Growth And Yield Response Of Maize To Nitrogen Application at Different Growth Stages

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Abstract
The present study was undertaken to determine a suitable growth stage of maize crop for the application of nitrogen fertilizer for maximising yield and yield components of maize under agro-climatic conditions of Faisalabad. Maximum grain yield (5.27 t ha\(^{-1}\)) along with highest harvest index (37.00%) per hectare was obtained for the crop raised by split N fertilization i.e. 1/3 at sowing + 1/3 at lst irrigation + 1/3 at flowering and lowest grain yield (2.93 t ha\(^{-1}\)) and harvest index (23.50%) in control.

Introduction
Maize (Zea mays L.) is one of the leading cereals in the world. It ranks third in the world production of cereals next to wheat and rice. It contributes a lot to Pakistan’s economy, as it is a source of food, feed and fodder. It provides a valuable raw material for the preparation of many industrial products like corn, oil, flakes, custard, glucose, jelly, energile etc. In view of its increasing importance as an attractive food and cash crop, its demand is enhancing day by day in the agro-based industries. Maize (Zea mays L.) occupies a key place in the existing cropping systems of the country because it is a short duration crop and provides good economic return to the growers. Maize crop has higher yield potential but its average yield in Pakistan is 1.45 t ha\(^{-1}\) which is far low as compared to that of other maize growing countries in the world (Anonymous, 1997). The yield is below the production potential of maize varieties under cultivation. Many factors are responsible for this low yield but astute use of fertilizers and potent cultivars to utilize the nutrient elements efficiently, are of major importance.

A valuable success has already been acquired as regards management practices and evolution of new varieties to realize a bumper crop, which cannot yield to their inherent capacity unless a suitable growth stage for the application of fertilizer is traced out. Undoubtedly, application of fertilizer has rather become popular among the farming community but its judicious and timely application is still a matter of grave concern, both for economic and industrial point of view. Moreover, a substantial amount (40-50%) of applied nitrogen is lost through volatilization, nitrification and leaching as nitrates (Gill, 1978) Thereby, the fertilizer nitrogen, being an expensive input, needs special attention in its use to assume maximum yield efficiency.

Materials and Methods
An experiment to determine the growth and yield response of maize to nitrogen application at different growth stages was conducted at the Agronomic Research Area, University of Agriculture, Faisalabad. The experiment was laid out in a randomized complete block design with four replications. Maize variety “Golden-95” was sown in the lst week of August. Net plot size was 3 x 5 m. Whole of the phosphorus (75 kg ha\(^{-1}\)) was applied as follows, F\(_0\) (control), F\(_1\) (150 kg N at stem elongation), F\(_2\) (1/2 dose of N at sowing + 1/2 dose of N at stem elongation), F\(_3\) (150 kg N at tasseling), F\(_4\) (1/2 dose of N at sowing + 1/2 dose of N at tasseling), F\(_5\) (150 kg N at silking), F\(_6\) (1/2 dose of N at sowing + 1/2 dose of N at silking) and F\(_7\) (1/3 dose of N at sowing + 1/3 dose of N at silking) and F\(_8\) (1/3 dose of N at sowing + 1/3 dose of N at silking + 1/3 at lst irrigation + 1/3 at flowering). The crop was sown in 60 cm apart single rows and plant to plant distance was maintained 22 cm by thinning. The crop was sown on a well prepared seed bed using seed rate of 30 kg ha\(^{-1}\). Following observations were recorded during the course of study, plant height (cm), number of cob bearing plant/plot, number of grains per cob, 1000-grain weight (g), grain yield (t ha\(^{-1}\)) and harvest index (%). Data collected on growth and yield parameters were analyzed statistically and differences among treatment means were compared by using least significant difference (LSD) test at 5 percent probability level (Steel and Torrie, 1984).

Results and Discussion
Maximum plant height was recorded (236.9 cm) from the plots where treatments F\(_7\) (1/3 at sowing + 1/3 at 1st irrigation + 1/3 at flowering) was applied. Minimum plant height was recorded (188.8 cm) in the treatment F\(_0\) (control). Treatments F\(_1\) (150 kg N at stem elongation) and F\(_8\) (150 kg N at silking) were statistically at par with each other. Treatments F\(_7\) (1/2 dose of N at sowing + 1/2 dose of N at stem elongation) and F\(_3\) (150 kg N at tasseling)
Table 1: Effect of different nitrogen levels on the growth and yield of maize at different growth stages

<table>
<thead>
<tr>
<th>Treatments</th>
<th>Plant height (cm)</th>
<th>Cob bearing Plant Plot</th>
<th>No. of grains cob⁻¹</th>
<th>1000-grain weight (g)</th>
<th>Grain yield t ha⁻¹ (%)</th>
<th>Harvest Index</th>
</tr>
</thead>
<tbody>
<tr>
<td>F₀ (0 Kg N)</td>
<td>188.8f</td>
<td>74.47d</td>
<td>262.9e</td>
<td>226.1d</td>
<td>2.932e</td>
<td>3.5f</td>
</tr>
<tr>
<td>F₁ (150 Kg N at stem elongation)</td>
<td>208.9d</td>
<td>90.30bc</td>
<td>374.9d</td>
<td>235.9c</td>
<td>3.600d</td>
<td>28.00de</td>
</tr>
<tr>
<td>F₂ (1/2 dose of N at sowing + 1/2 dose of N at stem elongation)</td>
<td>211.1e</td>
<td>94.43bc</td>
<td>379.7d</td>
<td>212.4e</td>
<td>3.750d</td>
<td>29.50cd</td>
</tr>
<tr>
<td>F₃ (150 Kg N at tasseling)</td>
<td>209.9e</td>
<td>86.10c</td>
<td>370.8d</td>
<td>229.8d</td>
<td>3.700d</td>
<td>27.00e</td>
</tr>
<tr>
<td>F₄ (1/2 dose of N at sowing + 1/2 dose of N at silking)</td>
<td>224.6c</td>
<td>100.1b</td>
<td>454.9c</td>
<td>235.8c</td>
<td>4.375bc</td>
<td>30.75c</td>
</tr>
<tr>
<td>F₅ (150 Kg N at silking)</td>
<td>221.1d</td>
<td>90.1b</td>
<td>473.0bc</td>
<td>229.8d</td>
<td>4.000cd</td>
<td>29.25cd</td>
</tr>
<tr>
<td>F₆ (1/2 dose of N at sowing + 1/2 dose of N at silking)</td>
<td>228.8b</td>
<td>101.2a</td>
<td>497.5b</td>
<td>241.3b</td>
<td>4.725b</td>
<td>34.50b</td>
</tr>
<tr>
<td>F₇ (1/3 at sowing + 1/3 at 1st irrigation)</td>
<td>236.9a</td>
<td>117.87a</td>
<td>611.7a</td>
<td>247.2a</td>
<td>5.275a</td>
<td>37.00a</td>
</tr>
</tbody>
</table>

Any two means in a column not sharing a letter differ significantly at 0.05 p

irrigation + 1/3 at flowering) were also statistically similar, while F₄ (1/2 dose of N at sowing + 1/2 dose of N at tasseling) and F₆ (1/2 dose of N at sowing + 1/2 dose of N at silking) were statistically different from each other and rest of the treatments. More plant height in F₇ (1/3 at sowing + 1/3 at 1st irrigation + 1/3 at flowering) could be referred to the timely availability and split doses of N. These results are supported by the findings of Tiwary et al. (1970), who obtained increased plant height with a split application of nitrogen.

Cob Bearing Plant Plot: Data showed that maximum cob bearing plants (117.8) were recorded in case of treatment F₇ (1/3 at sowing + 1/3 at 1st irrigation +1/3 at flowering) and minimum (74.47) with respect to F₀ (control). Treatments F₆ (1/2 dose of N at sowing + 1/2 dose of N at silking) and F₇ (1/3 at sowing +1/3 at 1st irrigation +1/3 at flowering) were statistically at par with each other. Similarly, F₁ (1/2 kg N at stem elongation), F₃ (1/2 dose of N at sowing + 1/2 dose of N at stem elongation) and F₅ (150 kg N at silking) were statistically similar with one another. Similarly, F₃ (150 kg N at tasseling), F₁ (1/2 kg N at stem elongation), F₅ (150 kg N at stem elongation) and F₇ (1/3 at sowing + 1/3 at 1st irrigation + 1/3 at flowering) were statistically similar with one another. More number of cob bearing plants in treatment F₇ (1/3 at sowing + 1/3 at 1st irrigation +1/3 at flowering) may be attributed to split doses of nitrogen.

Number of Grains Cob⁻¹: Results showed the highly significantly effect of N application on number of grains per cob at various growth stages. Table 1 showed the difference among the treatment means. Treatment F₇ (1/3 at sowing + 1/3 at 1st irrigation + 1/3 at flowering) gave the maximum (611.7) number of grains per cob while minimum number of grains per cob (262.9) was observed in case of control. The treatment F₅ (150 kg N at silking) and F₆ (1/2 dose of N at sowing + 1/2 dose of N at silking) were statistically at par. Treatment F₁ (150 kg N at stem elongation), F₂ (1/2 dose of N at sowing + 1/2 dose of N at stem elongation) and F₃ (150 kg N at tasseling) were statistically similar with one another. Similar, treatments F₄ (1/2 dose of N at sowing + 1/2 dose of N at tasseling) and F₅ (150 kg N at silking) were statistically at par with each other. These results are in confirmation with the results of Bangarwa et al. (1998). They concluded that three equal splits of N i.e., at sowing, 100 days after sowing and at tassel initiation increased number of grains per cob, 1000-grain weight and grain yield.

1000-grain Weight: The highest 1000-grain weight (247.29) was obtained from the treatment F₇ (1/3 at sowing + 113 at 1st irrigation + 1/3 at flowering) and lowest 1000-grain weight (226.1 g) was obtained from the control. Treatment F₀ (control), F₃ (150 kg N at tasseling) and F₅ (150 kg N at silking) were statistically at par with one another. Similarly, F₁ (150 kg N at stem elongation) and F₄ (1/2 dose of N at sowing + 1/2 dose of N at silking) were also statistically similar with each other. While treatment F₅ (1/2 dose of N at sowing + 1/2 dose of N at silking) and F₇ (1/3 at sowing + 1/3 at 1st irrigation + 1/3 at flowering) were also statistically similar with each other. More number of cob bearing plants in treatment F₇ (1/3 at sowing + 1/3 at 1st irrigation + 1/3 at flowering) may be attributed to split doses of nitrogen.

These results are in confirmation with the results of Hussain (1991). They concluded that split application of N increased 1000-grain weight and grain yield.
Maqsood **et al.**: Zea mays, growth yield and nitrogen

weight and grain yield of maize crop.

**Grain yield**: Showed the analysis of variance of the grain yield, which revealed that results were highly significant for N application at different growth stages. Maximum (5.28 t ha\(^{-1}\)) in case of treatment F\(_7\) (1/3 at sowing + 1/3 at 1st irrigation + 1/3 at flowering). Treatment F\(_7\) gave significantly maximum yield over all other treatments. Treatments F\(_4\) (1/2 dose of N at sowing + 1/2 dose of N at tasseling) and F\(_6\) (1/2 dose of N at sowing + 1/2 dose of N at silking) were statistically at par with each other. Similarly, treatments F\(_3\) (150 kg N at stem elongation), F\(_1\) (1/2 dose of N at sowing + 1/2 dose of N at stem elongation), F\(_7\) (150 kg N at tasseling) and F\(_5\) (150 kg N at silking) were statistically similar with one another. While treatments F\(_0\) (control) and F\(_7\) (1/3 at sowing + 1/3 at 1st irrigation + 1/3 at flowering) were not only different from each other, but also from rest of the treatments. These results are similar to the findings of Schmitt and Beck (1991). These concluded the grain yield increases with nitrogen. Gaur **et al.** (1992) and Gautam **et al.** (1964) who reported that N application in splits gave better results.

**Harvest index**: Maximum harvest index (37.00%) was attained by the F\(_7\) (1/3 at sowing + 1/3 at 1st irrigation + 1/3 at flowering) and minimum (23.50) was observed with F\(_0\) (control). The harvest index value ranged from 23.5 to 37 percent. Results remained statistically at par in case of F\(_3\) (1/2 dose of N at sowing + 1/2 dose of N at stem elongation) and F\(_5\) (150 kg N at silking). Similarly, F\(_1\) (1/2 kg N stem elongation) and F\(_5\) (150 kg N at silking) were also statistically similar with one another. While treatment F\(_0\) (control), F\(_8\) (1/2 dose of N at sowing + 1/2 dose of N at silking) and F\(_7\) (1/3 at sowing + 1/3 at 1st irrigation + 1/3 at flowering) were statistically differ from one another and from all other treatments. These results are supported by the findings of Bangarwa **et al.** (1998). They concluded that split application of nitrogen increases the harvest index.

**References**


