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RESEARCH ARTICLE

Response of three maize (*Zea mays* L.) cultivars to foliar application of Al-Nahrain liquid fertilizer

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Abstract

A factorial experiment was conducted during the 2023-2024 growing season in the Abi Gharaq region, Babylon province to evaluate the response of three maize cultivars to foliar spray with liquid fertilizer of Al-Nahrain. The experiment was designed using randomized complete block design (RCBD) in a factorial arrangement at three replications. The study contained two factors: the first factor included three concentrations of Al-Nahrain liquid fertilizer (0, 3 and 6 mL L^{-1}), represented as T0, T1 and T2. The second factor involved three maize cultivars: IPA 5012, Buhooth 106 and Fajr, represented as F1, F2 and F3. The results demonstrated that the cultivar IPA 5012 (F1) outperformed the other cultivars in most of the studied traits, including ear length, rows number per ear, grains number per row and total grains number per ear. On the other hand, the Fajr cultivar (F3) recorded the highest mean for 500 grain weight, reaching 107.33 g. Regarding the fertilizer concentrations, the foliar application of 6 mL L^{-1} (T2) excelled in all the studied traits, including ear length, rows number per ear, grains number per row, total number of grains per ear and 500 grain weight. The combination F3×T2 achieved the highest averages for ear length (20.69 cm) and 500-grain weight (112.10 g). F1×T2 combination recorded the maximum averages for the grains number per row (40.04 grains row^{-1}) and total grains number per ear (471.10 grains ear^{-1}). F2×T2 combination resulted in the maximum value for the rows number per ear, reaching 16.8 rows ear^{1}.

Keywords: agronomic traits; Al-Nahrain liquid fertilizer; cultivar performance; *Zea mays*

Introduction

Maize (*Zea mays* L.) is among the most important cereal crops globally due to its high yield potential, ease of cultivation, versatility and lower production costs compared to other grains. Its multiple uses allow it to adapt across a wide range of environments (1, 2). Maize ranks second globally in terms of cultivated areas, following wheat and first in productivity. In Iraq, the cultivated area in 2019 totaled 128.8 thousand hectares, with a 473.1 thousand tons of production, averaging 3.673 tons per hectare food, feed, biofuel (3, 4). Enhancing crop production is critical and can be achieved either by expanding the cultivated area or by increasing productivity, which depends on several factors. Genetic factors require the development of superior genetic combinations with a broader genetic base than single hybrids. A broader genetic base enhances crop resilience, improves adaptability to environmental stresses and increases potential for yield improvement through breeding. offering better environmental adaptability. This is considered one of the most successful approaches for boosting maize productivity. Environmental factors, particularly optimal planting time, play a key role by providing suitable temperatures for germination, emergence, flowering and seed production, soil fertility and rainfall played an important role. Genetic diversity and physiological performance, such as root system expansion and root hair density for nutrient uptake, as well as canopy architecture for maximizing light interception and photosynthesis, also influence grain yield (5, 6). Substantial improvements in maize yield have been documented with the application of different NPK levels under diverse environmental conditions. Similarly, previous research indicated yield gains of 31 %, 36 % and 25 % over control when iron and zinc were applied at concentrations of 0 %, 0.05 %, 0.1 % and 1.5 % (7, 8). These nutrients were applied via foliar spray, soaking, or dusting, with foliar spray showing superior results over other methods. The study aims to evaluate the response of three maize cultivars to foliar spray with liquid fertilizer of Al-Nahrain.

Materials and Methods

Soil properties

A summary of the field soil properties is shown in Table 1.

A factorial experiment was conducted during the 2023–2024 growing season in the Abi Gharaq, Babylon province. The study aimed to assess the response of maize to foliar spray with liquid fertilizer of Al-Nahrain (Table 2) and three cultivars.

The cultivars were obtained from the General Authority for Agricultural Research. The experiment was arranged in a RCBD with a factorial arrangement and three replications. Two factors were studied:

Table 1. Analysis of some physical and chemical properties of the field soil

Trait	Value
Soil pH	7. 4
Electrical conductivity (dS m^{-1})	3.8
Organic N (g kg^{-1})	1.03
CaCO3 (g kg^{-1})	294.0
Available P (mg kg^{-1})	6.4
Available K (mg kg^{-1})	175.0
Organic matter (g kg^{-1})	10.4
Soil separates (g kg^{-1})	
Sand	183
Clay	334
Silt	473

Table 2. Composition of Al-Nahrain liquid fertilizer

Nutrient	Concentration (%)
Nitrogen (N)	10 %
Phosphorus (P_2O_5)	8 %
Potassium (K_2O)	6 %

1. Foliar fertilizer concentrations, of Al-Nahrain liquid fertilizer at 0-, 3- and 6- mL L^{-1}, denoted as T0, T1 and T2.

2. Maize cultivars, namely IPA 5012, Buhooth 106 and Fajr, represented as F1, F2 and F3. The selected cultivars were chosen based on their agronomic importance, adaptability to local environmental conditions and previous performance in regional field trials.

The field was plowed twice using a moldboard plow, followed by soil refinement with a leveling machine. The experimental unit measured 3×3 m, consisting of six rows, 75 cm apart and 25 cm between hills. Triple superphosphate (46 % P_2O_5) was applied at 180 kg ha^{-1} along with half the nitrogen fertilizer at 120 kg N ha^{-1} as urea (46 % N) before planting, with the remaining nitrogen applied when the plants reached a height of 35 cm. Granular diazinon insecticide (10 % concentration) was applied twice for preventive control of corn stem borers, with the first application after 20 days of sowing whereas the second a month later. Additionally, NPK compound fertilizer was incorporated at 140 kg ha^{-1}, 180 kg P_2O_5 and 60 kg K_2O per hectare under optimal irrigation conditions during soil preparation and irrigation was provided as required by the plants. The control treatment (T0) received only the recommended basal soil fertilization without any foliar application. This was done to isolate and evaluate the specific effects of the foliar fertilizer treatments on the measured parameters. Ten plants were selected from the central rows of each treatment to measure key traits, including the number of rows per ear, number of grains per row, total grains per ear, ear length (cm) and the weight of five hundred grains (g). Data were statistically analyzed and averages were compared utilizing the least significant difference (LSD) test at a probability level of 0.05 (9). The statistical analysis was performed using GenSTAT software.

Results and Discussion

Ear length (cm)

Table 3 highlights a significant effect on ear length among the studied cultivars and fertilizer treatments. Cultivar F1 (IPA 5012) achieved the highest average ear length of 21.31 cm, surpassing other cultivars, while F3 (Fajr) recorded the lowest average at 19.73 cm. This superiority may be attributed to genetic traits such as improved vegetative growth and plant height (8). Fertilizer concentration T2 (6 mL L^{-1}) yielded the longest ears, with an average of 20.72 cm, compared to the control treatment T0 (0 mL L^{-1}), which recorded 19.95 cm. This could be attributed to the role of nutrients in fertilizer, particularly Zn, in synthesis of the tryptophan amino acid, chlorophyll and proteins. The higher ear length reported for F1 refers to the main effects, while the interaction effects between cultivars and treatments showed variations in specific combinations. This clarifies the apparent contradiction. Zinc also activates several enzymes, contributes to the formation of energy compounds and RNA and enhances the plant's ability to absorb water and nutrients. These effects collectively lead to improved plant growth indicators. These results are consistent with the findings of (10-13). The interaction of cultivar F3 with T2 resulted in the highest ear length at 20.69 cm, while F3 T0 recorded the lowest at 19.95 cm.

Rows number ear^{-1}

The findings revealed significant differences among cultivars and fertilizer treatments for the rows number (Table 4). Cultivar F1 exhibited the highest average (15.66 rows per ear), while F3 had the lowest (14.10 rows per ear). These differences are likely due to genetic variability among the cultivars; this is supported by studies conducted by (14-17) These studies provide valuable insights into the effects of nutrient management and cultivar differences on maize growth and yield. Their findings support the importance of optimizing fertilizer applications and selecting suitable cultivars, which aligns with the objectives of the present research., which confirmed significant differences between parental lines and their hybrids for several studied traits. Foliar fertilizer concentration T2 significantly increased the number of rows per ear, averaging 15.50, compared to the control (T0), which recorded 13.86. This can be due to the functions of nutrients, particularly zinc, in enhancing the fashioning of primary floral structures in the main ear of the plant. This leads to an increase in the number of rows for each ear, as the ear bud requires this element during its development and growth. Additionally, the effective role of nutrients, when increased during different growth stages, further raises the rows number. These findings align with those of (18-21) who highlighted the functions of nutrients, including Zn, in increase the number of rows per ear. The findings of the two-way overlap between cultivars and fertilizer concentrations (F, T) indicate a significant influence on this parameter. The T_2 F_2 combination outperformed the other

Table 3. The influence of foliar fertilizer concentrations and cultivars on length of ear (cm)

Cultivars	Concentrations of Al-Nahrain liquid fertilizer (mL L^{-1})			Mean F
	T0	T1	T2	
F1	21.11	21.58	21.24	21.31
F2	19.68	19.96	20.25	19.96
F3	19.07	19.44	20.69	19.73
Mean T	19.95	20.32	20.72	
L. S. D (0.05)		**T= 0.43**	**F= 0.43**	**F*T= 0.83**

Table 4. The influence of foliar fertilizer concentrations and cultivars on rows number ear^{-1}

Cultivars	Concentrations of Al-Nahrain liquid fertilizer (mL L^{-1})			Mean F
	T0	T1	T2	
F1	15.1	15.8	16.1	15.66
F2	13.1	14.1	16.8	14.66
F3	13.4	14.4	14.5	14.10
Mean T	13.86	14.76	15.50	
L. S. D (0.05)		**T= 0.28**	**F= 0.28**	**F*T= 0.46**

combinations, recording the maximum average of 16.8 rows per ear, while the T_0 F_2 combination recorded the lowest average of 13.1 rows per ear.

Grains number row^{-1}

Table 5 shows a significant influence of maize cultivars, foliar fertilization and their two-way overlap. Cultivar F1 recorded the highest average of 38.77 grains row^{-1}, while F3 had the lowest average at 27.00 grains row^{-1}. This difference may be attributed to the direct influence of cultivars on increasing the grains number for each row, that is a crucial factor in enhancing grain production per row and per ear. These findings align with those of (22-24).

Foliar fertilizer levels also significantly influenced grains number for each row, with the T2 level (4 mL L^{-1}) yielding the highest average of 35.95 grains row^{-1}, while the control treatment (T0) recorded the lowest average of 29.91 grains row^{-1}. This increase can be linked to improved plant height and leaf area, which enhance photosynthetic activity and the transport of its products to the ear. Additionally, greater plant height reduces shading of the leaves above the ear, leading to increased pollination and fertilization rates, thereby boosting the number of grains. Furthermore, nitrogen's role in regulating hormonal activity and controlling auxin-mediated apical dominance of the ear also contributes to this improvement (25-28).

The two-way interaction between cultivars and fertilizer levels (F, T) had a significant effect on this parameter. The F1 T2 combination produced the maximum average of 40.04 grains row^{-1}, whereas F3 T0 recorded the minimum average of 23.19 grains row^{-1}.

Grains number ear^{-1}

The findings indicate a significant increase in the average grains number for each ear with the application of liquid foliar fertilizer of Al-Nahrain. Cultivar F1 achieved the highest mean of 468.54 grains ear^{-1}, while F3 recorded the lowest average of 368.34 grains ear^{-1} (Table 6). The superiority of F1 can be attributed to the shorter interval between male and female flowering, which improved pollination and fertilization rates, resulting in an increased number of grains per ear. This finding is supported by many early works who reported significant differences in grain number per ear among maize hybrids, with a negative correlation between the flowering interval and grain number per ear (29-32).

The results also reveal significant differences in this trait due to varying levels of foliar fertilization (Table 7). The T2 level (4 ml L^{-1}) resulted in the maximum mean of 428.23 grains ear^{-1}, whereas the control treatment (T0) produced the minimum mean of 368.34 grains ear^{-1}. This increase can be linked to improved ear length, rows number for each ear and grains number for each row, all of which were influenced by the nutrient content of the foliar fertilizer. These findings align with those of (25, 26) who observed increase in the rates of maize growth with higher nutrient concentrations, along with the role of macronutrients in cell division and expansion.

The two-way interaction (F ×T) had a significant effect on this parameter. The combination T2 F1 recorded the maximum average of 471.10 grains ear^{-1}, while T0 F3 had the lowest average of 359.77 grains ear^{-1}.

Table 5. The influence of foliar fertilizer concentrations and cultivars on grains number row^{-1}

Cultivars	Concentrations of Al-Nahrain liquid fertilizer (mL L^{-1})			Mean F
	T0	T1	T2	
F1	38.28	38.01	40.04	38.77
F2	28.26	29.30	38.08	31.88
F3	23.19	28.08	29.74	27.00
Mean T	23.19	28.08	29.74	
L. S. D (0.05)		**T= 2.28**	**F= 2.28**	**F*T= 4.54**

Table 6. The influence of foliar fertilizer concentrations and cultivars on grains number ear^{-1}

Cultivars	Concentrations of Al-Nahrain liquid fertilizer (mL L^{-1})			Mean F
	T0	T1	T2	
F1	466.10	468.43	471.10	468.54
F2	423.77	427.10	429.43	426.76
F3	359.77	361.10	384.17	368.34
Mean T	23.19	28.08	29.74	
L. S. D (0.05)		T= 5.10	F= 5.10	F*T= 12

Table 7. The influence of foliar fertilizer concentrations and cultivars on weight of five hundred grains (g)

Cultivars	Concentrations of Al-Nahrain liquid fertilizer (mL L)			Mean F
	T0	T1	T2	
F1	83.10	84.43	84.44	83.99
F2	98.42	96.76	95.11	96.76
F3	103.53	106.37	112.10	107.33
Mean T	95.01	95.85	97.21	
L. S. D (0.05)		T= 2.45	F= 2.45	F*T= 4.87

Weight of 500 grains (g)

The results show that weight of 500 grains significantly increased with higher levels of Al-Nahrain liquid foliar fertilizer. Cultivar F3 recorded the highest average of 107.33 g, while F1 had the lowest average at 83.99 g. These results align with those of (27, 28), who reported significant differences among cultivars for this trait.

The levels of foliar fertilizer demonstrated significant differences in 500 grain weight. The T2 level (4 mL L^{-1}) produced the maximum mean of 97.21 g, whereas T0 treatment (control) resulted in the minimum mean of 95.01 g. This increase can be attributed to the role of potassium in transporting photosynthetic products from source tissues to reproductive organs, enhancing grain weight. Potassium also delays leaf senescence by inhibiting the formation of abscisic acid (ABA) in leaves, prolonging the grain -filling period and thereby improving grain weight. Additionally, the micronutrients present in Al-Nahrain fertilizer, such as iron and zinc, contributed to increasing stem diameter, which explains the plant's capability to soak up water and nutrients. This finding is consistent with the results of (33, 34), who highlighted the functions of these elements in enhancing plant growth traits.

The two-way interaction between fertilizer levels and cultivars (T×F) revealed significant differences. The combination T2 F3 recorded the maximum value weight of 112.10 g, whereas T0 F1 recorded the lowest average of 83.10 g (Improved by 34.9 %).

Conclusion

This study highlights the significant influence of foliar application of Al-Nahrain liquid fertilizer and genetic variation among maize cultivars on key agronomic traits. Cultivar F1 (IPA 5012) demonstrated superior performance in traits such as ear length, number of grains per ear and overall grain yield, while F3 (Fajr) excelled in 500 grain weight, showcasing its genetic potential for specific productivity traits. The application of 6 mL L^{-1} of Al-Nahrain liquid fertilizer (T2) consistently outperformed other treatments across all studied parameters, underscoring the pivotal role of micronutrients like zinc, iron and potassium in enhancing photosynthetic efficiency, nutrient translocation and grain filling.

The two-way interactions between fertilizer levels and cultivars further revealed synergies that could be harnessed to maximize yield potential. For instance, the combination of T2×F1 recorded the highest grain count per ear, while T2×F3 produced the heaviest grains, demonstrating the need for tailored agronomic practices to optimize cultivar-specific traits. F1 likely exhibited higher yield due to superior overall plant vigor, better nutrient uptake, or more effective resource use efficiency, while F3 may have produced heavier grains due to genetic traits favoring grain filling or larger kernel size. In conclusion, the integration of targeted foliar fertilization with appropriate cultivar selection can significantly boost maize productivity. These findings provide a practical framework for enhancing maize cultivation under diverse environmental conditions, offering valuable insights into future agricultural strategies aimed at achieving sustainable food security.

Recommendation

Based on the findings of this study, it is recommended to adopt the foliar application of Al-Nahrain liquid fertilizer at a concentration of 6 mL L^{-1} to enhance maize productivity by improving key traits such as ear length, grain count per row and grain weight. Additionally, selecting high-performing cultivars like F1 (Ibaa 5012) for traits related to grain yield and F3 (Fajr) for grain weight can maximize production potential. Future research should explore the combined effects of foliar fertilizers with other agronomic practices, such as optimized planting densities and irrigation schedules, to further refine maize cultivation strategies for diverse environmental conditions.

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Authors' contributions

RKH, RAA and ASAR wrote the article and designed it. All authors read and approved the final manuscript.

Compliance with ethical standards

Conflict of interest: None

Ethical issues: None

References

1. Abd-Allah Ramadan AS, Ghadeer MA, Muhammad AA. Estimation of combining ability and gene action of maize (*Zea mays* L.) lines using line × tester crosses. Biochem Cell Arch. 2020;20(1):1769. https://doi.org/10.35124/bca.2020.20.1.1769

2. Mukhlif FH, Abdullah AS, Hammody DT. Study of combining ability and hybrid vigor in many maize lines (*Zea mays* L.). IOP Conf Ser Earth Environ Sci. 2021;904(1):012017. https://doi.org/10.1088/1755-1315/904/1/012017

3. Mukhlif FH, Ramadan ASA, Hammody DT, Mousa MO, Shahatha SS. Molecular assessment of genetic divergence among maize genotypes. SABRAO J Breed Genet. 2023;55(3):739–48. https://doi.org/10.54910/sabrao2023.55.3.12

4. Directorate of Agricultural Statistics. Production of cotton, maize and potatoes. Central Statistics Organization, Ministry of Planning, Iraq; 2020.

5. Abood NM, Khrbeet HKh, Saleh AKh. Effect of foliar application of nitrogen on grain yield and its component in sorghum. Iraqi J Agric Sci. 2017;48(3):740–8. https://doi.org/10.36103/ijas.v48i3.387

6. Abdulhamed ZA, Abas SA, Noaman AH, Abood NM. Review on the development of drought tolerant maize genotypes in Iraq. IOP Conf Ser Earth Environ Sci. 2021;904:012010. https://doi.org/10.1088/1755-1315/904/1/012001

7. Abdulhamed ZA, Abood NM, Noman AH. Recurrent selection for general and specific combining ability in maize. Iraqi J Agric Sci. 2024;55(Suppl Issue):99–110. https://jcoagri.uobaghdad.edu.iq/index.php/intro/article/view/1889

8. Ahmed SAH. Stages of growth characteristics and yield of cultivars of maize under the influence of planting dates [thesis]. University of Baghdad; 2001.

9. Steel RGD, Torrie JH. Principles and procedures of statistics. McGraw Hill; 1980. p. 485. https://www.scirp.org/reference/referencespapers?referenceid=383208

10. Abdulhamed ZA, Abdulkareem BM, Noaman AH. Efficiency of ISSR markers to detect genetic and molecular variation between barley genotypes. Int J Agric Stat Sci. 2021;17(Suppl 1):1503–8. https://connectjournals.com/file_full_text/3463401H_1503-1508

11. Alialawi EAA. Genetic behavior of single maize (*Zea mays* L.) hybrids using factorial crossing [thesis]. Department of Field Crops, College of Agriculture, University of Mosul; 2013.

12. Al-Janabi YA, Abood NM, Hamdan MI. Effect of amino acids and planting date on some growth characteristics of three maize varieties. IOP Conf Ser Earth Environ Sci. 2021;904:012064. https://doi.org/10.1088/1755-1315/904/1/012064

13. Abas SA, Abdulhamed ZA, Abood NM. Impact of climate change on growth, yield and cultivar performance of sunflower under the influence of plant density. Iraqi J Agric Sci. 2025;56(Suppl Issue): 99–110. https://doi.org/10.36103/9z5web62

14. Aziz MS, Mohammed AS. Effect of planting dates in spring and fall seasons on maize (*Zea mays* L.) yield. J Agric Rafidain. 2012;40 (Suppl 1):4–15. https://uomosul.edu.iq/en/iraqi-al-rafidain-agricultural-journal

15. Dhaif AM, Falehi MAH, Salman KA. Development and evaluation of some new hybrids of maize. Iraqi Agric J. 1999;4(2)(Suppl Issue):61–74.

16. Abdulhamed ZA, Al-Baurki FR. Morphological and molecular characterization using ISSR PCR markers for half diallel crossing for five genotypes of flax. AIP Conf Proc. 2023;2977:040040. https://doi.org/10.1063/5.0181920

17. Ibrahim MM, Abdulhamed ZA. Efficiency of selection in inducing genetic-molecular variations in sunflower. IOP Conf Ser Earth Environ Sci. 2023;1158:062032. https://doi.org/10.1088/1755-1315/1158/6/062032

18. Hamad HS, Abdulhamed ZA. Estimation of combining ability of growth and yield and its components of maize under salicylic acid concentrations. J Bionature. 2023;8(1). https://doi.org/10.21931/RB/CSS/2023.08.03.67

19. Fahd AA, Abdulrazzaq S, Malih KM. Water requirements for maize in the fall season in central Iraq under full and deficit irrigation. Agric Sci Stud. 2005;32(3).

20. Fadel AA, Abdulhamed ZA, Yousif SA. RAPD technique to determine the genetic divergence of barley genotypes. IOP Conf Ser Earth Environ Sci. 2022;1060:012123. https://doi.org/10.1088/1755-1315/1060/1/012123

21. Hamza MMA, Kazim SH. Effect of foliar feeding with Unigreen fertilizer on some growth traits of maize (*Zea mays* L.). J Technol. 2010;23(2):174–84.

22. Mutlag NA, Fayyad SA, Abdulhamed ZA, Ibraheem MM. Estimation of hybrid vigor, combining ability and gene action using line × tester analysis in maize. Iraqi J Agric Sci. 2018;49(5):740–7. https://doi.org/10.36103/ijas.v49i5.33

23. Abdulhamed ZA, Hwaidi MI, Alqaisi MRM. Determination of maize genotypes performance under water deficit using ISSR molecular index. Plant Sci Today. 2023;10(1):30–7. https://doi.org/10.14719/pst.1728

24. Issa SS. Response of three maize cultivars to zinc addition in Babylon Governorate. J Al-Qadisiyah Agric Sci. 2013;1(3):54–61.

25. Hamad HS, Abdulhamed ZA. Role of salicylic acid in stay-green, growth and yield of two-purpose maize hybrid. Bionatura. 2022;7 (4):33. https://doi.org/10.21931/RB/2022.07.04.33

26. Jaliya MM, Falaki AM, Mahmud M, Sani YA. Effect of sowing date and NPK fertilizer rate on yield components of quality protein maize (*Zea mays* L.). J Agric Biol Sci. 2008;3(2):23–9.

27. Abd MS, Abdulhamed ZA, Ghadir MA. Response of maize hybrids and inbred lines to yield and its components under irrigation interval. IOP Conf Ser Earth Environ Sci. 2021;904:012003. https://doi.org/10.1088/1755-1315/904/1/012003

28. Kandil EEE. Response of some maize hybrids (*Zea mays* L.) to different levels of nitrogen fertilization. J Appl Sci Res. 2013;9 (3):1902–8. https://aensiweb.com/old/jasr/jasr/2013/1902-1908.pdf

29. Abd HS, Abdulhamed ZA, Ghadir MA. Estimation of genetic parameters using full diallel cross in maize under different irrigation intervals. IOP Conf Ser Earth Environ Sci. 2021;904:012054. https://doi.org/10.1088/1755-1315/904/1/012054

30. Abdulhamed ZA, Sarhan IA, Abbas SA. Combining ability, heterosis and gene action using line × tester analysis in corn. Iraqi J Agric Sci. 2017;48(1):294–301. https://doi.org/10.36103/ijas.v48i1.448

31. Abdulhamed ZA, Abas SA, Noaman AH, Abood NM. Genetic performance of inbred and hybrid maize under irrigation interval. IOP Conf Ser Earth Environ Sci. 2021;904:012001. https://doi.org/10.1088/1755-1315/904/1/012001

32. Mohana AA, Suleiman MM, Khedr WS. Effect of humic acid and rates of nitrogen fertilizer on yield and drought resistance. Crop Sci. 2015;44:1737. https://archives.ju.edu.jo/index.php/jjas/article/view/8604

33. Oudah AM, Abdulhamed ZA, Hammadi HJ. Efficiency of the RAPD molecular indicator to determine the genetic polymorphism of flax genotypes. IOP Conf Ser Earth Environ Sci. 2024;1371:052049. https://doi.org/10.1088/1755-1315/1371/5/052049

34. Hamad HS, Abdulhamed ZA, Abood NM. Genotypic and phenotypic variance, correlation and path coefficient analysis in maize. Anbar J Agric Sci. 2024;22(2). https://iasj.rdd.edu.iq/journals/uploads/2025/01/14/af1f19b334fcbf6773e35761b46809ef.pdf

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