Plant Archives Vol. 20 No. 1, 2020 pp. 473-479 **e-ISSN:2581-6063 (online), ISSN:0972-5210**

ROOT QUALITIES AND NITROGEN UPTAKE EFFICIENCY FOR HYBRID OF MAIZE AND THEIR PARENTS

Jawad Ali Hamood[1,2]* and Layla Ismail Mohammed Al-Majidi[1]

[1*]College of Agricultural, Engineering Sciences, University of Baghdad, Iraq.
[2]College of Agriculture, University of Wasit, Iraq.

Abstract

Field experiments were carried out at the field crop research station in Jadriyah, Faculty of Agricultural Engineering Sciences - University of Baghdad, and the Faculty of Agriculture – University of Wasit with the aim of producing a single hybrid of maize characterized by efficient absorption of nitrogen and its utilization in the production of high yield to minimize the damage of nitrogen loss in the environment. The propagation of seeds of the strains was done in the spring and autumn seasons of 2017 in both sites of Baghdad and Wasit and then the strikes were conducted according to the second method of Griffing (1956) mixed model, between six strains of corn (Zin11, Zin6, Zin9, Zin8, Zin4 and Zin19, which are indicated by 1, 2, 3, 4, 5 and 6, respectively). Hybridization was done manually in the field. The comparison experiment was applied during the spring season of 2018 in Baghdad and Wasit sites, according to the design of the complete randomized block in the order of split plots with three replicates. The main plot included nitrogen fertilization levels (120, 220 and 320 kg $N.ha^{-1}$) and the secondary plot included the genetic structures (22 genotypes). Six breeds (fathers) and 15 crosses as well as the For at comparison class). The obtained results of the comparison experiment showed that there were significant differences between the levels of nitrogen fertilization. Most of the studied traits increased significantly by increasing the level of nitrogen fertilization from 120 to 320 kg $N.ha^{-1}$ for both sites. The fertilizer level 320 kg $N.ha^{-1}$ was exceeded by giving the highest yield of unit area (7.26 and 6.24 $mg.ha^{-1}$) for both sites respectively and decreased the efficiency of nitrogen absorption (0.94 and 0.78% for the Baghdad and Wasit sites, respectively). The results also showed that there were significant differences between genotypes (strains, cross-strains and comparison class) in all studied traits, and a number of strikes showed a significant hybrid force in the desired direction in the studied traits. Strain 3 and multiplication (5×2) were superior to root length, root weight and grain yield. Per unit area (12.49 and 9.94 $Mg.ha^{-1}$) in the Baghdad and Wasit sites, respectively, as well as giving it the efficiency of absorption of nitrogen. It can be concluded that strain 3 and genotype (2×5) in both locations were characterized by their large root length and high weight as well as gave high yield and reflected on the efficiency of absorption of nitrogen. Therefore, root qualities can be adopted as one of the effective strategies to reduce the cost of fertilizers and reduce excessive use of fertilizers which damage the environment.

Keywords : Root quality, fertilization, maize, nitrogen.

Introduction

Agricultural scientific research faces a fundamental challenge in providing the food needed to cope with the increasing turbulent population, and achieving a high productivity while maintaining a safe and secure environment. Most farmers in developing countries rely on increasing the rates of use of nitrogen fertilizers to increase productivity of maize crop (*Zea mays* L.) which considered as one of the world's major crops, producing about 967 million tons in 2013 to meet growing demand (Ort and Long, 2014). Yang *et al.* (2017) demonstrated that maize crop is one of the most productive crops in the world that provides food and feed and used in the production of biofuels. It was found that the yield of maize grains responds largely to the amount of nitrogen added, and that nitrogen is a quantitative nutrient for plant growth, development and production, through its contribution to the manufacture of chlorophyll and the synthesis of amino and nucleic acids, protein and cell walls (Kramer, 2004). The production of nitrogen fertilizers consumes approximately 1% of the total energy processed annually

***Author for correspondence :** E-mail : jwadhmood@uowasit.edu.iq

in the world, causing the release and emission of gases containing pollutants that have a negative impact on the environment and can contribute to global warming (Smith, 2002 and Zhang *et al.*, 2013). Moreover, excessive use of nitrogen fertilizers in many regions of the world negatively affects the overall ecosystem (Tilman *et al.*, 2002), leading to increased levels of pollution that reflect on human health (Fischer *et al.*, 2014). Economic problems faced by farmers due to the high prices of nitrogen fertilizers and their volatile nature, the global economic return of fertilizer use in cereal crops (such as maize) has been estimated at 25-50%. The direction and degree of movement of most of the ready nitrogen in the form of nitrates in the growing season depends on the water inside the soil and its rate of downward movement. Studies have shown that nitrates can move downward at a greater rate than that used by the crop (Dixon, 2003). Increasing the density of root length between plant lines allows them to be distributed in the plot to be more useful for nitrogen absorption. Pengcheng Li *et al.*, (2015) have explained that there was a significant genetic relationship between the Root System Architecture (RSA) and NUE traits by detecting promising genetic areas to improve the efficiency of nitrogen use in maize, so it is expected that the structure of the RSA in the maize has a key role in obtaining nitrogen although nitrogen efficiency (NUE) and nitrogen uptake efficiency (NupE) were significantly correlated with RSA, especially the seed roots (r = 0.15-0.31) and coronary roots (r = 0.15-0.18), but the genetic relationship between them is still requires clarification. The aim of this research is to produce and improve maize genotypes that combine high nitrogen absorption efficiency with high yield (genotypes that achieve the highest yield with the lowest amount of nitrogen), to be one of the effective strategies to increase the yield, reduce the cost of fertilizers and reduce excessive use of fertilizers that damage the environment.

Materials and methods

The research was carried out in the fields of the research station of the Faculty of Agricultural Engineering Sciences - University of Baghdad, Jadriyah and the fields of the Faculty of Agriculture, Wasit University, during the seasons, autumn 2017 and spring 2018 to study the growth and nitrogen use efficiency for six strains of maize and hybrids, syndrome with high yield. Seeds of strains were obtained from a. Dr. Ziad Ismail Abd (Faculty of Agricultural Engineering Sciences - Department of Field Crops (Plant Breeding), and were represented by (Zin11, Zin6, Zin9, Zin8, Zin4 and Zin19) and given the numbers 1, 2, 3, 4, 5 and 6, respectively, in the program of strikes. Soil service and crop yielding, tillage, softening and dividing were carried out according to the requirements of the experiment. The seeds were planted three days after irrigation by placing two seeds in the hole, which was reduced to one plant after two weeks of emergence. Irrigation and weeding were provided when needed. The corn stalk digger (*Sesamia cretica*) fought with a 10% granulated diazinon pesticide at a rate of 6 $kg.ha^{-1}$. Nitrogen was added at a rate of 320 $kgN.ha^{-1}$ (urea fertilizer (46% N) as its source), in two batches, the first in planting and the second after one and a half months of cultivation, except for the comparison experiment for quantities of nitrogen. Phosphorus was added at a rate of 150 $kgP_2O_5.ha^{-1}$ (common phosphate fertilizer as p source), and potassium was added in the comparison experiment at a rate of 100 kg K_2O ha^{-1} (potassium sulfate K2SO4 by (50-50) as its source) when planting (Ali, 2012). Breeding, hybridization, selecting and evaluation program was according to the agricultural seasons. In the autumn season 2017. The hybridization between the six strains was done and three of the strains had relatively high nitrogen content compared to the other strains with less content. Seeds were planted on 1 of August 2017 in the field of the Faculty of Agriculture - University of Wasit. The strains were introduced into a one-way hybridization program between the strains according to the second method of Griffing (1956b), when the plants reached flowering stage, female inflorescences were encapsulated before silk erupted with small paper bags to prevent cross-pollination. Male inflorescences were encapsulated with large paper bags the day before. From the start of the pollination process and after the release of pollen the next day, the calorie ready to receive the pollen was inoculated, and in the same way the required pollination were made between the six strains to produce F_1 and the self-pollination of the strains. At maturity stage, ears of the resulting strikes were reaped and dried and separated individually for cultivation in the following season. In the spring season 2018, the comparison experiment was carried out in two locations, the first in one of the research stations of the Faculty of Engineering Sciences of Agriculture - University of Baghdad in Jadriya on 20 of March 2018, and the second in the field of the Faculty of Agriculture - University of Wasit on 21 March 2018. The area of the experiment was divided into lines with 2.6 m long with one line for each genotype, where the distance between the lines was 0.85 and 0.20 m between the plants with the density of 59000 $plant.ha^{-1}$. The RCBD design was used in the order of split plots with three replicates. The main plot included the levels of nitrogen fertilization 120, 220 and 320 kg $N.ha^{-1}$, taking into account the amount of ready nitrogen in the soil (Appendix 2), while the secondary plot included genotypes (22 genotypes, six strains and fifteen individual hybrids as well as the For at synthetic variety for comparison for both sites. The studied traits included:

The root length (cm): It was measured using the ruler.

Root weight (g): After root extraction with a cylinder with a diameter of 20 cm and a height of 40 cm and then washed with water to ensure most of the total root.

Cereal yield of plant (Mg.ha^{-1}).

Nitrogen uptake efficiency (NUpE): It was calculated by dividing the absorbed nitrogen (Nt) in the plant at maturity stage (grain + stover) by total nitrogen supply (Ns). It is a measure of the ability of plants to absorb nitrogen (Moll *et al.*, 1982).

NUpE = Nt / Ns

Table 1: Average root length (cm) of maize genotypes at three nitrogen levels for Baghdad and Wasit sites.

Geno-types	Baghdad site Nitrogen levels kg N.ha^{-1}			Ave-rage	Wasit site Nitrogen levels kg N.ha^{-1}			Ave-rage
	120	220	320		120	220	320	
1	31	29	35	31	22	26	28	25
2 × 1	30	34	32	32	26	27	29	27
3 × 1	27	30	33	30	25	29	29	28
4 × 1	28	28	30	29	24	24	24	24
5 × 1	27	28	31	29	22	22	25	23
6 × 1	29	25	37	30	22	21	29	24
2	32	32	32	32	25	24	27	25
3 × 2	31	30	30	30	32	32	26	30
4 × 2	29	32	35	32	28	23	24	25
5 × 2	34	35	36	35	31	30	29	30
6 × 2	34	31	33	33	24	26	26	25
3	33	36	34	34	26	28	26	27
4 × 3	34	38	34	36	22	27	24	24
5 × 3	36	37	38	37	27	25	31	28
6 × 3	27	27	32	28	25	22	22	23
4	24	28	27	26	20	24	26	23
5 × 4	27	23	27	26	22	26	22	23
6 × 4	32	26	27	28	22	23	22	22
5	27	28	32	29	27	27	27	27
6 × 5	30	33	32	32	27	25	26	26
6	21	22	26	23	25	22	19	22
Class of comparison	26	27	29	28	25	27	24	25
L.S.D 5%		5		3		7		4
	29	30	31	30	25	25	26	25
L.S.D 5%		2				N.S		

The absorbed nitrogen (Nt) was calculated according the following equation:

Nt = (GY x GNC) + (SY x SNC)

GY: Grain yield (g.m^{-2})

GNC: Grain Nitrogen Concentration (%)

SY: Stover yield (g.m^{-2})

SNC: Hay content of nitrogen Stover Nitrogen concentration (%)

The attributes were statistically analyzed according to the required design and the averages were compared based on the lowest significant difference at 0.05 (Gomes and Gomes, 1984).

Results and discussion

Root Length (cm): The length of the roots and their extension in the soil layers increases the absorption of nitrogen moving deep into the soil with irrigation water. The results of Table 1 showed that there were significant differences in nitrogen levels at Baghdad site, where the level of 320 kg N.ha^{-1} achieved the highest mean length of the root with mean of 31 cm which was significantly superior on the level of 120 kg N.ha^{-1} (with an increase of 6.9%), while it did not differ from fertilizer level 220 kg N.ha^{-1} as well as fertilization levels did not achieve significant differences at Wasit site although genotypes gave the highest average root length of 26 cm at N320 level. The obtained results indicated that the addition of nitrogen can affect the growth and development of roots, and that the growth of roots will be reflected in some important growth traits and yield components, such as the number of corn ears. This is consistent with finding of Durieux et. al., (1994) who indicated that multi-corn ears may need a more effective radical system to compensate for the ear requirements. The results also showed that there were significant differences between the mean length of the roots according to the different genotypes and their response to the added nitrogen. Strain 3 gave the highest average root length of 34 cm, and it did not differ significantly from strain 2, while it was significantly superior to the other strains (1, 4, 5 and 6) and comparison strain in the site of Baghdad. However, at the site of Wasit, the values of strains 5 and 3 were similar with average root length of 27 cm and did not differ significantly from strains 1 and 2, which were the same, giving an average of 25 cm, while strain 6 was the shortest (23 and 22 cm for the two sites, respectively), although they did not make significant differences on strains 1, 2 and 5 at the site of Wasit.

The difference between strains in the average length of the roots were reflected on their strikes. It was noted that the superiority of 7 and 6 strikes on the general average of the trait for both sites of Baghdad and Wasit, respectively. Also, 7 strikes at the site of Baghdad, and two strikes at the Wasit site were significantly superior on the class of comparison. Striking (5×3) gave the highest average root length of 37 cm, exceeding the rest of the strikes and comparison class, and did not differ significantly from the strikes (4×3) and (5×2) and strain 3 in the Baghdad site. In Wasit, the average length of the roots (30 cm) was the same for (3×2) and (5×2) strikes, which was significantly higher than the rest of the strikes except the (2×1), (3×1) and (5×3) that gave an average of 28, 28 and 27 cm respectively. While the minimum root length was 26 cm (5×4) at Baghdad site, and 22 cm (6×4) at Wasit.

The results showed a significant interaction between the levels of nitrogen fertilization and the genotypes in the average root length, indicating the different behavior of the genotypes through the nitrogen fertilization treatments. The root length was 38 cm at the site of Baghdad, and it did not differ significantly from 21.2% of the genotypes (6 at level N320 and 4 at both N120 and N220 levels). At Wasit, the genotype (3×2) gave the highest average root length of 32 cm at 120 and 220 kg N.ha^{-1}. It did not significantly differ from 45.5% of the genotypes (13 at level N320, 9 at N220 and 8 at N120).

Dry root weight (gm.): The spread of roots in the soil helps to absorb more nutrients, including nitrogen. However, the total root weight does not have to be specific to the absorption efficiency of the roots without geometry of its distribution and effectiveness. The results of Table 2 showed that the fertilization levels had a significant effect on the average root weight. The fertilization level of 320 kg gave an average of 24 gm. which was superior on the N120 and N220 levels in Baghdad site, while the three nitrogen levels did not achieve significant differences at Wasit site. The results showed that there were significant differences between the average dry weight of the roots of the genotypes where strain 3 gave the highest mean weight of the roots of 26 and 25 g and significantly superior to the other strains, for the sites of Baghdad and Wasit, respectively, and did not differ significantly from the comparison class in both sites, while the mean dry root weight of strain 6 (10 and 13 g for Baghdad and Wasit sites, respectively) was significantly d the decreased compared to the other strains but it did not differ significantly from strain 4 at Wasit site. The variance between the strains was reflected in the mean traits in their strikes, as it was noticed that 9 and 7 strikes were superior on the general mean traits in both sites, respectively, while 3 strikes was significantly superior on the class of comparison in the site of Baghdad, where the strike (5×3) was the highest with mean of 30 g, and did not differ significantly from the strike (5×2). As for Wasit site, the strike (5×2) was superior with the lower significant difference on the comparison class, giving the highest average weight of the roots reached 27 gm. while it was not significantly different from Strikes (2×1), (6×2), (4×3) and (5×3). The strike (5×2) have the largest total roots which may explain its superiority in most studied traits, including grain yield. This is consistent with finding of Yu *et al.* (2015) who found that hybrids that possessed a better total root structure contributed to increased absorption of nitrogen and removal of many minerals at a depth of 0-60 cm in the soil.

The results showed a significant interaction between the levels of nitrogen fertilization and genotypes

Table 2: Average weight of dry roots (g) of maize genotypes at three levels of nitrogen for Baghdad and Wasit sites.

Geno-types	Baghdad site Nitrogen levels kg N.ha^{-1}			Ave-rage	Wasit site Nitrogen levels kg N.ha^{-1}			Ave-rage
	120	220	320		120	220	320	
1	24	21	27	24	19	22	21	21
2 × 1	23	26	30	26	21	24	29	25
3 × 1	20	23	27	23	23	25	24	24
4 × 1	22	26	23	24	23	21	22	22
5 × 1	25	23	24	24	21	21	22	21
6 × 1	21	22	21	21	19	20	22	20
2	23	19	27	23	21	21	22	21
3 × 2	21	22	21	22	24	23	21	22
4 × 2	19	21	22	21	26	20	23	23
5 × 2	28	29	31	29	27	26	27	27
6 × 2	24	24	27	25	25	27	27	26
3	26	29	24	26	26	26	23	25
4 × 3	25	29	29	28	24	27	27	26
5 × 3	30	29	30	30	25	26	26	26
6 × 3	20	23	24	22	22	22	21	21
4	17	15	18	17	16	14	15	15
5 × 4	16	16	17	16	15	16	20	17
6 × 4	17	15	12	15	19	14	15	16
5	18	19	21	19	19	18	19	19
6 × 5	23	26	25	24	20	21	22	21
6	9	11	12	10	13	14	13	13
Class of comparison	23	27	29	26	23	24	26	24
L.S.D 5%		4		2		5		3
	21	22	21	22	25	25	26	22
L.S.D 5%		1.4				n. s.		

in the average weight of the roots, which indicates the different behavior of the genotypes through the treatments of nitrogen fertilization, in general, it was noted that 50% and 45.4% of the genotypes have gradually increased the rate of nitrogen levels of the two sites, Sequentially, the rest of the genotypes differed in the quantity and direction of response, as the average root weight increased in 63.6% of the genotypes (3 strains, 10 strikes and comparison class) at N320 level than the general mean trait at Baghdad site, and 40.9% of genotypes (strain, 7 strikes and comparison class) at the site of Wasit. In addition, 12 and 9 genotypes at the N220 level, and 11 and 10 genotypes at the N120 level were higher than the general average for both Baghdad and Wasit sites, respectively.

Grain yield (Mg.ha^{-1}): The results shown in Table 3 showed that fertilization levels had a significant effect on grain yield per unit area. By increasing the level of fertilizer from 120 to 320 kg N. ha^{-1}, the grain yield increased significantly from 5.68 to 7.26 Mg ha^{-1} and from 4.89 to 6.24 Mg ha^{-1} for the sites Baghdad and Wasit, respectively, and this increase indicates the ability of plants to use nitrogen efficiently during the stages of growth and formation of crop components. This was in agreement with the assurance of Luque *et al.* (2006) who found that increasing the yield of plant seeds was associated with the highest absorbed nitrogen and the highest ability to utilize this element and represent it in the plant to produce the highest yield. The results showed that there were significant differences between the genotypes, where the strain 3 was significantly higher than the other strains and the comparison class, with an average yield of 9.03 and 7.41 Mg .ha^{-1} for both sites Baghdad and Wasit, respectively, and that the superiority of strain (3) was associated with its superiority on the other strains in the number of plant ears and the number of grains of plant while strain 4 was the lowest number (2.03 and 2.09 Mg .ha^{-1} and for both sites respectively where their yield was decreased significantly from the rest of the strains, as well as the overall average by 70% and 62.9% for both sites respectively. This decrease indicates the effect of the degradation of the pairs of genes governing grain yield trait during the self-pollination of previous seasons. The difference in the average grain yield of the strains was clearly reflected in the grain yield per unit area in its strikes, noting that 66.6% of the strikes in the Baghdad site and 60% of the Wasit site strikes are higher than the general average of the trait, and 12 strikes in Baghdad site and 11 in Wasit site were significantly superior on comparison class. Moreover, significant superiority was observed for all the strikes in which the strain 2 was involved as a mother (3×2, 4×2, 5×2 and 6×2) and the genotype (5×3) on the highest breeds in both locations, in addition to the strike(6×5) in Wasit site with the highest value in the genotype (5×2) which gave an average grain yield of 12.49 Mg.ha^{-1} at the site of Baghdad, and (4×2) which recorded an average yield of 9.94 Mg.ha^{-1} at Wasit site, that significantly exceeding all strikes, strains and comparison class in both sites, while the strike (6×4) gave the lowest average grain yield of 2.63 and 2.28 Mg.ha^{-1} for both sites, respectively and it did not differ significantly from the genotype (5×4) of both sites. Overall, there was an increase of 15.6% in the average grain yield of the genotypes at Baghdad site compared to the general average grain yield of the genotypes at Wasit site.

Table 3: Average grain yield (Mg.ha^{-1}) of maize at three levels of nitrogen for Baghdad and Wasit locations.

Genotypes	Baghdad site Nitrogen levels kg N.ha^{-1}			Average	Wasit site Nitrogen levels kg N.ha^{-1}			Average
	120	**220**	**320**		**120**	**220**	**320**	
1	4.30	5.07	5.67	5.02	4.70	5.16	5.83	5.23
2 × 1	5.33	7.49	7.05	6.62	4.04	5.81	6.42	5.43
3 × 1	4.51	5.15	6.86	5.50	5.29	6.69	7.96	6.65
4 × 1	7.26	7.38	8.27	7.64	5.07	5.88	6.13	5.69
5 × 1	7.67	7.24	8.50	7.80	3.32	3.41	4.75	3.83
6 × 1	6.07	7.03	7.91	7.00	6.20	7.13	8.21	7.18
2	4.97	5.21	6.40	5.53	2.90	3.57	4.93	3.80
3 × 2	8.69	9.99	10.07	9.58	6.46	9.89	10.03	8.79
4 × 2	9.51	11.54	11.49	10.85	9.47	10.48	9.88	9.94
5 × 2	11.27	12.93	13.27	12.49	8.80	9.48	9.84	9.37
6 × 2	8.28	9.86	10.75	9.63	7.91	7.48	9.14	8.17
3	8.51	9.12	9.47	9.03	6.88	7.51	7.83	7.41
4 × 3	3.07	4.40	5.81	4.42	3.41	4.09	4.59	4.03
5 × 3	8.38	11.41	11.29	10.36	7.41	8.58	8.63	8.20
6 × 3	4.40	5.06	6.13	5.20	4.25	4.84	5.32	4.80
4	1.85	1.96	2.03	1.95	2.09	1.95	2.23	2.09
5 × 4	2.78	2.57	2.90	2.75	2.20	2.34	2.92	2.49
6 × 4	2.01	2.74	3.15	2.63	1.72	2.69	2.44	2.28
5	2.36	2.46	3.08	2.64	2.52	3.12	3.25	2.96
6 × 5	6.99	8.16	9.50	8.21	6.93	9.13	8.74	8.27
6	3.01	4.32	4.92	4.08	3.08	3.38	3.32	3.26
Class of comparison	3.78	4.38	5.23	4.46	3.03	4.36	4.94	4.11
L.S.D 5%		0.68		0.39		0.67		0.39
	5.68	6.61	7.26	6.52	4.89	5.77	6.24	5.64
L.S.D 5%		0.22				0.12		

The results indicated that there was a significant interaction between nitrogen fertilization levels and genotypes in the average grain yield. The average yield for most genotypes varied by increasing the level of fertilization from 120 to 320 kg N.ha^{-1}, but the two genotypes (5×2) and (4×2) achieved a significant superiority within the level of nitrogen 120 kg N.ha^{-1} on the highest breeds and comparison class, giving a yield of 11.27 and 9.51 Mg.ha^{-1} in the Baghdad site and 8.80 and 9.47 Mg.ha^{-1} in the Wasit site, which refers to the efficiency of these two strikes under nitrogen-poor conditions. While there was no significant difference for most genotypes by increasing the level of fertilization from N220 to 320N, this was consistent with the results of El-Mekser and Badawy (2015) who noted that grain yield of maize strikes did not differ significantly at levels 214 and 321 kg N. ha^{-1}. The genotype (5×2) gave the highest average yield of 13.27 Mg. ha^{-1} at the level of N320 and did not differ significantly from the level of N220, followed by (4×2) that followed the same behavior at the site of Baghdad, and gave the highest value of the yield recording mean of 10.48 Mg.ha^{-1} at the level of N220 in Wasit.

Table 4: Average absorption efficiency NUpE (%) of maize genotypes at three nitrogen levels for Baghdad and Wasit sites.

Geno-types	Baghdad site Nitrogen levels kg N.ha^{-1}			Ave-rage	Wasit site Nitrogen levels kg N.ha^{-1}			Ave-rage
	120	220	320		120	220	320	
1	1.82	1.21	0.81	1.28	1.74	0.99	0.65	1.13
2 × 1	2.20	1.50	0.85	1.52	1.86	1.10	0.72	1.23
3 × 1	1.76	0.97	0.80	1.18	2.00	1.09	0.82	1.31
4 × 1	2.31	1.42	1.03	1.59	1.68	1.04	0.76	1.16
5 × 1	2.65	1.37	1.00	1.67	1.65	0.95	0.61	1.07
6 × 1	2.42	1.29	1.00	1.57	2.01	1.15	0.94	1.37
2	2.12	1.14	0.83	1.36	1.82	0.91	0.65	1.13
3 × 2	2.62	1.49	0.96	1.69	2.17	1.51	0.96	1.55
4 × 2	3.14	1.91	1.27	2.11	2.85	1.60	1.11	1.85
5 × 2	3.65	1.61	1.13	2.13	2.72	1.17	0.92	1.60
6 × 2	2.85	1.79	1.23	1.96	2.10	1.22	0.92	1.42
3	3.03	1.51	1.11	1.88	2.08	1.14	0.89	1.37
4 × 3	2.24	1.30	0.99	1.51	1.87	0.99	0.71	1.19
5 × 3	3.90	2.03	1.11	2.35	2.59	1.44	0.74	1.59
6 × 3	2.25	1.17	0.70	1.38	1.99	0.99	0.56	1.15
4	1.59	1.17	0.68	1.15	1.26	0.95	0.63	0.94
5 × 4	1.41	1.04	0.58	1.01	1.20	1.08	0.56	0.95
6 × 4	1.37	0.89	0.68	0.98	1.23	0.89	0.66	0.93
5	1.77	0.91	0.78	1.15	1.51	0.81	0.71	1.01
6 × 5	3.33	1.78	1.29	2.13	2.55	1.59	1.01	1.72
6	1.38	0.97	0.72	1.02	1.25	0.94	0.71	0.97
Class of comparison	2.09	1.09	1.02	1.40	1.91	1.03	0.83	1.26
L.S.D 5%		0.39		0.23		1.91		0.19
	2.36	1.34	0.94	1.55	1.91	1.12	0.78	1.27
L.S.D 5%		0.12				0.07		

These results showed the efficiency of the genotype in tolerance of low nitrogen and yield of high grain yield despite its cultivation in spring season. This is consistent with result of Tollenaar *et al.* (2004) who demonstrated that the high grain yield of hybrids under low nitrogen conditions indicates their tolerance to nitrogen stress compared to other hybrids.

Nitrogen Uptake Efficiency: Table 4 showed significant differences in fertilizer levels with the highest mean was 2.36% and 1.91% for the two sites, respectively, for the level N120 and the lowest mean was 0.94% and 0.78% for the two sites, respectively for the level of N320 which can be attributed to the large variation in nitrogen levels compared to the change in the yield or quantity of the absorbed Nitrogen, despite significant increase in the level of N320. The obtained result is consistent with finding of Souza *et al*. (2008) who found that there was an inverse relationship between increase the level of nitrogen fertilizer addition and nitrogen absorption efficiency, where it obtained a 199% increase in nitrogen absorption efficiency at low nitrogen levels compared to high nitrogen levels, which is mainly due the variation in the amount absorbed resulted from the increase in nitrogen levels is lower than the variation in the added amount of fertilizer. The results also showed that there were significant differences between the genotypes in the efficiency of absorption of nitrogen, where strain 3 significantly superior to the rest of the strains and comparative class, giving a ratio of 1.88% and 1.37% for both sites in Baghdad and Wasit, respectively, while the strain 6 was the lowest efficiency In nitrogen absorption, that gave 1.02% and did not significantly differ from strains 4 and 5 at Baghdad site, while strain 4 was the lowest (0.94%) at Wasit site and did not differ significantly from strains 5 and 6. These differences between the strains were clearly reflected in the average trait in their strikes. It was noted that 9 strikes at Baghdad site and 8 strikes at Wasit site, have exceeded the general mean trait, and also significantly increased 7 strikes at Baghdad site and 5 strikes at Wasit site on the comparison class. (Which gave 1.40% and 1.26% of the nitrogen absorption efficiency of the Baghdad and Wasit sites, respectively). The strike (5×3) achieved a rate of 2.35% and did not differ significantly from the (5×2) and (6×5) in the site of Baghdad, while in Wasit site gave the strike (4×2) the highest rate 1.85% did not differ significantly from the strike (6×5), while the strike (6×4) gave the lowest rate among the strikes with mean of 0.98% and 0.93% for both sites (Baghdad and Wasit respectively).

The obtained results revealed that the strain 4 and the strikes that contributed with as a mother, were the lowest in the efficiency of absorption of nitrogen and efficiency of the use of nitrogen, while the strike (4×2), where strain 4 was as a father gave the best averages in the site of Wasit, and this confirms the role of the cytoplasm in showing the dominant gene act on the trait. This wide range of genotypes reflects genetic differences among them in the efficient use of nitrogen and shows the role of hybrid force in superiority of strikes, as 4 of the strikes were superior on the highest strains in both Baghdad and Wasit sites, respectively.

The results of Table 4 indicated a significant interaction between the levels of nitrogen fertilization and the genotypes in the efficiency of nitrogen absorption, indicating that they differ in the quantity and not the direction of the response of the genotypes through the nitrogen fertilization treatments. The lowest nitrogen level gave the highest efficiency and gradually decreased when the nitrogen increased from level 220N to 320N. Genotype (5×3) achieved the highest nitrogen absorption ratio of 3.90% and 2.03% at the N120 and 220N levels, respectively, thus significantly exceeding the rest of the genotypes except (5×2) at level of N120 and genotypes (4×2), (6×2) and (6×5) at the level of N220, while genotype (6×5) gave the highest rate of absorption of nitrogen amounted to 1.29% and did not differ significantly from 9 genotypes in the site of Baghdad. In the Wasit site the genotype (4×2) followed the same direction and gave the highest nitrogen absorption efficiency with mean of 2.85% at level of N120 and then decreased to 1.60% and 1.11% at 220N and N320 levels, respectively. The differences did not reach significant limit with 3 and 6 genotypes at nitrogen levels N120, N220 and N320 respectively. It can be concluded that the significant differences in nitrogen absorption efficiency between genotypes decreased by increasing the nitrogen level such as 320 kg N. ha^{-1}.

In conclusion, the strain 3 and genotype (2×5) for both sites, has been characterized by the length of its roots and high weight which gave high yield and reflected on the efficiency of the absorption of high nitrogen ratio, therefore the roots can be adopted to be one of the effective strategies in reducing the cost of fertilizers and reduce excessive use for fertilizers that damage the environment.

References

Ali, Noureddine Shawky (2012). Fertilizer technologies and their uses. Ministry of Higher Education and Scientific Research - University of Baghdad.

Dixon, R.C. (2003). Foliar Fertilization Improves Nutrient Use efficiency. *Fluid J.*, **40**: 22-23.

Durieux, R.P., E.J. Kamprath, W.A. Jackson and R.H. Moll (1994). Root distribution of corn: the effect of nitrogen fertilization. *Agronomy Journal*, **86(6)**: 958-962.

El-Mekser, H.K. and S.A. Badawy (2015). Nitrogen use efficiency of some maize hybrids. *J. Food, Agriculture and Environment (JFAE).*, **13(2)**:138-142.

Fischer, E.V., Jacob, D.J., Yantosca, R.M., Sulprizio, M.P., Millet, D.B., Mao, J., ... and R.W. Talbot (2014). Atmospheric peroxyacetyl nitrate (PAN): a global budget and source attribution. *Atmospheric Chemistry and Physics*, **14(5)**: 2679-2698.

Gomez, K.A. and A.A. Gomez (1984). Statistical Procedures for Agricultural Research. John Wiley and Sons. USA.

Griffing, B. (1956b). Concept of general and specific combining ability in relation to diallel crossing system. *Aust. J. of Bio. Sci.*, **9**: 463-493.

Krämer, R. (2004). Production of amino acids: physiological and genetic approaches. *Food Biotechnology*, **18(2)**: 171-216.

Moll, R.H., E.J. Kamprath and W.A. Jackson (1982). Analysis and interpretation of factors which contribute to efficiency of nitrogen-utilization. *Agronomy Journal*, **74**: 562-564.

Ort, D.R. and S.P. Long (2014). Limits on yields in the corn belt. *Science*, **344(6183)**: 483-485.

Smith, B.E. (2002). Nitrogenize reveals its inner secrets. *Science*, **297(5587)**: 1654-1655.

Tilman, D., K.G. Cassman, P.A. Matson, R. Naylor and S. Polasky (2002). Agricultural sustainability and intensive production practices. *Nature*, **418**: 671-677.

Tollenaar, M., A. Ahmadzadeh and E.A. Lee (2004). Physiological basis of heterosis for grain yield in maize. *Crop Science*, **44(6)**: 2086-2094.

Yang, Q., P. BalintKurti and M. Xu (2017). Quantitative disease resistance: dissection and adoption in maize. *Molecular plant*, **10(3)**: 402-413.

Zhang, W. F., Z. X. Dou, P. He, X.. Ju, D. Powlson, D. Chadwick, … and X.P. Chen (2013). New technologies reduce greenhouse gas emissions from nitrogenous fertilizer in China. *Proceedings of the National Academy of Sciences*, **110(21)**: 8375-8380.