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Study of Seed Soaking and Foliar Application of Ascorbic Acid, Citric Acid and Humic Acid on Growth, Yield and Active Components In Maize

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Abstract

Foliar application and seed soaking has been used as a means of supplying supplemental doses of nutrients, plant hormones, stimulants, and organic components. the effects of these applications have included yield increases, and improved drought tolerance, and enhanced crop quality, so A field experiment was carried out during spring seasons in 2019 and 2020 for styding Seed soaking and Foliar Application of Ascorbic acid, Citric acid and Humic acid on Growth, Yield and Active Components IN Maize. Randomized complete block design in split plots arrangement was used with three replicates. Main-plots were for seeds soaking with ascorbic, citric (100 mg l^{-1}) frequently and humic at (1 ml l^{-1}). Sub-plots were for vegetative parts nutrition with same acids above. Results showed a significant superiority of seeds soaking in humic acid for traits of ears number per plant (1.3 and 1.6), rows number per ear (16.6 and 17.5), grains number per row (39.3 and 45.3), grains number per ear (644.3 and 793.5), weight of 300 grains (75.3 and 100.6 g), total grain yield (6.0 and 8.3 ton ha^{-1}) , shelling ratio (79.3 and 85.1%), biological yield (20.7 and 26.8 ton ha^{-1}), harvesting index (30.4 and 31.2%), in both seasons respectively. Effect of vegetative parts nutrition or interaction between studied factors was non-significant on most traits studied. It can be concluded that soaking maize seeds in humic acid improves yield and yield components.

Keywords: Chlorophyll, Crop growth, Dry matter weight, Foliar spraying, Priming.

1.Introduction

Many studies referred that seed priming improved seedling growth in corn different plants , sorghum, and under drought stress in wheat and improved embryos vitality of deteriorated seed which reflected positively on callus induction in wheat. Also improved seedling growth of deteriorated seed in oat [1-10].

Vitamin C [ascorbic acid (AsA)] is an antioxidant molecule and a key substrate for the detoxification ,there levels influence hormonal balance, growth responses, MAPK signaling cascades and antioxidant enzyme activities, while glutathione levels remain unaffected. Consequently, due to its apoplastic localization, AsA constitutes a vital role in stress perception, redox homeostasis and subsequent regulation of oxidative stress and plant physio-biochemical responses under normal as well as different abiotic stresses [11,12].

[13], results pointed to the role of gibberellic acid, salicylic acid, cytokine, and ascorbic acid 30 mg $liter^{-1}$, that treatment with ascorbic acid achieved the highest value of 1000 grains and total grains yield. [14], mentioned thatsoaking wheat seeds with ascorbic acid at different concentrations for 8 hours, the best level was 50 mg $liter^{-1}$ led to an increase the growth , yield and biological yield .

Foliar nutrition is an effective way to better absorption of nutrients, which contributes to increasing growth and yield by allowing absorption and rapid utilization of the nutrients used. Ascorbic acid is one of the basic components necessary in the normal growth of high-end plants because of its many functions in plant tissues, including reducing heat stress and toxicity, stimulating respiration and cell division, increasing the activity of enzymes, and preserving cell components from photo-oxidation, especially chlorophyll [15,16]. Citric acid plays an influential role in formation and production of compounds that contribute to building of cell plant and compounds formation such as fats, proteins and carbohydrates, chlorophyll, phytochromes and cytochromes during growth period [17], Humic acid spraying or soil application is an effective source of carbon that necessary for the activity of microorganisms, which increases root growth, also it has a hormonal effect on cell protoplasm and cell wall, which leads to rapid cell division and growth [18,19]. [20], pointed that citric acid led to improve the maize growth by increased the ear length, ear diameter, rows per ear, grains number per ear, weight of 100 grains and total grain yield of maize. Accordingly, this study aimed to investigate the effect of seeds soaking and vegetative part nutrition with ascorbic, citric and humic acids on yield and its components in maize.

2. Materials and Methods

A field experiment was carried out during two spring seasons at the fields of the College of Agricultural Engineering Sciences, University of Baghdad in 2019 the expirment was repeated at Babylon governorate in 2020 due to the the corona pandemic (COVID-19). Randomize complete block design in split plot arrangement was used with three replicates. Main-plots were for seeds soaking with acids of ascorbic and citric (100 mg l^{-1}) for both of them and humic (1 ml l^{-1}), as well as the control treatment. The seeds were soaked for 18 hours. Sub-plots were for vegetative parts nutrition with the same acids above, in addition to the control treatment. Two nutrition stages for acids were fixed when 6 and 10 real leaves appeared. Maize seeds (cv. Baghdad3) were obtained from the Agricultural Research Department, Ministry of Agriculture. The soil was analyzed before planting by taking samples with a depth of 0-30 cm to study some physical and chemical characteristics (Table 1). Soil and crop service operations were conducted according to the recommendations of (Ministry of Agriculture 2015). DAP fertilizer (46:18) (P: N) was added when preparing the soil by 436 kg h^{-1}. 348 kg h^{-1} urea fertilizer (46% N) was added when planting [21]. The planting was carried out on lines with a distance of 75 cm between one line and another, and 25 cm between hole and another to obtain density of 53333 plant h^{-1}. The experimental unit consisted of four lines 9 m^2 to each experimental unit , and the distance between replications was 1.5 m. The seeds were planted on March 21st. The plants were irrigated as needed (Ministry of Agriculture, 2015). Traits were studied as follow:
Ears number per plant (ear $plant^{-1}$).
Rows number per ear (row ear^{-1}).
Grains number per row (grain row^{-1}).
Grains number per ear (grain ear^{-1}).
Weight of 300 grains (g). Total grains yield (ton ha^{-1}): It was calculated by multiplying yield of one plant x plant density, then adjusting weight to (ton ha^{-1}) (El-Sahookie, 1990).
Shelling ratio (%): It was estimated through following equation [22].

$$\text{Shelling ratio (\%)} = (\text{grain weight} / (\text{grain weight} + \text{ear weight})) \times 100.$$

Biological yield (ton ha^{-1}): Represents sum of dry matter of grain yield + leaves + stems + roots. Harvesting index (%): It was calculated by the following equation: Harvest index = (grain yield / biological yield) × 100.
Data were analyzed using the GenStat program. The variance analysis was performed according to randomize complete block design in split plot arrangement with three replications. Means were compared using the least significant difference test at the probability level of 0.05 (LSD 5%)

Table 1. Some physical and chemical characteristics of the experimental soil in the two spring seasons of 2019 and 2020.

Characteristics	Unit	Spring season 2019	Spring season 2020
Sand	g kg^{-1} soil	592	233
Silt	g kg^{-1} soil	320	342
Clay	g kg^{-1} soil	88	425
Soil texture		silty loam	silty clay loam
pH		7.12	7.46
Available nitrogen	mg kg^{-1} soil	25.11	27.7
Available phosphorus	mg kg^{-1} soil	8.35	11.4
Available potassium	mg kg^{-1} soil	80.71	100.8
Organic material	g kg^{-1} soil	6.3	10.7
EC	dS m^{-1}	3.30	3.20
HCO^{-3}	meq l^{-1}	2.10	2.12
Cl^{-1}	meq l^{-1}	28.22	26.18
SO^{-4}	meq l^{-1}	2.56	2.44
Ca	meq l^{-1}	18.10	20.11
Mg	meq l^{-1}	10.41	12.25
Na	meq l^{-1}	3.89	4.10

3.Results and Discussion

3.1 Ears number per plant (ear plant^{-1})

Table 2 showed that there was a significant effect of seed soaking on the number of ears per plant, while the effect of vegetative parts nutrition and the interaction treatments was not significant during both seasons. Seeds soaking in humic acid outperformed significantly by giving the highest mean of ears number per plant (1.3 and 1.6), which didn't differ significantly with seeds soaking in citric and ascorbic acids during spring of 2019, while seeds soaking in distilled water gave the lowest mean 1.2 ear plant^{-1} during both seasons. This may be attributed to the role of humic acid in increasing the units of carbonate representation and increasing the efficiency of the plant to give the largest number of ears.

Table 2. Ears number per plant (ear plant^{-1}) affected by seeds soaking and vegetative parts nutrition with acids of ascorbic, citric and humic in maize during spring seasons of 2019 and 2020

	Vegetative parts nutrition	Seeds soaking				Mean
		Distilled water	Ascorbic	Citric	Humic	
2019	Distilled water	1.2	1.2	1.3	1.3	1.3
	Ascorbic	1.2	1.3	1.4	1.3	1.3
	Citric	1.2	1.3	1.3	1.3	1.3
	Humic	1.2	1.2	1.3	1.3	1.3
	LSD 5%		NS			NS
	Mean	1.2	1.3	1.3	1.3	
	LSD 5%		0.06			
2020	Distilled water	1.2	1.4	1.5	1.6	1.4
	Ascorbic	1.3	1.6	1.3	1.5	1.4
	Citric	1.2	1.5	1.4	1.7	1.4
	Humic	1.3	1.4	1.5	1.7	1.5
	LSD 5%		NS			NS
	Mean	1.2	1.5	1.5	1.6	
	LSD 5%		0.08			

LSD 5%: least significant difference at the probability level of 0.05; NS: Non-significant at P>0.05

3.2 Rows number per ear (row ear^{-1})

Table 3 showed the significant superiority of seeds soaking in humic acid by giving the highest mean of rows number per ear (16.6 and 17.5), while the control treatment gave the lowest mean (14.5 and 15.0) during both seasons, respectively. The reason may be explained by the fact that seeds soaking in humic acid improves growth, reduces the rate of ovarian abortion, increases fertilization, and thus increases the number of rows per ear. This is consisted with the results of [23,24]. The effect of vegetative parts nutrition or the interaction between two factors wasn't significant during both seasons.

Table 3. Rows number per ear (row ear^{-1}) affected by seeds soaking and vegetative parts nutrition with acids of ascorbic, citric and humic in maize during spring seasons of 2019 and 2020.

	Vegetative parts nutrition	Seeds soaking				Mean
		Distilled water	Ascorbic	Citric	Humic	
Spring of 2019	Distilled water	14.7	15.0	16.6	16.3	15.7
	Ascorbic	14.4	15.3	16.5	16.7	15.7
	Citric	14.5	15.1	16.0	16.6	15.7
	Humic	14.5	15.1	16.2	17.1	15.6
	LSD 5%		NS			NS
	Mean	14.5	15.1	16.4	16.6	
	LSD 5%		0.38			
Spring of 2020	Distilled water	14.7	15.7	16.7	17.5	16.1
	Ascorbic	15.1	16.3	15.7	17.3	16.1
	Citric	14.7	16.3	16.0	17.6	16.2
	Humic	15.3	16.0	16.0	17.6	16.2
	LSD 5%		NS			NS
	Mean	15.0	16.1	16.1	17.5	
	LSD 5%		0.43			

LSD 5%: least significant difference at the probability level of 0.05; NS: Non-significant at P>0.05

3.3 Grains number per row (grain row^{-1})

Table 4 showed that seeds soaking in humic acid giving the highest mean of grains number per row (39.3 and 45.3), while the control treatment gave the lowest mean (32.3 and 39.5) during both seasons, respectively. Humic acid contains major elements and a group of trace elements, vitamins and growth regulators that are used in plant nutrition and improve growth properties, which was reflected in the increase of grains number per row. The effect of vegetative parts nutrition or the interaction between the two factors wasn't significant.

Table 4. Grains number per row (grain row^{-1}) affected by seeds soaking and vegetative parts nutrition with acids of ascorbic, citric and humic in maize during spring seasons of 2019 and 2020.

	Vegetative parts nutrition	Seeds soaking				Mean
		Distilled water	Ascorbic	Citric	Humic	
Spring of 2019	Distilled water	32.0	33.1	37.3	36.6	34.8
	Ascorbic	31.4	34.1	36.8	39.3	35.9
	Citric	31.5	35.6	38.3	40.1	36.4
	Humic	34.2	35.3	37.8	41.1	36.7
	LSD 5%		NS			NS
	Mean	32.3	34.5	37.6	39.3	
	LSD 5%		1.22			
Spring of 2020	Distilled water	38.3	42.1	42.3	44.6	41.8
	Ascorbic	39.4	42.5	43.9	45.4	42.8
	Citric	40.2	42.8	43.5	44.5	42.8
	Humic	40.1	43.5	42.7	46.7	43.3
	LSD 5%		NS			NS
	Mean	39.5	42.7	43.1	45.3	
	LSD 5%		1.25			

LSD 5%: least significant difference at the probability level of 0.05; NS: Non-significant at P>0.05

3.4 Grains number per ear (grain ear^{-1})

Results in table 5 showed that there was a significant effect of seed soaking treatments on the grains number per ear during both seasons, while the effect of vegetative parts nutrition and the interaction between the two factors wasn't significant during both seasons. Soaking the seeds with humic acid was superior significantly and gave the highest mean (644.3 and 793.5) during both seasons, respectively, which didn't differ significantly with citric acid during spring of 2019, while the control treatment gave the lowest mean (469.2 and 591.6) during both seasons, respectively, and the reason may be due to the increase in the rows number per ear and grains number per row (Tables 3, 4), and this is in agreement with the results of [25,26].

Table 5. Grains number per ear (grain ear^{-1}) affected by seeds soaking and vegetative parts nutrition with acids of ascorbic, citric and humic in maize during spring seasons of 2019 and 2020.

	Vegetative parts nutrition	Seeds soaking				Mean
		Distilled water	Ascorbic	Citric	Humic	
Spring of 2019	Distilled water	471.6	496.0	620.5	595.4	545.9
	Ascorbic	454.4	515.9	596.3	641.6	562.2
	Citric	457.6	539.1	657.2	658.1	573.9
	Humic	493.0	539.5	624.9	682.2	578.9
	LSD 5%		NS			NS
	Mean	469.2	522.6	624.7	644.3	
	LSD 5%		25.9			
Spring of 2020	Distilled water	576.5	686.3	666.6	772.9	675.6
	Ascorbic	591.0	674.8	727.3	776.6	692.4
	Citric	582.1	693.5	704.5	801.0	695.3
	Humic	617.0	696.3	686.0	823.3	705.7
	LSD 5%		NS			NS
	Mean	591.6	687.7	696.1	793.5	
	LSD 5%		26.1			

LSD 5%: least significant difference at the probability level of 0.05; NS: Non-significant at P>0.05

3.5 Weight of 300 grains (g)

It can be noted from the results of Table 6 that weight of 300 grains was affected significantly by soaking the seeds during both seasons and by the interaction between seeds soaking and vegetative parts nutritions during spring of 2019, only, while the effect of vegetative parts nutrition during both seasons and the interaction between two factors during spring 2020, only, weren't significant. Soaking the seeds in humic acid was superior significantly by giving the highest mean of weight of 300 grains (75.3 and 100.6 g), which didn't differ significantly with soaking the seeds in citric acid during spring 2019, while the control treatment gave the lowest mean (67.7 and 85.8 g) during both seasons, respectively. The reason for the superiority of the treatment of seeds soaking in humic acid may be attributed to the role of humic acid in increasing the rate of crop growth, and the increase in the accumulation of dry matter in the plant, which is transferred to the grains later by increasing the net photosynthesis stored in the stem and leaves [27-29].

Table 6. Weight of 300 grains (g) affected by seeds soaking and vegetative parts nutrition with acids of ascorbic, citric and humic in maize during spring seasons of 2019 and 2020.

	Vegetative parts nutrition	Seeds soaking				Mean
		Distilled water	Ascorbic	Citric	Humic	
Spring of 2019	Distilled water	64.7	66.7	76.7	74.0	70.5
	Ascorbic	64.7	69.3	74.7	75.3	71.0
	Citric	71.3	68.0	73.3	76.0	72.2
	Humic	70.0	72.0	73.3	76.0	72.8
	LSD 5%		3.08			NS
	Mean	67.7	69.0	74.5	75.3	
	LSD 5%		1.85			
Spring of 2020	Distilled water	84.7	88.7	94.7	96.7	91.2
	Ascorbic	86.0	96.0	93.3	95.0	92.6
	Citric	81.3	92.7	93.3	106.0	93.3
	Humic	91.3	89.0	92.0	104.7	94.3
	LSD 5%		NS			NS
	Mean	85.8	91.6	93.3	100.6	
	LSD 5%		2.07			

LSD 5%: least significant difference at the probability level of 0.05; NS: Non-significant at P>0.05

3.6 Total grains yield (ton ha^{-1})

The results in Table 7 showed that there was a significant effect of seeds soaking on the total grain yield, while the effect of the vegetative parts nutrition and the interaction between the two factors weren't significant during both seasons. Soaking seeds in humic acid outperformed significantly by giving the highest mean of total grain yield (6.0 and 8.3 ton ha^{-1}) during both seasons, respectively, which didn't differ significantly with seeds soaking in citric acid during spring 2019, only, while the control treatment gave the lowest mean (4.7 and 6.2 ton ha^{-1}) during both seasons, respectively. This can be explained by the role of humic acid in increasing the yield components (ears number per plant, rows number per ear, grains number per row, grains number per ear, and weight of 300 grains (Tables 2, 3, 4, 5 and 6), which was reflected in the increase in the total grain yield [30,31].

3.7 Shelling ratio (%)

The results in Table 8 showed that there was a significant effect of seeds soaking on the shelling ratio, while the effect of vegetative parts nutrition and the interaction between the two factors weren't significant during both seasons. Seeds soaking in humic acid outperformed significantly by giving the highest shelling ratio (79.3 and 85.1%), while the control treatment gave the lowest ratio (73.0 and 77.9%) during both seasons, respectively. This is attributed to the increase in the number of grains per ear (Table 5), which in turn led to an increase in the percentage of shelling.

Table 7. Total grains yield (ton ha^{-1}) affected by seeds soaking and vegetative parts nutrition with acids of ascorbic, citric and humic in maize during spring seasons of 2019 and 2020.

	Vegetative parts nutrition	Seeds soaking Distilled water	Ascorbic	Citric	Humic	Mean
Spring of 2019	Distilled water	4.7	4.9	5.7	5.6	5.2
	Ascorbic	4.8	5.1	5.5	6.3	5.4
	Citric	4.6	5.4	6.4	6.1	5.6
	Humic	4.8	5.7	5.8	6.1	5.6
	LSD 5%	NS				NS
	Mean	4.7	5.3	5.8	6.0	
	LSD 5%	0.3				
Spring of 2020	Distilled water	6.2	6.6	7.0	8.0	6.9
	Ascorbic	6.1	6.8	7.0	8.0	7.0
	Citric	6.3	7.0	8.0	8.6	7.5
	Humic	6.2	7.4	7.8	8.7	7.5
	LSD 5%	NS				NS
	Mean	6.2	7.0	7.4	8.3	
	LSD 5%	0.26				

LSD 5%: least significant difference at the probability level of 0.05; NS: Non-significant at P>0.05.

Table 8. Shelling ratio (%) affected by seeds soaking and vegetative parts nutrition with acids of ascorbic, citric and humic in maize during spring seasons of 2019 and 2020.

	Vegetative parts nutrition	Seeds soaking				Mean
		Distilled water	Ascorbic	Citric	Humic	
Spring of 2019	Distilled water	71.6	73.7	77.7	78.8	75.5
	Ascorbic	74.0	75.2	76.5	77.7	75.8
	Citric	73.0	73.8	78.2	80.9	76.5
	Humic	73.5	76.0	77.7	79.7	76.7
	LSD 5%		NS			NS
	Mean	73.0	74.7	77.6	79.3	
	LSD 5%		1.06			
Spring of 2020	Distilled water	77.4	79.8	81.6	84.1	80.7
	Ascorbic	77.7	80.2	82.0	85.2	81.3
	Citric	77.7	81.7	81.2	85.4	81.5
	Humic	78.8	81.2	82.9	85.6	82.1
	LSD 5%		NS			NS
	Mean	77.9	80.7	81.9	85.1	
	LSD 5%		0.8			

LSD 5%: least significant difference at the probability level of 0.05; NS: Non-significant at P>0.05

3.8 Biological yield (ton ha^{-1})

The results in the table 9 showed that there was a significant effect of seeds soaking during both seasons, and a significant effect of the vegetative parts nutrition and the interaction between the two factors during spring 2020, only, while the effect of the vegetative parts nutrition and the interaction between the two factors weren't significant during spring 2019, only. Seeds soaking in humic acid was superior significantly and gave the highest mean of biological yield (20.7 and 26.8 ton ha^{-1}), which didn't differ significantly with seeds soaking in citric acid during spring 2019, while the control treatment gave the lowest mean of biological yield (16.7 and 22.3 ton ha^{-1}) during both seasons, respectively. The vegetative parts nutrition in humic acid outperformed significantly in comparison to the citric and ascorbic acids by giving the highest mean of biological yield (25.2 ton ha^{-1}), but it didn't differ significantly with the treatment of spraying with distilled water during spring 2020. Also, the results indicated that the interaction between the two treatments of seeds soaking and the vegetative parts nutrition in humic acid was superior significantly by giving the highest mean of biological yield (28.8 ton ha^{-1}), while the treatment of seeds soaking and the vegetative parts nutrition in ascorbic acid gave the lowest mean of biological yield (21.0 ton ha^{-1}) during spring 2020. Perhaps the effect of using humic acid led to an increase in the average of plant growth, as well as an increase in the total grain yield (Table 8), so there was an increase in the biological yield and this is in agreement with [31].

Table 9. Biological yield (ton ha^{-1}) affected by seeds soaking and vegetative parts nutrition with acids of ascorbic, citric and humic in maize during spring seasons of 2019 and 2020.

	Vegetative parts nutrition	Seeds soaking				Mean
		Distilled water	Ascorbic	Citric	Humic	
Spring of 2019	Distilled water	16.7	18.0	19.7	20.1	18.6
	Ascorbic	16.8	17.9	19.1	20.6	18.6
	Citric	16.8	18.3	19.4	20.1	18.7
	Humic	16.4	18.9	21.5	22.2	19.8
	LSD 5%		NS			NS
	Mean	16.7	18.3	19.9	20.7	
	LSD 5%		0.15			
Spring of 2020	Distilled water	21.0	22.2	23.8	26.4	23.4
	Ascorbic	23.3	23.6	25.0	25.5	24.4
	Citric	21.8	26.0	26.3	26.4	25.1
	Humic	23.0	26.0	23.3	28.8	25.2
	LSD 5%		0.13			0.10
	Mean	22.3	24.4	24.6	26.8	
	LSD 5%		0.06			

LSD 5%: least significant difference at the probability level of 0.05; NS: Non-significant at P>0.05

3.9 Harvesting index (%)

The results in table 10 showed that there was a significant effect of seeds soaking during both seasons and a significant effect of the interaction between two factors during spring 2020, while the effect of the vegetative parts nutrition during both seasons and the interaction effect between the two factors during spring 2019 weren't significant. Seeds soaking in humic acid outperformed significantly by giving the highest mean of harvest index (30.5 and 31.2%), which didn't differ significantly with seeds soaking in citric acid, while the control treatment gave the lowest mean of harvest index (26.8 and 27.8%) during both seasons, respectively. Also, the results indicated that seeds soaking and the vegetative parts nutrition in humic acid was superior significantly by giving the highest mean of harvest index (34.1%), while the control treatment gave the lowest mean of harvest index (26.6%) during the spring 2020. The superiority of the treatment of seeds soaking in humic acid and gave the highest mean of harvest index is attributed to the superiority of this treatment in the total grain yield and biological yield (tables 8, 9), which reflects the efficiency of humic acid in converting the dry matter from the vegetative system (source) to the sink represented by the grains, and this is consistent with [32].

Table 10. Harvesting index (%) affected by seeds soaking and vegetative parts nutrition with acids of ascorbic, citric and humic in maize during spring seasons of 2019 and 2020.

	Vegetative parts nutrition	Seeds soaking				Mean
		Distilled water	Ascorbic	Citric	Humic	
Spring of 2019	Distilled water	26.7	27.1	27.8	28.2	27.4
	Ascorbic	26.4	27.2	29.5	30.7	28.5
	Citric	27.4	28.2	28.6	31.3	28.9
	Humic	26.7	28.3	32.5	31.6	29.8
	LSD 5%		NS			NS
	Mean	26.8	27.7	29.6	30.4	
	LSD 5%		1.19			
Spring of 2020	Distilled water	26.6	29.2	26.9	27.7	27.6
	Ascorbic	28.8	26.6	30.7	32.5	29.6
	Citric	29.3	27.7	31.4	30.4	29.7
	Humic	26.7	29.8	33.1	34.1	30.9
	LSD 5%		2.78			NS
	Mean	27.8	28.3	30.5	31.2	
	LSD 5%		1.05			

LSD 5%: least significant difference at the probability level of 0.05; NS: Non-significant at P>0.05

Conclusions

The seeds soaking of humic acid has been improved the yield and its components while the vegetative parts nutrition didn't show significant effect , which refers to the necessity of reconsider concentrations that would be used in future studies. It can be recommended to soak seeds of maize in humic acid at a concentration of 1 ml l^{-1} before planting based on our study conditions.

References

[1] Akram NA, Shafiq F and Ashraf M (2017) Ascorbic Acid-A Potential Oxidant Scavenger and Its 10.3389/fpls.2017.00613

[2] Al-bahrani, I.Q.M. 2015. Effect of Phosphate and Humic Acid Dissolving Bacteria on Phosphorous Balance, Nutrient Readiness and Yield of Maize (Zea Role in Plant Development and Abiotic Stress Tolerance. Front. Plant Sci. 8:613. doi: mays L.). PhD. Thesis. College of Agriculture. University of Baghdad.

[3] AL-Baldawi, M.H.K. and J.H. Hamza. 2017. Seed priming effect on field emergence and grain yield in sorghum. Journal of Central European Agriculture. 18(2): 404-423. DOI: 10.5513/JCEA01/18.2.1915

[4] Ali, M.K.M. and J.H. Hamza. 2014. Effect of GA3 on germination characteristics and seedling growth under salt stress in maize. Iraqi Journal of Agricultural Sciences. 45(1): 6-17.

[5] Al-Juthery,H.W.A.,Ali,E..H.A.M.,Al-Ubori,R.N.,Al-Shami,Q.N.M.andAL-Taey,D.K.A (2020) role of foliar application of nano npk, micro fertilizers and yeast extract on growth and yield of wheat. Int. J. Agricult. Stat. Sci. Vol. 16, Supplement 1, : 1295-1300. DocID: https://connectjournals.com/03899.2020.16.1295

[6] Al-Selawy, R.L. 2011. Growth and Yield Response of some Rice Varieties for Seed Stimulation. PhD. Thesis, Department of Field Crops, College of Agriculture, University of Baghdad. pp: 106.

[7] AlTaey, D. K. A. (2017). Alleviation of Salinity Effects by Poultry Manure and Gibberellin Application on growth and Peroxidase activity in pepper. International Journal of Environment, Agriculture and Biotechnology ;2(4) 1851-1862 http://dx.doi.org/10.22161/ijeab/2.4.49

[8] Al-Taey, D.K.A. and Saadoon, A.H. (2012). Effect of treatment of kinetin to reduce the salinity damage by drainage water irrigation on the growth and nitrate accumulation in the leaves of spinach, Spenacia oleracea L. Euphrates Journal of Agriculture Science. 4(4):11–24

[9] Al-Taey,D.K.A.,M.J.H. Al-Shareefi , A.K. MijweL, A. RZ. Al-Tawaha, A. RM. Al-Tawaha.(2019). The beneficial effects of bio-fertilizers combinations and humic acid on growth, yield parameters and nitrogen content of broccoli grown under drip irrigation system. Bulgarian Journal of Agricultural Science, 25 (5), 959–966.

[10] Efthimiadou, A., D. Bilalis, A. Karkanis, B. Froud-Williams, and I. Eleftherochorinos. 2009. Effects of cultural system (organic and conventional) on growth, photosynthesis and yield components of sweet corn (Zea mays L.) under semi-arid environment. Not. Bot. Hort. Agrobot. Clu. 37(2): 104-111.

[11] El-Sahookie, M.M. 1990. Maize Production and Improvement. Ministry of Higher Education and Scientific Research, University of Baghdad, Higher Education and Scientific Research Press, Baghdad.

[12] Feyhan, N.A., N.K.A. Mohammed, H.A. Ahmed, M.A. Majeed, A.S. AL-Rawi, J.H. Hamza. 2019. Effect of deteriorated seed soaking with different concentrations of gibberellin (GA3) on germination and seedling growth of two oat (Avena sativa L.) cultivars. Tikrit Journal for Agricultural Sciences. 19(1): 111-117.

[13] Ghassemi-Golezani, K. and B. Dalil. 2014. Effects of seed vigor on growth and grain yield of maize. Plant Breeding and Seed Science. 70: 81-90.

[14] Hamza, J.H. 2012. Seed priming of bread wheat to improve germination under drought stress. Iraqi Journal of Agricultural Sciences. 43(2): 100-107.

[15] Hamza, J.H. and M.K.M. Ali. 2017. Effect of seed soaking with ga3 on emergence and seedling growth of corn under salt stress. Iraqi Journal of Agricultural Sciences. 48(3): 650-659.

[16] Hamza, J.H., I.A. Hamza, N.R. Mohammad and L.E. Abdul-Jabaar. 2013. Stimulation of deteriorated seeds of bread wheat and test their ability to induce callus in vitro. Iraqi Journal of Agricultural Sciences. 44(1): 58-68.

[17] Jalil, A. A. 2011. Response of two compositions of maize to different treatments of plant and animal wastes. MSc. Thesis. Technical College, Al-Musayyib, Technical Education Authority, Iraq. Pp: 4-79.

[18] Mohammed, M.A., Salman, S.R., (2017), Structural and surface roughness effects on sensing properties of ZnO doping with Al thin films deposited by spray pyrolysis technique, Journal of Engineering and Applied Sciences, 12 (Specialissue6), pp. 7912-7918.

[19] Manea, A.I., AL-Bayati, H.J. and AL-Taey, D.K.A . 2019. Impact of yeast extract, zinc sulphate and organic fertilizers spraying on potato growth and yield. Res. on Crops 20 (1) : 95-100. DOI : 10.31830/2348-7542.2019.013

[20] Ministry of Agriculture. 2015. Maize: Its Uses, Cultivation, Production. Guidance. Maize and Sorghum Research Department. Agricultural Researches Directory. pp: 29.

[21] Muhanna, A.A., M.M. Salman and W.S. Khader. 2015. Effect of humic acid and nitrogen fertilization on some characteristics of the Zea mays L. and its productivity. Jordanian Journal of Agricultural Sciences. 11(1): 229-242.

[22] Mustafa, A.S., N.F. Shajai, F.F. Saleh and J.H. Hamza. 2020. Effect of soaking with bread yeast extract on sorghum seed germination under salt stress conditions. Plant Archives. 20 (1): 3111-3116.

[23] Najm, R. R. 2016. Effect of seed stimulation on germination and emergence of seedlings, growth and yield of sorghum kernels. MSc. Thesis. University of Baghdad, College of Agriculture, Department of Field Crops.

[24] Mohammed, M.A., Abdulridha, W.M., Abd, A.N., (2018), Thickness effect on some physical properties of the Ag thin films prepared by thermal evaporation technique, Journal of Global Pharma Technologythis , 10(3), pp. 613–619.

[25] Palaniswamy, U.R, R.J. McAvoy, B.B. Bible, J.D. Stuart. 2003. Ontogenic variations of ascorbic acid and phenethyl isothiocyanate concentrations in watercress (Nasturtium officinale R.Br.) leaves. J. Agric Food Chem. 51(18):5504-5509.

[26] Seif El-Yazal, M. 2019. The application of citric acid in combination with some micronutrients increases the growth, productivity and a few chemical constituents of maize (Zea mays L.) plants. International Letters of Natural Sciences. 76: 86-97.

[27] Shah, T., S. Latif, H. Khan, F. Munsif and L. Nie. 2019. Ascorbic acid priming enhances seed germination and seedling growth of winter wheat under low temperature due to late sowing in Pakistan. Agronomy. 9(11):757.

[28] Shahryari, R., M. Khayatnezhad and N. Bahari. 2011. Effect of two humic fertilizers on germination and seedling growth of maize genotypes. Adv. Environ. Biol. 5(1): 114-118.

[29] Sharifi, R.S. and T. Hizaden. 2009. Response of maize (Zea mays L.) cultivars of different levels of nitrogen fertilizer. Journal of food Agricultural Environment. 7(3-4): 518-521.

[30] Shihab, M. O. and J.H. Hamza. 2020. Germination and seedling growth in primed sorghum seed with gibberellic and salicylic acids. Plant Archives. 2(1): 1409-1416.

[31] Steel, R.G.D. and J.H. Torrie. 1980. Principles and Procedures of Statistics. A Biometrical Approach, 2nd Edition, McGraw-Hill Book Company, New York.

[32] Verma, S.K. and M. Verma. 2008. A Text Book of Plant Physiology, Biochemistry and Biotechnology 10th Edition, D.S. Chand and Company LLTD. Ram Nagar, New Delhi, India.