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# Influence of different planting densities and nitrogen levels for accomplishing optimum growth and yields in maize (*Zea mays* L.) in India

**Nawabpet Prudhvi and Dr. Chandra Mohan Mehta**

**Nawabpet Prudhvi**
M.Sc. Agronomy, Lovely Professional University, Phagwara, Punjab, India

**Dr. Chandra Mohan Mehta**
Associate Professor Agronomy, Lovely Professional University, Phagwara, Punjab, India

**Corresponding Author:**
**Nawabpet Prudhvi**
M.Sc. Agronomy, Lovely Professional University, Phagwara, Punjab, India

## Abstract
Maize is one of the important cereal crop which is grown around the globe because of its wider adaptability to different climatic conditions and especially can be grown in countries with warm climate and adequate moisture content and even in temperate and sub humid and humid regions as this crop can with stand many adverse climatic conditions and ability to sustain even in drought regions in northern plain regions this crop can be cultivated in all three seasons i.e., kharif, Rabi, spring round the year maize plant shows rapid and quick growth in all the stages of crop *viz*., planting – emergence-tasseling-Silking-physiological maturity hence requires higher amounts of nutrient to get optimum yields. Hence planting densities and nitrogen requirements plays a crucial role in on its growth and yields, so the investigations on plant densities and nitrogen requirement of the maize crop have much importance so as to know which treatment yields optimum returns to farmers and are also viable for farmers in cultivation process.

**Keywords:** Influence, planting, densities, accomplishing, *Zea mays* L.

## Introduction
Maize which is scientifically known as *Zea mays* also popular as "queen of cereal" crops as it is the most flexible crops to cultivate and to make it more responsive under different agro-climate conditions. It also has the maximum genetic yield potential among the cereals. It is considered as the global crop and is widely cultivated as cereal grain that was domesticated variant of teosinte in Central America. In India, maize is grown all year round, for various purposes, such as cereal, fodder, cobs, maize, baby maize and pop maize. In India, Rajasthan, Maharashtra, Bihar, Uttar-Pradesh and Madhya Pradesh are mainly cultivated for corn. *Zea mays* indurate or flint corn is the major variety grown in India. Maize is a large, determinate annual C4 plant, which varies in height between 1-4 metres, producing large, narrow and opposite leaves and alternately bearing along a solid stem length. Few of the peculiar characters of maize are, it has all types of roots i.e., seminal roots, adventitious roots and prop or brace roots. maize inflorescences contain both male and female flowers, or hermaphrodite flowers.

Some biotic and abiotic factors have a major impact on maize production; however, variations in plant density are more affected than others (Vega *et al*., 2001) [27] maize crop varies in plant density responses (Luque *et al*., 2006) [11] Agronomic practices like planting density is recommended for obtaining higher yield of maize. (Abuzar *et al*., 2011) [1] But the use of high population increases interplant competition for light, water and nutrients, which may be detrimental to final yield because it stimulates apical dominance, induces barrenness, and ultimately decreases the number of ears produced per plant and kernels set per ear (Sangoi, 2001) [19].

Nitrogen is one of the primary nutrient present abundantly on the earth surface mostly in gaseous form and a little amount in elemental form that may utilized for plants. It plays a vital role in crops life cycle majorly in maintaining crop greenness by improving chlorophyll content, protein percentage in plants, it also increasing the economic produce and also helps in achieving better yields. A big advancement can be made with Maize in terms of rapid development and productivity improvements, In addition, increase in the quality of the nitrogen usage. Due to higher mean values for yield attributes and longer grain filling periods, Kumar and Singh (1999) [10] have recorded greater maize yield. Maize must be planted using multiple spacing, guaranteeing the efficient intake of nutrients and the minimum reciprocal rivalry over shading and interplant competition, along with the most suitable fertilizer dose to maximize the yield capacity of the fertilizer. Nitrogen requirement of maize varies with soil types, climatic conditions, genotypes and different agronomic management practices in the following review we studied about the effect of most important agronomic practices like different levels of nitrogen application and also different planting densities on the growth and yield of maize crop. Here we see the how these two factors affect the different stages and parameters of maize growth and development one by one in brief.

**Need for nitrogen application in maize**

Nitrogen occupies an outstanding place in maize metabolism system. All vital processes in plants are associated with protein, of which nitrogen is a major constituent. In order to obtain higher crop production, application of nitrogen is crucial and inevitable. Nitrogen assumes a pivot role in maize cultivation by enhancing the crop yield and also upgrades the quality of corn. Optimum application of Nitrogen increases photosynthetic function, leaf area, green colour of leaf by increasing chlorophyll content in addition to net assimilation rate. The leaf size, maximum leaf area (LA) and total biomass of plants are a contributing factors of higher yields in maize. Since in past many years the usage of nitrogenous fertilizers helped in achieving higher yield in maize globally, with the optimum use of N along with timely and proper management practices have shown better results as it contributes for the vigorous growth and developmental process of the maize crop.

**Effect of different planting densities on growth parameters of maize**

Maize is crop where we see a vigorous growth in very less time to measure the growth of any crop we consider various parameters like initial plant population which reflects the germination ability of seeds, plant height, plant fresh weight, dry weight, no. of leaves, day for 50% tasseling and silking and so on are considered at various growth stages of crop at regular intervals will together constitute the growth aspects. Plant population has various effect on each of these parameters as the crop faces competition for nutrients, light, carbon di oxide and moisture content in soil.

Maximum crop growth rate (17.39 g/m2/day) and net assimilation rate (6.27 g/m2/day) was recorded in bed seed methods (Tanveer *et al*. 2014) [24] In comparison with crane sowing and in flat seed methods less values were observed. It was observed that growing attributes of maize were substantially higher than those of narrower rows with a wider range distance (Sachan and Gangawar, 1996) [17]. 'Pro Agro4640', a maize hybrid variety performance was significantly higher than in the higher plant densities (83333 plants ha-1) at a lower plant densities (111111 plants ha-1) (Chandankar *et al*. 2005) [6]. Height of plant and leaf area increased linearly with a rise in distances between 60 cm x 10 cm and 60 cm x 20 cm and 60 cm x 30 cm. (Muniswamy *et al*. 2007) [18]. For 100 000 plants ha-1 (60 cm /16.6 cm) above 50000 (60 cm x 33.3 cm) and 75 000 plants ha-1 dry matter accumulation was substantially the highest among the 100 000 plant population (60 cm x 22.2 cm). (Singh and Tajbaksh, 1986). Production of dry matter in the 90s and 120s DAS has decreased significantly from 111111 to 55556 Ha-1 plants on silty loam soils (Singh *et al*. 1997).in most of the cases we can observe that higher dry matter production plant can be achieved in plots where lower planting densities are seen like 60x25 cm when compared to that of 60x20cm (Singh and Singh, 2006) [21]. of 60 cm x 30 cm recorded significantly superior results to 60 cm x 20 cm in leaf area, and total dry matter production per plant of maize and we can also observe that the higher accumulation of dry matter at higher densities of planting may be because of more number of plants per unit area of land (Suryavanshi *et al*. 2009). Maize increased slowly to 60 DAS, then quickly from 90 DAS to harvest, due to rising temperatures for growth and production, resulting in an increase in the accumulation of dry matter (Nandal and Agarwal, 1991) [13]. We can also observe a trend of increase in barren plants with an increased plant population was also reported by Krishnamurthy *et al*. (1974) [9], Roy and Singh (1986) [16], Sahoo and Mahapatra (2007) [18].

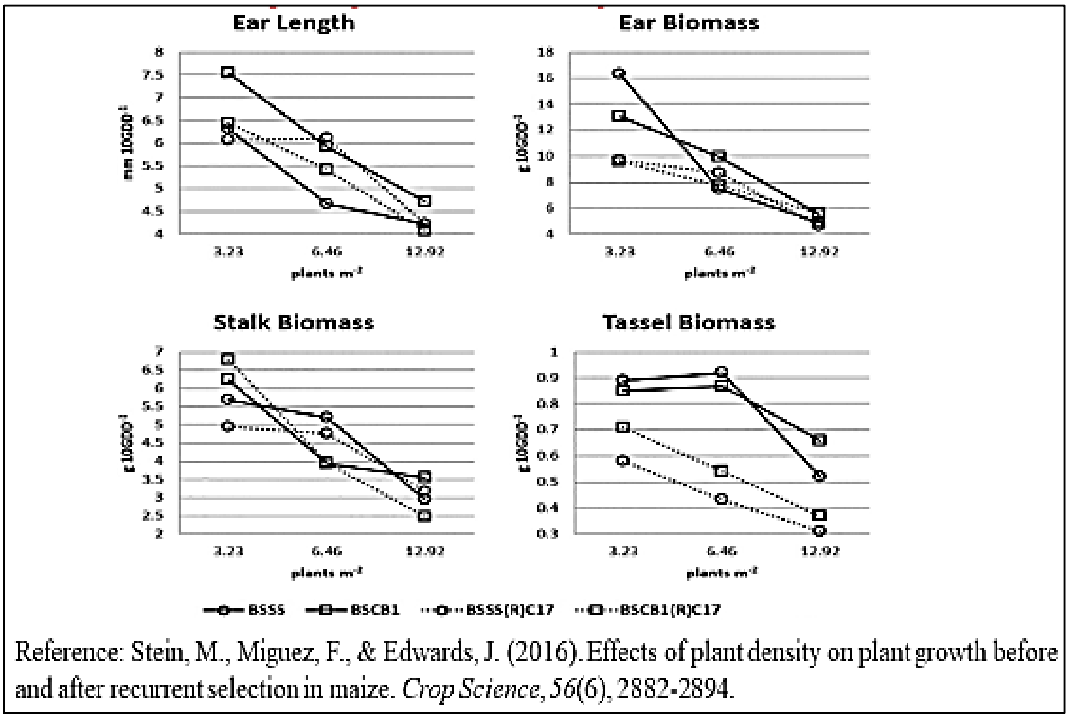


**Fig 1:** Effect of planting densities on different Oarameters of maize

**Effect of different planting densities on yield parameters of maize**

Maize sown by bed planting method are shown increase of 5.2% of grain yield and 6.8% of increase in stover yield as compared to the flat sown crop (Randhawa, 2004) [15]. planting one row per bed (67.5 cm x 15 cm) of Buland variety of maize produced significantly increase in grain yield as compared to flat sown crop with the earthing up in month of February is resulted in improved grain yield over ridge sown crop (Anonymous 2004). On the other hand, (Jat *et al* 2005) observed dropped yield of maize grown in ridges (14.5 q ha-1) as compared to crop grown by flat sowing method or when the ridges were formed only after the first inter-culture (15.3 q ha-1).we can observe supreme grain yield of winter maize with the planting density of 110000 plants $ha^{-1}$ joined with 240 kg N $ha^{-1}$ (Kumar and Bangarwa, 1997) [10] and highest grain yield was achieved from from the combination of 88888 plants ha-1 (Tyagi *et al*. 1998) [25]. while a considerable improvement in the yield of grain and stover of spring maize, on sandy loam soils by increasing the plant density from 65000 to 85000 plants Ha-1. (Verma and Singh, 1976) [28] and an increase of the crop population from 60,000 to 80,000 plants ha-1 has not significantly influenced the yield of pop maize cv. T 17 (Roy and Singh,1986) [16] with comparison to that higher maize planting density (99999 plants ha-1) showed considerably more grain than 6666 and 3333 plants ha-1 planted densities (Babu and Mitra, 1989) [3]. We can also see an increment of the grain yield of kharif maize with intra row spacing of 25 cm with compare to the intra row spacing of 20 and 15 cm (Mali and Singh (1989) and increased corn yield with an increasing intra-row spacing of 30 cm, significantly higher than 22,5 and 15 cm intra row spacing (Monga and Gautam, 1970) [12]. maximum seed yield of maize (African Tall) is observed with the spacing of 75 cm x 30 cm (44444 plants ha-1) over 75 cm x 20 cm (66666 plants ha-1), 60 cm x 45 cm (37037 plants ha-1), and 60 cm x 30 cm (55555 plants ha-1) plant spacings. (Khot and Umrani 1992) [8].

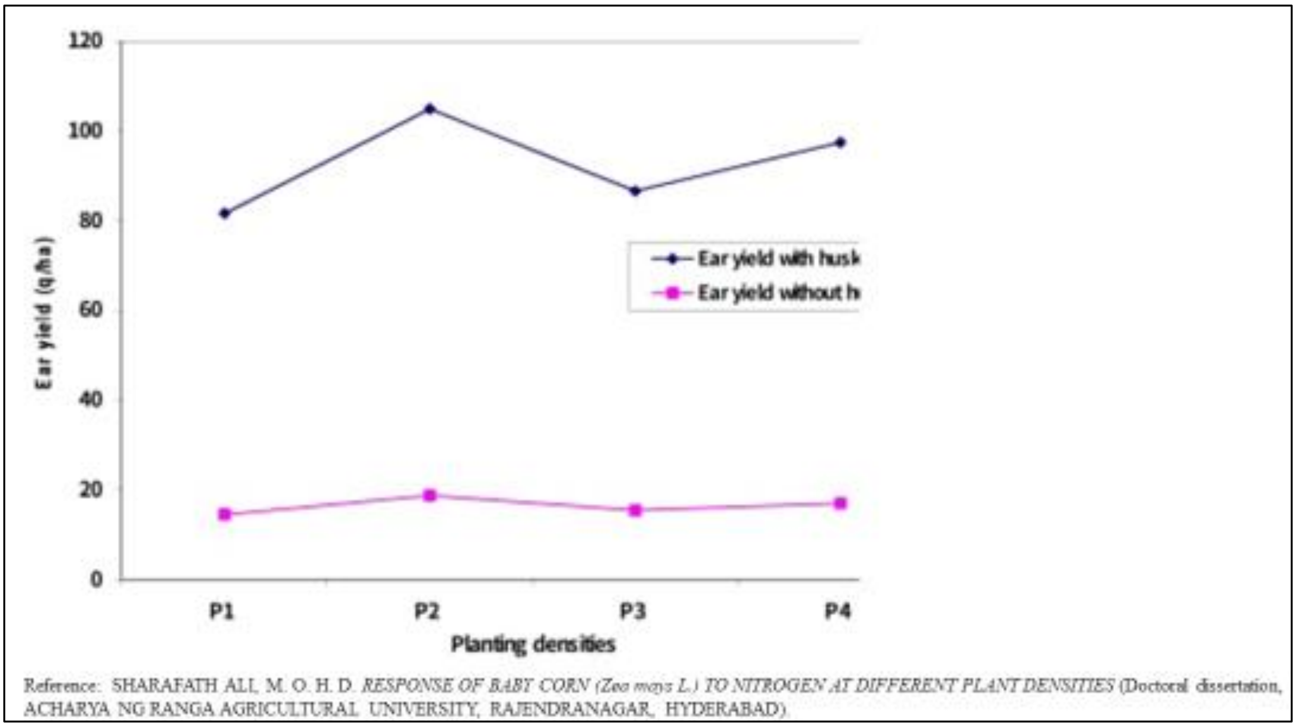


**Fig 2:** Effect of planting densities on ear yield of maize

**Effect of different nitrogen levels on growth parameters of maize**

Maximum plant height recorded at 240 kg N ha-1 which was at par with 160 and 200 kg N ha-1 from 60 DAS to harvest. cob length shows a significant increase with increasing nitrogen levels at each planting density and the supreme cob length (20.7 cm) was achieved at minimum planting density of 66666 plants ha-1 which is significantly greater than other two higher planting densities at 240 kg N ha-1. (Zakkam, M. 2011) [29]. Growth parameters *viz*., plant height, dry matter of maize increased significantly with relative increase in levels of nitrogen from 0 to 60 kg N ha-1 (Vadivel *et al*. 2001) [26] and we can also see a parallel increase in various growth parameters *viz*., plant height, bio mass of plant and leaf area of maize with the increase in nitrogen level from 0 to 150 kg N ha-1 according to Prasad *et al*. (1987) [14] the same can be observed in sandy and sandy loam (Nandal and Agarwal, 1991) [13] and sandy clay loamy soils too. (Vadivel *et al*. 2001) [26].

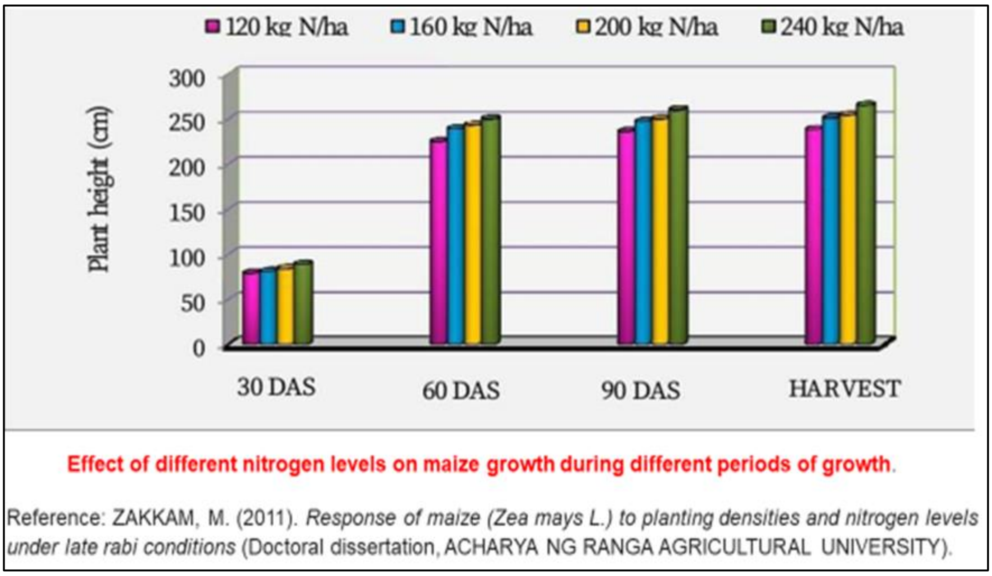


**Fig 3:** Effect of different nitrogen lavels on Maize growth during different periods of growth

**Effect of different nitrogen levels on yield parameters of maize:**

In maize the nitrogen levels have a significance effect on the different yield parameters like cob length, cobs per plant, no of grains per cob, test weight, seed index, grain yields etc. where a clear variation can be observed in this crop here we can observe how each of the above mentioned parameter are effected or responded for the varying nitrogen levels and optimum levels are see at what levels of nitrogen

In maize higher no of cobs per plant, number of grains per cob were obtained by applying 125% RDF (Singh and singh 2006) [21] and with the application of 90 kg of N ha-1 decreased the time of the ears plant-1, grain weight ear-1, 100 grain weight and maize ear length substantially to 50 percent and increased the time for plant$^{-1}$, grain ear$^{-1}$, over0, 30 and 60, 90kg of maize N ha-1 (Prasad and Singh 1990) [14], Where AS the maximum number of grains per cob and cobs per plant were achieved with 180kg N ha$^{-1}$in comparison with the 0 and 60 kg N ha$^{-1}$ the maximum test weight and harvest index is observed with application of 150 kgN ha$^{-1}$when compared with that of 50 and 100 kg N ha$^{-1}$(Banerjee and Singh 2003) [4] and also with the application of 125%RDF (Singh and singh 2006) [21] and also on par with 180 Kg N ha$^{-1}$ (Tank *et al*. 2006) [23] the yield achieved by application of more higher doses of nitrogen like 240kg N ha-1 and 300 kg N ha-1 were almost similar when the parameters like cobs per plant, number of grains per plant were compared and was also same or on par with the grain weight (Bharathi *et al*. 2010) [4].

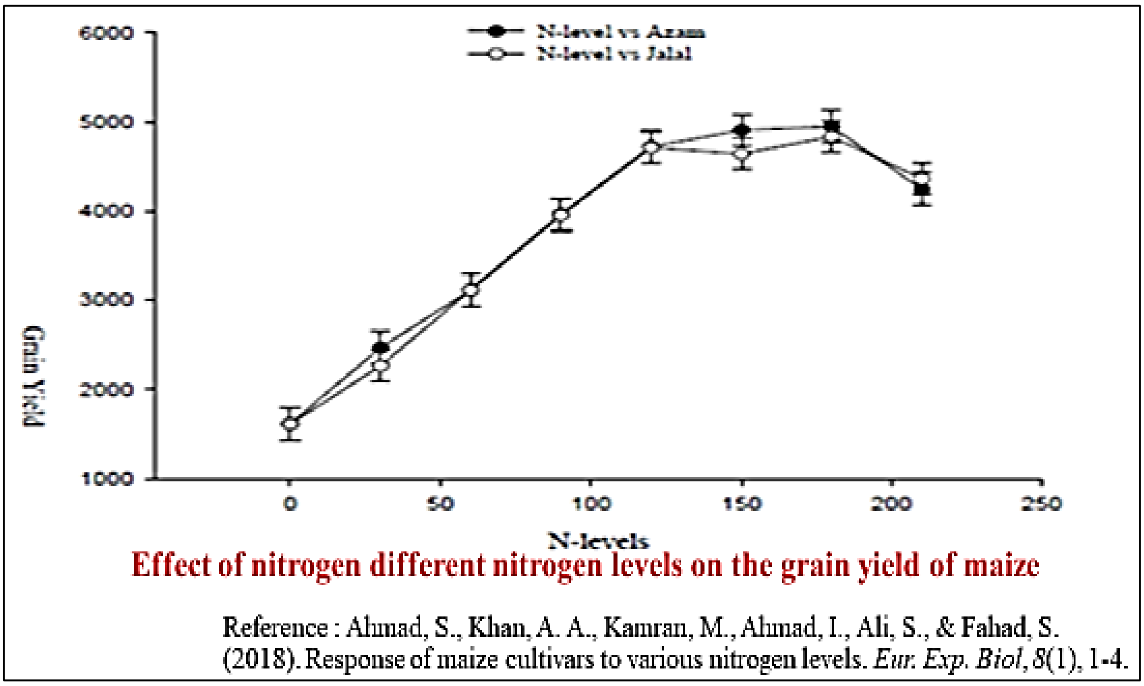


**Fig 4:** Effect of different nitrogen lavels on the grain yield of Maize

**Conclusion**

At a lower plant density of 66666 plants, maize responds positively with higher dry matter per plant, yield attributes were significantly lower with higher planting density of 133333 plants ha-1 compared to that of lower planting density. A notable improvement in yield was observed with low density of 66666 plants ha-1 over 88888 plants ha-1 which was however, on a par with that of higher planting density of 133333 plants ha-1With an increase in level of nitrogen from 120 to 240 kg ha-1 both the growth and yield attributes increased and the highest growth and yield was seen with the application of 240 kg N ha-1 (ZAKKAM, M. 2011) [29]. Maize that was grown on raised beds with application of 150 kg N ha-1 records higher productivity per unit land. With the application of 150 kg N ha-1 records significantly optimum grain yield in comparison with 0, 90 and 120 kg N ha-1. The quality parameters were not influenced significantly by different planting methods however; application of 180 kg N ha -1 recorded higher protein content and total minerals but showed notable reduction in the total sugars as compared to all other N levels except 150 kg N ha-1. (Kaur, A. 2016) [7]. Population density of 1,11,111 plants ha-1 with application of 160 kg N ha-1 gave highest yield and sustainable net returns

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