INNSPUB

International Journal of Biosciences | IJB |
ISSN: 2220-6655 (Print) 2222-5234 (Online)
http://www.innspub.net
Vol. 3, No. 8, p. 116-123, 2013

RESEARCH PAPER OPEN ACCESS

The interactive effects humic acid application and several of nitrogen fertilizer on remobilization star wheat

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Key words: Humic acid, nitrogen, remobilization rate, yield, current photosynthesis.

doi: http://dx.doi.org/10.12692/ijb/3.8.115-123 Article published on August 20, 2013

Abstract

In order to study the effect of the application of Humic acid and different levels of nitrogen on remobilization, production, and yield of star wheat a field experiment was carried out in the region of Viss in the form of split plot and randomized complete block design with four replications in crop year of 2011-2012. Main plots included various levels of nitrogen fertilizer (N0=50, N1=100, and N3=150 kgNha^{-1}) and subplots included the application of Humic acid (H0= lack of Humic acid, H1=foliar spraying at stem elongation stage, H2=foliar spraying at reproductive stage).Results indicated that the effect of nitrogen and Humic acid on leaf area index, grain yield, rate of remobilization, share of remobilization, rate of photosynthesis and share of photosynthesis was significant. The highest amounts of leaf area index, grain yield, remobilization rate, current photosynthesis rate and share were obtained in treatment of 150 kgNha^{-1}. The highest leaf area index, grain yield, remobilization rate, current photosynthesis rate and share were obtained at foliar spraying at reproductive stage. In examining the interactive effect of nitrogen and humic acid on leaf area index, remobilization rate, remobilization rate and share, the difference was significant. Also, at level of 150kgNha^{-1} the difference was significant for grain yield and current photosynthesis share at foliar spraying at reproductive stage but the difference was not significant at level of 100 kgNha^{-1} at foliar spraying at stem elongation stage. Therefore, for economical benefits, the application of 100 kgNha^{-1} along with humic acid foliar spraying at stem elongation stem is recommended.

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Introduction

Grain yield of cereals depends on three carbohydrate sources: photosynthesis, transfer of stored assimilates to the seed before flowering and transfer of stored assimilates to the stem after flowering. During the grain filling stage when current photosynthesis is not able to mee*t al*l the storage needs, plants reserves can be transferred again to the seed through the remobilization process(Yoshida and Parao, 1976; Pirdashti, 1999). Photosynthesis materials are transferred to different parts of the plants after being produced and then turn into different compounds. Most of the reserved compounds are carbohydrates. When the plan enters the seed filling stage it converts starch to sugar and transfers it to the grains. Transfer of assimilates from the place they were reserved to a new place where they are reused is called assimilate remobilization. (Bidinger and Musgrave, 1977; Ellen and Spiertz, 1980; Hossain and Cox, 1990). One of the most important factors for increasing agricultural production which is in line with operations of optimum breeding and optimum cropping is the optimum management of chemical fertilizer consumption. Among various chemical fertilizers, a high correlation has been reported between nitrogen and grain yield (56%) (Delogu and Cattivelli, 1998).

Organic materials are the main factor of soil fertility. According to the conducted experiments, the ideal amount of organic materials of agricultural oil is approximately 4 to 6 percent. Since Iran is located in an arid and semi-arid region, the amount of organic materials in its soil is very low and has low levels of nitrogen. Most plants in these areas lack nitrogen and thus it is necessary to provide nitrogen by means of chemical and organic fertilizers (Malakouti and Homaee, 2004). The application of different kinds of organic acid has increased in order to improve the quantity and quality of agricultural and horticultural products. Small amounts of organic acids have considerable effects on improvement of physical, chemical, and biological properties of the soil. Moreover, hormonal compounds have useful effects on the increase and improvement of agricultural products (Samavati and Malakouti, 2005).

Humic materials include three categories of humic acid, Folic acid, and Humin (Jeyhoni, 2010). Humic acid and Folic acid are extracted from different resources such as soil, humhs, peat, oxidized lignite, coal, etc. which are different in molecular size and chemical structure (Sebahattin and Necdet, 2005). Humic acid with molecular weight of 30-300 kDa and Folic acid with molecular weight less than 30 kDa will respectively cause the formation of insoluble and soluble stable complex with micronutrients (Michael, 2011).Soil fertility greatly depends on the content of organic materials. Humic acid has positive effects on soil and crops and by chelating necessary elements and nutrients it will increase their absorption and increases the soil fertility and the crops yield (Malik and Bahtin, 1979). Considering the fact that supplying nitrogen in terms of quantity and sufficiency whenever the crops need it is one of the most important factors to achieve high quantitative grain yield and with regard to the general hypothesis that different kinds of wheat have different behavior in terms of dry matter remobilization at different conditions of access to nitrogen, this research aims to study the optimum effect of organic fertilizer on remobilization and production components of Star wheat and to create an interactive management of these fertilizers and chemical ones in order to reduce the indiscriminate use of chemical fertilizers and to study the effect of constant concentration of Humic acid and concentration of nitrogen fertilizers on remobilization rate and production components to achieve the best quality of Star wheat.

Materials and methods

This research was conducted in crop year of 2011-2012 in the farm of Sookhtezadeg located in the town of Vissat latitude 31° 36´ north and longitude 48°53´ east and 51m above the sea level. The total annual rainfall is 173.4 mm, the lowest observed temperature is 4°C and the highest temperature is 50°C, the average maximum temperature is 34.3°C and the average minimum temperature is 19.9.

And the average annual temperature is 27.1°C. The maximum relative humidity in the region is 100 and

the minimum is 6 and the average of maximum crop year is 63 and the average of minimum crop year is 21. The total annual evaporation is 3097.8 mm, and the average of crop year evaporation is 258.15mm. The soil of experiment site has syllith-clay texture with Ph=7.59 and CEC=56 d S/m.

The experiment was conducted in the form of split plot and randomized complete block design with four replications. In this experiment three levels of nitrogen fertilizer (N0=50, N1=100, and N3=150 kgNha-1) from Urea source were selected as the main plot and the subplots included the application of Humic acid (H0= lack of Humic acid, H1=foliar spraying at stem elongation stage, H2=foliar spraying at reproductive stage). In order to carry out the experiment on October 7, 2011, the land preparation operation was done including plowing to the depth of 20 cm, making holes to the depth of 15 cm and flatting. After preparation, the farming land was plotted according to the plan. In each plot 9 planting lines were made as long as 6.5 m each. Sowing operation was done manually on November 22, 2011 with the density of 300 seeds per square meter. The land was irrigated immediately after sowing. The weeding was done manually after the seeds germinated and the stems got strong. The amount of humic acid to be consumed in each plot was measured to be 200 P/m and was sprayed to the field with a special 20-liter spraying pump. The first stage of germination was on January27, 2011 and the second stage of reproduction was on March 16, 2011. The grain yield started from the three middle lines as long as 1 meter after eliminating the margins and the total harvest area was 2.25 m2. In order to measure the total weight of dry matter of the shoots during the maturity stage concurrent with the time when spikes completely lost their green color and the plants had died the second sampling was done and after drying the samples in oven their weight was measured like the first samples. The rate and share of remobilization and the rate and share of current photosynthesis was calculated by the following formula.

Dry weight of vegetative parts at physiological maturity stage=yield of total weight of dry matter-grain yield;Dry matter at remobilization process (gr/m2) = weight of dry matter at remobilization process (gr/m2) - dry weight of vegetative parts at physiological maturity stage (gr/m2);

Remobilization share in grain yield (per cent) =

Weight of dry matter at remobilization process (gr/m2) x 100

Grain yield (gr/m2)

Weight of dry mated resulted from current photosynthesis (gr/m2) = grain yield (gr/m2) - weight of dry matter at remobilization process (gr/m2)Share of current photosynthesis in grain yield = 100 – remobilization share in grain yield.

Results and discussion

Leaf Area Index

Leaf area index is the ratio of leaf area of the crop to the area of the ground which is shadowed by it. Results indicated that the effect of nitrogen fertilizer and the application of humic acid were significant at 1% level in terms of leaf area index. (Table4.1). the highest leaf area index belonged to nitrogen fertilizer with an average of 5.975 related to the treatment with 150kgNha-1 and the lowest was to the treatment with 50 kgNha-1 with an average of 4.298 (table 4.2). It seems that the positive effect of nitrogen on the size and lifetime of the leaf increased the leaf area index which was consistent with the results obtained by Robert and Andrew (1994) and Davis (1994). During the different times of spraying Humic acid, the highest leaf area index with an average of 5.413 belonged to reproduction stage and the lowest leaf area index with an average of 4.816 belonged to lack of Humic acid (Table 2). As reported by Sakinejad (2011) and Aiman (2009), the use of humic acid improves morphological traits of the crop and thus increases the leaf area index and reduces the period of slow growth which was consistent with the results obtained by sabzevari and Khazaee (2009). The results showed that the interactive effect of nitrogen fertilizer and humic acid foliar sprayingwas not significant (Table 1).

Grain yield

According to table (1), the effect of nitrogen fertilizer,

humic acid, and the interactive effect of nitrogen fertilizer and Humaic acid on grain yield were significant. The highest amount OG grain yield belonged to the treatment with 150 kgNha-1 with an average of 541.34 gr/m2 and the lowest belonged to the treatment with 50 kgNha-1 with an average of 395.33 gr/m2 (Table 2). As Bohrani and Sarvestani (2006) stated, the yield increase (due to increase of nitrogen consumption) resulted from the increase of yield components specially the number of fertilized spikes per square meter and the increase of grains in spike had a minor role in increasing the yield.

Table 1. Analysis of varian ceTraits in wheat (Leaf Area Index ,Grain Yield, Rate of Remobilization and Current Photosynthesis, Contribution of Remobilization and Current Photosynthesis).

s.o.v	df	LAI	Grain yield (tha-1)	Rate of Remobilization (g/m)	Contribution of Remobilization (%)	Current Photosynthesis (g/m)	Current Photosynthesis (%)
R	2	0/1805	20977n.s	239/68 n.s	90/630 n.s	16928 n.s	9/630 n.s
N	2	6/3981**	48693*	709/16*	90/070*	481/81*	90/070*
Ea	4	0/1119	3909	141/63	8/352	2916	8/352
H	2	0/9031**	30029**	406/63*	48/411**	28009**	48/411**
H* N	4	0/0495 n.s	20822**	80/59 n.s	8/465 n.s	1700 n.s	8/465*
Eb	12	0/0292	2119	48/57	3/624	1742	3/624
CV		3/30	9/7	8/41	10/63	10/66	2/30

n.s: Non-Significant *, **. Significant 5% and 1% probability levels, respectively.

Table 2. Comparison of mean levels of foliar application nitrogen and humic acid on Traits in wheat. (Leaf Area Index, Grain Yield, Rate of Remobilization and Current Photosynthesis, Contribution of Remobilization and Current Photosynthesis).

	LAI	Grain yield (tha-1)	Rate of Remobilization (g/m)	Contribution of Remobilization (%)	Current Photosynthesis (g/m)	Current Photosynthesis (%)
N						
N1: 50 kg	4/ 298b	395/44 c	77/93 b	20/72 a	317/51 b	79/28 b
N2:100 kg	5/253a	484/72 b	83/98 a	17/47 b	400/73 a	82/53 a
N3:150 kg	5/979a	541/34 a	84/97 b	15/60 c	456/36 a	85/60 a
Humic acid foliar application						
Ho	4/816b	407/53 b	79/87 b	20/57 a	327/65b	79/83 b
H1	5/300a	500/71 a	84/39 a	17/02 b	417/32 a	83/38 a
H2	5/413a	513/25 a	82/61 a	16/21 b	430/64 a	84/19 a

Means in each column followed by similar letter(s) are not significantly at 5% probability level using LSD test.

These results were consistent with the findings of Geivani *et al.* (2004), Fuller and Bridon (2001) and Ayoub *et al.* (1994).

In comparing the average of humic acid, the highest grain yield was related to reproduction process and the lowest was related to the lack of humic acid consumption with the average of 513.25 gr/m2 and 407.53 ge/m2 respectively (table 3).As naderi (2002) reported, humic acid enhances crops yield through positive physiological effects such as the effect on metabolism of crop cells and the increase of

chlorophyll concentration. This was consistent with the findings of Sakinejad and Haghighi (2011). On the other hand, zudan (1986) stated that spraying humic materials during the spike growth stage increased the grain yield 7-8 % in relation to control treatment. Due to the interactive effects of two factors, the highest grain yield of the crop was related to the treatments of reproduction stage and consumption of 100 kg nitrogen fertilizer with the average of 563.38 gr/m2 and the lowest grain yield was related to lack of Humic acid and 50 kg nitrogen fertilizer with the average of 311.06 gr/m2 (table 3). Researchers believe that the reason of yield increase in interactive feeding methods is the greater consistency between the usable nitrogen of soil and the crop needs (Maleki *et al.*, 2004).

Table 3. Average comparison interaction time of foliar application nitrogen surfaces on the characteristics of humic acid. (Leaf Area Index, Grain Yield, Rate of Remobilization and Current Photosynthesis, Contribution of Remobilization and Current Photosynthesis).

Nitrogen fertilizer	Humic acid foliar application	Grain yield (tha-1)	Current Photosynthesis (%)
N1: 50 kg	H0: lack of Humic acid	311/06 d	73/39 c
	H1: foliar spraying at stem elongation stage elongation	417/22 c	81/34 b
	H2:foliar spraying at reproductive stage	458/04 b	83/10 ab
N2:100 kg	H0: lack of Humic acid	408/50 cb	81/65 b
	H1: foliar spraying at stem elongation stage elongation	521/53 a	82/95 b
	H2:foliar spraying at reproductive stage	524/11 a	82/98 b
N3:150 kg	H0: lack of Humic acid	503/01 ab	84/46 a
	H1: foliar spraying at stem elongation stage elongation	563/38 a	85/86 a
	H2:foliar spraying at reproductive stage	557/61 a	86/50 a

Means in each column followed by similar letter(s) are not significantly.

Rate of Remobilization and Current Photosynthesis

The effect of nitrogen fertilizer on rate of remobilization and current photosynthesis was significant (table 1). The highest rate of remobilization with an average of 84.97 gr/m2 and the highest rate of current photosynthesis with an average of 456/36 gr/m2 belonged to the treatment with 150 kgNha-1 and the lowest rate of remobilization and current photosynthesis with the average of 77.93 and 317.51 gr/m2 respectively belonged to the treatment with 50 kgNha-1 (table 2). In this trait, by increasing nitrogen fertilizer a noticeable increasing trend was seen in the increase of assimilates redistribution. The optimum use of nitrogen accelerates the leaf growth and assimilates storage which will transfer to the seed during the filling stage. At low levels of nitrogen the leaves grow slowly and the increase of remobilization is not possible which is consistent with the findings of Bohrani and sarvestani (1385).

Current photosynthesis is a process in which the assimilates made by the green parts of the crop specially the flag leaf move towards the seed since the pollination stage till the seed maturity stage and have a direct effect in filling and growth of seeds (Naderi, 2000). It seems like as Zakernejad (2006) stated nitrogen increases the current photosynthesis because of producing more leaf area (Zakernejad) and its more continuity through the delay in leaves aging (Yang *et al.*, 2001). Moreover, nitrogen increases fertile paws and spikes and thus creates stronger tanks for receiving current photosynthesis assimilates; in other words, as long as there are not strong tanks in the plant and the plant need is not increased, photosynthesis doesn't increase either. These results were consistent with findings of Naderi (2000).

The effect of humic acid on the rate of remobilization and current photosynthesis was meaningful (Table 1). The highest rate of remobilization with the average of 84.39 gr/m2 belonged to the treatment of foliar spraying at elongation stage and the highest rate of current photosynthesis with the average of 435/64 gr/m2 belonged to the treatment of foliar sparying at reproductive stage and the lowest rate of remobilization and current photosynthesis with the average of 79.87 and 327.65 gr/m2 respectively belonged to the lack of Humic acid (Table 2). Results indicated that the interactive effect of nitrogen fertilizer and humic acid spraying on the rate of remobilization and current photosynthesis was not significant (Table 1). Contribution of Remobilization and Current.

Photosynthesis

The effect of nitrogen fertilizer on the share of remobilization and current photosynthesis was significant (Table1). The highest share of remobilization with the average of 20.72% belonged to the treatment of 50 kgNha-1 and the highest share of current photosynthesis with the average of 85.60% belonged to the treatment of 150 kgNha-1 and the lowest share of remobilization with the average of 15.60% belonged to the treatment of 150 kgNha-1 and the lowest share of current photosynthesis with the average 79.28% belonged to the treatment of 50 kgNha-1(Table 2). It seems that due to the increase ofleaf area and consequently the increase of current photosynthesis at high levels of nitrogen, the seed dependence on reserved materials of growing parts for remobilization at high levels of nitrogen is limited and thus the share of current photosynthesis is more important at high levels of nitrogen. These results are consistent with the findings of Ghasemi (2002).

The effect of humic acid on the share of remobilization and current photosynthesis was significant (Table 1). The highest share of remobilization with the average of 20.57% belonged to the treatment of lack of Humic acid and the highest share of current photosynthesis with the average of 84.19% belonged to the treatment of foliar spraying at reproductive stage. The lowest share of remobilization with the average of 16.21% belonged to the reproduction stage and the lowest share of current photosynthesis with the average 79.83% belonged to the treatment of lack of Humic acid (Table 2).

Results showed that the interactive effect of nitrogen fertilizer and humic acid spraying on the share of remobilization was not significant, but the interactive effect of nitrogen fertilizer and humic acid spraying on the share of current photosynthesis was significant (Table 1). The highest share of current photosynthesis with the average of 85.50% belonged to the foliar spraying at reproduction stage with 150 kgNha-1 and the lowest share with the average of 73.30% belonged to the lack of Humic acid with 50 kgNha-1(Table 3).

Conclusion

Generally, with regard to the results of the experiment the increase of nitrogen level had a positive effect on the leaf area index and grain yield. Since the optimum use of nitrogen accelerates the leaf growth and the reserve of assimilates it could be concluded that nitrogen increases the current photosynthesis by growing more leaf area ant its more continuity by means of the delay in leaves aging. In fact, due to the increase of leaf area since the pollination stage till physiological maturity the seed dependence on reserved materials of growing parts for remobilization at high levels of nitrogen is limited. On the other hand, at presence of humic acid, more nitrogen from chemical fertilizer is absorbed. Considering the fact that by adding organic materials to the soil, first the organic process and then the mineralization process of nitrogen occurs, adding organic and chemical fertilizers at the same time provides the required nitrogen for the crop and reduces nitrogen waste and then gradually nitrogen can be absorbed by the crop and will be sufficient during the growth of the crop. In the study of the interactive effect of nitrogen and Humic acid on the leaf area index, the rate of remobilization, and the rate and share of remobilization the difference was significant and also the effect on the grain yield, share of current photosynthesis with 150 kgNha-1 at foliar spraying

and reproduction stage was significant but the difference at the level of 100kfNha-1 during the stem elongation was not significant. Therefore, for economical benefit the consumption of 100 kgNha-1 along with humic acid spraying at stem elongation is highly recommended.

Acknowledgements

The authors would like to acknowledge the agronomy Department of Islamic Azad University Ahvaz Branch for its noticeable help.

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