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Evaluation of the performance of four genotypes of Corn (*Zea mays* L.) and path coefficient analysis by Bacterial biofertilizers effects

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ABSTRACT

A field experiment was conducted in the Musayyib project area in Babil province during the autumn season 2018 with the aim of selecting an effective bacterial vaccine from combinations of three different types of Rhizobium spp. With Azospirillumbrasilense bacteria as biofertilizers and their effect on four genotypes of yellow maize (5012, Research 106, 5017 and 5018) the design of complete random segments and three replicates was used. The results showed superiority of A.brasilense treatment with R.leguminosarum (AZ. + RL2) in plant height, foliar area, longevity of larvae, number of grains per larvae, plant yield and total yieldGenotypes did not differ among the studied traits. As for the intervention, treatment (AZ. + RL2) outperformed half of the recommended fertilizer and genotype 5018 in most studied traits. The number of plant arains showed a higher genetic and phenotypic negative correlation with grain yield (0.111-, 0.039-). The analysis of the genetic and phenotypic pathway coefficient showed that the number of grains in Arouss gave the highest positive direct phenotypic effect on grain yield (8,31822) and genetically negative (0,1067).

Key words : Bio-Fertilizer, Genotype, Genotypic orrelation, Path coefficient

Introduction

The maize crop is an important grain crop. It ranks third in production and depends on it for food because of the high nutritional value of its carbohydrate and protein compounds. For the purpose of improving the growth and productivity of maize genotypes, both qualitatively and qualitatively, nitrogen and phosphorus must be added because they are necessary and determinants of crop growth and production because they are involved in the synthesis of amino acids, nucleic acids and other nitrogenous compounds (Al-Niamy, 1987). This has led to problems in environmental pollution and the erosion of the ozone layer and the leakage of many compounds of nitrates, nitrites and heavy metals from these fertilizers to drinking water and food causing diseases and poisoning of humans, in addition to Biologically proven by microorganisms, whereas about 20% of it is proven by industrial methods (Applonia, 1996). Nutrients from carbohydrates and energy from the plant while the host gets ready nitrogen from the organism the high cost of fertilizer production. The hands of studies to approximately 80% of the nitrogen that is installed on the ground Rhizobiaceae is a non-symbiotic fixation, represented by Azospirillum called Associative Bacteria (Baset and Shmsuddin, 2001). Rich in organic phosphate and insoluble phosphate materials, but generally lacks the dissolved phosphorus and

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ready for the plant. The rhizopia genera produce many chemical compounds that affect plant growth (Riboflavins, Phytochromes and Oligo-saccharide) that help germinate and sprout seeds, increase vegetative growth, and increase the rate of metabolism. Photosynthesis and biological control of some diseases thus increasing plant productivity (Dakora, 2003). Several studies have shown that the use of bacterial insemination on cereal crops by the bacterium Azospirillum results in an increase in both the size and number of roots, which in turn improves the absorption of nutrients and water, and leads to an increase in the amount of grains. Inoculation of five wheat varieties with A. brasilense increased nitrogen by 39% over comparison (Bashan and de-Bashan, 2010). The importance of yellow maize crop in Iraq the aim of the research to find an effective bacterial vaccine with the best genetic composition with the reduction of 50% of the chemical nitrogen fertilization and study its effect on some growth and yield. The economic value of any type of grain is influenced by a number of qualities of economic importance. The extent and direction of response between traits is usually measured by a genetic correlation that expresses the degree of binding of a gene or multiple genes that control a particular quantity trait in a gene or multiple genes that control another quantitative trait. The phenotypic correlation between two traits is the association between the aggregate and non-aggregate effects of the genes responsible for the two traits and environmental influences.

Materials and Methods

Genotypes -1

Genotypes were used (5012, behoth 106, 5017, 5018))

- Used bacteria 2

- Development and examination of bacteria Azospirillumbrasilense

Local isolation A. brasilense was used by the Department of Microbiology - Department of Agricultural Research. The bacterial isolation was activated using the Nfb medium semi-solid food medium. In a planned manner, the bacteria were transported to containers on the solid medium and incubated at 30 ° C. A glass slide was prepared and dyed with a colored stain to ensure that it was negative for a- stained strain of crescent shape with a dot shaped dark object in the center of the crescent body (Dakora, 2003)

Development and examination of *Rhizobium* spp.

Samples were collected from the root nodes of a number of legume plants, namely peas, mash, jet and alfalfa, in different regions of Baghdad, Babil and Karbala governorates. Bacteria specialized in plant host infection were not diagnostic tests). RL2 isolation from R.leguminosarum, RMI isolation from meliloti and RT3 isolation from R.trifoli were selected (Vincent, 1970)

Preparation of bacterial vaccine

The vaccine was prepared from the isolates of nitrogen-fixing bacteria R.leguminosarum, R.meliloti and R. trifoli by their development on the yeast extract mannitol agar (ym medium) for 48 hours at 28 ° C. 10 mL of each type of bacteria was withdrawn above. In addition, sterile bags containing batmos were previously sterilized at 121 m 0 for an hour. In the same way, the A. brasilense vaccine was prepared using nf-base medium (Burton, 1976). Corn seeds were contaminated with bacterial vaccines. Of fertilizer recommendation for maize crop (urea fertilizer 46% N: 300 and superphosphate fertilizer Tertiary 46% P_2O_5 : 150 kg E-1) In the Musayyib project area, according to the design of complete random sectors (RCBD) and after harvest, yellow corn samples were collected for growth and yield tests. The parameters were as follows:

Table 1. Treatment used in the experiment.

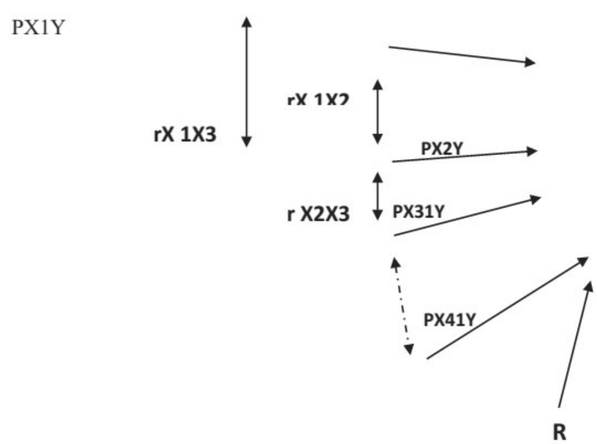
No	Treatment	Chemical vaccine	Bacterial fertilizer
1	Cotrol treatment	ÜÜÜÜ	100%
2	Bacterial vaccine Azospirillum	+	50%
3	Bacterial vaccine (Az. + RL2)	+	50%
4	Bacterial vaccine (Az. + RM1)	+	50%
5	Bacterial vaccine (Az. + RT3)	+	50%

4- Field measurements: Plant height, leaf area, number of plant Aranis, plant length, number of grains per plant, weight of 1000 grains, plant yield and total grain yield were measured.

The data were analyzed using the statistical analysis program Genestat and the arithmetic averages were compared with extracting the least significant difference L.S.D. At a significant level of 0.05

Analysis of path coefficient and genetic and phenotypic correlation

The path coefficients described by Wright (1921), then developed (Li, 1956 and Turner and Stevens, 1959), are used to interpret natural equations by finding the standard partial regression coefficient of multiple regression. The path coefficient is represented by two types of arrows (single and double-headed). The direct coefficient and the double-headed arrow represent the indirect effect. The coefficient of the path is calculated as the product of multiplying the two rx1x2 (p2y) and the sum of the magnitudes of all the paths of the first variable consists of an instantaneous or natural equation. The number of natural equations is equal to the number of effecting variables, and each equation represents the fragmentation of the correlation coefficient between the causative variable and the responsive variable into its components, namely the direct or path factor (pxy) and indirect effects. Each number includes the value of the correlation coefficient between the variables and the path coefficient according to the following diagram.



where Xi: causative factors (seven studied traits). Y: effector (grain quotient). R: Remaining factors.

Pxiy: A vector representing a path coefficient from a causative to a transponder.

Vector : represents a correlation coefficient between rxixi attributes.

From the above diagram, the grain yield y is the result of the causative factors x1, x2, x3 and x4 T

rx1y=px1y+px2yr12+ ……..+px4yr14

rx2y=px1yr21+px2y+ ……..+px4yr24

rx4y=px1yr14+px2yr24 +……..+px4y

rRy=PRY=(1-ΣPxiYrxiy) 1/2

These simultaneous equations are placed in a matrix as follows:

$$\begin{bmatrix} rx1y \\ rx2y \\ rx4y \end{bmatrix} = \begin{bmatrix} rx1x1 & rx1x2 \ldots\ldots\ldots\ldots & rx1x4 \\ rx2x1 & rx2x2 \ldots\ldots\ldots\ldots & rx2x4 \\ rx4x1 & rx4x2 \ldots\ldots\ldots\ldots & rx4x4 \end{bmatrix} \times \begin{bmatrix} rx1y \\ rx2y \\ rx4y \end{bmatrix}$$

CBA

To calculate matrix values C (path coefficient values) we calculate the inverse of matrix B.

$$\underset{C}{\begin{bmatrix} px1y \\ px2y \\ px4y \end{bmatrix}} = \underset{B^{-1}}{\begin{bmatrix} 1 & rx1x2 \ldots\ldots\ldots\ldots & rx1x4 \\ rx2x1 & 1 \ldots\ldots\ldots\ldots & rx2x4 \\ Rx4x1 & rx4x2 \ldots\ldots\ldots\ldots & 1 \end{bmatrix}} \times \underset{A}{\begin{bmatrix} rx1y \\ rx2y \\ rx4y \end{bmatrix}}$$

After solving these matrices according to a special statistical program, the coefficients of the path are calculated according to the method set by Li (1956) and used by Dewey and Lu (1959) and then used by Singh and 1985 (Caudhary) for agricultural applications. The table of the main matrix diameter is regulated by path coefficients ie direct and indirect effects at both ends of the matrix according to their position in the immediate equation (Williams *et al.*, 1990). The results are interpreted in the light of the data obtained

Results and Discussion

Plant height cm^{-1}

The results of Table 1 indicate significant differences in the effect of nitrogen fixing bacteria on plant height. The treatment of double bacterial vaccine (AZ. + RL2) with 50% chemical fertilization gave the highest rate of 211.06 cm and did not differ significantly from the comparison treatment (without bacterial vaccine with 100% chemical fertilization) .The increase in plant height may be due to the availability of nitrogen from fertilization Chemical and biological nitrogen fixation in sufficient quantity to stimulate leg elongation leading to increased plant height (Baset and Shamsuddin, 2001).

The results also indicated that there was no difference between the genotypes in plant height As for the intervention, the table indicated the superiority of treatment of double bacterial vaccine (AZ. + RL2) with 50% chemical fertilization of the genotype 5018 and gave the highest rate of 220.47 cm.

Leaves area cm^2

The results of Table 2 indicate significant differences in the effect of nitrogen fixing bacteria on the leafy area. The treatment of double bacterial vaccine (AZ. + RL2) with 50% chemical fertilization gave the

Table 1. Effect of biofertilizer use on plant height (cm) of four maize genotypes.

GenotypsBiofertilizer	5012	behoth 106	5017	5018	mean
Control	213.33	203.00	210.33	206.00	208.17
Azospirillum	194.67	190.67	185.40	188.60	189.83
AZ. +RL2	186.13	220.27	217.37	220.47	211.06
AZ. + RM1	206.03	206.53	208.40	201.40	205.59
AZ. + RT3	204.30	204.97	195.07	202.73	201.77
L.S.D. 5%	6.30	3.15			
Mean	200.89	205.09	203.31	203.84	
L.S.D. 5%	N.S				

Table 2. Effect of use of biofertilizers on leaves area (cm 2) of four maize genotypes

Genotyps Biofertilizer	5012	behoth 106	5017	5018	Mean
Control	5194	5081	5153	5020	5112
Azospirillum	4742	4818	4628	4736	4731
AZ. +RL2	4882	5287	5345	5356	5218
AZ. + RM1	4946	4950	4925	5052	4968
AZ. + RT3	4547	4388	4415	4468	4454
L.S.D. 5%	225.6	112.8			
Mean	4862	4905	4893	4926	
L.S.D. 5%	N.S				

highestrate of 5218 cm^2 and did not differ significantly from the comparison treatment (without bacterial vaccine with 100% chemical fertilization). The secretion of many growth regulators that help increase the vegetative total of the plant and these results are consistent with his findings (Sengupta *et al.,* 2015). The results also indicated that there was no difference between the genotypes in the leafy area. As for the intervention, the table indicated the superiority of treatment of double bacterial vaccine (AZ. + RT3) with 50% chemical fertilization of the genotype 5018 and gave the highest rate of 5356 cm^2

Sthe number larvae 3

The results of Table 3 indicate that there were no significant differences in the effect of nitrogen-fixing bacteria and their genotypes and their interaction in the number of larvae S.

The length of larvae cm

The results of Table 4 indicate significant differences in the effect of nitrogen-fixing bacteria on plant length. The treatment of double bacterial vaccine (AZ. + RL2) with 50% chemical fertilization gave the highest rate of 19.21 cm. These findings are consistent with the findings of Ghasemi *et al.* (2013) who reported a significant increase in larvae length when treating maize plants with bacterial vaccine compared with non-vaccine treatment.

The results also indicated that there was no difference between genotypes in the length of larvae.

As for the intervention, the table indicated the superiority of treatment of double bacterial vaccine (AZ. + RT3) with 50% chemical fertilization of the

Table 3. Effect of use of biofertilizers on plant aranes for four maize genotypes

Genotyps Biofertilizer	5012	behoth 106	5017	5018	Mean
Control	1.60	1.72	1.67	1.95	1.74
Azospirillum	1.73	1.65	1.58	1.85	1.70
AZ. +RL2	1.69	1.91	1.88	2.05	1.88
AZ. + RM1	1.83	1.84	1.66	1.59	1.73
AZ. + RT3	1.99	1.68	1.78	1.71	1.79
L.S.D. 5%	N.S	N.S			
Mean	1.77	1.76	1.72	1.83	
L.S.D. 5%	N.S				

genotype 5018 and gave the highest rate of 19.33 cm.

The number of grain for larvae

The results of Table 5 indicate significant differences in the effect of nitrogen-fixing bacteria on the number of grains of larvae. The treatment of double bacterial vaccine (AZ. + RL2) with 50% chemical fertilization gave the highest rate of 430.70 arnus-1 pills. (Baset and Shamsuddin, 2001) agree with the findings of Iwugwn *et al.* (2013) who reported significant differences in the number of grains when treating maize plants compared to non-vaccine treatment. The results also indicated that there was no difference between the genotypes in the number of grains of larvae. As for the intervention, the table indicated the superiority of treatment of double bacterial vaccine (AZ. + RT3) with 50% chemical fertilization of the genotypes 5018 and gave the highest rate of 535.00 grains larvaes - 1.

6- weight of 1000 tablets (g)

The results of Table 6. showed that the comparative treatment (without bacterial vaccine with 100% chemical fertilization) was superior and gave the highest rate of 323.2 g and did not significantly differ from treatment of double bacterial vaccine (AZ. + RL2) with 50% chemical fertilization which gave a rate of 320.4 g. This may be due to the role of bacteria in the stabilization of nitrogen in the atmosphere and increase the absorption of nitrogen and nutri-

Table 4. Effect of biofertilizer use on cinnabar length (cm) of four maize genotypes

Genotyps Biofertilizer	5012	behoth 106	5017	5018	mean
Control	18.74	18.06	19.19	17.95	18.49
Azospirillum	16.86	17.09	16.84	16.63	16.86
AZ. +RL2	19.23	19.17	19.10	19.33	19.21
AZ. + RM1	17.81	17.50	18.17	18.53	18.01
AZ. + RT3	16.21	15.82	15.54	16.04	15.90
L.S.D. 5%	0.75	0.37			
Mean	17.77	17.53	17.77	17.70	
L.S.D. 5%	N.S				

Table 5. Effect of use of biofertilizers on the number of grains of larvae for four corn genotypes.

	Genotyps				
Biofertilizer	5012	behoth 106	5017	5018	mean
Control	426.7	410.7	432.0	407.7	419.2
Azospirillum	386.3	391.3	374.7	377.3	382.4
AZ. +RL2	433.0	427.7	427.0	435.0	430.7
AZ. + RM1	407.7	397.3	405.0	409.0	404.8
AZ. + RT3	366.0	353.7	330.7	360.0	352.5
L.S.D. 5%	21.23	10.62			
Mean	403.9	396.1	393.8	397.8	
L.S.D. 5%	N.S				

Table 6. Effect of the use of biofertilizers on the weight of 1000 grain (g) of four maize genotypes

Genotyps /Biofertilizer	5012	behoth 106	5017	5018	Mean
Control	321.3	326.0	320.0	325.7	323.2
Azospirillum	323.7	323.0	317.3	311.3	318.8
AZ. +RL2	323.7	325.7	312.7	319.7	320.4
AZ. + RM1	313.7	314.0	321.7	318.0	316.8
AZ. + RT3	303.0	321.0	326.0	301.0	312.8
L.S.D. 5%	14.19	7.10			
Mean	317.1	321.9	319.5	315.1	
L.S.D. 5%	N.S				

ents and increase the fullness of grains with chemical components in grains (Vessy, 2003) and consistent with the conclusion reached by Sahar et al. (2012), which indicated that the treatment of maize plants vaccine leads to increase In the weight of the pill compared to no treatment.

The results also indicated that there was no difference between the genotypes in grain weight.

As for the intervention, the table indicated the superiority of treatment of double bacterial vaccine (AZ. + RT3) with 50% chemical fertilization of the genotype 5017 and gave the highest rate of 326 g.

7- Plant yielld

The results of Table 7 indicate significant differences in the effect of nitrogen fixing bacteria on plant yield. The treatment of double bacterial vaccine (AZ. + RL2) with 50% chemical fertilization gave the highest rate of 157.58 g. The increase in plant yield may be due to the availability of nitrogen element from chemical fertilization and biological fixation of nitrogen in sufficient quantity and its role in the production of various chemical compounds, hormones and growth factors. These results are consistent with the findings of Ghasemi *et al.* (2013) who indicated an increase in plant yield when treating yellow maize with bacterial vaccine compared to comparative treatment.

The results also indicated that there was no difference between the genotypes in the plant crop As for the intervention, the table indicated the superiority of treatment of double bacterial vaccine (AZ. + RT3) with 50% chemical fertilization of the genotype 5018 and gave the highest rate of 158.33 g.

Total yield (tonh-1).

The results of Table 9 indicate significant differences in the effect of nitrogen fixing bacteria on the total number of products.

The treatment of double bacterial vaccine (AZ. + RL2) with 50% chemical fertilization gave the highest rate of 10.98 tons E-1.

The increase in the total yield may be due to the availability of nitrogen element from chemical fertilization and biological nitrogen fixation which leads to increased absorption of nutrients, especially nitrogen element. These results play an important role in increasing photosynthesis and hence increasing grain yield (Baset and Shamsuddin, 2001). These results are consistent with the findings of Ghasemi *et al.* (2013) who reported an increase in the total yield when treating yellow maize with bacterial vaccine compared with comparative treatment.The results also indicated that there was no difference between the genotypes in the total yield.As for the intervention, the table indicated the superiority of

Table 7. Effect of biofertilizer use on plant yield (gm) of four maize genotypes

Genotyps/Biofertilizer	5012	Behoth 106	5017	5018	Mean
Control	145.67	139.33	149.00	133.00	141.75
Azospirillum	121.00	121.67	115.33	119.67	119.42
AZ. +RL2	157.00	157.67	157.33	158.33	157.58
AZ. + RM1	137.00	131.33	130.33	138.67	134.33
AZ. + RT3	119.33	125.00	121.00	122.00	121.83
L.S.D. 5%	11.83	5.91			
Mean	136.00	135.00	134.60	134.33	
L.S.D. 5%	N.S				

Table 9. Effect of use of biofertilizers on total yield (Tan .h-1) of four maize genotypes

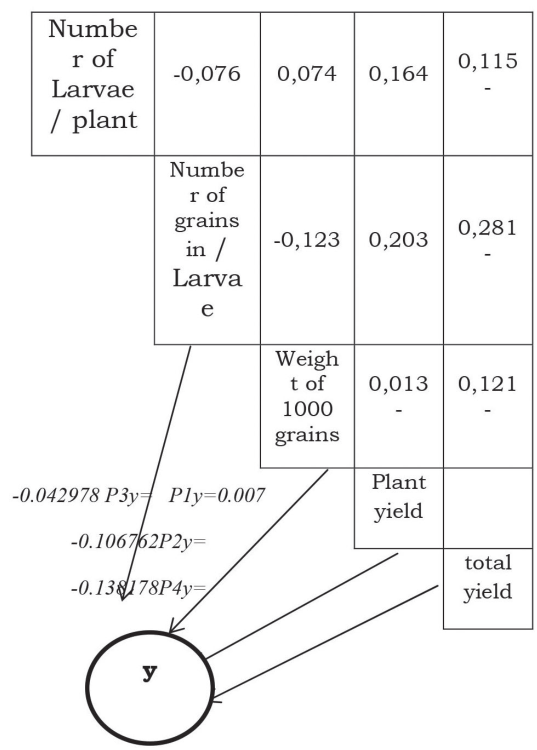
Genotyps/Biofertilizer	5012	behoth 106	5017	5018	Mean
Control	10.51	10.05	10.19	8.47	9.81
Azospirillum	8.19	8.18	8.10	8.15	8.16
AZ. +RL2	10.92	10.90	11.06	11.03	10.98
AZ. + RM1	8.64	8.45	8.37	8.84	8.58
AZ. + RT3	8.14	8.15	8.04	8.12	8.11
L.S.D. 5%	0.65	0.32			
Mean	9.28	9.15	9.15	8.92	
L.S.D. 5%	N.S1				

treatment of double bacterial vaccine (AZ. + RT3) with 50% chemical fertilization of the genotype 5018 and gave the highest rate of 11.033 tons E-1.

Genetic and phenotypic correlations and path coefficient analysis

The correlation between five traits was studied where the results of the analysis shown in Chart 1 indicate that the number of germs / plant was negatively and genotypically associated with the total yield (0.1115, 0.039-). It was positively and genetically and morally negatively correlated positively with a weight of 1000 grains (0.074, 0.162. The number of grains in the head was significantly and genetically and phenotypically negatively correlated with grain yield (0,281, 0,107-) and positively correlated with individual plant yield (0,203, 0,620) and correlation with 1000 grains weight was significantly negative (0.123-,0.364). The result is consistent with the findings of Saadalla, Refay (2000) and Jawad (2006) and a 1000-grain weight recipe. Negative and non-significant correlation with the individual plant yield (0.013, -0.049). The results of the analysis of variance showed the existence of high moral differences between the studied traits and since the phenotype is the result of overlap between the genetic and environmental structures and as a result of the correlations or partnership between traits with direct and indirect effects, it was found that the analysis of the correlation only measures the correlation between any two variables and does not give a complete or real picture For the more complex cases of this, the coefficient of pathway analysis was conducted to arrive at a definitive conclusion to describe the nature of the partnership between these traits and grain yield. This analysis provides more accurate and important measurements of the direct effect of a cause on the grain yield as well as the indirect effects of the same cause on the grain yield by other attributes. Therefore, thane of the important statistical genetic analyzes used by plant breeders for the purpose of fragmentation of the correlation coefficient between these traits and the grain yield to its different effects for the purpose of determining the most traits as a criterion for the selection of the high yield (Dewey and Lu, 1956). The effect of four traits on the total yield was studied. The results indicated in the table indicate that the number of heads per plant has a positive direct effect of the phenotypic pathway coefficient (7,365) on grain yield. As for the indirect effect through other traits, there is no genetically indirect effect. In addition, there is a negative effect indirectly by the number of grains in the head and the weight of 1000 grains and plant yield (1.827-, 0.611-, 4.856). The direct effect of the number of grains in Arnous on the grain yield was genetically negative (0,106762), phenotypic positive (8,31822) and indirect effect by other traits. These results are consistent with Saadalla, Refay (2000); Biswas *et al.* (2001). There was no direct and indirect effect of the gene pathway coefficient by weight of 1000 grains and their association with other traits. On the phenotypic basis, there is a positive direct effect of the weight of 1000 grains on the grain yield (3,78005) and indirectly negative by the number of aranes and the number of grains in the arousa (1,191, 3,024) and positively by the individual plant yield (0,451). The direct effect of individual plant yield on grain yield was genetically and phenotypically negative (0,138,178, 9,1829) and indirect effect was positively positive by the number of plant aranes and the number of grains in arnous (3,895, 5,158) respectively and the phenotypically negative by Weight of 1000 tablets. Genetically it had no indirect effect by other traits.

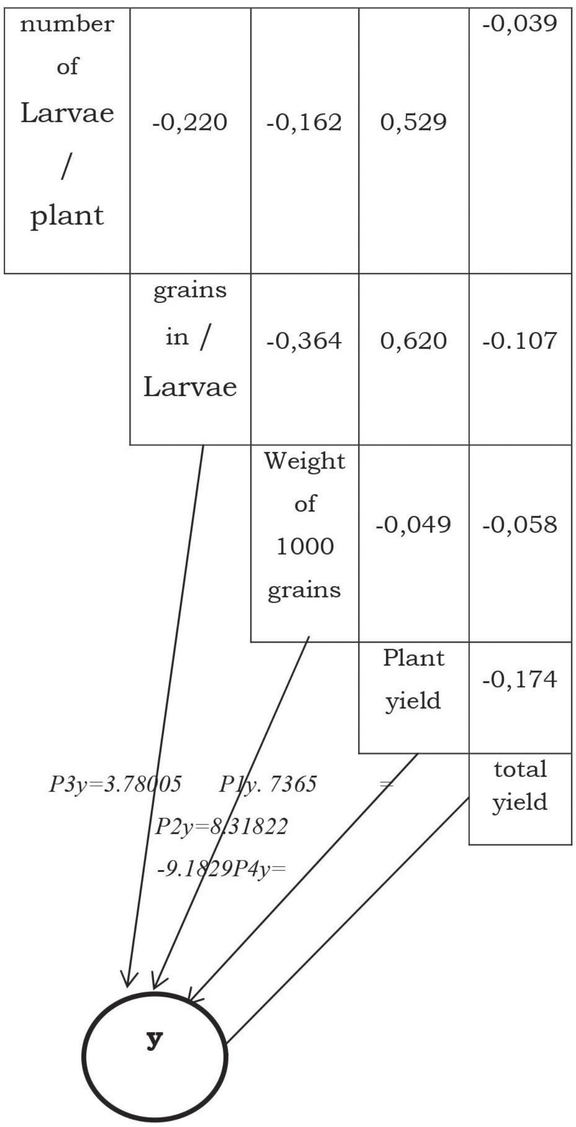
Diagram 1. Genetic correlation values and genetic path coefficient.



whereas :

X1: Number of Aranis / plant
X2: number of grains in a pineapple / plant
X3: Weight of 1000 grains
X4: Plant yield
X5: total yield

Digram 2. Appearance correlation values and phenotypic path coefficient



References

Al-Niamy, S. N. 1987. Fertilizers and soil fertilization. House Books for print-ing and publishing.

Applonia, B.L. 1996. How flour affects bread quality. Lallemand Baking Update. 1(17) : 1 2.

Baset, M. and Shamsuddin, Z. 2001. Rhizobium as a crop enhancer biofertilizer.

Bashan, Y. and de-Bashan L. E. 2010. How the plant growth- promot-ing.bacteriumAzospirillum promotes plant growth–a critical as-sessment. *In Advances in Agronomy* (20) 108 : 77-136.

Biswas. B. K. , M. Hasanuzzaman, F. El. Taj, M. S. Alam and M. R. Amin. 2001. Simultaneous selection for fodder and grain yield in sorghum. *Online J. of Biological Sciences.* 5 : 321-323.

Dakora, F.D. 2003. Defining new roles for plant and rhizobial molecules in sole and mixed plant cultures involving symbiotic legumes, New, *Phytologist.* 158: 39-49.

Dewey, Douglas R. and K. H. Lu. 1959. A correlation and path coefficient analysis of components of crested wheatgrass seed production. *Agron. J.* 78 : 515-517 .

Ghasemi, S., Ramezani, M., Fatemi-Nik, F. and Bazdar, 2013. Effect of microbial phosphate biofertilizer on corn (*Zea mays*, L. S.C.704) under water deficit stress in the Mehran region of Iran. *Int. Jour. of Agri. Scie.* 3(3) : 253-262.

Jawad, Afaf Mahdi Mohammed, 2006. Analysis of path coefficient in grain corn (Moench.) L bicolor Sorghum Master Thesis. *College of Agriculture.* University of Baghdad

Jawad, Afaf Mahdi Mohammed, 2006. Analysis of path coefficient in grain corn (Moench.) L bicolor Sorghum Master Thesis. College of Agriculture. University of Baghdad.

Iwuagwu, M., Chukwuka, K.S., Uka, U.N. and Amandianeze, M.C. 2013. effect of biofertilizers on the growth of *Zea mays* L. *Asian Jr. of Microbiol. Biotech. Env.Sc.* 15 (2) : 235-240.

Paula, G.F., Esther, M. and Raul, R. 2015. Role of bacterial biofertilizers in agriculture and forestry. *Bioengineering.* 2(3) : 183-205.

Khalequzzaman, K. M. 2015. Seed Treatment Biofertilizer for Controlling Foot and Root Rot of Chickpea. *International* with Rhizobium)

Li, C. C. 1956. The concept of path coefficient and its impact on population genetics. *Biometrics.* 12 : 191-209

Robinson, H. F., Comstock, R.E. and Harvey, P. H. 1951. Genotypic and phenotypic correlations in corn and their implication in selection. *Agron. J.* 43 : 282-2876.

Saadalla, M. M. and Refay, Y. A. 2000. Genotypic response, correlations , and path coefficients in grain sorghum as affected by contrasting water regimes. *Rull. Fac. Agric. Cairo Univ.* 51 : 207-252.

Sengupta, C., Bhosale, A. and Malusare, S. 2015. Effect of plant growth promoting rhizobacteria on seed germination and seeding develop-ment of *Zea mays*. *International Journal of Research in Advent Technology-Special Issue.* 2321-9637

Sahar, B.K., Bahram, M. and Farhad, F. 2012. Improvement of Corn Yield by Seed Biofertilization and Urea Application. *World Applied Sciences Journal*. 16 (9) :

1239-1242.

Singh, R.K. and Chaudhary, B.D. 1985. *Biometrical Methods in Quantitative Genetic Analysis.* Kalyani publishers. New Delhi Ludhiana.

Steel, R.G.D. Torrie, J.H. and Dickey, 1980. *Principles and Procedures of Statistics : a Biometric Approach* 3rd Ed. McGraw –Hill Book Co. Inc., New York. USA. Pp: 485.

Vessy, J. K. 2003. Plant growth promoting *Rhizobacterica*as bio fertilizer. *Plant Soil.* 255 : 571-585.

Vincent, J. M. 1970. Amanual for the practical study root_nodulebachand book No 15, Oxford.

Wahib, Karima Mohammed, 2001. Evaluation of Response of Some Maize Genotypes to Different Nitrogen Fertilizer Levels and Plant Density and Estimation of Path Features. PhD thesis, College of Agriculture, University of Baghdad Special Crops. 2 (6): 1-3.

Williams, W. A., Jones, M. B. and Demment, M. W. 1990. Aconcise table for path analysis statistics. *Agron. J*. 82 : 1022-1024.

Wright, S. 1921. Correlation and causation. *J. Agric. Res.* 20: 557-587.