Response of rice (*Oryza sativa* L.) to foliar application with nutrients and growth regulators

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Abstract:

A field experiment was carried out at the rice research station in Al-Mishkhab in Al-Najaf Al-Ashraf Governorate - Iraq for the summer season 2012, in order to investigate the response of the rice crop, Amber 33 variety, to application with nutrients and a growth regulator and its effect on some growth and yield characteristics. A randomized complete block design was used with three replications.. The results showed that there was a significant effect of the different treatments in the experiment, as the treatment of application with the nutrient (GZ) with the growth regulator (Setter-2) achieved the highest averages for the characteristics of plant height, flag leaf area, weight of 1000 grains, and grain yield, reaching 143.73 cm, 21.37 cm^2, 26.22 g, and 5.657 $tons.ha^{-1}$,respectively. depending on the previous data, we can conclude that the use of a combination of nutrients containing nitrogen and potassium with growth regulators such as ascorbic acid and citric acid may lead to an increase in the crop's ability to metabolize and thus increase the growth and yield characteristics of the crop.

Keyword: Rice, nutrient, growth regulator

Introduction:

Rice (*Oryza sativa* L.) is considered one of the main grain crops in the world, especially the countries of South and East Asia, which top the list of countries in producing and exporting this crop, as it feeds on about three billion people, and thus it is considered the basic food for most of the population of the globe more than any other crop (13). Its nutritional importance comes from the fact that it contains a high amount of easily digestible carbohydrates that a human needs in food to provide him with energy, in addition to the fact that rice protein has a balanced content of essential amino acids, especially lysine, compared to other grain crops (5). The reports of the Food and Agriculture Organization of World stated that the global production rate for the year 2021 is about 787 million tons for a cultivated area of about 165 million hectares, while in Iraq the cultivation of this crop still suffers from many difficulties, which affected on the production, as the amount of production reached it between 2010 - 2020 is reached 304 thousand tons in all regions of Iraq, with a cultivated area estimated at about one hundred thousand hectares (7), which is a small amount that does not sufficient local need for this important substance, and it is an indicator of the clear decline in the local productivity of this crop.

One of the most important factors in increasing productivity is the crop service operations, and depending on the fertilization and water management, the yield decrease in rice crop can reach from 35-91% (17), as the important role that nutrients play in many physiological processes within Plant such as photosynthesis, respiration, chlorophyll formation, ATP energy production, enzymatic reactions, amino, fatty and nucleic acids building, as well as increasing the efficiency of transporting photosynthetic products from their places of manufacture(source) to the rest of the plant parts are an important basis for plant growth and development (4). In addition, the plant growth regulators, which are organic compounds of great importance in controlling

the biological and physiological processes that occur in the plant, which are synthesized in the different parts of the cells meristematic plant and then transferred to other parts of the plant where they are responsible for one of the biological, biochemical and physiological process or Inhibiting or changing its biological pathway (12). And that plant growth is the result of the interaction between the influence of growth regulators and nutrients. It was found that the process of growth and development as well as yield in plants is greatly affected by combinations of plant hormones with nutrients in both irrigated and non-irrigated conditions (14). Adopting scientific methods to manage the crop service operations, such as fertilization and weed control, can significantly increase crop productivity (16), and rice is one of the crops that well respond to fertilization to improve yield and quality. Nitrogen is also the determining factor for vegetative growth, number of tillers, height of plant, and number of spikes. Also, nitrogen fertilizers are exposed to losses by the leaching and volatilization under immersion and drying conditions (9). Therefore, most of the research focused on nitrogen fertilizers, as (11) found that the use of nitrogen led to a significant increase in yield and its components characteristics of rice plants. As for potassium, it is one of the major nutrients necessary for the growth and production of rice. It has a major role in the formation of sugars, starch and protein, It also affects the increase in the area of the flag leaf and the photosynthesis by stimulating various enzymes and activating of the transporting of photosynthesis products from the source to the sink (1). As for (8), he was found that the treatment of foliar fertilization with nitrogen and potassium was significantly effective in giving the highest rate of grain yield, biological yield and the number of tillers per plant.

The production ability of any variety of rice, whatever its specifications, depends on the service operations applied according to the correct scientific foundations, so it was necessary to invest the means to raise the productivity. Among the most important ways to achieve this goal is the interest in mineral nutrition because of its great role in improving the growth and productivity of this crop. Therefore, due to the importance of rice, this experiment was carried out with the aim of knowing the effect of foliar application of nutrients and growth regulators on some growth and yield characteristics of rice crop.

Materials and methods:

A field experiment was carried out at the rice research station in Al-Mishkhab / Al-Najaf Governorate during the summer agricultural season 2012, in order to investigate the response of the rice crop to foliar nutrients and growth regulators and their impact on the growth and yield of rice (Amber 33 variety). The experiment included four treatments: the nutrient solution treatment GZ (a solution of nitrogen and potassium = N13%, K5%), the growth regulator treatment Setter-2 (containing Ascorbic Acid 5000ppm and Citric Acid 5000ppm), the combination treatment of the nutrient solution GZ with the growth regulator Setter-2 (GZ+Setter-2) and control treatment (without any foliar applied). A randomized complete block design (RCBD) used in this experiment with three replicates. The field was divided into experimental units with an area of (5×3) m, and plowed with two orthogonal plows, and smoothing operations were carried out by means of disc harrows, and the land was leveled. Seeds were sown by direct sowing by the dry method on 6/28/2012 with 180 g per experimental unit according to 120 $kg.h^{-1}$. Phosphate fertilizer 72 kg.ha-1 phosphorus was added in the form of a compound fertilizer (18 - 18) N-P when preparing the soil, and nitrogen fertilizer 130 $kg.ha^{-1}$ nitrogen in the form of urea (N 46%) in two applications splited, the first once at the beginning of the tillering stage after 35 days From planting and the second after 30 days from first applying (10). The experiment was irrigated starting when planting,

and the light irrigation operations were repeated every 5-8 days, according to the plant's need, then the continuous irrigation system was applied after the plant reached the age of 25 days. The applications of the treatments began 30 days after planting, with five applications splited, with a period of 10 days between once spray and another. The field was harvested on November 15th.

Studied characteristics:

After completing the experiment, the required characteristics were measured as follows:

1- Plant height (cm): measured from the soil surface level to the end of the panicle for ten random plants at maturity.
2- Flag leaf area (cm2): The flag leaf area was estimated for ten random flag leaves at the beginning of physiological maturity according to the following equation: Flag leaf area = leaf length x maximum width x 0.74 (15).
3- The number of active tillers (tiller. m^{-2}): calculated per square meter of each experimental unit harvested at full maturity.
4- Weight of 1000 grains (g): It was measured by taking a random sample of grains from the yield of an area of 1 square meter harvested. 1000 grains were counted and then weighed with a sensitive electric scale.
5- Grain yield (ton.h^{-1}): It was calculated from the grain yield taken from square meters of each experimental unit. And then the conversion to the total grain yield (ton.ha^{-1}).

statistical analysis:

The data under study was analyzed according to the analysis of variance method for the Randomized Complete Blocks Design (RCBD) using the least significant difference L.S.D to compare between the means at the probability level of 0.05 and using the statistical program Genstat.

Results and Discussion:

Plant height (cm):

The results in Figure (1) showed that there are significant differences between the treatments. The treatment of the nutrient GZ with the growth regulator Setter-2 prevailed in giving the highest rate of this characteristics, reached 143.73 cm, achieving an increase about 14.5% compared to the control treatment (without applying) Which recorded the lowest average plant height of 125.53 cm. As for the two treatments of applied GZ and Setter-2 each separately, there was no significant difference between them and the control treatment. This is consistent with what some researchers found that the use of nutrients with growth regulators may lead to an increase in the positive plant response and then increase growth characteristics such as plant height (2). (3) also indicated that the use of nitrogen fertilizer led to an increase in plant growth significantly in plant height compared to the control treatment. This may be by stimulating the division and elongation of the cells in the stem of the plant, which leads to an increase in the size of the plant tissue, and then the elongation of the internodes, and thus an increase in the size of the plant.

Fig.(1) Effect of the GZ nutrient and the growth regulator Setter-2 treatments on the height of rice plants (cm).

Flag Leaf area (cm^2):

The results showed in Figure (2) that all the treatments had a significant effect on giving the highest means of flag leaf area, as the treatment of the GZ nutrient with the growth regulator Setter-2 achieved the highest mean for this characteristic as it reached 21.37 cm^2 with an increase of 66.56%, followed by the GZ nutrient treatment Alone, then the treatment of the growth regulator Setter-2, reached 19.77 and 17.39 cm^2 for the two treatments, respectively, with an increase of 54.09% and 35.54%, respectively, compared to the control treatment, which recorded the lowest rate of flag leaf area of 12.83 cm^2. This may be due to the role played by nutrients and growth regulators in increasing the efficiency of the photosynthesis process and its products and impact on the rest of the processes that are reflected in the growth characteristics of the plant (12 and 4). Furthermore AL-Jebbori (2017) found that spraying setter-2 solution on the leaves of wheat plant led to a significant increase in flag leaf area. As that the use of nutrients such as potassium affects increase of the flag leaf area and the process of photosynthesis by stimulating various enzymes and activating the process of transporting processed products from the source to the sink (1) and this is consistent with the results of this characteristic.

Number of the active tillers (tiller. m^{-2}):

From the results in Figure (3), it appears that there are no significant differences between all the treatments of the experiment, but we notice a numerical superiority for all the treatments compared to the control treatment, which achieved the lowest mean of the number of the active tillers, reaching 235.0 tillers.m^{-2}, while the treatment of Nutrient GZ with growth regulator Setter-2 had the highest mean for this characteristic, which reached 278.3 tillers.m^{-2}. However, this superiority, it did not reach the level of significance. This may be related to the genetic factor of the variety or the date of treatments applying (one month after planting) whereas the tillering process comes in the early stages of the plant's life. Furthermore (8) indicated that the treatment of foliar fertilization

with nitrogen and potassium was significantly superior in giving the highest number of tillers per plant compared with the control treatment (without spraying).

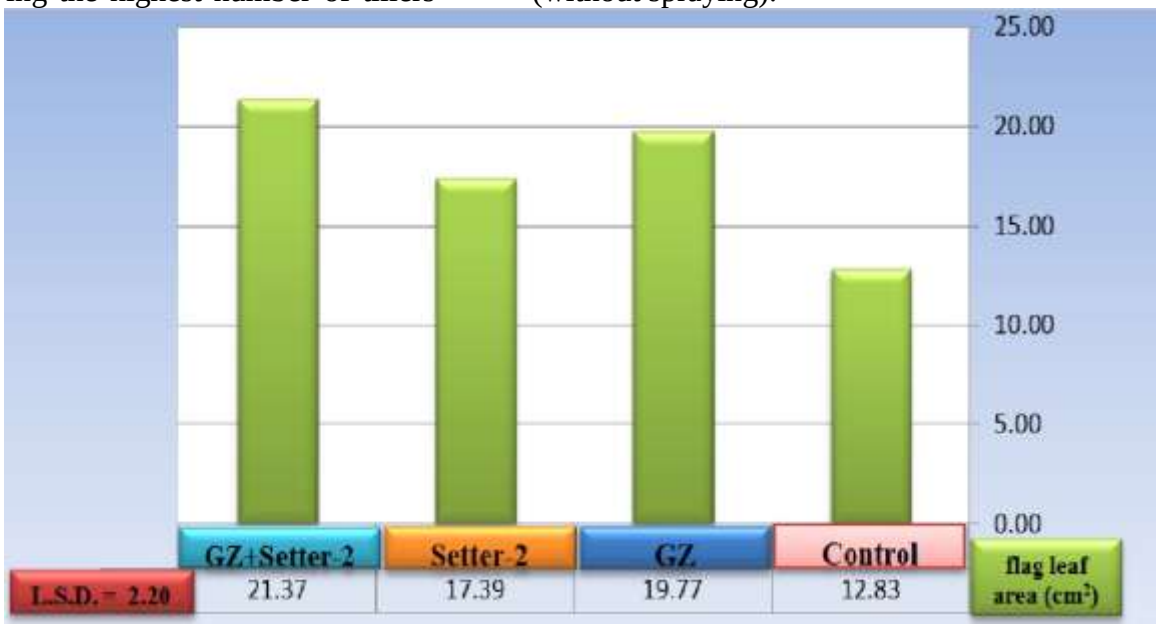

Fig.(2) Effect of the GZ nutrient and the growth regulator Setter-2 treatments on the flag leaf area of rice plants (cm^2)

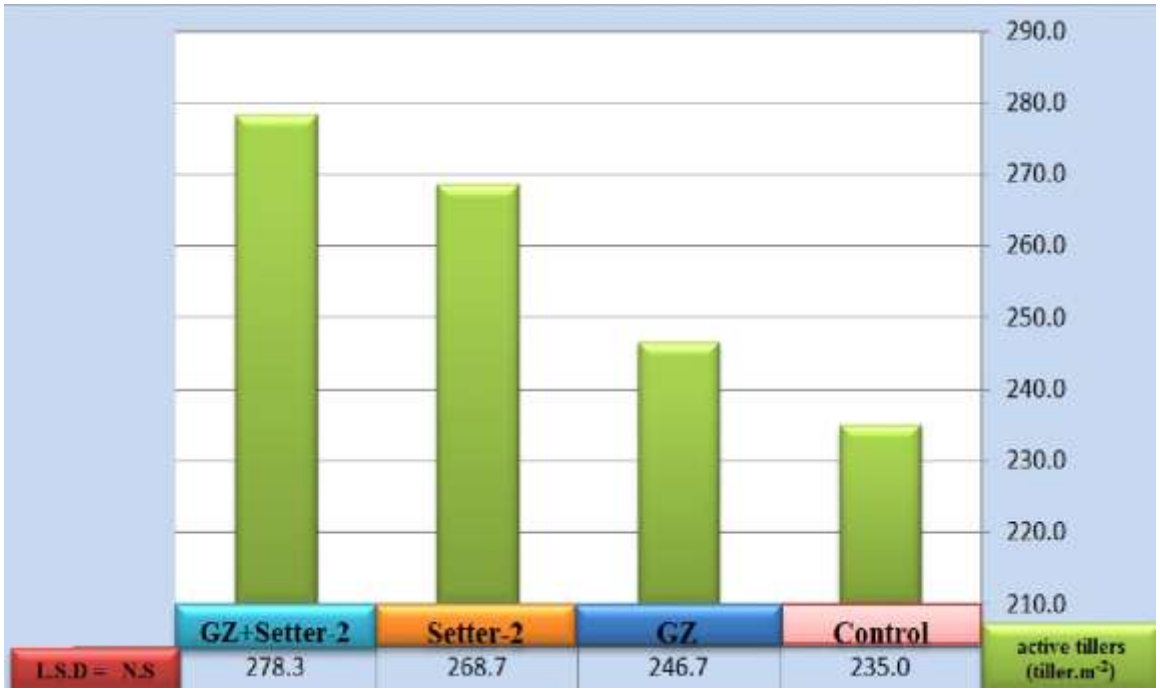

Fig.(3) Effect of the GZ nutrient and the growth regulator Setter-2 treatments on Number of the active tillers in rice ($tiller.m^{-2}$).

Weight of 1000 Grain (g):

The results in Figure(4) show that the different factors in the study had a significant effect on weight of 1000 grains, the treatment of the nutrient GZ with the growth regulator Setter-2 gave the highest value for this characteristic reached 26.22 g , thus achieving an increase in the average weight of 1000 grains of 34.81% compared to the control treatment, followed by the treatment of growth regulator Setter-2 alone, which amounted to 25.19 g, an increase of 29.51% compared to the control treatment, followed by the treatment of the nutrient GZ, reached 24.05 g , an increase of 19.13%, compared to the control treatment, which recorded the lowest value, reached 19.45 g . These results may reflect an important role that nutrients play in many biological and physiological processes within the plant such as metabolism, respiration, chlorophyll formation, ATP energy production, enzymatic reactions, building amino, fatty and nucleic acids, as well as increasing the efficiency of transporting photosynthetic products from source to the sink, which is an important for growth and development of plant (4), which is positively reflected in obtaining the best accumulation of dry matter in the sink (grains). The use of nitrogen positively affects the accumulation of dry matter in rice (6) These results also agree with Al-Aboud et al. (2006) who found that treatment with potassium led to a significant increase in the weight of 1000 grains.

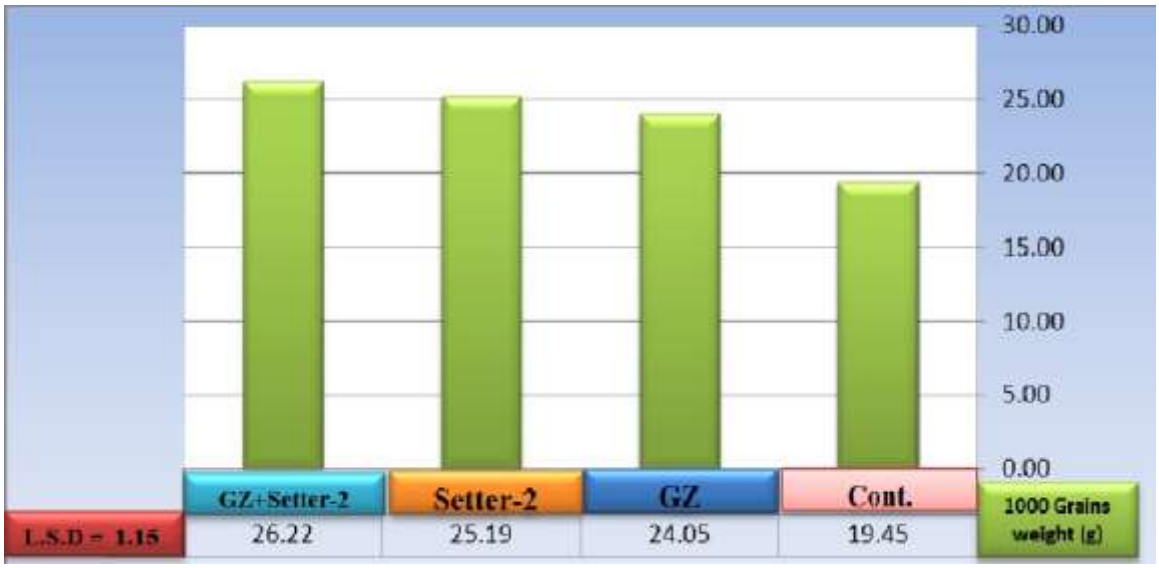

Fig.(4) Effect of the GZ nutrient and the growth regulator Setter-2 treatments on weight of 1000 Grains (g).

Grain yield (ton.ha^{-1}):

The results in Figure (5) show that the treatment of the nutrient GZ with the growth regulator Setter-2 was significantly in the highest value of grain yield, followed by the treatment of the growth regulator Setter-2, reached 5.657 and 5.627 tons.ha^{-1}, respectively, achieving an increase about 48.2% and 47.4% for the treatments, respectively, compared to the control treatment, however, these two treatments did not differ significantly from the of the nutrient GZ treatment alone. As for the lowest value of grain yield, it was recorded by the control treatment, reached 3.817 tons.ha^{-1}. The increase in grain yield may be due to the positive effect of the treatments on growth characteristics and yield components (plant height, leaf area, and weight of 1000 grains) to increase the efficiency of the biological and physiological processes within the crop, which is reflected positively in increasing the yield

components and thus reaching high yield. These results are consistent with (8).

From the results of the current study, we can conclude that the treatment of using the GZ nutrient with the growth regulator Setter-2 was significantly superior in most of the characteristics under study. This enhances the use of growth regulators with foliar nutrients to obtain the highest yield. The nutrients and growth regulator treatments non-significant differ among themselves in most of the characteristics under the study. While the lowest value were in the control treatment, and this confirms the role of foliar feeding and growth regulators in increasing the growth and development of crops, and then obtaining the best results from vegetative characteristics, yield and its components. Based on the above, we recommend using a combination of the growth regulator Setter-2 with the nutrient GZ to obtain the best results for the rice crop.

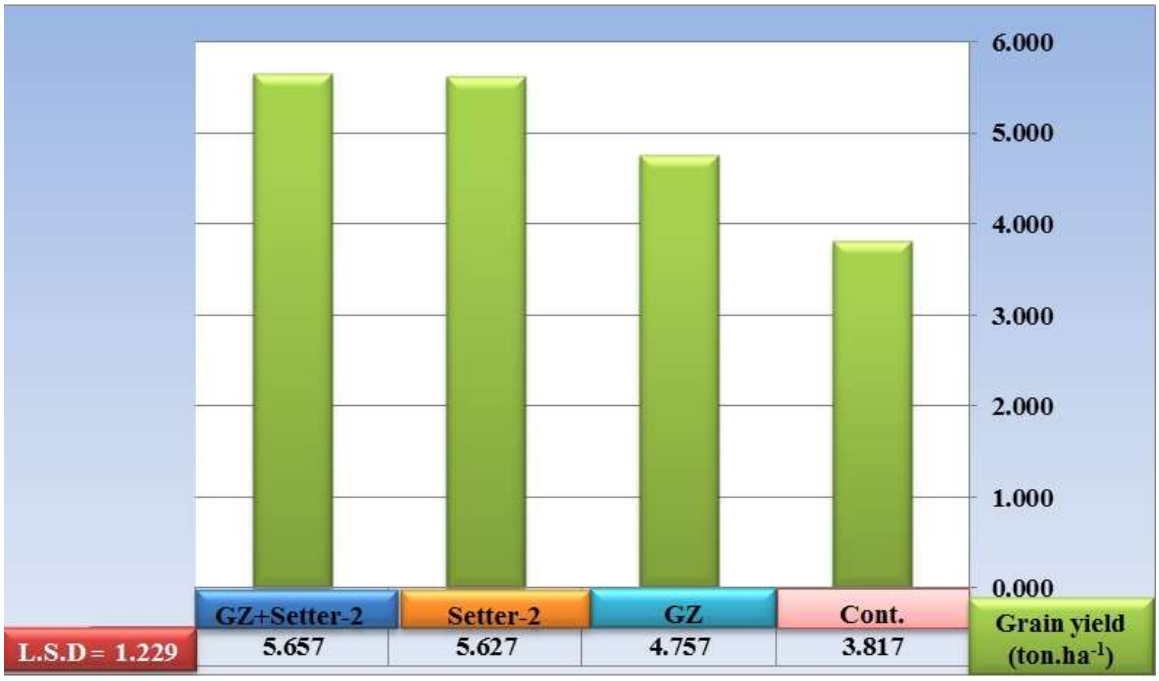

Fig.(5) Effect of the GZ nutrient and the growth regulator Setter-2 treatments on Grain yield (ton.ha^{-1}).

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