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Effect of Foliar Application and N-Levels on Productivity and Granis Quality of Barley

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ABSTRACT

To study the influence of foliar applications, N-levels and their interaction on growth, yield and its attributes and grain quality of barley Giza 123 cultivar, a field experiments was carried out at the Experimental Farm of Sahl El-Husseiniya, Agriculture Research Station, as a new reclaimed soils (salinity affected soils), during 2015/2016 and 2016/2017 seasons using design of strip-plot with 4 replicates. Vertical plots devoted to five foliar applications *i.e.* without, spraying with; Macro + Micro, amino acids, humic acid and the combination of Macro + Micro, amino acids and humic acid. Horizontal plots billed to 3 levels of N-fertilizer (40, 60 and 80 kg N/fed). Spraying barley plants with the combination of (Macro + Micro), amino acids and humic acid at the rates of 2 g + 1 ml + 1.25 ml/liter water, respectively in each spraying was the best treatment to increase barley growth, productivity and grains quality, which produced the highest values of these characters, with exception of total carbohydrates % in grains, which had inverse trend into both seasons. Fertilizing plants of barley with 80 kg N per fed gave the uppermost mean values of barley growth, productivity and quality of grains, except carbohydrates % in grains in together seasons. Foliar spraying barley Giza 123 cultivar with Macro + Micro, amino acids and humic acid at the side of fertilizing by 60 kg N per fed in order to maintain high productivity and grains quality and decrease production costs and environmental pollution under salinity affected soils conditions.

Keywords: Barley, Foliar spraying, Macro-nutrients, Micro nutrients, Amino acids, Humic acid, N-levels, Growth, Yield, Grains quality.

INTRODUCTION

Barley (*Hordeum vulgare* L.) grains can be ground into a flour and used as a cereal in making bread, porridge in addition barley water is used to dilute cows' milk (Alazmani, 2014).

Common practice in production of cereal commonly and barley especially is foreword nutrients through the soil. However, recently it has been discovered that different nutritive solutions containing the elements, enable easy availability of nutrients to plants, which results in positive outcomes (Arif *et al.*, 2006). Because of the fact that soil application of nutrient solutions can lead to loss of nutrients, over the last decades it has been confirmed for the fact that foliar application is the preferred option and it can reduce losses (Cakmak, 2008 and Babaeian *et al.*, 2011). Fast and efficient input of required elements into the plants, in the form of nutrient solutions is commonly performed through the leaf. This method has higher efficiency and lower cost and at the same time, it does not pollute the environment (Bozogi *et al.*, 2011). Babaeian *et al.* (2012) reported that among micro elements (iron sulfate, zinc sulfate and magnesium sulfate), use of iron sulfate ($FeSO_4$) had more influence on barley yields. Boorboori *et al.* (2012) found that to achieve an acceptable grain yield of barley providing the micro and macro nutrients by foliar method are fundamentals. Alinezhad *et al.* (2013) showed that highest barley grain yield amount with foliar straying plants with Humax + Biomin and the lowest means resulted from control treatment (without foliar spraying). Eleiwa *et al.* (2013) revealed that foliar spraying by zinc concentrations (50, 100, and 150 ppm) had a significant effect on the studied growth and yields as well as the physiological and chemical parameters of barley when compared with the control treatment. Sary *et al.* (2014) indicated that foliar spraying barley plants with micronutrients treatments positively affected all growth, yield and yield components traits as compared with control treatment. Abdel-Ati and Eisa (2015) revealed that spraying plants of barley with 30 ppm $ZnSO_4$ increased barley productivity as a result of enhancing the plant metabolism and growth. Boshev *et al.* (2016) found that the highest barley grain yield (1347 kg/ha) was registered when plants treated with Agrosal $N_{12}P_5K_7$+ME, while the lowest barley grain yield was measured on the plants treated with Agrosal $N_{31}P_0K_0$+ME Highest protein content was registered on the plants treated with Agrosal $N_{31}P_0K_0$+ME at the rate of 10 %, whilst the lowest protein content resulted from plants treated with Agrosal $N_{12}P_5K_7$+ME at the rate of 0.5%. Janmohammadi *et al.* (2016) stated that foliar spraying barely plants with micronutrient nano-fertilizer (iron and zinc) significantly increased days to anthesis and maturity, grains weight, spike length, number of the grains/spike, chlorophyll content, grain yield and harvest index.

Nitrogen application may influence the amount formed chlorophyll, cell size, leaf area and photosynthetic activity (Marschner, 1995). Ottman (2011) decided that nitrogen fertilizer is a major cost in barley production, and growers may benefit from knowing how barley responds to nitrogen fertilizer especially compared to wheat. Abido and Seadh (2015) showed that application of 75 kg N per fed as minerals nitrogen and 25 kg N per fed from poultry manure significantly increased content of chlorophylls, area of flag leaf, spikes number per m^2, the length of spike, grains number/spike, weight of grains /spike, hundred grains weight, yields of grain and straw, protein and carbohydrates % in barley grains and produced the highest in both seasons. Alazmani (2015) reported that nitrogen application at the rate of 225 kg N/ha resulted in maximum plant height, harvest index, straw yield, grain yield and protein yield of barley.

Thus, this study was recognized to decide the effect of different foliar applications and N- levels on productivity and quality of barley grain (Giza 123 cultivar) under conditions of new reclaimed soils (salinity affected soils at Sahl El-Husseiniya district, Sharkia Governorate, Egypt).

MATERIALS AND METHODS

A field experiment was done at the Experimental Farm of Sahl El-Husseiniya, Agriculture Research Station, as a new reclaimed soils (salinity affected soils), during seasons of 2015/2016 and 2016/2017 to study the effect of

foliar applications and N- levels on productivity and quality of barley grain (Giza 123 cultivar).

The experiment was done in design of strip-plot through 4 replicates. Vertical plots were devoted to 5 foliar applications *i.e.* without foliar spraying, spraying with; a solution of macro and micro nutrients (Macro + Micro) consists of two commercial compounds "Super Sahara" as a source macro-nutrients and "Action Balance" as a source micronutrients in the ratio of 1 : 1 (2 g/liter water), amino acids in the form of Amino Super Power (1 ml Amino Super Power/liter water), humic acid in the form of Hamar (1.25 ml Hamar/liter water) and the combination of Macro + Micro, amino acids and humic acid at the rates of 2 g + 1 ml + 1.25 ml/liter water, respectively in each spraying.

Horizontal plots allocated to three rates of nitrogen fertilizer (40, 60 and 80 kg N/fed).

Each plot was 3 × 3.5 m (10.5 m^2). Rice was the receding crop in both years. Mechanical and chemical properties of soil field shown within Table 1.

Table 1. Experimental sites mechanical & chemical soil properties in 2015/2016 and 2016/2017 seasons.

Soil analyses		2015/2016	2016/2017
A: Mechanical analysis:			
Coarse sand (%)		7.75	7.95
Fine sand (%)		30.95	31.25
Silt (%)		20.58	20.25
Clay (%)		35.90	40.55
Texture class		Clay	Clay
F.C. (%)		26.39	26.25
P.W.P. (%)		12.56	12.50
A.W. (%)		13.90	14.00
B.D. (g/cm^3)		1.40	1.39
S.P (%)		44.00	44.20
B: Chemical analysis:			
E.C. ds. M^{-1} (1 : 5)		10.37	10.10
pH (1 : 2.5)		8.12	8.05
Organic matter (%)		0.55	0.75
$CaCO_3$ (%)		11.90	11.50
Available (mg/kg)	N	39.55	40.15
	P	4.85	4.90
	K	186.00	190.00
Extractable DTPA (mg/kg)	Fe	2.58	2.65
	Mn	1.07	1.13
	Zn	0.65	0.66
	Cu	1.13	1.15
Soluble cations (meq/L)	Ca^{++}	14.50	15.10
	Mg^{++}	25.31	26.50
	Na^{+}	63.14	62.20
	K^{+}	0.75	0.80
Soluble anions (meq/L)	CO_3^{-}	0.00	0.00
	HCO_3^{-}	8.50	8.60
	Cl^{-}	50.18	49.70
	SO_4^{--}	45.02	46.30

Sowing done at the rate of 90 kg/fed were sown by using broadcasting Afir method on Nov. 20th and 25th in both seasons, respectively.

Studied traits:

A- Growth traits:

After 100 days from sowing, the following traits were estimate; total chlorophylls (SPAD), area of flag leaf (cm^2), height of plant (cm) and tillers number/plant.

B- Yield and its attributes:

At harvesting, the following traits were estimate; spikes number /m^2, length of spike (cm), grains number/spike, the weight of grains per spike (g), hundred grains weight (g), yields of grain & straw per fed as well as harvest index (HI).

$$HI = \frac{\text{Economic yield (grain yield)}}{\text{Biological yield (grain + straw yields)}}$$

C- Grains quality traits:

- Protein %. The total nitrogen was estimated as A.O.A.C. (2007), then calculated crude protein %.
- Total carbohydrates % was estimated as shown by Sadasivam and Manickam (1996).

All data were analyzed according to Gomez and Gomez (1984) using ANOVA for the strip – plot design by Computer software of "MSTAT-C" package. LSD method at 5 % level of probability used as Snedecor and Cochran (1980) to examination the differences among means of treatment.

RESULTS AND DISCUSSION

1. Effect of foliar applications:

On the subject of the effect of foliar applications i.e. control treatment, spraying barley plants with solution of macro and micro nutrients (Macro + Micro) consists of two commercial compounds "Super Sahara" as a source macronutrients and "Action Balance" as a source micronutrients, amino acids in the form of Amino Super Power, humic acid in the form of Hamar and the combination of Macro + Micro, amino acids and humic acid on growth traits (total chlorophylls, area of flag leaf, height of plant and number of total tillers/plant), yield and its attributes (spikes number/m2, length of spike, grains numbers/spike, the weight of grains/spike, hundred grains weight, yields of grain and straw yield and harvest index) and grains quality (protein and total carbohydrates %), it was significant at two seasons as shown from data presented in Tables 2 & 3.

Spraying barley plants with Macro + Micro, amino acids and humic acid at the rates of 2 g + 1 ml + 1.25 ml/liter water, respectively was the top foliar application treatment to increase studied traits of barley and created the uppermost values of these traits into both seasons, with exception total carbohydrates percentage in grains, which had inverse trend. It was followed by spraying with HA (1.25 ml Hamar/liter water), then AA at the rate of 1 ml Amino Super Power/liter water and macro and micro nutrients (Macro + Micro) consists of two commercial compounds "Super Sahara" as a source macronutrients and "Action Balance" as a source micronutrients in the ratio of 1 : 1 (2 g/liter water) in the first and second seasons, excluding total carbohydrates percentage in grains, which had opposite tendency. Quite the opposite, without spraying obtained the lowly mean values of these characters, except total carbohydrates percentage in grains in two seasons.

These increases in growth, yields and components and quality barley grains by spraying with Micro + Macro, Amino Acids and Humic Acid may be due to the fact that these substances may partially compensate for the insufficient uptake of the roots. Also, the role of macro and micro nutrients in the production of some growth regulators reflects increases in photosynthesis. In addition, the role of amino acids in increasing the concentration of chlorophyll and photosynthesis. Also, the role of humic

acid in enrichment soil with nutrients, increase of microbial population, improvement of soil structure as well as various biochemical actions exerted at the cell wall, membrane or cytoplasm and mainly of hormonal nature. These outcomes are in accordance with those stated by Boorboori *et al*. (2012), Alinezhad *et al*. (2013), Sary *et al*. (2014), Abdel-Ati and Eisa (2015), Boshev *et al*. (2016) & Janmohammadi *et al*. (2016).

Table 2. Chlorophyll content, flag leaf area, plant height, number of total tillers/plant, spikes number per /m^2, length of spike and grains number per spike of barley as affected through foliar applications, mineral N- levels and their interaction throughout 2015/2016 and 2016/2017 seasons.

Characters / Treatments / Seasons	Chlorophyll (SPAD)		Area of flag leaf (cm^2)		Height of plant (cm)		No. of total tillers/plant		No. of spikes/m^2		Spike length (cm)		No. of grains/spike	
	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
A- Foliar application treatments:														
Without	21.77	21.77	13.13	13.18	76.02	76.18	8.05	8.37	55.3	90.6	7.05	7.14	41.68	42.39
Macro + Micro	24.51	24.59	14.83	14.95	80.24	80.89	9.04	9.34	89.5	108.2	7.72	7.76	43.02	44.09
Amino acids	24.60	24.60	14.73	14.81	80.27	81.10	9.18	9.36	93.3	109.8	7.96	7.98	43.07	44.13
Humic acid	24.62	24.69	15.17	15.17	81.78	82.18	9.42	9.57	94.7	112.5	8.15	8.10	43.70	44.62
Mixture	26.77	26.77	16.27	16.57	82.90	83.70	10.23	10.52	117.4	132.2	8.41	8.30	44.35	45.24
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	0.46	0.47	0.22	0.27	0.71	0.62	0.35	0.26	5.7	5.5	0.14	0.11	0.21	0.18
B- Nitrogen fertilizer levels:														
40 kg N/fed	23.67	23.67	14.40	14.46	79.14	79.77	8.58	9.02	77.9	101.4	7.74	7.71	42.72	43.69
60 kg N/fed	24.40	24.45	14.73	14.87	80.30	80.91	9.16	9.43	91.8	111.2	7.82	7.85	43.14	44.05
80 kg N/fed	25.28	25.33	15.35	15.48	81.28	81.75	9.82	9.85	100.4	119.4	8.02	8.02	43.64	44.54
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	0.37	0.33	0.24	0.30	0.31	0.30	0.18	0.19	3.2	4.3	0.09	0.07	0.28	0.16
C- Interaction (F. test):														
A × B	*	*	N.S.	*	*	N.S.	*	N.S.	*	*	N.S.	N.S.	N.S.	N.S.

Table 3. Weight of grains /spike, 1000 – grain weight, grain yield per feddan, straw yield per feddan, harvest index, protein and total carbohydrates percentages in barley grains because affected through foliar applications, mineral N- levels and their interaction throughout 2015/2016 and 2016/2017 seasons.

Characters / Treatments / Seasons	Grains weight perspike (g)		1000 – grain weight (g)		Yield of grain (ardab/fed)		Yield of straw (t/fed)		Harvest index (HI)		Protein (%)		Total carbohydrates(%)	
	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017	2015/2016	2016/2017
A- Foliar application treatments:														
Without	1.286	1.529	30.85	36.02	8.33	9.85	1.884	1.899	0.346	0.384	10.01	10.09	77.54	77.49
Macro + Micro	2.007	2.108	46.17	47.77	11.13	11.59	2.153	2.170	0.382	0.391	10.60	10.65	76.26	76.21
Amino acids	2.047	2.113	47.47	47.77	12.04	11.94	2.159	2.178	0.401	0.397	11.40	11.40	75.86	75.81
Humic acid	2.074	2.180	47.52	48.89	12.29	13.21	2.172	2.180	0.404	0.421	10.95	10.95	76.21	76.16
Mixture	2.457	2.603	55.39	57.24	14.21	14.28	2.235	2.252	0.432	0.432	11.51	11.58	75.49	75.44
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	0.048	0.064	0.59	0.64	0.50	0.45	0.009	0.012	0.010	0.008	0.21	0.20	0.03	0.02
B- Nitrogen fertilizer levels:														
40 kg N/fed	1.891	1.973	43.85	44.98	10.76	11.73	2.101	2.118	0.377	0.398	9.76	9.81	77.70	77.65
60 kg N/fed	1.974	2.121	45.52	47.78	11.55	12.15	2.117	2.134	0.393	0.405	10.57	10.59	76.61	76.56
80 kg N/fed	2.058	2.225	47.06	49.85	12.49	12.65	2.144	2.155	0.409	0.412	12.36	12.40	74.51	74.46
F. test	*	*	*	*	*	*	*	*	*	*	*	*	*	*
LSD at 5 %	0.037	0.048	0.52	0.58	0.47	0.39	0.006	0.010	0.009	0.006	0.11	0.16	0.02	0.02
C- Interaction (F. test):														
A × B	*	*	*	*	*	*	*	*	N.S.	N.S.	*	*	*	*

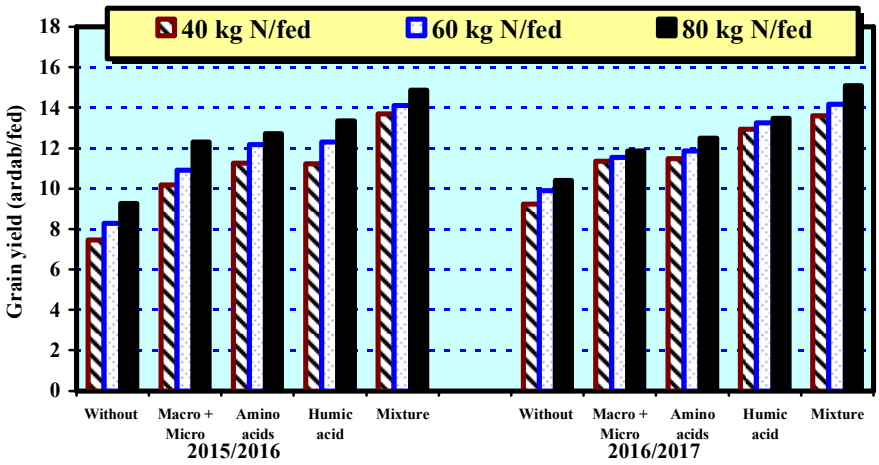

Fig. 1. Grain yield (ardab/fed) of barley because affected through the interact between foliar applications and N- levels throughout 2015/2016 and 2016/2017 seasons.

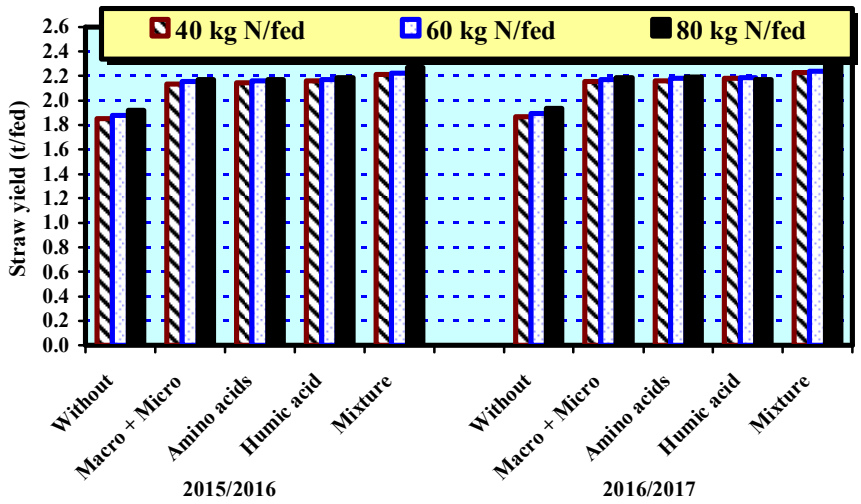

Fig. 2. Straw yield (t/fed) of barley because affected through the interact between foliar applications and N-levels throughout 2015/2016 and 2016/2017 seasons.

2. Effect of nitrogen fertilizer levels:

With reference to the effect of N- levels (40, 60 and 80 kg N/fed) on growth traits (total chlorophylls, flag leaf area, plant height and number of total tillers/plant), yield and its attributes (spikes number/m^2, length of spike, grains numbers/spike, weight of grains/spike, hundred grains weight, yields of grain and straw yield and harvest index) and grains quality (protein and total carbohydrates %), Each increase in N-levels was associated with a significant increase in all studied traits, and the total carbohydrate content of the grains in both seasons (Tables 2 and 3.

Fertilizing with 80 kg N per fed gave the highest mean values of studied traits, with exception total carbohydrates percentage in grains in the two seasons. Barely plants fertilizing through 60 kg N per fed ranked secondly in both seasons. Barely plants fertilizing by 40 kg N per fed produced the lowest values of every one considered characters, with exception total carbohydrates percentage in grains in both seasons.

These increases can be identified in all studied traits of barley allied with increased N-levels for their role in the formation of protoplasm and chlorophyll, and the promotion of meristemy activity and cell division, thus increasing cell volume that caused increased metabolism and photosynthesis. These results are in good agreement with those Ottman (2011), Shafi *et al.* (2011), Mousavi *et al.* (2012), Alazmani (2014), Abido and Seadh (2015) and Alazmani (2015).

3. Effect of interaction:

Results indicated that there was a significant effect due to the interaction between foliar applications and N-levels on many traits as shown from data obtainable in Tables 2 and 3. The authors there only the significant effect on grain and straw yields/fed.

Fertilizing with 80 kg N per fed in addition spraying with Macro + Micro, amino acids and humic acid resulted in uppermost means of grain & straw yields/fed in both seasons (Figs. 1 and 2). The next treatment was adding 60 kg N per fed besides spraying with Macro + Micro, amino acids and humic acid in both seasons.

CONCLUSION

Spraying barley Giza 123 cultivar with Macro + Micro, amino acids and humic acid beside adding 60 kg N per fed could be recommended to preserve high productivity and grains quality under salinity affected soils conditions at Sahl El-Husseiniya district, Sharkia Governorate, Egypt.

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تأثير التسميد الورقى ومستويات السماد النيتروجينى على إنتاجية وجودة حبوب الشعير

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أقيمت تجربتان حقليتان في المزرعة البحثية في منطقة سهل الحسينية (أراضي حديثة الاستصلاح ومتأثرة بالأملاح)، مركز البحوث الزراعية ، مصر، خلال موسمى 2016/2015 و 2016 / 2017 لدراسة تأثير معاملات الرش الورقى ومعدلات السماد النيتروجينى على النمو والمحصول وجودة حبوب الشعير صنف جيزة 123. نفذت كل تجربة فى تصميم الشرائح المتعامدة فى أربع مكررات. احتوت كل تجربة على خمسة عشر معاملة مكونة من خمسة معاملات للرش الورقى و ثلاث مستويات من السماد المعدنى النيتروجينى. إشتملت الشرائح الرأسية على 5 معاملات للرش الورقى (حيث تم الرش الورقى مرتين الأولى بعد 35 يوم من الزراعة والثانية بعد 50 يوم من الزراعة) وهى؛ بدون رش ورقي (معاملة المقارنة) ، الرش الورقى بمحلول العناصر الكبرى والصغرى والمكون من السماد ين التجارين "سوبر صحارى" كمصدر للعناصر الكبرى و"أكشن بلانس" كمصدر للعناصر الصغرى بنسبة 1 : 1 بمعدل 2 جم ماء / لتر ماء في كل رشة ، الأحماض الأمينية في صورة مركب أمينو سوبر باور بمعدل 1 مل / لتر ماء في كل رشة ، حمض الهيومك في صورة مركب هامر بمعدل 1.25 مل / لتر ماء في كل رشة وخليط من العناصر الكبرى والصغرى ، الأحماض الأمينية وحمض الهيومك بمعدل 2 جم + 1 مل + 1.25 مل / لتر على التوالي في كل رشة. أما الشرائح الأفقية فإحتوت على 3 مستويات من السماد المعدنى النيتروجينى (40 ، 60 و80 كجم نيتروجين / فدان). توضح النتائج المتحصل عليها أن الرش الورقي لنباتات الشعير مرتين بخليط من العناصر الكبرى والصغرى ، الأحماض الأمينية وحمض الهيومك بمعدل 2 جم + 1 مل + 1.25 مل / لتر على التوالي في كل رشة كانت أفضل معاملات الرش الورقى تحت الدراسة تأثيراً على صفات النمو والمحصول ومكوناته وصفات جودة الحبوب ، حيث أعطت هذه المعاملة أعلى القيم لجميع الصفات تحت الدراسة فيما عدا النسبة المئوية للكربوهيدرات الكلية بالحبوب في كلا الموسمين. أدى التسميد المعدنى لنباتات الشعير بأعلى مستوى من السماد النيتروجيني (80 كجم نيتروجين/ فدان) للحصول على أعلى القيم لصفات النمو والمحصول ومكوناته وصفات جودة الحبوب، باستثناء صفة النسبة المئوية للكربوهيدرات الكلية بالحبوب في الموسمين الأول والثاني. أما التسميد المعدني لنباتات الشعير بـ 60 كجم نيتروجين/ فدان فقد جاءت في المرتبة الثانية بعد معاملة التسميد بـ 80 كجم نيتروجين/ فدان في كلا الموسمين. من نتائج هذه الدراسة يمكن أن نوصى برش نباتات الشعير صنف جيزة 123 ورقياً وذلك مرتين بعد 35 يوم وأيضاً بعد 50 يومً من الزراعة بخليط من العناصر الكبرى والصغرى ، الأحماض الأمينية وحمض الهيومك وذلك بالمعدلات التالية في كل رشة ؛ 2 جم + 1 مل + 1.25 مل / لتر مع التسميد بـ 60 كجم نيتروجين / فدان من أجل الحفاظ على إنتاجية وجودة مرتفعة من حبوب الشعير، مع خفض تكاليف الإنتاج والحد من التلوث البيئي فى ظروف للأراضي المتأثرة بالأملاح في منطقة سهل الحسينية، محافظة الشرقية، مصر.