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Response of Bread Wheat Crop to the Spray of Alcoholic Sugars and A balanced Mineral Fertilizer in the Central Region of Iraq

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Abstract

Two field experiments were conducted during the season 2021-2022 in central Iraq represented by the Al-Muthanna governorate - Al-Majd District and Al-Qadisiyah governorate / Al-Nouriah Research Station to determine the productivity of the Baghdad 3 cultivar from spray foliar fertilization of Macro and Micro elements with alcoholic sugars and half the fertilizer recommendation for addition floor, three treatments were used for fertilization: T1 as the control treatment and T2 with alcoholic sugar fertilization at a concentration of 20 $g.L^{-1}$ + the fertilizer combination of Macro and Micro elements, and T3 with alcoholic sugar fertilization at a concentration of 40 g.L-1 + the fertilizer combination of Macro and Microelements, at irrigation 55% of the water is depleted available water. The results showed that the seasonal water consumption was 437.5 and 425 mm in Al-Muthanna and AL-Qadisiyah locations, respectively and spraying with alcoholic sugars and fertilizer combination (balanced mineral fertilizer and micro-elements) during the different growth stages achieved significant differences in plant height, leaf area, number of branches plant-1 and chlorophyll content and it showed the success of the integrated fertilizer combination to spray nitrogen, potassium and microelements in the presence of alcoholic sugars with sorbitol with fertilization with triple superphosphate before planting 20 kg ha-1, and urea fertilizer 156 kg ha-1 under the conditions of the current experiment. The total yield of wheat was (4000 kg ha-1) and (5300 kg ha-1) at T2 and T3 fertilization treatment, respectively, compared to T1 treatment (5780 kg ha-1) in Al-Muthanna province. In Al-Qadisiyah Governorate location, the weight of the total yield increased with the fertilization treatments T2 (3768 kg ha-1) and T3 (4332 kg ha-1) compared to the treatment of T1 fertilization (3264 kg ha-1).

Keywords: Sorbitol, foliar, Macro Micro elements, water productivity and wheat

Introduction

Alcoholic sugars are organic compounds derived from sugar. They are a hybrid between sugar and alcohol molecules, without ethanol. Common alcoholic sugars include one the following ingredients: maltitol, sorbitol, xylitol, erythritol, mannitol, isomalt, and hydrogenated starch gluten. Alcoholic sugars are characterized by the following characteristics: their molecular weight is low, they require little or no energy to form complexes and rapid transfer within the plant, highly stable in basic pH solutions and do not need to adjust the pH because they are dissolved in all media with a linear structural shape so they are quickly absorbed as well as Its product in the plants, With increase absorption period of leaves to micro and macro nutrients. It works to absorb and transfer nutrients directly into the phloem quickly, and prevents the activity of most types of pathogenic bacteria that may infect agricultural crops. Alcoholic sugars bind with metal anions [1,2].

Wheat is one of the most important grain crops in the world, it is of nutritional importance and influential in the economy and politics of most countries of the world. About 35% of the world's population depends for their food on this crop, which together with other crops constitutes 65% and 50% of the total global production of cereals and protein, respectively [3]. Iraq is one of the original places for the emergence of the wheat crop. However, the conditions and factors of salinization and desertification due to the less of rains, weak vegetation cover and traditional agricultural services play a major role in low productivity and poor quality. so, it needs urgent to increase production in quantity and quality. Therefore, the current study came within the plans and strategies of the Ministry of Agriculture by adopting the national program for the development of wheat cultivation in Iraq, supporting and balanced fertilizer program with major and micro nutrients as ground addition or foliar spray as one of the quick solutions in raising the metabolic efficiency of the plant while making maximum use of fertilizer programs and overcoming the unsuitable environmental conditions, which leads to best growth and highest production. In order to address the shortage in wheat production in Iraq, it is necessary to use modern agricultural technologies and sciences in production processes and rationalize the care of fertilization programs without damaging and polluting the soil, and human safety is found, as well as fertilizer has reduced in use and costs. As the use of quantities in excess of the prescribed limit causes wasting large quantities of it and is considered an economic loss due to rising costs.

Therefore, the study aims to: Adding fertilizers in appropriate quantities and times is an important factor in the success of fertilization programs, by increasing the time required for the leaves to absorb macro and micronutrients by adding them with alcoholic sugars. It is one of the successful scientific methods for treating nutrient deficiencies and knowing their effect on the growth and yield of wheat crop in two different locations, the addition of mineral fertilizers to the ground additives is half of the recommended amounts.

Materials and Methods

Executing the experiment

Two field experiments were conducted during the agricultural season 2021-2022 in central Iraq represented by the Al-Muthanna governorate - Al-Majd District/ in the agricultural land owned by the farmer Shubra Ahmed Abdul Karim and Al-Qadisiyah governorate/ Al-Nouriah Research Station to determine the productivity of the Baghdad 3 wheat crop from nutrition or foliar fertilization For Macro and Microelements with alcoholic sugars and half the fertilizer recommendation for ground addition.

Field preparation and agricultural processes

The basic measurements and analyzes of soil were conducted using the standard methods mentioned in [4, 5] (Table 1). The land is tillage by a moldboard, after which the field is leveled by laser. The field was divided into plot, the plot area is 30 m2, leaving an interval of 1.5 m between one plot and another and 2 m between the replicate for controlling the horizontal movement of water. Experimental units were planted with *Triticum aestivum* L. Baghdad 3 cultivars on 5/12/2021 and 2/12/2021 in first and second locations, respectively, at a seeding rate of 140 kg ha^{-1}. All crop service processes were conducted manually and periodically during the entire growing season, and the plants were harvested on 20/5/2022 and 12/5/2022 in Muthanna and Qadisiyah locations, respectively. The study included the following fertilizer treatments (Table 2):

The irrigation process was conducted after depleting 55% of the available water (the electrical conductivity of irrigation water = 3.1 dSm^{-1} in the Al-Muthanna governorate location and 3.6 $dS\ m^{-1}$ in the Al-Qadisiyah governorate location) of the plant for the 0-0.2 m layer from cultivation to vegetative growth and the water depth was increased Irrigation for the layer 0-0.4 m from the beginning of the flowering stage until the harvest by monitoring the moisture content in the soil and using the weight method. In order to control the amount of water added for the purpose of compensating for the moisture deficiency for each treatment, plastic tubes with a diameter of 3 inches were used and a water meter was connected at the end of it, according to the depth of water that must be added to compensate for moisture depletion using (Equation 1) [6] and according to the seasonal water need according to Water Balance Equation (Equation 2):

Attributes and measurements studied during the experiment:

$$d = (\theta_{fc} - \theta_w) \times D \text{.....(1)}$$

where: -

d = depth of water added (mm)

Θfc = volumetric moisture content at field capacity

Θw = volumetric moisture content before irrigation

D = soil depth at effective roots (mm)

$(I+P+C) - (ET_a+D+R) = \Delta S$ ... ... (2)

where:

Table (1): Some physical and chemical properties of field soil before planting

Properties	location		Units
	Al-Qadisiyah	Al-Muthanna	
Sand	232	532	g kg^{-1} soil
Silt	660	380	
Clay	108	88	
Soil Texture	Silt loam	Sandy loam	
Bluk density	1.42	1.46	µg m^{-3}
Volumetric moisture content at 33 kPa	0.241	0.211	$cm^3.cm^{-3}$
Volumetric moisture content at 1500 kPa	0.171	0.154	
Electrical conductivity EC 1:1	4.77	3.20	dS m^{-1}
pH	7.81	7.63	
Organic matter	6.90	9.14	gm.kg^{-1} soil
carbonate minerals	298	321	
available nitrogen	21.00	29.00	mg.kg^{-1} soil
available phosphorous	11.76	13.98	
available potassium	295	220	

Table (2): study fertilizer treatments

NO.	Treatment	Spraing date (Day after germination)	Fertilization
T1	Control		The experimental land was fertilized with tri superphosphate fertilizer before planting 20 ha^{-1}, while urea fertilizer 156 kg ha^{-1} was add in three batches: a quarter of the amount at t beginning of the tillering stage, half of the amount in t elongation stage, and the last quarter in the bo ing stage.
T2	Alcoholic sugars at concentration of 20 gm L^{-1}Sorbit Calcium Chelate +The fertilizer recommendation used in the control treatment	30	spray 3000 mg N L^{-1} (urea as a source of nitrogen 46% N) + 4500 mg K L^{-1} (potassium sulfate fertilizer K 41%) + 20 g L^{-1} Alcoholic sugars
		45	Spraying microelements (program combination Fe, Zn, Cu, Mn) at a rate of 800 g ha^{-1} + 20 g L^{-1} Alcoholic sugars
		60	spray 3000 mg N L^{-1} (urea as a source of nitrogen N46%) + 4500 mg K L^{-1} (potassium sulfate fertilizer K 41%) + 20g L^{-1} Alcoholic sugars
		80	spray 3000 mg N L^{-1} (urea as a source of nitrogen N46%) + 4500 mg K L^{-1} (potassium sulfate fertilizer K 41%) + 20 g L^{-1} Alcoholic sugars
		95	Spraying microelements (program combination Fe, Zn, Cu,Mn) at a rate of 800 g ha^{-1} + 20 g L^{-1} Alcoholic sugars
T3	Alcoholic sugars at concentration of 40 gm L^{-1}Sorbitol Calcium Chelate+The fertilizer recommendation used in the control treatment	30	spray 3000 mg N L^{-1} (urea as a source of nitrogen 46% N) + 4500 mg K L^{-1} (potassium sulfate fertilizer K 41%) + 40 g L^{-1} Alcoholic sugars

		45	Spraying microelements (program combination Fe, Zn, Cu, Mn) at a rate of 800 g ha^{-1} +40 g L^{-1} Alcoholic sugars
		60	spray 3000 mg N L^{-1} (urea as a source of nitrogen N46%) + 4500 mg K L^{-1} (potassium sulfate fertilizer K 41%) + 40 g L^{-1} Alcoholic sugars
		80	spray 3000 mg N L^{-1} (urea as a source of nitrogen N46%) + 4500 mg K L^{-1} (potassium sulfate fertilizer K 41%) + 40 g L^{-1} Alcoholic sugars
		95	Spraying microelements (program combination Fe, Zn, Cu, Mn) at a rate of 800 g ha^{-1} + 40g L^{-1} Alcoholic sugars

I = depth of irrigation (mm)

P = rain water depth (mm)

C = capillary height of water (mm), assuming it is zero because the groundwater is deep.

ETa= actual evaporation transpiration (mm)

D = depth of drainage water (mm) = zero because deep leaching losses are 0.

R = runoff water (mm) = 0.

Δ S = change in soil moisture storage between the beginning and end of the season.

Randomized Complete Block Design was used with three replications and treatments were distributed on the plot randomly so that the number of experimental units was 9 experimental units in each location. The data were statistically analyzed using the SAS program [7] and the averages were compared when the least significant difference (LSD) test at the 5% level. Study traits were selected from the midlines of each experimental unit, as the plant height (cm) and the flag leaf area (cm^2 $plant^{-1}$) were measured when flowering was completed, according to [8]. The number of branches $plant^{-1}$ and the chlorophyll content, spike length (cm), 1000 grains and grain yield kg ha^{-1}.

Results and Discussion

Total water requirements

Table 3 show the amount of seasonal water consumption, the quantity of irrigation water and the number of irrigations for full irrigation treatments (when 55% of the available water is depilation) during the entire season. The seasonal water consumption reached 437.5 and 425 mm in Muthanna and Qadisiyah locations, respectively.

Table (3): Water balancing factors for wheat crop

Amount of water used (m^3/ha)	Water consumption ETa (mm)	Irrigation Water Depth (mm)	Rain Water Depth (mm)	number of irrigations	location
4375	437.5	425	12.5	12	Al-Muthanna
4250	425	418.6	6.4	12	Al-Qadisiyah

vegetative growth traits

Table (4) show the effect of spraying with alcoholic sugars and the fertilizer combination (balanced mineral fertilizer and micro-elements) during the different stages of growth in plant height (cm) in Muthanna and Qadisiyah locations. It is noted that there are significant differences in the average plant height as a result of the effect of spraying with alcoholic sugars at different levels with the fertilizer combination. The T3 treatment excelled by giving the highest average plant height of 110 cm with an increase of 10% and 23.60% compared to T2 and T1 treatments, respectively. Also, T2 treatment excelled on T1 treatment with an increase of 12.36% in Muthanna location. The table also shows that there are significant differences between the values of the average plant height in Al-Qadisiyah location, where the T3 treatment excelled by giving the highest average plant height of 99 cm with an increase of 8.79% and 12.5% Compared to T2 and T1, respectively. Also, T2 treatment excelled on T1 treatment with an increase of 3.41%.

Table (4) shows the effect of spraying with alcoholic sugars and the fertilizer combination (balanced mineral fertilizer and microelements) during the different stages of growth in the leaf area (cm^2). It is noticed that there are significant differences in the average leaf area as a result of the effect of spraying with alcoholic sugars at different levels with the fertilizer combination. The T3 treatment excelled by giving the highest average leaf area of 43.89 cm2 with an increase of 33.89% and 106.25% compared to T2 and T1 treatment, respectively. T2 treatment excelled on T1 treatment with an increase of 54.04% in Muthanna location. The table also shows that there are significant

differences between the values of the average leaf area in Al-Qadisiyah location, as T3 treatment excelled by giving the highest average leaf area amounting to 39.78 cm2 with an increase of 29.75% and 96.35% compared to treatment T2 and T1 respectively. Also, T2 treatment excelled on T1 treatment with an increase of 51.33%. The results in Table 3 show that there is a significant effect of the treatments of spraying with alcohols sugar and the fertilizer combination (balanced mineral fertilizer and microelements) on the number of tillering. plant^{-1} at the study location in Muthanna. The plants of the fertilization treatments achieved significant differences between them that amounted to 4, 7 and 9 (number of tillering) for the T1, T2 and T3 fertilization treatments, respectively, and the chlorophyll content was 42, 50 and 52 for the T1, T2 and T3 fertilization treatments, respectively.

Table (4): Effect of spraying with alcoholic sugars and fertilizer combination on plant height (cm), leaf area (cm^2), number of plants tillering $^{-1}$, and chlorophyll content

Al-Qadisiyah					Al-Muthanna				
Chlorophyll content	number of tillering	Leaf area	plant height	Fertilization treatments	Chlorophyll content	number of tillering	Leaf area	plant height	Fertilization treatments
----	----	20.26	88	T1	42	4	21.28	89	T1
----	----	30.66	91	T2	50	7	32.78	100	T2
----	----	39.78	99	T3	52	9	43.89	110	T3
----	----	30.23	93	mean	48	6.67	32.65	100	mean
		5.43	4.25	LSD 0.05	2.33	2.12	4.21	5.11	LSD 0.05

Wheat yield indicators

Table (5) show the effect of spraying with alcoholic sugars and the fertilizer combination (balanced mineral fertilizer and micro-elements) during the different stages of growth in the spike length of the during the agricultural season 2021/2022 in the Muthanna province location. It was noticed that there were significant differences in the spike length as a result of the different fertilization treatments, where the spike length was (17 cm) and (21 cm) when the T2 and T3 fertilization treatments, respectively, compared to the T1 (13 cm) treatment. In Al-Qadisiyah province location, the spike length increased with the fertilization treatments T2 (16 cm) and T3 (21 cm) compared to the fertilization treatment T1 (11 cm).Table (4) also show the effect of spraying with alcoholic sugars and the fertilizer combination (balanced mineral fertilizer and microelements) during the different growth stages in the weight of 1000 grains during the agricultural season 2021/2022 in the Muthanna province location, It

was noticed that there were significant differences in the weight of 1000 grains as a result of the different fertilization treatments, where the weight of 1000 grains reached (43 g) and (46 g) when the T2 and T3 fertilization treatments, respectively, compared to the T1 (40 g) treatment. In Al-Qadisiyah province location, the weight of 1000 grains increased with T2 (40 g) and T3 (43 g) fertilization treatments compared to T1 (38 g) fertilization treatment. It is noted from Table (4) the effect of spraying with alcoholic sugars and the fertilizer combination (balanced mineral fertilizer and micro-elements) on the total yield of wheat during the agricultural season 2021/2022 in the locations of Al-Muthanna and Al-Qadisiyah province location. It was noticed that there were significant differences in the total yield as a result of the different fertilization treatments, where the total yield of wheat reached (4000 kg ha^{-1}) and (5300 kg ha^{-1}) when the T2 and T3 fertilization treatments, respectively, compared to the T1 treatment (5780 kg ha^{-1}). in Al Muthanna province location. In Al-Qadisiyah province location, the weight of the total yield increased with the fertilization treatments T2 (3768 kg ha^{-1}) and T3 (4332 kg ha^{-1}) compared to a treatment of T1 fertilization (3264 kg ha^{-1}). Water productivity increase in T1 (0.89, 1.21 kg m^{-3}) and T2 (1.02, 1.32 kg m^{-3}) compared with T1 (0.77, 0.91 kg m^{-3}) in Al-Qadisiyah and Al-Muthanna, respectively.

Table (5): Effect of spraying alcoholic sugars and fertilizer combination on spike length (cm), weight of 1000 grains (gm) and total yield (kg ha^{-1}) and water productivity (kg m^{-3})

Al-Qadisiyah					Al-Muthanna				
water productivity	Total yield	Weight of 1000 grain	spike length	Fertilization treatments	water productivity	Total yield	Weight of 1000 grain	spike length	Fertilization treatments
0.77	3264	38	11	T1	0.91	4000	40	13	T1
0.89	3768	40	16	T2	1.21	5300	43	17	T2
1.02	4332	43	21	T3	1.32	5780	46	21	T3
0.89	3788	40	16	mean	1.15	5027	43	17	mean
0.13	288	2.26	2.08	LSD 0.05	0.15	316	2.78	2.16	LSD 0.05

It is evident from the results of the current study (Tables 4 and 5) that the increase in plant height, leaf area and spike length may be due to the important role of foliar fertilization with the fertilizer combination of Macro and Micro nutrients with alcoholic sugars at concentrations of 20 gm L^{-1} and 40 gm L^{-1} during different growth stages. Alcoholic sugars increase the time required for the leaves to absorb macro- and micronutrients before drying, and work to absorb and transfer nutrients directly into the bark, which is a unique feature of the sugar-alcoholic fertilizers [9]. Micronutrients (iron, zinc, copper and manganese) also work. There is a role for iron in the formation of many cytochromes and ferredoxin compounds of great importance in the photosynthesis process, which leads to an increase in their rates and then an increase in growth average, which is reflected in an increase in plant height, leaf area and spike length.

The existing chlorophyll increases in the presence of microelements, where nutrients have an important role in the formation of this pigment, and by increasing this pigment, the photosynthesis process increases, which leads to an increase in plant height, leaf area and spike length. [10] indicated the presence of micro-nutrients leads to an increase in the concentration of chlorophyll pigment, and then to an increase in the process of photosynthesis, and then an increase in the plant height. Also, many types of research indicated the great role of zinc in microelements in increasing plant height and leaf area. Zinc has a direct role in the formation of the amino acid Tryptophan, from which the hormone IAA is derived, which is necessary for cell elongation. In the direction of increasing the flag area, in addition to the role of nitrogen, phosphorous and potassium in activating the photosynthesis process, and then increasing plant height and leaf area, it is known that potassium has an effective role in increasing the division of living cells of the plant and encouraging the growth of meristematic tissues, which leads to increased plant growth [11 and 12]. Also, the increase in the of flag leaf area in wheat plants resulting from the addition of micro-nutrients may be due to its role in increasing the efficiency of the photosynthesis process by increasing the content of plant pigments and the formation of energy compounds with the activation of a number of enzymes involved in this process, which increases the outputs of the photosynthesis process. It provides a better opportunity for the growth and expansion of the flag leaf area, which has a very important role in the photosynthesis process [13]. The grain yield per unit area is the aim of the producers of grain crops, and it is the most important field measure that gives the final assessment of the productive agricultural process. The results of the grain yield indicate that there are significant differences between the control treatment and the foliar fertilization treatments with the fertilizer combination of nitrogen, potassium and microelements with alcoholic sugars. This excelled in grain yield under the integrated fertilizer blend and alcoholic sugars and by adding triple super phosphate fertilizer before planting 20 kg ha-1, and urea fertilizer 156 kg ha^{-1}, This may be attributed to the availability of nutrients that coincide with the emergence and development of the spike from the stage of formation of the branches to the booting stage, which created a better incentive for the growth and development of the spike, which contributed to raising the efficiency of photosynthesis, which was reflected in the growth and increase in the length of the spike. This indicates that the addition of fertilizers with good management led to an increase in the product return, thus achieving an increase in the economic return. It can also be noted that the complete combination of foliar fertilization of nitrogen, potassium and micro-nutrients achieved the highest percentage increase in yield in return for a low economic cost of these nutrients. The spraying of micro-nutrients zinc, iron, manganese and copper on wheat in two stages of plant growth led to the availability of these elements available for absorption in the presence of alcoholic sugars for a longer period [14 and 15].Which led to an increase in the chlorophyll pigment in the leaves of the plant, and then an increase in the efficiency of photosynthesis and the provision of a sufficient amount of food manufactured in the leaves, and the benefit of the rest of the plant parts from it, including spike lets that lead to an increase in the fertilization

process and the production of healthy and strong pollen, especially when zinc is present and this is reflected in the Increase the number of grains and increase the grain yield.

The study conclude the success of the integrated fertilizer combination for spraying nitrogen, potassium and microelements in the presence of alcoholic sugars with sorbitol with ground fertilization with triple superphosphate fertilizer before planting 20 kg ha^{-1}, and urea fertilizer 156 kg ha^{-1} under the conditions of the current experiment and it can be adopted as an alternative to other fertilization systems where it has achieved highest productivity, this means that 75% of the chemical fertilizers can be replaced without significant differences in the grain yield and its components. This We conclude from this study the success of the integrated fertilizer combination for spraying nitrogen, potassium and microelements in the presence of alcoholic sugars with sorbitol with half fertilization under the conditions of the current experiment. This study also showed that the foliar application of alcoholic sugars with sorbitol achieved a significant increase in the total yield with the addition of half of the ground chemical fertilizer recommendation. The results of the study showed that calcium chelated with alcoholic sugars enhanced the absorption of nutrients, the growth of the crop and the dry matter.

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