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THE INTEGRATED EFFECT OF HUMIC ACID AND MICRONUTRIENTS IN COMBINATION WITH EFFECTIVE MICRO-ORGANISMS ON WHEAT AND PEANUT GROWN ON SANDY SOILS

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ABSTRACT: A field experiment was carried out on wheat (Sakha 69)-peanut (Giza 5) cropping sequence grown on sandy soils at El Ismailia Agricultural Research Station during the two successive agricultural growing seasons of 2000-2001. The current study aimed to identify the integrated effect of humic acid (HA), micronutrients (MN) and effective micro-organisms (EM), used as foliar spray in individual or combined treatments, on crop yield and its components, with special reference to the chemical composition of wheat grains and peanut seeds.

The results obtained revealed that, in general, peanut yield and its components responded markedly to all the tested treatments either added individually or together more than that observed for wheat. Data also indicated that the individual treatments of HA, MN and EM recorded significant increases in both wheat and peanut for protein content, as well as, on yield component and 1000 grain weight for wheat and 100 seed weight, seed oil content and harvested index for peanut, with superiority to HA treatment.

As for effect of the combined treatments on both wheat and peanut, it was noticed that foliar spray of EM in combination with either HA or MN gave significant increases in crop yield, yield components, protein content and peanut seed oil content more than that of HA or MN, when solely added. Moreover, data revealed that HA+EM treatment surpassed the other tested treatments either added individually or together.

Also, the beneficial effect of HA in the combined treatment of HA+MN cleared through enhancing the chelating agent by active groups of micronutrients and forming organo-metalic complexes,

which are considered as a storehouse and more mobile or available to uptake by plants, and in turn reflected positively on development of yield and its components for both studied wheat and peanut crops.

Key words: Humic acid, micronutrients, Effective micro-organisms, wheat, peanut and sandy soil.

INTRODUCTION

The main mechanical constituent of sandy soils is the sandy fraction, which is not partially capable to retain neither water nor nutrients for growing plants. Accordingly, these soils are poor not only in the nutrient-bearing minerals, but also in organic matter, which are a storehouse for the essential plant nutrients. In addition, the occurrence of inadequate water retention under such severe conditions, in turn the productivity of different crops tends to decrease markedly (Metwally and Khamis, 1998).

Humic acids have been found to a profound effect on not only the biological activity and soil structure, but also on the plant its self. This is due to their positive effect on the increament in plant nutrients and their availability to the growing plants (El Fakharani, 1999). Tan and Tantiwiramanond (1983) found that seed yield, protein and oil contents of peanut were increased with increasing level of humic acids up to 20 kg/ha and thereafter it declined.

Deffune *et al*, (1995) stated that growth of wheat seedlings was increased by spraying low concentrations of humic acids. Also, Garcia *et al* (1998) found that humic complexes produce a significant increase in Fe assimilation and led to an increase in shoot dry weight of wheat with respect to the control. Cheng *et al.*, (1998) reported that spraying humic acids decreased the loss of soil moisture, enhanced the water retention, increased the ability rate of wheat leaves for photosynthetic process, increased the grain filling intensity, enhanced the drought resistance of wheat and increased its thousand grain weight.

Nardi *et al*, (1999) attributed the beneficial effect of humic acid on plant growth to its acting as plant growth hormones, since it had a gibberellin like activity and suggested that humic fractions exhibited an auxin like activity, exhibiting higher amounts of phenolic and a considerable amount of carboxyl showed the best metabolic effect. Mackowiak (2001) studied the effect of humic acid on plant growth and nutrient suptake in wheat, and he found that humic acid improved Fe-bioavailability by complexing $\approx 10^6$ M Fe, which prevented early Fe deficiency.

Micronutrients content may become a limiting factor in crop production, particularly in sandy and calcareous soils. El Kholany *et al*, (1989) found that foliar application of Fe, Mn & Zn increased grain and straw yields of wheat as well as their contents of N and P. Ghaly *et al*, (1993) and Negm and Zahran (2001) reported that supplying nutrient elements to plants as foliar application, at specific physiological growth is undoubtedly of great importance, especially in case of micronutrient deficient sandy soils. Moussa *et al*, (1998) reported that the micro-nutrients (Fe, Mn & Zn) enhanced the seed yield and oil content of peanut plants grown in sandy soil, because of their beneficial effect on some bio-process, and in turn on the growth of peanut plants.

The influence of effective micro-organisms technology on growth and developments of plants were suggested by many investigators, such as Cho-Cho-Myint *et al*, (1999) who found that effective micro-organisms, when applied with agricultural hyproducts such as plant residues and farm manures, showed improvement not only in production of some crops, but also in chemical and physical properties of cultivated soil. Moreover, these compound fertilizers could be considered as a suitable option for agriculture and production of organic food (Yu *et al*, 1999).

Yadav (1999) stated that efficacy of effective micro-organisms attributed to its role on accelerating the mineralization processes of organic and help nutrient release under temperate conditions and this enhance utility values of organic matter. Hussain *et al*, (1999) found that application of effective micro-organisms in a long-term experiment, increase significantly the grain and straw yields of wheat. This may be attributed to its positive effect on photosynthesis rate and dry matter accumulation (Nissanka and Sangakkara, 1999).

The current work aims to identify the integrated effect of humic acids and micronutreints in combination with effective micro-organisms on wheat and peanut yields and their components. Also, the chemical composition of wheat grains and peanut seeds were taken in consideration.

MATERIALS AND METHODS

A field experiment was carried out on wheat (Triticum aestivum, Sakha 69)-peanut (Arachis hypogaea, Giza 5) cropping sequence grown on sandy soils at El Ismailia Agricultural Research Station during the two successive agricultural growing seasons of 1999-2001. This study aims to identify the integrated effect of humic acids (HA), micronutrients (MN) and effective micro-organisms (EM), used as foliar spray in individual or combined treatments, on crop yield and its components, with special reference to the contents of wheat grains and peanut seeds of some nutrients.

To achieve this target, an experiment was started with wheat at winter season of 1999/2000, followed by peanut at summer season of 2000/2001 in fixed plots with an area of 10.5 m^2. Each experiment was laid out with seven treatments of the previous amendments, with three replicates, arranged in a complete randomized block design were conducted.

All wheat plots received the recommended rate of N (120 kg/fed) as ammonium sulphate (20.6% N) was applied in five equal doses starting from planting and every two weeks, 30 kg/fed P_2O_5 as superphosphate (15% P_2O_5) and 24 kg/fed K_2O as K-sulphate (48% K_2O) before cultivation. While peanut plants received the N (40 kg/fed) as ammonium sulphate (20.6% N) as a basal does in two equal doses (after one and two months of planting), 31 kg/fed P_2O_5 as superphosphate (15% P_2O_5) and 50 kg/fed K_2O as K-sulphate (48% K_2O) before cultivation.

HA applied, in a solid form as K-humate, (50 mg/L) and EM* (1:100, EM:water) were sprayed on the plants at rate of 400 L/fed for each one, three times, once every month starting from sowing.

* EM is a biological solution produced in vats from cultivation of over 80 varieties of micro-organisms belonging to different families, i. e., photosynthetic bacteria, yeast, lacticacid bacteria and fungi) and included both aerobic and anaerobic species (Higa, 1994).

A mixture of chelating micronutrients formed of Fe (6 %), Mn (13 %) and Zn (12 %) at a ratio of 3:2:2, respectively, and concentration of 1 g/L was foliar applied among two times of 45 and 60 days from planting.

Some physical and chemical properties of the investigated soils were determined according to the methods described by Piper (1950), Richards (1954) and Jackson (1973). Available N, P and K were extracted by 1 % potassium sulphate, 0.5 M solution bicarbonate and 1 N ammonium acetate, respectively, and determined according to Jackson (1973). Available micronutrients of Fe, Mn and Zn were extracted by DTPA (Lindsay and Norvell, 1978) and determined using Atomic Absorption Spectrophotometer.

Yield components of wheat and peanut, i. e., weight of grain or seed as ardab/fed, yield of straw or folliage as ton/fed, weight of 1000 grain or 100 seed and the harvest index (grain yield/ grain and straw yields X 100) were recorded. Wheat grain and peanut seeds were dried, ground and digested to determine nitrogen, phosphorus and potassium (Van Schouwenburg, 1968). Crude protein was calculated by multiplying total N-content by 6.25 (Deyoe and Shellenberger, 1965). The micronutrients (Fe, Mn and Zn) were determined using Atomic Absorption Spectrophotometer. Oil content for peanut seed was determined according to Bligh and Dyer (1959). The data obtained were subjected to statistical analysis according to Snedecor and Cochran (1967).

RESULTS AND DISCUSSION

I. Experimental soil:

An investigation was carried out on the studied soil, data illustrated in Tables (1 and 2) showed that it is characterized by sandy in texture with a dominant coarse sand fraction, non-saline (TSS = 0.074 %), soil pH tends to slight alkaline (7.8), low contents of $CaCO_3$ (1.72 %), organic matter (0.22%) & available micronutrients, i. e., 1.93, 1.13 & 0.51 ppm for Fe, Zn & Mn, respectively. So, it could be mentioned that this soil is, in general, poorer from all aspects, where it is skeletal in texture, weak structure and unfavourable fertility status.

2. Effect of the applied treatments on yield and its components:

2.1. Wheat grain and straw yields:

Data in Table (3) revealed that the individual treatments of

Humic acid (HA), micronutrients (MN) and effective micro-organisms (EM) increased grain and straw yields, with a superiority for HA, since it increased their values by 60.52 & 44.34%, 16.81 & 10.08% and 10.70 &9.18% over the control, EM and MN treatments, respectively.

These results could be explained according to the findings of Mac Carthy *et al.* (1990) who reported that the beneficial effect of HA on plant growth related to its role, since it acted like plant growth hormones. Also, Cheng *et al.*, (1998) stated that spraying humic acid decreased the loss of soil moisture, enhanced the water retention, increased the ability rate of wheat leaves for photosynthetic process, increased the grain filling intensity, enhanced the drought resistance of wheat and increased its thousand grain weight.

Results also showed that the combined treatments of EM with each of HA and MN stimulated their positive effect on wheat grain and straw yields, where EM+HA treatment gave the highest increase in grain yield reached 92.41 and 19.87 % over the control and HA treatments, respectively. On the other hand, EM+MN treatment surpassed the other ones for straw yield, since it increased its values by 66.31 and 25.79 % over the control and MN treatments, respectively. These results are in agreement with Yu *et al.* (1999).

Concerning the effect of combined treatment of HA+MN, data in Table (3) showed pronounced increases reached 66.38 & 47.00 % and 14.74 & 11.21 % for grains & straw over both of the control and MN treatments, respectively.

The previous results are confirmed by the statistical data of Table (3), where the HA+EM treatment exhibited a significantly superior over the other ones. Accordingly, the positive effect of the applied treatments (individual or together) on both grain and straw yields can be arranged, in general, into the descending order of HA+EM > MN+EM > HA+MN >HA > MN > EM.

As for the 1000 wheat grain weight, data in Table (3) indicated that the tested treatments added solely or jointly significantly increased its values, with superiority to EM+HA treatment.

It is worthy to mention that the applied foliar HA+EM treatment surpassed all the tested ones either those individually added or together.

Table (1): Some physical and chemical characteristics of the experimental soil sites during the two growing seasons.

Soil characteristics	Growing season 1	Growing season 2	Soil characteristics	Growing season 1	Growing season 2
Particle size distribution %			*Soil water extract (1:5):*		
Coarse sand	73.95	73.32	Total soluble salts %	0.074	0.067
Fine sand	21.00	21.50	*Soluble ions (meq / l :*		
Silt	4.40	4.50	Ca^{2+}	0.90	0.88
Clay	0.65	0.68	Mg^{2+}	0.80	0.80
Texture class	Sandy	Sandy	Na^{+}	0.40	0.36
Some available macro and micro-nutrients (ppm).			K^{+}	0.10	0.26
			CO_3^{2-}	--	--
N	0.49	0.52	HCO_3^{-}	1.80	1.90
P	2.60	2.55	Cl^{-}	0.20	0.20
K	56.2	53.92	SO_4^{2-}	0.20	0.20
Fe	1.93	1.85	pH (1:2.5 soil water susp.)	7.81	7.60
Mn	1.13	1.05	$CaCO_3$ %	1.72	1.88
Zn	0.51	0.48	Organic matter %	0.22	0.28

Table (2); Critical levels of the studied available plant nutrients (ppm), after Lindsay and Norvell (1978).

Nutrient level	N	P	K	Fe	Mn	Zn
Low	< 40.0	< 5.0	< 85.0	< 4.0	< 1.0	< 0.5
Medium	40.0-80.0	5.0-10.0	85.0-170.0	4.0-6.0	1.0	0.5-1.0
High	> 80.0	> 10.0	> 170.0	> 6.0	> 1.0	> 1.0

Table (3): Grain & straw yields, harvest index, weight of 1000 grain and protein conten of wheat as affected by the used treatments.

Treatment	Grain yield		Straw yield		Harvest index	1000 grain (g)	Protein %	
	*Ardab/ fed.	Increase %	Ton/ fed.	Increase %			Grain	Straw
Control	5.80	--	1.68	--	34.12	36.80	12.24	5.27
EM	7.97	37.41	2.203	31.13	35.54	42.31	18.38	7.38
HA	9.31	60.52	2.425	44.34	36.54	45.92	20.63	8.13
MN	8.41	45.00	2.221	32.20	36.22	43.87	16.69	7.50
EM+HA	11.16	92.41	2.696	60.48	38.31	54.72	24.14	10.06
EM+MN	10.99	89.48	2.794	66.31	37.11	46.81	22.06	9.44
HA+MN	9.65	66.38	2.470	47.02	36.95	46.73	20.94	8.75
L.S.D./0.05	1.257		0.1378		N.S.	4.998	1.547	1.342

* Ardab = 150 kg

This could be attributed to the beneficial effects of both HA and EM, since HA rich in both organic and mineral substances essential to plant growth, stimulating the seed germination and activating the bio-chemical processes in plants (respiration, photosynthesis and chlorophyll content), which increased the wheat quality as well as quantity, i. e., the grain weight and number of grains/ear (Malik and Azam, 1986). In addition, the EM application enhancing and sustaining the crop yield (Yu *et al*, 1999).

2.2. Peanut seed and folliage yields:

Results given in Table (4), revealed that the increases in the peanut seed and folliage yields were significantly higher than those rcorded for the similar applied treatments of wheat crop. These findings are more attributed to the high nutrative value of the nodulated peanut plants (Yano *et al*, 1994).

Table (4): Seed & folliage yields, harvest index, weight of 100 seed, oil an protein contents of peanut as affected by the tested treatments.

Treatment	Seed yield		Folliage yield		Harvest index	100 seed (g)	Oil %	Protein %	
	*Ardab/ fed.	Increase %	Ton/ fed.	Increase %				Seed	Foll-iage
Control	9.76	--	1.45	--	33.51	85.3	35.0	11.69	9.31
EM	15.58	59.63	2.137	47.38	35.35	92.0	40.5	19.56	13.88
HA	19.45	99.28	2.180	50.34	40.09	102.5	43.8	23.00	16.94
MN	18.30	87.50	2.156	48.69	38.89	96.0	42.0	19.88	14.13
EM+HA	24.31	149.08	2.317	59.79	44.08	115.0	51.6	25.94	18.63
EM+MN	20.27	107.68	2.196	51.44	40.91	106.0	47.0	24.13	17.56
HA+MN	19.99	104.82	2.191	51.10	40.63	103.0	46.3	23.19	15.25
L.S.D./0.05	2.277		0.118		2.798	7.487	2.748	5.42	1.686

* Ardab = 75 kg

Data in Table (4), also indicated that the positive effect of the applied humic acid (HA) treatment surpassed the EM and MN ones, where the increases in seed and folliage yields reached 99.28 & 50.35 %,respectively, over the control treatment, as well as, 24.80 and 6.28 % for seed over the EM and MN ones, respectively. The beneficial effect of HA was discussed previously in the case of wheat crop (Tan and Tantiwiramanond, 1983).

As for the combined treatments, data showed that the addition of EM enhanced the role of both HA and MN treatments for increasing the seed and folliage yields of peanut. So, the HA+EM treatment recorded the highest seed & folliage yields, since the increases reached 149.08 & 59.79 % and 24.99 & 6.28 % over the control and HA alone, respectively.

Also, the combined treatment of MN+EM increased the seed & folliage yields by 107.68 & 51.44% and 10.76 & 1.86 % over the treatments of the control and MN alone, respectively. These results are in the line with those obtained by Kohopliya and Higa (1999).

Concerning the HA+MN treatment, data showed that the increases in seed & folliage yields reached 104.82 & 51.10% and 9.23 & 1.62 % over the treatments of the control and MN alone, respectively. Also, data cleared that there is a significant difference between HA+EM and both MN+EM & HA+MN for increasing the yields of seed and folliage.

Regarding the 100 seed weight, data in Table (4) showed a significant increase for all the studied treatments, with a superiority for the HA treatment as compared to MN and EM, when solely used. Whereas, the combined treatments of HA+EM showed the highest value of 100 seed weight over all the tested treatments either individually added or in combination. These results are in agreement with those obtained by Singaravel *et al.* (1993).

2.3. Harvest index:

Values of the harvest index, Tables (3 & 4), showed that neither the individual treatments nor the combined ones had significant effect on harvest index of wheat. On the other hand, the harvest index of peanut was significantly response to the tested treatments, with superiority for the combined one of HA+EM, which exhibited the highest value of 44.08 %. The treatments of HA, MN, HA+MN and EM+MN were significantly increased the harvest index, but there are no significant differences among them.

3. Protein and oil contents:

3.1. Wheat:

Data in Table (3) indicated that the protein content in the grain or straw of wheat was significantly increased as a result of all the tested treatments, with significant differences among them. The corresponding increases for protein in grain were 68.54, 50.16 and 36.36 % for the applied treatments of HA, EM and MN, respectively, vs 97.22, 80.22 and 71.08 % for the combined ones of HA+EM, MN+EM & HA+MN, respectively. Concerning the straw protein, data revealed that, in general, either individual treatments or combined ones showed significant increased in protein content, without significant differences for the individual treatment of HA, EM and MN. Also, all the combined treatments increased protein content significantly without significant differences among them. Whereas, there were significant differences at 5 % level appeared between both (HA+EM & MN+EM) and (HA, EM & MN).

3.2. Peanut:

Protein content in both seed and folliage, Table (4), showed a markedly increased than that observed in the case of wheat crop. Data indicated that the humic acid (HA) treatment increased seed and folliage protein, with significant differences between their effect and both of EM and MN treatments, when they solely used.

The beneficial effect of EM cleared when added in combination with HA, where the treatment of EM+HA, as compared to the control one, increased the protein contents from 11.69 to 24.13 % for seed and from 9.31 to 17.56 % for folliage. These results are in agreement with those reported by Nissanka and Sangakkara (1999).

Regarding oil content, data in Table (4) revealed that its content as a percentage was progressively increased (47.42% over the control), when peanut plants sprayed with the HA+EM treatment as compared with the other ones of individually added or together.

This is due to the effect of HA and EM for enhancing the biosynthesis of seed oil of peanut plants. The magnitude of the increases for the treatments of MN+EM, HA+MN, HA, MN and EM were 34.29, 32.29, 25.14, 20.00 and 15.71 % over the control, respectively.

4. Wheat grain or peanut seed nutrient concentrations and uptake:

Data illustrated in Tables (5 and 6), showed the positive effect of foliar application using HA, EM and MN and their combination on some nutrient concentrations and uptake in wheat grain & straw or peanut seed & folliage.

4.1. Wheat

Data in Table (5) represent the values of macronutrients (N, P and K), which showed a response to the applied treatments, however, the highest values were strictly

Table (5): Effect of the tested treatments on the macro & micronutrient concentrations and their uptake by wheat grain & straw.

Treatment	Nutrient concentration						Dry weight (kg/fed)	Nutrient uptake					
	Macronutrient content %			Micronutrient (ppm)				kg/fed			g/fed		
	N	P	K	Fe	Mn	Zn		N	P	K	Fe	Mn	Zn
							Grain						
Control	1.96	0.234	0.320	190	28.0	46.0	777.0	15.22	1.82	2.49	147.60	21.76	35.74
EM	2.94	0.314	0.365	267	31.3	48.3	1027.5	30.20	3.23	3.75	274.30	32.19	49.63
HA	3.30	0.397	0.480	312	33.6	50.0	1248.0	41.18	4.95	5.99	389.38	41.93	62.40
MN	2.67	0.293	0.370	330	35.0	51.7	1018.5	27.19	2.98	3.77	336.10	35.65	52.63
EM+HA	3.99	0.640	0.580	365	34.8	53.7	1471.5	58.71	9.42	8.53	537.09	51.21	79.02
EM+MN	3.53	0.440	0.510	363	36.6	55.3	1455.0	51.36	6.40	7.42	528.17	53.25	80.46
HA+MN	3.35	0.425	0.490	361	35.5	53.4	1195.5	40.05	5.08	5.86	431.58	42.20	63.84
L.S.D./0.05	0.126	0.0484	0.025	5.572	N.S.	N.S.	187.5	7.26	1.10	1.101	69.2	9.53	13.14
							Straw						
Control	0.843	0.060	1.300	280	34.0	65.0	1660.0	13.99	0.99	21.58	464.80	56.44	107.90
EM	1.18	0.083	1.420	310	38.0	69.1	1830.0	21.59	1.52	25.99	567.30	69.54	126.51
HA	1.30	0.097	1.770	505	39.0	72.6	2350.0	30.55	2.27	41.59	1186.75	91.65	170.61
MN	1.20	0.076	1.690	494	40.0	74.6	1760.0	21.12	1.33	29.74	869.46	70.40	131.29
EM+HA	1.61	0.130	1.990	565	45.0	75.0	3130.0	50.39	3.75	62.29	1768.50	140.85	234.75
EM+MN	1.51	0.098	1.950	510	44.0	77.0	2770.0	41.83	2.71	54.02	1412.70	121.88	213.08
HA+MN	1.40	0.096	1.930	508	41.6	76.0	2480.0	34.72	2.38	47.86	1259.84	103.17	188.48
L.S.D./0.05	0.217	0.014	0.047	6.692	3.24	3.61	491.0	7.11	0.529	6.01	248.63	20.53	38.60

Table (6): Effect of the tested treatments on the macro & micronutrient concentrations and their uptake by peanut seed & folliage.

Treatment	Nutrient concentration						Dry weight (kg/fed)	Nutrient uptake					
	Macronutrient content %			Micronutrient (ppm)				kg/fed			g/fed		
	N	P	K	Fe	Mn	Zn		N	P	K	Fe	Mn	Zn
							Seed						
Control	1.87	0.289	0.38	210	34.0	71.7	680.3	12.72	1.97	2.58	142.85	23.13	48.77
EM	3.13	0.361	0.93	280	36.3	78.3	1110.0	34.74	4.01	10.32	310.8	40.29	86.91
HA	3.68	0.619	0.81	295	35.8	77.3	1396.5	51.39	8.64	11.31	411.97	49.99	107.95
MN	3.18	0.387	0.48	290	37.6	83.8	1291.5	41.07	4.99	6.20	374.54	48.56	108.22
EM+HA	4.15	0.575	0.98	380	37.5	89.0	1668.8	69.25	9.50	16.35	634.13	62.58	148.52
EM+MN	3.86	0.630	0.88	372	40.4	87.0	1495.5	57.73	9.42	13.16	556.33	60.42	130.11
HA+MN	3.71	0.566	0.86	350	39.3	79.0	1460.3	54.18	8.27	12.55	511.08	57.39	115.36
L.S.D /0.05	0.8674	0.0374	0.0545	25.548	2.259	5.74	152.8	11.79	1.15	1.67	74.16	6.20	15.07
							Folliage						
Control	1.49	0.180	1.20	270	79.0	55.0	1337.0	19.92	2.41	16.04	360.99	105.62	73.54
EM	2.22	0.291	1.33	325	79.5	56.0	2014.0	44.71	5.86	26.78	654.55	160.11	112.78
HA	2.71	0.296	1.46	390	80.0	56.6	2147.0	58.18	6.36	31.35	837.33	171.76	121.52
MN	2.26	0.291	1.43	387	80.3	55.8	1947.0	44.00	5.67	27.84	753.49	156.34	108.64
EM+HA	2.98	0.299	1.94	450	85.0	57.1	2191.0	65.29	6.55	42.50	985.95	186.24	125.11
EM+MN	2.81	0.297	1.83	436	84.6	55.9	2165.0	60.84	6.43	39.62	943.94	183.16	121.02
HA+MN	2.44	0.296	1.76	320	83.3	55.3	1994.0	48.65	5.90	35.09	638.08	166.10	110.27
L.S.D./0.05	0.2703	0.0308	0.1713	6.248	4.54	3.03	1020.3	4.752	0.534	3.699	37.55	12.07	10.95

associated with the applied combined treatment of HA+EM, since it raised the N-concentration in grain & straw by 103.57 and 90.98 % over the control treatment, respectively. Also, data revealed that concentration of P in grain reached about 3-4 times greater than that in straw, while the opposite trend was true for K.

As for the N & K-uptake, results of the statistical analysis revealed that, in general the applied individual treatments of HA, EM and MN significantly increased for both nutrients uptake, without a significant difference between both EM and MN treatments.

Whereas, the combined treatments of HA+EM, MN+EM and HA+MN were superior to the control, with significant differences among them for N-uptake by both grain and straw. Data also cleared the stimulating effect of EM on the N-uptake in both grain & straw, when sprayed in combination with HA or MN, since it increased its values by 42.56 & 64.94 % and 88.89 & 98.06 %, respectively, over the HA and MN treatments when solely used. Also, the combined treatment of HA+MN increased N-uptake in both grain and straw by 47.30 and 64.00 %, respectively, over the Mn treatment when individually used.

The corresponding values for P were 417.58 & 278.79 % over the control treatment and 90.30 & 65.20 % over the HA alone. These results coincided with Macowiak (2001).

The K-uptake was positively significant increased in the individual treatments of EM and MN for grain, as well as, those of HA and HA+MN, but without any significant differences among them for both the previous categories. The reverse was true for wheat straw, where the positive effect of the tested treatments was more pronounced than in grain, since all the combined treatments increased K-uptake with high significant differences among them. So, it could be arranged the combined treatments according their positive effect into the descending order of HA+EM > MN+EM > HA+MN.

Results of the micronutrient contents of Fe, Mn and Zn and their uptake by wheat grain and straw are shown in Table (5), showed a significantly increased for all the tested treatments for Fe, with a superiority to the combined treatment of HA+EM, since it increased Fe-content in grain with insignificant increased, while the reverse was true for their uptake in grain.

As for nutrients content and uptake in wheat straw, the combined treatments with EM (HA+EM & MN+EM) exhibited markedly response for all studied nutrients (Fe, Mn and Zn). This finding indicated a positive role of EM for improving the efficiency and enhance nutrient uptake, and in turn increasing the quantity and quality of wheat crop.

4.2. Peanut:

Table (6) showed that the used treatments, individually or together, recorded significantly increased macro (N, P and K) and micronutrient (Fe, Mn and Zn) concentrations or uptake for seed and folliage, with superiority for HA+EM followed by MN+EM and HA+MN treatments, without any significant differences among the latter ones towards all nutrients uptake in seed or P and Zn in folliage.

N-uptake ranged 12.72-69.25 and 19.92-65.29 kg/fed in seed and folliage, respectively. As for P-uptake, data showed that the applied EM stimulate HA and MN towards increasing P-uptake, since the treatment of EM+HA raised its values by 11.06 over the HA treatment. Whereas, EM+MN treatment increased P-uptake by 88.77 % over the MN treatment, when solely used.

Fe-uptake in seed showed a progressive increased reached its maximum value in the case of HA+EM treatment, where it raised by 343.90 and 173.12 % over the control treatment for seed and follige, respectively. Mn-uptake ranged 23.13-62.58 g/fed and 105.62-186.20 g/fed in seed and folliage, respectively. Zn-uptake was positively affected by all the tested treatments, with superiority to the combined ones.

From the above-mentioned results, it was cleared that the contents of P, Fe and Zn were greater in seed than that in straw. Whereas, K and Mn contents behaved the opposite trend.

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التأثير المتكامل لحامض الهيوميك والمغذيات الصغرى والمخصب الحيوى EM على نباتات القمح والفول السودانى النامية فى أراضى رملية

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أجريت تجربة حقلية على محصول القمح (سخا ٦٩) يليه محصول الفول السودانى (جيزة ٥) المنزرعين فى أرض رملية بمحطة البحوث الزراعية بالإسماعلية خلال الموسمين الزراعيين لعامى ٢٠٠٠ /٢٠٠١ ، وتهدف هذه الدراسة إلى إستبيان مدى التأثير المتكامل لحامض الهيوميك والمغذيات الصغرى والمخصب الحيوى EM (كإضافات منفردة أو مشتركة) على المحصول ومكوناته ، بالإضافة إلى التركيب الكيميائى لحبوب القمح وبذور الفول السودانى .

وتشير النتائج المتحصل عليها إلى حدوث إستجابة كبيرة لكل المركبات تحت الدراسة التى تم إضافتها فى صورة معاملات منفردة أو مشتركة خاصة فى حالة محصول الفول السودانى مقارنة بمحصول القمح ، وبالنسبة للمعاملات المنفردة فقد سجلت معاملة حامض الهيوميك تفوقا على كل من والمغذيات الصغرى والمخصب الحيوى EM ، حيث أظهرت النتائج فروقا معنوية فى قيم محصول حبوب القمح أو بذور الفول السودانى ، محتواها من البروتين ، وزن ١٠٠٠ حبة أو ١٠٠ بذرة ، محتوى البذور من الزيت ، دليل النضج لمحصول الفول السودانى . أما بالنسبة للمعاملات المشتركة ، فلقد لوحظ أن الرش بمركب المخصب الحيوى EM مشتركا مع أى من حامض الهيوميك أو المغذيات الصغرى قد أعطى تأثيرا معنويا على ناتج كلا المحصولين ، حيث سجلت المعاملتين المشتركتين (المخصب الحيوى EM + حامض الهيوميك) ، (المخصب الحيوى EM + المغذيات الصغرى) تفوقا على كل من معاملتى حامض الهيوميك والمغذيات الصغرى عند إضافتهما بصورة منفردة ، مع تفوق ملحوظ بالنسبة للمعاملة المشتركة الأولى .

ويؤكد ذلك نتائج التحليل الإحصائى حيث أظهرت فروقا معنوية فى قيم محصول حبوب القمح أو بذور الفول السودانى ، مكونات كلا المحصولين ، محتواها من البروتين ، محتوى بذور الفول السودانى من الزيت . وقد يرجع التفوق الخاص بالمعاملة المشتركة (المخصب الحيوى EM + حامض الهيوميك) إلى حامض الهيوميك الذى يعمل كهرمون منشط للنمو ، هذا بالإضافة إلى دور المخصب الحيوى EM فى تشجيع النمو الخضرى للنبات من خلال تنشيط عملية التمثيل الضوئى وزيادة نشاط الإنزيمات كنتيجة لتنشيط المواد المضادة للأكسدة والتى تمثل الجهاز الدفاعى للنبات . كما يرجع التأثير الإيجابى لحامض الهيوميك فى المعاملة المشتركة (HA+MN) لقدرته على خلب المغذيات الصغرى وتكوين معقدات معدنية-عضوية تعتبر مخزون عنصرى أكثر صلاحية وتيسر للنباتات تحت ظروف الأراضى تحت الدراسة ، مما يؤثر إيجابيا على زيادة إنتاجية كلا المحصولين (القمح والفول السودانى) ومكوناتهما .