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Response of Phenology and Dry Matter Remobilization of Durum Wheat to Nitrogen and Plant Density

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Abstract: In order to investigate influence of different nitrogen levels and plant densities on phenology and dry matter remobilization of durum wheat Cv. Seymareh, a split plot experiment based on randomized complete block design whit three replications was conducted at agricultural research station, Islamic Azad University, Ardabil branch, Iran in 2009-2010. Main plot included three densities (300, 350 and 400 seed m^{-2}) and sub plots contained four nitrogen levels (0, 70, 140 and 210 kg ha^{-1} N). Results showed that whit increasing nitrogen levels, length of vegetative growth period increased and dry matter remobilization in to grain and its impact of grain yield was decreased. Also, the length generative growth and ripening period and grain yield were obtained using 140 kg ha^{-1} N and excess rates, decreased grain yield. Whit increasing plant density, all measured traits were increased. As results to increase remobilization and grain yield, prevent of environmental pollution and decrease in fertilizer application as excess cost, application of 140 kg ha^{-1} N in 400 plant m^{-2} density (whit conditions of this research), is recommended.

Key words: Remobilization · Plant density · Phenology · Nitrogen and durum wheat.

INTRODUCTION

Phenology consists of timing study of biological events, instruments and biological and non - biological causes of this timing and evaluation of them [1]. Wheat reaction to density a more than row plants. In cereals, low rate of seed is produced due to high competition for light and water in higher densities Amount of N distribution is effective on rate and assignment of it inside the plant [2]. High soil fertility or increase in N application causes the higher plant growth and consequently, seed yield in maize [3]. Plant density has the crucial impact on the length of different phonological stages in maize [4]. With increasing plant density, delay in flowering, earring and decrease in reproductive period length in deserved [5]. Lang *et al.* [6] reported decrease in infertile plants number with increasing N and decreasing plant density. Rudha *et al.* [7] found that increase in N application resulted in significantly decrease in the required time to flowering. Density can influence the leaves and shoots by impacting on the nutrient elements, waters solar radiation and plant phonological stages. Permanent cool-season grasses and small-seed cereals produce new complete leaves each 6 to 10 days of experience optimal environmental conditions while this time reaches 4 to 6 days in maize and warm-season cereals [2]. Low temperatures may postpone vegetative and flowering period lengths via increase in the required time to leaf emerge and hence, limit the availability of nutrients for plant [8, 9].

Movement of photosynthelically substances from the sources to sinks or usage places depends on both the production of these matters and sinks capacity that may result in the yield loss if there is no balance between them. While source potential for assimilates decreases, share of the components moving again to the seeds, in creases [10]. All vegetative organs may refer to as sink, at least in part of their growth period reserving photosynthetic substances. As there is close relation between photosynthetic are a and amount of reserved matters in plant, so, changes in the environmental conditions which affect photosynthesis, may influence making and replacement of the soluble carbohydrates. For example, if producing photosynthetic matters restricted dne to high density and shading, remobilization of stem reserves increases to compensate for photosynthesis decline [11]. Uhart and Andrade [12] suggested that decrease in soluble carbohydrates remobilization as a result of, shading, may be attributable to growth decrease and lower physiological demand for assimilates. Part of seed carbohydrates of maize is supplied via remobilization from

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stem [13]. Main sources for carbon in plants include current photosynthesis in leaves and other green organs such as items, spikes and awns. Also, this involves remobilization of stored matters in vegetative parts prior to anthesis [14]. przulj and Momcilovic [15] showed in an experiment on barley that among plants, some cultivars under optimal conditions, lost a large amount of their reserve substances stored in vegetative parts from flowering to ripening indicating that substantial part of dry matter prior to flowering, is assigned to other sinks except seeds. Also, those cultivars assign more matters reserved before flowering, caused lower yields, however, correlation between transferred dry matter and seed yields, however, correlation between transferred dry matter and seed yield was significant.

The aim of this work was to evaluate impact of N and plant density on phenology and dry matter remobilization in Durum wheat.

MATERIALS AND METHODS

In order to investigate influence of different nitrogen levels and plant densities on phenology and dry matter remobilization of durum wheat Cv. Seymareh, a split plot experiment based on randomized complete block design whit three replications was conducted at agricultural research station, Islamic Azad University, Ardabil branch, Iran in 2009-2010. Main plot included three densities (300, 350 and 400 seed m^{-2}) and sub plots contained four nitrogen levels (0, 70, 140 and 210 kg ha^{-1} N). To determine chemical and physiological traits of the soil of the site, sampling was carried out from the depth of 0-30 cm. Results of the soil analysis has been shown in Table 1.

After surface sterilization, seeds were planted at the depth of 3-4 cm a rows with a distance of 15-20 cm apart. Sub-plots included 10 growing rows each 4 meters at which; different densities were adjusted by changing distances between the seeds. The first irrigation applied after planting and the rest, depending on the environmental circumstances and plant requires weed control was done mechanically and chemically. One third of N was applied pre-plant and the rest as top dress in spring at stem stage [16]. To evaluate appearance dates of some organs, recounting were done as follows [17]:

Length of the vegetative period: from planting to 50% flowering.

Length of the reproductive period: from flowering to physiological ripening.

Physiological ripening: from planting to being sot plants yellowish.

To evaluate the rate of remobilization and share of it in seed yield, amount of transferring of dry matters to the seeds from pre-earring to physiological ripening stages was measured. So that, at pre-earring, in main rows of each plot, some alike plants were marked and from earring to physiological ripening, three plants in three or for day intervals were taken from each plot.

Harvested plants then separated to stem leaf and read and after drying (in oven at 75.c for 72 hour more to constant weight) were weighed and eventually, dry matter remobilization and other traits, were calculated [18, 19, 20]. In following equations, respiratory drop has not been considered and supposed that respiration in this work is same for the environmental conditions. Ehdaie and Wanies [21] have accepted such suggestion in evaluation of genetic variation and dry matter remobilization in wheat.

$$M\ D_m\ A_p\ H - D_m\ Ap_{(ES)} = D_m R_{(S)}\ P_r$$

Where$_3$ M = maximum, D_m = Dry matter, A_p = Aerial parts, H= Harvest Ap (ES) = Aerial part except seed, R(S) = Remobilization to seed, Pr = physiological ripening.

Remobilization (seal yield) = Dry mater transferring to seed / seed yield*100

At the end of plant growth, while they ripped completely, crop of the 1.5 m^{-2} from each plot was clipped from the soil level, placed in the bags and transferred to the laboratory for yield measurement.

Data were subjected to analysis by SAS, graphs were drawn in Excel and mean comparisons were done using Duncan's multiple range test software.

RESULTS AND DISCUSSION

Length of the Vegetation Growth Period: Length of the vegetative growth period was affected by plant density, N level and N level*plant density interaction. Results showed that there was significant (P<0.01) difference between N level, plant densities and their interaction on the length of the vegetative growth period.

Table 1: Results of the soil analysis

	Soil structure											
Soil type	And	Silt	Clay	potassium (ppm)	Phosphorus (ppm)	Total N (%)	Organic carbon (%)	Natural matter	Total acidity	Electrical conduction (ds/m)	Saturation percent	Depth (cm)
Loam-clay	31	41	28	460	4.8	0.103	0.97	4.8	7.8	2.66	48	0-30

Table 2: Mean comparisons of N levels and plant densities on some traits at (P<0.05).

Treatments		Vegetative growth period (DAP)	Reproductive growth period (DAP)	Ripening period (DAP) in grain yield (%)	dry matter remobilization to grain (mg)	Share of dry matter remobilization	Grain yield per area (g)
Plant density (plant m^{-2})	300	180.25b	60.00a	240.25b	133.06b	15.39b	873.21a
	350	184.25ab	58.83a	243.08ab	196.08a	21.82a	878.03a
	400	185.16a	60.75a	245.95a	219.27a	26.30a	888.20a
Nitrogen levels (kg ha^{-1})	0	179.33c	57.55c	236.88a	230.22a	24.16a	835.04b
	70	183.11b	59.00bc	242.11a	135.83b	15.90b	845.28b
	140	184.44ab	63.33a	247.77a	187.74ab	22.47a	986.15a
	210	186.00a	59.55b	245.55a	177.41b	22.14a	852.79b

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

The highest and lowest rates were observed in 400 and 300 seed m^{-2}, respectively. As a result of N increment, this period was increased so that the highest rate vas achieved using 210 kg ha N. with increasing N amount and plant density, this period was prolonged (Table 2). Based on the graph resulted for the interaction effect, treatment of 400 seed m^{-2} with no N (Control) resulted the lowest period (Fig 1). Excess rates of N by enhancing growth of aerial parts, prolongs this period [22]. Also, Jamaati-e-Somarin *et al.* [23] reported the some results Lang *et al.* [6] found that as a result of each plant more than optimal density, vegetative growth. Period delayed one day than normal which is in accordance with our results.

Length of the Reproductive Growth Period: Results showed that N levels and interaction of N levels*plant densities had significant (p<0.01) effect on length of the reproductive growth period. Plant density did not show such effect. It was observed that using N up to 140 kg ha^{-1}, increased this period but beyond this amount, reproductive growth period was decreased. The shortest time for this trait was achieved in control (Table 2). In the treatment of 300 seed m^{-2} and control, the lowest and in the 400 seed m^{-2} and 140 kg ha^{-1} N, the highest period length was observed (Fig 2). As with the findings of the researchers about decreasing reproductive growth period as a result of higher densities, it seems that in lower densities, branches tend to grow higher and consequently, amount of absorbed photosynthetically active radiation is increased and in turn, resulted in the enhancement of photosynthetically efficiency. Eventually, this lends to the fast flowering [6]. Since reproductive period is initiated with flowering, it seems that with increasing plant density, length of the reproductive growth period would increase. Jamaati-e-Somarin *et al.* [23] reported the same findings, as well.

Length of the Ripening Periods: Only plant density and interaction of N levels*plant densities were significant (p<0.01) for the length of the ripening period and there and no significant difference for N Mounts increase in plant dainty prolonged this period so that, plant densities of 300 and 400 seed m^{-2} caused the shortest and longest period (Table 2). For interaction effect it was observed that with increasing plant density and N level, this period was prolonged so that, by application of 140 kg ha^{-1} N and 400 seed m^{-2} the longest and without N (Control) and application and density of 300 seed m^{-2}, the lowest period was gained (Fig3). Increase in N application appears to be cause of the plant growth increment and consequently, delays in plant sense cense and ripening the finding is in accordance with Jamaati-e-Somarin *et al.* [23].

Rate of Dry Matter Remobilization into Seed: Results revealed that there was significant (P<0.01) differences among N levels, plant densities and their interaction for the rate of dry matter remobilization in to seed mean comparisons showed that the rate was increases with increasing plant density and decreased with increasing N application (Table 2). Hokmalipour [24] and Hokmalipour *et al.* [25] reported increase and decreased in this trait with increasing plant density and N application, respectively. Treatment of 400 seed m^{-2} and no N application caused the highest amount and in higher rates of N along with the decrease in plant density, it was declined, remarkably (Fig 4). The same results also by Schussler and Westgate [26] have been reported in maize as plant density was increased. Jones and Simmous [27] believe that remobilization increases if plant density, shading and demand for sink is incensed in this work, likely high density has been led to the higher dry matter remobilization due to shading and increase in competition within the plants.

Share of Dry Matter Remobilization in Seed Yield: Plant density and interaction of N levels*plant densities significantly (P < 0.1) affected share of dry matter remobilization in seed yield also, effect of N application was significant (P<0.05) on this traits dry matter remobilization reached from 15.39% in density of 300 seed m-2 to 2630% in density of 400 seed m-2. such trend was

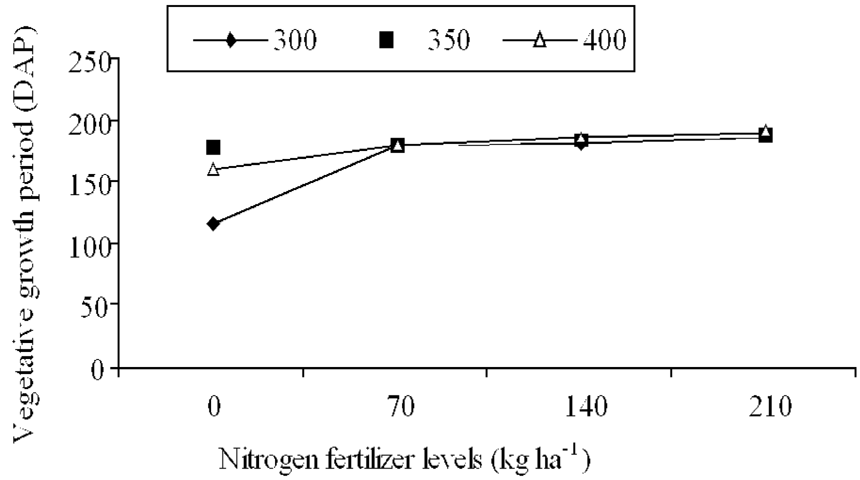

Fig. l: Length of the vegetative growth period as affected by N and plant density

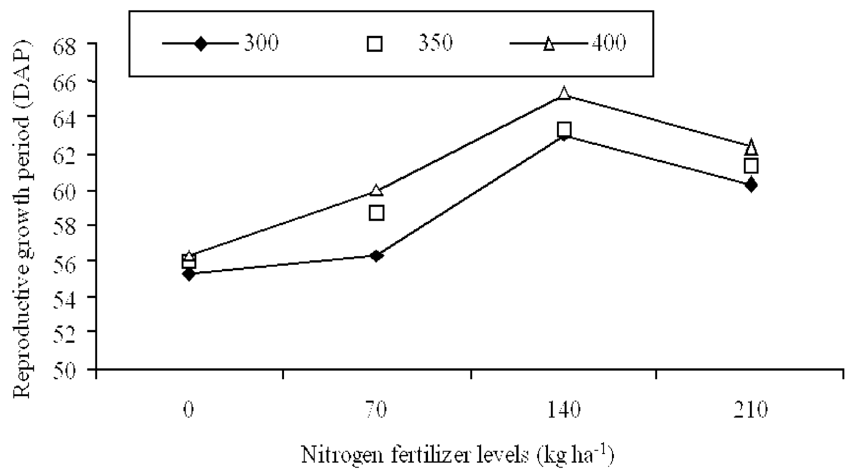

Fig. 2: Length of the reproductive growth period as affected by N and plant density

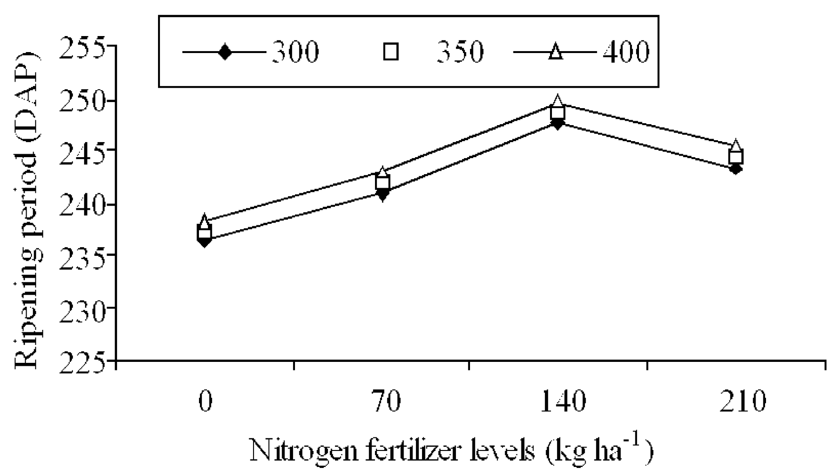

Fig. 3: Length of the ripening period as affected by N and plant density

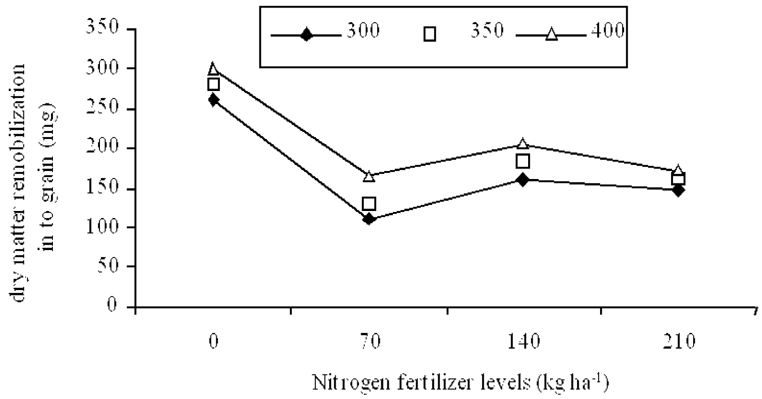

Fig. 4: Rate of dry matter remobilization into grain as affected by N and plant density

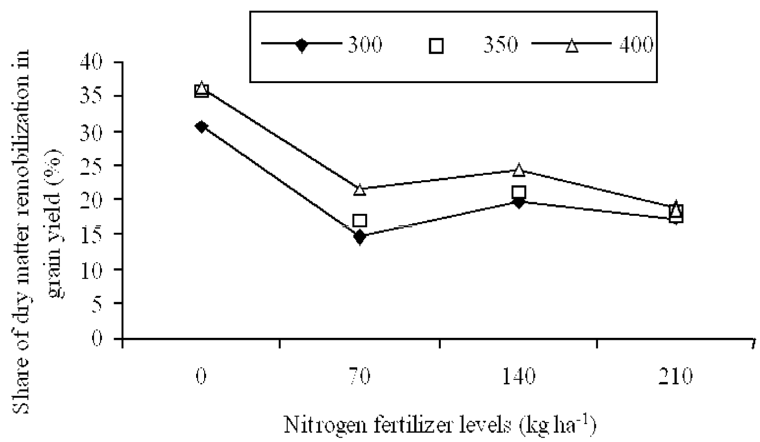

Fig. 5: Share of dry matter remobilization in grain yield as affected by N and plant density

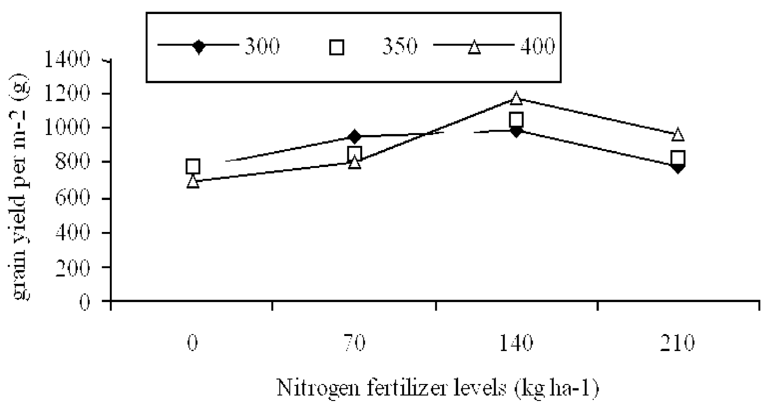

Fig. 6: Grain yield as affected by N and plant density

observed by decreasing N application (Table2). For the interaction effect, the highest value was gained without N application in the highest density of 36.17%. With incensing N levels and decreasing plant densities, decline in this trait was observed (Fig 5) Hokmalipour [24] and Hokmalipour *et al.* [24] have reported the same results. Reserved matters prior to flowering contributed to seed filling up to 90% with an average of 20 to 40% [28]. Yoshida [29] has reported this value up to 50%.

Grain Yield: Results showed that there was significant ($P<0.01$) difference between N levels and interaction of N levels*plant densities on grain yield. Plant density did not show significant effect, however, the highest and lowest grain yield was obtained from densities of 400 and 300 seed m^{-2}, respectively. With increasing N levels grain yield was increased so that the highest yield was observed using 140 kg ha^{-1} N wile, other N levels statistically placed in the same group and increase in N amount more than 140 kg ha^{-1}, led to yield lass with increasing N amount up to 140 kg ha^{-1} along with the plant density, the highest seed yield was achieved. (Table 2). Hokmalipour [24], Hokmalipour *et al.* [25] and Jamaati-e-Somarin [23, 30] have reported the same results. For the interaction effects it was found that in treatment of 140 kg ka^{-1} N in density of 400 seed m^{-2}, the highest seed yield was resulted (Fig 6). Mazaheri [31] reported that increase in N application leads to yield increase.

Cuomo *et al.* [31] found that with increasing plant density, grain yield is increased. Hamidi and Dabbagh Mohammadinasab [33] illustrated that in higher densities, anthesis and tussel initiation take place in a long time from each other in maize and consequently, number of produced seeds per plant is decreased due to lower pollination but this decrease is compensated for the higher number of plants per unit area. Mengel [34] described that the first effect of N application in the field, is increase in size and number of leaves per plant. By incensing number of mature leaves, N cause photosynthesis is increased relative to respiration and hence, yield is increased but in excess rates, over the optimal range, expanding of the vegetative parts highly occurs. Therefore number of leaves placed in the shadow is increased, photosynthesis to respiration ration decreased, loss assimilates transferred to the seeds and more matters consumed by these laves [17].

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