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# The Effect of Pre-Sowing Plants and Different Levels of Nitrogen Consumption on Quantitative and Qualitative Yield of Grain Maize

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**ABSTRACT**

In order to examine the effect of pre-sowing plants and different nitrogen levels on quality and yield of maize, a research was conducted in the field of Agricultural Jihad Management in Bawi (Molasani). The experiment was conducted as split plots in the form of randomized complete block design with four replications. Main plots included different levels of urea fertilizer (0, 100, 150 kg/ha) and sub plots included the pre-sowing plants of canola and wheat. The ANOVA results showed that the studied traits including the yield and yield components (number of grains per row, number of rows per ear, number of grains per ear, 1000-grain weight, and harvest index). Grain yield was particularly affected by different levels of urea fertilizer, type of pre-sowing plant (canola and wheat) and their interactive effect. Mean comparison of different levels of urea fertilizer showed that as the consumption of urea fertilizer increased in maize the studied traits increased, too. Moreover, planting maize after canola compared to wheat led to the increase of all traits. The results of interactive effect showed that during the maize planting after canola along with the consumption of more urea fertilizer the traits were positively influenced. Consequently, it can be stated that the consumption of 150 kg/ha urea fertilizer and canola pre-sowing led to the improvement and increase of quantitative and qualitative traits in maize.



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## INTRODUCTION

Abnormal growth of population, increasing demand for food and insufficient food supplies have made a large number of people around the world face hunger and malnutrition. Optimal use of resources, facilities, and development of high yield crops are the solutions to this phenomenon. Among the crops which are used as food supplies maize which is widely cultivated is a promising product to deal with this phenomenon [19]. Since the increase of soil organic matter improves physical, chemical, biological properties and fertility of soil, crop rotation is an effective method to increase the soil fertility. In fact, any operation that leads to the increase of crop residues on the soil surface will result in the increase of soil organic carbon [3]. In Khuzestan area different crops are used for production but their arrangement does not follow any specific order. In other words, logical agricultural objectives are not followed. This highly influences the agricultural production potential in the region. On the other hand, failure to adhere to certain crop principles such as selection of appropriate pre-sowing plants which demands certain crop management has threaten production sustainability and ecological stability of crop systems in many regions of the country particularly in Khuzestan Province. Therefore, it seems necessary to study crop rotation patterns and to determine the effect of pre-sowing plants and various crop managements on the establishment of correct patterns of agriculture in the region. Khuzestan plain with very broad and nearly flat lands is one of the agricultural poles of Iran. Due to its flat and fertile lands and excessive light energy this province is appropriate for production of crops particularly grain maize [20]. Nitrogen is one of the most important nutrients and the key factor to achieve optimal yield in crops and plays an important role in the increase of crops yield. This element forms 2% to 5% of plant dry weight and is one of the primary components of many organic compounds such as amino acids and nucleic acids. Nitrogen as a widely used element and due to its tasks in plants vital processes plays a major role in achieving optimal yield. Since the leaf nitrogen is the most important component of chlorophyll pigment and many other compounds in plant which absorb sunlight spectrum, any disruption in supplying nitrogen for crops particularly setting it in leaves can severely affect the

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production potential of crop and even its adaptation to inappropriate environmental conditions [37]. The increase of nitrogen consumption not only delays aging and growth stimulation but also changes the appearance of plant in certain circumstances. Especially if nitrogen is highly available in the root environment at early stages of growth, the elongation of the aerial parts of the plant will increase but the growth of roots will be inhibited, a change which is not suitable for taking nutrients and absorbing water in the next stages [40]. Long-term sustainability of farming systems depends on the effective management of natural resources. The pre-sowing plant impacts the yield and yield components and also the qualitative features of the main crop. Maize (American name) with the English name of corn and the scientific name of Zea mays belongs to grain family (Poaceae) and is one of the four major crops in the world and since 2005 it has been ranked in the first place in terms of production [27]. In this research, the effect of pre-sowing plants and different levels of nitrogen on quality and yield of maize was examined. The research was carried out in the field of Agricultural Jihad management in Bawi (Molasani) as split plots in the form of randomized complete block design with 4 replications.

## MATERIALS AND METHODS

In order to examine the effect of pre-sowing plants and different nitrogen levels on quality and yield of maize, the research was conducted in the field of Agricultural Jihad Management in Bawi (Molasani) located in 36 km away from northeast of Ahvaz. The experiment was conducted as split plots in the form of randomized complete block design with four replications. Main plots included different levels of nitrogen fertilizer (0, 100, 150 kg/ha) and sub plots included the pre-sowing plants of canola and wheat. These plants are among the most common plants cultivated in Ahvaz. Before the land preparation, the samples were taken from the depths of 0-30 and 30-60 cm. the distance between the main plots was 2 m and the distance between the sub plots was 1 m. each sub plot was as long as 5 m and as wide as 4 m. Maize 704 was planted on July 11, 2013. During the growth season, grass weeds were cut manually and irrigation was done based on the plant need and the region custom. The maize was harvested in the early November from the two middle lines of each plot which were specified for the yield. After the harvest, the grain yield of maize was calculated based on the moisture content of 14%. The studied traits included the yield of dry matter, grain yield and yield components (number of grains per row, number of grains per ear, and 1000-grain weight), and grain protein percentage. In order to measure the yield components, 15 corns were randomly selected and the above mentioned traits were determined and in order to measure the harvest index 3 plants were randomly selected from each plot. After the plant was established the samples were taken every 14 days for plant growth analysis and LAI, TDW, LDW components were measured and after the formation of corn the samples were taken every 5 days for the grain growth analysis. 100-grain weight was also calculated by measuring two 500-seed samples of the harvested maize for each plot. Total nitrogen was evaluated via the Kjeldahl method.

The research population included a research field in which each plot contained 7 lines as long as 5 m and as wide as 4 m. the space between sub plots was 1 m and the space between main plots was 2 m.

*Data Analysis:*

The data were analyzed using SAS software and the means were compared using the Duncan's multi range test at 5% level. The diagrams were drawn by Excel software.

*Results:*

*Protein Percentage:*

Table (1) showed that protein percentage at 5% level was affected by different levels of nitrogen fertilizer, type of pre-sowing plant and their interactive effect. The results of Table (2) showed that as the nitrogen fertilizer consumption increased, the protein percentage increased too and the highest protein percentage by 9.49% was related to the consumption of 150 kg/ha nitrogen fertilizer which was not significantly different from the consumption of 100 kg/ha nitrogen and the lowest protein percentage belonged to the treatment without consumption of nitrogen. According to table (2) it was observed that planting maize after canola increased protein percentage by 9.6% compared to the wheat by 7.96%. Mean comparison of the interactive effect of both treatments showed that consumption of 150 kg/ha nitrogen fertilizer and planting maize after canola caused the production of the highest rate of protein by 10.79% and the lowest rate of protein was 6.5% (Table 3).

*Number of Grains per Ear:*

The ANOVA results in Table (1) showed that treatments with different levels of nitrogen fertilizer, type of pre-sowing plant and their interactive effect influenced the number of grains per ear and caused a significant difference between the means. Mean comparison of the number of grains per ear in Table (2) indicated that further consumption of nitrogen fertilizer increased the trait and the highest number of grains per ear by 390.44 grains belonged to the treatment with consumption of 150 kg/ha nitrogen. Sowing the maize after canola increased the number of grains per ear by 349.89 grains and the lowest number of grains by 290.67 ones was related to sowing the maize after wheat. The interactive effect of the two treatments showed that consumption of more nitrogen fertilizer and sowing the maize after canola compared with wheat increased the number of grains per ear. The highest number of grains per ear belonged to the treatment with consumption of 150 kg/ha nitrogen fertilizer and sowing the maize after canola by 416 grains and the lowest number by 208.33 grains belonged to the treatment without consumption of nitrogen and sowing the maize after wheat (Table 3). Nitrogen also has a significant effect on stem diameter, leaf area, ear, and number of grains per ear [14]. Ghasemi Pir Balooti [13] reported that as the nitrogen level increased, plant height, number of grains per ear and number of grains per row increased. As the nitrogen application increased, the number of grains per ear increased significantly. The critical period of maize grain formation is one-two weeks before the silk emergence until there weeks after the silk emergence. Availability of assimilates and their transfer into the ear in this period is closely related to the number of grains per ear [38]. The results were consistent with the findings of Legg and Bennet [21]. In this respect, Zineslmerie *et al.* [42] reported that the final number of grains per ear would be determined during the pollination. Insufficient amount of assimilates for the growth of all embryonic cells has a negative effect on the number of grains per ear. Therefore, the increase of nitrogen levels and assimilates mobilization have a positive effect on this trait. It seems like that as the rate of nitrogen increases during the critical period, the formation of maize grain due to availability of assimilates and their mobilization into ear in the stage of determining the number of egg cells in row leads to the increase of the number of grains per row; therefore, the increase of nitrogen levels led to the increase of number of grains per ear.

*Number of Rows per Ear:*

The table of ANOVA results indicates that both treatments affected the number of rows per ear (Table 1). The results of Table (2) showed that the increase of nitrogen consumption increased the number of rows per ear and the highest number of rows per ear by 14 rows belonged to the treatment with consumption of 150 kg/ha nitrogen and the lowest number by 12 belonged to the treatment without consumption of nitrogen. Comparison of the type of pre-sowing plant showed that maize planting after canola increased the number of rows per ear by 13 rows and the lowest number by 12 rows belonged to maize planting after wheat. The interactive effect of both treatments on the number of rows per ear showed that the highest number of rows per ear belonged to the treatment with maize planting after canola and consumption of 150 kg/ha nitrogen by 14 and the lowest number of rows per ear by 11 belonged to the treatment with maize planting after wheat and without consumption of nitrogen (Table 3).

With regard to the distinction of the number of rows per ear which is strongly influenced by genetic characteristics, Ritichi and Hanway [32] determined the final number of grain rows per ear and reported that during the determination of the number of grain rows per ear there was not serious completion between other components to use assimilates and the relative stability of these two grain yield components has been reported in lots of reports [41, 33, 20, 5].

*Number of Grains per Row:*

According to Table (1) it was observed that the effect of treatments on the number of grains per row was significant. Mean comparison of different levels of nitrogen fertilizer showed that the increase of nitrogen consumption increased the number of grains per row and with consumption of 150 kg/ha nitrogen the number of grains per row reached 27.78 which was not significantly different from the consumption of 100 kg/ha nitrogen and the lowest number of grains per row by 20 grains belonged to the treatment without consumption of nitrogen (Table 2). Table (2) showed that sowing canola compared to wheat before the maize as pre0sowing plant had a greater effect on the increase of the number of grains per row. The highest number of grains per row belonged to the treatment with planting after canola by 26.22 grains per row and the lowest number belonged to the treatment with planting after wheat by 23.33 grains. Examining the interactive effect of different nitrogen levels and the type of pre-sowing plant (Table 3) showed that as the consumption of nitrogen increased particularly in maize planting after canola the number of grains per row increased and the highest number of grains per row belonged to the treatment with consumption of 150 kg/ha nitrogen and maize planting after canola as the pre-sowing plant by 29 grains and the lowest number belonged to the treatment without consumption of nitrogen and maize planting after wheat as pre-sowing plant by 18.33 grains. Majidian and Ghadiri [22] reported that as the nitrogen level increased, plant height, number of grains per ear and number of grains per row increased. As the nitrogen application increased, the number of grains per row increased so that the highest number of grains per row by 37 grains belonged to the treatment with consumption of 240 kg/ha nitrogen and the lowest number by 26.89 belonged to the control treatment.

The increase of nitrogen application removes nitrogen limitations for corn and increases photosynthetic and production efficiency of plant and leads to the increase of number of grains per row. Costa *et al.* [8] and Hamidi *et al.* [14] stated in different reports that as the nitrogen consumption increased, the number of grains per row increased, too. Reed *et al.* [31], Al-Rudha and Younis [2] reported that the increase of number of grains per row commensurate with the increase of nitrogen consumption. Kiniry and soliman [17] stated that the availability of nutrients particularly nitrogen since three weeks before silk emergence until two weeks after that in maize had a close relationship with grain production. Classen and Hshowa [7] and Moss and Downey [25] reported that the increase of nitrogen levels and mobilization of assimilates into the corn had a significant effect o the number of grains per row and increased it.

*1000-Grain Weight:*

The ANOVA results in Table (1) showed that different nitrogen levels, type of pre-sowing plant, and their interactive effect affected 1000-grain weight. As it was observed in Table (2), the increase of nitrogen consumption led to the increase of 1000-grain weight and the highest weight of 1000-grain belonged to the treatment with consumption of 150 kg/ha nitrogen by 264.89 g and the lowest weight belonged to the treatment without consumption of nitrogen by 204.33 g. Table (2) indicates that the type of pre-sowing plant affected the weight of 1000-grain and maize planting after canola compared to wheat produced the highest weight. The highest grain weight by 236.78 g belonged to maize planting after canola and the lowest weight by 217.33 g belonged to maize planting after wheat. As it was referred to in Table (2), planting maize after canola had the highest effect on the increase of 1000-grain weight and at the same time the increase of nitrogen consumption increased 1000-grain weight. Therefore, according to Table (3) it is concluded that the highest weight of 1000-grain belonged to the treatment with planting after canola and consumption of 150 kg/ha nitrogen by 282 g and the lowest weight belonged to the treatment with planting after wheat and without nitrogen consumption by 198.67 g. the increase of nitrogen leads to the increase of dry matter production and leaf area continuity and consequently the increase of current photosynthesis and 1000-grain weight. Uhart and Andrade [40] reported that the mean of 1000-grain weight depends on the assimilates mobilization into corn during flowering stage and grain maturity stage which in turn depend on the leaf longevity after pollination stage and also the relationship between the source and sink and target. The results were consistent with the findings of Osborne [29], Banzinger *et al.* [4].

*Starch Percentage:*

According to Table (1) it was observed that the effect of treatments on the percentage of starch was significant. Mean comparison of different levels of nitrogen fertilizer showed that the increase of nitrogen consumption increased the starch percentage and with consumption of 100 kg/ha nitrogen it reached 64.63% which was not significantly different from the consumption of 150 kg/ha nitrogen and the lowest rate by 53.63% belonged to the treatment without consumption of nitrogen (Table 2). Table (2) showed that sowing canola compared to wheat before the maize as pre-sowing plant had a greater effect on the increase of starch percentage. The highest percentage of starch belonged to the treatment with planting after canola by 66.71% and the lowest percentage belonged to the treatment with planting after wheat by 53.37%. Examining the interactive effect of different nitrogen levels and the type of pre-sowing plant (Table 3) showed that the use of canola as pre-sowing plant before the maize at all levels of nitrogen consumption increased the percentage of nitrogen and there was no significant difference between nitrogen levels in this regard. The highest percentage of starch belonged to the treatment with consumption of 100 kg/ha nitrogen and maize planting after canola as the pre-sowing plant by 54.43% and then the treatment without consumption of nitrogen and also application of 150 kg/ha nitrogen and planting after canola by 64.93% and 64.68% respectively and the lowest percentage belonged to the treatment without consumption of nitrogen and also consumption of 150 kg/ha nitrogen and maize planting after wheat as pre-sowing plant by 58.19% and 58.31%, respectively.

*Grain Yield:*

The ANOVA results in Table (1) showed that different nitrogen levels, type of pre-sowing plant, and their interactive effect affected the grain yield. As it was observed in Table (2), the increase of nitrogen consumption led to the increase of -grain yield. The highest grain yield by 9144 kg/ha belonged to the treatment with consumption of 150 kg/ha nitrogen and the lowest grain yield by 4218.6 kg/ha belonged to the treatment without consumption of nitrogen. The results of Table (2) indicated that the highest grain yield by 7070.3 kg/ha belonged to the treatment with planting canola before maize and the lowest grain yield by 5917.3 kg/ha belonged to the treatment with planting wheat before maize. The interactive effect of both treatments on the number of grains/m2 showed that the highest grain yield belonged to the treatment with planting maize after canola and consumption of 150 kg/ha nitrogen by 9639.4 kg/ha and the lowest grain yield belonged to the treatment with planting maize after wheat and without nitrogen consumption by 3853.9 kg/ha (Table 3). Kamprath and *et al.* [16] studied the interactive effect of cultivar and nitrogen levels on the grain yield in maize and reported that the highest grain yield belonged to SC 404 and consumption of 240 kg/ha nitrogen. The grain yield at nitrogen levels of 160 and 240 kg/ha was similar and more than the grain yield at nitrogen level of 80 kg/ha. Bundy and Carter [6] reported that there were some differences between Maize hybrids in terms of their reaction to nitrogen fertilizer. Similar reports have been reported by Kamprath *et al.* [16], Nxumalo *et al.* [28]

and Bundy and Carter [6]. Dlamini [9] also reported the increase of grain yield of different cultivars of maize due to the increase of nitrogen levels. Costa *et al.* [8] applied different levels of nitrogen fertilizer for Maize and reported that the consumption of nitrogen fertilizer up to 225 kg/ha increased the grain yield. Torbert *et al.* [39] reported that the increase of nitrogen level up to 168 kg/ha led to the increase of grain yield, total biomass, and nitrogen uptake. Kogbe and Adedrian [18] reported that the maize yield would increase at nitrogen levels above 100 kg/ha. The increase of nitrogen level due to the decrease of abortion led to the increase of number of grains [20]. The results of correlation showed that there was a positive and significant correlation coefficient between the grain yield and the number of grains per row and the number of grains per ear [1]. Therefore, the increase of grain yield at nitrogen level of 200 kg/ha was due to the increase of the number of grains per ear. The increase of grain yield via the number of grains per ear has been reported by Mansouri-far [24] and Alavi Fazel [1]. Eck [11] concluded that sufficient nitrogen fertilizer under drought stress conditions increased the grain yield of maize less than that of optimal conditions.

*Harvest Index:*

Table (1) showed that the harvest index was affected by different nitrogen levels, type of pre-sowing plant, and their interactive effect. The results of Table (1) showed that the increase of nitrogen consumption increased the harvest index and the highest rate of harvest index by 44.84% belonged to the treatment with consumption of 150 kg/ha nitrogen and the lowest rate by 22.70% belonged to the treatment without consumption of nitrogen. According to Table (1) it was observed that planting maize after canola increased the harvest index by 39.57% compared to planting maize after wheat by 27.04%. Mean comparison of the interactive effect of both treatments showed that at each level of nitrogen consumption there was no difference between the effects of pre-sowing plants on the harvest index. Consumption of 150 kg/ha nitrogen and planting maize after canola and wheat led to the highest index production by 43.47% and 42.79% respectively and the lowest harvest index belonged to the treatment without consumption of nitrogen by 22.99% and 21.25% (Table 2). The lack of change of harvest index at various levels of nitrogen has been reported by other researchers that indicates the lack of the effect of nitrogen on harvest index and relatively similar changes trend of grain yield and total biomass [22, 37].

**Table 1:** The ANOV results of the studied traits in maize at different levels of nitrogen and pre-sowing plant.

| S.O.V | df | Protein percentage | Number of grains per ear | Number of rows per ear | Number of grains per row | 1000-grain weight | Starch percentage | Grain yield | Harvest index |
|---|---|---|---|---|---|---|---|---|---|
| replication | 3 | 14.04 ns | 3712.03 ns | 0.51 ns | 6.26 ns | 92.59 ns | 19.36 ns | 2279999 ns | 81.82 ns |
| Nitrogen | 2 | 27.05 * | 57972.14 ** | 1.91 * | 182.26 ** | 585.59 * | 134.32 * | 54658563 ** | 1104.12 ** |
| Main error | 6 | 3.93 | 1698.20 | 0.22 | 4.81 | 80.81 | 18.54 | 442452 | 8.49 |
| Pre-sowing | 1 | 22.31 * | 8036.03 ** | 1.69 * | 19.70 ** | 876.70 * | 52.19 * | 3520875 ** | 22.79 * |
| Nitrogen × pre-sowing | 2 | 12.06 * | 764.04 * | 1.22 * | 2.26 * | 27.45 * | 52.26 * | 420361 * | 14.45 * |
| Minor error | 9 | 5.34 | 219.26 | 0.24 | 0.68 | 7.18 | 13.01 | 127769 | 4.52 |
| CV (%) | - | 8.84 | 13.86 | 4.59 | 3.84 | 1.17 | 22.62 | 5.39 | 6.33 |

ns, *, ** respectively mean non-significant difference, significant difference at 5% and 1% probability levels.

**Table 2:** Mean comparison of the simple effects of different levels of nitrogen and pre-sowing plant on the studied traits in Maize.

| Treatments | | | | Traits mean | | | | |
|---|---|---|---|---|---|---|---|---|
| Nitrogen (kg/ha) | Protein percentage | Number of grains per ear | Number of rows per ear | Number of grains per row | 1000-grain weight (g) | Starch percentage | Grain yield (kg/ha) | Harvest index (%) |
| 0 | 7.39 b | 234.00 b | 12 b | 20.00 b | 204.33 c | 53.63 b | 4218.6 c | 22.70 c |
| 100 | 8.67 a | 343.33 ab | 13 a | 26.11 a | 244.89 b | 64.63 a | 6538.6 b | 34.43 b |
| 150 | 9.49 a | 390.44 a | 14 a | 27.78 a | 264.89 a | 63.20 a | 9144.6 a | 44.87 a |
| | | | | | | | | |
| Pre-sowing plant | | | | | | | | |
| Wheat | 7.96 b | 290.67 b | 12 b | 23.33 b | 217.33 b | 53.37 b | 5917.3 b | 27.04 b |
| Canola | 9.60 a | 349.89 a | 13 a | 26.22 a | 236.78 a | 66.71 a | 7070.3 a | 39.57 a |

According to Duncan's multi range test there is no significant difference between the means of treatments with similar letters at 5% level.

**Table 3:** Mean comparison of the interactive effects of different levels of nitrogen and pre-sowing plant on the studied traits in Maize.

| Treatment | | | | | Traits mean | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Nitrogen (kg/ha) | Pre-sowing plant (plant/ha) | Protein percentage | Number of grains per ear | Number of rows per ear | Number of grains per row | 1000-grain weight (g) | Starch percentage | Grain yield (kg/ha) | Harvest index (%) |
| 0 | Wheat | 6.50 c | 208.33 e | 11 d | 18.33 d | 198.67 e | 58.19 c | 3853.9 f | 22.99 d |
| | Canola | 9.52 b | 264.00 d | 12 c | 22.00 c | 208.6 d | 64.93 a | 4551.9 e | 21.25 c |
| 100 | Wheat | 8.49 bc | 308.67 c | 13 b | 24.33 b | 236.67 c | 61.79 b | 5685.4 d | 33.33 b |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | Canola | 9.00 ab | 369.67 b | 13 b | 27.66 b | 249.67 b | 65.43 a | 7019.7 c | 32.25 b |
| 150 | Wheat | 9.18 ab | 355.00 bc | 13 b | 27.33 b | 246.67 b | 58.31 c | 8212.7 b | 42.79 a |
| | Canola | 10.79 a | 416.00 a | 14 a | 29.00 a | 282.00 a | 64.68 a | 9639.4 a | 43.47 a |

According to Duncan's multi range test there is no significant difference between the means of treatments with similar letters at 5% level.

*Discussion:*

Among the grain, maize due to high genetic variation, simple planting, growing, and harvesting, palatability, erosion and weed control, lower expectations towards nutrients, having high starch and sugar in comparison with other crops is highly important. The maize yield is low in most arid and semiarid regions of country due to low content of soil organic matters and nitrogen deficiency. This problem should be resolved by means of nitrogen fertilizers. Unfortunately, such fertilizers have not been used effectively and their efficiency is low [23].

With regard to the role of nitrogen in the increase of yield, relative ease of preparing nitrogen fertilizers and dynamicity of the mentioned element, the consumption of nitrogen fertilizers in fields is high (80 million tons per year) and in the fields where more water is used a large amount of it as nitrate is leached from the soil and pollutes the groundwater. Moreover, excessive consumption of nitrogen fertilizer leads to the accumulation of nitrate in plants, increase of plant growth period, and the delay of crop maturity and even in some crops it causes lodging, decrease of plant resistance to frost, pests, and diseases. Thus, it is necessary to modify the use of nitrogen fertilizers depending on the type of product, optimal performance, type of fertilizer, and field management and to prevent the overuse of nitrogen fertilizers [10]. The low efficiency of nitrogen is due to loss of it through denitrification, leaching, and sublimation of ammonium. The loss of nitrogen not only decreases the efficiency of nitrogen consumption but also is one of the main reasons of environment pollution due to incorrect use of chemical fertilizers particularly nitrogen in agriculture. This matter specifies the necessity of revising the methods of increasing production more and more. Selecting appropriate cultivars and accurate recommendation to use fertilizers based on the plant need is one of the solutions to increase the efficiency of nitrogen consumption, to reduce environment pollution, and to increase the grain yield. The amount of fertilizer required by plant is different based on the availability of moisture content during the growth period, type of soil and its fertility, and type of cultivar [36].

Nitrogen application has a significant effect on quantitative and qualitative yield of maize [35, 15]. The results of the studies by Bundy and Carter [6] showed that the reaction of maize hybrids to various levels of nitrogen is different. Hardas and Aragiaanne-Hrestous [15] separately examined the effect of nitrogen on the maize yield and reported that application of 180 and 200 kg/ha nitrogen led to the achievement of optimal yield of maize.

Samira *et al.* [34] and Torbert *et al.* [39] during separate investigations reported that the yield and yield components of maize hybrids increased due to the increase of consumed nitrogen. El-Sheikh [12] reported that application of 160 kg/ha nitrogen significantly increased number of grains per ear and grain yield. Kamprath *et al.* [16] attributed the increase of grain yield of maize as a result of nitrogen consumption to the increase of the number of grains per ear and the increase of grain weight per ear. Uhart and Andrade [40] believe that the increase of grain yield of single plant due to nitrogen consumption might be related to the increase of number of grains per ear or the increase of 1000-grain weight. Muchow and Sinclair [26] believes that as the nitrogen decreases the weight of grain decreases, too. However, Purcino *et al.* [30] believe that the weight of grain is not affected by nitrogen. This contradiction might be due to the difference between the maize hybrids in response to nitrogen fertilizer.

*Conclusion:*

Generally, using a plant that can improve physical and chemical conditions of soil for the next cultivation (particularly maize) and that can control the weeds, pests, and diseases frequently will increase the productivity and efficiency of the following plant. According to the present results it seems better not to use crops from the grain family as the pre-sowing plant for maize and it is better to use weed plants such as canola which has wide leaves.

It is recommended to do research on experimental plots in the farms of the area and also to examine different hybrids and cultivars of maize and also the rate of nitrogen fertilizer in different maize hybrids after planting the pre-sowing plants. Since leaching is one of the most important disadvantages of nitrogen fertilizers and one of the most common ways of nitrogen loss, it is recommended to study the use of urea fertilizer with sulfur coat.

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