Effect of Planting Date and Nitrogen Fertilizer Application on Grain Yield and Yield Components in Maize (SC 704)

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Abstract: In order to determine the effect of planting date and nitrogen requirements on the leaf area index (LAI) and grain yield of corn hybrid (variety SC704), a field experiment was carried out in the factorial arrangement in randomized complete block design with three replications at Gorgan Agriculture University during 2010-2011 cropping season. Three sowing dates (May 14, and May 22, July 13) were assigned as a main plot and four levels of nitrogen fertilizer (0, 100, 150 and 200 kg ha⁻¹) were selected as a sub plot. The results showed that sowing date had significant effect on grain yield, number of kernels per row, number of kernels per ear, 1000-grain weight, biomass, harvest index and plant height to sheath. So that the highest grain yield was obtained with 11654 kg ha⁻¹ on May 22. Nitrogen fertilizer application was significantly affected on studied traits expect number of kernels per row. Application of 150 kg ha⁻¹ produced grain yield of 11768 kg ha⁻¹ while non using nitrogen fertilizer produced of 6547 kg ha⁻¹. On the other hand, with increasing nitrogen fertilizer from 150 N kg ha⁻¹ to 200 N kg ha⁻¹ decreased grain yield.

Key words: Corn • Nitrogen fertilizer • Sowing date • Grain yield

INTRODUCTION

Maize (Zea mays L.) is an important cereal crop, cultivated throughout the world, is of significant importance for countries like Iran, where rapid increase in population have already out stripped the available food supplies [1]. Maize is produced primarily for human consumption as either a fresh or processed product. In addition, maize is produced for animal feed and industrial uses such as starch, flour, ethanol, cooking syrup and crisp [2]. Fertilizer application is one of the quickest and easiest ways to increasing yield per unit area. Experimental studies showed that increased maize productivity, however, the problem with fertilizer nutrient supplementation is that it leads to pollution of groundwater after harvest and does not improved soil structure [3]. The later influenced plant growth and development [4] as the grain yield is determined by grain number and individual grain weight, which were affected by pre and post silking environmental conditions, respectively. In order to use the crops to best utilize moisture, nutrients and solar radiation, they must been grown on an optimum sowing date. Many studies have been emphasized the nitrogen positive effect on grain yield increase, per ear grain and grain weight in maize different hybrids [5]. Jokla and Randall [6] reported that nitrogen manure consumption increase is by size, leaf life length which causes the leaf area index increased. Nitrogen consumption has a strange effect on production and expanding leaf area plants which receive the most nitrogen contain more leaf area index than wild plants [7]. Fedotkin and Kravtsov [8] found that the best growth and highest yields were obtained with 240 kg N ha⁻¹. Plant height, cob length, grains ear⁻¹ and 1000 grain weight

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Table 1: Physical and chemical properties of soil characteristic of the experimental site

<table>
<thead>
<tr>
<th>Texture soil</th>
<th>P mg/kg</th>
<th>K mg/kg</th>
<th>Total N (%)</th>
<th>Organic matter (%)</th>
<th>EC dSm⁻¹</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loamy clay sand</td>
<td>4</td>
<td>200</td>
<td>0.12</td>
<td>1.24</td>
<td>0.05</td>
<td>7.8</td>
</tr>
</tbody>
</table>

Table 2: The average of precipitation and temperature in 2010-2011 cropping season

<table>
<thead>
<tr>
<th>Month</th>
<th>Minimum temperature (%)</th>
<th>Maximum temperature (%)</th>
<th>Precipitation (mm)</th>
<th>Minimum moisture (%)</th>
<th>Minimum moisture (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mar</td>
<td>13.4</td>
<td>38.2</td>
<td>13.5</td>
<td>12</td>
<td>98</td>
</tr>
<tr>
<td>Apr</td>
<td>19.6</td>
<td>40.8</td>
<td>0</td>
<td>23</td>
<td>96</td>
</tr>
<tr>
<td>May</td>
<td>19.6</td>
<td>40.8</td>
<td>0</td>
<td>23</td>
<td>96</td>
</tr>
<tr>
<td>June</td>
<td>19.6</td>
<td>40.8</td>
<td>0</td>
<td>23</td>
<td>96</td>
</tr>
<tr>
<td>Aug</td>
<td>19.6</td>
<td>40.8</td>
<td>0</td>
<td>23</td>
<td>96</td>
</tr>
<tr>
<td>Sept</td>
<td>19.6</td>
<td>40.8</td>
<td>0</td>
<td>23</td>
<td>96</td>
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<tr>
<td>Oct</td>
<td>19.6</td>
<td>40.8</td>
<td>0</td>
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<td>96</td>
</tr>
<tr>
<td>Nov</td>
<td>19.6</td>
<td>40.8</td>
<td>0</td>
<td>23</td>
<td>96</td>
</tr>
</tbody>
</table>

In order to determine the effect of planting date and nitrogen requirements on the and grain yield of maize (SC 704), a field experiment was carried out in the factorial arrangement in randomized complete block design with three replications at Gorgan Agriculture University during cropping season of 2010-2011 in Gorgan, Iran (Latitude 36°51: longitude 54°26' and 155m height from sea). Sowing date at three sowing dates (May 14, and May 22, July 13) were assigned as a main plot and four levels of nitrogen fertilizer (0, 100, 150 and 200 kg ha⁻¹) were selected as a sub plot. Physical and chemical properties of soil and the average of precipitation are shown in (Table 1&2).

Irrigation performed once every day, in early of plant growth period and next that, once 9 days, 300 kg ha⁻¹ urea, 150 kg ha⁻¹ super phosphate and 100 kg ha⁻¹ sulfate potash used for all treatments based on soil test. Used seeds disinfected by fungicide and vitawax before planting. Firstly, 3-5 cm furrow to assuring, rowing seeds and homogeneity in vegetative cover of farm plants thinned of after full planting and growing seeds at 4 leaves stage.

Experimental plots consisted of 8 m six planting rows in 75 cm spacing. Samples selected randomly from any plot to calculating plant height, the number of kernels per row and the number of kernels per ear and then sent to laboratory. Five samples form seeds of any cultivar. Counted separately and weighted by balance after harvesting and their mean calculated and reported as 1000 grain weight. 6m² harvested after foil ripeness and 14% moisture of grain and omitting two side line sand edge of then crop amount of any plot weighted and determined as kg/ha. Index harvest calculated as dividing grain yield by biological yield multiplied by 100. Leaf Area Index was calculated by tool (AM 100, Halfman Germany). Statistical calculations calculated using MSTAT-c software and means compared using Duncan's Multiple Range Test.

**RESULTS AND DISCUSSION**

**Grain Yield:** Sowing date and nitrogen levels had significantly effect on grain yield (Table 3). The highest and lowest grain yield was produced from the 22 May with mean 11654 kg ha⁻¹ and 13 July with mean 6502 kg ha⁻¹, respectively. This observation is conformity with increasing nitrogen level from 0 to 150 kg ha⁻¹ nitrogen significantly increased grain yield from 6547 to 11654 kg ha⁻¹, while further increase to 150 kg N ha⁻¹ significantly reduced the grain yield to 8648 kg ha⁻¹ indicating that addition of more quantity of nitrogen was unnecessary beyond 200kg ha⁻¹. Grj [11] studied the effect of sowing date on increase of corn yield and function during the years 1985-1983 in Arlington in Mexico and they found out that the performance decreases in late sowing. Carlone and Russell [12] reported that grain yield was increased by 78.1% as nitrogen rate was increased from 0 to 80 kg ha⁻¹.
Number of Kernels per Row: Data regarding to the effect of sowing date and nitrogen levels on number of grains per ear row are given in Table 3. Mean comparisons indicated that maximum number of grains per ear row 51.2 kernels was observed for May 22 sown and minimum value 41 kernels for July 13 sown date. The response of number of grains per ear row to nitrogen levels was significant. The maximum number of grains per ear row (47.86 kernels) was recorded at 150 kg ha\(^{-1}\) and the minimum (43.2 kernels) in non using nitrogen fertilizer.

Number of Kernels per Ear: Data regarding to the effect of sowing date and nitrogen levels on number of kernels per ear are given in Table 3. The response of sowing date was significant to number of kernels per ear. On the other hand, mean comparisons indicated that the maximum number of kernels per ear (712.6 kernels) was recorded for May 22 sown date while, the minimum (574.5 kernels) for July 13 sown. Number of kernels per ear plays an important role in determining grain yield. The response of number of kernels per ear to nitrogen levels was significant (Table 3). Across nitrogen levels the maximum number of kernels per ear (677.4 kernels) was recorded at 150 kg ha\(^{-1}\) while, the minimum (599.7 kernels) at 0 kg ha\(^{-1}\). On the other hand, the number of kernels per ear was increased with increasing nitrogen level. Our results concur partly with observations made by Sanjeev and Bangarwa [13], who reported that the kernel number decreased with increasing nitrogen level. Similar results have been reported by Torbert et al. [14].

1000-grain Weight: 1000-grain weight was affected by sowing date (Table 3). 1000-grain weight was reduced from 294.08 g in the May 22 sown plants to 273.2 and 228.1g on 14 May and 13 July sown plants, respectively (Table 4). The 1000-grain weight resulting from delayed sowing was probably due to low daily incident radiation which is consistent with findings of Cirilo and Andrade [4]. The significant correlation between yield and 1000-grain weight (Table 3) revealed that grain yield reduction associated with decayed sowing was probably due to reduction in 1000-grain weight. This confirmed earlier findings from Adediran and Banjoko [15] which showed that application of nitrogen is important input for enhancing yield of maize.

The delay in sowing date on 13 July leads to g was reduced grain weight to 228.1g. This suggests that because of shortening the growth period, corn was affected by the short days of late growth period, low sun radiation, low air temperature and the opportunity for transfer of photosynthesis materials and seed filling was not provided. Other study, Hunter and et al., [16] reported that by delay in sowing, plant growth period is shortened, and providing enough Assimilate to save in seeds decreases and eventually reduced the weight of corn seed. Khan et al., [17] indicated that the delay in sowing leads to decrease in single seed weight. In the second sowing date, due to favorable conditions for photosynthesis in the plant and transfer more produced Assimilate to growing seeds, 1000-grain weight increases, but on the third sowing date due to decreasing air temperature, plant has little opportunity for transferring photosynthetic material to the grain. The 1000 grain weight at 150 kg ha\(^{-1}\) level of nitrogen with the average of 287.02 g was the maximum amount and has a significant difference with the control group and 200 kg ha\(^{-1}\) levels. The 1000 grain weight was the minimum amount in control group with the average of 240.7 g (Table 4). Also Uhahrt and Andréd [7] concluded that nitrogen deficiency reduces yield and this reduction is in both the grain number and grain weight.

Biomass: Sowing date and nitrogen levels significantly affected biomass (Table 3). Biomass production at final harvest was highest in May 22 sown plants (1789 kg ha\(^{-1}\)) and was higher than May 14 sown plants (1419 kg ha\(^{-1}\)) and July 13 sown plants (12010 kg ha\(^{-1}\)), respectively. Among the different amounts of nitrogen fertilizer on biomass, it was determined that the highest biomass is for the 150 N kg ha\(^{-1}\) with an average of 17020 kg ha\(^{-1}\). The lowest amount of treatment (without nitrogen fertilizer) was the average of 12950 kg ha\(^{-1}\).

Harvest Index (HI): Harvest index indicating transforming percent photosynthetic matters from vegetative organs (source) to seeds (sink) [18]. HI was increased from 44% in July 13 sown plants to 57% in the May 22 sown plants (Table 4). HI increased as the nitrogen level increase. The greatest HI was produced from 150 kg nitrogen treated plants (57%) and was 55%, 52% and 43% higher than 100, 200kg nitrogen and nitrogen treated plants, respectively. The mean comparisons (Table 4) showed that harvest index had significant differences in different levels of nitrogen, so that the maximum harvest index occurred in 150 kg ha\(^{-1}\) level with an average of 57 and the control group had the minimum harvest index with the average 43. The control group has significant difference with the levels of 100 kg ha\(^{-1}\), 150 kg ha\(^{-1}\) and 200 kg ha\(^{-1}\) which are consistent with the opinions of Guindo et al. [19], Havlin et al. [20] and Muchow [21]. They believed...
that if consumption of nitrogen increases, the plant will have the more use possibility and by more nitrogen absorbing by the roots and transferring to reproductive organs, harvest index will increase. While in the situation of this element lack (especially in the seed filling stage) transferring and assigning it to the seed decreases and consequently leads to decreases of nitrogen harvest index and protein function.

**Plant height:** The height of plant is an important growth character directly linked with the productive potential of plant in term of grain yield. An optimum plant height is claimed to be positively correlated with productivity of plant [22]. Maize plants were tallest in May 22 sown plants followed by May 14 and July 13 in that order throughout the sampling periods (Table 4). Nitrogen levels significantly increased the plant height in maize hybrid. Data regarding the effect of maize hybrid and different levels of nitrogen on plant height are given in (Table 3). In general, the maximum plant height Maize plants were tallest in those plants that received 150 kg ha\(^{-1}\) followed by 100 kg ha\(^{-1}\) while, the shortest plants were those plants without treatment. The deficiency of major nutrients in the plots without nitrogen treatment stunted the plants growth. The tallest plants were observed in May 22 sown plants treated with 150 kg N ha\(^{-1}\). Analysis of variance (Table 4) showed that sowing date and nitrogen effects on final plant height and leaf area index are given in Table 4. These results indicated that effective factor in plant height is date of sowing. The more delayed sowing date, the more reduced plant height. In the early sowing
date, due to high temperature, the plant passes its growth stages faster and it would end its vegetative growth earlier and thus has a lower height. The results were consistent the findings of Cao [23]. The plant height to the sheath was with an average of 154.1 cm in 150 kg ha\(^{-1}\) the level of nitrogen and the control group showed the lowest height with the average 140.33 cm. Bobinson [24] stated that the increasing use of nitrogen fertilizer can increase plant height. Increased Nitrogen amount can increase plant height and crop growth rate (CGR) increases. Morin and Dormency [25] reported that delay of sowing caused a decline in plant height.

**Leaf Area Index:** Different sowing date and nitrogen level had significant effect on LAI throughout the sampling period. Maximum LAI was observed in May 22 sown date, followed by May 14 and July 13 (Tables 3&4). As nitrogen decreased LAI was also decreased and plant receiving no nitrogen produced minimum LAI throughout the sampling periods (Table 3). The greatest LAI were given by May 22 sown plants treated with 150 kg N ha\(^{-1}\) (Table 4). LAI observed in May 22 sown plants showed longer duration than in May 14 and July 13 sown plants. Higher LAI associated with nitrogen treated plants have been probably due to increased leaf production and leaf area duration. As a consequence, a high amount of radiation was intercepted. According to the results of analysis of variance in Table 3, we find out that a significant difference exists between the different levels of nitrogen, so that LAI (leaf area index) at 150kg ha\(^{-1}\) level of nitrogen fertilizer with an average of 5.3 is the Maximum leaf area index and control group with the average 4.06 showed the lowest leaf area index (Table 4). Interaction effect of sowing date and nitrogen fertilizer shows that plant growth and leaf area index increased by increasing the amount of nitrogen fertilizer in third sowing date. These results were in accordance with the results of other researchers, including. Muchow [21] showed that the use of nitrogen has a potent effect on leaf production and development. The plants which receive the most amount of nitrogen have more leaf area index than the controls. This result is in agreement with those reported by Oikeh et al. [26]. The interaction effect between sowing date and nitrogen fertilizer on the leaf area index was significant. So that the maximum leaf area index is for the 150 kg ha\(^{-1}\) with an average of 5.55 in the first sowing date while, the minimum of LAI is for the control group with an average of 3.9. The interaction of second sowing date with different levels of nitrogen indicated that the maximum leaf area index of the second sowing date occurred with 150kg ha\(^{-1}\) level with an average of 6.01, which there is no significant difference between the control group nitrogen fertilizer levels and 100 kg ha\(^{-1}\) respectively with the averages of 4.3 and 4.41 (Table 5). But there are significant differences with the 200 and 150 kg ha\(^{-1}\) with averages of 4.89 and 6.01 respectively. In third of sowing date the effect of its Interaction with different levels of nitrogen fertilizer showed that the highest LAI occurs at the 200 kg ha\(^{-1}\) level of nitrogen with an average of 5.7, and it shows this fact that increasing amounts of nitrogen fertilizer can make LAI and vegetative growth to increase and compensate the delay in sowing and shortened growth period. These results are in agreement with the findings of Yarnia [21] indicated that nitrogen has a strong effect on the leaf area production and development. Plants that are receiving more nitrogen have more LAI than the control group. Who also reported that interaction between delay sowing decreased leaf area of amaranth at least 19.63 up to 97.15%.

**CONCLUSIONS**

In this experiment, nitrogen levels showed significant effects on maize hybrid yield (SC704). The highest grain yield was recorded at N 150 kg ha\(^{-1}\) and grain yield differences between early sown and late sown plants have been attributed to decreased dry matter partitioning to grain resulting in decreased grain weight. Higher grain yield accrued to the nitrogen treated plants have been attributed among other factors to higher plant height, LAI and efficient transfer of assimilates to sink leading to greater biomass. This study revealed that plants sown early (May 22) and given 150kg ha\(^{-1}\) gave the highest yield with 11654 kg ha\(^{-1}\).

**REFERENCES**


