RESPONSE OF PEANUTS TO K FERTILIZATION AND FOLIAR SPRAYING WITH ZINC AND BORON UNDER SANDY SOIL CONDITIONS

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ABSTRACT: A field experiment was carried out at El-Khattara region Sharkia Governorate, Egypt during 2006 season to study the effect of K fertilization and foliar spraying with Zn and B or their combinations on growth, yield, yield components, oil percentage as well as uptake of some macro- and micronutrients by peanut (*Arachis hypogaea* L. cv. Ismailia 1) grown on a sandy soil. The obtained results can be summarized as follows: 1) The highest values of peanut yield and its attributes as well as seed quality were obtained when plants treated with K combined with foliar spraying with (Zn + B). 2) The highest nutrient content and uptake by plant were obtained when treated with K combined with foliar spraying with (Zn + B). 3) Soil available N, P and K were increased due to the different treatments, the highest N, P and K values (50.1, 5.18 and 160 mg kg^{-1} soil, respectively) were observed under the combined treatment of (K + Zn + B). 4) The highest values of available Zn, B, Mn and Cu (1.19, 0.92, 3.75 and 0.86 mg kg^{-1} soil, respectively) were obtained due to the combined treatment (K+Zn+ B).

Key words: Sandy soil, peanuts, K fertilization, foliar spray with micronutrients.

INTRODUCTION

The peanut is an important oil and protein crop, it contains about 40-50% oil, 25 – 30% protein, 20% carbohydrates and 5% fiber and ash, and make a substantial contribution to human nutrition (Fageria et al., 1997). In Egypt, peanut is known to be successfully cultivated in the newly reclaimed sandy soils. Production of oil crops in Egypt is insufficient for local consumption. So, it is of great importance to improve peanut production, which could be achieved by several agricultural practices choosing the promising varieties and foliar spraying with K and boron. Under sandy soil conditions, peanuts may need P, K and micronutrient fertilizers to improve pod production and quality, (Ali and Mowafy, 2003).

Regarding the potassium fertilization, Bahl et al., (1986) reported that application of N, P and K to peanut plants improved yield of seed and hay weight of pods and oil %. Dahdouh (1999) showed that application K fertilizer up to 48 kg K_2O fed.$^{-1}$ increased significantly pod yield, shelling percentage and seed oil percentage.

With respect to the influence of micronutrients, many investigators reported the importance of zinc and / or boron application for improving plant growth and yield attributes of peanuts (Brar, 1980; Deshpande et al., 1986; Pal, 1986; Revathy et al., 1997 , Sontakey et al., 1999).

Zinc is an essential component or activator for many enzymes involved in photosynthesis and hence has an important role in early seedling vigor (Welch, 1995). Sarkar et al., (1998) stated that application of Zn and Mo gave the greatest effect in increasing groundnut biomass production, leaf area index, crop growth rate and yield attributes, resulting in 61% greater pod yield over control. Lourduraj et al., (1998) found that N, P and K recommended rates in conjunction with Zn, B, Fe, Mn and Mo produced the highest groundnut pod yield. Darwish et al., (2002) used 1000 ppm Zinc sulphate and 100 ppm boric acid, found that fertilized peanut by 48 kg K_2O fed.$^{-1}$ combined with spraying zinc gave the highest values of seed yield and oil yield fed.$^{-1}$. Ali and Mowafy (2003) pointed out that foliar spraying with Zn or B and their combinations slightly improved yield and its attributes as well as quality in two seasons. Rifaat, et al., (2004) stated that Zn and B fertilization had a significant effect on the seed yield, pod yield, seed weight plant $^{-1}$ as well as seed oil content for the combined data.

As for boron, it plays a role in plant metabolism and in the synthesis of nucleic acid .Also, it is important for tissue development and facilitates sugar translocation (Gauch and Dugger, 1954). In this respect, Bhuiyan et al., (1997) mentioned that application of 1 kg B ha $^{-1}$ increased groundnut nodulation and seed yield. Grewal et al., (1998) found that oil seed rape shoot and root dry matter production as well as chlorophyll content of fresh leaf tissue were significantly influenced by B supply at early vegetative growth in a sand culture.

The present study was initiated to evaluate the effect of K fertilization with the foliar application of Zn or B and their combination on peanut yield, yield components, chemical composition, nutrient content as well as nutrient available forms in soil after harvest under sandy soil conditions.

MATERIALS AND METHODS

A field experiment was carried out during the season 2006 at El-Khattara region, El-Sharkia Governorate, Egypt to study the response of peanut plant to application of fertilizer K with the foliar application of Zn and B. A representative soil sample (0 – 30 cm) was taken before planting to determine some physical, chemical and nutritional properties (Table 1).

The analysis of plants and soil were determined using the methods described by Black (1965) and Chapman and pratt (1961). Available Mn, Zn and Cu were extracted by DTPA (Lindsay and Norvell, 1978) and determined using inductively Coupled Plasma (ICP) Spectrometer model 400 (Soltampour, 1985). Available B was extracted by hot water and determined by the azomethine – H colorimetric method (Gaines and Mitchell, 1979). Protein percentage was calculated by multiplying the nitrogen percentage by the converting factor 6.25 (Hymowitz et al., 1972). Phosphorus fertilizer was added to all plots before sowing at a rate of 30 kg P_2O_5 $fed.^{-1}$ as superphosphate (15.5 % P_2O_5). Nitrogen fertilizer was added to all plots at a rate of 20 kg N $fed.^{-1}$ in the form of ammonium sulphate (20.6% N) in two equal splits, immediately after thinning (20 days from sowing) and 10 days later. Potassium sulphate (48 % K_2O) was applied as soil application at a rate of 48 kg K_2O $fed.^{-1}$ in two equal split, 30 and 45 days after sowing. In addition, after 21, 35 and 60 days from sowing, plants were sprayed with boron in the form of borax (11 % B) at the concentration of 0.5% (0.193 kg B fed^{-1}) and zinc in the form of zinc sulphate (23 % Zn), at the concentration of 2% (1.61 kg Zn fed^{-1}). A randomized complete blocks design with three replicates, having a plot area 3 X 2 m^2, was used. Each plot consisted of 6 rows 50cm apart, two plant/ hill and 20 cm between hills. Peanut seeds (*Arachis hypogaea* L.) cv. Ismailia 1 were sown after soil

preparation. Seeding was carried on May 15 th, 2006. Seeds of peanut were inoculated with an effective strain of (*Brady rhizobium arachis* A.R.C. 601) just before sowing. The treatments were as follows:
1) control. 2) K. 3) Zn. 4) B. 5) K + Zn. 6) K + B. 7) Zn + B. 8) K + Zn + B.

At maturity, two rows of each plot were harvest, air dried, then pods yield (kg fed.$^{-1}$), seed yield (kg fed.$^{-1}$), seed oil percentage, oil yield (kg fed^{-1}) and protein yield (kg fed.$^{-1}$) were estimated. In addition, representative ten plants were taken randomly from each plot to record the following characters.
1) Number of pods plant^{-1}.2) Pods weight plant^{-1}.3)100- seed weight. 4) Seed weight plant^{-1}. 5) Shelling percentage.

Seed and hay samples were digested with a mixture of concentrated sulphoric and perchloric acids for nutrient determination. Oil seed content was determined using Soxhlet method (AOAC, 1990).

The obtained data were subjected to the analysis of variance as described by Snedecor and Cochran (1967). Then Duncan's multiple range test (Duncan, 1955) was used to compare among means.

Table 1. Some physical and chemical properties of the experimental soil

Particle size distribution (g kg^{-1})				Textural class	OM (g kg^{-1})	$CaCO_3$ (g kg^{-1})
C. sand	F. sand	Silt	Clay			
584.4	316.7	60.2	38.7	sand	6.2	7.5

Φ pH	EC (S m^{-1})	Cations (cmol kg^{-1})				Anions (cmol kg^{-1})			
		Ca^{+2}	Mg^{+2}	Na^{+1}	K^{+1}	CO_3^{-2}	HCO_3^{-1}	Cl^{-1}	SO_4^{-2}
8.00	0.05	1.2	0.7	1.4	1.6	0.0	1.8	1.5	1.6

Available nutrients (mg kg^{-1})						
Macronutrients			Micronutrients			
N	P	K	B	Mn	Zn	Cu
17.5	5.16	23.2	0.35	2.30	0.68	0.43

Φ (1 : 2.5) soil : water suspension

RESULTS AND DISCUSSION

Hay, Pod and Seed Yields

Results shown in Table 2 reveal that peanut hay, pod and seed yields were promoted by the different treatments of K, Zn and B.

Application of K resulted in a significant positive response. Such beneficial effect of K fertilizer could be attributed to its essential role in growth and establishment of peanut plants in addition to its role as an activator in the enzymatic reaction during plant growth. These results are in agreement with those reported by Gabr (1998), Anton and Bassiem (1998), Dahdouh, (1999) and Ahmed and Zeidan (2001) who reported that K application increased pod yield by 40 to 39.6%. Baier and Baierova (1999), found that the increases in yield through K application may be due to: (i) the induction of nutrient absorption by root system, (ii) the increase in the plant internal translocation capacity and hence, (iii) the transport of nutrients essential to metabolism in active areas.

Regarding the influence of foliar spray with Zn or B and their combinations on hay and pod yields (Table 2), the results indicate significant increases compared to the control. This may be due to the role of zinc in the synthesis of the amino acid tryptophane which is a precursor the auxin of indole acetic acid which has a role in symbiotic N_2-fixation by legumes. It has also a role in starch metabolism (Jyung et al., 1975) and closely involved in N-metabolism in plant (Price et al., 1972). Boron spraying resulted in a significant increase in hay, pod and seed yields as compared to the control treatment. This may be due to its role in plant metabolism and in the synthesis of nucleic acids. Also, it is an important element for tissue development and facilitates sugar translocation (Gauch and Dugger, 1954). In this respect, Lourduraj et al., (1998) found that recomm-ended rate of N, P and K fertilizers in conjunction with Zn, B, Fe, Mn and Mo produced the highest groundnut pod yield.

The highest hay, seed and pod yields were obtained when the plants were treated with K application combined with foliar spraying with (Zn + B). Darwish et al., (2002) found that fertilized peanut by 48 kg K_2O $fed.^{-1}$ combined with spraying zinc produced the highest values of seed and oil yields $fed.^{-1}$. Rifaat, et al., (2004) stated that zinc and boron fertilization had a significant effect on the seed, pod yields, and seed weight plant $^{-1}$ of peanut plants.

Pod Shelling Percentage

Shelling percentage as influenced by K application and foliar spraying with Zn and B is given in Table 2. Application of K resulted in an insignificant increase in shelling percentage due to the vital role of K in increasing seed weight on account of pod hulls because of its important role in flowering and pod setting, (Ahmed and Zeidan, 2001). Similar results were obtained by Nasr-Alla et al., (1998) and Dahdouh (1999).

Regarding to the foliar spraying with Zn or B and their combinations on shelling percentage Table 2. The results indicate an insignificant increase compared to the control treatment. However, the highest shelling percentage was obtained due to the treatment of (K + Zn + B). Ali and Mowafy (2003) pointed out that foliar spraying with Zn or B and their combinations tended to improve shelling percentage.

Yield Attributes

Potassium application had a significant effect on all yield attributes including seed weight plant^{-1} and 100-seed weight (Table 3). This may be due to its main role in plant metabolism as an activator of large number of enzymes including those pertaining to protein synthesis (Ahmed and Zeidan, 2001). In this concern, Anton and Bassiem (1998) reported that pod weight plant^{-1}, straw weight plant^{-1} and 100-seed weight were increased significa-

Table 2. Peanut hay yield, seed yield, pod yield (Kg fed.$^{-1}$) and pod shelling (%) as affected by K application or foliar spraying with Zn and B and their combinations

Treatment	Hay yield	Pod yield	Seed yield	Pod shelling
Control	1076 h	604 c	315 e	52.2
K	1580 f	672 bc	431 d	64.1
Zn	1400 g	683 bc	452 cd	66.2
B	1829 e	710 bc	525 bc	73.0
K + Zn	2224 d	719 abc	546 b	75.9
K + B	2654 c	736 ab	557 b	75.7
Zn + B	2838 b	709 bc	504 bcd	71.1
K + Zn + B	3097 a	832 a	641 a	77.0

ntly when peanut plants fertilized with the high levels of P and K (30 kg P_2O_5 + 48 Kg K_2O fed.$^{-1}$) compared with the lower levels of both elements. These results may be due to the beneficial effect of P and K on Rhizobium activity and plant growth which in turn reflected positively on peanut yield attributes. Similar results were obtained by Bastawisy and Sorial, (1998); Nasr-Alla et al., (1998) and Dahdouh, (1999). Concerning the influence of micronutrients on yield attributes of peanuts, no significant differences could be detected. However the interaction effect of K and foliar spraying with Zn and or B showed an ascending increases in the order of, K+Zn+B > K+B > Zn+B > K+Zn for all attributes compared with the control treatment.

The highest values of seed weight plant^{-1} and 100-seed weight were obtained due to the treatment (K+Zn+B).

Seed Oil Parameters

Data in Table 3 indicate that, seed oil percent was increased significantly when peanut plants treated with the different treatments of K application and foliar spraying with Zn or B and their combinations compared to the control. Ahmed and Zeidan, (2001) noted that the oil percentage of peanuts was increased with K application compared to the control. This may be due to its important role in enhancing some metabolic processes in plant such as photosynthesis, glycolysis and synthesis of fats. Rifaat, et al., (2004) stated that Zinc and B fertilization had a significant effect on the seed oil content of peanuts.

Concerning the effect of micronutrient spraying on the seed oil percent and oil yield kg fed.$^{-1}$, the results reveal insignificant differences. However, a slight increase in the oil yield kg fed^{-1} was observed when the combined Zn + B was applied. Ali and Mowafy, (2003) stated a slight increase in the oil yield when the combined Zn + B was applied, but the differences could not reach the level of significantly. Darwish et al., (2002) reported that application of (K + Zn) increased seed yield and oil yield.

Seed Protein Parameters

The results in Table 3 indicate that K application significantly increased the protein yield compared to the control. Nasr-Alla et al., (1998) reported a highly significant effect of potassium on protein content of peanut seeds. Regarding the effect of foliar spraying with Zn or B and their combination on protein yield,

Table 3. Effect of K application and foliar spraying with Zn or B and their combinations on yield attributes and quality of peanuts

Treatment	Seed weight $plant^{-1}$ (g)	100-seed weight (g)	Seed oil (%)	Oil yield (Kg $fed.^{-1}$)	Protein (%)	Protein yield (Kg $fed.^{-1}$)
Control	3.21 g	50.4 c	29.6 f	93.2 e	15.1 e	47.5 e
K	6.34 e	62.6 b	38.9 c	168 cd	16.7 d	71.9 d
Zn	4.93 f	59.4 bc	35.6 d	161 d	16.8 d	76.0 d
B	6.82 de	66.8 ab	34.8 d	183 cd	17.2 d	90.3 c
K + Zn	7.54 cd	68.9 ab	32.8 e	179 cd	18.1 c	98.7 c
K + B	8.23 bc	70.8 ab	43.6 b	243 b	20.8 b	116 b
Zn + B	9.09 ab	69.7 ab	38.3 c	193 c	20.5 b	103 bc
K + Zn + B	9.83 a	75.9 a	45.7 a	293 a	21.6 a	138 a

Table 3 indicates insignificant differences between treatments. On the other hand, the interaction between K application and foliar spraying with (Zn + B) gave the highest significant increase in protein yield.

From the above previous results, it can be concluded that the highest peanut yield and its attributes as well as the seed quality were obtained when the plants were treated with K combined with foliar spraying with (Zn + B).

Macronutrients Uptake

Nitrogen uptake

It is clear from the data in Table 4 that, foliar spraying with the combination of (Zn + B) in the presence of K addition was superior for increasing the uptake of N in both of hay and seeds compared to the other treatments. Ahmed and Zeidan, (2001) pointed out that K treatments increased significantly seed N% of peanuts by 48.5% and 47.3% compared to the control in two successive seasons. They suggested that the application of K improved the N% and helped in the translocation of N to the seeds. These results are in agreements with those obtained by Bastawisy and Sorial (1998) and Dahdouh (1999).

Data also revealed an ascending increases in N uptake in the order of(K+Zn+B) > (K+B) > (Zn+B) > (K+Zn) for seeds and in the order of (K+Zn+B) > (Zn+B) > (K+B) >(K+Zn) for hay. The highest N-uptake of hay and of seeds was obtained with the treatment of (K + Zn + B).

Phosphorus uptake

Data in Table 4 show that the phosphorus uptake was increased significantly due to the different treatments compared to the control.

As for the K application and foliar spraying with Zn or B and their combinations, it is clear that, all treatments increased the uptake of P in the order of B > Zn > K for hay, but the same was not true regarding the P–uptake by seeds. On the other hand, foliar spraying with the combination of (Zn + B) in the presence of K addition was superior for increasing the P- uptake in both of hay and seeds compared to the other treatments. Data also reveal an ascending increases in P-uptake in the order of (K+Zn+B) > (Zn+B) > (K+B) > (K+Zn) for hay and in the order of (K+Zn+B) > (K+B) > (K+Zn) > (Zn+B) for seeds. The highest P-uptake of hay and seeds was obtained due to the application treatment of (K + Zn + B).

Potassium uptake

As shown in Table 4 addition of potassium as well as foliar spraying with Zn or B and their combinations significantly increased K- uptake by peanuts. This trend was true for both hay and seeds. The treatment of (K + Zn + B) proved to be the most promotive one. However, no significant difference is shown between the two treatments (K +

Table 4. N, P and K-uptake by hay and seed (Kg fed.$^{-1}$) of peanuts as affected by K application and foliar spraying with Zn or B and their combinations

Treatment	Hay			Seed		
	N	P	K	N	P	K
Control	16.7 g	0.43 h	21.3 g	7.60 e	0.78 f	2.32 e
K	28.1 f	1.42 g	34.4 e	11.5 d	1.21 e	4.84 d
Zn	24.6 f	2.24 f	30.0 f	12.2 d	1.45 e	5.09cd
B	36.2 e	3.11 e	40.4 d	14.4 c	1.79 d	5.96 b
K + Zn	48.0 d	4.00 d	50.0 c	15.8 c	2.08 bc	6.33 b
K + B	60.8 c	5.84 c	60.5 b	18.5 b	2.34 b	6.47 b
Zn + B	66.7 b	6.81 b	63.0 b	16.5 bc	1.97 cd	5.78 bc
K + Zn + B	74.6 a	8.36 a	96.0 a	22.1 a	3.01 a	7.48 a

Zn) and (K + B).

Micronutrients Uptake

Data in Table 5 pointed out that application of K fertilization and foliar spraying with Zn or B and their combinations increased significantly the Zn, B, Mn and Cu uptake by peanut plants as compared to the control treatment. This may be due to K application which plays an important role in enhancing metabolic processes such as photosynthesis, starch synthesis, glycolysis and synthesis of fats and protein. Also, when leaf of peanuts were sprayed by Zn and B , the movement of Zn and B from leaves to pods sink was more efficient due to the role of K in increasing absorption and translocation of nutrients to the pods, Osterbuis (1994).

Zn uptake by peanut plants was recorded in Table 5. The greatest Zn uptake by seeds and hay was occurred with the K application in combination with Zn + B.

As shown in Table 5 addition of potassium and the foliar spraying with Zn or B and their combinations significantly increased B- uptake by hay and seeds. The data stated the superiority of (K+Zn+B) treatment On the other hand, no significant differences were found between (Zn+B) and (K+B) for B uptake by hay or (Zn+B) and (K+Zn) for B uptake by seeds. Again, the treatment (K + Zn + B) proved to be the most promotive one in this concern.

Data in Table 5 indicate that the interaction between K application and foliar spraying with Zn or B significantly increased Mn uptake by hay though, it was insignificant respecting the seeds. The highest Mn uptake by hay and seeds was observed due to the treatment of (K + Zn + B).

Data in Table 5 also illustrated that the highest Cu uptake by hay as well as seeds was obtained due to the K application + foliar spraying with (Zn+B).

From the above results, it can be concluded that the highest nutrient content and uptake by peanuts were obtained when the plants treated with K combined with foliar spraying with (Zn + B). Basing on the foregoing results, it can be concluded that the highest values of peanut yield and its attributes as well as seed quality were obtained with the plants supplied with K combined with foliar spraying with (Zn + B).

Table 5 . Zn , B, Mn and Cu -uptake by hay and seeds (g $fed.^{-1}$) of peanuts as affected by K application and foliar spraying with Zn or B and their combinations

Treatment	Hay				Seed			
	Zn	B	Mn	Cu	Zn	B	Mn	Cu
Control	24.4 g	38.5 f	81.0 g	9.25 f	3.85 e	0.03 e	4.79 e	0.06 f
K	43.1 f	60.5 e	125 f	13.3 e	5.81 d	0.06 d	10.9 d	0.10 de
Zn	43.3 f	63.7 e	114 f	13.2 e	6.91 d	0.07 d	10.2 d	0.09 e
B	68.6 e	90.7 d	154 e	20.7 d	8.45 c	0.10 c	14.6 c	0.13 cd
K + Zn	113 d	124 c	192 d	25.6 c	10.1 b	0.09 c	16.0 bc	0.14 bc
K + B	127 c	172 b	240 c	33.7 b	10.4 b	0.12 b	17.3 b	0.16 b
Zn + B	157 b	176 b	269 b	33.5 b	10.1 b	0.10 c	14.4 c	0.14 bc
K + Zn + B	195 a	230 a	308 a	43.1 a	14.2 a	0.15 a	21.3 a	0.20 a

Available Macronutrients in Soil After Harvest

Table 6 indicates that the applied K fertilizer as well as foliar application with Zn or B increased available N, P and K contents in soil as compared to the control .

As for the combination between K application and foliar spraying with Zn and /or B, data show that the treatment (K + Zn + B) seems to be the most promotive which is possibly due to the beneficial effect of K in increasing the availability of other nutrients in soil.

Available Micronutrients in Soil After Harvest

As shown in Table 6 application of the different treatments slightly increased available Zn, B, Mn and Cu contents in soil as compared to the control treatment. El-Tabey and Hassan (2002) showed that available zinc was significantly increased in some Egyptian soils, when treated with zinc application, as compared to the control. This result agrees with the findings of Jahiruddin et al., (2001); Radwan et al., (2001). Highest available Zn, B , Mn and Cu contents in soil (1.19, 0.92, 3.75 and 0.86 mg kg^{-1} soil respectively) were obtained under applied treatment of (K + Zn + B).

Table 6. Available macro and micronutrients (mg kg $^{-1}$ soil) after harvest as influenced by K fertilization or foliar spraying with Zn or B and their combinations

Treatments	Macronutrients			Micronutrients			
	N	P	K	Zn	B	Mn	Cu
Control	37.1	3.45	125	1.10	0.55	3.21	0.65
K	40.2	4.72	145	1.12	0.75	3.35	0.67
Zn	42.9	4.75	132	1.17	0.70	3.48	0.68
B	41.3	4.71	137	1.13	0.79	3.51	0.73
K + Zn	44.4	4.85	152	1.17	0.69	3.52	0.75
K + B	46.4	4.87	157	1.14	0.83	3.55	0.78
Zn + B	45.4	5.12	154	1.16	0.80	3.56	0.82
K + Zn + B	50.1	5.18	160	1.19	0.92	3.75	0.86

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استجابة الفول السوداني للتسميد البوتاسى والرش الورقى بالزنك والبورون تحت ظروف الأراضى الرملية

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أجريت تجربة حقلية بمنطقة الخطارة بمحافظة الشرقية موسم صيف ٢٠٠٦ لدراسة تأثير التسميد البوتاسى والرش بالعناصر الصغرى الزنك والبوتاسيوم ومخلوط منهما على المحصول وصفاتة وجودة البذور وكذلك امتصاص بعض العناصر الغذائية الكبرى والصغرى بواسطة نبات الفول السوداني صنف إسماعيلية ١ كما اشتملت الدراسة على استبيان هذا التأثير على بعض الخواص الكيميائية للتربة تحت الدراسة بعد الحصاد ويمكن تلخيص أهم النتائج المتحصل عليها كما يأتي:

١) أعلى القيم لمحصول الفول السوداني ومساهماتة وكذلك جودة الحبوب قد تم التحصل عليها نتيجة المعاملة (التسميد بالبوتاسيوم + الرش بالزنك + البورون).
٢) أعلى القيم لمحتوى العناصر الكبرى و الصغرى وامتصاصها بواسطة النبات قد تم التحصل عليها نتيجة المعاملة (التسميد بالبوتاسيوم + الرش بالزنك + البورون).
٣) ازدادت قيم النيتروجين و الفسفور و البوتاسيوم الميسرة بالتربة بعد الحصاد نتيجة لإضافة المعاملات المختلفة وكانت أعلى قيم للنيتروجين و الفسفور و البوتاسيوم (50.1 و 5.18 و 160 ملليجرام / كجم تربة على التوالي) قد تم التحصل عليها نتيجة المعاملة (التسميد بالبوتاسيوم + الرش بالزنك + البورون).
٤) أعلى قيم للزنك و البورون و المنجنيز و النحاس الميسرة بالتربة بعد الحصاد (1.19 ، 0.92 ، 3.75 , 0.86 ملليجرام / كجم تربة على التوالي) تم التحصل عليها نتيجة معاملة الإضافة (التسميد بالبوتاسيوم + الرش بالزنك + البورون).