A Study on the Relation between Yield and Some Maize Genotypes Traits in the Presence of Humic Liquid Fertilizer Based on Peat

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Abstract: In order to study the response of maize genotypes against the application of peat based liquid humic fertilizer. The Experiment was conducted as Split Plot in the form of randomized complete block design with three replications. The main factor included two conditions (with the application of humic fertilizer; without humic fertilizer) and the sub factor included 6 maize genotypes. Considering the compound ANOVA results in studied traits, it was observed that there is a significant difference between all traits at probability level of 1% in experimental conditions. Results indicate that among studied genotypes Golden West with a mean of 19.80 ton per hectare had the highest biological yield and OS 499 genotype with a mean of 14.56 ton per hectare had the lowest biological yield. According to data, it can be suggested that applying humic fertilizer based on peat had good effects on studied traits.

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Introduction:

Maize (Zea mays L.) is C4 plant in terms of photosynthesis and has a better growth in tropical and subtropical(Emam, 2008) areas and native regions of South and Central America(Khodabandeh, 1998). The maize role in providing seeds, forage and livestock feed and its industrial use has increased the importance of the product in Iran. Hence, by implementing programs to increase maize seed production during recent years, this crop has quickly grown in cultivation, production and performance(Cakir, 2004).

Humic substances (HS) are the components of organic decomposition and they are the natural organic compounds which comprise 50 to 90 % of the organic matter of peat, lignites and 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 with high molecular weight and they are refractory" (Kulikova et al. 2005). Yang et al(2004) has stated that the humic materials can affect physiological processes of plant growth directly and indirectly. Their direct effects include increase in cell membrane permeability, respiration, nucleic acid biosynthesis, ion uptake, enzyme activity and sub-enzyme activity. The biological activity of HS encompasses all activities of HS in regulating plant biochemical and physiological processes, irrespective of their stimulatory or inhibitory roles. Soil organic matter is one of the important indices of soil fertility, since it interacts with many other components of the soil. Soil organic matter is a key component of land ecosystems and it is associated with the basic ecosystem processes for yield and structure(Pizzeghello et al, 2001). In spite of numerous studies on the biological effects of HS, the mechanism of their action remains unclear[4]. However, farmers use humates to accelerate seed germination and improve rhizome growth. These materials are able to stimulate oxygen transport, accelerate respiration and promote efficient utilization of nutrient by plants(Islam et al. 2005). Nevertheless, humic acid in proper concentrations can enhance plant and root growth(Bacilio et al. 2003). Presence of HS is important during all stages of plants' development but particularly vital in the early stages. That is why the pre-planting treatment of seeds is very important. Even before germination begins, vital forces are awakened, and the immune system is stimulated(Levinsky, 2009). Numerous researches have demonstrated conclusively that HS have significant impacts on the soil structure and plant growth(Fong et al. 2007).

A proper method for identifying effective traits on yield is determination of the simple correlation between those traits and yield. Traits which are not in a significant relation with yield do not have practical application in modification programs(Wallace et al. 1972).

Correlation analysis provides the information of interrelationship of important plant characters and also leads to a directional model for direct and/or indirect improvement in grain yield. Although direct selection for various parameters could be misleading, indirect selection via related parameters with high heritability might be more effective than direct selection(Shahryari and Mollasadeghi, 2011).

Shahryari(2010) expressed that a biometric procedure such as Path analysis leads us to understanding of the genetic association of traits and their contribution to yield. Comparison of path coefficients in two different conditions of that study revealed there were more complex relations between characters at presence of potassium humate. And cumulative effects (significantly direct and indirect effects) of traits caused increase in yield.

The following research tries to compare the humic liquid fertilizer based on peat effects on biological yield and some yield components in six maize genotypes in Ardabil region.

Materials and Method:

In order to study the response of maize genotypes against the application of peat base liquid humic fertilizer (Table 1), an experiment was conducted at experimental field of Islamic Azad University, Ardabil Branch (5 km west of Ardabil City). The Region has a semiarid and cold climate, where the temperature during winter season usually drops below zero. This region is located 1350 m above the sea level with longitude and latitude being 48.2˚ eastern and 38.15˚ northern, respectively. Average annual minimum and maximum temperatures are -1.98 and 15.18˚C respectively; whereas maximum absolute temperature is 21.8 ˚C; and mean annual precipitation has been reported to be 310.9 mm. The soil of the field was alluvial clay with a pH ranging from 7.8-8.2.

Vegetative material included 6 maize genotypes prepared from Agriculture and Natural Resources Research Center of Ardabil Province. The Experiment was conducted as Split Plot in the form of randomized complete block design with three replications. The main factor included two conditions (by application of humic fertilizer; without humic fertilizer) and the sub factor included 6 maize genotypes (ZP677, Golden west, OS499, ZP434, Ns540 and Single Cross 704). Each experimental plot included 3, 320 cm long rows recurring 80 cm from each other containing plants recurring at 20cm distance. Pretreatment of seeds were done on the basis of 220 mL per 10 L of water to be applied for 1 ton of seeds.

Weed-fighting was done both mechanically and manually during all growth stages. Liquid humic fertilizer was prepared and applied based on 400 mL per 50 L of water for 1 hectare of maize plantation. The prepared solution was sprayed upon the aerial part of the plants during 4-5th leaf stage, appearance of reproductive organs, flowering and grain filling stages. All the samples were taken randomly from competitive plants at middle rows.

Studied traits included Length of ear at the harvesting time, number of grains per ear, grain weight per ear, grain weight, ear dry weight and biological yield.

Analysis of variance of data and mean comparison of them was done using MSTATC, SPSS and Minitab programs. Mean comparison was done using Duncan's Multiple Range Test, at 5% probability level.

Table 1. Compounds of liquid humic fertilizer based on peat

Parameter name	**Dry residue (%)**	**pH**	**Total nitrogen (mg/l)**	**Phosphorus (mg/l)**	**Potassium (mg/l)**	**Nitrate nitrogen (mg/l)**
amounts	**56.304**	**10.08**	**1318**	**97**	**10845**	**78.81**
Parameter name	**Total carbon (g/l)**	**Humic acids carbon (g/l)**	**Humic acids (g/l)**	**Fulvic acids carbon (g/l)**	**Fulvic acids (g/l)**	**Sum of humic and fulvic acids (g/l)**
amounts	**21.69**	**17.68**	**33.23**	**4.01**	**9.02**	**42.25**

Results and Discussion

Considering the compound ANOVA results (Table 1) in studied traits, it was observed that there is a significant difference between all traits at probability level of 1% in experimental conditions. Also, there was a significant difference between studied genotypes based on all evaluated traits at probability level of 1%. This indicates that the genetic diversity between genotypes to choose the desired traits. Also genotype effect × experimental conditions in biologic yield terms were significant at probability level of 5% and other traits were significant at probability level of 1%.

According to Shahryari et al(2009) this means that under study genotypes had the same responses to potassium humate.

According to data mean, which compare (Table 2) the studied genotypes, NS 540 genotype with a mean of 21.12 cm had the highest ear at the harvesting time while OS 499 genotype with a mean of 18.57 cm had the lowest length of ear. ZP 677 and Single Cross 704 genotypes formed a group and showed no differences in the studied traits. Based on number of grains in ear, ZP 677 genotype with a mean of 420.50 was the highest and OS 499 with a mean of 303 was the lowest. Golden West and NS 540 genotypes formed one group and showed no differences in the studied traits. ZP 677 genotype with a mean of 48.97gr had the highest grain weight per ear and NS 540 genotype with a mean of 34.57 gr had the lowest weight per ear. OS 499, ZP 434, Golden West, Single Cross 704 and NS 540 genotypes formed a group and showed no differences in the studied grain weight per ear. Based on grain weight among the studied genotypes, ZP 434 with a mean of 159.41 gr was the best genotype and Single Cross 704 genotype with a mean of 101.65 gr was the lowest studied genotype. ZP 677 ad Golden West and also OS 499 and NS 540 genotypes formed a groups and showed no differences in the studied traits. Based on ear dry weigh, ZP 677 with a mean of 132.48 gr was the best genotype and OS 499 genotype with a mean of 92.97gr was the lightest. ZP 434, Single Cross 704 and NS 540 genotypes formed a group and showed no differences in the studied traits. Golden West with a mean of 19.80 ton per hectare had the highest biological yield and OS 499 genotype with a mean of 14.56 ton per hectare had the lowest biological yield. ZP 434, Single Cross 704 and NS 540genotypes formed a group and showed no differences in the studied traits.

Shahryari and Shamsi (2009) reported that potassium humate increased the rate of biological yield of wheat from 3.26 to 3.72 gr/plant; but it had not effect on harvest index. Also they found that uses of potassium humate increased grain yield.

Results mean comparison (Table 1) in experimental conditions suggested that applying humic fertilizer based on peat had good effects on studied traits.

Ayas and Gulser (2005) reported that humic acid caused to increase growth and height and subsequently increase biological yield through increasing nitrogen content of the plant. It has been reported that application of humic acid in nutritional solution led to increased content of nitrogen within aerial parts and growth of shoots and root of maize(Tan, 2003). In another investigation, the application of humic acid led to increased phosphorus and nitrogen content of bent grass plant and increased the accumulation of dry materials(Mackowiak et al. 2001). Humic acid leads to increased plant yield through positive physiological effects such as impact on metabolism of plant cells and, increasing the concentration of leaf chlorophyll(Naderi et al. 2002). Also, spraying humic acid on wheat crop increased its yield by 24%(Delfine et al. 2002).

Simple correlation coefficients between various traits without humic fertilizer application are presented in Table 3. In these conditions, the relation between dry ear weight and Length of ear at the harvesting time was positively significant at probability level of 1% (r=0.923) and the relation between dry ear weight and number of grains in ear was positive significant at probability level of 5% (r=0.816). Other traits correlation coefficients are presented in Table 3.

Shahryari and Mollasadeghi(2011) reported that all possible correlations were worked out to determine the relationship between harvest index with economic yield and biological yield separately in four studied experimental conditions.

Correlation between economic and biological yield was positively significant for all of four irrigation and humate levels. Thus, there is a linear relationship between these traits. Also, there was positively significant linear relationship between economic yield and harvest index for well-watered and drought stress+ humic fertilizer levels while no correlation was observed among them in the other two conditions.

Correlation of biological yield and harvest index was negatively significant for well watered+humic fertilizer. But relationships between these characters did not have a linear correlation for other conditions.

Simple correlation coefficients between various traits with humic fertilizer application are presented in Table 4. In these conditions, the relation between dry ear weight and Length of ear at the harvesting time and number of grains in ear was positive significant at probability level of 5%. Also, the relation between grains weight in ear and number of grains in ear was positive significant at probability level of 5% (r=0.844).

Shahryari (2010) reported that seed weight per spike had the most effect on yield increase with direct effect (r = 0.576) at presence of potassium humate. After that spike length (r = 0.337), biomass (r = 0.254) and seed number per spike (r = 0.175) had total correlation effects on increasing of grain yield.

Conclusion

Results of this experiment indicated that the application of liquid humic fertilizer can positively affect the maize biological yield and some agronomic traits related to it. These desirable effects can be a consequence of its effect on the physiology of the maize. In general, application of humic acid can lessen the need for using chemical fertilizers and subsequently reduce environmental pollution, and it is also cost effective since the desired target is achieved by using less amount of it. Finally, it can be suggested that application of humic fertilizer not only increases the yield of maize, but also can play a significant role in achieving the goals of sustainable agriculture.

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Table 1. Combined Analysis of variance of evaluated traits under various experimental conditions for 6 maize genotypes.

Source of Variations	df	Mean Square					
		Length of ear at the harvesting time	Number of grains per ear	Grain weight per ear	Grain weight	Ear dry weight	Biological yield
Replication	2	2.70	90.58	2.18	143.09	32.88	20.98
Experimental conditions (E.C.)	1	95.58**	156025.00**	2086.21**	24666.79**	14733.11**	318.03**
Error 1	2	0.96	22.75	4.38	3.21	5.91	3.75
Genotype (G)	5	5.17**	10089.60**	172.74**	2407.44**	1114.95**	23.27**
G × E. C.	5	6.73**	10192.33**	112.58**	1336.44**	725.04**	14.02*
Error 2	20	0.76	956.13	21.18	30.97	63.37	5.09
CV (%)		4.38	8.59	11.97	4.53	7.04	12.74

* and **: Significant at $p < 0.05$ and < 0.01, respectively

Table 2. Mean comparison of Studied traits of maize genotypes

Genotypes	Characters					
	Length of ear at the harvesting time(cm)	Number of grains per ear	Grain weight per ear(gr)	Grain weight(gr)	Ear dry weight(gr)	Biological yield (ton\h)
OS 499	18.57 d	303.00 d	35.26 b	112.60 c	92.97 d	14.56 c
ZP 677	20.34 ab	420.50 a	48.97 a	123.95 b	132.48 a	16.34 bc
Golden West	19.00 cd	359.50 bc	38.77 b	126.82 b	102.69 c	19.80 a
ZP 434	19.93 bc	334.50 cd	36.15 b	159.41 a	115.75 b	18.98 ab
Single Cross 704	20.17 ab	388.50 ab	36.83 b	101.65 d	117.54 b	18.97 ab
NS 540	21.12 a	354.00 bc	34.57 b	112.95 c	116.76 b	17.63 ab

Differences between averages of each column which have common characters are not significant at probability level of 5%.

Table 3. Simple correlation coefficients between traits for maize genotypes at absence of humic fertilizer

	Length of ear at the harvesting time	Number of grains per ear	Grain weight per ear	Grain weight	Ear dry weight	Giological yield
Length of ear at the harvesting time	1					
Number of grains per ear	0.666	1				
Grain weight per ear	-0.038	0.692	1			
Grain weight	-0.757	-0.350	0.336	1		
Eardry weight	0.481	0.923**	0.816*	-0.027	1	
Biological yield	0.578	0.578	0.102	-0.665	0.239	1

* and **: Significant at $p < 0.05$ and < 0.01, respectively

Table 4. Simple correlation coefficients between traits for maize genotypes at presence of humic fertilizer

	Length of ear at the harvesting time	Number of grains per ear	Grain weight per ear	Grain weight	Ear dry weight	Biological yield
Length of ear at the harvesting time	1					
Number of grains per ear	0.726	1				
Grain weight per ear	0.521	0.844*	1			
Grain weight	-0.003	-0.403	-0.369	1		
Ear dry weight	0.915*	0.867*	0.704	-0.084	1	
Biological yield	0.034	0.031	-0.355	0.499	0.101	1

* and **: Significant at $p < 0.05$ and < 0.01, respectively

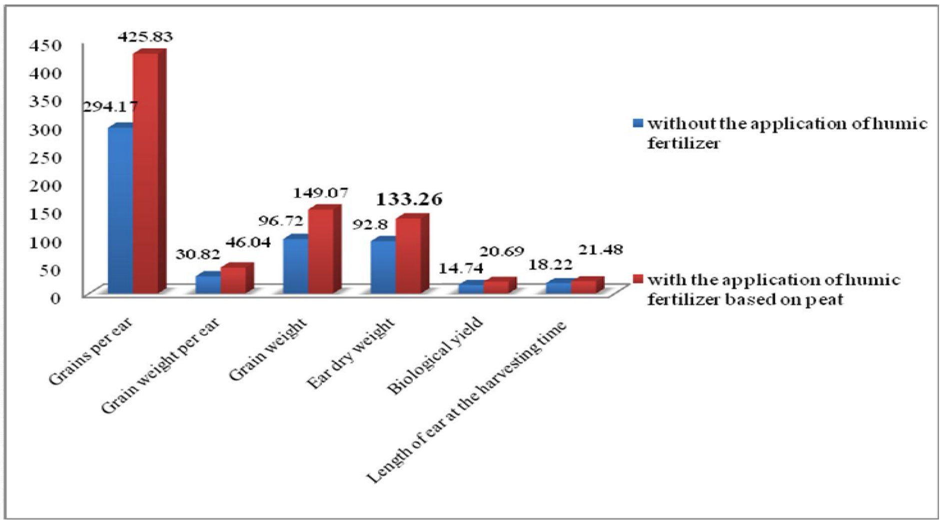

Figure 1. Effect of the usage of humic fertilizer derived from peat on measured traits of maize genotypes

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