PLANTING OF STIMULATED CORN SEEDS AT DIFFERENT DATES IN SPRING SEASONS

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ABSTRACT

This study was aimed to investigate the appropriate planting date and tolerance to adverse growing conditions in the spring season through seeds stimulation technology. A field experiment was carried out in the spring seasons of 2022 and 2023 according to a randomized complete block design in a split-plot arrangement with four replications. The main factor is planting dates (February 15th, March 1st and 15th, and April 1st and 15th). The secondary factor is seeds stimulation (potassium nitrate 6 mg L^{-1} + licorice extract 6 g L^{-1}, as well as soaking with distilled water only). The stimulated seeds (potassium nitrate + licorice extract) and the planting date of February 15th were superior in traits of fertility ratio, number of grains per ear, weight of 300 grains, total grains yield, biological yield, and harvest index in both seasons (2022 and 2023). The stimulated seeds (potassium nitrate + licorice extract), planted on February 15th, excelled in the traits above (95.6 and 97.7%), (640.7 and 816.9 grain ear^{-1}), (76.19 and 82.69 g), (7.2 and 7.8 ton ha^{-1}), (17.5 and 18.9 ton ha^{-1}) and (41.5 and 41.2%) in both seasons, respectively. It can be concluded that seeds stimulation improved the yield and its components of corn crop under a wide range of environmental conditions, and that planting the stimulated seeds on February 15th contributed to take advantage of the prevailing environmental conditions and regulating the relationship between source efficiency and sink capacity to obtain the highest grain yield. It can be recommended that soaking the seeds with potassium nitrate 6 mg L^{-1} + licorice extract 6 g L^{-1} together when planting in mid-February in the spring season to increase grains yield.

Key words: fertility ratio, *Glycyrrhiza glabra,* grains yield, licorice root, potassium nitrate

زراعة البذور المحفزة في الذرة الصفراء بمواعيد مختلفة في العروة الربيعية

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المستخلص

هدفت هذه الدراسة إلى معرفة موعد الزراعة المناسب وتحمل ظروف النمو المعاكسة في العروة الربيعية عن طريق تقنية تحفيز البذور. نفذت تجربة حقلية في العروتين الربيعية 2022 و 2023 وفق تصميم القطاعات الكاملة المعشاة بترتيب القطع المنشقة وبأربعة مكررات. العامل الرئيسي هو مواعيد الزراعة (15 شباط و 1 و 15 آذار و 1 و 15 نيسان). العامل الثانوي هو تحفيز البذور (نترات البوتاسيوم 6 ملغم لتر$^{-1}$ + مستخلص عرق السوس 6 غم لتر$^{-1}$ وكذلك النقع بالماء المقطر فقط). تفوقت البذور المحفزة (نترات البوتاسيوم + مستخلص عرق السوس) وموعد الزراعة 15 شباط في صفات نسبة الخصب وعدد الحبوب في العرنوص ووزن 300 حبة وحاصل الحبوب الكلي والحاصل البيولوجي ودليل الحصاد في كلا العروتين (2022 و2023). تفوقت البذور المحفزة (نترات البوتاسيوم + مستخلص عرق السوس) المزروعة في 15 شباط في الصفات أعلاه (95.6 و 97.7%) و (640.7 و 816.9 حبة عرنوص$^{-1}$) و (76.19 و 82.69 غم) و (7.2 و 7.8 طن هـ$^{-1}$) و (17.5 و 18.9 طن هـ$^{-1}$) و (41.5 و 41.2%) في كلا العروتين بالتتابع. يمكن الاستنتاج أن تحفيز البذور أدى إلى تحسين إنتاجية حاصل الذرة الصفراء ومكوناته تحت مدى واسع من الظروف البيئية، وأن زراعة البذور المحفزة في 15 شباط اسهمت في الاستفادة من الظروف البيئية السائدة وتنظيم العلاقة بين كفاءة المصدر و قدرة المصب للحصول على أعلى إنتاجية من الحبوب. يمكن التوصية بنقع البذور بنترات البوتاسيوم 6 ملغم لتر$^{-1}$ + مستخلص عرق السوس 6 غم لتر$^{-1}$ معاً عند زراعتها في منتصف شهر شباط في العروة الربيعية لزيادة إنتاجية الحبوب.

الكلمات المفتاحية: نسبة الخصب، جذور عرق السوس، حاصل الحبوب، موعد الزراعة، نترات البوتاسيوم، نقع البذور.

Received: 22/8/2023, Accepted:5/11/2023

INTRODUCTION

Corn has low grain yield in the spring season in Iraq as a result of environmental conditions such as temperature and relative humidity during the growth stage, especially germination, field emergence, and seedling growth (31, 33). Low soil temperature affects germination, field emergence and other growth stages (25, 32). The appropriate planting date is related to climatic conditions accompanying the growth of the crop from planting until harvest (15,35). Planting date impacts number of grains per ear (10). The planting date was reported to have a significant effect on the grain yield when planting during March and April, and it decreased when planting was delayed until June (16). The differences in grain yield are due to the variation in temperatures and the short time needed for the grain to fill (27,30). Soaking period, activating solution and temperature should be adjusted to improve emergence ratio (18). Cold test and first count in sorghum and accelerated aging test in maize were closer to predict the field emergence (24,26), which explained that time of germination and field emergence due to soil temperature and microorganism could be reduced by stimulating the seeds that increased the seedling vigor index and the germination rate in the accelerated age test and the cold test (7). Germination responds to temperatures which extend to the seeds ability to emerge and growth at field (28). Seed priming before planting increased the viability and vigor of sorghum seeds, seedling growth and tolerate drought stress (17,41,42,43). Corn and wheat seeds had tolerated drought stress to some extent after priming and germination and field emergence was improved (7,29,38,39). Seeds soaking with GA3 improved germination, seeds vigor, emergence properties and growth of wheat seedling (20,21). Seeds soaked in GA3 a key to expand growth and enhance grain yield in wheat (3). Seeds stimulation technology contributes to improving the vitality and vigour of seeds and their tolerance to adverse growing conditions, as it gives good results in field establishment, starting from field emergence to increasing yield in natural conditions and various environmental stresses (6,19,23,34). This technology improves crop performance and increases production when there are environmental limitations, including temperatures and salinity of irrigation water (12,22,36,44,45). Plant extracts have been used in many studies because it contains natural compounds that stimulate germination and growth (19,35) including licorice root extract, which contributes to improving the plant's ability to withstand abiotic conditions because it contains glycyrrhizin, amino acids and plant hormones, including gibberellin (40). In addition, licorice extract contains many compounds, including (K, Mg, Mn, Zn, Cu, P), and these elements are important in stimulating the germination process and contributing to accelerating growth and improving yield (35). Licorice root extract contains natural products such as nutrients and other effective substances, acids, phenols, and steroids, licorice extract acts as gibberellin in stem elongation, plant height, number of leaves, and root length through two physiologically different processes: cell division and cellular elongation of plant tissue cells internally, leading to increased growth and the weight of the shoot, and use of licorice extract has an effect similar to growth regulators in improving the vegetative and flowering characteristics of different plants (13). Licorice extract has a role in increasing the percentage of total soluble solids and vitamin C in fruits and improving chemical properties (8). Seeds stimulation with licorice extract increased total grain yield in the spring and fall seasons of different varieties of sorghum (4). Potassium nitrate contributes to eliminating the action of abscisic acid, enhancing gibberellin, energy production, and increasing the activity of enzymes, especially antioxidant enzymes, including peroxidase (POX) and ascorbate oxidase (AOX) in many plants (47), it's also contributes to enhancing dehydrogenase and α-amylase enzymes under low temperatures (47). It has been shown that stimulating seeds with potassium nitrate before planting improves plant performance in the field under adverse conditions and increases the productivity of maize (14,37). Stimulating wheat seeds with potassium nitrate increased grain weight (46). The seeds soaking treatment with licorice extract and potassium nitrate was superior by giving the highest mean germination, seedling vigor index, accelerated aging and cold test (35). Germination and seedling growth indicators could be improved in a wide range of environmental conditions when seeds are soaked in licorice extract, potassium nitrate, or both, in addition to using licorice extract as an alternative to gibberellin in stimulating germination (35). This study was aimed to determine the appropriate planting date and tolerance to adverse growing conditions in the spring season through seeds stimulation technology. Improving the production capacity per area despite environmental growth determinants such as temperature and humidity by stimulating the potential energy of plant.

MATERIAIS AND METHODS

A field experiment was carried out during two spring seasons of 2022 and 2023 according to a randomize complete block design in a split-plot arrangement with four replications. Main factor is planting dates (February 15th, March 1st and 15th, April 1st and 15th). Secondary factor is seeds stimulation (potassium nitrate 6 mg L^{-1} + licorice extract 6 g L^{-1} as well as soaking treatment with distilled water only). The soaking duration was 18 hours (34,35). The field was well plowed and smoothed. Area of the experimental unit for secondary plot was 12 m^2 (4×3m), with five lines, 75 cm apart and 25 cm between holes, with a plant population of 53.333, and the distance between the main plots and another was 1 m and between replication and another was 1.5 m. Seeds of Baghdad-3 cv. were planted with three seeds in each hole. Thinning process was carried out after emergence when plant height reached 15-20 cm, keeping one plant in each hole. The field was covered with nets to protect the seedlings from birds. Soil and crop management in accordance to recommendations were carried out. Corn stem borer was controlled using granular diazinon pesticide (10% active ingredient) at a dose of 6 kg ha^{-1} by feeding the growing top of the plant as a preventive control at the 4-5 leaf stage, and the second after 15 days of the first control. Climate data was reported in the spring seasons of 2022 and 2023 (Table 1). Five ears of guarded plants were collected randomly at each experimental unit for studied following traits:

Fertility ratio (%) was calculated by dividing number of grains of ear on total of ovaries multiplied by 100, number of grains per ear, weight of 300 grains (g), grains yield (ton ha^{-1}) was calculated by multiplied grains number per plants by density of plants (53333 plants ha^{-1}), biological yield (ton ha^{-1}) and harvest index (%). Weights calculation were corrected based on a humidity of 15.5% (11). Statistical analysis; data were analyzed statistically according to randomize complete block design in a split-plot arrangement with four replications (9). Planting date treatments were placed in main plots. Seeds stimulation treatments were placed in subplots. Means were compared by test of least significant difference (LSD) at 5% probability (5). Genstat: A statistical program was used. Note: Traits that had no data in planting date in April 15th were analyzed as four dates only.

Table 1. Climate data in the spring seasons of 2022 and 2023

From sowing date to…..	Spring season 2022			Spring season 2023		
	Date dd/mm	Temp avg C°	RH avg %	Date dd/mm	Temp avg C°	RH avg %
Silking	15/02 – 26/05	20.77	36.09	15/02 – 17/05	20.49	52.12
Physiol. Maturity	15/02 – 17/06	22.88	33.53	15/02 – 05/06	22.49	49.74
Full maturity	15/02 – 26/06	25.73	30.31	15/02 – 14/06	23.34	48.69
Silking	01/03 – 30/05	21.47	33.93	01/03 – 17/05	20.49	52.12
Physiol. Maturity	01/03 – 22/06	23.87	31.55	01/03 – 05/06	22.49	49.74
Full maturity	01/03 – 07/07	24.99	30.49	01/03 – 09/06	24.33	49.39
Silking	15/03 – 05/06	25.76	29.81	15/03 – 07/06	25.04	48.43
Physiol. Maturity	15/03 – 21/06	24.80	30.34	15/03 – 21/06	26.35	45.63
Full maturity	15/03 – 10/07	28.47	27.03	15/03 – 02/07	27.17	43.11
Silking	01/04 – 17/06	26.80	28.78	01/04 – 19/06	27.70	42.88
Physiol. Maturity	01/04 – 03/07	27.96	27.57	01/04 – 03/07	28.72	39.55
Full maturity	01/04 – 12/07	28.57	26.96	01/04 – 12/07	29.26	37.55

Average temperature according to number of days to reach the exact stage was taken. Ministry of Agriculture, Agricultural Meteorology Center, Baghdad Governorate, Abu Ghraib Research Station, Longitude 23.44°, Latitude 32.33

RESUITS AND DISCUSSION

Fertility ratio (%)

The seeding date in February 15th was significantly superior to other dates in the fertility percentages and achieved the highest mean (94.3 and 95.5%). The lowest mean for this trait was at the planting date of April 1st (52.5 and 67.0%) in both seasons, respectively (Table 2). The stimulation treatment (potassium nitrate + licorice extract) superior the control treatment (Table 2). The planting date in February 15th when treated with the stimulus (potassium nitrate + licorice extract) exceeded the fertility ratio and recorded the highest mean of (97.7%), while the date of April 1st when treated the seeds with the stimulus with distilled water only recorded the lowest mean of 65.1% in the spring season of 2023 (Table 2). The reason for the decreases in the corn flowers fertility ratio in recent times could be due to the increases in temperatures and the length of photoperiod, which is accompanied by decreases in relative humidity during the flowering stage, which negatively affects flowering and the formation of unpollinated florets ratio as a result of the failure of fertilization process, due to the effect of temperature. The highest pollen moisture content during the flowering stage prevents the dispersal of the tassel pollen grains during the emerges on the silk and thus the pollination process fails (1). The average of temperature increased on February 15th from 20.77 and 20.49°C to 26.80 and 27.70°C in April 1st with a decrease in relative humidity from 36.09 and 52.12% to 28.78 and 42.88% in the two seasons, respectively (Table 2). The reason could be due to the effect of stimulants in increasing the speed of seedling growth, improving growth indicators in the plant, and the transfer of nutrients to the flower origin, which led to increases in the percentage of zygotes.

Table 2. Effect of seeds stimulation and planting date on fertility ratio (%) of corn in spring seasons 2022 and 2023

	Spring season 2022 Seeds stimulation				Spring season 2023 Seeds stimulation		
Planting date	**KNO_3+ Licorice extract**	**Distilled water only**	**Mean**	**Planting date**	**KNO_3+ Licorice extract**	**Distilled water only**	**Mean**
Feb. 15th	**95.6**	**93.1**	**94.3**	**Feb. 15th**	**97.7**	**93.4**	**95.5**
Mar. 1st	**88.0**	**83.4**	**85.7**	**Mar. 1st**	**91.5**	**83.9**	**87.7**
Mar. 15th	**56.4**	**51.4**	**54.0**	**Mar. 15th**	**75.3**	**73.4**	**74.3**
Apr. 1st	**54.8**	**50.2**	**52.5**	**Apr. 1st**	**68.9**	**65.1**	**67.0**
Apr. 15th	**---**	**---**	**---**	**Apr. 15th**	**---**	**---**	**---**
$LSD_{0.05}$	**N.S**		**8.6**	**$LSD_{0.05}$**	**4.8**		**4.6**
Mean	**73.7**	**69.5**		**Mean**	**83.4**	**79.0**	
$LSD_{0.05}$	**2.1**			**$LSD_{0.05}$**	**1.3**		

$LSD_{0.05}$, Least significant difference test at probability level of 0.05; N.S: Non-significant at P≤0.05; ---, Planting date gave no data

Number of grains ear^{-1}

The planting date in February 15th was superior to the other date significantly in the number of grains per ear and recorded the highest mean (581.2 and 761.6). The lowest mean was at the date of April 1st (364.2 and 372.1) in the two seasons, respectively (Table 3). The reason could be due to suitable environmental conditions, which led to increases in leaf area and its index, then reflected positively on formation and increasing in the number of fertilized florets and the number of grains per ear (2). The reason for the decreases of the number of grains at late planting date could be due to the influence of the prevailing unsuitable environmental conditions when planting in the spring season, as the delay of planting date causes the lower number of grains (1,46). The stimulation treatment (potassium nitrate + licorice extract) was superior to the control treatment, soaking with distilled water only (Table 3). The reason for the increase of the grains number could be attributed to the role of both potassium nitrate and licorice root extract in improving germination and seedling growth in a wide range of environmental conditions, as potassium nitrate contributes to activating enzymes and regulating the photosynthesis process, in addition to the extract containing many organic compounds. Minerals and a group of micro- and macro-elements and enzymes that increase various growth activities, including carrying out the process of photosynthesis, increasing the production of nutrients that move from the source to the sink, enhancing the potential ability, and then raising the plant's productivity (36). The planting date of February 15th and the stimulating treatment (potassium nitrate + licorice extract) recorded the highest mean (816.9), while the seeds treated with distilled water only and planted at the date of April 1st recorded the lowest mean (347.1) (Table 3). The reason for the decrease of grains number in the late date could be due to the change in temperature and humidity, which affects the flower buds from which the grains are produced, especially since the late date give the lowest number of grains per ear (1).

Table 3. Effect of seeds stimulation and planting date on number of grains per ears of corn in spring seasons 2022 and 2023

Planting date	Spring season 2022 Seeds stimulation: KNO_3+ Licorice extract	Distilled water only	Mean	Planting date	Spring season 2023 Seeds stimulation: KNO_3+ Licorice extract	Distilled water only	Mean
Feb. 15th	640.7	521.7	581.2	Feb. 15th	816.9	706.4	761.6
Mar. 1st	511.1	485.1	498.1	Mar. 1st	663.3	525.6	594.4
Mar. 15th	440.3	400.4	420.3	Mar. 15th	520.7	453.9	487.3
Apr. 1st	395.5	332.0	364.2	Apr. 1st	397.0	347.1	372.1
Apr. 15th	---	---	---	Apr. 15th	---	---	---
$LSD_{0.05}$	N.S		51.1	$LSD_{0.05}$	74.46		72.91
Mean	496.9	434.8		Mean	599.5	508.3	
$LSD_{0.05}$	25.5			$LSD_{0.05}$	15.26		

$LSD_{0.05}$, Least significant difference test at probability level of 0.05; N.S: Non-significant at $P \leq 0.05$; ---, Planting date gave no data

Weight of 300 grains (g)

The planting date of February 15th was superior to the other date significantly and recorded the highest mean of 300 grains weight (73.65 and 79.42 g), while the April 1st recorded the lowest mean (61.54 and 69.73 g) in both seasons, respectively (Table 4). The reason for the decreases in grain weight on the date of April 1st is due to the rise in temperature and a decreases in relative humidity, which leads to a shortening of the grain filling period, as the period of physiological maturity was shortened from 113 and 110.5 days on February 15th to 93 and 92 days on April 1st (35) as a result of temperatures rising from 22.88 and 22.49°C in February 15th to 27.96 and 28.72°C in April 1st, with decreases in the relative humidity from 33.53 and 49.79% to 27.57 and 39.55% in the two seasons, respectively (Table 1). The stimulation treatment (potassium nitrate + licorice extract) was superior to the stimulation treatment with distilled water only (Table 4). This may be due to the role of stimulating treatments in the early emergence and formation of the seedling, reducing the time needed for growth, increasing the efficiency of photosynthesis and the transfer of nutritional components that determine the growth of the grain.

Grains yield (ton ha^{-1})

The planting date of February 15th recorded the highest mean of total grains yield (6.4 and 7.1 ton ha^{-1}), which differed significantly with the other dates, while April 1st recorded the lowest mean (2.2 and 4.0 ton ha^{-1}) (Table 5). The stimulation treatment (potassium nitrate + licorice extract) was superior to the control treatment (distilled water only) (Table 5). The interaction between planting date of February 15th and stimulant treatment (potassium nitrate + licorice extract) was superior and gave the highest mean (7.2 and 7.8 ton ha^{-1}), which differed with the other date significantly, while the treatment of April 1st and seeds stimulation with distilled water only, recorded the lowest mean (2.0 and 3.9 ton h^{-1}) (Table 5). The reason for the increase in total grain yield at early dates is due to the suitability of the prevailing environmental conditions and their positive impact on the components of the yield at the same date, including number of grains per ear, and the weight of 300 grains (Tables 3,4).

Table 4. Effect of seeds stimulation and planting date on weight of 300 grains (g) of corn in spring seasons 2022 and 2023

Planting date	Spring season 2022 Seeds stimulation: KNO_3+ Licorice extract	Spring season 2022 Seeds stimulation: Distilled water only	Mean	Planting date	Spring season 2023 Seeds stimulation: KNO_3+ Licorice extract	Spring season 2023 Seeds stimulation: Distilled water only	Mean
Feb. 15th	76.19	71.10	73.65	Feb. 15th	82.69	76.15	79.42
Mar. 1st	70.59	66.99	68.79	Mar. 1st	79.18	73.83	76.51
Mar. 15th	70.38	59.50	64.94	Mar. 15th	75.77	69.52	72.65
Apr. 1st	66.60	56.48	61.54	Apr. 1st	73.67	65.79	69.73
Apr. 15th	---	---	---	Apr. 15th	---	---	---
$LSD_{0.05}$	N.S		4.5	$LSD_{0.05}$	N.S		1.74
Mean	70.94	63.52		Mean	77.83	71.32	
$LSD_{0.05}$	2.9			$LSD_{0.05}$	0.83		

$LSD_{0.05}$, Least significant difference test at probability level of 0.05; N.S: Non-significant at P≤0.05; ---, Planting date gave no data

Table 5. Effect of seeds stimulation and planting date on total grains yield (ton ha^{-1}) of corn in spring seasons 2022 and 2023

Planting date	Spring season 2022 Seeds stimulation: KNO_3+ Licorice extract	Spring season 2022 Seeds stimulation: Distilled water only	Mean	Planting date	Spring season 2023 Seeds stimulation: KNO_3+ Licorice extract	Spring season 2023 Seeds stimulation: Distilled water only	Mean
Feb. 15th	7.2	5.6	6.4	Feb. 15th	7.8	6.5	7.1
Mar. 1st	5.2	4.3	4.7	Mar. 1st	6.9	5.7	6.3
Mar. 15th	3	2.1	2.5	Mar. 15th	4.6	4.4	4.5
Apr. 1st	2.5	2.0	2.2	Apr. 1st	4.2	3.9	4.0
Apr. 15th	---	---	---	Apr. 15th	---	---	---
$LSD_{0.05}$	0.90		0.86	$LSD_{0.05}$	0.66		0.55
Mean	4.5	3.5		Mean	5.8	5.1	
$LSD_{0.05}$	0.24			$LSD_{0.05}$	0.31		

$LSD_{0.05}$, Least significant difference test at probability level of 0.05; ---, Planting date gave no data

Biological yield (ton ha^{-1})

The planting date of February 15th recorded the highest mean of biological yield (16.4 and 18.0 ton ha^{-1}), which didn't differed significantly with March 1st, while it differed with the other dates significantly. The planting date of March 15th achieved the lowest biological yield (9.5 and 12.2 ton ha^{-1}) (Table 6). The stimulation treatment (potassium nitrate + licorice extract) was superior to the stimulation treatment with distilled water significantly (Table 6). The reason for the superiority of planting date and stimulation treatment could be due to the fact that the same treatments gave the highest mean for the number of grains per ear (Table 3) and the weight of dry matter (35).

Harvest index (%)

February 15th was significantly superior to other dates and recorded the highest mean for harvest index (39.2 and 39.8%), while April 1st recorded the lowest mean (13.3 and 29.5%) (Table 7). The stimulation treatment (potassium nitrate + licorice extract) was significantly superior to the stimulation treatment with distilled water in the spring season 2022 only (Table 7). The interaction between February 15th and seeds stimulation (potassium nitrate + licorice extract) was superior on harvest index significantly in the spring season 2023 only, and recorded the highest mean 41.2% compared to the interaction between April 1st and seeds soaked in distilled water (Table 7). The reason for the superiority of the harvest index is that the planting dates and stimulation treatments and their interaction are the same parameters that recorded the highest mean for total grain yield and biological yield (Tables 5 and 6).

Table 6. Effect of seeds stimulation and planting date on biological yield (ton ha^{-1}) of corn in spring seasons 2022 and 2023

Planting date	Spring season 2022 Seeds stimulation KNO$_3$+ Licorice extract	Distilled water only	Mean	Planting date	Spring season 2023 Seeds stimulation KNO$_3$+ Licorice extract	Distilled water only	Mean
Feb. 15th	17.5	15.3	16.4	Feb. 15th	18.9	17.1	18.0
Mar. 1st	17.1	14.9	16.0	Mar. 1st	18.6	16.7	17.6
Mar. 15th	10.5	8.3	9.5	Mar. 15th	12.8	11.5	12.2
Apr. 1st	11.8	9.7	10.7	Apr. 1st	15.2	12.7	14.0
Apr. 15th	---	---	---	Apr. 15th	---	---	---
LSD $_{0.05}$	N.S		2.1	LSD $_{0.05}$	N.S		1.4
Mean	14.2	12.1		Mean	16.4	14.5	
LSD $_{0.05}$	0.8			LSD $_{0.05}$	0.7		

LSD $_{0.05}$, Least significant difference test at probability level of 0.05; N.S: Non-significant at P≤0.05; ---, Planting date gave no data

Table 7. Effect of seeds stimulation and planting date on harvest index (%) of corn in spring seasons 2022 and 2023

Planting date	Spring season 2022 Seeds stimulation KNO$_3$+ Licorice extract	Distilled water only	Mean	Planting date	Spring season 2023 Seeds stimulation KNO$_3$+ Licorice extract	Distilled water only	Mean
Feb. 15th	41.5	37.0	39.2	Feb. 15th	41.2	38.4	39.8
Mar. 1st	34.5	28.9	31.7	Mar. 1st	37.1	34.4	35.7
Mar. 15th	28.3	24.9	26.6	Mar. 15th	36.2	38.3	37.3
Apr. 1st	13.4	13.1	13.3	Apr. 1st	27.5	31.5	29.5
Apr. 15th	---	---	---	Apr. 15th	---	---	---
LSD $_{0.05}$	N.S		9.3	LSD $_{0.05}$	5.0		4.6
Mean	29.4	26.0		Mean	35.5	35.7	
LSD $_{0.05}$	2.8			LSD $_{0.05}$	N.S		

LSD $_{0.05}$, Least significant difference test at probability level of 0.05; N.S: Non-significant at P≤0.05; ---, Planting date gave no data

CONCLUSION

It can be concluded that planting stimulated seeds at the appropriate time contributed to employing the prevailing environmental conditions and regulating the relationship between source efficiency and sink capacity to obtain the highest grains yield. The response of seeds to soaking with potassium nitrate or licorice extract may also be positive at concentrations higher than 6 mg L^{-1} and other concentrations >3 and <9 g L^{-1}, respectively.

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