EFFECT OF MAIZE SEEDS SOAKING WITH ACIDS OF ASCORBIC, CITRIC AND HUMIC ON FIELD EMERGENCE

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ABSTRACT

A field experiment was conducted during two spring seasons in 2019 and 2020 to achieve rapid, uniform, and high ratio of field emergence of maize seeds (cv. Baghdad3). Randomize complete block design was used with three replications. Seeds were soaked in acids of ascorbic and citric (100 mg l^{-1}) and humic (1 ml l^{-1}) for 18 hours, as well as control treatment (seeds soaking in distilled water only). The results showed the significant superiority of soaking treatment in humic acid, which gave averages of field emergence properties in both seasons as follows: last day of field emergence (12.6 and 12.9 days), difference between first and last day of field emergence (4.8 and 4.9 days), ratio of field emergence at first count (49.5 and 55.5%), ratio of field emergence at final count (93.2 and 93.2%), daily average of field emergence (7.8 and 7.8 days), average of field emergence time (9.0 and 8.8 days) and index of field emergence average (10.5 and 10.7 days). It can be concluded that seeds soaking in humic acid improved properties of emergence and seedlings; therefore it can be recommended to soak maize seeds in humic acid (1 ml l^{-1}) for 18 hours when planting in the spring season.

Key words: priming, first count, final count, time rate, rate index
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مجلة العلوم الزراعية العراقية -2021: 52 (4):971-976 كاظم وحمزة

تاثير نقع بذور الذرة الصفراء بحوامض الاسكوربيك والستريك والهيوميك في البزوغ الحقلي

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المستخلص

نفذت تجربة حقلية في العروتين الربيعيتين في العامين 2019 و 2020 بهدف الحصول على بزوغ حقلي سريع وموحد وبنسبة عالية لبذور الذرة الصفراء (صنف بغداد3). أستعمل تصميم القطاعات الكاملة المعشاة RCBD وبثلاث مكررات. تم نقع البذور لمدة 18 ساعة بحوامض الأسكوربيك والستريك (100 ملغم لتر$^{-1}$) لكل منهما والهيوميك (1 مل لتر$^{-1}$)، فضلاً عن معاملة المقارنة (نقع البذور بالماء المقطر فقط). أوضحت النتائج التفوق المعنوي لمعاملة النقع بحامض الهيوميك، إذ بلغت المتوسطات لخصائص البزوغ الحقلي في كلا العروتين بالتتابع كما يأتي: أخر يوم للبزوغ الحقلي (12.6 و 12.9 يوم) والفرق بين أول واخر يوم للبزوغ الحقلي (4.8 و 4.9 يوم) ونسبة البزوغ الحقلي في العد الاول (49.5 و55.5%) ونسبة البزوغ الحقلي في العد النهائي (93.2 و 93.2%) ومعدل البزوغ الحقلي اليومي (7.8 و 7.8 يوم) ومتوسط زمن البزوغ الحقلي (9.0 و 8.8 يوم) ودليل معدل البزوغ الحقلي (10.5 و 10.7 يوم). نستنتج من ذلك ان نقع البذور بحامض الهيوميك حسن خصائص البزوغ والبادرات، لذلك نوصي بنقع بذور الذرة الصفراء بحامض الهيوميك بتركيز (1 مل لتر$^{-1}$) ولمدة 18 ساعة عند زراعتها في العروة الربيعية.

كلمات مفتاحية: تنشيط، العد الأول، العد النهائي، متوسط زمن، دليل معدل
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INTRODUCTION

The aim of using seeds stimulation is to achieve an increase in the percentage of emergence, reduce the average germination time and improve seedling growth under a wide range of environmental conditions (2, 6 and 20). Technique of seeds priming can be used to improve the viability and seeds vigour under drought stress through the escaping mechanism, which happens by reduce some of the need of seeds from moisture to complete the process of germination, as seeds completed a part of metabolic processes during the pre-activation that preceded seeds planting (8). Seeds stimulation had effectiveness in improving the viability and vigour of deteriorated seeds of wheat, also has improved embryo viability, which was reflected positively in callus induction (10). Ascorbic acid is one of the basic components necessary in the growth of plants, due to its many functions in plant tissues, including reducing heat stress and toxicity, stimulating respiration and cell division, increasing the activity of a number of enzymes and preserving cell components from photo-oxidation, especially chlorophyll (16). Citric acid plays an active and influential role in the formation and production of compounds that contribute to the building of the plant cell and the formation of its compounds, such as the various fats, proteins and carbohydrates that the plant makes during its growth period, as well as chlorophyll, growth pigments, phytochromes and cytochromes (23). Humic acid is an effective source of carbon necessary for the activity of micro-organisms, and seeds soaking with acid or spraying it on plants or adding it to the soil increases the growth of the root system, and it has a hormonal effect on the cell protoplasm and the cell wall, which leads to the speed of cell division and growth (1). Seeds quality must be linked to field emergence, taking into consideration that field emergence is determined by the seed's genetic characteristics and environmental factors (11). Hamza (7) concluded that seeds sowing in areas with low temperatures during the germination stage should investigate the potential performance and ability of seeds under field conditions. Scientific studies focus on the possibility of improving seed and seedling vigour to germinate and grow under biotic and abiotic stresses by soaking the seeds in various nutrient solutions (9). Low soil temperature as well as low water stress in planting of maize in the spring season are obstacles that cause low germination in the spring time (14). This study was aimed to obtain a rapid and uniform field emergence of maize sees with a high percentage in spring season.

MATERIAIS AND METHODS

A field experiment was carried out in the two spring seasons in the field of experiments of the College of Agricultural Engineering Sciences, University of Baghdad for the year 2019 and in Babylon governorate for the year 2020. It was not possible to repeat the implementation of the experiment in the same first site due to the curfew imposed by the Corona pandemic (COVID-19). Randomize complete block design was used with three replications. The concentrations used for the acids were ascorbic and citric (100 mg l^{-1}) for both of them and humic (1 ml l^{-1}). The seeds were soaked for 18 hours, as well as the control treatment (soaking the seeds with distilled water only). 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 the Ministry of Agriculture (15). 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. The soil was plowed and smoothed, and to obtain the necessary plant density of 53333 plant h^{-1}, 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. The experimental unit consisted of four lines, 3 m long, with a total area of 9 m^2, and the distance between replications was 1.5 m. The seeds were planted in March 21st. The plants were irrigated as needed (15).

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

The following characteristics were studied:

1. Last day of field emergence (day): The day on which the last state of field emergence occurred (21 days after planting), and the lowest values indicate the fastest end of field emergence (12).
2. Time taken for field emergence (day): It is the time between the first and last state of field emergence of a quantity of seeds, and that the highest values indicate the highest difference in the speed of field emergence between the fast and slow emergence of the quantity of seeds (12).
3. Percentage of field emergence at the first and final counts (%): It was calculated from the number of seeds planted in the two middle lines from each experimental unit and for each treatment and according to the number of seedlings emerging on the soil surface. Then the results were converted into a percentage. First count was calculated after 8 days and the final count was 12 days after planting.

$$\textbf{Field emergence } (\%) = \frac{\textbf{number of emerged seedlings}}{\textbf{total number of planted seeds}} \times \mathbf{100}$$

4. Daily emergence rate (% day^{-1}): Number of emerged seedlings after 12 days divided the number of days.
5. Average of field emergence time (day): The lowest value indicates the seeds that have the highest field emergence speed (after 12 days of planting), and was calculated from Equation No. 1 (12).
6. Index of field emergence rate (% day^{-1}): It reflects the percentage of emerged seedling (%) for each day of the period of field emergence. The highest value indicates higher and faster field emergence (12 days after planting), and was calculated from Equation No. 2 (12).

$$\textbf{Average of field emergence time (day)} = \frac{\sum(\boldsymbol{NiTi})}{\sum \boldsymbol{Ni}} - - - (\mathbf{1})$$

$$\text{Index of field emergence rate } (\%\ day^{-1}) = \sum\left(\frac{Ni}{i}\right) - - - (2)$$

Since: N is the percentage of emerged seedlings (%) at day i, and Ti is the day's sequence from planting.

Data were analyzed statistically using the GenStat program. The variance analysis was performed according to the randomize complete block design with three replications. Averages were compared using the least significant difference test at a probability level of 0.05 (L.S.D 5%)(21).

RESUITS AND DISCUSSION

Last day of field emergence (day)

Table 2 showed a significant superiority of treatment of soaking with humic acid for two seasons by giving lowest average of last day of field emergence (12.6 and 12.9 days), respectively, while control treatment gave the highest last day of field emergence (13.8 and 14.0 days), respectively. Humic acid had a positive effect on germination through its effect on physiological processes of seeds of cereal crops such as sorghum, and this is in agreement with Baldotto et al. (3) and Vendruscolo et al. (22). Humic acid carried essential nutrients and water to the seeds, and stimulated germination (13 and 17).

Table 2. Effect of seeds soaking in acids of ascorbic, citric and humic on last day of field emergence (day) in maize.

Seeds soaking treatments	Spring season 2019	Spring season 2020
Distilled water	13.8	14.0
Ascorbic acid	13.6	13.7
Citric acid	13.2	13.4
Humic acid	12.6	12.9
L.S.D 5%	0.3	0.2

Time taken for field emergence (day)

Table 3 showed significant superiority of soaking treatment in humic acid for both seasons by giving lowest average of the difference between the last day and the first day of field emergence (4.8 and 4.9 days), respectively, while the control treatment gave the highest time taken for field emergence (5.8 and 6.0 days), respectively. Humic acid caused an increase in the permeability of the cell membrane, which is important for the transfer and availability of micronutrients, and the absorption of nutrients stimulates the seeds germination and then their viability by increasing the absorption of oxygen and this causes an increase in the ability of the plant to grow and development, as humic caused a significant increase in the percentage of nitrogen in the soil and stored nitrogen in plants (19). Researchers emphasized that humic is one of the most important organic fertilizers that can positively affect plant growth and increases plant absorption of nitrogen, potassium, calcium, magnesium and phosphorous (18).

Percentage of field emergence at first counts (%)

Table 4 showed the significant superiority of the soaking treatment in humic acid for both seasons by giving the highest average first count ratio (49.5 and 55.5%), respectively, while control treatment gave the lowest values (40.5 and 38.0%), respectively. This is due to the fact that humic acid had a positive effect on ion transport inside the plant cell, which improves its permeability, and thus affects the absorption process, and thus enhances the increase in respiration and the speed of enzymatic reactions of the Krebs cycle, which leads to an increase in energy production as ATP, and this is in agreement with Zandonadi et al. (24).

Table 3. Effect of seeds soaking in acids of ascorbic, citric and humic on time taken for field emergence (day) in maize.

Seeds soaking treatments	Spring season 2019	Spring season 2020
Distilled water	5.8	6.0
Ascorbic acid	5.6	5.7
Citric acid	5.2	5.4
Humic acid	4.8	4.9
L.S.D 5%	0.3	0.2

Table 4. Effect of seeds soaking in acids of ascorbic, citric and humic on percentage of field emergence at first counts (%) in maize.

Seeds soaking treatments	Spring season 2019	Spring season 2020
Distilled water	40.5	38.0
Ascorbic acid	42.7	38.7
Citric acid	45.2	47.5
Humic acid	49.5	55.5
L.S.D 5%	5.4	6.8

Percentage of field emergence at final counts (%)

Results in table 5 showed the significant superiority of the treatment of soaking in humic acid for the two spring seasons by giving the highest average of percentage of field emergence in the final count (93.2 and 93.2%), respectively, while control treatment gave the lowest average (78.8 and 80.8%), respectively. The superiority of the emergence ratio at final count is explained by its superiority in emergence ratio at first count (Table 4), which reflects the inherent ability of seeds in these treatments to give a high percentage of active seedlings, and the reason is that humic acid activates H^+ + ATPase in the plasma membrane, which explains the increase in absorption rates and the raising of nutrients to get rid of solutes, increase water capacity, increase capacity of cation exchange, and thus increase ratio of field emergance (4).

Table 5. Effect of seeds soaking in acids of ascorbic, citric and humic on percentage of field emergence at final counts (%) in maize.

Seeds soaking treatments	Spring season 2019	Spring season 2020
Distilled water	78.8	80.8
Ascorbic acid	82.0	81.3
Citric acid	88.0	87.0
Humic acid	93.2	93.2
L.S.D 5%	4.3	2.1

Daily emergence rate (% day^{-1})

Table 6 showed the significant superiority of the treatment of soaking in humic acid for the two spring seasons by giving the highest average of daily emergence rate (7.8 and 7.8 % day^{-1}), respectively, while control treatment gave the lowest average (6.6 and 6.7 % day^{-1}), respectively. The reason for this is that stimulated seeds in humic acid had a beneficial effect on seed germination and can enhance plant growth through early root development (5).

Table 6. Effect of seeds soaking in acids of ascorbic, citric and humic on daily emergence rate (% day^{-1}) in maize.

Seeds soaking treatments	Spring season 2019	Spring season 2020
Distilled water	6.6	6.7
Ascorbic acid	6.8	6.8
Citric acid	7.3	7.3
Humic acid	7.8	7.8
L.S.D 5%	0.3	0.1

Average of field emergence time (day)

Table 7 showed a significant superiority of treatment of soaking in humic acid for both spring seasons by giving the lowest average of field emergence time (9.0 and 8.8 days), respectively, while control treatment gave the highest average (9.1 and 9.3 days), respectively. The superiority of seeds priming treatment in humic acid at reducing an average of field emergence time is attributed to its superiority in field emergence ratio at first and final counts (Table 4 and 5).

Table 7. Effect of seeds soaking in acids of ascorbic, citric and humic at average of field emergence time (day) in maize.

Seeds soaking treatments	Spring season 2019	Spring season 2020
Distilled water	9.1	9.3
Ascorbic acid	9.0	9.1
Citric acid	9.1	9.1
Humic acid	9.0	8.8
L.S.D 5%	0.1	0.2

Index of field emergence rate (% day^{-1})

Table 8 showed a significant superiority of the treatment of soaking in humic acid for both spring seasons by giving the highest average of index of field emergence rate (10.5 and 10.7 % day^{-1}), respectively, while control treatment gave the lowest average (8.8 and 8.9 % day^{-1}), respectively. This may be due to the fact that humic acid with a low molecular weight is absorbed quickly by the seeds, which increased the absorption of important nutrients such as nitrogen and phosphorous (5, 18), and this led to an increase in ratio of field emergence (Table 4, 5), and then index of field emergence rate.

Table 8. Effect of seeds soaking in acids of ascorbic, citric and humic on index of field emergence rate (% day^{-1}) in maize.

Seeds soaking treatments	Spring season 2019	Spring season 2020
Distilled water	8.8	8.9
Ascorbic acid	9.3	9.1
Citric acid	9.9	9.8
Humic acid	10.5	10.7
L.S.D 5%	0.5	0.3

CONCLUSIONS

It can be concluded that soaking maize seeds in humic acid led to improve the characteristics of field emergence and seedling behavior, so we recommend soaking maize seeds in humic acid at a concentration of 1 ml l^{-1} for 18 hours when planted in the spring season, which is less ideal for germination and emergence compared to the conditions of fall season.

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