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(Original Article)

Influence of Humic Acid, Bio and Nitrogen Fertilizer on Grain Sorghum (*Sorghum bicolor* L.) Productivity

Eman M.A. Soliman[1*]; Ragab A. Dawood[2]; Ibrahim A. El-Far[2] and Ahmed E.A. Mourad[3]

[1] Agriculture Research Station at Arab El-Awamer, Assiut Governorate, Assiut, Egypt.
[2] Department of Agronomy, Faculty of Agriculture, Assiut University, Assiut, Egypt.
[3] Sorghum Research Department, Field Crops Research Institute, Agriculture Research Center, Giza, Egypt.

[*]Corresponding author e-mail: emansoliman87@yahoo.com
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Abstract

Two field experiments were carried out during 2022 and 2023 seasons to study the impact of humic acid, bio-fertilizer and nitrogen fertilizer rates on grain sorghum hybrid Shandaweel-1 productivity. The randomized complete block design using a split-split plot arrangement with three replicates was employed, where nitrogen fertilizer rates (60, 80 and 100 kg N/fed.) were assigned in the main plots, while the humic acid rates (0, 15 and 30 kg/fed.) were allocated in sub-plots and bio-fertilizer (Microbein, Nitrobein and Cerealin) was fixed in sub-sub-plots The grain was planted on 26th and 21st June in the first and second seasons, respectively. The plot area was 12 m^2 (4 m long and 3 m width).

The results declared that the 100 kg N/fed. × 30 kg HA/fed. interaction treatment gave the tallest plants and the heaviest 1000 grain in the 2nd season, as well as 60 kg N/fed. × without humic acid interaction treatment gave the highest mean values for grains weight/panicle and grain yield/fed. in both seasons. In general, the 80 kg N/fed. xMicrobein interaction treatment recorded the maximum grains weight/panicle and grain yield/fed, 100 kg N/fed. × Microbein interaction treatment recorded the heaviest 1000 grain in both seasons. The 15 kg HA/fed. × Microbein interaction treatment gave the tallest plants season and maximum grain yield/fed. in 1st and 2nd season, respectively. Moreover, without humic acid × Microbein interaction treatment gave the maximum mean values for 1000 grain weight in both seasons, grain weight/panicle and grain yield/fed. in the 1st season.

Keywords: *Bio-fertilizer, Grain yield, Humic acid, Its components of sorghum, N fertilizer rate.*

Introduction

Grain sorghum is one of the most important grain crops in Upper Egypt especially in Assiut and Sohag Governorates. Fertilizers are rich sources of plant nutrient required for increased crop productivity. Nitrogen is one of the major macronutrients that are most limited in grain sorghum production worldwide. Zand *et al*. (2014) stated that the nitrogen application rate was significant for grain yield, but it did not significant for 1000 grain weight. Ayat *et al.* (2014) denoted that the application of NPK fertilizers exerted significantly influence on plant height, panicle length, panicle weight, seed index and grain yield/fed. Hassan *et al*. (2016) declared that plant height, panicle length,

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panicle weight, 1000 grain weight and grain yield/fed. increased by increasing N fertilizer rates and the maximum values were achieved by 120 kg N/fed. in both seasons. Bartzialis *et al*. (2023) reported that higher nitrogen supply has been found to contribute to the maximum sorghum yield. Gierasimials *et al*. (2023) concluded that application of N fertilizer at 135 kg/ha gave the highest values for plant height, 1000 seed weight and grain yield/ha in both seasons.

Humic materials are one of the important components of the soil, which affected its chemical and physical properties and improved fertility. Humic acid has been reported as a promising resource showing persistent effects on plant growth promotion, nutrient uptake and improving soil nutrient status by increasing organic matter (9%), total N (30%), available P (166%) and available K (52%) indicating a substantial increase in soil nutrient status (Arjumend *et al*., 2015). Daur *et al*. (2013) exhibited the humic acid increment increased growth and quality of maize. Based on the present study findings 55 kg/ha of powder HA application to soil may be recommended. Al-Beiruty *et al*. (2018) stated that changes in plant height, seed weight/head, and seed yield/fed. were recorded after foliar application of humic acid at different concentrations. Shamsur *et al*. (2023) confirmed that humic acid application of 15 kg/ha increased yield of maize as compared to control.

Al-Bawee and Aziz (2019) detected that spraying humic acid with the concentration 2 ml/L led to increasing plant height, head length, grains weight/head and total yield. Ismail *et al*. (2019) indicated that adding humic acid (15 kg/ha) level led to an improvement in grain crop productivity and yield components of sorghum. Ali *et al*. (2020) showed that the maximum grain yield/fed. was achieved from plants sprayed by 2-2.5 ml of humic acid in both seasons. Tag El-Din *et al*. (2021) concluded that using humic acid and fulvic acid enhanced yield and its components of grain sorghum. The maximum grain yield was gained by using humic and fulvic acids with 75% N recommended.

Bio-fertilizers reduce the use of chemical fertilizer which causes pollution of aerial and soil environment. In addition, the positive influence of bio-fertilizer on soil fertility, organic matter content, enzymes, microbial population and crop yield has been demonstrated in the works of many researches. Ahmed (2009) exhibited the highest corn grain yield obtained from inoculated with bio-fertilizer with 80 kg N/fed. Baral *et al*. (2013) found that inoculation with Azotobacter significantly increased plant height, ear length, 1000 grain weight and grain yield of maize. El-Sheshtawy *et al*. (2015) recommended that treatment of wheat plants by microbein or cerealin or nitrobein with 75 or 100 kg N/fed. enhancing wheat production. Ibrahim *et al*. (2015) enhanced that application of Microbein + 90 kg N/fed. gave the highest values of 100 grain weight and grain yield of maize. El-Shafey and El-Hawary (2016) noted that inoculation of Cerealin with 75% mineral N fertilizers improved growth characters, yield components and increase maize productivity.

Abo-Marzoka *et al*. (2017) revealed that application of bio-fertilizer + 100 kg N/fed. caused a significant increase in plant height and ear length in both seasons. Hassanein *et al*. (2019) supported that inoculation maize grain with Azotobacter and Azospirillum gave the maximum values for the yield and yield components. Gomaa *et* *al*. (2021) mentioned that grown maize after berseem with fertilizer (75% NPK + microbin) resulted in the maximum values. Thus, prober nutrition, humic acid and bio-fertilizer are very important to get higher yield. Hence, the present study was undertaken to find out the impact of humic acid, bio-fertilizer and nitrogen fertilizer rates on hybrid grain sorghum Shandaweel-1 productivity.

Material and Methods

The present work was conducted in the Agricultural Research Station of Arab El-Awamer in Assiut governorate during the two growing seasons of 2022 and 2023 seasons to study the effect of humic acid, bio-fertilizer and nitrogen fertilizer rates on the productivity of hybrid grain sorghum Shandaweel-1. The soil used for this experiment was sandy and its structure is presented in Table 1.

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

Physical properties									
Particle size distribution (%)			Texture class	O.M (%)	$CaCO_3$ (%)	Moisture content (volumetric %)			AW (%)
Sand	Silt	Clay				SP	FC	WP	
89.9	7.1	3.0	Sandy	0.25	30.9	23.3	10.9	4.5	6.5

Chemical properties									
pH (1:1)	EC dS/m (1:1)	Soluble cations (meq/L)				Soluble anions (meq/L)		Available phosphorus (ppm)	Total nitrogen (%)
		Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{-} + HCO_3^{-}	Cl^{-}		
8.37	0.33	1.43	1.16	0.19	0.75	1.68	1.47	8.31	0.0125

SP= Saturation percentage, FC= Field capacity, WP= Wilting point, AW= Available water.

Experimental Design

The field experiment was carried out in randomized complete block design (RCBD) using a split-split plot arrangement with three replications. The nitrogen fertilizer rates (60, 80 and 100 k g N/fed.) were assigned in the main plot, while the humic acid rates (0, 15 and 30 kg/fed.) were allocated in the sub-plot and bio-fertilizer (Microbein, Nitrobein and Cerealin) were fixed in the sub-sub plots. The experimental unit area was 12 m^2 (3m × 4m) including 5 ridges (4 m length) of 60 cm apart at spacing 15 cm between hills.

Nitrogen fertilizer in the form of ammonium nitrate (33.5% N) was divided into three equal doses that were added after 15, 30 and 45 days from sowing. Recommended rate of humic acid, was applied at sowing and bio-fertilizer (nitrobein- microbein – cerealin) was mixed with seeds. Sorghum hybrid Shandaweel-1 was planted on 26^{th} and 21^{st} June in the first and second seasons, respectively. Three weeks after planting, plants were thinned into two plants per hill. The preceding crop was wheat in both seasons. All other agricultural practices were carried out as recommended for grain sorghum in both seasons.

Characters, sampling and measurement

Data was recorded by using competitive plants from each sub-sub plot (12 m^2). A plant was considered competitive when it was guarded from four sides, i.e., two sides on the same ridge and the other two sides on the adjacent ridges. Random samples of five plants were chosen from the two inner rows of every sub-sub plot.

The following characters were recorded: plant height (cm): measured from soil surface to the tip of the panicle; panicle length (cm); measured from the base to the tip of the panicle; seed index (g): is recorded by weight of 1000 grain from each plot; grain weight/panicle (g) and grain yield/fed.: it was estimated from the plot area in kg/plot and converted into ard/fed.

Statistical analysis

The obtained data from each season were exposed to proper statistical analysis of variance according to Gomez and Gomez (1984) using the MSTAT statistical Software package described by CoStat (2004). The least significant differences (LSD) at 5% level of probability were computed to detect the differences among means.

Results and Discussion

Main effects

The results in Table 2 showed that the plant height, panicle length, panicle weight and grain yield/fed. in both seasons, as well as 1000 grain weight in the 2nd season exerted significantly influence by the nitrogen fertilizer rates, whilst the 1000 grain weight in the 1st season did not significantly affect by this trail. The 1000 grain weight in both seasons and plant height in the first season increased by increasing N fertilizer rates and the maximum mean values were achieved by the highest N fertilizer rate (100 kg N/fed.). Moreover, the longest panicle as well as the maximum values for panicle weight and grain yield/fed. in both seasons were realized by 60 kg N/fed. It clears from these data that N fertilizer to grain sorghum enhanced the vegetative growth of the plants, increased photosynthetic activity and metabolites required to produce heavy panicles, increased grains weight and consequently, reacted grain sorghum yield. Gebremarium and Assefa (2015) mentioned that the application of N-fertilizer significantly increased the plant height, panicle length, yield per panicle, 100 grain weight and grain yield over the control. These results are coincided with those mentioned by Zand *et al*. (2014), Ayat *et al.* (2014), Hassan (2016), Gierasimiule *et al*. (2023) and Dimitios *et al.* (2023).

With attention to humic acid, data in Table 2 exhibited that all studied traits exerted significantly influenced by humic acid in both seasons, except panicle length and 1000 grain weight had insignificant effect by this trial in the 1st and 2nd seasons, respectively. The longest panicle, the heaviest panicle, heaviest 1000 grain and maximum yield were recorded without humic acid, whilst the tallest plants were achieved by 15 kg humic acid/fed. in both seasons. Al-Bawee and Aziz (2019) detected that spraying humic acid with the 2 ml/L concentration led to increasing plant height, head length, grains weight/head and total yield. These results are in accordance with those mentioned by Daur *et al*. (2015), Shamsur *et al*. (2016), Ismail *et al*. (2019), Ali *et al*. (2020) and Tag El-Din *et al*. (2021).

Table 2. Effect of nitrogen, humic acid and bio-fertilizer on yield and attributes for grain sorghum in 2022 and 2023 seasons.

Charact / Main effect	Plant height (cm)		Panicle length (cm)		Grains wt/panicle (g)		1000 grain weight (g)		Grain yield/fed. (g)	
	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
Nitrogen levels kg fed^{-1}										
60 kg	123.6	130.0	22.63	27.57	44.29	50.67	20.40	21.63	17.92	20.63
80 kg	118.1	122.5	22.31	25.97	42.85	48.73	19.81	20.76	17.52	19.71
100 kg	122.9	133.7	21.61	27.53	39.93	45.13	21.16	22.59	16.15	18.39
F-test	**	**	*	*	**	*	NS	*	**	**
LSD 5%	2.17	4.06	0.59	1.41	0.95	1.20	NS	1.16	0.26	0.71
Humic acid rates kg fed^{-1}										
Zero kg	119.3	126.8	22.71	27.65	45.32	50.21	21.06	21.83	18.34	20.31
15 kg	123.8	131.1	22.10	26.73	40.76	48.43	19.27	21.50	16.49	19.72
30 kg	121.5	128.4	21.74	26.68	40.99	45.90	21.03	21.65	16.77	18.59
F-test	**	**	NS	*	**	**	**	NS	**	**
LSD 5%	1.28	2.00	NS	0.74	1.35	1.11	0.58	NS	0.55	0.34
Bio-fertilizer										
Microbein	121.8	127.7	22.35	27.07	44.69	50.02	20.79	22.11	18.08	20.23
Nitrobein	121.7	130.7	22.40	27.34	40.65	47.25	20.37	21.50	16.45	19.24
Cerealin	121.1	127.6	21.81	26.65	41.73	47.26	20.21	21.37	17.07	19.15
F-test	NS	**	NS	NS	**	**	NS	NS	**	**
LSD 5%	NS	1.78	NS	NS	1.01	1.77	NS	NS	0.41	0.48

*, ** indicated to significantly and highly significantly at 5% and 1% levels of probability, respectively NS = Non-significant differences.

Table 3. Effect of the interaction between N levels and humic acid rates on yield and attributes for grain sorghum to 2022 and 2023 seasons.

Treatments		Plant height (cm)		Panicle length (cm)		Grains wt/panicle (g)		1000 grain weight (g)		Grain yield/fed. (g)	
N levels kg fed^{-1}	Humic acid rates kg fed^{-1}	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
60 kg	**Zero kg**	123.2	131.9	22.10	28.84	52.47	58.31	21.23	22.28	21.23	23.60
	15 kg	126.3	132.0	23.36	26.98	37.17	49.54	18.91	21.61	15.04	20.43
	30 kg	121.4	126.1	22.44	26.88	43.24	44.14	21.06	21.00	17.50	17.85
80 kg	**Zero kg**	120.5	127.5	23.20	27.56	45.06	57.62	20.21	21.17	18.47	23.31
	15 kg	116.9	122.4	21.80	24.99	43.98	46.31	18.90	20.33	17.79	18.73
	30 kg	116.7	117.6	21.94	25.36	38.91	42.26	20.31	20.78	16.31	17.10
100 kg	**Zero kg**	114.0	120.9	22.84	26.56	37.84	34.69	21.74	22.06	15.31	14.03
	15 kg	128.3	138.6	21.14	28.22	41.14	49.42	20.00	22.56	16.65	20.00
	30 kg	126.5	141.6	20.83	27.80	40.80	51.29	21.72	23.17	16.51	20.83
F-test		**	**	NS	**	**	**	NS	NS	**	**
LSD 5%		2.22	5.02	NS	1.28	2.34	1.93	NS	NS	0.95	0.59

** indicated to highly significantly at 1% levels of probability NS = Non-significant differences.

Concerning bio-fertilizers, the data in Table 2 declared that the bio-fertilizer exerted a significant influence on the plant height in the 2nd season, as well as in both seasons reacting significantly on grain wt/panicle and grain yield/fed. The microbin bio-fertilizer gave the tallest plants, the highest panicle weight, the heaviest 1000 grain and the maximum grain yield in both seasons, except plant height in the 2nd season. Moreover, the tallest plant in the second season and the longest panicle in both seasons were detected by Nitrobein, Hassanien *et al*. (2019) enhanced that inoculation maize grain with Azotobacter and Azospirillum gave the maximum for yield and its components. The results are in agreement with those denoted by Ahmed (2009), Baral *et al*. (2013), El-Sheshtawey *et al*. (2015), Ibrahim *et al*. (2015), El-Shafey and El-Hawary (2016), Abo-Marzoka *et al*. (2017), Gomaa *et al*. (2021) and Mohammed *et al.* (2024).

Interaction effect

Data in Table 3 revealed that nitrogen fertilizer with humic acid (N×H) exerted significantly influenced plant height, panicle weight and grain yield/fed. in both seasons and panicle length in the 2nd season. The other traits did not show any significant in both seasons. The heaviest gains/panicle and maximum grain yield/fed. in both seasons and the longest panicle in the 2nd season were recorded by N_1xH_0 (60 kg N/fed. × without humic acid). Moreover, the tallest plants and the heaviest 1000 grain were obtained by N_3xH_2 (100 kg × 30 kg HA/fed) in the 2nd season. Tag El-Din *et al*. (2021) stated that using humic acid and fulvic acid with 75% N recommended gave the maximum grain yield.

With respect to N×B (nitrogen fertilizer × bio-fertilizer) interaction, the results in the Table 4 pointed out that the N×B interaction exerted significantly influence on all studied traits, except 1000 grain weight did not significant by this trail in both seasons. The $N_1 \times B_1$ (60 kg N/fed. × Microbin) interaction treatment gave the longest panicle in the 1st season. Also, $N_2 \times B_1$ (80 kg N/fed. × Microbin) interaction treatment gave the maximum panicle weight and grain yield/fed. in both seasons. Moreover, $N_3 \times B_1$ (100 kg N/fed. × Microbin) recorded the heaviest 1000 grain, as well as $N_3 \times B_2$ (100 kg N/fed. × Nitrobein) gave the tallest plants in both seasons. Ibrahim *et al*. (2015) declared that application of Microbein + 90 kg N/fed. realized the highest values of 1000 grain weight and grain yield/fed. of maize. Similar findings were supported by Ahmed (2009), El-Sheshtawy *et al*. (2015), Abo-Marzouka *et al*. (2017) and Gomaa *et al*. (2021).

With attention to H×B (humic acid × bio-fertilizer) interaction, the results in Table 5 showed that the H×B interaction exerted significantly affected on all studied traits, except 1000 grain weight by this trial in both seasons. The $\mathbf{H_0 \times B_1}$ (without humic acid × Microbein) interaction treatment achieved the heaviest 1000 grain weight in both seasons, the maximum panicle weight and grain yield/fed in the 1st season. Likely, $\mathbf{H_1 x B_1}$ (15 kg HA/fed. × microbein) interaction treatment gave the tallest plant in 1st season, the maximum panicle weight and grain yield in the 2n season. Also, $\mathbf{H_1 \times B_2}$ (15 kg HA/fed. × Nitrobein) interaction treatment gave the tallest plants in the second season.

Table 4. Effect of the interaction between N levels and bio-fertilizer on yield and attributes for grain sorghum to 2022 and 2023 seasons.

Treatments		Plant height (cm)		Panicle length (cm)		Grains wt/panicle (g)		1000 grain weight (g)		Grain yield/fed. (g)	
N levels kg fed^{-1}	Bio-fertilizer	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
60 kg	Microbein	123.4	128.4	24.10	27.80	46.08	47.41	20.80	22.17	18.65	19.17
	Nitrobein	123.6	131.6	22.53	27.57	41.28	52.38	20.09	21.00	16.70	21.58
	Cerealin	123.9	130.0	21.27	27.33	45.52	52.21	20.31	21.72	18.42	21.13
80 kg	Microbein	122.3	124.3	22.92	26.76	49.67	59.98	19.98	21.17	20.09	24.27
	Nitrobein	115.8	122.1	22.09	26.76	40.53	44.72	19.57	21.11	16.40	18.09
	Cerealin	116.0	121.0	21.93	24.39	38.34	41.49	19.88	20.00	16.08	16.79
100 kg	Microbein	119.7	130.5	20.03	26.64	38.33	42.68	21.58	23.00	15.51	17.26
	Nitrobein	125.6	138.6	22.57	27.72	40.13	44.64	21.44	22.39	16.24	18.06
	Cerealin	123.5	131.9	22.22	28.22	41.32	48.08	20.44	22.39	16.72	19.53
F-test		**	**	**	**	**	**	NS	NS	**	**
LSD 5%		1.92	3.08	1.38	1.12	1.76	3.06	NS	NS	0.71	0.83

** indicated to highly significantly at 1% levels of probability. NS = Non-significant differences.

Table 5. Effect of the interaction between humic acid rates and bio-fertilizer on yield and attributes for grain sorghum to 2022 and 2023 seasons.

Treatments		Plant height (cm)		Panicle length (cm)		Grains wt/panicle (g)		1000 grain weight (g)		Grain yield/fed. (g)	
Humic acid rates kg fed^{-1}	Bio- fertilizer	2022	2023	2022	2023	2022	2023	2022	2023	2022	2023
Zero kg	Microbein	116.7	122.8	22.37	26.42	52.09	50.91	21.49	22.56	21.08	20.59
	Nitrobein	121.5	130.7	23.17	27.89	39.80	48.37	20.70	21.39	16.10	19.57
	Cerealin	119.6	126.8	22.61	28.64	44.08	51.34	21.00	21.56	17.83	20.78
15 kg	Microbein	124.9	131.4	23.13	27.91	41.69	51.66	19.81	22.00	16.87	20.90
	Nitrobein	123.9	132.4	21.46	27.48	40.69	47.71	19.31	21.11	16.46	19.69`
	Cerealin	122.7	129.1	21.71	24.80	39.91	45.91	18.69	21.39	16.15	19.21
30 kg	Microbein	123.8	129.1	21.56	26.87	40.30	47.50	21.06	21.78	16.30	19.21
	Nitrobein	119.6	129.1	22.57	26.67	41.46	45.67	21.09	22.00	16.77	18.48
	Cerealin	121.1	127.0	21.10	26.50	41.20	44.52	20.94	21.17	17.23	18.09
F-test		**	**	*	**	*	**	NS	NS	**	**
LSD 5%		1.92	3.08	1.38	1.12	1.76	3.06	NS	NS	0.71	0.83

*, ** indicated to significantly and highly significantly at 5% and 1% levels of probability, respectively. NS = Non-significant differences.

Conclusion

From the results obtained in this research, it could be concluded that applying mineral and bio-fertilizers as well as humic acid for the grain sorghum gave the highest values for the most growth, yield attributes and yield traits in both seasons. So, it is recommended to apply 60 and/or 80 kg N/fed. in combined with microbein and/or nitrobein bio-fertilizer under without and/or both 15 and 30 kg HA/fed. under Upper Egypt condition especially at Arab El-Awamer, Agricultural Research Station, Assiut governorate.

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تأثير حمض الهيوميك والتسميد الحيوي والنيتروجيني على إنتاجية الذرة الرفيعة

إيمان محمد أحمد سليمان[1]، رجب أحمد داود[2]، إبراهيم عبد الباقي الفار[2]، أحمد الرفاعي عبد العظيم مراد[3]

[1]محطة البحوث الزراعية بعرب العوامر، اسيوط، مصر.

[2]قسم المحاصيل، كلية الزراعة، جامعة أسيوط، اسيوط، مصر.

[3]قسم بحوث الذرة الرفيعة بحوث محاصيل الحقل، مركز البحوث الزراعية، الجيزة، مصر.

الملخص

نفذت تجربتان حقليتان خلال موسمي الزراعية 2022، 2023 لدراسة تأثير حمض الهيوميك والسماد الحيوي ومعدلات التسميد النيتروجيني على إنتاجية هجين الذرة الرفيعة شندويل-1. كان تصميم التجربة هو القطاعات الكاملة العشوائية باستخدام الأحواض المنشقة مرتين، حيث تم وضع معدلات التسميد النيتروجيني (60، 80، 100 كجم ن/فدان) في القطع الرئيسية، بينما تم وضع معدلات حمض الهيوميك (صفر، 15، 30 كجم/فدان) في القطع المنشقة مرة واحدة، كما تم وضع التسميد الحيوي (ميكروبين، نيتروبين وسيريالين) في القطع المنشقة مرتين. وتم زراعة حبوب الذرة الرفيعة بتاريخ 26 و21 يونيو في السنة الأولي والثانية على الترتيب. وكانت مساحة القطعة التجريبية هي 12 م2 (5 خطوط بمسافة 0,6 م بين الخطوط وطول الخط 4 م).

اوضحت النتائج ان معاملة التفاعل 100 كجم ن/فدان × 30 كجم حمض الهيوميك أعطت أطول النباتات وأثقل 1000 حبة في الموسم الثاني، كما أعطت معاملة التفاعل $N_1 \times H_0$ (60 كجم ن/فدان × بدون حمض الهيوميك) أعلى متوسطات القيم وزن الحبوب /قنديل ومحصول الحبوب/فدان في كلا الموسمين. عامة، سجلت معاملة التفاعل 80 كجم ن/فدان × ميكروبين أعظم وزن حبوب/قنديل ومحصول الحبوب/فدان، وسجلت معاملة التفاعل 100 كجم ن/فدان × ميكروبين أثقل 1000 حبة، كما سجلت معاملة التفاعل $N_3 \times B_2$ (100 كجم ن/فدان × نيتروبين) أطول النباتات في كلا الموسمين.

أعطت معاملة التفاعل $H_1 \times B_1$ (15 كجم حمض الهيوميك × ميكروبين) أعظم متوسطات القيم لوزن الحبوب/قنديل وأعظم محصول حبوب/فدان في الموسم الثاني وأطول النباتات في الموسم الأول. كما أعطت معاملة التفاعل $H_0 \times B_1$ (بدون حمض الهيوميك × ميكروبين) أعظم متوسطات القيم لوزن 1000 حبة في كلا الموسمين، وزن الحبوب/قنديل ومحصول الحبوب/فدان في الموسم الأول.

الكلمات المفتاحية: *التسميد الحيوي والنيتروجيني، حمض الهيوميك، محصول الحبوب ومكونات المحصول للذرة الرفيعة*