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وحماية المستهلك

EFFECT OF SEED STIMULATION BY ALPHA-AMYLASE ENZYME, STIMULUS TEMPERATURE DEGREE AND SOWING DATES ON SOME YIELD CHARACTERISTICS OF SORGHUM

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ABSTRACT

This study was conducted at Research Station A, Department of Field Crops, College of Agricultural Engineering Sciences - University of Baghdad, in Al-Jadriya for the fall season of 2023. The study aimed to investigate the impact of seed priming with alpha-amylase enzyme and induced temperature on yield traits of sorghum. A randomized completely block design (RCBD) with split plot arrangement with three replications and two factors was employed. The first factor included planting dates (June 25, July 15, and August 5) denoted as D1, D2, and D3, respectively, in sequence. The second factor included enzyme priming treatments (0.5, 1, and 1.5 mg L^{-1}) denoted as T1, T2, and T3, respectively, in sequence, along with a control treatment (distilled water) denoted as T0. The results showed that the plants grown in the second date (D2) had the highest rate of number of grains per head (5345 grains head-1), grain yield per plant (141.37 gm plant-1), and total grain yield (10.094 tons ha-1), while the first date (D1) excelled with the highest average weight of 500 grains (16.48 gm). The results indicated that treatment T2 was superior with the highest average for the number of head grains (4835 grains $head^{-1}$), grain yield per plant (132.94 gm $plant^{-1}$), and the total grain yield (9.492 tons ha^{-1}). The interaction between planting dates and stimulation parameters showed significant in the aforementioned traits, with the exception of weight 500 grain.

Keywords: Alpha-amylase enzyme, priming temperature, *Sorghum bicolor L.*, wide environmental range, yield traits.

[*]**This article is taken from the first researcher's master's thesis.**

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تأثير تحفيز البذور بأنزيم الالفا اميليز ودرجة الحرارة المحفزة ومواعيد الزراعة في بعض صفات حاصل الذرة البيضاء

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الخلاصة

نفذت تجربة حقلية في محطة ابحاث A التابعة لكلية علوم الهندسة الزراعية - جامعة بغداد - قسم المحاصيل الحقلية في منطقة الجادرية للموسم الخريفي (2023) بهدف معرفة تأثير تحفيز البذور بأنزيم الالفا اميليز ودرجة الحرارة المحفزة ومواعيد الزراعة في صفات حاصل الذرة البيضاء. استخدم تصميم القطاعات الكاملة المعشاة (RCBD) بترتيب الالواح المنشقة بثلاثة مكررات وعاملين، إذ تضمن العامل الاول مواعيد الزراعة (25 حزيران و15 تموز و5 آب) والمرمز لها (D1 و D2 و D3) بالتتابع والعامل الثاني تضمن معاملات التحفيز بأنزيم الالفا اميليز (0.5 و 1 و 1.5) ملغم لتر$^{-1}$ والتي رمز لها (T1 و T2 و T3) على التتابع، فضلاً عن معاملة المقارنة (الماء المقطر) ورمز لها T0. اظهرت النتائج ان النباتات المزروعة في الموعد الثاني (D2) تفوقت بأعلى متوسط لعدد حبوب الرأس (5345 حبة رأس$^{-1}$) وحاصل الحبوب للنبات (141.37 غم نبات$^{-1}$) وحاصل الحبوب الكلي (10.094 طن هـ$^{-1}$)، فيما تفوق الموعد الاول (D1) بأعلى متوسط لصفة وزن 500 حبة (16.48 غم). اشارت النتائج الى تفوق المعاملة T2 بأعلى متوسط لصفة عدد حبوب الرأس (4835 حبة رأس$^{-1}$) وحاصل الحبوب للنبات (132.94 غم نبات$^{-1}$) وحاصل الحبوب الكلي (9.492 طن هـ$^{-1}$). اظهر التداخل بين مواعيد الزراعة ومعاملات التحفيز معنوية في الصفات المذكورة بأستثناء صفة وزن 500 حبة.

الكلمات المفتاحية: انزيم الفا اميليز، درجة حرارة التحفيز، ذرة بيضاء، مدى بيئي واسع، صفات الحاصل.

INTRODUCTION

Sorghum [*Sorghum bicolor L. (Moench)*] belongs to the Poaceae family and is considered an important fodder and grain crop. It ranks fifth in terms of economic importance its cultivation is widespread in the semi-arid areas of the tropical and subtropical regions, and its seeds are used as food for humans and fodder for animals. Sorghum has been called one of the most important crops because it possesses characteristics that enable it to withstand drought, such as the efficiency of the root system, the large number of fibrous roots, and its leaves with a corky skin that helps reduce the rate of evaporation and transpiration, high rates of carbon assimilation into respiration, and the ability of the leaves to curl **(Ahmed, 2007)**. Despite its ability to grow rapidly after mowing and its abundant grain production, its locally produced seeds still suffer from a large gap between the standard laboratory germination rate and field emergence **(Alrawi & Cheyed, 2018)**. Previous studies have turned to many treatments to get rid of this problem by treating sorghum seeds before planting them to stimulate them and improve their performance in terms of increasing the rate and speed of germination and their tolerance to harsh environmental conditions, including classifying the seeds into different sizes, planting large seeds, or soaking the seeds before planting them with germination stimulants such as gibberellic acid or seed stimulation with different materials and compounds **(Saudi & Alrawi, 2023),** because of the ability of enzymes to reduce the negative effects of temperatures, improve field emergence, and reduce the time required for germination, which has attracted researchers to search for the effectiveness of these enzymes, as they break down complex nutrients and convert them into simpler materials to nourish the embryo and germination, as the germination process requires an effective enzymatic system. Thus, seed stimulation is an essential factor for growth **(Damalas *et al.*, 2019).** One of these enzymes is alpha-amylase, as it works on embryo growth and germination and improves the quality of the product because of its important role in carbohydrate manufacturing processes. **(Saudi & Alrawi 2023),** found significant differences in the traits of sorghum yields when they used the biostimulant (Appetizer). **Muhsen (2020)** confirmed that the difference in enzyme concentrations had a significant impact on weight of 100 grains and the total grain yield, as the concentration exceeded 1 mg L^{-1}, giving it the highest rate for the two traits (15.02 g and 58.86 tons ha^{-1}), respectively. **Zida *et al.* (2018)** reported that soaking seeds before planting resulted in an increase in Sorghum yield. The appropriate planting date is associated with the nature of the climatic conditions accompanying crop growth from planting to harvesting. Early planting, accompanied by a decrease in temperatures, may prolong germination and field emergence. Delayed planting accelerates flowering, but this does not prevent pollination and fertilization processes at high temperatures, reducing grain filling rate and yield. Late planting encourages early flowering and maturity due to shorter daylight compared to early planting, which has not reached the critical threshold that encourages flowering **(Alhassani, 2001)**. **Azrag *et al.* (2015)** indicated that there was no significant effect of different planting dates on weight of 1000 grains. **Joorabi *et al.* (2015)** found, through their study of three planting dates (June 10, 26, and July 11) on the white corn crop, that there was a significant difference in the grain yield traits, as June 26 had the highest rate of 9.75 tons ha^{-1} compared to the other two dates, while it gave The date is July 11, the lowest rate reached 8.51 tons ha^{-1}. This study aims to determine the extent of the effect of stimulation treatments on the yield of sorghum seeds and whether yield traits vary with different planting dates and combinations of study factors.

MATERIALS AND METHODS

The study was conducted at Research Station A, Department of Field Crops, College of Agricultural Engineering Sciences - University of Baghdad for the fall season of 2023. The study aimed to investigate the impact of seed priming using alpha-amylase enzyme, priming temperature, and planting dates on various yield traits of sorghum. The "Inqath" variety, introduced to Iraq in 1998 and adopted in 2001, was selected for its lodging resistance, sturdy stems, medium maturity duration of 110-120 days, and high grain yield potential. The experimental plots were cultivated in sandy loam soil, and soil analysis was conducted at the Central Laboratory for Soil, Water, and Plant Analysis – Consulting Office, College of Agricultural Engineering Sciences, University of Baghdad. Random soil samples were collected at a depth of 30 cm to determine soil type and study its chemical and physical properties. Climate data during the crop growth period were obtained from the General Authority for Meteorology and Seismology for the period from June 25, 2023, to January 1, 2024. This experiment was conducted according to a randomized complete block design (RCBD) with split plot arrangement, replicated three times. The main plots consisted of three planting dates (June 25, July 15, and August 5), denoted as D1, D2, and D3, respectively. The secondary plots included the best three seed priming treatments using alpha-amylase enzyme (0.5, 1, and 1.5 mg L^{-1}), denoted as T1, T2, and T3, respectively, based on the results of preliminary laboratory experiments. Additionally, a control treatment (distilled water) was included and denoted as T0. The seeds were soaked for 24 hours before planting under optimal temperature conditions (25°C), based on the results of the initial laboratory experiment. Soil preparation began by plowing the experimental area followed by disking, the soil was then fertilized with NPK fertilizer (18:46:0) at a rate of 278 kg ha^{-1} before planting. The soil was harrowed and leveled using disk harrows, then divided into experimental units in the form of plots, with each plot measuring 6 m^2 (2 × 3 m). Each plot contained 5 rows, spaced 75 cm apart, with 9 furrows per row spaced 20 cm apart. 3-5 seeds were sown per furrow and thinned to one plant per furrow after germination. Urea fertilizer was applied at a rate of 400 kg ha^{-1} in two split doses, the first application at crop emergence and the second 40 days after planting, following recommendations from **Iraqi Ministry of Agriculture, (2006)**, Corn stalk borer was controlled using Effector pesticide, with the first application applied when the plants had 4 - 5 leaves and the second application performed 14 days later. Crop management practices including irrigation, hoeing, and manual weeding were carried out as needed to maintain crop health and vigor.

Studied traits:

1- **Number of head grains (grain $head^{-1}$):** After harvesting the heads of five plants, cutting them, and cleaning them of dust and peels, they were counted using a seed counter (Contador) and the average was extracted for each experimental unit.

2- **Weight of 500 grains(gm):** 500 grains were taken from each experimental unit of plants whose seeds were randomly dispersed and counted using a seed counter (Contador), then weighed with a sensitive balance and the average weight of 500 grains was extracted **(Micheall, 2003)**.

3- **Grain yield per plant (gm $plant^{-1}$):** This trait was calculated by randomly taking the average seed weight of five heads per experimental unit from the midlines.

4- Grain yield (ton ha^{-1}): It was extracted from the product of multiplying the average yield per plant (gm) by the plant density and converted to tons ha^{-1} **(Elsahooki, 2009).**

RESULTS AND DISCUSSION

Number of head grains (grain $head^{-1}$)

This is the most important traits in the yield and one of its main components and the strongest association with it **(Elsahookie, 2007).** This trait is determined by several factors, including the number of flowers formed and the grain set, and then the success of the grain survival until the end of the season **(Muhammad, 2015).**

(Table, 1) indicates that there are significant differences between the planting dates and stimulation treatments and the interaction between them, as the second date (D2) gave the highest average for the trait, amounting to 5345 grains $head^{-1}$, which differed significantly from the other dates, while the first date (D1) gave the lowest average for the trait, reaching 3299 head grains^{-1}, The reason for the superiority of the second date (D2) may be attributed to the suitability of environmental conditions, which led to an increase in the leaf area and its index, and thus an increase in light interception and an increase in the materials manufactured in the photosynthesis process, which was reflected positively in improving the plant's performance in growth processes and thus was reflected in number of grains in the head. **Nazzal (2024); Hashim (2021)** reached a similar result.

The results of Table 1 showed that there were significant differences between the stimulation treatments, as the T2 treatment gave the highest rate of the trait, amounting to 4835 grains head^{-1}, and it differed significantly from the other stimulation treatments, and the stimulation treatment T3 gave the lowest rate of the trait, amounting to 3994 grains head^{-1}, The reason for the higher number of grains per head of plants resulting from soaking the seeds before planting with different concentrations of the enzyme is due to improving the strength and vitality of the seeds and increasing the manufactured nutrients from the source to the downstream, which reflects positively on this trait. This result agreed with **Muhsin (2020).**

The results of the same table indicated that there was a significant difference in the interaction between planting dates and stimulation treatments, as the T2 stimulation treatment at the second date (D2) recorded the highest average for this trait, amounting to 5959 grains head^{-1}, which did not differ significantly from the T1 treatment at the same date, which gave an average of 5634 grains head^{-1}, while the stimulus treatment T3 at the first date (D1) gave the lowest average for the trait, amounting to 2788 grains head^{-1}.

Table (1): Effect of planting dates and stimulation treatments on number of head grains.

Sowing dates (D)	**Stimulation treatments (S) (mg L^{-1})**				**Mean (D)**
	0 (Control)	0.5	1	1.5	
25 June	3235	3379	3796	2788	3299
15 July	4568	5634	5959	5217	5345
5 August	4346	3430	4750	3977	4126
L.S.D (0.05)	687.5				52.4
Means (S)	4148	4835	3994	4050	
L.S.D (0.05)	457.8				

Weight of 500 grains(gm)

It is an important trait because it represents one of the primary parts of the grain yield, and it represents an indicator of the efficiency of the transfer of food manufactured materials from the source to the downstream at the sites where the material is stored for the seed.
(Table, 2) indicated that there were no significant differences between the stimulation treatments and the overlap of planting dates with the stimulation treatments. This result does

not agree with what **Muhsin (2020)** reached, as he found that there were significant differences between the stimulation treatments.

The results of Table 2 showed that there were significant differences between the planting dates regarding weight of 500 grains, as the first date (D1) gave the highest rate of 16.48 gm, different from the other two dates, while the second date (D2) gave the lowest rate of (13.47 gm), The reason why the first date exceeded the weight of 500 grains may be attributed to the seed weight being negatively related to the number of grains per head, which led to a reduction in competition between grains for nutrients manufactured in the leaves (source), which caused their weight to increase. These are consistent with **Mutlag *et al.* (2023); Wahed & Al-Azawi (2023).**

Table (2): Effect of planting dates and stimulation treatments on Weight of 500 grains.

Sowing dates (D)	Stimulation treatments (S) (mg L^{-1})				Mean (D)
	0 (Control)	0.5	1	1.5	
25 June	16.63	17.27	16.40	15.63	16.48
15 July	13.67	13.67	12.93	13.73	13.47
5 August	14.60	15.77	14.40	14.60	14.94
L.S.D (0.05)	n.s				1.24
Means (S)	15.52	14.58	14.79	14.97	
L.S.D (0.05)	n.s				

Grain yield per plant (gm $plant^{-1}$)

Grain yield is the final result of the physiological processes of growth, development and collection of dry matter downstream after the flowering stage. Plant yield is affected by its basic components (number of heads, number of grains per head, grain weight), which in turn are affected by genetic and environmental factors. This is consistent with what **Hamdi (2021)** mentioned.

(Table, 3) indicates that there are significant differences in planting dates, stimulation treatments, and the interaction between them. The plants of the second date (D2) demonstrated their superiority by giving the highest yield per individual plant with an average of 141.37 gm $plant^{-1}$, and it differed significantly from the first date (D1) and the third date (D3), while the first date (D1) gave the lowest average of 106.68 gm $plant^{-1}$, The reason may be due to the appropriate environmental conditions of temperature and relative humidity during the flowering period, which enabled the plant to exploit its physiological capabilities to produce high yields. **Al-Kaisy (2015); Kazem (2020)** found it. **Al-Mashhadani (2015)** Asymptotic results.

The results of (Table, 3) indicated that the stimulation treatments differed significantly from each other, as the T2 stimulation treatment achieved superiority in the individual plant yield trait by giving it the highest average for the trait, amounting to 132.94 gm plant^{-1}, and it differed significantly from the other stimulation treatments used in the study, while the T1 stimulation treatment gave The lowest average for the trait is 108.61 gm plant^{-1}.

The data in Table 3 shows that there is a significant effect of the interaction between planting dates and stimulation treatments. T1 stimulation treatment was superior at the second planting date (D2) by giving it the highest average amounting to 151.89 gm plant^{-1}, and it did not differ significantly from T2 stimulation treatment which gave an average of 149.73 gm plant^{-1} for the trait at the same date, while it differed significantly from the other stimulation treatments at the same date, while T3 stimulation treatment gave the lowest average for the trait, amounting to 85.27 gm plant^{-1} at the first date (D1).

Table (3): Effect of planting dates and stimulation treatments Grain yield per plant.

Sowing dates (D)	Stimulation treatments (S) (mg L^{-1})				Mean (D)
	0 (Control)	0.5	1	1.5	
25 June	110.51	117.20	113.73	85.27	106.68
15 July	123.61	151.89	149.78	140.24	141.37
5 August	124.92	108.61	135.37	120.33	122.31
L.S.D (0.05)	8.94				6.22
Means (S)	119.68	125.90	132.94	115.28	
L.S.D (0.05)	5.13				

Grain yield (ton ha^{-1})

The result is a result of both the factors of genetics and environment and their interactions, and not the result of an increase in one factor and the cessation of the other factor **(Mitchell, 1984)**.

The results of the statistical analysis showed that there were significant differences between planting dates, stimulation treatments, and the interaction between them. The results shown in (Table, 4) recorded a significant superiority for the plants of the second date (D2) giving it the highest average of 10,094 tons ha^{-1}, and it differed significantly from the other dates, while the third date (D3) gave lowest average grain yield was 8.733 tons ha^{-1}, The reason may be due to the fitting natural circumstances that empowered the plant to take advantage of its physiological abilities to deliver exceptional returns. The outcome concurred with the consequence of **Al-Amili (2023); Al-Mashhadani (2010).**

It is noted from the results of Table 4 that the difference in enzyme concentrations had a significant effect on this characteristic. T1 stimulation treatment gave the highest average amounting to 9.492 tons ha^{-1}, and differed significantly from the other treatments, while the T2 stimulation treatment gave the lowest average amounting to 8.231 tons ha^{-1}. The reason is due to the role of the alpha-amylase enzyme in improving seed performance and increasing their growth and development rates, which was reflected positively in increasing the yield components of these plants. This result is consistent with the result obtained by **Al-Selawy *et al.* (2018); Al-Jubouri (2023)**.

The consequences of Table 4 demonstrated that there were huge contrasts in the connection between the review factors. The stimulation treatment T1 at the second date (D2) gave the highest average of 10,845 tons ha^{-1} and did not differ significantly from the stimulation treatment T2 which gave 10,690 tons ha^{-1} at the same date, while The T3 stimulation treatment at the first date (D1) gave the lowest rate of 6.088 tons ha^{-1}.

Table (4): Effect of planting dates and stimulation treatments on Grain yield (ton ha^{-1}).

Sowing dates (D)	**Stimulation treatments (S) (mg L^{-1})**				**Mean (D)**
	0 (Control)	0.5	1	1.5	
25 June	7.891	8.368	8.120	6.088	7.617
15 July	8.826	10.845	10.690	10.013	10.094
5 August	8.919	7.755	9.666	8.592	8.733
L.S.D (0.05)	0.638				0.444
Means (S)	8.989	9.492	8.231	8.545	
L.S.D (0.05)	0.366				

CONCLUSION

We conclude from the research that the date of 15 July is the best in terms of the traits of the yield and its components mentioned above. Therefore, it is the most suitable date than the dates of 25 June and 5 August for planting sorghum. Stimulating sorghum seeds by soaking them with alpha amylase enzyme for 24 hours has a positive effect on the seeds and the plants resulting from them, as the concentration of 1 mg L^{-1} was the best in terms of yield and its components.

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