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Investigation Response of Wheat Genotypes to Different level of Nitrogen Fertilizer, Crop Production, Seed Growth Trend and Correlation Between Traits

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ABSTRACT

BACKGROUND: Fertilizer management plays an important role for obtaining satisfactory yields and increase crop productivity. Nutrient management may be achieved by the involvement of organic sources, bio fertilizers, and micro-nutrients.
OBJECTIVES: Current study was done to determine the effect of different level of nitrogen and wheat genotypes on agronomic traits, seed growth rate and correlation between characteristics.
METHODS: Statistical pattern was split plot experiment according randomized complete block design with three replications. Main factor included four levels of nitrogen fertilizer (N_1=60, N_2=120, N_3=180, N_4=240 kg.ha^{-1}, Urea Source) and sub plots consisted four genotypes of Bread (V_1: S85-19 as line, V_2: Chamran) and Durum (V_3: Behrang, V_4: Dena) Wheat.
RESULT: Result of analysis of variance indicated effect of nitrogen fertilizer (instead number of seed per spikelet and 1000-seed weight), genotypes (instead number of seed per spikelet) and interaction effect of treatments (instead number of spikelet per spike, number of seed per spikelet, 1000-seed weight and harvest index) on all measured traits was significant. Correlation between traits showed the significant correlation between biologic yield ($r=0.97^{**}$), seed weight ($r=0.92^{**}$), harvest index ($r=0.91^{**}$), number of seed per m^2 ($r= 0.77^{**}$), number of seed per spike ($r= 0.75^{**}$), number of seed per spikelet ($r= 0.71^{**}$), rate of current photosynthesis ($r= 0.69^{**}$), rate of redistribution ($r= 0.66^{**}$), number of spike per m^2 ($r= 0.62^{*}$), number of spikelet per spike ($r= 0.59^{*}$), contribution of current photosynthesis ($r= 0.59^{*}$), efficiency of current photosynthesis ($r= 0.54^{*}$) and seed yield was observed.
CONCLUSION: The highest grain filling rate belonged to use 240 and 180 kg.ha^{-1} nitrogen fertilizer and Chamran genotype at 27 days after anthesis.

KEYWORDS: *Bread and Durum, Contribution of current photosynthesis, Efficiency of redistribution, Number of spikelet, Seed weight.*

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1. BACKGROUND

Fertilizer management plays an important role for obtaining satisfactory yields and to increase crop productivity. Nutrient management may be achieved by the involvement of organic sources, bio fertilizers, and micro-nutrients (Singh *et al*., 2002). Nitrogen fertilizer is a key nutrient in the production of non-legume crops. It is a component in many biological compounds that plays a major role in photosynthetic activity and crop yield capacity (Cathcart and Swanton, 2003) and its deficiency constitutes one of the major yield limiting factors for cereal production (Shah *et al*., 2003). Studies have shown that long-term use of fertilizers reduces crop yields. This decrease is due to the acidification of the soil, the reduction of biological activity of the soil and the inappropriate physical properties of the soil (Alexandratos, 2003). Chemical fertilizers have several negative impacts on environment and sustainable agriculture. Therefore, bio fertilizers are recommended in these conditions and growth prompting bacteria uses as a replacement of chemical fertilizers (Wu *et al*., 2005). Nitrogen is the most limiting essential nutrient for maize production (Aftab *et al*., 2007). Nitrogen has positive effect on storage of protein in Maize seed and hence, the rates of this element are effective in its distribution in plant (Souza *et al*., 1998). The growth and yield of crop can be adversely affected by deficient or excessive supply of any one of the essential nutrients. However, in intensive agriculture nitrogen is the major nutrient which determining crop yield. Nitrogen as an essential constituent of cell components having direct effect on growth, yield and quality of crop. Plant growth is affected more due to deficiency of nitrogen than that of any other nutrient. Nitrogen fertilization influences dry matter yield by influencing leaf area index, leaf area duration and photosynthetic efficiency (Mohan *et al*., 2015). A low nitrogen content in the soil leads to poor absorption of micronutrients by plants, which may be insufficient for the complete development of the plant tissue (Szulc, 2013). On the other hand, an excessive accumulation of mineral nitrogen in the soil poses a risk of water pollution as a result of nitrate leaching by precipitation (Ladha *et al*., 2005). Nitrogen (N) is essential for all biological process that occurs in the plant. A sub-optimal supply of N limits the expression of yield potentials of green bean varieties (Dauda *et al*., 2015). Nitrogen deficiency is frequently a major limiting factor for high yielding crops all over the world (Salvagiotti *et al*., 2008). The most important role of N in the plant is its presence in the structure of protein and nucleic acids which are the most important building and information substances of every cell. In addition, N is also found in chlorophyll that enables the plant to transfer energy from sunlight by photosynthesis. Thus, the supply of N to the plant will influence the amount of protein, amino acids, protoplasm and chlorophyll formed. Consequently, it influences cell size, leaf area and photosynthetic activity (Walley *et al*., 2005). Therefore, adequate supply of N is necessary to achieve high yield potential in crops. In general, N deficiency causes a reduction in growth rate, general chlorosis, often accompanied by early senescence of older leaves, and reduced yield (Erman *et al.*, 2011). Mckenzie and Hill (1995) studied the effects of two levels of N applications (0 and 50 kg N ha^{-1}) on chickpea and reported that the increase of N rate from 0 to 50 kg N ha^{-1} significantly enhanced seed and dry matter yield, harvest index, number of pods per plant and 1000 seed weight. Nitrogen deficiency generally results in stunted growth and chlorotic leaves caused by poor assimilate formation that leads to premature flowering and shortening of the growth cycle (Lincoln and Edvardo, 2006).

2. OBJECTIVES

Currrent study was done to determine the effect of different level of nitrogen and wheat genotypes on agronomic traits, seed growth rate and correlation between characteristics.

3. MATERIALS AND METHODS

3.1. Field and Treatments Information

This research was carried out to assess the effect of different levels of nitrogen fertilizer on agronomic traits of four wheat geno-types along 2010-2011 in Ahvaz city in south west of Iran. Experimental site located at altitude 31° 36' N and longi-tude 48° 53' E and 51 m above the sea level. Statistical pattern was split plot experiment according randomized com-plete block design with three replica-tions. Main factor included four levels of nitrogen fertilizer (N_1=60, N_2=120, N_3=180, N_4=240 $kg.ha^{-1}$, Urea Source) and sub plots consisted four genotypes of Bread (V_1: S85-19 as line, V_2: Chamran) and Durum (V_3: Behrang, V_4: Dena) Wheat. Nitrogen fertilizer was consumed twice (a half during the greening and the rest during the stem elongation) equally. To determine soil properties, sampling test was done before sowing. Results of soil analysis were shown in table 1.

Table 1. Physical and chemical properties of studied field

Soil depth (cm)	Ec ($ds.m^{-1}$)	pH	Absorbable elements (ppm)			Soil tissue components (%)			Soil type
			Total nitrogen	Phosphorus	Potassium	Clay	Silt	Sand	
0-20	2.7	8.1	740	16.1	210	38.5	44	17.5	Slit clay loam
20-40	2.4	8	380	7.2	120	44.3	42	13.7	

3.2. Farm Management

After ground preparation, the soil feeding process was carried out based on the results of soil sample analysis in the laboratory. Nitrogen fertilizer from urea source was consumed at 252 gram per plot. One-third deduction was applied before planting as basal, next section at end of tillering and final one-third deduction applied at the spike emergence stage. Phosphorus (P_2O_5) fertilizer was obtained from triple super phosphate source and was applied in amount 120 gram per plot at pre-planting stage. Potassium fertilizer was applied from the potassium sulfate source at 120 gr per plot. To combat and try control the broadleaf and narrow leaf weeds, Duplosan Super (2.5 $L.ha^{-1}$) and topic (1 $L.ha^{-1}$) herbicides was used at the end of tillage stage and before use of topdressing fertilizer, respectively.

3.3. Measured Traits

In order to determine the yield two planting lines from each plot harvested and after the removal of marginal effect were carried to the laboratory and were placed in the oven at 75°C for 48 hours and after ensuring that the samples were completely dry, they were weighted and finally the total yield was measured. In order to evaluate remobilization efficiency and contribution and current photosynthesis seven days after flowering from each plot after removing the effects of lateral margin, five plants were harvested and total dry weight was measured. At the end of plant growth grain yield and related traits were calculated using the relationship. Agro-physiological traits were calculated by the following equations (Papakosta and Gagianas, 1991):

Equ.1. $R= Y_2-Y_1$

R= Redistribution of storage material ($gr.m^{-2}$)

Y_2= Dry weight of vegetative organs at anthesis ($gr.m^{-2}$)

Y_1= Dry weight of vegetative organs at Maturity

Equ.2. Efficiency of redistribution ($gr.gr^{-1}$) = R/Y_2

Equ.3. Contribution of redistribution (%) = R/seed yield

Equ.4. Current photosynthesis ($gr.m^{-2}$) = seed yield-redistribution of storage material

Equ.5. Current photosynthesis efficiency ($gr.gr^{-1}$) = Rate of current photosynthesis/dry weight of vegetative organs at anthesis.

Equ.6. Contribution of current photosynthesis (%) = 100-contribution of redistribution (%)

3.4. Statistical Analysis

Data analysis of variance was done via using SAS software (Ver. 8) and the means were compared by Duncan's multi range test at 5% probability level. Correlation between traits was determined by Minitab software (Ver. 15).

4. RESULT AND DISCUSSION

4.1. Result of analysis of variance

4.1.1. *Number of spike per square meter*

According result of analysis of variance effect of nitrogen fertilizer, genotypes and interaction effect of treatments on number of spike per square meter was significant at 5% probability level (Table 2). Researchers reported that the increase in nitrogen consumption increases the number of spikes per unit area, which can increase vegetative growth and, consequently, increase the amount of tillering due to nitrogen consumption. In such a situation, the number of fertilized tillers per unit area increases and the number of spikes per unit area also increases (Mosanaei *et al.*, 2017).

4.1.2. *Number of spikelet per spike*

Result of analysis of variance revealed effect of nitrogen fertilizer and genotypes on number of spikelet per spike was significant at 5% and 1% probability level, respectively but interaction effect of treatments was not significant (Table 2).

Table 2. Result analysis of variance of measured traits

S.O.V	Number of spike per m^2	Number of spikelet per spike	Number of seed per spikelet	Number of seed per spike	1000-seed weight	Seed yield	Biologic yield	Harvest index
Replication	ns	ns	ns	ns	ns	ns	ns	ns
Nitrogen (N)	*	*	ns	**	ns	**	**	*
Genotypes (G)	*	**	ns	*	**	*	**	**
N × G	*	ns	ns	**	ns	*	**	ns
CV (%)	10.71	8.60	7.9	11.8	7.4	12.23	11.49	12.80

ns, * and **: no significant, significant at 5% and 1% of probability level, respectively.

Continue table 2.

S.O.V	Rate of Redistribution	Efficiency of redistribution	Contribution of redistribution	Rate of current photosynthesis	Efficiency of current photosynthesis	Contribution of current photosynthesis
Replication	ns	ns	ns	ns	ns	ns
Nitrogen (N)	*	*	*	*	*	*
Genotypes (G)	*	*	*	*	*	*
N × G	*	*	*	*	*	*
CV (%)	9.85	14.9	11.13	9.42	7.75	6.75

ns, * and **: no significant, significant at 5% and 1% of probability level, respectively.

4.1.3. *Number of seed per spikelet*

According result of analysis of variance effect of nitrogen fertilizer, genotypes and interaction effect of treatments on number of seed per spikelet was not significant (Table 2).

4.1.4. Number of seed per spike

Result of analysis of variance revealed effect of nitrogen fertilizer and interaction effect of treatments on number of seed per spike was significant at 1% probability level also effect of genotypes was significant at 5% probability level (Table 2). The correct and proportional nitrogen application rate of fertilizers increases wheat grain yield by increasing the number of spikes per unit area, and increasing the number of seeds per spike has a lower role in raising the yield (Fowler and Brydon, 2001). According to the research of Mosanaei *et al*. (2017), the effect of nitrogen fertilizer on the number of wheat spikes was significant, which was consistent with the results of the present study. Nitrogen increases the biomass production and increases the possibility of retransmission of photosynthetic materials, producing more seeds per spike and better filling them after flowering, which will increase seed yield (Shanggan *et al*., 2000).

4.1.5. 1000-seed weight

According result of analysis of variance only effect of genotypes on 1000-seed weight was significant at 1% probability level but effect of nitrogen fertilizer and interaction effect of treatments was not significant (Table 2). Sadeghi and Kazemeini (2011) reported increasing the amount of nitrogen application increased the weight of 1000-seed in barley varieties. Since nitrogen fertilizer increases dry matter production and leaf area, barley seed also became heavier with increasing nitrogen application.

4.1.6. Seed yield

Result of analysis of variance revealed effect of nitrogen fertilizer on seed yield was significant at 1% probability level also effect of genotypes and interaction effect of treatments was significant at 5% probability level (Table 2). Some researches realized nitrogen fertilizer can increase vegetative growth and seed yield. A desirable increase of nitrogen can expand the most important factor of seed yield, number of seeds per spike (Fang *et al*., 2010; Khalilzadeh *et al*., 2013).

4.1.7. Biologic yield

According result of analysis of variance effect of nitrogen fertilizer, genotypes and interaction effect of treatments on biologic yield was significant at 1% probability level (Table 2). Naseri *et al*. (2010) reported that the highest seed yield and biologic yield were obtained in 160 and 240 kg $N.ha^{-1}$ with 5100 and 14360 $kg.ha^{-1}$, respectively.

4.1.8. Harvest index

Harvest index is also an important factor in increasing yield, in grains, the increase in biomass has reached its final limit, hence the increase in seed yield through the allocation of more photosynthetic materials to the sink (seeds) is possible, in which case the harvest index will significantly increase (Krishnan *et al*., 2003). Result of analysis of variance revealed effect of nitrogen fertilizer and genotypes on harvest index was significant at 5% and 1% probability level, respectively but interaction effect of treatments was not significant (Table 2). The variability of the harvest index in the plants depends on the difference in the production of the assimilates during the seed filling and retransplantation of the assimilates before the pollination of each genotype and the strength of the reservoir (Nour mohammadi *et al*., 2001).

4.1.9. Rate of Redistribution

According result of analysis of variance effect of nitrogen fertilizer, genotypes and interaction effect of treatments on rate of redistribution was significant at 5% probability level (Table 2). Sources of photosynthetic material for grain filling include current photosynthesis, re-transfer of photosynthetic materials stored in vegetative organs before pollination and redistribution of stored materials in vegetative organs from pollination stage to beginning of linear growth grains (Naderi, 2001).

4.1.10. Efficiency of redistribution

Result of analysis of variance revealed effect of nitrogen fertilizer, genotypes and interaction effect of treatments on efficiency of redistribution was significant at 5% probability level (Table 2). High photosynthetic capacity of the plants under treatment assimilates transfer to the seed and productions of dry matter are the factors that influence the number of fertile spikes. Adding micronutrients to the soil at sensitive growth stages of plant especially at the tillering stage and stem elongation stage will increase the number of spikes per square meter and consequently will enhance the yield (Gastillo *et al*., 1992). Modhej and Mojadam (2006) reported that, biological yield is one of the traits which deeply decrease when nitrogen decrease. The redistribution of the substances stored in transient sources to the sink organs is called remobilization (Gardner *et al*., 2003).

4.1.11. Contribution of redistribution

According result of analysis of variance effect of nitrogen fertilizer, genotypes and interaction effect of treatments on contribution of redistribution was significant at 5% probability level (Table 2). Schneider (1993) stated two types of carbohydrate sources are providing photosynthetic material at grain filling period. Current photosynthetic products are transferred directly to seed and redistribute the photosynthetic materials stored in stored tissues.

4.1.12. Rate of current photosynthesis

Result of analysis of variance revealed effect of nitrogen fertilizer, genotypes and interaction effect of treatments on rate of current photosynthesis was significant at 5% probability level (Table 2). The wheat grain yield mainly depends on the formation, translocation, partitioning and accumulation of assimilates during grain filling period. Also, photosynthetic activity of source (leaves) and storage ability of the sink (grains) after anthesis are the main factors limiting wheat grain yield (Bijanzadeh and Emam, 2010).

4.1.13. Efficiency of current photosynthesis

According result of analysis of variance effect of nitrogen fertilizer, genotypes and interaction effect of treatments on efficiency of current photosynthesis was significant at 5% probability level (Table 2).

4.1.14. Contribution of current photosynthesis

Result of analysis of variance revealed effect of nitrogen fertilizer, genotypes and interaction effect of treatments on contribution of current photosynthesis was significant at 5% probability level (Table 2). Saeedin (2016) evaluated correlation between biological yield and seed yield of cowpea and reported a positive and significant correlation between mentioned traits. Its seem biological yield increased because of accumulation of photosynthetic products and high potential of seeds (reservoir) for absorption and accumulation of dry matter. Therefore, any increases in seed yield also increases the biological yield. However, less dry matter is accumulated in case of micronutrient deficiency, which decreases biological yield.

4.2. Seed growth rate

Grain filling rate changes between different level of nitrogen fertilizer until 27 days after anthesis had an increasing trend and after it decreased. The similar trend has been seen between different wheat genotypes. 240 and 180 kg.ha^{-1} nitrogen had the highest amount of seed weight and the lowest one was for control (Fig.1).

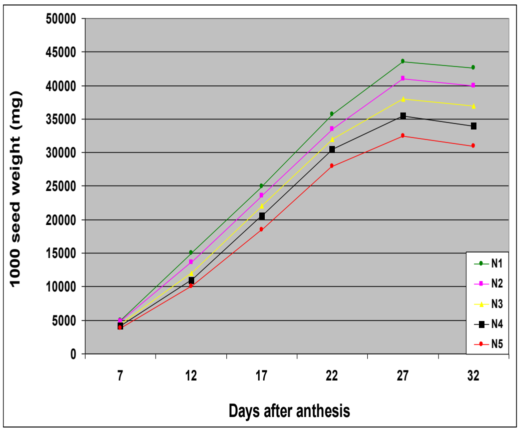

Fig. 1. Compare seed growth rate of different level of Nitrogen. (N1=60, N2=120, N3=180, N4=240 kg.ha^{-1}).

Also Chamran and S-85-19 had the maximum and minimum amount of seed weight between different genotypes (Fig.2).

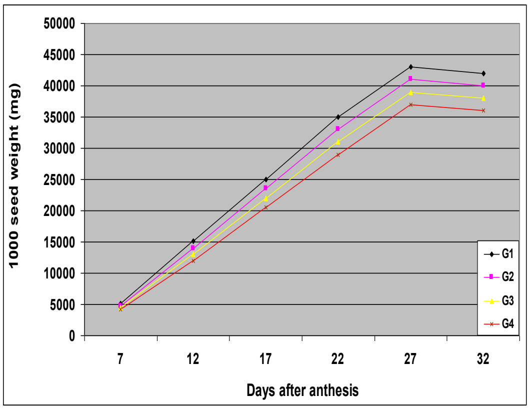

Fig. 2. Compare seed growth rate of different wheat genotypes. (G_1: S85-19, G_2: Chamran, G_3: Behrang, G_4: Dena).

Nitrogen increases the production of biomass and increases the possibility of retransmission of photosynthetic materials, producing more seeds per spike and better filling them after flowering, which will increase seed yield (Shanggan *et al*., 2000).

4.3. Correlation between traits

Correlation coefficient analyses help researchers to distinguish significant relationship between traits (Agrama, 1996). Assessment of relationship using correlation coefficient analyses help breeders to distinguish significant relation between traits. Determination of correlation coefficients is an important statistical procedure to evaluate breeding programs for high yield, as well as to examine direct and indirect contributions to yield variables (Semahegn Belete, 2011). Knowing the relationship among these processes and investigating other quantitative traits make breeding programs and their success more optimistic and secure (Mijic *et al*., 2006). Seed yield is a quantitative trait, which expression is the result of genotype, environmental effect and genotype-environment interaction (Gunasekera *et al*., 2006). Simple correlation coefficients between studied traits were estimated according to Pearson coefficient. Result showed the significant correlation between biologic yield ($r=0.97^{**}$), seed weight ($r=0.92^{**}$), harvest index ($r=0.91^{**}$), number of seed per m^2 ($r= 0.77^{**}$), number of seed per spike ($r= 0.75^{**}$), number of seed per spikelet ($r= 0.71^{**}$), rate of current photosynthesis ($r= 0.69^{**}$), rate of redistribution ($r= 0.66^{**}$), number of spike per m^2 ($r= 0.62^{*}$), number of spikelet per spike ($r= 0.59^{*}$), contribution of current photosynthesis ($r= 0.59^{*}$), efficiency of current photosynthesis ($r= 0.54^{*}$) and seed yield was observed (Table 3).

Table 3. Correlation between traits

Traits	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	-														
2	-0.52*	-													
3	0.59*	0.52*	-												
4	0.61*	-0.56*	-0.51*	-											
5	0.53*	0.61*	0.66*	0.61*	-										
6	0.55*	0.65*	0.69**	0.70**	0.74**	-									
7	0.62*	0.59*	0.71**	0.75**	0.77**	0.92**	-								
8	0.65*	0.63*	0.73**	0.79**	0.82**	0.95**	0.97**	-							
9	0.67*	0.66*	0.75**	0.73**	0.91**	0.84**	0.91**	0.91**	-						
10	0.27ns	0.25ns	0.23ns	0.33ns	0.25ns	0.33ns	0.66**	0.51*	0.48ns	-					
11	0.29ns	0.23ns	0.20ns	0.20ns	0.23ns	0.38ns	0.63*	0.55*	0.43ns	0.51*	-				
12	0.24ns	0.21ns	0.14ns	0.22ns	0.33ns	0.35ns	0.61*	0.50*	0.41ns	0.53*	0.53*	-			
13	0.22ns	0.25ns	0.16ns	0.17ns	0.21ns	0.37ns	0.69**	0.56*	0.49ns	0.57*	0.57*	0.51*	-		
14	0.19ns	0.15ns	0.18ns	0.19ns	0.18ns	0.39ns	0.54*	0.52*	0.47ns	0.59*	0.59*	0.54*	0.50*	-	
15	0.15ns	0.17ns	0.22ns	0.26ns	0.33ns	0.41ns	0.56*	0.53*	0.45ns	0.52*	0.52*	0.56*	0.59*	0.55*	-

ns, * and **: no significant, significant at 5% and 1% of probability level, respectively.

1: Number of spike per m^2, **2**: Number of spikelet per spike, **3**: Number of seed per spikelet, **4**: Number of seed per spike, **5**: Number of seed per m^2, **6**: 1000-seed weight, **7**: Seed yield, **8**: Biologic yield, **9**: Harvest index, **10**: Rate of Redistribution, **11**: Efficiency of redistribution, **12**: Contribution of redistribution, **13**: Rate of current photosynthesis, **14**: Efficiency of current photosynthesis, **15**: Contribution of current photosynthesis.

Some researchers reported the increase of nitrogen causes a significant increase of the number of tillers per plant and fertilized tillers, leaves surface and durability of flag leaf, biological yield, number of spike per square meter and number of seeds per spike and the positive and significant effects of these traits on the seed yield, also a positive correlation between the number of seeds per spikelet and the number of spikelet per spike with the seed yield (Ehdaie and Waines, 2001; Kumar *et al*., 2001).

5. CONCLUSION

The highest grain filling rate belonged to consume 240 and 180 kg.ha^{-1} nitrogen fertilizer and Chamran genotype at 27 days after anthesis.

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FOOTNOTES

CONFLICT OF INTEREST: Author declared no conflict of interest.

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