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Effect of Nitrogen Fertilizer Levels and Plant Density on Some Physiological Traits of Durum Wheat

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Abstract: In order to investigate the effect of nitrogen fertilizer levels and plant density on some physiological traits of durum wheat Seimareh cultivar, an experiment based on randomized complete block design was conducted at the agricultural research station of the Islamic Azad University, Ardabil branch, Ardabil, Iran in 2008-2009 growing season with three replications. Factors included nitrogen levels: 0, 60, 120 and 180 kg ha^{-1} and plant densities: 300, 350 and 400 plant m^{-2}. Results showed that with increasing nitrogen application, the length of the growth vegetative, reproductive and ripening periods, were increased. Also, the highest straw and spike dry weight, the number of spikes, 1000 grain weight and grain yield and harvest index were achieved using the 120 kg ha^{-1}.whereas, in the majority of the traits such as yield, 1000 grain weight, harvest index and the number of the spike per unit area, application of 120 kg ha^{-1} was the same with the 60 kg ha^{-1} and increase in the nitrogen application more than 120 kg ha^{-1} led to decrease in the yield and other traits. With increasing the plant density per unit area, the length of the vegetative growth period was decreased but the length of the reproductive growth period, were increased. Also, with increasing plant density, straw and spike dry weight, the number of spike and grain yield per unit area were increased and 1000 grain weight and harvest index were decreased. So, generally, to prevent environmental pollutions and excess cost, the use of the 60 kg ha^{-1} nitrogen with a population of 400 plant m^{-2} is recommended to gain the highest yield.

Key words: Plant density · Yield · Nitrogen fertilizer and durum wheat

INTRODUCTION

Cereals from late were used by humans and a variety of cereal products produced today are one of which is pasta [1]. Tetra haploid durum wheat is one species of the genus wheat after wheat in terms of area under cultivation is second with about 10% of the total global area of wheat has been allocated to Rajabzadeh [2]. Uncontrolled use of nitrogen fertilizers in the cultivation of crops, in addition to compromising the quality and reduce the consumption of healthy donors over time cause is environmental pollution. Therefore, determining the optimum level of nitrogen in which the maximum yield and nitrogen use efficiency and the environmental pollution is to establish at least, is very important [3]. Plant density on morphological characteristics of most crops, including cereals are an important influence, for example, corn can be said about the increased congestion, ear diameter, number of grain s in rows and many other traits, decreased [4]. Nitrogen also had significance for tillering, number of grains increases and the grain weight is increased. N in the grains, pods, grain s per pod and grain weight increases [5]. Since the density, dry weight and plant aerial parts is increased and a major proportion of the total dry weight are allocated to, so it seems logical that the density increased harvest index on amount be added [6]. Also, in some plants, the results obtained a photograph, thus the Reddy *et al.* [7] reported that increasing plant density in corn, harvest index decreased. The effect of plant density on corn silage, two densities of 8 and 11.6 plants per square meter was examined and was observed with increasing density, harvest index decreased [8]. While some scholars have expressed the harvest index were affected by plant density is not. Including other factors affecting the value of harvest index, genotype and rate of nitrogen fertilizer is used. Nitrogen effect on harvest index has meaning. So that with increasing nitrogen fertilizer rate and harvest index

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decreased in the nitrogen effect on biological yield and economic performance more than the increase of harvest index therefore decreased [9]. Because of the arid and semi arid region located, naturally the amount of soil organic matter was low and most plants are nitrogen deficient. So this problem with nitrogen fertilizer is resolved. Unfortunately, nitrogen fertilizers are not used as effectively and their efficiency is low [10]. Wheat response to higher density of plants is weeding. The highest density in cereal crop due to excessive competition between plants for light, moisture or small amounts of grain are produced. Distribution of nitrogen fertilizers on the level and distribution of nitrogen in plants is effective [11]. High soil fertility and nitrogen consumption, increased growth and yield are finally [12]. Severe effect on plant densities during different phenological stages of corn are [13]. With increasing plant density delayed emergence flowers, spike bloom and reduced reproductive period is observed by Daynard and Muldoon [14]. Lang *et al.* [15] reduced the percentage of sterile plants with reduced nitrogen consumption and density reported. Rudha and Al-younis [16] observed an increase in nitrogen consumption significantly decreased the time needed for the emergence of flowers.

The aim of this study was to investigate the effect of nitrogen levels and plant density on some of physiological traits of durum wheat.

MATERIALS AND METHODS

In order to investigate the effect of nitrogen fertilizer levels and plant density on some physiological traits of durum wheat Seimareh cultivar, an experiment based on randomized complete block design was conducted at the agricultural research station of the Islamic Azad University, Ardabil branch, Ardabil, Iran in 2009 growing season with three replications. Factors included nitrogen levels: 0, 60, 120 and 180 kg ha^{-1} and plant densities: 300, 350 and 400 plant m^{-2}. The research center in which the work was carried out was located in north-western of Iran with the elevation of 1350 meters of sea level (48°, 20' E, 38°, 5' N). The weather of the region is very cool in winters and rather warm in summers. Soil of the location was loamy- clay with a pH of 7.7 and the depth of 70 cm. grain s were prepared from the agricultural organization, Germy, Iran. Surface sterilization of grain s was performed using Diniconazol fungicide before planting. Grain s were placed at the depth of 3-4 cm by spacing 15-25 cm apart on 10 rows each 4 meter length. The first irrigation was done after planting and the rest, while the plant needed, based on the different plant requirements and environmental conditions. Mechanical and chemical weed controlling were executed during the season. Amount of $^1/_3$ total applied nitrogen was applied at the planting time and the rest, was used as surface spread in the spring after the weather began to be warmer coincide with the tillering stage, 2 times. To investigate the date of appearance of several growing stages, following records were performed [17]:

Vegetative Growth Period: From the planting date to the 50 percent flowering stage.

Reproductive Growth Period: From the flowering date to the physiological maturity.

Ripening Period: From the planting to the beginning of 50 percent plants turn to yellow.

At the end of the growing plant and the plant fully arrived, measuring yield and yield components, followed by calculation of nitrogen agronomic performance of durum wheat, one of our most important goals in this project was about 1.5 m of each plot to remove the margins, on the floor and put into bags and were transferred to the laboratory and using these samples yield and yield components of some morphological traits, plant dry weight and some other traits were measured. Data were subjected to analysis by SAS and mean companions were performed using the Duncan's multiple range test procedure. Also, graphs were drawn in Excel software.

RESULTS AND DISCUSSION

Vegetative Growth Period: The growth length period of wheat was affected by the plant populations and nitrogen levels. (Table 1). Results of the analysis of variance (data not shown) showed that there is a significant difference ($p<0.01$) between the nitrogen levels and plant populations but there was no significant difference for the interaction effect of these treatments.

The longest and shortest vegetative growth period were gained at the 300 and 400 plant m^{-2}, respectively. With increasing the nitrogen amounts, length of this period was increased so that, the longest one was obtained by application of 180 kg ha^{-1} nitrogen. However, there was no significant difference between the 60 and 120 kg ha^{-1} nitrogen on this trait, but with increasing the nitrogen levels and decreasing the plant populations,

Table 1: Effects of plant density and nitrogen levels on measured traits

Treatments		Vegetative growth period (day after planting)	Reproductive growth period (day after planting)	Ripening period (day after planting)	Straw dry weight per square meter (g)	Spike dry weight per square meter (g)	Number of spike in one square	1000 grain weight (g)	Grain yield per square meter (g)	Harvest index (%)
Nitrogen fertilizer	0	173.66c	55.66b	227.94c	1543.72c	801.65d	404.83b	48.66c	647.08c	42.44c
levels (kg ha^{-1})	60	177.44b	56.55ab	241.05b	1671.36b	901.61d	476.79a	52.33ab	833.81a	49.88ab
	120	178.00b	58.33a	243.94b	1804.48a	942.78a	493.17a	54.33a	892.65a	51.93a
	180	183.77a	56.88ab	259.63a	1560.03b	848.72c	447.91ab	51.22b	745.71b	47.86b
Plant density	300	181.07a	53.00c	240.22a	1487.76b	787.69c	386.06c	53.66a	676.40c	46.31b
(plant m^{-2})	350	177.50b	57.58b	242.97a	1507.75b	815.33b	432.67b	50.83b	753.42b	51.02a
	400	176.08b	60.00a	246.22a	1939.19a	1018.04a	548.28a	50.41b	909.63a	46.76b

*Numbers with the same words in each column, have no significant differences to each other.

the length of vegetative growth period was increased (Table 1). Higher amounts of nitrogen resulted in the increase in the growth of the aerial parts and delayed the period [18, 19]. Lang *et al.* [15] observed that with increasing the plant population over the favorable point, this period is delayed one day.

Reproductive Growth and Ripening Period: Results revealed that plant populations and nitrogen levels significantly ($p<0.05$) affected the reproductive growth period, respectively. With increasing plant population, this period was decreased so that, in 300 plant m^{-2}, the shortest and in 400 plant m^{-2}, the longest one was achieved (Table 1).

Based on the some researches performed on the reduction of the mentioned period caused by the higher rates of plant population, it seems that at lower populations, the stronger growth of the leaves and lateral stems may result and hence, the incident light radiation needed for the better photosynthesis is increased and eventually, the more suitable growth of the flowering buds is prepared [15, 19]. Accordingly, the beginning of the reproductive period starts with the flowering so, it is logical that with increasing plant population, the length of the reproductive growth period increases.

Also, it was found that nitrogen amount up to the 60 kg ha^{-1} decreased this period but increase in nitrogen application higher than this amount increased the period so that, the longest one was achieved at the level of 120 kg ha $^{-1}$ (Table 1).

Nitrogen significantly ($p<0.01$) affected the length of the ripening period and simple effect of plant population and interaction effect of plant population × nitrogen level was not significant on this trait. Increase in the nitrogen application increased the length of this period, but there was no significant difference between the 60 and 120 kg ha^{-1} usage. The longest and shortest time to the ripening were gained at the levels of 180 kg ha^{-1} nitrogen and control, respectively (Table 1). It seems that increase in nitrogen application may improve the vegetative growth and hence, plant come to senescence later and ripening happens with delay.

Straw and Spike Dry Weight per Square Meter: Dry straw and spike wheat away studied in this experiment affected the density and nitrogen levels were, between fertilizer levels N, density and interaction density levels of nitrogen level of 1 percent are a significant difference. Most dry straw and spike in the density of 400 plants per square meter and the lowest density of 300 plants per square meter was obtained. Effect of increased nitrogen levels in dry straw and spike is grown and the most dry straw and spike in the use of 120 kg N ha^{-1} respectively. Increasing the level of nitrogen fertilizer to 120 kg ha^{-1} and with increasing plant density per unit area, the highest dry straw and spikes were obtained (Table 1). The interaction density for levels of nitrogen fertilizer was also the highest dry weight of straw and spike combination treatments in the density of 120 kg of nitrogen fertilizer plant in the 400 meters and the lowest value of this trait in the combined density of 300 plants per treatments m fertilizer levels were seen (Fig. 1 and 2). Nitrogen is the most important element of land facing wheat and nitrogen at different growth stages of wheat by increasing the number of tillers per plant, ear number per unit area, number of grains per spike, grain weight and material accumulation dry grain yield is increased [17].

Number of Spikes / m^2: ANOVA results showed that among different levels of nitrogen fertilizer, density and interaction density levels of nitrogen fertilizer per unit area for a number of spikes on 1 percentage level there are significant differences. Most spike plants in the density of 400 m^2 and the lowest density of 300 plants / m^2 was obtained. Increasing levels of nitrogen increased the number of spikes and most use of spike in the 120 kg N ha^{-1} respectively. With increasing the level of nitrogen

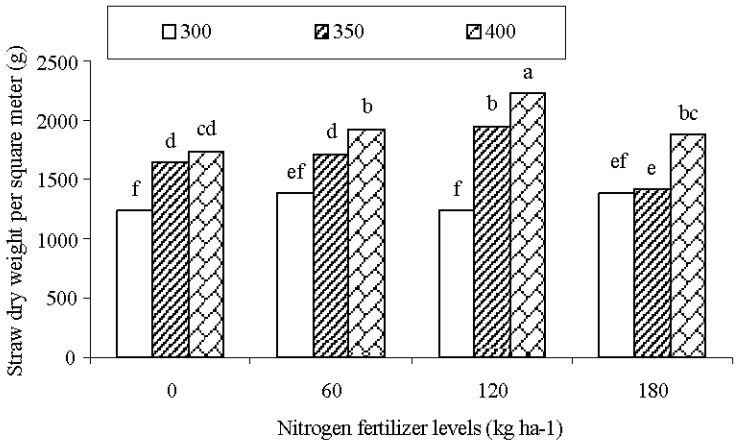

Fig. 1: Straw dry weight per square meter as affected by N and plant density.

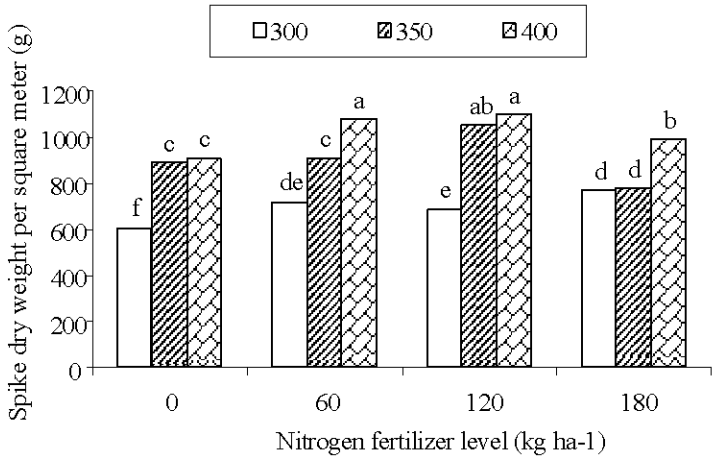

Fig. 2: Spike dry weight per square meter as affected by N and plant density.

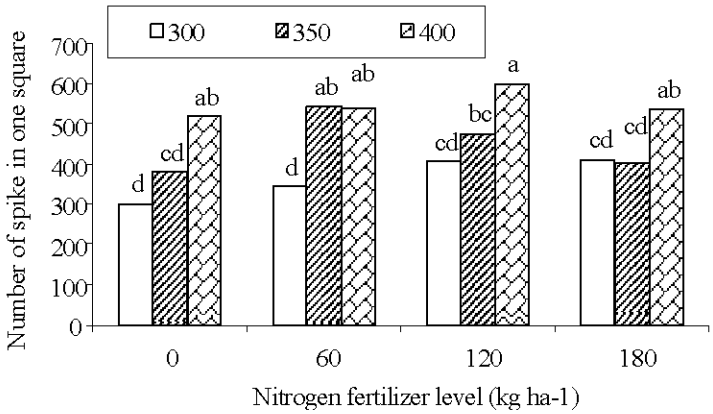

Fig. 3: Number of spike in one square meter as affected by N and plant density.

fertilizer to 120 kg ha^{-1} and with increasing plant density per unit area, number of spikes was increase (Table 1). Hashemidezfooli *et al.* [20] reported that spike numbers was increased per unit area with increasing nitrogen fertilizer. The interaction between plant density and nitrogen fertilizer, with increasing the level of nitrogen fertilizer to 120 kg ha^{-1} and with increasing plant density per unit area to 400 plant / m^2, number of spikes was increase and the lowest value of this trait was obtained in plant density of 300 plant / m^2 with fertilizer control, respectively (Fig. 3).

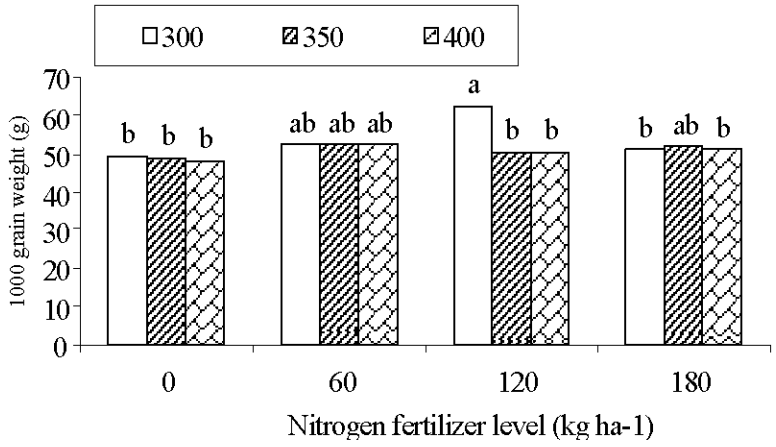

Fig. 4: 1000 grain weight as affected by N and plant density

1000-Grain Weight: The highest plant density of 300, 1000 grain weight in plants /m^2 and the lowest density of 400 plants /m^2 was obtained and this was while the density of 350 plants with 400 plants /m^2 were in a statistical group. Some researchers to reduce the effect of 1000 grain weight increased plant density have noted [14]. The interaction density × nitrogen fertilizer was the highest 1000 grain weight in 120 kg nitrogen fertilizer and plant density of 300 /m^2 and the lowest value of this trait was obtained in plant density of 400 plants /m^2 in control fertilizer, respectively (Fig. 4). Increasing of nitrogen, increased 1000 grain weight and 1000 grain weight in 120 kg N ha^{-1} respectively. In fact, with increasing of nitrogen fertilizer up to 120 kg ha^{-1} and with increasing plant density in m^2, the highest was obtained the 1000 grain weight (Table 1). Nitrogen at different growth stages of wheat by increasing the number of tillers per plant, number of grains per spike, 1000 grain weight and dry matter accumulation increased the yield [17, 19].

Grain Yield /m^2: ANOVA analyses showed that there is a significant difference among different levels of nitrogen fertilizer and plant density in 1 percent level in main effect and for interaction effect of plant density × nitrogen fertilizer there is significant difference in 5 percent level for grain yield /m^2. The highest yield was obtained in density of 400 plants /m^2 and the lowest yield was obtained in density of 300 plants /m^2. The effect of N fertilizer increased grain yield increased. The highest yield was obtained in the use of 120 kg N ha. Meanwhile, the levels of 120 kg with 60 kg nitrogen level in one group were analyzed. Whit increased nitrogen fertilizer more than 120 kg grain yield was reduced. Increasing the level of nitrogen fertilizer to 120 kg and with increasing plant density per unit area was obtained the highest grain yield (Table 1). Jamaati-e-Somarin *et al.* [18, 21] and Panahyan-e-Kivi and Jamaati-e-Somarin [19] also reported results are quite similar. The interaction density levels of nitrogen fertilizer also observed that the open highest yield in the combined treatments of 60 and 120 kg of nitrogen and density of 400 plants /m^2 and the lowest value of this trait in combination treatments density of 300 plants /m^2 in the control fertilizer was obtained (Fig. 5). Mazaheri [22] reported that whit increasing N increased the grain yield. Cuomo *et al.* [23] reported that increasing plant density per hectare yield increases. Hamidi and Dabagh Mohammadinasab [24] also argue that the gap between high density and peak bloom corn pollination and therefore increases the rate of inoculation of grain s per plant decreased, but the loss of yield per plant per unit area increases whit increasing number of plants.

Harvest Index: Analysis of variance related to harvest index showed that plant density in the 5 percent level, nitrogen levels and plant density × nitrogen of levels is statistically significant in 1 percent level probability. For interaction effect of density and nitrogen fertilizer levels were determined in the combined treatments in 180 kg nitrogen per hectare in the density of 350 plants m^2 was obtained the highest harvest index (Fig. 6). With increasing plant density, harvest index was significantly decreased. So, the highest harvest index was obtained in plant density of 350 plants m^2 and densities of 300 and 400 plants m^2 jointly were showed lowest harvest index (Table 1). Reddy *et al.* [7] reported that increasing plant density in corn, harvest index decreased. Cox and Cherny [8] were observed with increasing density, harvest index decreased. While some researches have expressed the harvest index were not affected by plant density [24].

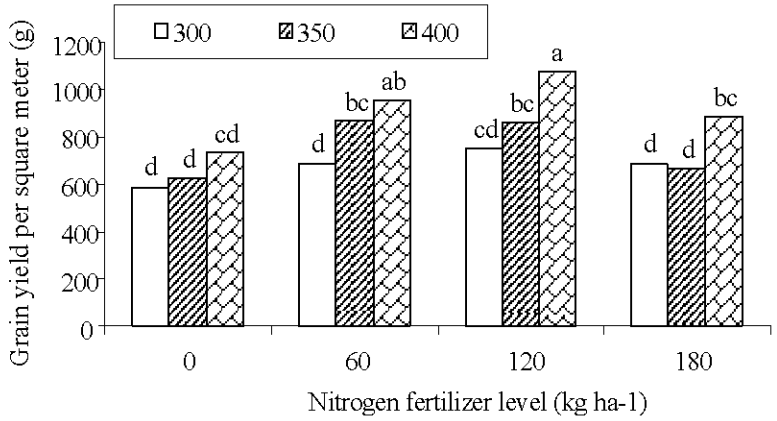

Fig. 5: Grain yield per square meter as affected by N and plant density.

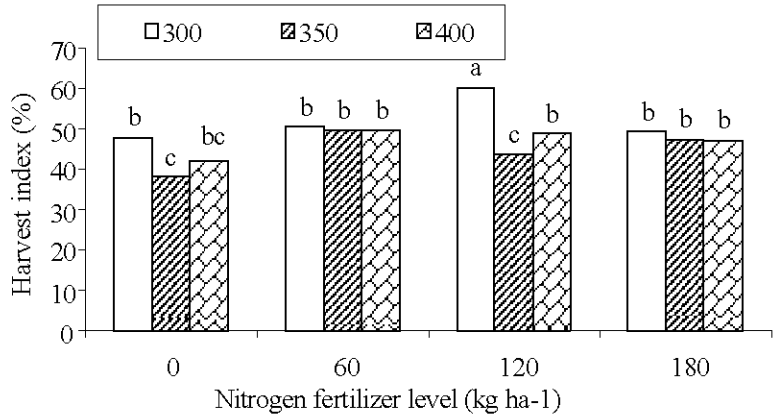

Fig. 6: Harvest index as affected by N and plant density.

Pooruoseph *et al.* [25], reported that effect of planting pattern and plant density on yield and yield components of two varieties of hybrid corn were investigated and concluded that the density does not affect harvest index. The observed increase in nitrogen harvest index is increased and thus the maximum of harvest index was obtained in the level of 120 kg fertilizer per hectare. Although the control level of nitrogen, allocated to the lowest (Table 1).

Reddy *et al.* [7] and Panahyan-e-Kivi and Jamaati-e-Somarin [19] reported that whit increased nitrogen fertilizer harvest index increase too. Meanwhile, the Hamidi and Dabagh Mohammadinasab [26] in their study reported that increasing nitrogen fertilizer the harvest index decreased because it was mentioned that this kind of nitrogen fertilizer stimulates growth and increases been growing sector and thus to reproductive parts in plants increases. Including other factors affecting the value of harvest index, genotype and rate of nitrogen fertilizer is used. With increasing nitrogen fertilizer rate and harvest index decreased in the nitrogen effect on increasing the biological yield and the economic yield lower than biological yield increase therefore of harvest index decreased [9].

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