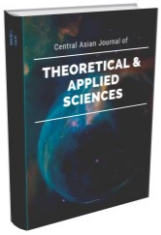

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Article

Response of rice genotypes (*Oryza sativa* L.) to foliar spray with Biozyme TF regulator

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Abstract In order to study the influence of the growth regulator Biozyme TF (foliar applications at three levels: 0, 1.5, and 3 mg L-1, at the physiological stage V3/V4, and then after 15 days) on some growth traits, yield and its components of five rice genotypes ((Anber 6, Anber 33, Pokkali, genotype 13, genotype 14) and some chemical properties, a field experiment was conducted with a RCBD with three replicates in a farmer's farm in Najaf Governorate during the 2024 agricultural season. The results showed that spraying with Biozyme growth regulator led to a clear increase in all studied vegetative growth traits in all genotypes, as the B2 spray treatment outperformed and recorded the highest average of leaf area, panicle length and dry weight, which amounted to 65.00 cm2, 17.832 and 79.00 respectively, compared to the control treatment B0, which recorded the lowest averages. Treatment B2 gave the highest average leaf content of Mg, Cu, Fe and Zn, reaching 243.451, 5.8378, 263.852 and 10.4206, respectively, while the control treatment T0 gave the lowest average for the mentioned traits. Genotype Anber 33 also outperformed other genotypes in the leaf content of copper (6.3911), zinc (10.6456), and iron 326.470.

Keywords: Biozyme TF, *Oryza sativa*, genotype, trace elements.

1. Introduction

Rice (*Oryza sativa* L.) is a major food crop grown In many countries of the world, it is eaten by more than half of the world's population, especially in Asia, where more than 80% of the world's production is consumed [1]. As the Earth's population grows by 2050, demand for rice is expected to increase to 607 million tons based on current consumption [2], however, during the past twenty years, due to climate change, rice production has decreased and this decrease will continue in the future [3], so it is necessary to use several methods, including the use of compounds of natural origin that contain regulators of plant growth and other nutrients that contribute to growth of plant and development through their regulatory role [4] by reducing the negative effects resulting from the plant's exposure to stress and controlling the stimulation or delay of growth, maturation, aging and accumulation of secondary metabolites in the plant [5], Through improving the system of signal transport, encouraging cell division, and the movement and transfer of nutrients towards the treated areas as high metabolic centers, in addition to its effects in enhancing the growth of buds, the development of flowers and fruits, seed germination, improving the qualitative traits, and increasing the productivity of many grain crops like rice [6]. Foliar spraying with Biozyme has been studied on several crops [7, 8, 9]. Biozyme is a natural compound extracted from plants that contains three main types of growth hormones: cytokinins, auxins, and gibberellins, and a group of trace minerals: magnesium, boron, iron, sulfur, and zinc. The results obtained by [10] showed that the maximum rice grain production of (4.88 tons/hectare) was achieved when the leaves of rice plants were sprayed with Biozyme at a concentration of 75% RDF. The role of trace elements added through spray solutions has a positive effect on many physiological processes and improves growth and yield traits, leading to an increase in plant height, flag leaf area, number of tillers, panicle length, and yield [11]. Spraying squash plants with Biozyme TF growth regulator at 1 mg L^{-1} concentration, it resulted in a significant increase in the number of tillers (57.97 tiller. $plant^{-1}$), plant height (109.44 cm), number of panicle (2.13 panicle. $plant^{-1}$) and total yield (43.31 tons ha^{-1}) compared to the treatment of control group, which achieved the lowest averages [12]. [4] found that spraying plants with cytokinins had a significant effect on trait of flag leaf area, reaching 32.55 cm2, because it leads to the accumulation of N element in old leaves and reduces its accumulation in new leaves. [13] observed when treating five wheat genotypes with Biozyme compound, the positive effect of foliar spraying through a clear gradual increase in the leaf content of iron, copper and manganese, reaching 406.3545, 4.0126 and 27.21450, respectively, and the leaf area trait recorded superiority over the rest of the traits, reaching 52.26 cm^2. The results obtained by [14] when treating rice plants with gibberellin at a rate of 25 g ha^{-1} showed a significant increase in plant height, leaf area, dry matter production, number of panicles m-2 and number of filled grains. When five levels of kinetin were used, plant height increased by 6.5%, inflorescences No. (38.5%), stems No. (34.7%), and rice yield (21.6%) compared to the control treatment, In addition, the plant content of NPK increased by 53.2, 27.7 and 10.8% in grains and 83.1, 36.4 and 26.0% in straw, respectively, compared to the control treatment. [15].This study was conducted to evaluate the response of rice genotypes (*Oryza sativa* L.) to foliar spray with Biozyme TF regulator.

2. Material And Methods

In a farmer's field in the city of Al-Mishkab, Najaf Governorate, a field experiment was carried out during the summer season of 2024 with the aim of studying influence of the regulator of growth Biozyme on some morphological and chemical characteristics of three rice varieties (Anber 33, Anber 6, and Pokkali) according to the RCBD

randomized complete block design with three replicates. The seeds were planted on 6/10/2024 at a quantity of 120 kg ha-1, and fertilization was carried out according to the recommendations [16].The growth regulator Biozyme TF produced by the French company Arysta Life Sciences was used, which consists of the three growth regulators (78.8%) cytokinins (83.2 ppm), auxins (32.3 ppm), gibberellins (32.3 ppm) and a group of trace minerals (1.86%), namely S 0.44%, Zn 0.37%, Mg 0.14%, Mn 0.12%, B 0.30%, in addition to (19.27%) of diluting and conditioning agents. The compound was added at three levels (0, 1.5, 3 mg L-1) which are symbolized as N0, N1, N2 respectively) by spraying on the leaves at the physiological stage V3/V4, and after 15 days and Early in the morning, to improve absorption, 5 ml of diluted Tween 20 solution (0.1%) was added to each 20-liter sprayer, and the properties were then measured after 15 days from the third spray. Spray during the budding stage and the second in the flowering stage, at concentrations of (0, 2, 4) mg L-1 using a one-liter hand insecticide in the early morning, and at the maturity stage the plants were harvested on 12/12/2024. Growth and yield traits and their components (flag leaf area cm2, number of active branches plant-1, panicle length cm, number of grains per panicle, weight of 1000 grains g-1, grain yield kg-1, biological yield) were calculated, and some microelements (Fe, Zn, Cu and Mg) were analyzed according to the protocol followed by [17, 18]. Phenotypic data were analyzed statistically by using the program of statistical Genstat Discovery 4, the means were then compared using the test of least significant difference (LSD) at a significance level of 5% [19].

Table (1) Analysis of Chemical and physical properties of soil

Properties	**Unit**	**Results**
Ece	ds m^{-2}	2.47
pH	-	7.6
O.M	mg kg^{-1}	1.13
N	mg kg^{-1}	50.02
P	mg kg^{-1}	21.65
K	mg kg^{-1}	184.42
Sand	mg kg^{-1}	49.00
Silt	mg kg^{-1}	40.48
Clay	mg kg^{-1}	10.52
Soil texture	Silty clay	

3. Results and Discussion

Effect of spraying with Biozyme on vegetative growth traits

1.Leaf area

In data of table (2), the results showed that spraying with Biozyme growth regulator on rice genotypes led to a clear increase in all studied vegetative growth traits. The B2 spray treatment recorded the highest average leaf area of 65.00 cm^2 compared to the control treatment B0, which recorded the

lowest average of 54.8 cm². The genotype Anber 33 recorded the highest average leaf area of 83.33 cm2, while the genotype 14 recorded the lowest average of 33.00 cm². The interaction treatment (Anber 33 × B1) achieved the highest average of 109.00 cm², and the interaction treatment (Genotype 14 × B2) recorded the lowest average of 28.00 cm².

Table (2): The effect of Biozyme compound on the leaf area and the interaction between them

Genotype	B0	B1	B2	Average	L.S.D
Anber 6	74.00	83.00	82.00	79.67	N=0.524
Anber 33	65.00	76.00	109.00	83.33	
Pokkali	73.00	85.00	58.00	72.00	V=0.956
Genotype 13	33.00	42.00	34.00	36.33	
Genotype 14	29.00	28.00	42.00	33.00	N×V=1.656
Average	54.80	62.80	65.00		

Panicle Length

Regarding the panicle length, the highest average was recorded at treatment B2, which amounted to (17.832 cm),, while the control treatment gave the lowest average amounted 16.6 cm, while the Anber 33 gave the highest average of 22.49 cm, and the Genotype 14 gave the lowest average of 10.60 cm. The interaction treatment (Anber 33 x B1) gave the highest average of 24.17 cm, and the interaction treatment (Genotype 14 x B2) gave the lowest average of 9.63 cm (Table 3).

Table (3):The effect of Biozyme compound on the panicle length and the interaction between them

Genotype	B0	B1	B2	Average	L.S.D
Anber 6	19.00	18.66	20.53	19.40	N= N.S
Anber 33	21.00	24.17	22.30	22.49	
Pokkali	19.00	20.66	21.60	20.42	V= 0.943
Genotype 13	13.00	13.00	15.10	13.70	
Genotype 14	11.00	11.17	9.63	10.60	N×V=1.633
Average	16.60	17.53	17.83		

Dry Weight

The treatment B2 recorded the highest average when calculating dry weight, which amounted to 79 g, while treatment B1 recorded the lowest averageof 64.2 g, while the Pokkali variety gave the highest average, which amounted to 113.33 g, while the Genotype 14 gave the lowest average, which amounted to 27.00 g. The interaction treatment (Pokkali × B2) recorded the highest average of 148.00 g, while the interaction treatment (Genotype 14 × B1) recorded the lowest average, which amounted to 21.00 g (Table 4).

No. of inactive tillers

The results of Table (5) indicated that the control treatment was superior in the number of inactive tillers, which reached 10.2 tillers, while the B1 treatment registered the lowest average of 1.00 tillers. The genetic composition Anber 6 recorded the highest average of 10.333 tillers, while the genotype 14 recorded the lowest average of 3.00 tillers. The interaction treatment (Anber 6 x B0) recorded the highest average of 19.000 tillers, while the interaction (Genotype 14 x B1) and (Anber 6 x B1) recorded the lowest average of 0.00 tillers.

Table (4):The effect of Biozyme compound on the dry weight and the interaction between them

Genotype	B0	B1	B2	Average	L.S.D
Anber 6	81.00	76.00	73.00	76.67	N = 0.525
Anber 33	106.00	60.00	91.00	85.67	
Pokkali	87.00	105.00	148.00	113.33	V= 0.959
Genotype 13	23.00	59.00	49.00	43.67	
Genotype 14	26.00	21.00	34.00	27.00	L.S.D N×V
Average	64.60	64.20	79.00		1.661

Table (5):The effect of Biozyme compound on the No. of inactive tillers and the interaction between them

Genotype	B0	B1	B2	Average	L.S.D
Anber 6	19.000	0.000	12.000	10.333	N=0.4395
Anber 33	11.00	0.00	1.00	4.00	
Pokkali	12.00	2.00	2.00	5.33	V=0.8023
Genotype 13	7.00	3.00	1.00	3.66	
Genotype 14	2.00	0.00	7.00	3.00	N×V=1.3897
Average	10.20	1.00	4.60		

No. of inactive tillers

The results of Table (5) indicated that the control treatment was superior in the number of inactive tillers, which reached 10.2 tillers, while the B1 treatment registered the lowest average of 1.00 tillers. The genetic composition Anber 6 recorded the highest average of 10.333 tillers, while the genotype 14 recorded the lowest average of 3.00 tillers. The interaction treatment (Anber 6 x B0) recorded the highest average of 19.000 tillers, while the interaction (Genotype 14 x B1) and (Anber 6 x B1) recorded the lowest average of 0.00 tillers.

Table (5):The effect of Biozyme compound on the No. of inactive tillers and the interaction between them

Genotype	B0	B1	B2	Average	L.S.D
Anber 6	19.000	0.000	12.000	10.333	N=0.4395
Anber 33	11.00	0.00	1.00	4.00	
Pokkali	12.00	2.00	2.00	5.33	V=0.8023
Genotype 13	7.00	3.00	1.00	3.66	
Genotype 14	2.00	0.00	7.00	3.00	N×V=1.3897
Average	10.20	1.00	4.60		

This increase in the studied growth traits: leaf area (Table 2), panicle length (Table3) and dry weight (Table4) may be due to the positive role and effectiveness of growth regulators and its components of microelements such as manganese and iron, which positively affect many physiological processes such as

increasing cell division, improving the efficiency of metabolic processes, transporting materials to the estuary, increasing the level of plant pigments, and the synthesis of many enzymes and proteins, which leads to an increase in leaf area, panicle length, and dry weight [13 , 6], or this is consistent with what was mentioned by [20].

Effect Of Spraying with Biozyme on Yield and Its Components

No. of active tillers

It is clear from the results of Table No. (6) that spraying with the growth regulator "Biozyme " had a significant effect on the crop and its components, as treatment "B2" recorded the highest average number of No. of active tillers, which amounted to 44.6 panicles^{-1}, while the second level B1 recorded the lowest level, which amounted to 40.2 panicles^{-1}. Genotype 14 also gave the highest average, which amounted to 48.67 panicles^{-1}, while the genotype Anber 33 gave the lowest average of 34.33 panicles^{-1}. As for the interaction, the interaction treatment (Genotype 14×B2) gave the highest average, which amounted to 59.00 panicles^{2}, While the two interaction treatments (Anber 33×B1) and (Anber 33×B2) gave the lowest average of 32.00 panicles^{-1}.

Table (6): The effect of Biozyme compound on the No. of active tillers and the interaction between them

Genotype	B0	B1	B2	Average	L.S.D
Anber 6	38.00	46.00	32.00	38.67	N= 0.504
Anber 33	39.00	32.00	32.00	34.33	
Pokkali	37.00	44.00	48.00	43.00	V=0.920
Genotype 13	48.00	43.00	52.00	47.67	
Genotype 14	51.00	36.00	59.00	48.67	N×V= 1.593
Average	42.60	40.20	44.60		

Weight of 1000 grain

It is noted from the data in Table (7) that treatment B2 achieved the highest average for 1000 grain weight trait of 23.50 g, while the control level recorded the lowest average, which amounted to 21.80 g. Genotype 13 gave the highest average of 25.538 g, while Anber33 recorded the lowest average, which amounted to 19.59 g. The interaction treatment (Genotype 14 × B2) recorded the highest average of 26.860 g, while (Anber33 × B2) recorded the lowest average, which amounted to 19.150 g.

Table (7):The effect of Biozyme compound on the weight of 1000 grain (g) and the interaction between them

Genotype	B0	B1	B2	Average	L.S.D
Anber 6	22.66	23.15	23.24	23.01	N=0.3609
Anber 33	24.33	26.43	25.85	25.53	

Pokkali	19.66	21.81	22.41	21.29	V= 0.6589
Genotype 13	19.66	19.96	19.15	19.59	
Genotype 14	22.66	25.00	26.86	24.842	N×V 1.1413
Average	21.80	23.27	23.50		

Grain yield

As for the grain yield trait, the results of Table (8) showed that the treatment of B1 recorded the highest average amounted of 52 g plant^{-1} while the control treatment gave an average of 30.40 g plant^{-1}. The genotype of Pokkali gave the highest average of 51 g plant^{-1} and the genotype 14 gave the lowest average of 23.333 g plant^{-1}. Regarding the interaction, the treatment (Anber 6 x B1) gave the highest average of 95.00 g plant^{-1}, and the interaction treatment (Genotype 14 x B0) gave the lowest average for this trait of 20.00 g plant^{-1}.

Table (8):The effect of Biozyme compound on the Grain yield (g plant^{-1}) and the interaction between them

Variety	B0	B1	B2	Average	L.S.D N
Anber 6	25.00	28.00	95.00	49.33	N= 0.4649
Anber 33	40.00	55.00	50.00	48.33	
Pokkali	45.00	53.00	55.00	51.00	V=0.8488
Genotype 13	22.00	35.00	35.00	30.66	
Genotype 14	20.00	25.00	25.00	23.33	N×V=1.4702
Average	30.40	39.20	52.00		

Biological Yield

The results of Table (9) indicated that treatment B2 achieved the highest average yield of 118.8 g plant-1, and the control group gave the lowest average of 95.2 g plant-1. The Pokkali genotype achieved the highest average of 164.333 tons ha-1, whereas the genotype 14 recorded the lowest average of 50.333 g plant-1. The Pokkali × B2 interaction treatment gave the highest average of 201 g plant-1, whereas the interaction treatments (Genotype 13 × B0), (Genotype 14 × B0), and (Genotype 14 × B1) gave the lowest average of 46.0 tons g plant-1.

Table (9):The effect of Biozyme compound on the biological yield (g plant^{-1}) and the interaction between them

Genotype	B0	B1	B2	Average	L.S.D N
Anber 6	106.00	171.00	101.00	126.00	N= 0.4498
Anber 33	146.00	110.00	146.00	134.00	
Pokkali	132.00	160.00	201.00	164.33	V= 0.8213
Genotype 13	46.00	94.00	84.00	74.66	
Genotype 14	46.00	46.00	59.00	50.33	N×V=1.4225
Average	95.20	116.20	118.20		

Harvest Index

The results of Table (10) showed that treatment B1 gave an average of 45.39% for the harvest index trait, whereas the treatment B2 registered the lowest level of 35.16%. Also, the genotype 14 achieved a significant increase with an average of 46.72%, while the genotype Pokkali registered the lowest average of 31.61%. As for the interaction, the treatment (Anber 6 × B1) gave the highest average of 55.56%, whereas (Anber 6 × B0) was the lowest average of 23.58%.

The reason for the improvement in these results and the increase achieved in the characteristics and components of the crop may be due to the increase in some characteristics, including carbon construction and vegetative growth, which was reflected in the increase in the accumulation of dry matter and its transfer to the ears during the grain filling period [21], these results are consistent with what [10] found, or it may be attributed to the role of the components of the complex of growth regulators and micronutrients which enhances plant growth and increases the yield and its components, including the number of grains in the panicle and weight of 1000 grain [22], which is consistent with what was mentioned by [23].

Table (10):The effect of Biozyme compound on the harvest index % and the interaction between them

Genotype	B0	B1	B2	Average	L.S.D N
Anber 6	27.72	23.58	55.56	35.62	N= 0.510
Anber 33	37.67	27.40	45.46	36.84	
Pokkali	26.37	34.10	34.37	31.61	V= 0.930
Genotype 13	41.68	47.87	37.23	42.26	
Genotype 14	42.36	43.46	54.33	46.72	N×V = 1.611
Average	35.16	35.28	45.39		

Effect Of Spraying With Biozyme On The Leaves Content Of Trace Elements

The results of Table (11, A) showed the effect of spraying with Biozyme on the trace element content of leaves. Regarding manganese, treatment B2 recorded the highest average of 243.45, and treatment B1 recorded the lowest average of 187.50. Genotype 13 recorded the highest average of 257.049, whereas Genotype 14 recorded the lowest average of 183.33. The interaction treatment (Pokkali × B2) showed the highest average of 312.64, whereas the interaction treatment (Genotype 14 × B1) recorded the lowest average of 119.80. Regarding the leaf copper content, treatment B2 achieved the highest average of 5.837, whereas treatment B0 gave the lowest average of 3.8094. The Anber 33 recorded the highest average of 6.3911, whereas the genotype 14 gave lowest average of 3.2733. Regarding the interaction between the two factors, treatment (Pokkali × B2) produced the highest average of 7.5533, in return, the treatment (Anber 6 × B0) recorded the lowest average of 1.48000 (Table 11. B). As for iron, treatment B2 gave the highest average of 263.852, while treatment B1 recorded the lowest average of 212.044. The genotype Anber 33 also achieved the highest average of 326.470, while genotype 14 recorded the lowest average of 187.523. As for the interaction, treatment (Anber 33 × B1) gave the highest average of 378.353, while the interaction treatment (Genotype 14 × B1) recorded the lowest average of 144.504. Table (4). The results of (Table 11, C) indicated that the highest leaf zinc content was recorded in treatment B2, with the highest average of 10.4206, whereas treatment B1 recorded the lowest average of 5.3244. The Anber 33 variety recorded the highest average of 10.6456, in return, the Anber 6 gave the lowest average of 4.7367. The (Anber 33 x B2) achieved the highest

average of 16.0600, whereas the interaction treatment (Anber 6 x B0) recorded the lowest average of 2.2533. Table (11, D).

The reason for this increase in the leaf content of these four elements may be due to the effect of adding these microelements present in the Biozyme compound, which enhanced the concentration of the leaf content of these microelements and increased their absorption as well as improves most of the characteristics of vegetative growth, yield and some of its components. This is what [13] indicated, and this is consistent with what was found by [24].

Table (11): Effect of spraying with Biozyme on the leaves content of trace elements and the interactions between them

A: Manganese (Mn)					
Genotype	**B0**	**B1**	**B2**	**Average**	L.S.D
Anber 6	175.900	275.317	240.407	230.541	N= 0.0609
Anber33	295.380	254.910	211.440	253.910	V= 0.0861
Pokkali	218.399	142.897	312.640	224.645	
Genotype 13	306.147	202.350	262.650	257.049	N× V 0.1492
Genotype 14	191.710	119.800	238.500	183.337	
Average	222.510	187.504	243.451		
B: Copper (Cu)					
Anber 6	1.4800	4.5200	5.2900	3.7633	N=0.04243
Anber33	7.0400	5.3533	6.7800	6.3911	
Pokkali	4.1267	3.4800	7.5533	5.0533	V= 0.06001
Genotype 13	3.7500	2.8967	4.2000	3.6156	
Genotype 14	2.7133	2.8467	4.2600	3.2733	N×V=0.10394
Average	3.8094	3.8717	5.8378		
C: Iron (Fe)					
Anber 6	168.663	276.860	237.897	227.807	N= 0.0647
Anber 33	347.567	378.353	253.490	326.470	
Pokkali	217.243	172.607	369.863	253.238	V= 0.0915
Genotype 13	332.700	155.547	298.660	262.302	
Genotype 14	198.403	144.504	219.663	187.523	N×V=0.1586
Average	243.148	212.044	263.852		
D: Zinc (Zn)					
Anber 6	5.2567	4.6400	6.9633	5.6200	N=0.04250
Anber 33	7.8033	8.0733	16.0600	10.6456	
Pokkali	5.2067	3.7533	14.1667	7.7089	V=0.06010
Genotype 13	4.9433	5.1367	8.9667	6.3489	
Genotype 14	2.2533	4.8033	7.1533	4.7367	N×V=0.10409
Average	5.3350	5.3244	10.4206		

CONCLUSION

The results indicate that morphological traits associated with productivity varied among the studied rice genotypes, and that rice genotypes responded differently to foliar sprays with the growth regulator "Biozyme ." The use of the growth regulator was effective in most traits. These results support the hypothesis that external foliar sprays with growth regulators and microelements can improve the growth and productivity of treated plants.

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