EFFECT OF FOLIAR APPLICATION OF MAGNESIUM ON GROWTH, YIELD, AND PHOTOSYNTHETIC PIGMENTS OF BARLEY PLANT

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ABSTRACT

The present study was done to assess the role of magnesium on growth and yields of Barley plant (*Hordeum distichon* L. Acsad 14). Foliar Mg applicated at concentration (0, 5, 10, 15, 20ppm) by using MgO and $MgNO_3$. A randomized complete block design with three replication of each treatment was applied. The results showed that the vegetative growth parameters: shoot dry weight and flag leaf area were increased significantly at different stages of growth compared to untreated (control) groups. Mg treatments after 110 days caused significant increases in the number of spike and weight of spike compared to the control plants. Foliar Mg application significantly increased chlorophyll a, chlorophyll b, total chlorophyll and carotenoids in the leaves. The highest increasing in all parameter were recorded with (10ppm) of MgO and (5ppm) of MgNO3.

Keywords: *foliar application, Magnesium, Barley, Yield, Photosynthetic pigments.*

1. INTRODUCTION

Barly belongs to the genus *Hordeum* in the Triticeae of the grass family, Poaceae (also known as Gramineae). The Triticeae tribe is a temperate plant group containing several economically important cereals and forages as well as about 350 wild species (Von Bothmer, 1992).

Barly is one of the founder crops of old world agriculture and was one of the first domesticated cereals. It is also a model experimental system because of its short life cycle and morphological, physiological, and genetic characteristics. Barly is the fourth most important cereal crops in the world after wheat, maize, and rice, and is among the top ten crop plant in the world (Akar *et al.,* 2004).

Globally, over 136 million tones of barly is produced annually on about 56 million hectares. Leading exporters of barly include Australia, Ukraine, EU, Canada and Russian federation, while the principal markets for importing barley are Saudi Arabia, Japan and China (USDA, 2007). Originally, barly was mainly cultivated and used for human food, but it is now used primarily for animal feed and to produce malt, with smaller amounts used for seed and direct human consumption. Barly is also used to the production of starch, either for food or for the chemical industry (OECD, 2004). In addition, barly has some useful by-products, the most valuable being the straw which is used manily for bedding in developed countries, but also for animal feed in developing and under-developed countries (Akar *et al.,* 2004).

Plants require more than 16 nutrients for their growth and development. Three of these, carbon, hydrogen and oxygen, are obtained from the atmosphere and from soil water. If proper conditions of aeration and moisture are maintained in the soil, there is no problem with these three nutrients. However, if any of the other 13 elements, nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, boron, copper, manganese, molybdenum, zinc, or chlorine, is deficient, they must be applied for the plants' use. These nutrients may be applied to the soil or they may be applied to the foliage of the plants. When applied to the foliage they are known as foliar sprays (McCall, 1980).

Magnesium is an important macronutrient with a number of physiological functions in the plant. The importance of magnesium in the plant is in many ways connected with photosynthesis. It is the central atom of chlorophyll and it activates enzymatic processes. Magnesium also favorably influences assimilation (Kraus, 2003).

Mg deficiency reduces the content of chlorophyll in the leaves and changes the chlorophyll a: b ratio in favour of chlorophyll b. Visually it is seen as chlorosis of leaves, especially older leaves and causes premature abscission. Chlorosis is caused either by absolute lack of soil Mg, high content of soil Ca (calcareous soils) or a combination of these factors (Gluhić *et al*., 2009; Ksouri *et al*., 2005; Marschner, 2002).

Mg uptake by the plant is also affected by the antagonistic effect of Ca and K and was confirmed by (Garcia *et al*., 1999) who discovered a marked reduction of Mg in grape berries on soils with a high supply of Ca connected with an increase in the total acid content. Skinner and Matthews (1990) reported Mg deficiency also in low-soil-reaction and low-phosphorus-content vineyards. A deficit of magnesium or unbalanced ratio between K and Mg also caused stalk necrosis and shrivelling of berries (Hlušek *et al*., 2002).

The present study aimed to observe the role of foliar application of magnesium on growth and yields of Barley (*Hordeum distichon* L. Acsad 14).

2. MATERIALS AND METHODS

The present study was carried out in the glass house of biology department, college of Education, Sciences Departments, at University of Salahaddin- Erbil, during 17th December /2008 to 15th April / 2009 to study the effect of magnesium on growth, yield and photosynthetic pigment in leaves of barley plants . The plastic pots with a diameter of 24 cm and 21 cm in depth were used in the experiment. Each pot was filled with 7 kg of dried sandy loam soil. In each pot 3 seed were sown, NP fertilizer were added before sowing as Di-ammonium phosphate (DAP) which contain 18% N and 46% P at the level of 50 and 30 ppm K as potassium chloride 52. 34% K.

MgO was prepared by dissolving 0.133g MgO in few milliliters then completed to one liter with D.W. $MgNO_3$ was prepared by dissolving 1.066g $MgNO_3$ in few milliliters then completed to one liter with D.W. Two drops of tween were added to which spray solution. Foliar application was carried out twice after 30 and 40 days from sowing in early morning hours by small handed sprayer. Sandy loam soil was used and physical and chemical properties were analyzed.

Plant height, number of branches/ plant, number of leaves/plant, shoot dry weight, number of spike/plant, weight of spike/plant, flag leaf area, length of spike/plant were recorded after 75 days from treatment and at the end of the experiment. The photosynthetic pigment (chlorophyll a, chlorophyll b and carotenoids were estimated by the spectrophotometric method recommended by Metzner *et al*., 1965).

The data were statistically analyzed according to randomized complete block design (R.C.B.D) with three replication. The statistical analysis was carried out by using SPSS program (version 13.0). L.S.D. test was used to compare between the mean treatments.

3. RESULTS AND DISCUSSION

Table (1) manifests the effect of foliar application of magnesium on vegetative growth and yield of barley after 75 days from treatment. 10ppm MgO and 5 ppm MgNO3 caused significant increases in shoot dry weight and flag leaf area as compared to non-treated plants. As shown in table (2) barley treated with magnesium in the end of experiment caused significant increases in shoot dry weight, flag leaf area, number of spike per plant and weight of spike. The highest increasing was recorded with 10ppm MgO and 5ppm MgNO3.Table (3) reveals the effect of foliar application of magnesium on photosynthetic pigment of barley leaves. Treated of barley with magnesium significantly increased chlorophyll a, chlorophyll b, and carotenoids in the leaves compare with non-treated plants. These results are in agreement with those reported by (Jaber and Rahi, 2000) and (Jaber, 1994).

Nutrients applied to the foliage are generally absorbed more rapidly than when applied to the soil. Foliar application provides a means of quickly correcting plant nutrient deficiencies, when identified on the plant. It often provides a convenient method of applying fertilizer materials, especially those required in very small amounts and the highly soluble materials.

The most effective means of foliar application is the use of spray equipment. Either low pressure or high pressure equipment may be used. Spray equipment provides better placement, less loss by dripping and more effective coverage of the foliage than most other methods of application (McCall, 1980).

Magnesium exists in the soil solution (a readily available source) and in both the exchangeable (readily available) and non-exchangeable or mineral forms (McLaren and Cameron, 1996). When the exchangeable form is depleted, usually through root uptake or leaching, the conversion of non-exchangeable to exchangeable Mg is slow. Although it is still possible for the weathering of clay minerals such as vermiculite, montmorillonite and illite to annually supply sufficient Mg for crop removal, the speed at which this occurs can lead to transient Mg deficiency (Archer, 1988). This is because when plants quickly put on vegetative growth as they do through the late spring, early summer the replenishment of readily available Mg from the soil cannot immediately match the plants requirements. Plants also often find difficulty in translocating Mg quickly enough from the older to younger leaves. This is usually only a temporary phenomenum. Roots absorb Mg from the soil solution which is in direct contact with the root. The quantity of Mg in soil solution must be greater than the actual crop requirement to encourage a high enough flux rate towards the root to maintain uptake (Grimme and Huttl, 1991).

The increasing of the growth, yields and photosynthetic pigments of leaves of Barley in the present study due to the role of magnesium in increasing component of chlorophyll, activators of number of photosynthetic and respiratory enzymes, combines the subunits of ribosomes, ATPase activity, synthesis and hydrolysis of ATP and synthesis of DNA and RNA (Verma, 2008). Other roles include its involvement in cell wall structure and cell turgor, protein synthesis, carbohydrate movement and formation, as a carrier of phosphorus particularly in oil seed crops (eg. canola), as a component or activator of several enzymes, CO_2 assimilation, cation-anion balance and cellular pH (Bould *et al* 1983; Reuter and Robinson, 1998). Magnesium is an activator for many of the enzymes involved in carbohydrate metabolism such as those participating in glycolysis, pentose phosphate pathway and calvencucle and these enzymes includes (glucokinase, fructokinase, galactokinase, hexokinase, trisekinase, enolase, puruvic kinase, carboxylase, phosphoglyceric kinase and others), (Verma, 2008)

Table (1): Effect of foliar application of Mg on vegetative growth and yield of Barley after 75 days from treatment.

	Concentration of Mg (ppm)	Plant height (cm)	Number of tiller / plant	Number of leaves / plant	Shoot dry weight (gm)	Flag leaf area (cm^2)
MgO	control	20.35	5.70	18.00	0.68	25.94
	5	18.80	4.83	17.66	1.02	46.78
	10	21.08	6.33	21.33	1.57	44.12
	15	20.23	4.51	14.66	1.04	38.09
	20	19.48	4.20	15.66	1.50	33.66
$MgNO_3$	5	23.61	5.00	14.50	2.03	40.36
	10	21.26	4.30	13.50	2.06	37.60
	15	20.27	4.33	11.50	1.68	30.07
	20	18.44	3.13	11.33	1.08	37.46
	L.S.D $p \leq 0.05$	N.S	N.S	N.S	0.435	8.23

Table (2): Effect of foliar application of Mg on vegetative growth and yield of Barley after 110 days from treatment.

	Concentration of Mg (ppm)	Plant height (gm)	Number of tiller/ plant	Number of leaves/ plant	shoot dry weight (gm)	flag leaf area (cm^2)	Length of spike (cm)	Number of spikes/ plant	Weight of spike (gm)
	Control	53.00	6.93	36.76	13.95	9.44	7.08	3.33	0.69
MgO	**5**	52.66	6.16	31.23	14.94	11.01	7.14	3.33	0.72
	10	57.33	13.50	57.50	17.15	12.45	6.35	4.83	0.82
	15	52.00	11.50	38.00	14.54	14.29	6.82	4.33	0.62
	20	53.66	6.13	24.03	15.64	6.89	6.24	3.33	0.61
$MgNO_3$	**5**	64.10	7.03	30.03	25.85	10.55	6.73	4.86	0.72
	10	62.46	8.76	36.00	26.31	13.67	6.88	4.43	0.70
	15	53.50	6.00	22.50	13.49	13.60	7.48	2.83	0.79
	20	52.26	5.86	28.96	13.39	8.38	7.24	2.93	0.71
L.S.D	**P ≤ 0.05**	N.S	N.S	N.S	3.49	1.99	N.S	1.01	1.00

Table (3): Effect of foliar application of Mg on photosynthetic pigment of Barley leaves after 45 days of treatment.

	Concentration of Mg (ppm)	**Chlorophyll a µg /gm**	**Chlorophyll b µg /gm**	**Carotenoids µg/gm**
	Control	2.05	3.72	1.78
MgO	**5**	5.37	3.89	2.99
	10	5.15	3.77	2.64
	15	4.61	2.85	2.50
	20	4.62	1.53	2.76
$MgNO_3$	**5**	5.04	3.66	3.14
	10	5.04	2.27	3.71
	15	4.19	1.26	2.47
	20	4.88	1.61	2.69
	L.S.D P≤ 0.05	1.42	0.04	1.14

4. REFERENCES

Akar, T., Avci, M., Dusunceli, F. (2004). Barley: Post-harvest operations.http://www.fao/inpho/content/compend.text/ch31.htm.Accessed on 15 August 2007.

Archer, J. (1988). Crop nutrition and fertilizer use. 2nd edition, Farming Press Ltd., Ipswich, United Kingdom.

Bould, C., Hewitt, E.J., and Needham, P. (1983). 'Diagnosis of Mineral Disorders in Plants, Volume 1 Principles'. Ed. J.B.D. Robinson, 174pp. Her Majesty's Stationery Office, London.

Garcia, M., Daverede, C., Gallego, P., and Toumi, M. (1999). Effect of varions potassium calcium ratios on cation nutrition of grape grown hydroponically. *Journal of Plant Nutrition*, 22: 417– 425.

Gluhić, D., Herak, M., Petek, M., Čoga, L., Slunjski, S. and Sinćić, M. (2009): The content of Mg, K and Ca ions in vine leaf under foliar application of magnesium on calcareous soils. *Agriculturae Conspectus Scientifi Cus* 2: 81–84.

Grimme, H; Huttl, R.F. (1991). Magnesium in agricultural and forest ecosystems. In Magnesium – a relevant ion. Eds B. Lasserre and J. Durlach. Proceedings of the 3rd European Congress on Magnesium, March 1990, 9-20, John Libbey Eurotext, Montrouge, France.

Hlušek, J., Richter, R. and Ryant, P. (2002). Vyživa a hnojeni zahradnich plodin. 1 ed. Praha, Zemědělec, 81 p. (in Czech).

Jaber A. S., and Rahi, H. S.. (2000). Effect of Magnesium and Nitrogen on the uptake of some nutrients in cucumber at soils of plastic houses. *Iraqi J. Agri. Sci*. 4:127-140.

Jaber. A. S. (1994). Effect of potassium and magnesium application on Barley yield (*Hordum vulgare* L.) in calcareous soil. *Iraqi J. Agri. Sci*. 25:25-28.

Kraus, V. (2003). Pěstujeme revu vinnou. 1 ed. Praha, Grada Publishing, 96 p. (in Czech).

Ksouri, R., Gharsalli, M., and Lachall, M. (2005).Physiological responses of Tunisian grapevine varieties to bicarbonate-induced iron deficiency. *Journal of Plant Physiology*, 162: 335–341.

Marschner, H. (2002). Mineral Nutrition of Higher Plants. 2nd edition. London: Academic Press, 889 p.

McCall, W. (1980). Foliar application of fertilizers. Hawall Cooperative Extension Service.

McLaren, R.G., and Cameron, K.C. 1996. Soil Science - Sustainable production and environmental protection. 2nd Edition, Oxford University Press, Auckland.

Metzzener, H., Rava, H. and Sender, H. (1965). Unter suchungen zur synchronis iebekiety pigments mangel von chlrella. *Planta,* 65: 186-190.

Reuter, D.J., and Robinson, J.B. Eds (1998). 'Plant analysis: an interpretation manual'. 2nd edition, CSIRO Publishing, Australia.

Skinner, P. W. and Matthews, M. A. (1990). A novel interaction of magnesium translocation with the supply of phosphorus to roots of grapewine (Vitis vinifera L.). *Plant, Cell and Environment,* 13: 821–826.

Verma, V. (2008). Textbook of plant physiology. Ane Books India.

USAD (2007). Foreign and Agricultural Services Production, Supply and Distribution (PSD) online database.

Akar, T., Avci, M., and Dusunceli, F. (2004). Barly: post-harvested operations.

OCDA (2004). Consensus document on compositional considerations for new varieties of Barley (Hordeum vulgare L.): Key food and feed nutrients and anti-nutrients. Report No. 12, Environmental Directorate, OCDA, Paris.

Von Bothmer, R. (1992). The wild species of *Hordeum*: relationships and potential use for improvement of cultivated barley. Chapter 1. In: PR Shewry, ed. Barley: Genetics, Biochemistry, Molecular Biology, and Biotechnology. C.A.B. International, Walling ford.

تاثير التسميد الورقي للمغنيسيوم على النمو ، الحاصل و صبغات البناء الضوئي في نبات الشعير

الملخص:

تم اجراء هذه الدراسة لتقييم دور المغنيسيوم على النمو و الحاصل لنبات الشعير .*Hordeum distichon* L (Acsad 14). تم اختبار التسميد الورقي للمغنيسيوم باستخدام MgO و $MgNO_3$ و بتراكيز (صفر ، 5 ، 10 ، 15 ، 20 جزء بالمليون).تم تطبيق التصميم العشوائي الكامل و بثلاث مكررات لكل معاملة. اظهرت النتائج ان: الوزن الجاف للمجموعة الخضرية و مساحة ورقة العلم قد ازدادت معنويا خلال المراحل المختلفة من النمو مقارنة مع مجموعة السيطرة الغير المعاملة.ووجد ان معاملة المغنيسيوم بعد 110 ايام قد سببت زيادة معنوية في عدد السنبلة و وزن السنبلة مقارنة مع نباتات السيطرة. التسميد الورقي للمغنيسيوم زادت معنويا من كلوروفيل a ، كلوروفيل b ، الكلوروفيل الكلي و الكاروتينات في الاوراق. تم تسجيل اعلى زيادة في النمو عند استخدام 10 جزء بالمليون من MgO و 5 جزء بالمليون من $MgNO_3$.

كاریگەری پرژانی گەلا بە مەگنیسیوم لە سەر گەشە ، بەرهەم وە ڕەنگەکانی ڕۆشنەپێکهاتن لە ڕووەکی جۆ (*Hordeum distichon* L. Acsad 14)

پوختە

ئەم توێژینەوەیە ئەنجام درا بۆ هەڵسەنگاندنی کاریگەری مەگنیسیۆم لەسەر گەشەو بەرهەمی ڕووەکی جۆ (*Hordeum distichon* L. Acsad 14). پرژانی گەلا بە مەگنیسیۆم ئەنجام درا بەبەکارهێنانی MgO وە $MgNO_3$ وە بە خەستی (سفر ، 5 ، 10 ، 15 ، 20 بەش لە ملیۆن). دیزاینی هەرەمەکی تەواو بە سێ دووبارە بۆ هەر مامەڵەیەك بەکارهات. ئەنجامەکان نیشانیان دا کەوا پێوەرەکانی سەوزە گەشە: کێشی سەوزی ووشك وە ڕووبەری گەڵای ئاڵا بە شێوەیەکی بەرچاو زیادی کرد لە قۆناغە جیاکانی گەشەدا بەبەراورد لەگەڵ کۆمەڵەی مامەڵەنەکراو. مامەڵەکردن بە مەگنیسیۆم پاش 110 ڕۆژ بووە هۆی زیادبوونێکی بەرچاو لەژمارەو کێشی گوڵە گەنم بەبەراورد لەگەڵ ڕووەکەکانی کۆنترۆڵ. پرژانی گەلا بە مەگنیسیۆم بەمەگنیسۆم بووە هۆی زیادبوونێکی بەرچاو لە کلوروفیل a ، کلوروفیل b ، کلۆرۆفیلی گشتی وە کارۆتینات لە گەلا. باشترین زیادبوون لە هەموو پێوەرەکان دا تۆمارکرا بەبەکارهێنانی 100 بەش لە ملیۆن لە MgO وە 5 بەش لە ملیۆن لە $MgNO_3$.