $D_2N_0$ (60×20 cm spacing and no fertilizer application) 6003 kg $ha^{-1}$ and 8685 kg $ha^{-1}$ during Summer and Kharif seasons of 2012, respectively. It might be due to appropriate combination of plant density and inorganic nutrient source was found to enhance the efficiency of nutrients and ultimately increased the yield components. The results are in accordance with the findings of Srikanth *et al*. (2009) and Zamir *et al*. (2011).

**Table -2. Effect of plant density and N level on grain and stover yield of maize**

| Treatments | Yield (kg ha$^{-1}$) | | | |
|---|---|---|---|---|
| | Summer | | Kharif | |
| | Grain | Stover | Grain | Stover |
| Plant density | | | | |
| $D_1$ | 5630 | 8158 | 5702 | 9424 |
| $D_2$ | 5651 | 8456 | 5755 | 9530 |
| $D_3$ | 5586 | 7993 | 5747 | 9420 |
| S.Ed | 15.26 | 24.43 | 14.16 | 36.23 |
| CD(P=0.05) | 30.52 | 49.87 | 29.33 | 72.45 |
| Nitrogen level | | | | |
| $N_0$ | 3856 | 6549 | 3863 | 8824 |
| $N_1$ | 5755 | 7757 | 5804 | 9328 |
| $N_2$ | 6329 | 8936 | 6473 | 9776 |
| $N_3$ | 6529 | 9568 | 6666 | 9906 |
| S.Ed | 17.12 | 24.26 | 16.43 | 29.08 |
| CD(P=0.05) | 35.25 | 57.59 | 33.87 | 59.16 |
| D X N | | | | |
| S.Ed | 30.02 | 49.35 | 29.34 | 51.23 |
| CD(P=0.05) | 61.05 | 99.75 | 58.67 | 102.47 |
| N X D | | | | |
| S.Ed | 52.35 | 85.36 | 50.31 | 88.24 |
| CD(P=0.05) | 105.74 | 172.77 | 101.62 | 177.49 |

**Harvest index**

The highest harvest index was recorded in the treatment 0f 60×20 cm spacing along with application of 225 kg of nitrogen ha$^{-1}$ ($D_2N_3$) recorded the highest 39.28 and 40.57 during Summer and Kharif seasons, respectively. The treatment with $D_2N_0$ (60×20 cm spacing and no fertilizer application) registered the lowest harvest index of 34.01 and 27.78 during Summer and Kharif seasons, respectively.

**ECONOMICS**

The highest gross return (Rs. 44989 and Rs. 54448 during Summer and Kharif, 2012, respectively) and net return (Rs. 30300 and Rs. 30960 during Summer, and Kharif, 2012, respectively) were obtained under the treatment combination $D_2N_3$ (60×20 cm 83000 plants ha$^{-1}$+ 225 kg nitrogen). The least gross return (Rs. 28589 and Rs. 24934 during Summer and Kharif, 2012, respectively) and net return (Rs. 2468 and Rs. 10469 during summer and Kharif, 2012, respectively) were obtained under the treatment combination, $D_2N_0$ (60×20 cm spacing and no fertilizer application).

The highest return rupee$^{-1}$ invested was obtained under $D_2N_3$ (60×20 cm 83000 plants ha$^{-1}$ + 225 kg nitrogen) *viz.*, Rs.2.88 and Rs. 2.99 during Summer and Kharif, 2012, respectively. The least return rupee$^{-1}$ invested was obtained under $D_2N_0$ (60×20 cm spacing and no fertilizer application) *viz.*, Rs. 1.09 and 1.00 during Summer and Kharif, 2012, respectively.

**CONCLUSION**

From the results of the study it is concluded that, application of nitrogen at the rate of 225 kg ha$^{-1}$ and plant density of 60×20 cm produced maximum yield and yield components. Hence, it is suggested that (60×20 cm 83000 plants ha$^{-1}$ + 225 kg nitrogen ha$^{-1}$) could help to increase maize yield.

**Table – 3. Effect of plant density and N level on economics of maize**

| Treatments | *Summer* | | *Kharif* | |
|---|---|---|---|---|
| | Net income (Rs.ha$^{-1}$) | Return rupee$^{-1}$ invested | Net income (Rs.ha$^{-1}$) | Return rupee$^{-1}$ invested |
| $D_1N_0$ | 30300 | 2.88 | 30960 | 2.99 |
| $D_1N_1$ | 29060 | 2.82 | 30060 | 2.94 |
| $D_1N_2$ | 28033 | 2.84 | 29246 | 2.89 |
| $D_1N_3$ | 27448 | 2.79 | 28542 | 2.86 |
| $D_2N_0$ | 21939 | 2.56 | 26236 | 2.45 |
| $D_2N_1$ | 20191 | 2.51 | 21674 | 2.44 |
| $D_2N_2$ | 19546 | 2.46 | 20017 | 2.43 |
| $D_2N_3$ | 19490 | 2.41 | 19887 | 2.41 |
| $D_3N_0$ | 19058 | 2.39 | 19740 | 2.19 |
| $D_3N_1$ | 18973 | 2.29 | 18933 | 1.93 |
| $D_3N_2$ | 9351 | 1.35 | 12803 | 1.72 |
| $D_3N_3$ | 2468 | 1.09 | 10469 | 1.00 |

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