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EFFECT OF HUMIC ACID FOLIAR IN THE GROWTH, YIELD AND QUALITY OF SEVERAL GENOTYPES FOUR OF *VICIA FABA* L.

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Abstract

Field experiment was conducted in the agricultural fields in Zouayt Sityih / Ramadi / Anbar province, in 2016 - 2017 and 2017- 2018, according to split-plot design by using (R.C.B.D) with three replicates to study the effect of Humic acid on the growth, yield and quality of several genotypes from faba bean, the main plots included three different humic acid concentrations (0, 1.5 and 3) cm3 L^{-1} while subplots included four genotypes (American, Dutch, Local and Spanish) in both seasons respectively. The results were as follows: The genotype V2 showed the highest plant height of (75.39, 77.32) cm for both seasons respectively. While the genotype V1 gave highest rate of the number of branches plant 9.59 and 10.74 brancheplant^{-1}, the number of pods in the plant reached 12.90 for the first season. The seed yield was 6.15,7.76 ton.h^{-1}. The concentrations of the humic acid were significant in most studied traits. H3 gave the highest seed yield 6.27, 6.95 ton.h^{-1} in both seasons, while H0 gave the lowest mean 3.12 , 6.27 ton h^{-1} in both seasons. The interaction between genotypes and concentrations of humic acid was significant in most characters in the 2017-2018 season.

Keywords: Humic acid, genotype, seed yield, quality, faba bean.

تأثير رش حامض الهيومك في نمو وحاصل ونوعية أربع تراكيب وراثية من الباقلاء

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المستخلص

نفذت تجربة حقلية في احد الحقول الزراعية التابعة لمنطقة زورية سطيح قضاء الرمادي/ محافظة الانبار خلال الموسمين الزراعيين 2016–2017 و2017–2018 وفق تصميم القطاعات العشوائية الكاملة وبترتيب الالواح المنشقة وبثلاث مكررات ولكلا الموسمين لدراسة تأثير تراكيز حامض الهيومك في نمو وحاصل ونوعية عدة تراكيب وراثية من الباقلاء اذ اشتملت الالواح الرئيسية ثلاث تراكيز مختلفة لحامض الهيومك (0، 1.5 و3) سم3 لتر$^{-1}$.بينما تضمنت الالواح الثانوية اربع تراكيب وراثية (امريكي، هولندي، محلي واسباني) في كلا الموسمين وكانت النتائج كما يلي اذ حقق التركيب الوراثي V2 اعلى معدل لصفة ارتفاع النبات بلغ 75.39 و 77.32 سم لكلا الموسمين بالتتابع. بينما حقق التركيب الوراثي V1 اعلى معدل لصفة عدد التفرعات بالنبات بلغ 9.59 و10.74 فرع نبات$^{-1}$ ولكلا الموسمين، عدد قرنات بالنبات بلغ 12.90 للموسم الاول وحاصل البذور بلغ 6.15 و7.76 طن هـ$^{-1}$ ونسبة بروتين بلغت 26.44% و26.29% لكلا الموسمين بالتتابع. اثرت تراكيز حامض الهيومك معنويا في اغلب الصفات المدروسة حيث اعطى التركيز H3 اعلى حاصل بذور بلغ 6.27 و6.95 طن هـ$^{-1}$ في كلا الموسمين بينما اعطى التركيز H0 اقل معدل لصفة الحاصل بلغ 3.12 و6.27 طن هـ$^{-1}$ في كلا الموسمين. كان التداخل بين التراكيب الوراثية وتراكيز حامض الهيومك ذو تأثير معنوي في بعض الصفات في الموسم 2017–2018.

كلمات مفتاحية: حامض الهيومك، التركيب الوراثي، حاصل البذور، النوعية، الباقلاء.

Introduction

Broad Bean is one of the high-value winter fabasia crops, its seeds contain high protein content, contain carbohydrates, minerals, vitamins and amino acids (9). Despite the importance of this crop in Iraq, but it suffers from a decrease in the mean of production (13). The genotypes of the faba bean crop has different genetic, in their growth, it varies in their response to different environmental conditions (5 and 6). Several studies have been conducted on the humic acid to increase productivity using various factors, including humic and organic nutrients that should not have negative organic effects on the environment. These nutrients are the acidic acid that has played an important role in enzymatic reactions to improve cellular division, elongating cells and increasing plant resistance for harsh environmental conditions which lead to improve the growth (8). Humic acid contains some of the major components called humus and contains most of the rare metals known and necessary for the development of plant life. These acids are part of the humic substances, they improve the growth of plant. This acid represents most of the nitrogenous substances in the soil which have a significant impact on the growth of the plant through leaf feeding by spraying the plant through the vegetative part. Humic acid can be used successfully in many agricultural areas, where it acts as an activator of plant growth and increases the protein content in the plant and helps to resist the diseases and agricultural spaces that affect the crop during the growth period. Humic acid stimulates the microorganisms

in the soil to activate the bacterial root nodes in the plant roots, which helps to provide the nitrogen element in the soil and thus increase soil fertility.

Materials and Methods

This study was carried out during the 2016-2017 and 2017-2018 seasons in Zouayt Sityih / Ramadi / Anbar to study the effect of humic acid on the growth, yield and quality of several genotypes of faba according to split-plot design in (R.C.B.D) with three replicates, the main plots included three different humic acid concentrations (0, 1.5 and 3) cm3.L^{-1}, (H0, H1.5 and H3) while subplots included genotypes (American (V1), Dutch (V2), Local (V3) and Spanish (V4). Each replicator contained 12 experimental units (3 x 2.5 m) 75 cm wide between the units replicator and another 1 m. the planting was made at a distance of 25 cm between the pits. The planting process was carried out on 25 October in both seasons by placing two seeds in one pit and covered with soil at a depth of 5 cm (13 and 16). The field was irrigated immediately after cultivation and other irrigation was given depending on soil moisture and its need for water during the growing season. After the germination, removing the additional plants were carried out to keep one plant in the pit (11), After the height of the plant reached 20 cm, the first spray was done with three concentrations (0, 1.5 and 3) cm3 L^{-1}. A month later, the second spray was performed with the same concentrations. The third spray was carried out before flowering. 5 plants were selected from the middle lines for the experimental unit randomly to study plant height cm, number of branches, branch per plant, number of pods, number of seeds per pod, the weight of 100 seeds, seeds yield and the percentage of protein in the seeds. In terms of fertilizer, phosphate fertilizer was added at the rate of 200 kgP h^{-1} by DAP and nitrogen fertilizer at urua 46 % N. The first stage in the planting, and the second stage at the beginning of the flowers (2). The plants of the experiment were cultivated several times during the two seasons to remove the growing weeds. The plant of the experiment harvested at 15^{th} of April in both seasons.

Results and Discussions

The results of table 1 showed significant differences between the genotypes in plant height in both seasons. In the first season, the genotype V2 showed superiority significantly on the other genotypes, it gave the highest plant height 75.39 cm. while the genotype V4 registered the lowest plant height was 64.79 cm. In the second season, V2 gave the highest plant height 77.32 cm. while V4 gave the lowest height of plant 65.21 cm, the reason behind superiority of the V2 may return to the nature of genetic and which reflected in the response to the environmental conditions, resulting increased mean of cell division and elongation, which positively affected the increase of them in plant height. (4) referred to that the genotype variation in some characteristics growth vegetative because of the genetic diversity in the genotypes, it also effected by the environmental conditions or it might also because the interaction between the genetic factors with the environmental conditions. The results showed that there was a significant effect of concentrations of humic acid in plant height during the two seasons of the study. In the first season experiment, the highest concentration H3 gave the highest plant height of 74.03 cm compared with the low concentration H0,

which gave the lowest rate of this characteristic was 66.31 cm. Those results came close to the results of the second season for the same experiment, as the high concentration H3 gave the highest mean of plant height of 76.12 cm in the second season compared to the lowest rate recorded concentration H0 67.10 cm, this increase is due to the role of the humic acid in the construction of amino acids, which stimulate the plant to produce Oxin that promote the process of cellular division and elongation of cells and thus increase the height of the plant (3). The results of the same table showed that there were significant differences in the interaction between genotypes × concentrations for both seasons. Table 1 showed no significant effect of the interaction coefficients on the effect of plant height in seeds for both seasons.

Table 1 Effect of genotypes, humic acid and their interaction in the mean plant height cm.

The first season 2016-2017						The second season 2017-2018					
Humic acid	Genotypes					Humic acid	Genotypes				
	V1	V2	V3	V4	Mean		V1	V2	V3	V4	Mean
H0	65.68	71.13	67.1	61.2	66.31	H0	66.86	72.16	68.27	61.11	67.10
H1.5	72.65	74.88	69.1	62.8	69.89	H1.5	75.01	77.06	70.17	63.77	71.50
H3	73.77	80.15	72.0	70.2	74.03	H3	77.32	82.74	73.66	70.76	76.12
Mean	70.70	75.39	69.4	64.7		Mean	73.06	77.32	70.70	65.21	
L.S.D value under 5% level, Humic acid = 3.065 Genotype = 1.972, VxH = N.S						L.S.D value under 5% level, Humic acid = 1.933 Genotype = 1.717, VxH = N.S					

The first season 2016-2017						The second season 2017-2018					
Humic acid	Genotypes					Humic acid	Genotypes				
	V1	V2	V3	V4	Mean		V1	V2	V3	V4	Mean
H0	65.68	71.13	67.16	61.29	66.31	H0	66.86	72.16	68.27	61.11	67.10
H1.5	72.65	74.88	69.18	62.85	69.89	H1.5	75.01	77.06	70.17	63.77	71.50
H3	73.77	80.15	72.01	70.22	74.03	H3	77.32	82.74	73.66	70.76	76.12
Mean	70.70	75.39	69.45	64.79		Mean	73.06	77.32	70.70	65.21	
L.S.D value under 5% level, Humic acid = 3.065 Genotype = 1.972, VxH = N.S						L.S.D value under 5% level, Humic acid = 1.933 Genotype = 1.717, VxH = N.S					

The first season 2016-2017	The second season 2017-2018

Table 2 Effect of genotypes, humic acid and their interaction in the mean branches plant^{-1}

Humic acid	Genotypes					Humic acid	Genotypes				
	V1	V2	V3	V4	mean		V1	V2	V3	V4	Mean
H0	10.51	9.93	9.17	8.44	9.51	H0	12.23	12.12	10.73	8.93	11.00
H1.5	13.71	12.76	11.90	10.24	12.15	H1.5	13.45	13.95	12.80	13.51	13.43
H3	14.47	13.14	12.77	12.72	13.27	H3	14.56	15.27	14.38	14.10	14.58
Mean	12.90	11.94	11.28	10.46		Mean	13.41	13.78	12.64	12.18	
L.S.D value under 5% level, Humic acid = 0.978						L.S.D value under 5% level, Humic acid = 0.924					
VxH = N.S, Genotype = 1.135						VxH = 1.609, Genotype = 0.929					

While the number of branches per plant^{-1} the results of table 2 indicate that there are significant differences between the genotypes in the number of branches for both seasons. In the first season, the genotype V1 showed the highest rate of branches in the plant 9.59 branches plant^{-1}. While V4 gave the lowest rate of this character 6.28 branches plant^{-1}. In the second season experiment, table 2 shows significant differences between the genotypes in the number of branches plant^{-1}. V1 gave the highest number of branches Plant^{-1} reached 10.74 branches plant^{-1} compared with the V4 it gave the lowest mean for this character 6.75 branches plant^{-1}, the reason of the variance in genotypes of this character may be due to the natural of the genetics in production of the number of branches (22). The results showed that there was a significant effect of concentration of humic acid during the seasons of the study. In the first season, H3 gave the highest mean of the character 8.81 branch plant^{-1}, while H0 recorded the lowest mean 7.02 branch.plant^{-1}. In the results of the second season, H3 gave the highest mean of the character 9.91 branch.plant^{-1}, while H0 recorded the lowest mean 7.72 branch plant^{-1}, the increase in the number of branches in the plant because increasing the level of leaf nutrition is due to the vital and positive role of the humic acid, which contributed to increase the process of carbon representation and the transfer of the products of this representation of leaves to the active areas of the plant (1). Table 2 shows that there was no significant effect for the interaction between the treatments in this character for both seasons.

However number of pod plant^{-1} the results of Table 3 showed that the genotypes of the faba bean showed significant differences between genotypes and humic acid concentrations in the character of number of pods plant^{-1} for both seasons. In the first season experiment, V1 achieved the highest mean 12.90 pod plants^{-1}, while V4 gave the lowest mean 6.28 pod plants^{-1} in the first season In the second season, showed that V2 gave the highest number of pod plants^{-1} 13.78, while V4 gave the lowers mean 12.18 pod plants^{-1}, because V1 has high genetic ability to response to the surrounded environmental conditions and use them in photosynthesis which helped in increasing the produced nutrients. As table 3 shows, the results indicated that there was a significant effect of humic acid concentrations in the character and for both seasons. In the first season experiment, the H3 was significantly higher than H1.5 and H0, with the highest number of pods plant^{-1} 13.27, while H0 achieved the lowest rate for number of pods plant^{-1} 9.51. in the second season, H3 achieved 14.58 No. of pods Plant^{-1} while H0 registered 11 number of pods plant^{-1}, The increase in the number of

pods in the plant is due to the role of humic acid in improving vegetative growth and reducing nutrients competition between pods (7). The results of table 3, showed in the first season no significant effect of the interaction between humic acid concentrations with genotypes, while there was a significant effect in the second season, V2 × H3 showed the highest mean number of pods at 15.27 pods Plant^{-1}. while the treatment of interaction V4 × H0 gave the lowest mean of 8.93 pods Plant^{-1}. in the experiment.

The results of table 4 indicate that there are significant differences between the genotypes in the number of seed pod^{-1} for both seasons. In the first season, the genotype V1 was significantly higher by giving the highest mean 4.55 seed pod^{-1}, while V4 gave the lowest mean for this character 3.39. In the second season V1 achieved the highest mean reached to 5.29 seed pod^{-1} for this character, on the other hand V2 showed the lowest mean for this character 4.13. The reason behind the difference between genotypes for this character is the difference the efficacy in distributing the production of photosynthesis which increase the number of seeds per pod (10). The results showed that there was significant differences between the humic acid concentrations in the number of seeds per pod. H3 was higher by giving the highest rate 4.38 seed pod^{-1}. H0 which gave 3.38 seed pod^{-1}, In the second season, H3 was higher by giving the highest rate 5.14 seed pod^{-1}. H0 which gave 4.53 seed pod^{-1},

Humic acid	Genotypes				
	V1	V2	V3	V4	Mean
H0	10.51	9.93	9.17	8.44	9.51
H1.5	13.71	12.76	11.90	10.24	12.15
H3	14.47	13.14	12.77	12.72	13.27
Mean	12.90	11.94	11.28	10.46	
L.S.D value under 5% level, Humic acid = 0.978					
Genotype = 1.135, VxH = N.S					

Humic acid	Genotypes				
	V1	V2	V3	V4	Mean
H0	12.23	12.12	10.73	8.93	11.00
H1.5	13.45	13.95	12.80	13.5	13.43
H3	14.56	15.27	14.38	14.1	14.58
Mean	13.41	13.78	12.64	12.1	
L.S.D value under 5% level, Humic acid = 0.924					
Genotype = 0.929, VxH = 1.609					

the increase in the number of seeds per pods is due to the role of humic acid in the transmission of photosynthesis products to the flowers and seeds to increase fertility percentage and production of fruits (17). The results of table 4 showed that there was no significant effect of the interaction coefficients on the effect of the number of seed pod^{-1} in the first season. The results of the table showed a significant interaction, the treatment (V1 × H3) gave (6.22) seed pod^{-1}, while the interaction treatment (V2 × H1.5) gave the lowest mean of number of seeds per pod 3.51 seed pod^{-1}.

Table 3 Effect of genotypes, humic acid and their interaction in the mean Pod plant^{-1}

Table 4 Effect of genotypes, humic acid and their interaction in the mean seed pod^{-1}

The results of table 5 showed that there was significant differences between the genotypes in the weight 100 seeds for both seasons. In the first season, the genotype V4 significantly increased by gave the higher ratio of 135.12 g, while V3 sequentially recorded the lowest rate 123.21g, in the second season experiment, the genotype V1 gave the higher rate of 133.24 g, while V3 sequentially recorded the lowest mean 127.38g. The accumulation of dry matter and the mean of net photosynthesis, which was sufficient to superiority of the genotype (20). The results showed that there be significant differences between the humic acid concentration in the weight of 100 seeds (15). H3 was higher by giving the highest rate 135.15 g. H0 which gave 121.08 g, In the second season, H3 was higher by giving the highest rate 133.08 . H0 which gave 126.10 g, the increase in the weight of the seed is inversely correlated with the number of seeds in pods. The increase in the number of seeds in pods increases the competition between them to get nutrients, it distributes the nutrients of the largest number of seeds which lead to reduce the mean of weight of 100 seeds (12). The results of table 5 showed that were no significant effect of the interaction coefficients on weight of 100 seeds in the first season. The results of the table 5 showed a significant interaction, the treatment V1 × H3 gave 139.75g, while the interaction V2 × H0 gave the lowest rate of 122.79g.

The results of table 6 indicate that was significant differences between the genotypes with the humic acid in seed yield for both seasons. The genotype V1 gave the highest seed yield 6.15 ton h^{-1}, while V4 recorded the lowest rate 3.93 ton h^{-1}. In the second season, V1 is superior by giving the highest rate 7.76 ton h^{-1}, while V2 gave 5.99 ton h^{-1} it was confirmed by (14) Who pointed out that the difference in seed yield between the genotypes is due to the different genotypes in the number of branches and the number of pods and the number of seeds in the pods and the weight of 100 seeds (15). The results showed that there were significant differences between the humic acid concentrations in the seed yield. In the first season, H3 was higher by giving the highest rate 6.27 ton h^{-1}. H0 which gave 3.12 ton h^{-1}, In the second season, H3 was

The first season 2016-2017						The second season 2017-2018					
Humic acid	**Genotypes**					**Humic acid**	**Genotypes**				
	V1	**V2**	**V3**	**V4**	**Mean**		**V1**	**V2**	**V3**	**V4**	**Mean**
H0	4.07	3.35	3.32	2.80	3.38	**H0**	5.19	3.61	5.33	3.99	4.53
H1.5	4.61	4.41	4.29	3.55	4.21	**H1.5**	6.22	3.51	3.94	5.99	4.91
H3	4.97	4.46	4.28	3.81	4.38	**H3**	4.45	5.27	6.06	4.76	5.14
Mean	4.55	4.07	3.96	3.39		**Mean**	5.29	4.13	5.11	4.91	
L.S.D value under 5% level, Humic acid = 0.4667 Genotype = 0.5101, VxH = N.S						**L.S.D value under 5% level, Humic acid = 0.347 Genotype = 0.689, VxH = 1.188**					

higher by giving the highest rate 6.95 ton h^{-1}. H0 which gave 6.27 ton h^{-1}. The reason for this is the role of humic acid in increasing the permeability of cellular membranes, activin enzymatic reactions and improving cellular division and elongation of cells, which increases the Carbohydrate substances manufactured in the leaves and their transfer to the fruits and lead to increase the components of the seed yield (20). The results of table 6 showed that there was no significant effect of the interaction on the

effect of the seed yield in the first season. The results of the table 6 showed a significant interaction, the treatment V1 × H1.5 gave 8.17 ton h^{-1}, while the

The first season 2016-2017						The second season 2017-2018					
Humic acid	Genotypes					Humic acid	Genotypes				
	V1	V2	V3	V4	Mean		V1	V2	V3	V4	Mean
H0	4.16	3.22	2.71	2.39	3.12	H0	8.01	5.55	6.88	4.65	6.27
H1.5	6.64	5.71	5.00	4.07	5.36	H1.5	8.17	5.42	5.25	7.84	6.67
H3	7.64	6.30	5.83	5.33	6.27	H3	7.30	7.00	7.30	6.20	6.95
Mean	6.15	5.08	4.51	3.93		Mean	7.76	5.99	6.47	6.23	
L.S.D value under 5% level, Humic acid = 0.608 Genotype = 0.713, VxH = N.S						L.S.D value under 5% level, Humic acid = 0.284 Genotype = 0.584, VxH = 1.0002					

interaction treatment V4 × H0 gave the lowest mean of number of seeds per pod 4.65 ton h^{-1}.

Table 5 Effect of genotypes, humic acid and their interaction in the mean weight

The first season 2016-2017						The second season 2017-2018					
Humic acid	Genotypes					Humic acid	Genotypes				
	V1	V2	V3	V4	mean		V1	V2	V3	V4	Mean
H0	25.05	24.03	20.67	22.70	23.11	H0	24.43	23.14	21.30	19.78	22.16
H1.5	26.64	24.94	22.12	23.73	24.36	H1.5	25.97	24.72	22.86	21.68	23.81
H3	27.64	25.87	23.74	24.26	25.38	H3	28.48	26.14	23.77	22.80	25.30
Mean	26.44	24.95	22.17	23.56		Mean	26.29	24.67	22.64	21.42	
L.S.D value under 5% level, Humic acid = 0.5670 Genotype = 0.5663, VxH = N.S						L.S.D value under 5% level, Humic acid = 0.704 Genotype = 0.599, VxH = N.S					

100 seeds.

Table 6 Effect of genotypes, humic acid and their interaction in the mean yield Seed

Table 7 Effect of genotypes, humic acid and their interaction in the mean percentage of protein in seeds

The results of table 7 showed that a significant differences between the genotypes with the humic acid in their effect on this character in both seasons, in the first season, the genotype V1 gave the highest percentage of protein in seeds 26.44% compared with the lowest recorded percentage of V3 22.17%. In the second season V1 has the highest protein percentage 26.29%, while V4 gave the lowest mean 21.42% since the

The first season 2016-2017						The second season 2017-2018					
Humic acid	Genotypes					Humic acid	Genotypes				
	V1	V2	V3	V4	Mean		V1	V2	V3	V4	Mean
H0	123.4	121.99	111.83	127.9	121.0	H0	132.4	122.7	125.1	124.0	126.1
H1.5	134.3	126.85	124.24	140.0	131.3	H1.5	127.5	139.3	129.1	129.8	131.3
H3	133.9	134.87	133.56	138.2	135.1	H3	139.7	132.6	127.8	132.1	133.0
Mean	130.5	127.90	123.21	135.1		Mean	133.2	131.5	127.3	128.5	
L.S.D value under 5% level, Humic acid = 6.730 Genotype = 5.102, VxH = N.S						L.S.D value under 5% level, Humic acid = 3.095 Genotype = 4.151, VxH = 7.188					

percentage of protein, which are difficult to change by environmental factors (18). These results are consistent with what they found (21). The results showed that a significant effect of the humic acid in the percentage of protein in the seeds for both seasons. In the first season, the of H3 was 25.38%, while the H0 was 23.11%. In the second season experiment, the H3 achieved the highest rate of seed protein ratio of 25.30%, while H0 was the lowest rate of this character and gave 22.16%. The addition of the humic acid to the vegetative total in the plant, it enters the plant tissue affects the various biological processes in the plant, especially those related to the composition of the protein as the humic acid in its composition contains the elements of carbon, nitrogen and oxygen and a small amount of phosphorus and sulfur (19). Table 7 showed significant effect of the interaction coefficients on the effect of protein percentage in seeds for both seasons.

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