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Effect of soil and foliar application of humic acid on productivity of grain sorghum (*Sorghum bicolcr* L moench) grown in calcareous soil under different levels of phosphate fertilizer

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ABSTRACT

The current study was conducted to assess the main and interaction effects of humic acid with different levels of phosphate fertilizer on yield and yield component of grain sorghum {*Sorghum bicolor* (L) Moench} grown in calcareous soil. Two field experiments were carried out consecutively at Tamiya experiment station Agric. Res. Center (A.R.C), Fayoum Governorate Egypt, during the summer growing seasons 2019 and 2020. The experimental layout was a split-split plot arranged in randomized complete block design with four replications.

The application of phosphorus fertilizers had significant effect in all yield attributes panicle length, panicle diameter, panicle weight, 1000 grain weight, shelling percentage (%), fodder yield and grain weight.

Soil application and foliar spraying of humic acid reflected positive significant influences on yield and its components in both seasons. Soil application H_{20} followed by H_{10} and Foliar spraying F_2 followed by F_1 were the potent treatment for increasing yield and its components compared with control treatments (without humic acid).

Key Words: sorghum (***Sorghum bicolcr L Moench***.), Humic acid, Phosphorus fertilizers, Reclaimed soils, Growth stage, Yield.

INTRODUCTION

Grain sorghum is one of the most versatile crops, capable of growing well under contrasting climatic conditions. Although grain sorghum is mostly grown in the U.S. for animal feed, it is the dietary staple of people in more than 30 countries. Some types are also used in making unleavened bread, cakes, wallboard, starch, dextrose, syrup, brooms, ethanol, high quality wax and even vodka and other alcoholic beverages.

Sorghum has a variety of uses including food for human consumption, feed grain for livestock, which provide meat, dairy products, wool, eggs and industrial applications such as ethanol production **Delserone, 2008.** In 2019 Grain sorghum cultivated area in Egypt was about 365439 feddan which producing about 792044 tons **FAO, 2019.**

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Plants suffer from phosphorus deficiency problem, in high **PH** soils especially when grown in calcareous soils because of formation of calcium phosphate and sub sequentially phosphorus becomes the in the non- concessional form. In lime soil, most likely found in Egypt reduction of available soil phosphorous is a common problem for plants due to phosphorous fixation into low level dissolved compounds e.g. calcium phosphate. This is considered nutrition for plants **Rezazadeh, et al., 2012.**

The humic acid has been widely regarded as playing a beneficial role in Fe acquisition by plants. This effect has been mainly attributed to the complexing properties of humic substances, which increases the availability of micronutrients from sparingly soluble hydroxides. Although only in part, humic substances, in particular those with a low molecular mass are taken up by plants and, therefore, may actively modify the plant metabolism. Their effects appear to be mainly exerted on cell membrane functions, promoting nutrient uptake or plant growth and development, by acting as hormone-like substances **Nardi, et al., 2002**.

Hence this study was performed to investigate the effect of soil and foliar application of humic acid and different levels of phosphate fertilizer on yield and its components of grain sorghum grown in calcareous soil.

MATERIALS AND METHODS

Tow field experiments were carried out at Tamiya experiment station Agric. Res. center (A.R.C), Fayoum Governorate Egypt, during the two successive seasons of 2019and 2020. The study was conducted in order to investigate the effect of phosphorous levels, soil application of humic acid, foliar spraying of humic acid and their interactions on growth and yield of grain sorghum grown in calcareous soil.

Each experiment included 27 treatments arranged in a split split plot design with 4 replicates. the experimental unit contained 5 ridges each of 3 m length and 0.6m width, resulted an area of 6 m^2 (1/466 fed) .

The treatments were the combinations of:

1-Three phosphorus levels (100, 200 and 300 kg/fed), occupied main plots. (P_{15}=100, P_{30} =200cm and P_{45} =300 kg/fed.).

2-Three levels of humic acid (HA) was applied as soil application i. e. (0, 10 and 20 kg/fed), arranged in the sub plots.

3-Three foliar spraying of humic acid (0, 400 and 800 mg/L), arranged in the sub-sub plots.

Cultural practices:

The grains of sorghum {*Sorghum bicolor* (L) Moench } were sown in April 17 and15 in the 1^{st} and 2^{st} seasons respectively after follow in both seasons. Each sub –sub plot was fertilized with NK fertilizers. Nitrogen fertilizer was added in the form of ammonium nitrate (33.5 % N) at the rate of 90 Kg N/fad, splatted into two equal doses , one half after thinning (before 1^{st} irrigation), and the other half (before 2 nd irrigation). Potassium fertilizer was added in the form of potassium sulphate (48% k_2o) at the rate of 24 kg k_2o/fed., added during the field preparation.

The plants were thinned to two plants per hill before the first irrigation. The first irrigation was applied after 21 days after sowing and the following irrigation was applied at 15 days intervals during the growing seasons. Hand hoeing twice was applied after 20 and 35 days after sowing. The other agricultural practices were kept the same as normally practices in sorghum field according to the recommendation s of ministry of agriculture and land reclamation, except for the factors under study. The preceding winter crop in the first and second seasons of the study was wheat.

Soil characteristics

The soil texture of the sites was clay loam in both seasons; mechanical as well as chemical analysis of the experimental sit was presented in table (1).

Table (1) some Physical and chemical analysis of the experimental site" tamiya experimental station" in 2019 and 2020 seasons.

Soil analysis	**2019**	**2020**
A: Mechanical analysis		
Sandy %	38.00	34.92
Silt %	21.20	22.50
clay%	40.80	42.58
Textural grade	Clay loom	Clay loom
B: chemical analysis		
PH	8.12	8.20
E.C(ds/m) at 25^{0}C	4.00	3.96
Organic matter %	1.68	1.72
CaCo3%	11.18	11.14
Available N ppm	8.0	8.2

Data recorded:

Yield components:

A random sample of 5 plants from each plot was taken at harvest, in order to determine the following characters:

1. Panicle length (cm): The distance between the base of the head and its top of five plants **Kambal and Webester 1966.**
2. Panicle diameter (cm).
3. Panicle weight (g): The average weight of five heads was calculated by a sensitive balance for each experimental unit. **Kambal and Webester 1966.**
4. Panicle grain weight (g): The average of five headers was calculated by a sensitive balance for each experimental unit.
5. 1000- Grain weight (g): 500 grains of each experimental unit were counted and weighed and multiplied by 2.

2. Yield:

At harvest, the middle two rows from each sub plot were harvested to determine the following:

1. Fodder yield (ton / fed.).
2. Grain yield (ardab / fed) it was determined by the weight of grains per kilograms adjusted 14 % moisture content of each plot.
3. Shelling percentage (%) : They were calculated from the following formula after drying the grains to the degree that allows them to be separated from the panicles:

Shelling percentage % = Grain weight in the panicle / Full panicle weight × 100.

All data obtained in both seasons were subjected to analysis using ANAOVA table in GenStat Statistical computer software (edition12). Treatment means were compared using the least significant difference (LSD) test according to **Gomez and Gomez, 1984** at the 5% level of significance.

RESULTS AND DESCUSSION

Effects of phosphorus fertilization, humic acid soil application, humic acid foliar application and their interactions on yield and its components at harvest.

1. Panicle length (cm):

Table (2) displays the main and interaction impacts of phosphorous fertilizers levels, soil application of humic acid, foliar spraying of humic acid and their interactions on panicle length during 2019 and 2020 seasons.

Data in (Table 2) revealed that average of panicle length significantly affected by different phosphorous fertilizers levels. Maximum value of panicle length **(**26.87 cm**)** recorded by phosphorus fertilization 300 kg P_2O_5 fed^{-1} (P_{45}), while the minimum value of panicle length (23.80 cm) recorded by phosphorus fertilization 100 kg P_2O_5 fed^{-1} (P_{15}).

Humic acid soil application i.e., 10 and 20 kg $fed.^{-1}$, reflected positive significant influences on panicle length in comparison with the untreated control. humic acid at 20 kg $fed.^{-1}$ gave the tallest average value of panicle length (27.83 cm), the shortest panicle length of sorghum was produced from the control treatment (without humic acid) recorded (23.29 cm).

With relation to the effect of foliar spraying of humic acid treatments of sorghum plants on panicle length, it can be clearly seen that this character was significantly affected by foliar spraying of humic acid treatments. From data in Table (8), it can be observed that, the control treatment (without humic acid) gave the lowest means of panicle length (24.40 cm). On the other side, sorghum plants sprayed with 800 mg/L was among those having longest panicle and significantly exceeded other spraying treatments in this respect, the result was (27.37 cm) followed by 400 mg/L., (25.35 cm).

Regarding, the interaction between phosphorous fertilizers and soil application of humic acid data in (Table 8) indicated that the highest value of panicle length (29.13) was produced by applying 300 kg P_2O_5 fed^{-1} (P_{45}) with 20 kg $fed.^{-1}$ humic acid, while highest value of panicle length (28.92cm) was recorded with phosphorus fertilization 300 kg P_2O_5 fed^{-1} (P_{45}), combined with the foliar spraying of humic acid 800 mg/L., Moreover, soil application of humic acid at 20 kg $fed.^{-1}$ combined with 800 mg/L. of spraying of humic acid gave the tallest value of panicle length.

Table (2): Effect of phosphorus fertilizers (P) levels, humic acid soil application (H), humic acid foliar application (F) and their interactions on panicle length (cm) at harvest of sorghum plants (combined analysis for 2019 and 2020 seasons).

Phosphorus fertilizers (P)	Humic Acid soil application(H)	Humic Acid foliar application (F)			
		F_0 (Control)	F_1 (400 mg/L)	F_2 (800 mg/L)	Mean
100 kg P_2O_5 (P_{15})	H_0 Control	19.63	19.98	22.43	20.68
	H_{10} 10 kg/fed.	22.22	24.63	24.78	23.88
	H_{20} 20 kg/fed.	26.08	24.69	29.78	26.85
	Mean	22.64	23.10	25.66	23.80
200 kg P_2O_5 (P_{30})	H_0 Control	24.14	25.10	25.69	24.98
	H_{10} 10 kg/fed.	25.87	26.18	28.47	26.84
	H_{20} 20 kg/fed.	26.71	27.37	28.47	27.51
	Mean	25.57	26.22	27.54	26.44
300 kg P_2O_5 (P_{45})	H_0 Control	22.32	24.36	25.98	24.22
	H_{10} 10 kg/fed.	25.98	27.42	28.40	27.27
	H_{20} 20 kg/fed.	26.60	28.42	32.37	29.13
	Mean	24.97	26.74	28.92	26.87
Means of humic acid soil application	H_0 Control	22.03	23.15	24.70	23.29
	H_{10} 10 kg/fed.	24.69	26.08	27.22	26.00
	H_{20} 20 kg/fed.	26.46	26.83	30.20	27.83
	Mean	24.40	25.35	27.37	25.71
L.S.D. 5% for					
Super phosphate (P)		0.68			
Humic Acid Powder (H)		0.48			
Humic Acid foliar (F)		0.72			
Interaction : (P x H)		0.91			
: (P x F)		N.S.			
: (H x F)		N.S.			
:(P x H x F)		1.95			

The interaction between phosphorous fertilizers, soil application of humic acid and spraying of humic acid (P x H x F) had a significant effect on panicle length. Adding of 300 kg P_2O_5 fed^{-1} (P_{45}), 20 kg $fed.^{-1}$ humic acid with 800 mg/L., foliar spraying of humic acid (P_{300} x H_{20} x F_2) was recorded the highest values in panicle length **(**32.37 cm**).**

2. Panicle Diameter (cm):

Data listed in table 3 show the impacts of three studied factors (phosphorous fertilizers, soil application of humic acid and foliar spraying of humic acid) and their interactions on panicle diameter, throughout the two experimental seasons of 2019 and 2020 seasons.

Soil application of phosphorus fertilizer, irrespective of the rate used, was responsible to produce, significantly, thicker panicle diameter than the untreated control. Generally, comparisons along with the mean values of panicle diameter showed that phosphorus fertilization 300 kg P_2O_5 fed^{-1} (P_{45}) seems to be suitable and recorded the largest mean values of panicle diameter.

Results presented in (Table 3) revealed that the main effect of soil application of humic acid was significant on panicle diameter. H_{20} treatments increased panicle diameter by 9.34% compared to control treatments .

Foliar application of humic acid treatments was significant on panicle diameter. F_2

treatments increased panicle diameter by 7.79% compared to control treatments.

The interaction between phosphorus fertilizer treatments and soil application of humic acid had a significant effect on panicle diameter. P_{45} x H_{20} interaction gave the greatest panicle diameter (7.94cm). while the major value of panicle diameter resulted from interaction between phosphorus fertilizer 300 kg P_2O_5 fed^{-1} (P_{45}) with foliar spraying of humic acid 800 mg/L., As well as The interaction between soil application of humic acid and foliar spraying of humic acid had a significant effect on panicle diameter, the maximum value of panicle diameter resulted from interaction between 20 kg fed.$^{-1}$ of soil application of humic acid with 800 mg/L., of foliar spraying of humic acid.

The differences in panicle diameter due to the interaction between phosphorus fertilizer (P), soil application of humic acid (H) and foliar spraying of humic acid (F) were significant. Adding of 300 kg P_2O_5 fed^{-1} (P_{45}), applied 20 kg fed.$^{-1}$ soil application of humic acid with 800 mg/L., of foliar spraying of humic acid (P_{45}x H_{20} x F_2) was recorded the highest values of panicle diameter.

3. Panicle Weight (g):

The effects of phosphorous fertilizers, soil application of humic acid and foliar spraying of humic acid and their interactions on panicle weight (g) during the combined analysis for 2019 and 2020 seasons were presented in Table (4).

Regarding, the effect of phosphorous fertilizers, results proved that, panicle weight values were significantly increased by increasing phosphorous levels, plots were treated by 300 kg P_2O_5 fed^{-1} (P_{45}) gave the highest panicle weight values (66.02 g). Whereas, the minimum values of panicle weight (60.44g) resulted from 100 kg P_2O_5 fed^{-1} (P_{15}).

Concerning the effect of soil application of humic acid on panicle weight results showed that, soil application of humic acid applied at 20 kg fed.$^{-1}$ increased panicle weight as compared to control. At the rate of 20 kg fed.$^{-1}$ of humic acid add as soil application, panicle weight was increased by 5.52 and 12.10% as compared with using 10 and zero kg fed.$^{-1}$ of humic acid.

Table (3): Effect of phosphorus fertilizers (P) levels, humic acid soil application (H), humic acid foliar application (F) and their interactions on panicle diameter (cm) at harvest of sorghum plants (combined analysis for 2019 and 2020 seasons).

Phosphorus fertilizers (P)	Humic Acid soil application (H)	Humic Acid foliar application (F)			
		F_0 (Control)	F_1 (400 mg/L)	F_2 (800 mg/L)	Mean
100 kg P_2O_5 (P_{15})	H_0 Control	6.10	6.71	6.92	6.58
	H_{10} 10 kg/fed.	6.60	6.93	7.29	6.94
	H_{20} 20 kg/fed.	7.23	6.85	7.46	7.18
	Mean	6.64	6.83	7.23	6.90
200 kg P_2O_5 (P_{30})	H_0 Control	6.49	7.19	7.33	7.00
	H_{10} 10 kg/fed.	7.46	7.22	7.66	7.45
	H_{20} 20 kg/fed.	7.44	7.72	7.97	7.71
	Mean	7.13	7.38	7.65	7.39
300 kg P_2O_5 (P_{45})	H_0 Control	7.38	7.25	7.23	7.29
	H_{10} 10 kg/fed.	7.28	7.66	8.12	7.69
	H_{20} 20 kg/fed.	7.59	7.75	8.49	7.94
	Mean	7.42	7.55	7.95	7.64
Means of humic acid soil application	H_0 Control	6.66	7.05	7.16	6.96
	H_{10} 10 kg/fed.	7.11	7.27	7.69	7.36
	H_{20} 20 kg/fed.	7.42	7.44	7.97	7.61
	Mean	7.06	7.25	7.61	7.31
L.S.D. 5% for					
Super phosphate (P)		0.145			
Humic Acid Powder (H)		0.145			
Humic Acid foliar (F)		0.148			
Interaction : (P x H)		N.S.			
: (P x F)		N.S.			
: (H x F)		N.S.			
:(P x H x F)		0.430			

Regarding to the effect of foliar spraying of humic acid on 2.panicle weight the results in Table (4) clearly show that F2 (800 mg/L) treatments increased panicle weight by 5.22 and 19.98% as compared with F_1 (400 mg/L) and Fo (Control), respectively.

Results illustrated that the interaction between phosphorous fertilizers treatments and soil application of humic acid (P x H) had a significant effect on panicle weight. The highest panicle weight (67.90) was obtained by interaction (P_{45} x H_{20}). Also, the greatest value of panicle weight was resulted from interaction between phosphorous fertilizers 300 kg P_2O_5 fed^{-1} (P_{45}) with 800 mg/L., of foliar spraying of humic acid. While interaction between 20 kg $fed.^{-1}$ of soil application of humic acid with 800 mg/L., of foliar spraying of humic acid gave the heights value of panicle weight (72.03 g).

The tri- interaction between phosphorous fertilizers, soil application of humic acid and foliar spraying of humic acid (P x H x F) had significant effect on panicle weight. Phosphorous fertilizers 300 kg P_2O_5 fed^{-1} (P_{45}) and applying 20 kg $fed.^{-1}$ of soil application of humic acid with 800 mg/L., of foliar spraying of humic acid gave the highest panicle weight value (73.12 g).

Table (4): Effect of phosphorus fertilizers (P) levels, humic acid soil application (H), humic acid foliar application (F) and their interactions on panicle weight (g) at harvest of sorghum plants (combined analysis for 2019 and 2020 seasons).

Phosphorus fertilizers (P)	Humic Acid soil application (H)	Humic Acid foliar application (F)			
		F_0 (Control)	F_1 (400 mg/L)	F_2 (800 mg/L)	Mean
100 kg P_2O_5 (P_{15})	H_0 Control	49.12	55.62	58.49	54.41
	H_{10} 10 kg/fed.	54.01	59.29	67.73	60.34
	H_{20} 20 kg/fed.	62.47	65.98	71.25	66.57
	Mean	55.20	60.30	65.82	60.44
200 kg P_2O_5 (P_{30})	H_0 Control	53.07	65.42	68.68	62.39
	H_{10} 10 kg/fed.	53.67	66.17	66.93	62.25
	H_{20} 20 kg/fed.	59.57	67.74	71.73	66.35
	Mean	55.44	66.44	69.11	63.66
300 kg P_2O_5 (P_{45})	H_0 Control	56.33	64.28	66.66	62.42
	H_{10} 10 kg/fed.	64.63	68.48	70.06	67.73
	H_{20} 20 kg/fed.	59.43	71.17	73.12	67.90
	Mean	60.13	67.97	69.95	66.02
Means of humic acid soil application	H_0 Control	52.84	61.77	64.61	59.74
	H_{10} 10 kg/fed.	57.44	64.64	68.24	63.44
	H_{20} 20 kg/fed.	60.49	68.30	72.03	66.94
	Mean	56.92	64.90	68.29	63.37
L.S.D. 5% for					
Super phosphate (P)		1.11			
Humic Acid Powder (H)		0.77			
Humic Acid foliar (F)		0.97			
Interaction : (P x H)		1.47			
: (P x F)		N.S.			
: (H x F)		1.56			
:(P x H x F)		2.77			

4. Grain weight / panicle (g):

Means of grain weight/panicle (g) as affected by phosphorus fertilizers levels, soil application of humic acid, foliar spraying of humic acid and their interactions combined analysis for 2019 and 2020 growing seasons are presented in (Table 5).

Regarding to phosphorus fertilization levels on grain weight/ panicle (g) data in Table 11 clear that phosphorus levels had a significant effect at 5% level of probability on grain weight/panicle (g) in combined analysis for two seasons. Increasing phosphorus fertilizer levels from 100 to 200 and 300 kg P_2O_5 fed^{-1} caused a significant increase in grain weight/panicle (g). At the rate of 300 kg P_2O_5 fed^{-1} (P_{45}) grain weight/panicle (g) was increased by 11.59 and 5.27 % as compared with using 100 and 200 kg P_2O_5 fed^{-1} , respectively. The increment of grain weight/ panicle (g) gained by increasing phosphorus doses may be due to the role of phosphorus fertilizer in improving panicle dimensions by increasing division or elongation of cells.

Results presented in (Table 5) revealed that the main effect of soil application of humic acid was significant on grain weight/panicle (g). H_{20} treatments increased grain weight/panicle (g) by 13.1 % compared to control treatments. Important in cell division and development of new tissue.

Foliar application of humic acid treatments was significant on grain weight/panicle (g). F_2 treatments increased grain weight/ panicle (g) by 23.97% compared to control treatments.

The interaction between phosphorus fertilizer treatments and soil application of humic acid had a significant effect on grain weight/ panicle (g). P_{45}x H_{20} interaction gave the greatest grain weight/ panicle (g) (50.10g). while the major value of grain weight/ panicle (g) resulted from interaction between phosphorus fertilizer 300 kg P_2O_5 fed^{-1} (P_{45}) with foliar spraying of humic acid 800 mg/L., As well, The interaction between soil application of humic acid and foliar spraying of humic acid had a significant effect on grain weight/ panicle (g), the maximum value of grain weight/ panicle (g) resulted from interaction between 20 kg $fed.^{-1}$ of soil application of humic acid with 800 mg/L., of foliar spraying of humic acid.

The differences in grain weight/ panicle (g) due to the interaction between phosphorus fertilizer (P), soil application of humic acid (H) and foliar spraying of humic acid (F) were significant. Adding of 300 kg P_2O_5 fed^{-1} (P_{45}), applied 20 kg $fed.^{-1}$ soil application of humic acid with 800 mg/L., of foliar spraying of humic acid (P_{300} x H_{20} x F_2) was recorded the highest values of grain weight/ panicle (g).

5. 1000- grain weight (g):

Averages of 1000-grain weight as affected by phosphorus fertilizers levels, soil application of humic acid, foliar spraying of humic acid and their interactions combined analysis for 2019 and 2020 growing seasons are presented in table 6.

With reference to the effect of phosphorus fertilization levels on 1000-grain weight, data listed in Table 6 show that 1000-grain weight was significantly affected by phosphorus fertilizer levels in combined analysis for 2019 and 2020 growing seasons. The highest values of 1000-grain weight were obtained from fertilizing sorghum plants with 300kg P_2O_5 fed^{-1} (30.17g) as compared with plants fertilized with 100 kg P_2O_5 fed^{-1} which gave the minimum average (28.00g). The increase in 1000-grain weight due to phosphorus fertilization may be ascribed to its role in activation cell division, size, elongation, also metabolic and photosynthesis processes, therefore increment grains weight.

Soil application of humic acid was significant on 1000-grain weight of sorghum (Table 12). The maximum values of 1000-grain weight (30.17g) was obtained from using soil application humic acid by rate 20 kg/fed^{-1}. On the other hand, the lowest values of 1000-grain weight (28.61g) was obtained from the control treatments (without humic acid).

Foliar application of humic acid treatments was significant on 1000-grain weight. F_2 treatments increased 1000-grain weight by 1.74% compared to control treatments.

The interaction between phosphorus fertilizer treatments and soil application of humic acid had a significant effect on 1000-grain weight. P_{45} x H_{20} interaction gave the greatest 1000-grain weight (30.84g). while the major value of 1000-grain weight resulted from interaction between phosphorus fertilizer 300 kg P_2O_5 fed^{-1} (P_{45}) with foliar spraying of humic acid 800 mg/L., as well as, The interaction between soil application of humic acid and foliar spraying of humic acid had a significant effect on1000-grain weight, The maximum value of 1000-grain weight resulted from interaction between 20 kg $fed.^{-1}$ of soil application of humic acid with 800 mg/L., of foliar spraying of humic acid.

The differences in 1000-grain weight due to the interaction between phosphorus fertilizer (P), soil application of humic acid (H) and foliar spraying of humic acid (F) were significant. Adding of 300 kg P_2O_5 fed^{-1} (P_{45}), applied 20 kg fed.$^{-1}$ soil application of humic acid with 800 mg/L., of foliar spraying of humic acid (P_{45} x H_{20} x F_2) was recorded the highest values of 1000-grain weight (g).

Table (5): Effect of phosphorus fertilizers (P) levels, humic acid soil application (H), humic acid foliar application (F) and their interactiosn on grain weight / panicle (g)at harvest of sorghum plants (combined analysis for 2019 and 2020 seasons).

Phosphorus fertilizers (P)	Humic Acid soil application (H)	Humic Acid foliar application (F)			
		F_0 (Control)	F_1 (400 mg/L)	F_2 (800 mg/L)	Mean
100 kg P_2O_5 (P_{15})	H_0 Control	35.00	39.54	42.24	38.93
	H_{10} 10 kg/fed.	38.06	42.14	49.10	43.10
	H_{20} 20 kg/fed.	45.14	48.18	51.90	48.41
	Mean	39.40	43.29	47.75	43.48
200 kg P_2O_5 (P_{30})	H_0 Control	37.99	46.72	50.28	44.99
	H_{10} 10 kg/fed.	38.28	46.95	49.23	44.82
	H_{20} 20 kg/fed.	42.27	50.19	52.88	48.45
	Mean	39.52	47.95	50.80	46.09
300 kg P_2O_5 (P_{45})	H_0 Control	40.14	47.34	50.56	46.02
	H_{10} 10 kg/fed.	45.92	50.21	52.23	49.45
	H_{20} 20 kg/fed.	42.84	52.53	54.92	50.10
	Mean	42.97	50.03	52.57	48.52
Means of humic acid soil application	H_0 Control	37.71	44.53	47.69	43.31
	H_{10} 10 kg/fed.	40.75	46.43	50.19	45.79
	H_{20} 20 kg/fed.	43.42	50.30	53.23	48.98
	Mean	40.63	47.09	50.37	46.03
L.S.D. 5% for					
Super phosphate (P)		0.77			
Humic Acid Powder (H)		0.53			
Humic Acid foliar (F)		0.67			
Interaction : (P x H)		1.01			
: (P x F)		1.16			
: (H x F)		N.S.			
:(P x H x F)		1.89			

The increase in grain weight/ear might be attributed to the increase in number of grains/ear which resulted from increased ear height and ear diameter and consequently an increase in number of grain/ear and number of grains per single row beside an increase in grain filling percentage **Gomaa et al, 2014**.

Also many investigators have confirmed that humic acids significantly affected 100 grain weight **Radwan et al., 2014 ;Bilal et al., 2016 and Osman, et al., 2013** in studies on maize and rice, respectively.

The increase in 100 grain weight/ear might be attributed to the increase in number of grains/ear which resulted from increased ear height and ear diameter and consequently an increase in number of grain/ear and number of grains per single row beside an increase in grain filling percentage **Radwan et al., 2014.**

Table (6): Effect of phosphorus fertilizers (P) levels, humic acid soil application (H), humic acid foliar application (F) and their interactions on 1000-grain weight (g) at harvest of sorghum plants (combined analysis for 2019 and 2020 seasons).

Phosphorus fertilizers (P)	Humic Acid soil application (H)	Humic Acid foliar application (F)			
		F_0 (Control)	F_1 (400 mg/L)	F_2 (800 mg/L)	Mean
100 kg P_2O_5 (P_{15})	H_0 Control	27.33	27.46	27.24	27.34
	H_{10} 10 kg/fed.	27.26	26.20	27.55	27.00
	H_{20} 20 kg/fed.	29.57	29.47	29.93	29.66
	Mean	28.05	27.71	28.24	28.00
200 kg P_2O_5 (P_{30})	H_0 Control	29.24	28.81	29.70	29.25
	H_{10} 10 kg/fed.	29.86	29.83	31.00	30.23
	H_{20} 20 kg/fed.	29.58	30.67	29.80	30.01
	Mean	29.56	29.77	30.17	29.83
300 kg P_2O_5 (P_{45})	H_0 Control	29.67	27.67	30.37	29.23
	H_{10} 10 kg/fed.	30.27	30.37	30.70	30.44
	H_{20} 20 kg/fed.	30.43	30.60	31.50	30.84
	Mean	30.12	29.54	30.86	30.17
Means of humic acid soil application	H_0 Control	28.75	27.98	29.10	28.61
	H_{10} 10 kg/fed.	29.13	28.80	29.75	29.23
	H_{20} 20 kg/fed.	29.86	30.24	30.41	30.17
	Mean	29.24	29.01	29.75	29.34
L.S.D. 5% for					
Super phosphate (P)		0.46			
Humic Acid Powder (H)		0.43			
Humic Acid foliar (F)		0.42			
Interaction : (P x H)		0.73			
: (P x F)		N.S.			
: (H x F)		0.72			
:(P x H x F)		N.S.			

6. Grain yield (ardab/fed):

Means of grain yield (ardab/fed) as affected by phosphorus fertilizers levels, soil application of humic acid, foliar spraying of humic acid and their interactions combined analysis for 2019 and 2020 growing seasons are presented in (Table 7).

Phosphorus fertilization levels had a significant effect on grain yield (ardab/fed) in combined analysis for two seasons. Increasing phosphorus fertilizer levels from 100 to 200 and 300 kg P_2O_5 fed^{-1} tended to increase grain yield (ardab/fed) in combined analysis for two seasons as shown in Table 7. The highest grain yield (ardab/fed) (17.25 ardab) was given from adding 300kg P_2O_5 fed^{-1} (P_{45}). However, the lowest ones (15.46 ardab) were produced from the lowest level of phosphorus fertilization 100 kg P_2O_5 fed^{-1} (P_{15}).

Regarding the effect of soil application of humic acid of sorghum on grain yield (ardab/fed), it was significant in combined analysis for two seasons. It was detected that sorghum plants treated with 20 kg humic acid had the highest means of this trait (17.41 ardab). However, the lowest ones (15.39 ardab) was obtained from the control treatments (without humic acid).

Foliar application of humic acid treatments was significant on grain yield (ardab/fed). F_2 treatments increased grain yield (ardab/fed), by 23.96% compared to control treatments.

The interaction between phosphorus fertilizer treatments and soil application of humic acid had a significant effect on grain yield (ardab/fed), P_{45}x H_{20} interaction gave the greatest grain yield (ardab/fed), (17.81 ardab). while the major value of grain yield (ardab/fed), resulted from interaction between phosphorus fertilizer 300 kg P_2O_5 fed^{-1} (P_{45}) with foliar spraying of humic acid 800 mg/L had a significant effect on grain yield (ardab/fed), the maximum value of grain yield (ardab/fed), resulted from interaction between 20 kg $fed.^{-1}$ of soil application of humic acid with 800 mg/L., of foliar spraying of humic acid.

The differences in grain yield (ardab/fed), due to the interaction between phosphorus fertilizer (P), soil application of humic acid (H) and foliar spraying of humic acid (F) were significant. Adding of 300 kg P_2O_5 fed^{-1} (P_{45}), applied 20 kg $fed.^{-1}$ soil application of humic acid with 800 mg/L., of foliar spraying of humic acid (P_{45} x H_{20} x F_2) was recorded the highest values of grain yield (ardab/fed).

Rezazadeh, et al., 2012 and Bilal et al., 2016 reported that humic acid affects plant growth both by direct and indirect action, Indirect effects comprise improvement/modification of soil physiochemical and biological environment such as aggregation, aeration, permeability, water holding capacity, hormonal activity, microbial growth, organic matter mineralization, transport and availability of micro (Fe, Zn and Mn) and some macro nutrients (P, K and Ca). Directly, humic compounds may have various biochemical effects either at cell wall, membrane level or in the cytoplasm, including increased photosynthesis and respiration rates in plants, enhanced protein synthesis and plant hormone like activity. In general, the effect of HA on plant physiology is recognized with regard to enhancement of root growth and nutrient uptake.

Humic substances may increase the tolerance of plants against stress and promote growth by increasing the uptake of nutrients; therefore, the application of humic substances could improve plant growth under calcareous soil conditions. the effects of humic substances soil application on growth, and mineral nutrients uptake of maize were investigated under calcareous soil conditions **Çelik et al. 2011.** In this respect, **Daur and Bakhashwain,2013; Violante,2013 and Yu et al., 2013** found that **e**ar grain weight was increased by humic acid application as a result of increasing the length and diameter of the ear which results in increase in number of grains / ear **.**

7. Fodder yield (ton/fed):

Means of fodder yield (ton/fed) as affected by phosphorus fertilizers levels, soil application of humic acid, foliar spraying of humic acid and their interactions combined analysis for 2019 and 2020 growing seasons are presented in (Table 8).

Phosphorus fertilization levels had a significant effect on fodder yield (ton/fed) in combined analysis for two seasons. Increasing phosphorus fertilizer levels from 100 to 200 and 300 kg P_2O_5 fed^{-1} tended to increase fodder yield (ton/fed) in combined analysis for two seasons as shown in (Table 8). The highest fodder yield (ton/fed) (18.73 ton) was given from adding 300kg P_2O_5 fed^{-1} (P_{45}). However, the lowest ones (16.05ton) was produced from the lowest level of phosphorus fertilization (100 kg P_2O_5 fed^{-1} (P_{15}).

Table (7): Effect of phosphorus fertilizers (P) levels, humic acid soil application (H), humic acid foliar application (F) and their interactions on grain yield (ardab/fed) at harvest of sorghum plants (combined analysis for 2019 and 2020 seasons).

Phosphorus fertilizers (P)	Humic Acid soil application (H)	Humic Acid foliar application (F)			
		F_0 (Control)	F_1 (400 mg/L)	F_2 (800 mg/L)	Mean
100 kg P_2O_5 (P_{15})	H_0 Control	12.44	14.06	15.02	13.84
	H_{10} 10 kg/fed.	13.53	14.98	17.45	15.32
	H_{20} 20 kg/fed.	16.05	17.13	18.45	17.21
	Mean	14.01	15.39	16.97	15.46
200 kg P_2O_5 (P_{30})	H_0 Control	13.50	16.60	17.87	15.99
	H_{10} 10 kg/fed.	13.60	16.68	17.49	15.92
	H_{20} 20 kg/fed.	15.01	17.83	18.79	17.21
	Mean	14.03	17.04	18.05	16.37
300 kg P_2O_5 (P_{45})	H_0 Control	14.26	16.83	17.97	16.36
	H_{10} 10 kg/fed.	16.32	17.85	18.57	17.58
	H_{20} 20 kg/fed.	15.23	18.67	19.52	17.81
	Mean	15.27	17.78	18.68	17.25
Means of humic acid soil application	H_0 Control	13.40	15.83	16.95	15.39
	H_{10} 10 kg/fed.	14.48	16.50	17.84	16.27
	H_{20} 20 kg/fed.	15.43	17.88	18.92	17.41
	Mean	14.44	16.74	17.90	16.36

L.S.D. 5% for	
Super phosphate (P)	0.273
Humic Acid Powder (H)	0.188
Humic Acid foliar (F)	0.236
Interaction : (P x H)	0.360
: (P x F)	0.412
: (H x F)	N.S.
:(P x H x F)	0.673

Regarding the effect of soil application of humic acid of sorghum on fodder yield (ton/fed), it was significant in combined analysis for two seasons. It was detected that from data in Table (14) the sorghum plants treated with 20 kg humic acid had the highest means of this trait (19.12ton). However, the lowest ones (15.75 ton) was obtained from the control treatments (without humic acid). Foliar application of humic acid treatments was significant on fodder yield (ton/fed). F_2 treatments increased fodder yield (ton/fed) by 19.51% compared to control treatments.

The interaction between phosphorus fertilizer treatments and soil application of humic acid had a significant effect on fodder yield (ton/fed). P_{45} x H_{20} interaction gave the greatest fodder yield (ton/fed). (20.91 ton). while the major value of fodder yield (ton/fed), resulted from interaction between phosphorus fertilizer 300 kg P_2O_5 fed^{-1} (P_{45}) with foliar spraying of humic acid 800 mg/L., as well as, the interaction between soil application of humic acid and foliar spraying of humic acid had a significant effect on fodder yield (ton/fed), the maximum value of fodder yield (ton/fed) resulted from interaction between 20 kg $fed.^{-1}$ of soil application of humic acid with 800 mg/L., of foliar spraying of humic acid.

The differences in fodder yield (ton/fed) due to the interaction between phosphorus fertilizer (P), soil application of humic acid (H) and foliar spraying of humic acid (F) were significant. Adding of 300 kg P_2O_5 fed^{-1} (P_{45}), applied 20 kg $fed.^{-1}$ soil application of humic acid with 800 mg/L., of foliar spraying of humic acid (P_{45} x H_{20} x F_2) was recorded the highest values of fodder yield (ton/fed).

Table (8): Effect of phosphorus fertilizers (P) levels, humic acid soil application (H), humic acid foliar application (F) and their interactions on fodder yield (ton/fed) at harvest of sorghum plants (combined analysis for 2019 and 2020 seasons).

Phosphorus fertilizers (P)	Humic Acid soil application (H)	Humic Acid foliar application (F)			
		F_0 (Control)	F_1 (400 mg/L)	F_2 (800 mg/L)	Mean
100 kg P_2O_5 (P_{15})	H_0 Control	12.67	14.09	14.52	13.76
	H_{10} 10 kg/fed.	16.28	15.98	18.54	16.93
	H_{20} 20 kg/fed.	15.06	18.07	19.26	17.46
	Mean	14.67	16.05	17.44	16.05
200 kg P_2O_5 (P_{30})	H_0 Control	14.66	15.33	17.37	15.79
	H_{10} 10 kg/fed.	16.39	18.65	19.42	18.15
	H_{20} 20 kg/fed.	17.34	18.57	21.04	18.98
	Mean	16.13	17.52	19.28	17.64
300 kg P_2O_5 (P_{45})	H_0 Control	18.04	16.45	18.56	17.68
	H_{10} 10 kg/fed.	15.12	16.83	20.83	17.59
	H_{20} 20 kg/fed.	19.24	19.94	23.56	20.91
	Mean	17.47	17.74	20.98	18.73
Means of humic acid soil application	H_0 Control	15.13	15.29	16.82	15.75
	H_{10} 10 kg/fed.	15.93	17.15	19.60	17.56
	H_{20} 20 kg/fed.	17.21	18.86	21.28	19.12
	Mean	16.09	17.10	19.23	17.47
L.S.D. 5% for					
Super phosphate (P)		0.36			
Humic Acid Powder (H)		0.48			
Humic Acid foliar (F)		0.44			
Interaction : (P x H)		0.74			
: (P x F)		0.70			
: (H x F)		0.78			
:(P x H x F)		1.29			

8. Shelling percentage (%):

Averages of shelling percentage as affected by phosphorus fertilizers levels, soil application of humic acid, foliar spraying of humic acid and their interactions combined analysis for 2019 and 2020 growing seasons are shown in (Table 9).

Phosphorus fertilization levels had a significant effect on shelling percentage (%) in combined analysis for two seasons. Increasing phosphorus fertilizer levels from 100 to 200 and 300 kg P_2O_5 fed^{-1} tended to increase shelling percentage (%) in combined analysis for two seasons as shown in Table (9). The highest values of shelling (%), (73.53%) was given from adding 300 kg P_2O_5 fed^{-1} (P_{45}). However, the lowest ones (71.85%) was produced from the lowest level of phosphorus fertilization (100 kg P_2O_5 fed^{-1} (P_{15}).

Regarding the effect of soil application of humic acid on shelling percentage (%), it was significant in combined analysis for two seasons. It was detected that sorghum plants treated with 20 kg humic acid had the highest means of this trait (73.22%). However, the lowest ones

(72.40%) was obtained from the control treatments (without humic acid).

Foliar application of humic acid treatments was significant on shelling percentage (%). F_2 treatments increased shelling percentage (%) by 2.49 % compared to control treatments.

The interaction between phosphorus fertilizer treatments and soil application of humic acid had a significant effect on shelling percentage (%). P_{45} x H_{20} interaction gave the greatest shelling percentage (%). (74.05%). while the major value of shelling percentage (%), resulted from interaction between phosphorus fertilizer 300 kg P_2O_5 fed^{-1} (P_{45}) with foliar spraying of humic acid 800 mg/L., as well as, the interaction between soil application of humic acid and foliar spraying of humic acid had a significant effect on shelling percentage (%), the maximum value of shelling (%) resulted from interaction between 20 kg fed.$^{-1}$ of soil application of humic acid with 800 mg/L., of foliar spraying of humic acid.

The differences in shelling percentage (%) due to the interaction between phosphorus fertilizer (P), soil application of humic acid (H) and foliar spraying of humic acid (F) were significant. Adding of 300 kg P_2O_5 fed^{-1} (P_{45}), applied 20 kg fed.$^{-1}$ soil application of humic acid with 800 mg/L., of foliar spraying of humic acid (P_{300} x H_{20} x F_2) was recorded the highest values of shelling (%).

Table (9): Effect of phosphorus fertilizers (P) levels, humic acid soil application (H), humic acid foliar application (F) and their interactions on shelling percentage (%) at harvest of sorghum plants (combined analysis for 2019 and 2020 seasons).

Phosphorus fertilizers (P)	Humic Acid soil application (H)	Humic Acid foliar application (F)			
		F_0 (Control)	F_1 (400 mg/L)	F_2 (800 mg/L)	Mean
100 kg P_2O_5 (P_{15})	H_0 Control	71.24	71.11	72.24	71.53
	H_{10} 10 kg/fed.	70.52	71.11	72.50	71.38
	H_{20} 20 kg/fed.	72.10	72.96	72.83	72.63
	Mean	71.29	71.73	72.52	71.85
200 kg P_2O_5 (P_{30})	H_0 Control	71.63	71.42	73.24	72.10
	H_{10} 10 kg/fed.	71.36	70.99	73.62	71.99
	H_{20} 20 kg/fed.	71.19	74.00	73.74	72.98
	Mean	71.39	72.14	73.53	72.36
300 kg P_2O_5 (P_{45})	H_0 Control	71.26	73.61	75.85	73.57
	H_{10} 10 kg/fed.	71.05	73.29	74.52	72.96
	H_{20} 20 kg/fed.	72.09	73.82	76.25	74.05
	Mean	71.47	73.57	75.54	73.53
Means of humic acid soil application	H_0 Control	71.38	72.04	73.78	72.40
	H_{10} 10 kg/fed.	70.98	71.80	73.55	72.11
	H_{20} 20 kg/fed.	71.79	73.59	74.27	73.22
	Mean	71.38	72.48	73.87	72.58
L.S.D. 5% for					
Super phosphate (P)		0.64			
Humic Acid Powder (H)		0.39			
Humic Acid foliar (F)		0.43			
Interaction : (P x H)		N.S.			
: (P x F)		0.83			
: (H x F)		N.S.			
:(P x H x F)		1.29			

REFERENCES

Baghdady, A.M.M. (2016) Response of some sorghum (Sorghum bicolor L.) cultivars to sowing dates and phosphorus fertilization under New Valley conditions. Middle East Journal of Applied 6(4): 1150-1159.

Bilal, M., M. Umer; I. Khan; H. Munir; A. Ahmad; M. Usman and R. Iqbal (2016). Interactive effect of phosphorous and humic acid on growth, yield and related attributes of maize. J Agric. Res., 54(3):433-445.

Celik, H.; A. V.Katkat ; B. B.Aşık & M. A. Turan (2011). Effect of foliar-applied humic acid to dry weight and mineral nutrient uptake of maize under calcareous soil conditions. Communications in soil science and plant analysis, 42(1), 29-38.

Daur, I. & A. A. Bakhashwain (2013) Effect of humic acid on growth and quality of maize fodder production. Pak. J. Bot, 45(S1): 21-25.

Delesrone, L. M. (2008) Sorghum. J. of Agric. and Food Information, 8, 9-14.

F A O " Food and Agriculture Organization of the United Nations " (2019). Nations, Food and Agriculture Organization of the United /FAOSTAT Statistics Division. http://www.fao.org/faostat/en/#home

Gomez KA, Gomez AA (1984). Statistical procedures for agricultural research. 2nd Ed. An International Rice Research Institute Book. John Wiley and Sons pp. 321- 323, 467-469.

Gomaa, M.A ; F.I. Radwan ; G.A.M. Khalil ; E.E. Kandil and M.M. El-Saber (2014) Impact of Humic Acid Application on Productivity of some Maize Hybrids under Water Stress Conditions. Middle East Journal of Applied Sciences 4(3): 668-673.

Kambal, A.E. and O.J. Webester (1966) Manifestation of hybrid vigor in grain sorghum and the relation among the components of yield, weight per bushel, and height. Crop Sci., 6: 513-515.

Nardi, S.; Pizzeghell, D.; Muscolo, A. and Vianello, A. (2002). Physiological effects of humic substances on higher plants. Soil Biol. Biochem. 34, 1527–15336.

Osman, A. S. and Ewees., M. S. A. (2008). The possible use of humic acid incorporated with drip irrigation system to alleviate the harmful effects of saline water on tomato plants. J. Agric. Res. Dev. 2, 52 – 70.

Radwan, F. I., Khalil, G. A. M., and Kandil, E. E. (2014). Impact of Humic Acid Application on Productivity of some Maize Hybrids under Water Stress Conditions.Middle East J. Appl. Sci., 4(3): 668-673.

Rezazadeh, H.; S.K. Khorasani and R.S.A. Haghighi (2012) Effects of humic acid on decrease of phosphorus usage in forage maize var. KSC704 (Zea mays L.). Australian Journal of Agricultural Engineering, 3(2): 34-38.

Violante, A. (2013). Elucidating mechanisms of competitive sorp- tion at the mineral/. water interface. Adv. Agron. 118, 111–176.

Yu, W.; Ding, X.; Xue, S.; Li, S.; Liao, X. and Wang, R. (2013). Effects of organic-matter application on phosphorus adsorption of three soil parent materials. J. Soil Sci. Plant Nutr. 13, 1003–1017.

الملخص العربى

تأثير الإضافة الأرضية والرش لحامض الهيوميك على إنتاجية الذرة الرفيعة النامية فى أرض جيرية تحت مستويات مختلفة من التسميد الفوسفاتى

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****قسم بحوث الذرة الرفيعة - معهد المحاصيل الحقلية– مركز البحوث الزراعية**

الهدف من هذه الدراسة الحالية هو تقييم تأثير ثلاثة معدلات من التسميد الفوسفاتى (١٥، ٣٠، ٤٥ وحدة فوسفور للفدان) كإضافات أرضية، وثلاثة مستويات من حامض الهيوميك فى صورة هيومات البوتاسيوم (صفر، ١٠، ٢٠كجم للفدان) كإضافات أرضية، وثلاثة معدلات من الرش الورقى لحامض الهيومك فى صورة هيومات البوتاسيوم (صفر، ٨٠٠،٤٠٠ ملليمول /لتر)، والتداخلات بينهما على المحصول ومكوناته لنباتات الذرة الرفيعة (هجين شندويل) النامية بالتربة الجيرية. لتحقيق الهدف من الدراسة الحالية نفذت تجربتان حقليتان بمزرعة محطة بحوث طامية التابعة لمركز البحوث الزراعية بالفيوم خلال الموسم الصيفي لعامى ٢٠١٩ و٢٠٢٠.

ولقد شملت كل تجربة ٢٧ معاملة تم التنفيذ فى تصميم القطع المنشقة مرتين (قطاعات كاملة العشوائية) بأربع مكررات أحتوت الوحدة التجريبية على ٥ خطوط بطول ٣ متر وعرض ٦٠ سم وكانت مساحة كل وحدة تجريبية ٩ متر مربع (٤٦٦/١ فدان).

اتبع فى التنفيذ الحقلى للتجارب استعمال تصميم القطع المنشقة مرتين (قطاعات كاملة العشوائية) بأربعة مكررات حيث ووزعت المعاملات عشوائيا لجميع مستويات العوامل الثلاثة ووضعت معدلات الفوسفور فى القطع الرئيسية، ووزعت عشوائياً الإضافة الارضية لمعدلات حامض الهيوميك (هيومات البوتاسيوم) فى القطع المنشقة الأولى ، وتم التوزيع العشوائى للإضافة الورقية لمعدلات حامض الهيوميك (هيومات البوتاسيوم) فى القطع المنشقة الثانية .

الصفات المدروسة :

عند الحصاد تم الاختيار العشوائى لخمسة نباتات من القطع التجريبية فى كلا الموسمين لتقدير الصفات التالية:
طول القنديل (سم)، قطر القنديل (سم)، وزن القنديل (جم)، وزن حبوب القنديل (جم)، وزن ١٠٠٠ حبة (جم)، محصول الحبوب (أردب /فدان) ، محصول العلف(طن/فدان)، نسبة التصافى (%) .

و يمكن تلخيص النتائج المتحصل عليها كما يلي:-

١- أثرت الإضافة الأرضية للتسميد الفوسفاتى بشكل معنوى على صفة طول القنديل فى نباتات الذرة الرفيعة ، وكانت معاملة التسميد الفوسفاتى بمعدل ٤٥ وحدة للفدان افضل المعاملات مقارنة بمعاملة الكنترول حيث أعطت اطول قنديل (٢٣.٨٠ سم) ، وكانت أقصر قناديل موجودة تحت معاملة ١٥ وحدة فوسفات للفدان .
٢- وأظهرت النتائج ان معاملة الفوسفات الارضى أثرت بشكل معنوى على قطر القنديل، حيث أدت معاملة الفوسفات ٤٥ كجم /للفدان الى زيادة قطر القنديل مقارنة بمعاملة الكنترول .
٣- أظهرت النتائج وجود فروق معنوية بين معاملات التسميد الفوسفاتى الارضى فى وزن القنديل لنبات الذرة الرفيعة ، حيث نتج عن معاملة التسميد الفوسفاتى ٤٥ وحدة / للفدان اعلى وزن للقنديل (٦٦.٠٢ جم) مقارنة بمعاملة الكنترول.
٤- أظهرت النتائج وجود زيادة معنوية فى محصول الذرة الرفيعة ومكوناته (طول وقطر و وزن الرأس ، وزن حبوب الرأس، وزن الألف حبة ، ومحصول حبوب الفدان نتيجة استخدام التسميد الفوسفاتى وذلك كمتوسط للموسمين. من ناحية اخرى أعطت النباتات التى تنمو بدون تسميد فوسفاتى أقل القيم لهذه الصفات السابقة كمتوسط للموسمين ايضاً.
٥- أثرت الإضافة الأرضية لهيومات البوتاسيوم بشكل معنوى على صفة طول القنديل فى نباتات الذرة الرفيعة ، وكانت معاملة هيومات البوتاسيوم بمعدل ٢٠ وحدة للفدان افضل المعاملات مقارنة بمعاملة الكنترول حيث أعطت اطول قنديل، وكانت أقصر قناديل موجودة تحت معاملة الكنترول .
٦- وأظهرت النتائج ان معاملة هيومات البوتاسيوم الارضى أثرت بشكل معنوى على قطر الساق، حيث أدت معاملة هيومات البوتاسيوم الارضى ٢٠ كجم /للفدان الى زيادة قطر الساق مقارنة بمعاملة الكنترول بنسبة (٨.٥٥%) .
٧- أظهرت النتائج وجود فروق معنوية بين معاملات هيومات البوتاسيوم الارضية فى وزن القنديل لنبات الذرة الرفيعة ، حيث نتج عن معاملة هيومات البوتاسيوم٢٠ كجم/ للفدان اعلى وزن للقنديل مقارنة بمعاملة الكنترول.
٨- أظهرت النتائج وجود زيادة معنوية فى محصول الذرة الرفيعة ومكوناته (طول وقطر ووزن القنديل ، وزن حبوب القنديل ، وزن الألف حبة ، ومحصول حبوب الفدان نتيجة الإضافة الأرضية لهيومات البوتاسيوم وذلك كمتوسط للموسمين. من ناحية اخرى أعطت النباتات التى تنمو بدون اضافة لحامض الهيوميك أقل القيم لهذه الصفات السابقة كمتوسط للموسمين ايضاً.

٩- الرش الورقى لحامض الهيومك أثر معنوياً على طول الرأس أو القنديل فى نباتات الذرة الرفيعة . وكان الرش الورقى بمعدل ٨٠٠ملجم/لتر أفضل معاملة والتى اعطت اطول قيمة لصفة طول القنديل بالسم (٢٧.٣٧سم) بينما أقل قيمة (٢٤.٤٠سم) نتجت من معاملة الكنترول (بدون حمض الهيوميك).

١٠- أوضحت النتائج أن الرش الورقى لحمض الهيوميك أثر معنوياً على قطر القنديل بالسنتيمتر. وحقق المعدل ٨٠٠ ملجم/لتر زيادة فى قطر الراس تقدر (٧.٧٩ %) مقارنة بمعاملة الكنترول بدون هيوميك.

١١- أوضحت النتائج وجود فروق معنوية بين معاملات الرش الورقى لحامض الهيوميك فى وزن القنديل بالجرام فى نبات الذرة الرفيعة ونتج عن معاملة الرش الورقى بمعدل ٨٠٠ ملجرام/لتر أعلى وزن القنديل (٦٨.٢٩جم) مقارنة بمعاملة الكنترول (بدون هيوميك) والتى أعطت أقل القيم لهذه الصفة (٥٦.٩٢جم).

١٢- أوضحت النتائج وجود زيادة معنوية فى محصول الذرة الرفيعة ومكوناته (طول وقطر ووزن القنديل ، وزن حبوب القنديل ، وزن الألف حبة ، ومحصول حبوب الفدان نتيجة الرش الورقى لحامض الهيومك وذلك كمتوسط للموسمين. من ناحية اخرى أعطت النباتات التى تنمو بدون اضافة لحامض الهيوميك أقل القيم لهذه الصفات السابقة كمتوسط للموسمين ايضاً.