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***Research Article***

# THE EFFECT OF CYCOCEL AND DIFFERENT LEVELS OF NITROGEN FERTILIZER ON YIELD AND YIELD COMPONENTS OF BARLEY

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## ABSTRACT
In order to investigate the effect of cycocel and different levels of nitrogen on quantitative and qualitative traits of southern barley, a split plot experiment in the form of randomized complete block design with three replications was carried out in 2011-2012. The treatments studied in this experiment consisted of the main factor including three levels of nitrogen fertilizer (50, 125, 200 kg/ha) and the sub factor including three levels of cycocel concentration (0, 1500, 3000 mg/l). The results showed that the use of cycocel increased the number of spikes/m2, number of grains per spike, grain yield, biological yield, and harvest index compare to the control treatment. The highest grain yield belonged to the treatments with 124 and 200 kg/ha nitrogen. In general, the results of the research showed that the best level of nitrogen was 125 kg/ha and the best concentration of cycocel was 1500 mg/l.

***Keywords***: *Southern Barley, Nitrogen, Cycocel, Yield, Yield Components*

## INTRODUCTION
Barley which is planted for producing grains is highly used for human and cattle feeding. The forage value of barley grains is comparable to the forage value of maize grains (Noor and Siadat, 2004). The importance of nitrogen in plants is due to its presence in the structure of protein and nucleic acids. Nitrogen overuse increases the plant growth and results in lodging risk, delay in maturity, and plant susceptibility to pests attacks and diseases (Alem *et al.*, 2007). The results of the research conducted by Lak *et al.*, (2010) on the maize hybrid SC 704 showed that the increase of nitrogen application increased the grain yield in maize. Grain yield increase due to the increase of nitrogen application resulted from the creation of a strong reservoir that is greater number of grains and the source activity that is further leaf area index and longer continuity. Different reports have shown that crop growth rate during the silk emergence which is highly associated with the number of grains in grain cereal and ultimately the grain yield is significantly affected by nitrogen application (Sadeghi, 2000). In a research conducted by Hasanzade *et al.*, (2008) to select the best cultivars and lines of arable wheat in terms of yield and efficiency of high nitrogen absorption in two treatments of nitrogen fertilizer (0, 150 kg/ha), from the urea source, they observed that the treatment with 150 kg/ha nitrogen significantly increased the number of grains per spike, 1000-grain weight, the main spike grain weight. Grain yield, and harvest index compared to the control treatment.
Nitrogen fertilizer consumption in grain cereals increases the tiller population density or tillers reproduction and its overall effect is determined by the amount and time of consumption. As a result, the increase of nitrogen consumption, save few exceptions, within the range of the experiment solution (0 to 200 kg/ha) will lead to the increase of spike population during the harvest.
The growth regulating effect of cycocel was first proved by Tolbert (1960) in a wide range of plants and the initial purpose of using cycocel in crop production was limited to its anti-lodging effect. The results of the subsequent research showed that cycocel application even in the absence of lodging would increase the grain yield.
Growth regulators are greatly used for the grain management such as reducing the amount of straw by decreasing the height and consequently increasing the resistance to lodging. They often have helpful effects on quality and quantity of grains while harvesting (Rajala and Synio, 2001). The increase of wheat grain yield due to the application of cycocel results from the increase of the number of spikes per square meter (Shekoufa and Imam, 2008). The most important performance of cycocel is its effect on shortening

the length by changing the anatomical structure. The performance which is achieved by the effect of cycocel is only observed in a low degree of technological quantity of wheat. Shortening of the length indirectly affects resistance capacity to drought by changing and modifying perspiration rate (Sadeghi, 2011).

The results of cycocel application in rice by Sigh *et al.*, (1972) have shown that plant growth retardant cycocel has reduced the height of plants by 23% which has led to the significant increase of grain yield. Moreover, the results of application of cycocel in three cultivars of fall barley showed that timely application of cycocel in barley fields could increase the grain yield (Khaje, 2007).

Raja reported that the use of plant growth regulator cycocel would reduce the stalk growth and lodging and this process would change the demand and distribution of assimilates and cause a larger share of assimilates mobilization into organs such as roots, tillers, spikelet, and ultimately grains and this means the increase of yield.

## MATERIALS AND METHODS

In order to investigate the effect of different levels of nitrogen fertilizer and cycocel concentration on yield and yield components of the southern barley an experiment was carried out in 2011-2012 in the research field of Shahid Salemi 70 km from south Ahvaz at longitude 48°40´E and latitude 31°20´N and 22.5 m above the sea level. Before the experiment, the physical and chemical properties and the texture of soil were determined. The experiment was conducted as the split plot in the form of randomized complete block design with three replications. The treatments studied in the experiment consist of:

The main factor including three levels of nitrogen fertilizer (50, 125, 200 kg/ha) from the urea source and the sub factor including three levels of cycocel concentration (0, 1500, 3000 mg/l). The hormone foliar spray was done at the beginning of stem elongation. Each plot included 7 planting lines as long as 4 m and the space between the lines was considered to be 20 cm. the plots were spaced 1.5 m from each other and the distance for each replication was considered to be 2m.

The optimal amount of phosphorus fertilizer was consumed according to the soil experiment and research center recommendation. After preparing the land the packed seeds were accurately distributed between the planting lines and the rigid planting was done manually on November 26. The planting lines were covered by soil as thick as 3 to 4 cm and phosphorus fertilizer as triple superphosphate was added to the soil as much as 100 kg/ha during the planting.

Cycocel was used during the stem elongation in concentrations of 1500 and 3000 mg/l as the foliar spray.

The grass weeds were cut manually. The harvest time is when the upper nodes of stem are dry, the leaves are yellow, and the grains are hard and the moisture content is about 14%. Considering the plant growth stages and its maturity time, the harvest time was on April 19 after removing the margin from the planting lines. The crop was harvested manually with a sickle in an area of 1m2 in each plot.

In order to measure the biological yield, after the removal of the margin in area of 1m2 the whole plants were harvested and they were weighed and numbered for each treatment separately. In order to determine the number of spikes per area unit, the total number of harvested spikes was counted in an area of 1m2 and was considered as the number of spikes per square meter. In order to measure the number of grains per spike, 20 spikes were randomly separated from the total spikes of the same area of 1m2 and after separating all the grains, they were counted and the number of grains per spike was obtained via dividing the number of grains by the number of spikes. In order to calculate the weight of 1000-grain the seeds were first cleaned and then two 500-seed samples were counted and weighed. In order to measure the grain yield, the total harvested spikes in an area of 1m2 and humidity content of 14% were harvested manually and weighed. The harvest index was obtained through dividing the grain yield by the biological yield in percent.

The data were analyzed by SAS software and the means were compared via Duncan's multi range test at 5% level. In order to draw the diagrams, Excel software was used.

## RESULTS AND DISCUSSION

### *Number of Spikes per Square Meter*

As the nitrogen level increased, the number of spikes/m2 increased significantly. The highest number of spike/m2 belonged to the treatment with 200 kg/ha nitrogen. According to Kazemaini *et al.*, (2008), there is a direct relationship between fertile tillers and the number of spikes per area unit. Numbers of spikes or fertile tillers that are the first components of the yield are controlled genetically and are a function of plant density, tillering strength, and tillers survival. The results of the research conducted by Alam *et al.*, (2007) showed that the decrease of leaf photosynthesis and leaf area index was correlated with the decrease of the number of grains per spike. The observed relationship between leaf photosynthesis and the number of grains per spike led to the assumption that the development of spike for producing grains per spike is directly regulated by the capability of access to assimilates.

**Table 1: The ANOVA results of grain yield and yield components, biological yield, and harvest index of Barley based on the mean of squares**

| Grain yield | Biological yield | Number of grains per spike | Number of spikes per m2 | 1000-grain weight | Degree of freedom | Sources of variation |
|---|---|---|---|---|---|---|
| 8930.2 | 11743 | 18.61 | 2253.0 | 4.92 | 2 | Replication (R) |
| 25628.6 $^{**}$ | 56966 $^{**}$ | 67.07 $^{*}$ | 7380.3 $^{**}$ | 5.19 $^{ns}$ | 2 | Nitrogen |
| 1717.3 | 1216 | 18.52 | 184.7 | 6.34 | 4 | Error a |
| 14009.0 $^{**}$ | 14204 $^{**}$ | 73.63 $^{**}$ | 3580.9 $^{**}$ | 17.11 $^{**}$ | 2 | Cycocel x nitrogen |
| 238.1 $^{ns}$ | 166 $^{ns}$ | 1.71 $^{ns}$ | 123.0 $^{ns}$ | 1.63 $^{ns}$ | 4 | Cycocel |
| 681.4 | 1895 | 4.65 | 158.1 | 2.70 | 12 | Error b |
| 7.17 | 3.63 | 8.29 | 3.44 | 4.98 | | C.V |

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

**Table 2: Mean comparison of grain yield and yield components, biological yield, and harvest index of barley**

| Grain yield (g/m2) | Biological yiel (g/m2) | Number of grains per spike | Number of spikes/m2 | 1000-grain weight (g) | Treatment |
|---|---|---|---|---|---|
| | | | **Nitrogen (kg/ha)** | | |
| 268.06 b | 1144.56 b | 24.08 b | 334.53 b | 33.45 a | a1=50 |
| 354.01 a | 1253.56 a | 26.83 a | 377.97 a | 34.91 a | a2=125 |
| 365.84 a | 1299.44 a | 27.28 a | 388.57 a | 34.55 a | a3=200 |
| | | | **cycocel (ppm)** | | |
| 285.15 b | 1187.22 b | 22.80 b | 350.19 c | 35.59 a | $b_1$=0 |
| 341.64 a | 1248.89 a | 27.22 a | 361.82 b | 34.48 a | $b_2$=1500 |
| 361.11 a | 1261.44 a | 28.16 a | 389.06 a | 32.85 b | $b_3$=3000 |

*Similar letters indicate non-significant difference at 5% level.*

## *Results and Discussion*

The highest number of spikes /m2 belonged to the treatment with concentration of 3000 mg/l cycocel compared to the control treatment and its main reason was the increase of the number of fertile tillers in plant (Alam *et al.*, 2007; Moe and Smith, 1991) stated that application of cycocel in barley increased the number of grains due to the increase of the number of spikes.

### *Number of Grains per Spike*

The effect of nitrogen and cycocel on the number of grains per spike was significant. As the nitrogen fertilizer increased the number of grains per spike increased too (Table 2). The results of the research conducted by Alam *et al.*, (2007) showed that the decrease of leaf photosynthesis and leaf area index was correlated with the decrease of number of grains per spike. The observed relationship between leaf photosynthesis and the number of grains per spike led to the assumption that the development of spike for producing grains per spike is directly regulated by the capability of access to assimilates.

The number of grains per spike in cycocel treatment with concentration of 3000 mg/l increased compared to the control treatment which could be due to the strength increase of the physiological destination before the flowering stage (Waddington *et al.*, 1968).

### *1000-Grain Weight*

The effect of different levels of nitrogen on 1000-grain weight was not significant, but the effect of cycocel on 1000-grain weight was significant. The concentration of 3000 mg/l cycocel decreased the weight of 1000-grain which could be due to the competition between tillers for the photosynthesis materials (Raja and Synio, 2001). The decrease of 1000-grain weight could be due to the fact that application of cycocel led to some factors such as the completion for assimilates between the tillers which had more spikes and grains. The formation of fertile tillers depends on assimilates which have been mobilized from the main stem and in this experiment the highest rate of tillers belonged to this concentration (3000 mg/l). According to the results of some experiments (Peltonen and Sainio, 2001) the weight of single grain might decrease slightly, but due to the increase of number of grains the yield will increase.

### *Grain Yield*

The effect of nitrogen and cycocel on the grain yield was significant (Table 1). The highest grain yield belonged to the treatment with application of 200 kg/ha nitrogen. The highest grain yield also belonged to the treatment with application of cycocel with concentration of 1500 and 3000 mg/l (Raja, 2004). The increase of grain yield due to the increase of nitrogen application mainly resulted from greater number of grains per spike and the increase of number of spikes/m2 and creating more photosynthesis surface which were consistent with the findings of Alem *et al.*, (2007). Nilsson *et al.*, (2002) reported that nitrogen would increase the grain yield.

The results of Table (1) show that the positive and significant effect of cycocel application on the number of spikes per area unit and the number of grains per spike increased the grain yield. The above results were consistent with the findings of Nilsson *et al.*, (2002) and Shekoofa and Imam (2008). Both cycocel and nitrogen caused the increase of fertility of flowers and the formation of more grains and also more continuity of green area of the leaf and more mobilization of assimilates into grains.

### *Biological Yield*

The effect of nitrogen on biological yield was significant (Table 1). The lowest biological yield belonged to the treatment with application of 50 kg/ha nitrogen and the highest biological yield belonged to the treatment with application of 200 kg/ha nitrogen (Table 2).

The positive effect of nitrogen fertilizer on biological yield could be due to its positive effect on the investment of assimilates in leaves and stem and the increase of accumulated materials in grain.

According to Tables 1 and 2 it is observed that the effect of cycocel on grain yield was significant at 1% level. As the cycocel concentration increased, the biological yield increased, too. The increase of biomass due to the effect of cycocel application could result from the development of strong and heavy stems and the increase of number of spikes/m2 which are consistent with the findings of Alam *et al.*, (2007).

In Summary, the results of the conducted research could be referred to as the following:

Mean comparison results of nitrogen treatments showed that the best level of nitrogen application belonged to the treatments with application of 125 and 200 kg/ha nitrogen.
Mean comparison results of cycocel treatments showed that the concentration of 1500 mg/l cycocel was selected as the most desirable level since its effect on the grain yield was not significantly different from the treatment with concentration of 3000 mg/l.

***Conclusion***

The results of the research showed that the treatment with 125 kg/ha nitrogen and concentration of 15000 mg/l cycocel were selected as the most desirable levels which could be recommended for further experiments.

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