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Applications of potassium humate to wheat for organic agriculture in Iran

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Abstract

Humic preparations are increasingly applied as stimulators in plant breeding. It has been reported that potassium humate (PH) causes increase in crop quality and tolerance of plant against biotic and abiotic stresses. Because of this, we conducted investigations for the determination of the effect of PH on bread wheat genotypes during the last years. In vitro evaluation of the early growth stage showed that genotypes produced different responses to PH and that PH increased the drought tolerance of the genotypes. In a field experiment, we observed that PH increased the average grain yield from 2.49 to 3.61 ton/ha under normal irrigation scheme. Also, it increased assimilate storages of the stem at the anthesis stage under terminal drought conditions. The PH also affected the protein, gluten and alpha amylase activity of the grains under terminal drought condition depending on the genotype. From our findings in different researches, we concluded that potassium humate is a beneficial natural substance for increasing the quantity and the quality of wheat and we can use it for organic production of wheat. Applications of humic substances (HS) may help in achieving of increasing organic food production as HS applications are generally recommended in organic agriculture. Therefore an agro-biotechnology perspective and programming of the HS technology needs to be introduced in our country.

Keywords: Organic agriculture, Quality, Quantity, Wheat, Humic Substances

Introduction

Organic matter in the soil exists in three different forms: 1) Living plant and animal matter, 2) Dead plant and animal matter and 3) decomposed plant and animal matter (humic substances)(Islam et al., 2005).

Humus is defined by Stevenson (1994) as the total organic fraction in soils exclusive of non-decomposed plant and animal material, their partial decomposition products, and the soil biomass. Thus humic substances (humates, humic acids and fulvic acids) make up the bulk of humus (Pizzeghello et al., 2001). Humic substances (HS) are the result of organic decomposition and they are the natural organic compounds which comprise 50 to 90 % of the organic matter of peat, lignites, sapropels, as well as of the non- living organic matter of soil and water ecosystems. These substances are the source of the humates used in agriculture. According to the classical definition, HS are “a general category of naturally occurring heterogeneous organic substances that can generally be characterized as being yellow to black color, of high molecular weight and are refractory” (Kulikova et al., 2005). The HS in soils and sediments can be divided into three main fractions: humic acids (HA or HAs), fulvic acids (FA or FAs) and humin (IHSS, 2009).

The biological activity of HS encompasses all the activities of HS in regulating plant biochemical and physiological processes, irrespective of their stimulatory or inhibitory roles. In spite of numerous studies on the biological effects of HS, the mechanism of their action remains unclear (Kulikova et al., 2005).

The research has confirmed that HS can indirectly and directly affect the physiological processes of plant growth. They provide minerals, increase the micro-organism population, provide biochemical substances, and carry trace elements and growth regulators (Yang et al., 2004).

There are different scientific reports about the application of HS in horticulture and agriculture. Treatment of tomato seeds with 0.01 % Potassium humate solution before planting for 24 hours depending on variety increased the yield about 20 – 25 %. Also, Pre- planting seed treatment of cucumber by 0.01 % potassium humate solution for 24 hours increased the yield about 38 %. In addition, germination time and germination percentage investigated for hazel-nut seeds treated by three concentrations of potassium humate (0.01, 0.02 and 0.03 ml/seed) and two durations of treatment (12 and 24 hours). Depending on the variety, the germination percentage was increased between 37and 64% and the highest germination percentage (53%) observed in concentration of 0.02 relative to the control (43%) (Gadimov et al., 2007, Shahryari et al., 2008a, Shahryari et al., 2008b).

Application of humic acids (as one of the main fractions of humic substances) in agriculture as soil fertilizer and soil conditioner has been extensively discussed in the literature. To date, numerous researches have demonstrated conclusively that HS showed significant impacts on the soil structure and plant growth (Fong et al., 2007). Humic preparations are increasingly applied as stimulators in plant breeding. Humates of brown coal, peat and soils are mostly studied while sapropel humates (bottom organic sediments) are much less known (Perk and Popov, 2007). HA in proper concentrations can enhance plant and root growth (Bacilio et al., 2003).

Several HS have been identified (Islam et al., 2005). In regard to the potential of the HA, continuous development has led to availability of various commercial humic acid based products and they are widely marketed. The HA products are usually available in the form of inexpensive soluble salts, referred to as potassium humate (Fong et al., 2007).

Potassium humate causes an increase in crop quality and tolerance of plant to drought, saline, cold, diseases and pests stresses (Gadimov et al., 2007).

The main objective of the present investigation was to evaluate the possibility for the application of a humic substance as potassium humate in wheat for organic agriculture production in Iran.

Materials and Methods

A field experiment was done for evaluation of grain yield affected by potassium humate under normal irrigation condition in Agricultural Research Station of Islamic Azad University, Ardabil branch (north west of Iran). Soil properties of farmland presented table 1.

Table 1: Physiochemical properties of farmland soil

EC (ds/m)	pH	SP (%)	TNV (%)	Clay (%)	Silt (%)	Sand (%)	Tex.
2.01	7.68	42	6.024	26	36	38	Loam
OC (%)	N (%)	P (ppm)	K (ppm)	Zn (ppm)	Fe (ppm)	Cu (ppm)	Mn (ppm)
0.78	0.08	5.43	440	2.56	0.202	0.9	0.17

Six wheat genotypes were investigated in a factorial experiment using a completely randomized block design. Genotypes were Gascogen, Sabalan, 4057, Ruzi-84, Qobustan and Saratovskaya-29. The first factor was 'genotype' and the second was the addition of potassium humate derived from sapropel (Table 2) at a given irrigation systems (well watered; well watered+ potassium humate).

Table 2: Compounds of potassium humate derived from sapropel

N (%)	P (%)	K (%)	Humus (%)	pH	N-NH ₄ (mg/L)	N-NO ₃ (mg/L)	P ₂ O ₅ (mg/L)	K ₂ O (mg/L)
2.8	0.4	10.0	5	8.2	460	890	890	8600
MgO (mg/L)	Cu (mg/L)	Zn (mg/L)	S (mg/L)	Fe (mg/L)	Mn (mg/L)	B (mg/L)	Mo (mg/L)	Co (mg/L)
620	4.5	11.5	400	15	10	2	2	1

Treatments by potassium humate derived from sapropel (1ml/l) were done at four stages: 1) on seeds prior to planting 2) at the tillering stage 3) at stem elongation 4) after anthesis.

Chemical fertilizers were not used for any purposes in these investigations. Grain yield was measured after harvesting. Analysis of Variance was done by use of MSTATC statistical software. Comparison of means was done by use of Duncan's Multiple Range Test at 5 % probability level.

Results and Discussion

ANOVA (Table 3) showed that differences between Irrigation systems were very significant. Grain yield in two conditions of this system revealed that increased (by 45 %) from 2.49 ton/ha for well watered condition to 3.61 ton/ha for well watered + potassium humate.

Also, genotypes significantly produced different grain yields. Genotype 4057 and Sabalan produced the highest grain yield in this experiment. Interaction of Irrigation system and genotypes wasn't significant for grain yield. This means that under study genotypes had the same responses to potassium humate.

Table 3: Analysis of Variance for under study wheat grain yield

S.O.V	Df.	MS	Prob
Replication	2	0.292	
Irrigation systems	1	11.639	0.0000
Genotypes	5	2.308	0.0003
Irrigation systems × Genotypes	5	0.399	0.3117
Error	22	0.314	-
Total	35	-	-
CV (%)	18.32	-	-

Table 4: Comparison of grain yield for genotypes

genotypes	Gascogen	Sabalan	4057	Ruzi-84	Qobustan	Saratovskaya-29
means	2.94 B	3.35 AB	3.97 A	3.09 B	2.92 B	2.08 C

On the other hand, in vitro evaluation of early growth stage showed that genotypes had different responses to potassium humate and it increased the drought tolerance of genotypes (Shahryari et al., 2008 a and Shahryari et al., 2008 b). Also, it increased assimilate storages of the stem at the anthesis stage under terminal drought condition (Shahryari et al, 2009). Potassium humate increased total protein, gluten amount and alpha amylase activity of grains in terminal drought condition related to genotype (Shahryari et al, 2009). These are three important wheat flour qualities. Therefore pay attention to above mentioned statements, the following principal ways of HS action could be proposed: organism development, hormone-like activity, nutrient carriers, catalysts of biochemical reactions and antioxidant activity (Kulikova et al., 2005).

Conclusions

Result of this Investigation and others (Shahryari et al., 2008 a, Shahryari et al., 2008 b and Shahryari et al, 2009) on effect of potassium humate on wheat quantity and quality showed that it is possible apply this natural substance for organic wheat crop production in Iran. However an agro-biotechnology perspective and programming is needed to apply of HS technology in our country. Because of natural origin of HS, we can apply it in organic agriculture. The adoption of new technologies such as application of HS may help in achieving of increasing organic food production.

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