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# Optimizing Nitrogen Level to Improve Growth and Grain Yield of Spring Planted Irrigated Maize (Zea mays L.)

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## ABSTRACT

Nitrogen is one of the most important nutrients required by plants for vegetative growth and development. To investigate the effect of different levels of nitrogen on growth as well as grain yield of spring planted maize under irrigated conditions of central Punjab, a field trial was executed at Research Area of Maize and Millet Research Institute, Yousafwala Sahiwal, Punjab Pakistan, during 2009. The experimental design was randomized complete block design (RCBD) which was replicated thrice. Maize (cv. Sadaf) was sown in 75 cm apart rows, while plant to plant distance was maintained at 20 cm. Five levels of nitrogen (100, 120, 140, 160 and 180 kg per hectare) were employed as experimental treatments. Results revealed that all levels of nitrogen influenced the yield components as well as grain yield of maize. The highest grain yield (6.93 t ha-1) and biological yield (12.91 t ha-1) was given by nitrogen applied at the rate of 180 kg/ha. Similarly, the maximum number of grains per cob (471.3) and 1000-grain yield (328.4 g) was given by 180 kg/ha of nitrogen. The plant height, number of leaves per plant and stem diameter were also increased with increased level of applied nitrogen. Thus higher doses of nitrogen have the potential to give comparatively higher grain yield of spring planted irrigated maize.

**Keyword:** Corn, Cob, Fertilization, Growth and development, split application

## INTRODUCTION

Maize is an important member of Poaceae family and finds its use as food, feed and a variety of other industrial products [1-3]. In Pakistan, maize was cultivated on an area of about 1.1 million hectares with a production of 4.5 million tons during 2013-14 [4]. It is a matter of grave concern that maize average yield during 2013-14 was just over four tons per hectare which is much less as compared to other countries like USA. A score of seed, soil, agronomic and climate related factors result in a significant reduction in maize grain yield on per hectare basis [5-7]. But poor plant nutrition is the leading yield limiting factor which reduces grain yield and ultimately result in underutilization of precious resources [8-11]. In irrigated areas, currently available maize varieties have the potential to give a fairly high yield if proper fertilization is ensured. Almost all Pakistani soils are deficient in nitrogen and phosphorous, while over 90% of the soils are responsive to potassium application. But nitrogen is one of the most important nutrients among primary nutrients because nitrogen is directly involved in vegetative growth and development of crops. Nitrogen plays an important role in crop productivity [12] and its deficiency is one of the main yield limiting factors for cereal production [13]. Maize grain yield positively responses to applied nitrogen [14]. A linear relationship exists between nitrogen rates and days to tasseling, silking and maturity of maize crop [15]. Nitrogen deficiency is evident in the reduction of light interception by decreasing leaf area index which results lower grain yield [16]. The existing recommended dose of 200 kg ha-1 of nitrogen for hybrid maize production is low for Pakistani soils. However, grain yield of hybrid maize positively increases up to 300 kg ha-1 [17, 18]. Similarly, lower yield was founded in maize when the crop was subjected to high dose of nitrogen [19-21]. Therefore, judicious nitrogen management optimizes grain yield and nitrogen use efficiency while it also reduces the potential for leaching of nitrogen beyond the root zone [22, 23]. Quality characteristics in maize such as protein contents in seed were improved with optimum nitrogen level [24, 25]. Moreover low and high nitrogen dose have adverse effect on quality of maize [26]. Therefore, it was necessary to give optimum dose of nitrogen for improving quality in maize [27]. Similarly awareness of the need for improving nutrient use efficiency is immense; although nutrient use efficiency is easily misunderstand. Nitrogen optimization of non-hybrid conventional maize varieties is also of equal importance because a considerable area in Pakistan is under traditional maize varieties.

Keeping in view the above facts, the present study was conducted to evaluate the effect of different nitrogen levels on growth as well as grain yield of spring planted maize under irrigated conditions of Sahiwal, Punjab, Pakistan.

## MATERIALS AND METHODS

To investigate the effect different levels of nitrogen on the growth and yield of maize, a field trial was executed at

Research Area of Maize and Millet Research Institute Yousafwala Sahiwal, Punjab, Pakistan during 2009. The experimental design was randomized complete block design (RCBD) and was replicated thrice. Maize (cv. Sadaf) was subjected to 5 levels of nitrogen (100, 120, 140, 160 and 180 kg $ha^{-1}$). The seed rate was 100 kg $ha^{-1}$. The row to row and plant to plant distance was maintained at 75 cm and 20 cm respectively. All the phosphorous was applied at the time of sowing, while half of the nitrogen was applied at the time of sowing and remaining nitrogen was applied in two equal splits at the time of first and second irrigation. All agronomic practices were kept same and uniform for all experimental units throughout the growing season. All the data were recorded at 50% tasseling stage by following standard procedures and practices.

**Statistical Analysis:** Data collected were subjected to two-way ANOVA with the help of MSTAT-C computer software program [28] and least significant difference at 5% probability level was employed to compare treatment means [29].

## RESULTS AND DISCUSSION

Almost all yield components of maize were influenced by different levels of nitrogen and ultimately grain yield was also affected positively with the increase of nitrogen level. Plant height is an important indicator of plant growth and development and results revealed that different nitrogen levels had a significant effect on the plant height of maize as 180 kg/ha gave the highest plant height (168.5 cm) and it was followed by 160 kg/ha (163 cm) (Figure1). The significantly higher plant height given by 180 kg/ha was might be due to due to more vegetative growth and development triggered by nitrogen as compared to other treatments. These findings are in line with those of Hammad *et al*. [30], who reported more vegetative as well as reproductive growth with increasing amount of nutrients particularly nitrogen. Number of leaves per plant is a vital indicator of plant growth because leaves are the natural factories of photosynthesis and directly affect the growth and development of plants. Figure 2 reveals that the maximum number of leaves (12.1) was obtained in plots that were given nitrogen at the rate of 180 kg/ha, while the minimum number of leaves was recorded by 100 kg/ha. These results are in complete confirmation with those of Ali *et al*. [31], who reported more growth as a result of application of higher doses of nitrogen. Stem diameter indicates the stem thickness and is an important agronomic yield component of maize. The results showed that 180 kg/ha was instrumental in giving the highest stem diameter (4.9 cm) and it was followed by 160 kg/ha, whe the minimum stem diameter was observed in plots that were given nitrogen at the rate of 100 kg/ha (Figure 3). These results are in line with those of Hammad *et al*. [32], who observed more growth and development of maize crop with increasing the dose of nitrogen. The number of grains per cob and 1000-grain weight are vital indicators which determine the grain yield of maize. The results showed that the maximum number of grains per cob (471.3) (Figure 4 ) was recorded in plots that were supplied 180 kg/ha of nitrogen and it was followed by plots that were given nitrogen at the rate of 160 kg/ha. Similarly the highest 1000-grain weight (328.4 g) (Figure 5) was observed in plots which were given nitrogen at the rate of 180 kg/ha, while the minimum 1000-grain weight was given by nitrogen at the rate of 100 kg/ha. These finding are in line with Valero *et al.* [33], who reported more grain yield with increased rate of nitrogen applied. The grain yield of maize is the result of all yield components and results demonstrated that the maximum grain yield (6.93 t/ha) (Figure 6)was recorded in plots that were given by nitrogen applied at the rate of 180 kg/ha, while the minimum grain yield was given by nitrogen appled at the rate of 100 kg/ha. Similarly biological yield which shows the overall biomass produced by a crop was maximum in plots that were gie nitrogen at the rate of 180 kg/ha, while the minimum biological yield was recorded in plots that were supplied nitrogen at the rate of 100 kg/ha. These findings are in line with those of Inman *et al*. [34], who observed similar results with increasing the dose of nitrogen.

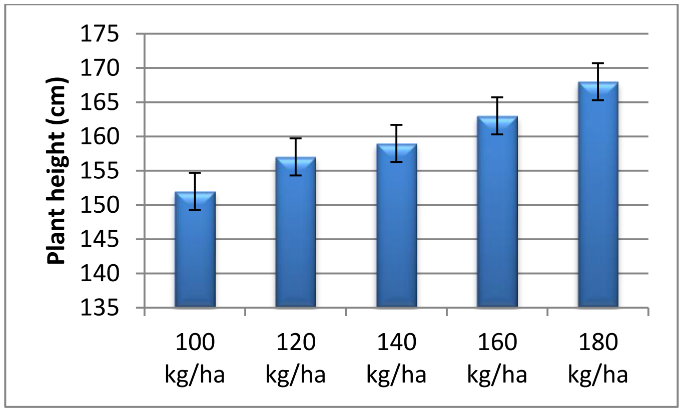


Fig. 1: Plant height (cm) of maize as influenced by different levels of nitrogen.

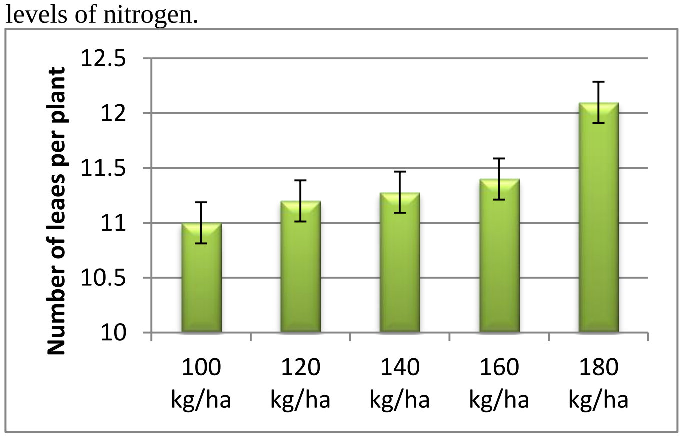


Fig. 2: Number of leaves per plant of maize as influenced by different levels of nitrogen.

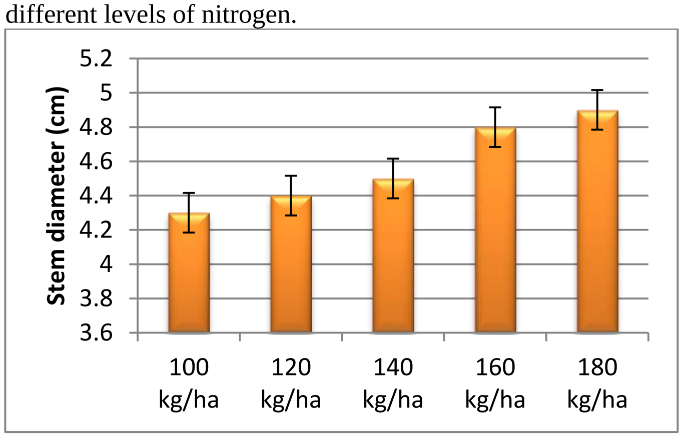


Fig. 3: Stem diameter (cm) of maize as influenced by different levels of nitrogen.

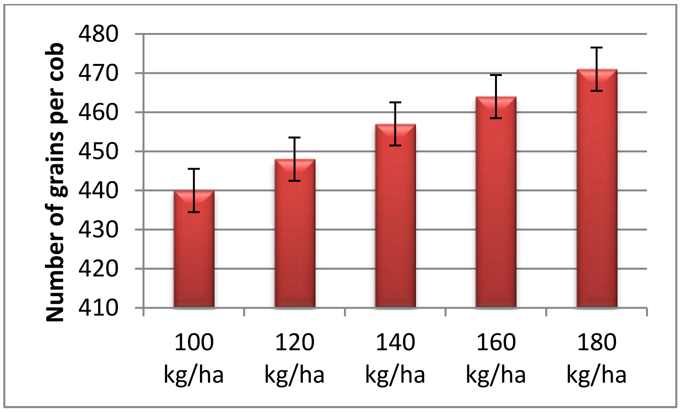

Fig. 4: Number of grains per cob of maize as influenced by different levels of nitrogen.

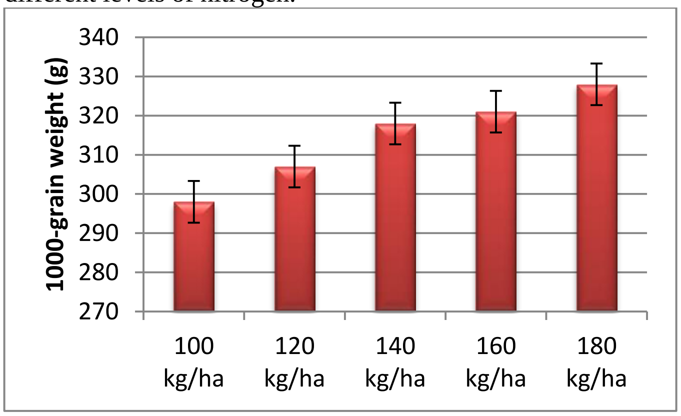

Fig. 5: 1000-grain weight (g) of maize as influenced by different levels of nitrogen.

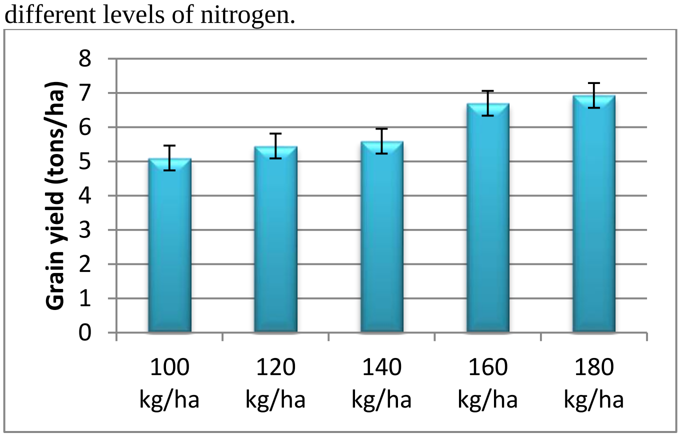

Fig. 6: Grain yield (tons ha-1) of maize as influenced by different levels of nitrogen.

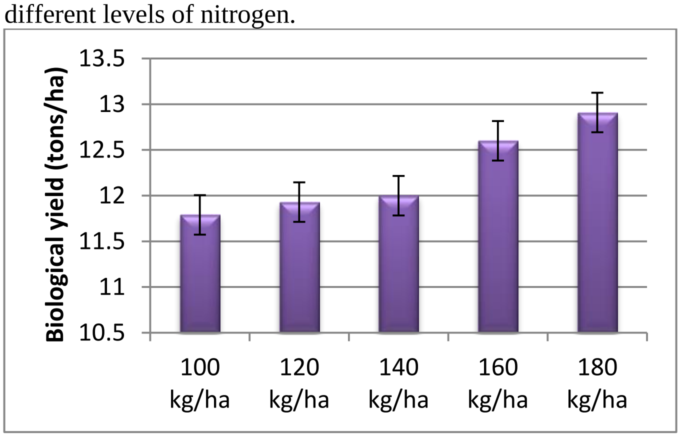

Fig. 7: Biological yield (tons ha-1) of maize as influenced by different levels of nitrogen.

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