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Full Length Research Paper

Effect of potassium humate on early growth of Gobustan wheat variety

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In order to study the effect of potassium humate on germination and seedling growth of Gobustan wheat variety, an experiment was conducted in a laboratory in 2009. Effect of drought stress in levels of 0 and -0.5 MPa polyethylene glycol (PEG) on germination and seedling growth was carried out as two-factor factorial experiment on the basis of completely randomized design with three replications. Factor A including two levels of drought (zero and -0.5 MPa), and factor B including two levels of potassium humate (with and without potassium humate). In this experiment, in standard germination test, traits including germination percentage, germination rate and average germination were measured, while in seedling growth test, traits including seedling length and seedling dry weight were also measured. Results show that stress levels did not have a significant impact on all traits other than germination percentage. Also, levels of potassium humate of dry weight, the average germination period and germination rate had significant effect. Mean comparison (Table 2) also showed that in trait seedling length, the highest amount (6.583 cm) was related to non-stress conditions combined with potassium humate, and the lowest (4.197 cm) was related to stress with potassium humate.

Key words: Bread wheat, potassium humate, polyethylene glycol, germination.

INTRODUCTION

Wheat is the world's most important crop which provides 20% of energy in human diets (Ahmadi et al., 2004). According to Food Policy International Center estimation, global wheat demand will increase greatly by 2020, while available resources are faced with restrictions for crop production. Therefore, it is expected that approximately 100 million tons of wheat supply shortage would exist in the world market in the above mentioned year (Ahmadi et al., 2004). Iran is located in world's desert belt, and considered as the arid and semi arid region. Average rainfall is about 250 mm and this is one third of average rainfall rate in the world, while 1.2% of the world's lands are allocated to Iran. On the other hand, of nearly 18.5 million hectares of agricultural lands, 6.2 million hectares (33.5%) is devoted to dry cultivation. About 1.2 million ha of dry lands under cultivation, more than 400 mm rainfall receives (Mohammadi et al., 2006).

Environmental stresses, especially drought stress plays an important role in reducing plant growth, especially during germination in arid and semiarid regions of Iran. Drought stress occurs when the amount of water intake plant is less than its losses. Drought and salinity stresses in addition to restricting water uptake of seed by affecting fluidity reserves and fetal protein synthesis causes reduced germination (Jevad, 2002). Osmotic and ionic compounds created by the stresses can be effective on these parameters, although, the impact depends on the type of material that causes stress and type of cultivar (Jevad, 2002; Ikeda et al., 2002). Dodd and Donovan (1999) also suggested that PEG as a non-ionic material with high molecular mass that is soluble and non-penetrable in water, prevent water absorption by seeds, but penetrable ions by reducing potential inside cell results in water absorption and starting to germinate. Reduction of osmotic and water potential caused by PEG have positive correlation with proline accumulation, free amino acids, soluble proteins, carbohydrates and phenols and accumulation of these solutions lead to decreased

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osmotic potential and help to keep plant growth in stressed environments (Anonymous, 2010; Daei and Sardari, 2008). In fact, maintaining the osmotic pressure in stressed conditions in tolerant cultivars is crucial for growth (Gharineh et al., 2004).

On the other hand, the optimal effect of humic materials with natural origin has been observed in biotic and abiotic stresses conditions (Mollasadeghi, 2010). Potassium humate increases product quality miraculously, and increases plant tolerance against biotic and abiotic stresses (Ghadimov et al., 2007). Yang et al. (2004) had stated that the humic materials can affect direct and indirect physiological processes of plant growth. Their direct effects including increase in cell membrane permeability, respiration, nucleic acid biosynthesis, ion uptake, enzyme activity and sub-enzyme activity. Humic acid reduces the amount of fertilizer consumption, and makes plant tolerant against heat stress, drought stress, cold, diseases, insects and other environmental and agricultural pressures. Also, production of total plant increases yield, and reinforce the plant stem as well (Anonymous, 2010).

Humic acid has important properties that contribute to increasing rooting and seed germination (Mollasadeghi, 2010). Humic acid is known to stimulate rooting; and it can be applied as pre-planting seed treatment with 2 per 1000 humic acid and fulvic acid to stimulate seed growth. The most important mechanism to stimulate rooting is increasing metabolism and also cells wall permeability to water and food. In addition, keeping soil warm and keeping moisture may also be involved in this process (Anonymous, 2010). Humic acid effect on root growth is so clear and dramatic that in some cases increases the size of the root several times (Dai and Sardari, 2009). Considering the importance of this subject, we studied the effect of potassium humate on germination and wheat seedling growth.

MATERIALS AND METHODS

This study was performed in the laboratory of Islamic Azad University, Ardabil branch. Effect of drought stress in levels of 0 and -0.5 Mega Pascal (by polyethylene glycol 6000) on germination and seedling growth of Gobustan, a variety from Azerbaijan was carried out as two-factor factorial experiment on the basis of completely randomized design with three replications. Factor A including two levels of drought (zero and -0.5 MPa), and factor B including two levels of humate (with and without potassium humate). In this experiment, in standard germination test, traits including germination percentage, germination rate and average germination were measured, and in seedling growth test, traits including seedling length and seedling dry weight were also measured. Firstly, wheat seeds were disinfected with 3% sodium hypochlorite solution for 2 min. Per Petri dish, 50 seeds were cultured. Germination test was done in germinator with temperature 25°C, 70% relative humidity and light conditions 16 h in lightness and 8 h in darkness.

In order to measure germination indices, the counting of germinated seeds was done on a daily basis and at the end of the last day traits including seedling length and seedling dry weight were measured. Germination rate (Rs), the final germination percentage (FGP) and mean germination time (MGT) were calculated using the following formula:

$$FGP= (Ng / Nt) \times 100$$ (Gharineh et al., 2004)

Ng = total number of Germinated seeds; Nt = Total number of evaluated seeds

Germination rate (Rs) was calculated according to the following equation (Rajabi and Poostini, 2005):

$$Rs= \Sigma\ Si / Di$$

Where, Si is the number of seeds germinated on day i; Di is the counting the days to n

Average duration of germination (MTG) (Andalibi et al., 2005) was calculated as follows:

$$\sum Ni = 100 / CVG / \sum NiTi = MGT$$

Where, Ni is the number of germinated seeds per day; Ti is the number of days to start testing

Statistical analysis

Statistical calculations were performed using MSTATC software and SPSS-16. Charts and statistical tables took place as Excel and Word software. Average under-study traits were compared using Duncan's Multiple Rang test at 5% level.

RESULTS AND DISCUSSION

Germination percent

The results show that the stress levels did not impact significantly on the germination percentage (Table 1). Also, potassium humate did not impact significantly on germination percentage. The lack of significance of this trait may be due to low germination time to show the differences. The results of current study are compatible with results of Akbari et al. (2004) and Kurdazo (2002).

Germination rate:

The results show that the stress levels had significant effect on trait germination rate at probability level of 1% (Table 1). Also this study showed that there was significant difference for levels of potassium humate at probability level of 5%. But interaction between stress levels and levels of potassium humate was not significant. Generally, increasing stress levels would lead to reduced germination rate. Also, when potassium humate was applied, compared to without its application, there was a reduced germination rate in mentioned cultivar. Hence, the present results do not match those of Gharineh et al. (2004) and George and Ray (2004).

Table 1. ANOVA for measured characters.

S. O. V	df	Mean of Squares				
		Seedling dry weight	Seedling length	Average germination period	Germination %	Germination rate
Factor A	1	0.0006**	7.023**	0.827**	208.33^{ns}	0.0004**
Factor B	1	0.00013*	0.011^{ns}	0.437*	48^{ns}	0.0002*
A*B	1	0.000014^{ns}	2.202*	0.066^{ns}	1.333^{ns}	0.000018^{ns}
Error	8	0.00003	0.270	0.059	44.25	0.000022
C.V (%)		0.49	9.70	3.55	7.14	3.19

*and ** Significantly at $p < 0.05$ and < 0.01, respectively; ns = non-significant. A: Drought levels; B: humate levels.

Table 2. Mean comparisons for measured traits.

Characters		Seedling dry weight	Seedling length	Average germination period	Germination %	Germination rate
Drought levels	Normal	1.01^{b}	6.125^{a}	6.607^{b}	97.33^{a}	0.152^{a}
	-0.5	1.024^{a}	4.595^{b}	7.132^{a}	89 ^{b}	0.140^{b}
Potassium humate levels	Potassium humate	1.02^{a}	5.33^{b}	7.06^{a}	91.17^{b}	0.142^{b}
	Non- Potassium humate	1.014^{b}	5.39^{a}	6.678^{b}	95.17^{a}	0.150^{a}

Average germination period

The results show that the stress levels had significant effect on average germination period at probability level of 1% (Table 1); also studies showed that there was significant difference for levels of potassium humate at probability level of 5%. But interaction between stress levels and levels of potassium humate was not significant. Generally, increasing stress levels, the average germination period would be increased. Also, when potassium humate was applied compared to non-application, an increase in average germination period in the mentioned cultivar was observed.

Seedling length

The results show that the stress levels had significant effect on seedling length at probability level of 1% (Table 1), the observed differences is probably because of seedlings growth in longer period than standard germination test and showing differences. Studies also showed that there were not significant differences for levels of potassium humate. But the interaction between stress levels and levels of potassium humate (Figure 1) was also significant at probability level of 5%. Moreover, increase in stress levels results in reduced seedling length. Also, when humate was applied compared to its non-application, it led to reduced seedling length in mentioned cultivar. The results of this study were compatible with the part of the Gharineh et al. (2004) and Malcolm et al. (2003).

Seedling dry weight

The results show that the stress levels had significant effect on seedling dry weight at probability level of 1% (Table 1). The observed differences were probably because of seedlings growth in longer period than standard germination test and showing differences. Studies also showed that there was significant difference for levels of potassium humate at probability level of 5%, but the interaction between stress levels and levels of humate was not significant. Generally, with increasing stress levels, seedling dry weight increased. Moreover, when humate was used compared to its non-usage, this also led to increased seedling dry weight. The results of this experiment are compatible with part of Akbari et al. (2004) and Nedoa and Nykoluva (1999).

In general and according to the results, potassium humate lead to more longitudinal and weight growth of seedling that results in better seedling establishment, plant growth and improved production performance in the field. Hence, we can use and design this natural material in larger scales.

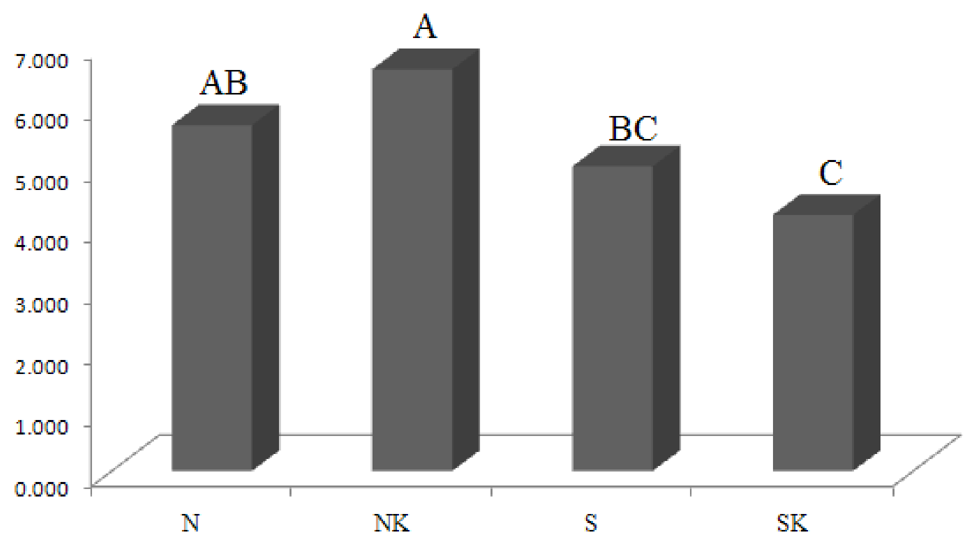

Figure 1. Interaction drought stress levels × humate levels for seedling length.

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