Tikrit Journal for Agricultural Sciences
ISSN:1813-1646 (Print); 2664-0597 (Online)
Journal Homepage: http://www.tjas.org
E-mail: tjas@tu.edu.iq

TJAS
Tikrit Journal for Agricultural Sciences

DOI: https://doi.org/10.25130/tjas.25.4.23

Effect of Seed Stimulation with the Amino Acid Tryptophan and Yeast on Seed Emergence, Growth, and Sorghum crop

Ahmed Ch. Al-Fahad , and Yaseen Abd AL-Janabi
Department of field crops College of Agriculture, University of Anbar

***Correspondence: ag.ahmedch.ali@uoanbar.edu.iq**

KEY WORDS:
Yeast powder, amino acid tryptophan, sorghum

Received: 20/06/2025
Revision: 08/09/2025
Proofreading: 18/11/2025
Accepted: 25/10/2025
Available online: 31/12/2025

ABSTRACT

The experiment study of field was conducted in an agricultural field in Anbar Governorate, Ramadi District, throughout the spring period of 2024, for investigation effect of seed stimulation with amino acid (tryptophan) and dried yeast suspension on the distinctness of field and several characteristic of growth and yield of sorghum. Applied the experiment of 2-factor by Randomized Complete Block Design (RCBD) through split-plot system and 3 duplicate, the seed stimulation treatment with the amino acid tryptophan at concentrations of 100 and 200 mg L-considered the major factor Furthermore the control treatment no spraying. The secondary factor was spraying yeast at three concentrations 1500, 2500 and 3500 mg L^{-1}, furthermore the control treatment no spraying. The best results according to the statistical analysis were for tryptophan at a concentration of 200 mg L-1, which showed the fewest days for the flowering period, which amounted to 66.00 days, the highest plant length, the largest leaf size, the chlorophyll index, the number of grains per head, weight for 500 heads, and the individual plant productivity, which amounted to 197.25 cm2, 4615 cm2, 53.33 SPAD, 2018.5 grains per head, 14.66 g, and 58.94 g respectively. Regarding the results of spraying by dry yeast , the concentration of 3500 mg was superior, giving the highest average field emergence percentage (74.11%) and field emergence speed (66.56%). The lowest number of days to reach 75% flowering (67.22 days) was recorded, as were the highest averages for plant height, leaf size, the grains number of per head, the weight of 500-grain , and individual the crop of plant (191.78 cm², 4306 cm², 53 SPAD, 1984.4 grains per head, 14.22 g, and 56.69 g), respectively. This study concludes that stimulating seeds with dry yeast suspension or the amino acid tryptophan, especially at high concentrations, improved in field indicators, growth and sorghum crop , and that this would provide effective treatment for seeds suffering from weak germination.

تأثير تحفيز البذور بالحامض الاميني التربتوفان والخميره في بزوغ البذور ونمو وحاصل الذرة البيضاء

احمد الفهد و ياسين الجنابي
قسم المحاصيل الحقلية ، كلية الزراعة ، جامعة الانبار ، العراق

الخلاصة
نفذت تجربة حقلية في الحقول الموجودة في محافظة الانبار قضاء الرمادي للعروة الربيعية لعام 2024، بهدف دراسة تأثير تحفيز البذور بتراكيز من الحامض الاميني التربتوفان, ومعلق الخميرة الجافة في البزوغ الحقلي وبالإضافة الى العديد من صفات نمو وحاصل نبات الذرة البيضاء. طبقت تجربة بعاملين باستعمال نموذج القطاعات الكاملة العشوائية بتصميم الالواح المنشقة و3 تكررات، مثل العامل الرئيسي معاملة تحفيز البذور الحامض الاميني 100 و200 ملغم **لتر**$^{-1}$، علاوة الى معاملة المقارنة دون استخدام الرش، اما العامل الثانوي فمثل رش الخميرة بثلاث تراكيز (1500 و2500 و3500) ملغم لتر$^{-1}$ بالإضافة الى معاملة المقارنة دون استخدام الرش. اظهرت نتائج التحليل الاحصائي تفوق الحامض الاميني التربتوفان بالتركيز 200 اقل عدد ايام للتزهير بلغ 66 يوم، واعلى ارتفاع للنبات والمساحة الورقية ودليل الكلوروفيل وعدد الحبوب بالراس ووزن 500 جبة وحاصل النبات الفردي بلغت 197.25سم و4615 سم^2 و53.33 سباد و2018.5 حبه راس و14.66غم و58.94 غم بالتتابع. اما عن تأثير الرش بمعلق الخميرة الجافة فقد تفوق التركيز 3500 ملغم من عند حقنه بالتربة في صفة نسبة البزوغ الحقلي وسرعة البزوغ الحقلي بإعطائها اعلى متوسط لهما بلغ 74.11% و66.56% بالتتابع، وسجلت اقل عدد من الايام وصولا لنسبة 75% من مرحلة التزهير (67.22 يوم) وبالإضافة لاعلى متوسط من الارتفاع في طول النبات والمساحة الورقية ودليل الكلوروفيل وعدد الحبوب بالراس ووزن 500 جبة وحاصل النبات الفردي (191.78 سم و4306 سم^2 و53 سباد و1984.4 حبة راس و14.22غم و56.69 غم) بالتتابع. يستنتج من هذه الدراسة ان تحفيز البذور بمعلق الخميرة الجافة او بالحامض الاميني التربتوفان لاسيما بالتركيز العالية أدى تحسين في مؤشرات البزوغ الحقلي ونمو وحاصل الذرة البيضاء، وان هذا من شأنه ان يعطي معالجة جيدة للبذور التي تعاني من ضعف الانبات.
الكلمات المفتاحية: معلق الخميرة الجافة، الحامض الاميني التربتوفان، الذرة البيضاء.

INTRODUCTION

Sorghum [*Sorghum bicolor* (L.) Monech] is a supreme annual harvest of summer due to its diverse uses. It is used as human food and animal feed in some poor countries and has multiple industrial uses. It ranks fifth globally after wheat, rice, barley, and maize. The global cultivated area is estimated at approximately 40.12 million hectares for the years 2021 and 2022, with a production of 62.659 million tons (USDA, 2022). It is a crop that tolerates some types of stress, the most important of which is its tolerance to salinity compared to maize. In Iraq, the cultivation of white corn is relatively weak although the greatness of this crop, due to the problems and obstacles that hinder its cultivation, such as its weak field germination, which leads to a decrease in plant density and consequently a decrease in productivity per unit area.

The vitality and emergence of seedlings are affected by external factors related to soil type and environmental conditions (Al-Dawoodi and Al-Fahad, 2021a, b; Al-Issawi and Al-Fahad, 2023). Internal factors related to the nutritional stores and hormonal systems of seeds. With increasing environmental pressures and limited resources, there is a need to adopt sustainable technologies to enhance crop growth and productivity. These technologies include seed induction techniques, a promising method for improving field seed emergence, vegetative growth, and flowering. These techniques involve preparing seeds with biological or chemical stimulants before planting. Among the substances that have proven effective in seed induction is yeast suspension, which is rich in vitamins such as B vitamins, amino acids, enzymes, and plant hormones similar to auxins and gibberellins. These substances help stimulate the enzymes responsible for analyzing nutrients within the seed, improving the seed's ability to germinate and resist environmental stresses (Khalil *et al.*, 2020). Field studies have shown that spraying the vegetative system or soaking seeds in yeast suspensions increased plant dry weight, leaf number, and leaf area, indicating increased photosynthetic efficiency (Abd El-Aziz & Balbaa, 2007). The synthesis of the natural auxin hormone in plants also depends primarily on tryptophan. It is converted into auxin within plant tissues, promoting cell division and elongation, positively impacting early growth, root development, and shoot growth. Studies have shown that stimulating seeds with tryptophan stimulates root growth and increases germination speed, in addition to stimulating the production of proteins necessary for early growth (El-Awadi *et al.*, 2011), enhancing plants' ability to tolerate salt stress, and improving overall physiological performance (Difei *et al.*, 2018). The combined use of yeast and tryptophan may have a cumulative effect through their combined effect on hormone production and improving plant nutritional status (Ahmed *et al.*, 2015; Abdallah & El-Ashry, 2022), which supports the idea of using this technique to effectively stimulate sorghum seeds.

Increasing germination rate and yield are goals that any farmer and agricultural researcher aspires to. Therefore, the goal of cultivating sorghum and stimulating its seeds with amino acids and yeast was to enhance their ability to germinate and field emergence, which would be reflected in seedling activity, evolution and final harvest of crops.

MATERIAL AND METHODS

A field experiment was conducted during the spring 2024 in an agricultural field in Ramadi District, Anbar Governorate, to investigate the effects of seed priming with the amino acid tryptophan and a dried yeast suspension on growth performance and yield traits sorghum.

Applied the experiment of 2-factor by Randomized Complete Block Design (RCBD) through split-plot system and 3 duplicate, The experiment involved 2 factors: In first treatment which included spraying the tryptophan at a concentration of 100 and 200 mg L^{-1}, Furthermore to the control treatment no spraying, which occupied the main panels, where the tryptophan applied as a first spray on the vegetative group when the plant had 5 leaves and until completely wetted using a 10-liter sprayer with the addition of the bright spreading material to increase the surface tension and the second spray before flowering. As for the second factor, it included three concentrations of yeast (1500, 2500, and 3500) mg L^{-1}, Also, to the control treatment no spraying, which occupied the secondary panels, with two sprays, the first after planting and before germination by injecting it into the soil and the second spray at the vegetative growth stage before flowering until completely. The field soil was prepared by plowing and leveling it well, and then the experimental structure was set up by dividing the field into 27 units with a 3-replicate system. The measurements of each unit were set to 3×3 and it was divided into holes with a space of 75 cm between each hole and 25 cm between each hole.

Three seeds were planted per hole on March 20, 2024, then it decreased to a single seedling at the germination stage. The field soil was enriched with fertilizers, according to the recommendations, with DAP fertilizer (N18% and P2O5 46%) when preparing of (100) kg ha-1 the soil (Iraqi Ministry of Agriculture, 2006). Urea fertilizer was also added to the plant at average of (400kg ha^{-1}) applied in two portions: the first portion after the completion of the field distinctness process and the plant reaching the 4-leaf stage (Cheyed *et al.*, 2014), and the second portion 40 days after the first batch (Iraqi Ministry of Agriculture, 2006). Crop care was applied like irrigation and manual the plants were harvested when they reached the physiological maturity stage at the end of July. Preparation of concentrations of tryptophan and dried yeast suspension.

The concentrations of L-tryptophan were prepared by dissolving the eights using 50% NaO_2 base with a small amount of 50% ethyl alcohol and distilled water in separate glass flasks. These were placed on a magnetic stirrer hotplate until the substance was completely dissolved. The volume was then increased to 1 liter with water to obtain the desired concentrations. Commercial dried yeast (Saccharomyces cerevisiae) was used, and four concentrations (1500, 2500, and 3500) mg L^{-1} were prepared. Each was added to 1 liter of warm distilled water containing 0.5 g of sucrose for activation. The flasks were placed in an incubator at 25°C for two hours (Chalutz *et al.*, 1977).

Field emergence percentage(%)

The trait was calculated 10 days after planting using the following equation and after determining the number of seeds in each hole (ISTA, 2013).

Field emergence (%) = (Number of seedlings emerging after 10 days ÷ Total number of seeds) × 100

Field emergence rate

After five days planting, the field emergence rate trait calculated using the following equation after determining the seeds number in every hole (ISTA, 2013).

Field emergence rate = (Number of seedlings emerging after 5 days ÷ Total number of seeds) × 100.

Days Number from planting to 75%flowering (days):

The flowering rate was calculated from planting until others appeared from the median lines.

Plant height (cm)

Ten plants were selected from the middle rows near the soil facing up to the top after flowering was complete. (El-Hosary *et al.,* 2011).

Leaf area ($cm^2 plant^{-1}$)

Using the equation below, the leaf area was calculated for 10 plants that reached the flowering stage at a rate of 100%, selected from the midribs of the studied replicates.

Leaf area (cm^2) = length of the fourth leaf × maximum leaf width × 6.18 (Al-Sahouki and Jihad, 2014).

Leaf chlorophyll index (SPAD)

Chlorophyll concentration in the leaves was measured using a chlorophyll meter to determine the degree of leaf greenness. Three readings were taken from three leaves selected from the midrib for each experiment and each replicate then the average was taken and measured in SPAD units (Blackmer and Schepers, 2013).

Grains number per head (grain head^{-1})

It was calculated for 10 plants after harvesting the heads, the average taken for each experimental unit (Al-Alahni, 2017).

Weight of 500 grains (g)

The trait was calculated by weighing 500 grains from the harvested plants using a sensitive balance for each experimental unit (Micheall, 2003).

Yield per plant (g plant^{-1})

Ten plant heads were selected for seed weight measurement; these were chosen from the midlines of each experimental unit, and plant yield was determined by averaging. For statistical analysis, using the GenStat statistical analysis program, averages analyzed and compared by the least significant difference (LSD, *P*<0.05) test (Kadem and Abed, 2018).

RESULTS AND DISCUSSION

Field emergence is an indicator of the strength and vigor of seedlings under field conditions and the surrounding environmental and biotic stresses, which are linked to field establishment, subsequent growth, and crop yield (Mustafa and Cheyed, 2018; Al-Rawi *et al.,* 2024). The results showed the treatment with dried yeast suspension in concentration of 3500 mg L^{-1} arrived to the highest average field emergence rate for 74.11%, outperforming all other concentrations. The treatment, however, produced the lowest significant decrease average for this trait, at 67.56% (Table 1). The reason for this increase when using a high-concentration dried yeast suspension may be due to the increased growth and improvement of the shoot and root when added to the soil. This is because it contains certain plant hormones that stimulate germination and elongation, such as auxins and cytokines, which increase the rate of field emergence (El-Kholy *et al.,* 2007). As for the amino acid tryptophan, it increased the field emergence rate when sprayed at a concentration for 200 mg L^{-1}, recording the highest a significant increase average of 72.25%, compared of the treatment without spraying, it is recorded the lowest significant decrease average for this trait, 69.58%. This result is consistent with what Klupczyńska (2021) found regarding breaking the dormancy of some seeds to increase the rate of emergence. The interaction also had a significant effect on this trait, as the interaction is another important factor affecting this trait, as the study showed the highest significant increase for the mixture (3500 mg yeast × 200 mg tryptophan), where the field maturity rate reached 75.67%, unlike the control treatment, which showed the lowest rate for this trait, reaching 64.67%.

Table 1. The effect of tryptophan and yeast stimulate seed on the field emergence rate of sorghum.

Tryptophan (mgL^{-1})	**Yeast (mgL^{-1})**				**Mean**
	0	**1500**	**2500**	**3500**	
0	64.67	69.33	71.33	73.00	69.58
100	69.00	71.67	72.67	73.67	71.75
200	69.00	71.57	72.77	75.67	72.25
Mean	67.56	70.85	72.22	74.11	
LSD α 0.05	**Tryptophan**	**Yeast**	**Tryptophan × Yeast**		
	0.29	**1.06**	**0.69**		

The highest rate was recorded for dry yeast suspension in the 3500 mg L^{-1} concentration where highest average by 66.56% compared with control, which produced a lower average for 55.22% (Table 2)This may be due to the properties of yeast, which has the ability to increase the cell's ability to elongate and divide, thus increasing enzyme activity within the seeds and increasing the rate of germination. (Hammad and Ali, 2014).

The results of table (2) showed that emergence speed increased with increasing tryptophan concentration, yielding 66.75%, at concentration of 200 mgL^{-1}, whereas the percentage decreased to 54.83% for the control treatment. The trait was also greatly significant by the 2-way interaction, as the combination (3500mgL^{-1} of yeast suspension + 200mgL^{-1} of tryptophan) recorded the elevated average emergence speed, arrived 75.00%, whereas the control treatment of both factors arrived at the lowest average for this trait, arrived 51.33%. We believe the reason is due to the role of tryptophan which stimulates all processes related to the rapid division and elongation of meristematic cells, which quickly differentiated into a mature embryo, producing a strong seed consisting of the shoot and a root. This result is consistent with (Jiang *et al.*, 2024; Yusuf *et al.*, 2024).

Table 2. The effect of tryptophan and yeast on seed stimulation and field emergence rate of sorghum.

Tryptophan (mgL^{-1})	**Yeast (mgL^{-1})**				**Mean**
	0	**1500**	**2500**	**3500**	
0	51.33	54.00	56.33	57.67	54.83
100	55.67	58.33	62.33	67.00	60.83
200	58.67	64.00	69.33	75.00	66.75
Mean	55.22	58.78	62.67	66.56	
LSD α 0.05	**Tryptophan**	**Yeast**	**Tryptophan × Yeast**		
	0.65	**0.75**	**1.30**		

The stimulation treatment with a 3500 mg L^{-1} dry yeast suspension showed the largest decrease in the number of days, 67.22 days, to arrive at 75% flowering, while unsprayed plants took 72.89 days to reach this stage (table 3). This may be due to the role of yeast suspension as a source of cytokinin, which increased cell division and elongation, thus decreasing the days number to flowering due to the completion of the reproductive organs of the sorghum plant when sprayed with the powder. This result is consistent with Sead and Abido (2014).

The lowest number of days to flowering was recorded by seeds stimulated with high concentrations of tryptophan, at 67.22 days, compared with the control, where it reached the highest days number, at 72.89 days. This may be the role played by the tryptophan in regulating flowering time, reducing inhibitory activity, increasing photosynthetic efficiency, physiological responses, and the plant's transition from the vegetative growth phase to the reproductive growth phase. Our results agree with the findings of Domagalska *et al*. (2010) and Alwutayd *et al*. (2024). The interaction between the two study factors also showed a significant effect on the rate of this trait. Plants treated with the high concentration of yeast powder and tryptophan occupy the least days number to arrive 75% flowering, at 61.67 days, compared with the control group, which took a long time to reach this stage for both treatments, the duration was (72.89 days).

Table 3. Effect of seed stimulation with the amino acid tryptophan and yeast on days number to flowering (75%) of sorghum.

Tryptophan (mgL^{-1})	**Yeast (mgL^{-1}) 0**	**1500**	**2500**	**3500**	**Mean**
0	76.33	74.33	73.00	70.67	73.58
100	73.67	70.33	69.67	69.33	70.75
200	68.67	67.33	66.33	61.67	66.00
Mean	72.89	70.67	69.67	67.22	
LSD α 0.05	**Tryptophan**	**Yeast**	**Tryptophan × Yeast**		
	0.88	**0.60**	**1.12**		

The results of the study, as shown in table (4), indicated a significant increase in plant height after soaking the seeds in a dry yeast suspension with a concentration of 3500 mg L^{-1}, As shown in Table (4), the highest mean was 191.78 cm for the treatment group compared to 175.44 cm for the control group. The cause behind the significant increase in plant height may be because of the stimulating effect of the yeast suspension on cell division and plant growth, due to the production of growth-promoting substances such as cytokinin, gibberellins, and vitamins. In addition, the dry yeast suspension contains amino acids, mineral elements, and nitrogen, which increase the growth rate (Sead and Abido (2014).

The study results showed that the highest average plant height reached 197.25 cm when treated with tryptophan at a concentration of 200 mg L^{-1} while the control treatment recorded the lowest plant height, at 172.67 cm, this may be due to the high nitrogen content of amino acids, which stimulates auxin production, which encourages cell division and elongation, thus increasing plant height (Nilesh *et al.,* 2012; Al-Janabi *et al.,* 2024).

As for interaction, the two stimulation treatments with the highest concentrations of dry yeast suspension and tryptophan (3500 and 200 mg L^{-1}), respectively, recorded the highest plant height, at 208.33 cm, while the control treatment for both recorded the lowest value for this trait, at 164.67 cm.

Table 4. The effect of tryptophan and yeast on the seed stimulation of height trait of sorghum

Tryptophan (mgL^{-1})	**Yeast (mgL^{-1}) 0**	**1500**	**2500**	**3500**	**Mean**
0	164.67	173.00	175.00	178.00	172.67
100	173.00	181.33	186.33	189.00	182.42
200	188.67	194.33	197.67	208.33	197.25
Mean	175.44	182.89	186.33	191.78	
LSD α 0.05	**Tryptophan**	**Yeast**	**Tryptophan × Yeast**		
	2.64	**2.05**	**3.64**		

The highest average leaf area was recorded in the yeast treatment group at a concentration of 3500 mg L-1, arrived at 4306 cm^2, compared to the other treatments, while the control group showed the lowest average leaf area, reaching 3847 cm^2, as shown in table (5). This increased because of the yeast suspension's ability to induce the cell division and ability of elongation and increase of cell due to its content of many amino acids, which are source of nitrogen and growth-stimulating plant hormones, which increased the plant's leaf area (Abbas, 2013).

Leaf area also increased when treated with tryptophan at the concentration of 200 mgL^{-1}, reaching 4615 cm^2. Plants who were treated with distilled water, however, observed the lowest average for this trait, arrived 3777 cm^2. This may be due to the ability of tryptophan in stimulating the plant to make hormones such as cytokinin and auxins, which increases the rate of cell division and elongation in all parts of the plant, resulting in increased leaf area. These results are coordinating with those reported by (Sivasankari *et al.* 2014), who reported that tryptophan has a positive effect on vegetative plant growth, including leaf area. Regarding the two-way interaction, we note from (Table 5) that the treatment with dry yeast suspension and high concentration of tryptophan showed the highest average at 5060 cm^2 compared to the control treatment which showed the lowest value at 3567 cm^2.

Table 5. The effect of tryptophan and yeast on seed stimulate the leaf area of sorghum

Tryptophan (mgL^{-1})	**Yeast (mgL^{-1})**				**Mean**
	0	**1500**	**2500**	**3500**	
0	3567	3721	3888	3932	3777
100	3767	3835	3693	3925	3805
200	4207	4443	4750	5060	4615
Mean	3847	4000	4111	4306	
LSD α 0.05	**Tryptophan**	**Yeast**	**Tryptophan × Yeast**		
	121	**115**	**193**		

In table (6), the results indicated that the chlorophyll index in leaves differed significantly when treated with a high-concentration dry yeast suspension (3500 mg L^{-1}), recording the elevated average of 53 SPAD, which is significantly difference at concentration of 2500 mgL^{-1}. In control treatment group; however, produced the lowest chlorophyll index, at 49 SPAD. This may be due to the role of the dry yeast suspension in stimulating certain enzymes that increase chlorophyll concentration in the leaves, as well as the dry yeast suspension containing amino acids and minerals, of which magnesium is one of the most important components of chlorophyll (Tawfik and Gomaa, 2005). The 200 mgL^{-1} tryptophan treatment showed the upmost chlorophyll index (CI) of 53.33 SPAD, compared to the control treatment, which showed the lowest concentration of 47.67 SPAD. This result is consistent with Sacakli et al. (2013). No significant differences were observed for the 2way interaction between the study treatment.

Table 6. The effect of tryptophan and yeast on seed stimulation of the chlorophyll index of sorghum

Tryptophan (mgL^{-1})	**Yeast (mgL^{-1})**				**Mean**
	0	**1500**	**2500**	**3500**	
0	45.33	46.67	48.67	50.00	47.67
100	51.00	51.00	51.33	53.00	51.58
200	51.33	52.67	53.33	56.00	53.33
Mean	49.22	50.11	51.11	53.00	
LSD α 0.05	**Tryptophan**	**Yeast**	**Tryptophan × Yeast**		
	0.75	**1.98**	**N.S**		

The upmost average number of grains per head was 1984 grains $head^{-1}$ when using a concentration of 3500 mg L^{-1} while the lesser average was 1817 grains $head^{-1}$ when treated with distilled water. Perhaps the reason for these results is the role played by the high concentration of dry yeast suspension in improving the growth characteristics of sorghum plants, including leaf area and chlorophyll index (tables 5 and 6), The increase in the number of grains is attributed to the increased qualification of photosynthesis, which in turn increases the rate of food production and consequently raises the fertility rate. Thus, our study's results are consistent with those of Al-Janabi et al. (2021), who concluded that an elevation fertility rate leads to an elevation in the number of grains.

Table 7 showed the upmost average grain head quantity for 2019 obtained with tryptophan treatment at a concentration of 200 mg L^{-1}, compared to the control group, which recorded the lowest average at a concentration of 1789.2 grain head-1. This was interpreted by Biswas (2023) as indicating tryptophan's ability to improve vegetative growth characteristics, leading to improved yield and its components.

Table 7. The effect of tryptophan and yeast on the seed stimulates the number of grains per head trait of sorghum

Tryptophan (mgL^{-1})	**Yeast (mgL^{-1})**				**Mean**
	0	**1500**	**2500**	**3500**	
0	1720	1741	1813	1883	1789
100	1825	1963	1980	1962	1932
200	1906	1997	2062	2108	2019
Mean	1817	1900	1951	1984	
LSD α 0.05	**Tryptophan**	**Yeast**	**Tryptophan × Yeast**		
	1720	1741	1813		

Table 8 showed that the elevated weight of 500 seeds, weighing 14.22 g, was obtained when treated with dry yeast suspension at a concentration of 3500 mg L-1. No significant difference was shown between the two treatments and the concentrations of 2500 and 1500 mg L-1, while the control group showed a significant decrease in weight (12.49 g).

The cause of increase in the weight of 500 seeds at the high concentration of dry yeast suspension is because to its superiority in plant height, leaf area, and chlorophyll index (tables 4, 5, and 6), which increased the products of photosynthesis and consequently increased the amount of processed nutrients transferred from their primary source (leaves and stems) And finally, it reached the seeds. Yeast contains many enzymes and metabolic derivatives such as fats, proteins, and amino acids, which stimulate physiological processes within the plant, which positively impacts the yield and its components (Sacakli, 2013 and Abbas, 2013). (Table 8) shows that stimulating the seeds with tryptophan at concentration of 200 mgL^{-1} resulted in the upmost seed weight of 14.56 g, while the weight of 500 seeds decreased to 11.79 g in the control treatment. This increase in seed weight may be due to this treatment affecting most growth traits, which positively impacted the crop and its components (Yazdanpanah *et al*. 2011). Regarding the interaction, the combination (3500 mgL^{-1} yeast + 200 mgL^{-1} tryptophan) arrived at the upmost average for the above trait, reaching 16.00 g, while the weight of 500 seeds decreased in the control treatment for both yeast and tryptophan, reaching 11.58 g.

Table 8. The effect of tryptophan and yeast on seed stimulation the weight of 500 sorghum seeds

Tryptophan (mgL^{-1})	**Yeast (mgL^{-1})**				**Mean**
	0	**1500**	**2500**	**3500**	
0	11.58	12.00	11.87	11.67	11.78
100	12.47	14.67	13.65	15.00	13.95
200	13.42	14.15	14.67	16.00	14.56
Mean	12.49	13.60	13.39	14.22	
LSD α 0.05	**Tryptophan**	**Yeast**	**Tryptophan × Yeast**		
	0.61	**0.76**	**1.22**		

Plant yield continued to increase significantly with increasing concentrations of dry yeast suspension seed stimulation. Table 9 shows that the high significant plant crop was achieved at a concentration of 3500 mg, averaging 56.69 g $plant^{-1}$ while the control group treatment showed the lowest crop at 45.59 g $plant^{-1}$. The cause for the increase may be consequent to the role of the dry yeast suspension in increasing vegetative growth feature, particularly plant height and leaf area (tables 4 and 5). This led to enhancing the plant's efficiency to access light, elevating the rate of photosynthesis and the accumulation and transfer of dry things to the estuaries. Our results are consistent with those of (Hu et al. 2017), who attributed the increase in weight to the increased number of seeds (tables 7 and 8), which would raise the economic return.

We note from the table that treating the seeds with concentration of 200 mgL^{-1} of tryptophan yielded the magnificent seed yield, arrived 58.94 g $plant^{-1}$, while the control treatment decreased the yield to 42.14 g $plant^{-1}$. This increase is due to the close correlation between yield and its components when the seeds are stimulated with a high concentration of tryptophan. This result supports the findings of Sivasankari et al.(2014) .

The interaction between the two study factors, treating the seeds with the high significant concentration of both studies, resulted in the highest seed yield value, reaching 67.6 g plant^{-1}, while the two-way interaction of the control treatment with both study factors showed the lowest average, at 40.11 g plant^{-1}.

Table 9. The effect of tryptophan and yeast on the seed stimulates the plant yield trait of sorghum

Tryptophan (mgL^{-1})	**Yeast (mgL^{-1})**				**Mean**
	0	**1500**	**2500**	**3500**	
0	40.11	41.79	43.03	43.63	42.14
100	45.49	57.60	54.02	58.85	53.99
200	51.17	56.50	60.50	67.60	58.94
Mean	45.59	51.96	52.52	56.69	
LSD α 0.05	**Tryptophan**	**Yeast**	**Tryptophan × Yeast**		
	2.86	**3.56**	**5.69**		

CONCLUSION

The seed stimulation technique of using dry yeast suspension or tryptophan amino acid, especially at higher concentrations, improved seed vigor and field emergence, which was subsequently reflected in improved vegetative growth characteristics. This increased efficiency in dry matter production, which positively impacted seed yield and its components. Depending on the results of our study, we suggest soaking seeds that suffer from poor germination and field emergence with dry yeast suspension, tryptophan amino acid, or both. This includes sorghum, which many local studies have confirmed has poor field emergence. This can significantly improve field emergence, extending this effect to plant yield and improving vegetative growth indicators.

CONFLICT OF INTEREST

The authors declare no conflicts of interest associated with this manuscript.

ACKNOWLEDGMENTS

The authors would like to thank workers at the College of Agriculture in University of Anbar for their generous help and technical and scientific assistant in cover this research.

REFERENCES

Abbas, S.M. (2013). The influence of biostimulants on the growth and on the biochemical composition of *Vicia faba* CV. Giza 3 beans. Romanian Biotechnological Letters; 18 (2):8061 -8068.

Abd El-Aziz, N.G., & Balbaa, L.K. (2007). Influence of tyrosine and zinc on growth and chemical constituents of Cupressus sempervirens seedlings. American-Eurasian Journal of Agricultural and Environmental Sciences, 2(4), 422-429.

Abdallah, M.M.F., & El-Ashry, S.M. (2022). Enhancing growth and yield of wheat using yeast extract and amino acids as seed priming agents. Plant Archives, 22(1), 155-162.

Ahmed, M.A., El-Sayed, E.A., & El-Bassiouny, H.M.S. (2015). Effect of seed priming with yeast extract and tryptophan on growth, yield and some biochemical aspects of rice. Middle East Journal of Agriculture Research, 4(2), 278-285.

Al-Alahni, N.S. (2017). The Effect of seed stimulation, seed measurement, and seed depth on field emergence, growth, and yield of white sorghum. PhD Thesis, Department of Field Crops, College of Agriculture, University of Baghdad.

Al-Dawoodi, R.M. & Al-Fahad, A.C. (2021). Vitality of sorghum seeds affected by storage duration and seeds stimulation with iron nanoparticles. IOP Conference Series: Earth and Environmental Science, 904(1), 012069.

Al-Issawi, A.K.M. & Al-Fahad, A.C. (2023 b). Response of sorghum seeds to soaking with antioxidants (Glutathione) and grown at three temperatures in laboratory conditions. IOP Conference Series: Earth and Environmental Science,2023. 1259(1), 012096.

Al-Issawi, A.M. & Al-Fahad, A.C. (2023 a). effect of foliar application of glutathione on viability and vigor seeds of sorghum effected by heat stress. IOP Conference Series: Earth and Environmental Science, 2023. 1252(1), 012026.

Al-Janabi, Y.A., Abood N.M. & Hamdan M.I. (2021). The effect of amino acids and the date of planting on some growth traits of the three varieties of maize. In IOP Conference Series: Earth and Environmental Science. IOP Publishing, 04: 012064.

Al-Janabi, Y.A., Al-Fahad A. Ch., Al-Hadeethi M.A., Sutthisaksopon P. & Rahman H. Kh. (2024). Variations in growth, yield, and anatomy of three varieties of soybeans (*Glycine max* L.). Anbar Journal of Agricultural Sciences.22(2):882-897

Al-Rawi, A.S.M., Shachai, N.F. & Cheyed, S.H. (2024). Effect of spraying dates with concentrations of nano-zinc on some maize growth traits, yield quality traits and field emergence. Yield Traits IOP Conference Series: Earth and Environmental Science, 1371(5), 05201

Alwutayd, K.M., Alghanem S.M.S., Alwutayd R., Alghamdi S.A., Alabdallah, N.M., Al-Qthanin, R.N. & Abeed A.H. (2024). Mitigating chromium toxicity in rice *Oryza sativa* L. via ABA and 6-BAP: Unveiling synergistic benefits on morphophysiological traits and ASA-GSH cycle. Science of The Total Environment، 908، 168208.

Biswas, S. Seal P., Majumder B. & Biswas A.K. (2023). Efficacy of seed priming strategies for enhancing salinity tolerance in plants: An overview of the progress and achievements. *Plant Stress*، 100186.

Blackmer, T.M & Schepers J.S. (2013). Use of a chlorophyll meter to monitor nitrogen status and schedule fertigation for corn. Journal of Production Agriculture 8(1): 56 – 60.

Chalutz, E., Lieberman M. & Sisler H.D. (1977). Methionine induced ethylene production by *Penicillium digitatum*. Plant Physiology. 60: 402-406.

Cheyed, S.S., Hashem M.H. & Qasim S. (2014). Optimum first application of urea for some sorghum cultivars. The Iraqi Journal of Agricultural Sciences – 45(2): 151-156.

Difei, L., Weiqi, Z. & Qiang C. (2018). Tryptophan application improves plant growth and alleviates salt stress in maize seedlings.Plant PhysiologyandBiochemistry,129,456-466. https://doi.org/10.1016/j.plaphy.2018.06.012

Domagalska, M.A., Sarnowska E., Nagy F. & Davis S.J. (2010). Genetic analyses of interactions among gibberellin, abscisic acid, and brassinosteroids in the control of flowering time in Arabidopsis thaliana. PloS one, 5(11), e14012.

El-Awadi, M.E., Hassan, H.M., & Abdel-Latif, A.M. 2011. Physiological role of tryptophan and gibberellic acid on growth and productivity of maize plant. *Research Journal of Agriculture and Biological Sciences*, 7(3), 271-281.

EL-Hosary, A.A.A. Sedhom, A.S. & EL-Badawy, M.EL.M. (2011). Genetical and biometrical analysis for some important traits in maize. LAP Lambert Academic Publishing, ISBN978-3-8465-3211-9, paperback,156 Pages

El-Kholy, M.H., Omar M.N.A. & Saleh Z. Sh. (2007). Growth response of wheat crop to microbial inoculation and yeast strain under different mineral phosphorus fertilizer levels at Journal of Soil Sciences and Agricultural Engineering.32(2):1513- 1520

Elsahookie, M.M. & S.H. Cheyed. (2014). Estimating the leaf area of sorghum using a single leaf. Iraqi Journal of Agricultural Sciences, 45(1):1-5.

Hammad, S.A.R. & Ali O.A.M. (2014). Physiological and biochemical studies on drought tolerance of wheat plant by application of amino acids and yeast extract. Annals of Agricultural Sciences, 59(1):133- 145

Hu, S., Sanchez, D. L., Wang, C., Lipka, A. E., Yin, Y., Gardner, C. A., & Lübberstedt, T. (2017). Brassinosteroid and gibberellin control of seedling traits in maize (*Zea mays* L.). Plant Science, 263, 132-141.

Iraqi Ministry of Agriculture. (2006). Guidelines for Sorghum Cultivation and Production, General Authority for Agricultural Guidance and Cooperation, Abu Ghraib. Sorghum Research Development Project, Guidance Bulletin No. 19.

ISTA (International Seed Testing Association). (2013). International Rules for Seed Testing. Adopted at the Ordinary Meeting. 2012, Budapest, Hungary to become effective on1st January 2005. The International Seed Testing Association. (ISTA).

Jiang, W., Lu C., Xu X., Riaz M.W., Aimin L.V., & Shao Q. (2024). Strigolactones: Biosynthetic regulation، hormonal interaction، and their involvement in abiotic stress adaption. Scientia Horticulturae, 325, 112689.

Kadem, F.A., & Abed N.Y. (2018). Application of statistics and analysis of agricultural experiments (practical part). Ministry of Higher Education and Scientific Research, College of Agricultural, University of Baghdad, Iraq. Pp:200.

Khalil, S.E., Eissa, A.M., & Abd El-Maksoud, H.M. (2020). Role of yeast extract and seaweed extract in improving germination and growth of maize under salinity stress. International Journal of Agricultural Technology, 16(6), 1391–1402.

Klupczyńska, E.A., & Pawłowski T.A. (2021). Regulation of seed dormancy and germination mechanisms in a changing environment. Int. J. Mol. Sci., 22(3):1357.

Micheall, T. (2003). Grain sorghum, Harvesting, Drying and Storage. Institute of Food and Agriculter Scince., *Agricultural Engineering Extension Publications*.p. 9.

Mustafa, A.S., & Cheyed, S.H. (2018). Effect of seed priming of organic, biochemical and mineral fertilizers on seed vigor of sorghum. International Journal of Agricultural and Statistical Sciences, 14(1), pp. 239–244.

Nilesh, G., Chakrborti P., Rai A. K., & Gupta P.C. (2012). Effect of Plant growth regulator on growth response and yield component in wheat *Triticum aestivum* L. Crop . Research Journal of Agricultural Sciences.3 (1): 204-208.

Sacakli, P., Koksal B.H., Ergun A. & Ozsoy B. (2013). Usage of brewer's yeast *Saccharomyces cerevisiae* as a replacement of vitamin and trace mineral premix in broiler diets. Revue de Médecine Vétérinaire.164(1):39-44.

Sead, S.E. & Abido W.A.E. (2014). Reducing in newly reclaimed sandy saline soils due to wheat nitrogen fertilization by using natural and safety substances. *International Journal of Agronomy and Agricultural Research*.5(2): 11-21

Sivasankari, B., Anandharaj M. & Daniel T. (2014). Effect of PGR producing bacterial strains isolated from vermisources on germination and growth of *Vigna unguiculata* (L.) Journal of Biochemical Technology,5(4):808-813.

Tawfik, M.M. & Gomaa A.M. (2005). Effect of organic and biofertilizers on the growth and yield of wheat plants. *Egyptian Journal of Agricultural Research*, 2(2): 711-725.

USDA. (2022). United States Department of Agriculture. Foreign Agricultural Service. Retrieved 6 July 2022.

Yazdanpanah, S. Baghizadeh, A. & Abbasi, F. (2011). The interaction between drought stress and salicylic acid and ascorbic acid on some biochemical characteristics of *Satureja hortensis*. African Journal of Agricultural Research, 6(4), 798-807.

Yusuf, M., Saeed, T., Almenhali, H. A., Azzam, F., Hamzah, A.I.A.H. & Khan T.A. (2024). Melatonin improved efficiency of 24-epibrassinolide to counter the collective stress of drought and salt through osmoprotectant and antioxidant system in pea plants. Scientia Horticulturae، 323، 112453.