The Partial Replacement of Seaweed Extract and Humic Acid Instead of Chemical Fertilizers and its Effect on the Growth and Yield of Rice Cultivars

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Abstract

Two field experiments were applied in one of the agricultural fields belonging to the Rice Research Station in Al-Mishkhab, Al-Najaf province, located at a latitude of 31 north and longitude of 44 east, at a height of 70 m above sea level in silty clay soil during the summer seasons (2019 and 2020). The study aimed to study the effect of Fertilizer combinations on the growth and yield of rice cultivars. The experiment was conducted using The Randomized Complete Block Design (RCBD) according to split-plot design, with three replicates. The cultivars (Jasmine, Amber 33, and AL-forat) occupied the main plots) and the fertilizer combinations occupied the sub-plots, which are symbolized by F1 = chemical fertilizer (as recommended), F2 = spraying with humic acid (2ml.L^{-1}) + fertilizer recommendation, F3= spraying with seaweed extract (4ml.L^{-1}) + fertilizer recommendation, F4 = spraying with humic acid (2ml.L^{-1}) + spraying with seaweed extract (4ml.L^{-1}) with whole fertilizer recommendation, F5 = chemical fertilizer 50% of the recommendation + spraying with humic acid (2ml.L^{-1}), F6 = Chemical fertilizer 50% of the recommendation + spraying with seaweed extract (4ml.L^{-1}), and F7= Chemical fertilizer 50% of the recommendation + spraying with seaweed extract (4ml.L^{-1}) + spraying with humic acid (2ml.L^{-1}). The results showed the superiority of the F4 treatment in plant height, leaf area, number of dahlias, number of grains per dahlia, and grain yield, which gave averages amounted to (103.89 and 102.35 cm), (29.03 and 28.17 cm^2), (268.7 and 270.1 dahlia^{-1}), (167.2 and 164.8 grains), and (7.61 and 8.03 tons.ha^{-1}) for both seasons, respectively. As for the cultivars, Anbar 33 cultivar has excelled in plant height, flag leaf area, and the number of grains per dahlia by giving averages amounted to (126.09 and 124.40 cm), (31.60 and 30.48 cm^2), and (171.6 and 168.3 dahlias^{-1}), while Al-Furat cultivar has excelled in the number of cultivars per dahlias, the weight of 1000 grains, and the grain yield by giving an average amounted to (280.3 and 276.2 dahlia^{-1}), (23.22 and 23.84 g) and (6.96 and 7.01 tons.ha^{-1}), while the Jasmine cultivar was the lowest in the percentage of infertility which gave an average amounted to (6.44 and 7.07 %) for both seasons, respectively. 1580

Key Words: Seaweed, Humic Acid, Rice Cultivars.

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Introduction

Although chemical fertilizers increase plant growth and its development, meet world food security, and increase yield, but crops grown in this way do not get enough time for each stage of plant growth to grow and mature properly. The toxic chemical materials produced from the treated crops will accumulate in the human body, which is considered very dangerous. The world has turned to using modern agricultural techniques to reduce pollution problems and pay attention to bio-organic farming technology that improves the quality of the crop and reduces the accumulation of chemical pollutants in seed tissues, which leads to obtaining food of high quality and health security, where bio-fertilizers are produced in many developing countries, However, the production is not sufficient to meet the needs of the markets, if we take into account the increased demand for this type of fertilizer, which can accompany the awareness campaign of the importance of these fertilizers.

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The global trend now is towards reducing the use of manufactured chemical fertilizers for the health, environmental and economic harms they produce, through the use of natural alternatives that are characterized by their non-toxicity, non-polluting of the environment, and low costs. It is also considered an encouraging material for plant growth when used in low concentrations and contributes to most of the important physiological functions of any crop, where it contains a number of macro and micronutrients. The basic substances of humic acid result from the decomposition of dead organic matter, and this compound, although it is called humic acid, is not a single acid, but a complex mixture of a number of different acids, including carboxyl and groups of phenols, so this compound behaves functionally as a dibasic acid or a triple basic acid. The use of humic acid as an organic nutrient to improve the performance and productivity of crops has become part of the agricultural application in a number of countries in the world. It is used as a nutrient in rain-dependent regions, as well as when cultivating in poor and medium fertile soils (Saudi, 2018; Adani et al., 2006). Seaweed extracts contain macro and micronutrients, vitamins, as well as antibiotics. Therefore, when sprayed on the vegetative system, it increases the efficiency of the leaves and increases the rates of carbon metabolism, as well as its important role in regulating cell components and increasing the plant's tolerance to environmental stresses such as salt stress and drought stress (Kasim et al., 2015; Anisimov and Chaikina, 2014; Shafeek et al., 2013). The traditional methods of producing this crop have become useless, so it is necessary to research the modern techniques used to achieve this goal, which is the use of organic fertilizers that encourage growth that is added to the soil or sprayed on the plant as a supplement to chemical fertilizers or as a substitute for it, such as seaweed extracts, humic acid and others (Amabika and Sujatha, 2015). So two field experiments were conducted in order to:

1. Legalizing the use of chemical fertilizers added to the soil and replacing it with foliar spraying of seaweed extract and humic acid in the growth and yield of three cultivars of rice.
2. identifying the appropriate fertilizer mixture that gives the best yield of rice seeds.

Materials and Methods

Two field experiments were applied in one of the agricultural fields belonging to the Rice Research Station in Al-Mishkhab, Al-Najaf province, located at a latitude of 31 north and longitude of 44 east, at a height of 70 m above sea level in silty clay soil during the summer seasons (2019 and 2020) in order to study the effect of partial replacement of seaweed extract and humic acid instead of chemical fertilizers on the growth and yield of three cultivars of rice. The experiment was conducted using The Randomized Complete Block Design (RCBD) according to split-plot design, with three replicates. The cultivars (Jasmine, Amber 33, and AL-forat) occupied the main plots) and the fertilizer combinations occupied the sub-plots, which are symbolized by F1 = chemical fertilizer (as recommended), F2 = spraying with humic acid ($2ml.L^{-1}$) + fertilizer recommendation, F3= spraying with seaweed extract ($4ml.L^{-1}$) + fertilizer recommendation, F4 = spraying with humic acid ($2ml.L^{-1}$) + spraying with seaweed extract ($4ml.L^{-1}$) with whole fertilizer recommendation, F5 = chemical fertilizer 50% of the recommendation + spraying with humic acid ($2ml.L^{-1}$), F6 = Chemical fertilizer 50% of the recommendation + spraying with seaweed extract ($4ml.L^{-1}$), and F7= Chemical fertilizer 50% of the recommendation + spraying with seaweed extract ($4ml.L^{-1}$) + spraying with humic acid ($2ml.L^{-1}$). The experiment included 63 experimental units, and each replicate contained 21 experimental units, the area of the experimental unit (3×2 m^2). In order to identify some of the physical and chemical properties of the soil before planting, random samples were taken from different places of the soil of the experiment field for both seasons, with a depth of 0-30 cm, and a set of required Physicochemical tests were conducted as shown in Table (1).

Table 1. Estimating some physical and chemical properties of soil samples (2019 and 2020).

Properties		First season	Second season
Soil reaction (pH)		7.4	7.8
Electrical conductivity (dS.m^{-1} (EC .)		3.2	4.2
Organic matter (g.kg^{-1})		13	11
Volume distribution of soil separates	percentage of Clay ratio (g.kg^{-1})	363	367
	percentage of silt (g.kg^{-1})	332	356
	percentage of sand (g.kg^{-1})	305	277
Soil texture			
Nitrogen %		0.41	
Phosphorous %		7.9	
potassium %		0.57	

The totals vegetative of rice plants were sprayed with seaweed extract and humic acid in the early morning using a back sprayer (18 L) under constant pressure throughout the spraying period through the charging battery with the use of a diffuser material (dishwashing solution) to reduce the surface tension of the water and was sprayed on the basis of complete wetness for the vegetative parts of the plant. The sub-experimental units were separated by using a piece of agricultural nylon as a barrier to prevent the transmission of the volatile spray of materials on adjacent treatments. The growing weeds were controlled during the experiment implementation period as needed and for both seasons.

Preparation of spraying solutions from seaweed extract and humic acid

3.6 g of solid humic acid was used and dissolved in a liter of water to get the required spraying concentration (2 ml.L^{-1}) so that the concentration of humic acid is 55%. As for the concentration of seaweed extract (100%), it is prepared by dissolving 4 g of the substance in 4 L of distilled water to obtain the solution at a spraying concentration of 4 ml.L^{-1}. The foliar fertilizers were sprayed after their concentrations referred to above were divided into three stages of plant growth (middle branching stage ZGS25, the beginning flowering stage ZGS61, and the beginning of grain filling stage ZGS71) according to (Zadoks et al., 1974).

The studied traits n field experiments

1- Plant height (cm)

Ten plants were randomly taken from the guard lines for each experimental unit, and the plant height was measured using a tape measure from the surface of the ground to the upper end of the dahlia.

2- The flag leaf area (cm^2)

It was calculated for ten randomly selected flags leaves, according to the following equation:

Flag leaf area = leaf length x width (maximum width) x 0.74 (palaniswamy and Gomez, 1971).

3- The flag leaf content of chlorophyll (SPAD)

The readings were taken from the leaves of ten plants randomly selected from each experimental unit in the flowering stage by the 502 Chlorophyll Meter model SPAD, which gives a direct reading. 1582

4- The percentage of Infertility

Ten parameters were taken randomly from each experimental unit and the percentage of infertility was calculated according to the following equation:

$$\text{The percentage of Infertility} = \frac{\text{number of empty grains}}{\text{total number of grains}} \times 100$$

5- Number of dahlias

It was calculated for one square meter and for each sub-sub-experimental unit at harvest.

6- Number of grains per dahlias

It was calculated for ten dahlias taken randomly from ten plants at full maturity.

7- The weight of 1000 grains (g)

A thousand grains were weighed with a sensitive scale and on the basis of 14% moisture.

8- Grain yield (tons.ha^{-1})

It was calculated from the harvested square meter for each sub-sub-experimental unit. The plants were studied manually and the grains were separated from the straw (plant residues stems and leaves), the weight of the grain yield and straw yield were converted into (tons.ha^{-1}).

Statistical analysis

The data were statistically analyzed for each experiment according to its appropriate design, and the arithmetic averages were compared using the least significant difference (L.S.D) test at the 5% level (Steel and Torrie, 1980) using the Genstat edition 7 program.

Results and Discussion

Plant height (cm)

The data in the same table indicated that there were significant differences between the treatments of fertilizer combinations and rice cultivars, where the plants of the F4 treatment has excelled by recording it the highest average of plant heights amounted to (103.89 and 102.35 cm) which differed significantly from all fertilizer combinations, while the average height decreased to 92.78 and 90.02 cm for both seasons respectively which achieved by the plants of the F6 treatment. Hashim, (2018) showed that the hormonal effect as a result of foliar spraying of organic fertilizers affected the cytoplasm of the cell wall, which caused an increase in the speed of cell division and growth reflected in the plant height, in addition to the bio-activity of auxin and cytokinin found in seaweeds extract, which causes elongation and expansion of internodes and increases From the division of the inner cells more quickly, causing an increase in the plant height. These results agree with (Singh et al., 2015; Aziz et al., 2014). Table (1) shows that the cultivars differed significantly among themselves, where the plants of the Amber 33 cultivar recorded the highest average of plant height amounted to (126.09 and 124.40 cm), while the Al-Forat gave the lowest average of plant height amounted to (79.44 and 77.50 cm) for both seasons, respectively, the difference in the plant height of cultivars is due to its genetic differences in this trait, which is strongly related to the genetic factor. This result agrees with (Al-Anawy 2015; Abdulkareem, 2018), who showed in their study on local cultivars of rice that the plant height varies between cultivars according to the genes associated with this trait. As for the effect of the interactions between the study factors on plant height, the results showed that there were no significant differences for the interaction in the first season. In the second season, the plants of the Amber 33 cultivar treated with the fertilizer combination recorded the highest average of plant height amounted to (127.68 cm) and it did not differ significantly from the interaction of the plants of the same cultivar treated with the fertilizer combinations (F1, F2, F3, and F7), respectively, while the plants of Al-Forat cultivar treated with the fertilizer combination F5 gave the lowest average for this trait amounted to (72.49 cm).

Table 1. Effect of fertilizer combinations on plant height of three rice cultivars for the two seasons 2019 and 2020

Cultivars Combinations	Season 2019			Average
	Jasmine	Amber 33	Al-forat	
F1	83.63	125.17	80.37	96.39
F2	88.33	126.67	80.87	98.62
F3	87.03	126.13	78.90	97.36
F4	94.90	131.20	85.57	103.89
F5	81.60	123.87	76.11	93.86
F6	80.77	123.13	74.43	92.78
F7	85.27	126.43	79.83	97.18
Average	85.93	126.09	79.44	
LSD0.05	Cultivars	Combination	Combination ✕ cultivars	
	4.907	3.089	N.S	
Season 2020				
F1	84.99	127.06	73.19	95.08
F2	85.15	127.00	84.99	99.05
F3	87.21	125.57	79.95	97.57
F4	94.45	127.68	84.93	102.35
F5	78.07	120.70	72.49	90.42
F6	78.91	118.55	72.61	90.02
F7	83.86	124.21	74.38	94.14
Average	84.66	124.40	77.50	
LSD0.05	Cultivars	Combination	Combination ✕ cultivars	
	3.949	2.919	5.538	

The flag leaf area (cm²)

Table (2) indicates that there was a reduction in the flag leaf area when reducing the fertilizer recommendation to half at the F5 treatment, which did not differ significantly from the F6 treatment, which gave averages amounted to (24.58 and 23.09 cm2) for the first and second seasons, respectively, while the flag leaf area increased in the plants of fertilizer treatment that sprayed with both types of organic fertilizer with the complete fertilizer recommendation (F4) by recording it the highest averages amounted to (29.03 and 28.17 cm^2), for the two seasons, respectively. it was found that foliar spraying with these fertilizers increases the concentration of nutrients in the leaves through the participation of growth hormones or an enzymatic action in increasing the absorption and movement of these elements, which increases the period of their effective survival for the transfer of metabolic materials and their displacement from the leaves to the sink (grains) (Grouch and Staden, 1993) and this was evident in the superiority of the plants of the F4 treatment, in addition to the fact that humic acid attracts beneficial food ions and forms chelates with micronutrients and slowly releases them across the plasma cell membrane, and this improves primary and secondary metabolism in the process of carbon metabolism. These chelates also work to prevent sedimentation, stabilization, filtration, and oxidation of the associated micro-nutrients, thus benefit from the expansion of the leaf area. This result agrees with (Mitra and Mandal, 2012; Al-Fahdawi, 2017). The cultivars differed among themselves in the flag leaf area as shown in Table (2). The plants of Amber 33 cultivar gave the highest averages amounted to (31.60 and 30.48 cm^2) for this trait, with a significant difference from the other two cultivars, while the lowest flag leaf area recorded for the plants of Al-forat cultivar with averages amounted to (22.31 and 19.99 cm^2) for both seasons, respectively. This is due to the variation of the cultivars in the physiological age for the expansion of the flag leaf area as a result of the difference in the genotypes between the cultivars (Mohammed et al., 2010). These results agree with (Al-Gawahry, 2019). As for the interaction between the fertilizer combinations and the cultivars, it was not significant in the flag leaf area and for both seasons, respectively, as shown in Table (2).

Table 2. Effect of fertilizer combinations on flag leaf area of three rice cultivars for the two seasons 2019 and 2020

Cultivars Combinations	Season 2019			Average
	Jasmine	Amber 33	Al-forat	
F1	23.90	30.83	22.36	25.70
F2	24.45	31.20	22.40	26.02
F3	25.72	31.88	22.52	26.71
F4	27.95	34.57	24.57	29.03
F5	23.15	30.13	20.48	24.58
F6	23.57	30.42	20.76	24.92
F7	25.10	32.14	23.06	26.77
Average	24.83	31.60	22.31	
LSD0.05	Cultivars	Combination	Combination ✕ cultivars	
	0.786	1.984	N.S	
Season 2020				
F1	22.90	29.55	19.00	23.82
F2	23.48	30.73	20.39	24.86
F3	25.10	31.80	20.19	25.70
F4	27.34	34.06	22.94	28.12
F5	21.88	28.60	18.82	23.10
F6	22.08	29.24	18.13	23.15
F7	23.56	29.40	20.46	24.47
Average	23.76	30.48	19.99	
LSD0.05	Cultivars	Combination	Combination ✕ cultivars	
	0.911	1.705	N.S	

The flag leaf content of chlorophyll (SPAD)

As for the effect of fertilizer combinations, it was observed in Table (3) that there were significant differences between them, where treatment F4 has excelled by recording it the highest flag leaf content of chlorophyll for the two seasons amounted to (45.85 and 47.25 SPAD), respectively, and which differed from all treatments, while the chlorophyll content decreased to 38.65 and 40.38 SPAD for both seasons at the F5 treatment. It is also observed that there is no significant difference between the F7 treatment with the control treatment F1 (full of the fertilizer recommendation), it was clear that the foliar spraying of nutrients significantly increased the flag leaf area and its content of chlorophyll. Hence, its efficiency has increased in the photosynthesis process and manufacturing the dry matter for seed supply, and perhaps it attributes the superiority of the sprayed treatment with both types of fertilizers due to the containment of these fertilizers, especially seaweeds on betaines which increases the leaf content of chlorophyll. This increase is due to the decrease in the decomposition of chlorophyll of the leaf and the delay in its Senescence, where it preserves the green tissue of the leaf for a long time as possible by supporting the grana inside the plastid when the harvest approaches (Blunden et al., 1997). Table (3) indicates that the cultivars differed significantly among themselves in this trait for the first season. Al-Forat cultivar, which recorded the highest average, did not differ significantly from the Anbar 33 cultivar by achieving averages amounted to (44.96 and 44.30 SPAD), respectively, while the Jasmine cultivar recorded the lowest average of the flag leaf content of chlorophyll amounted to (36.03 SPAD). In the second season, the Anbar 33 cultivar did not differ significantly from the jasmine cultivar, and they achieved averages amounted to (46.97 and 46.00 SPAD), respectively, while Al-forat cultivar recorded the lowest average for this trait, which amounted to (37.92 SPAD). The different cultivars in this trait are due to the difference in their genotypes, especially the geometric shape for the distribution of leaves on the stem and the angle of the leaf because it determines the amount of rays received by the plant and transferred to the reproductive parts. These results agree with (Abou Khalifa et al., 2014; Al-Aboudi, 2016). The plants of Al-Furat cultivar that treated with the F4 treatment were significantly excelled in the flag leaf content of chlorophyll by giving it the highest average amounted to (48.60 SPAD) and did not differ significantly from the plants of Amber 33 cultivar treated with the same treatment, while the plants of Jasmine cultivar treated with the F5 treatment recorded the lowest average amounted to (33.25 SPAD) which did not differ significantly from plants of the same cultivar treated with the F6 treatment, as for the second season, no significant differences were observed in this trait.

Table 3. Effect of fertilizer combinations on the flag leaf content of chlorophyll for three rice cultivars for the two seasons 2019 and 2020

Cultivars Combinations	**Season 2019**			**Average**
	Jasmine	**Amber 33**	**Al-forat**	
F1	36.37	44.04	44.43	41.62
F2	36.52	44.85	45.46	42.28
F3	36.48	45.52	46.59	42.86
F4	40.54	48.39	48.60	45.85
F5	33.25	41.13	41.59	38.66
F6	33.88	41.46	42.15	39.17
F7	35.17	44.70	45.87	41.91
Average	36.03	44.30	44.96	
LSD0.05	Cultivars	Combination	Combination × cultivars	
	1.097	0.618	1.310	
Season 2020				
F1	45.24	45.18	38.33	42.92
F2	46.12	48.52	38.81	44.48
F3	47.55	48.81	38.83	45.07
F4	49.84	51.22	40.69	47.25
F5	42.91	43.01	35.22	40.38
F6	43.49	43.71	35.59	40.39
F7	46.86	48.36	37.97	44.40
Average	46.00	46.97	37.92	
LSD0.05	Cultivars	Combination	Combination × cultivars	
	1.236	1.539	N.S	

The percentage of infertility (%)

The results of the same table showed that there were significant differences between the fertilizer combinations in this trait, where the F4 treatment achieved the lowest percentage of infertility for the two seasons amounted to (7.05 and 7.15%), respectively. This treatment differed significantly from the rest of the treatments, while the F5 treatment recorded the highest percentage of infertility amounted to (9.76 and 10.08%), and it did not differ significantly from the F6 treatment for both seasons. The superiority of plants treated with the F4 treatment is due to the lowest percentage of infertility due to the addition of humic acids that increase the absorption of phosphorous and because of its effective role in increasing the number of grains in the dahlia. This was confirmed by (Siavoshi et al., 2011) that adding organic or chemical fertilizers containing phosphorous increases the formation of grains. These results agree with (Bahia and Musa, 2014; Sarkar et al., 2014). Table (4) indicates that the lowest percentage of infertility was for plants of the jasmine cultivar, which recorded averages amounted to (6.44 and 7.07%) for both seasons, respectively, while the highest percentage of infertility recorded by plants of Al-forat cultivar by giving averages amounted to (10.60 and 10.01%) for both seasons, respectively. Perhaps the high percentage of infertile of Al-Forat cultivar is due to the fact that it has excelled in giving the highest average of dahlias, and this confirms the positive significant correlation between these two traits, where it occurred a competition between the number of dahlia on the results of the manufactured metabolites in the period when there may be fluctuation in the arrival of elements to pollen in order to complete the flower set. This is caused a failure in a number of them and produces grain sites, but the grain does not grow or is empty, and this raises the percentage of infertility, or it may be due to the variety of cultivars in the staying duration of the leaves in its green form and its effectiveness for conducting the photosynthesis process in addition to the number of vessels and their size in the leaf of the cultivar and its relationship to the speed of transfer of the products of metabolites and the duration of the effective filling of the grain. These factors have an effect in raising or lowering the percentage of infertility, or the variation of cultivars may be due to the extent to which they are affected by climatic conditions, especially during pollination and fertilization. These results agree with (Al-Atabi, 2008; Al-Mashhadani, 2010; Al-Jawahiri, 2019) that there were no significant differences for the interaction between the fertilizer combinations and the three rice cultivars in the percentage of infertility for the two seasons, respectively.

Table 4. Effect of fertilizer combinations on the percentage of infertility for three rice cultivars for the two seasons 2019 and 2020

Cultivars Combinations	**Season 2019**			**Average**
	Jasmine	**Amber 33**	**Al-forat**	
F1	7.33	9.13	10.80	9.09
F2	5.83	8.36	10.27	8.15
F3	5.62	8.16	10.00	7.92
F4	4.84	7.11	9.20	7.05
F5	7.48	9.80	12.00	9.76
F6	7.63	9.50	11.70	9.61
F7	6.33	7.90	10.23	8.15
Average	6.44	8.56	10.60	
LSD0.05	Cultivars	Combination	Combination × cultivars	
	1.538	1.013	N.S	
Season 2020				
F1	7.76	10.05	11.07	9.63
F2	7.09	9.12	9.93	8.71
F3	6.35	8.72	9.63	8.23
F4	5.41	7.66	8.38	7.15
F5	8.42	10.68	11.13	10.08
F6	7.91	10.24	10.50	9.55
F7	6.52	8.90	9.43	8.28
Average	7.07	9.34	10.01	
LSD0.05	Cultivars	Combination	Combination × cultivars	
	1.496	0.891	N.S	

Number of dahlias (m^2)

Table (5) shows the superiority of rice plants treated with the F4 treatment by giving it the highest average numbers of dahlias, which amounted to (268.7 and 270.1 dahlias) for both seasons, respectively, while the F5 treatment did not differ significantly from the F6 treatment, which gave the lowest average number of dahlias amounted to (225.1 and 217.5 dahlias) for both seasons, respectively. The productivity of rice depends largely on the number of effective branches (carrying dahlias) rather than the total number of branches, where it was observed that an increase in chemical fertilizers is not necessary to produce effective branches, where it can be supplemented with organic fertilizers that provide essential nutrients, especially microelements when needed, and in a balanced manner for the plant, which maintains the yield semi constant. This was evident in rice plants treated with the F4 treatment, to which the elements reach in an accessible manner, meaning that the activity of carbon metabolism was good, and increasing the influx of metabolic compounds to the dahlia. These results agree with (Radhika et al., 2013; Nayak et al., 2020). As for the effect of the cultivars, it was observed from the results of the same table that the plants of Al-forat cultivar have excelled in the number of dahlias recording it the highest averages for this trait amounted to (280.3 and 276.2 dahlias), which differed significantly from the rest of the cultivars, while the plants of Anbar 33 cultivar achieved the lowest averages amounted to (201.6 and 197.0 dahlias) for both seasons, respectively. Al-forat cultivar achieved the highest average number of dahlias due to its being one of the shorter-growing cultivars, and this gives it a greater branching ability, and perhaps is the feature that makes it highly productive by contributing to an increase in the weight of grains per unit area, as well as the discrepancy in the abilities between the cultivars to control the hormonal balance that stimulates the apical dominance through the connection between the lateral buds and the vascular system of the stem is the determinant for the growth of those buds and increasing the Tillers that may give dahlia in the future (Thimann et al., 1971). This was confirmed by the results of (Grace et al., 2018) that rice cultivars differ in their production of dahlias. The interaction between fertilizer combinations and cultivars was not significant in the first season. In the second season, Al-forat plants treated with the F4 treatment have excelled by achieving the highest average number of dahlias amounted to (302.2 dahlias). It did not differ significantly with plants of the same cultivar treated with the treatments (F2 and F3) and Jasmine cultivar plants treated with the F4 treatment, while Amber 33 plants treated with the F5 fertilizer recorded the lowest averages for this trait amounted to (165.5 dahlias) which did not differ significantly from plants of the same cultivar treated with the F6 fertilizer.

Table 5. Effect of fertilizer combinations on the Number of dahlias for three rice cultivars for the two seasons 2019 and 2020

Cultivars Combinations	Season 2019			Average
	Jasmine	Amber 33	Al-forat	
F1	248.2	197.6	273.7	239.8
F2	245.0	199.1	281.2	241.8
F3	255.3	205.8	289.2	250.1
F4	276.6	223.9	305.5	268.7
F5	225.4	188.6	261.2	225.1
F6	231.9	194.6	270.2	232.2
F7	245.0	201.6	280.9	242.5
Average	246.8	201.6	280.3	
LSD0.05	Cultivars	Combination	Combination ✕ cultivars	
	19.63	10.07	N.S	
Season 2020				
F1	233.5	192.2	265.7	230.5
F2	243.0	202.2	284.3	243.2
F3	243.5	213.7	297.8	251.7
F4	280.5	227.4	302.2	270.1
F5	234.5	165.5	252.4	217.5
F6	240.0	178.2	260.0	226.1
F7	232.6	199.7	270.7	234.3
Average	243.9	197.0	276.2	
LSD0.05	Cultivars	Combination	Combination ✕ cultivars	
	22.89	9.12	23.93	

Number of grains per dahlia

Table (6) shows that the rice plants treated with the F4 fertilizer combination have excelled on the rest of the other plants by giving it the highest averages number of grains amounted to (167.2 and 164.8 grain.dahlia^{-1}), while the number of grains per dahlia decreased when reducing the amount of fertilizer recommendation, and this was shown in rice plants treated with the fertilizer combination F5, which recorded the lowest averages amounted to (135.7 and 127.30 grain.dahlia^{-1}) for both seasons, respectively. The reason for the rising number of grains in dahlia for plants treated with the F4 fertilizer combination may be that the integration and availability of fertilizers in an easy way in the critical stage to determine the number of grains was sufficient to raise the percentage of fertility in the florets and this reduced their infertility during the period of their formation, which gives the possible number of mature seeds. Siavoshi et al., (2011) also confirmed that humic acid increases the absorption of phosphorous, which plays an important role in increasing the number of grains and reducing the percentage of infertility (empty) grains. This result agrees with (Hasanuzzaman et al., 2010; Pramanick et al., 2014) who found that the highest number of grains per Dahlia has achieved in plants of Amber 33 cultivar, with averages amounted to (171.6 and 168.3 grain.dahlia^{-1}), followed by the plants of the jasmine cultivar which gave averages amounted to (152.02 and 143.2 grain.dahlia^{-1}), while the plants of Al-forat cultivar achieved the lowest averages amounted to (124.7 and 118.6 grain.dahlia^{-1}) for both seasons, respectively as shown in Table (6). The reason is attributed to the increase in the number of grains per dahlia in plants of the Amber 33 cultivar due to an increase in the length of the dahlia, a decrease in the number of total branches, the number of dahlias, and the lowest percentage of fertility compared to plants of Al-forat, in which this trait decreased, which is negatively and significantly related to the number of grains, and the compensation mechanism, which is caused by the emergence and development of the grain sites on the axis of the dahlia at an early age, in addition to the limited photosynthesis products and their insufficiency in the high number of dahlias in Al-forat cultivar, was the reason for the decrease in the number of grains per dahlia. This result agrees with (Naing et al., 2010; al-Anawy, 2015; Khatun et al., 2015). As for the interaction between the fertilizer combinations and the cultivars, it was significant for both seasons, where the plants of Anbar 33 cultivar treated with the F4 fertilizer combination gave the best number of grains with averages amounted to (196.1 and 196.4) which differed significantly from the rest of the interactions, while the lowest averages for this trait amounted to (115.9 and 103.1) for plants of Al-forat cultivar treated with the fertilizer combination F6, which did not differ significantly from the plants of the same cultivar treated with the fertilizer combination F5 for both seasons, respectively.

Table 6. Effect of fertilizer combinations on the Number of grain per dahlia for three rice cultivars for the two seasons 2019 and 2020

Cultivars Combinations	Season 2019			Average
	Jasmine	Amber 33	Al-forat	
F1	149.9	167.1	119.8	145.6
F2	154.0	173.5	127.7	151.7
F3	157.3	177.2	124.8	153.1
F4	163.5	196.1	141.9	167.2
F5	138.3	152.4	116.4	135.7
F6	145.0	163.3	115.9	141.4
F7	156.2	171.2	126.7	151.4
Average	152.0	171.6	124.7	
LSD0.05	Cultivars	Combination	Combination ✕ cultivars	
	12.99	6.13	13.17	
Season 2020				
F1	142.0	162.5	116.6	140.3
F2	146.3	170.2	122.5	146.4
F3	150.3	176.2	119.6	148.6
F4	157.8	196.4	140.1	164.8
F5	127.2	147.1	107.6	127.3
F6	134.0	159.4	103.1	132.1
F7	144.9	166.5	120.6	144.0
Average	143.2	168.3	118.6	
LSD0.05	Cultivars	Combination	Combination ✕ cultivars	
	14.51	5.42	14.69	

Weight of 1000 grains (g)

The cultivars differed significantly in the weight of 1000 grains. The plants of Al-Forat cultivars have excelled by giving it the highest averages amounted to (23.22 and 23.84 g) for both seasons, respectively, while Amber plants gave the lowest average for this trait, which amounted to (18.71 g) in the first season. In the second season, plants of the two cultivars, Amber 33 and Jasmine, did not differ significantly between them, which gave average amounted to (19.19 and 18.90 g), respectively. The reason for the superiority of Al-Forat cultivar is that it has the lowest number of grains and according to the negative correlation with the weight of 1000 grains, it was sufficient for the metabolites to fill the grains and give more grain weight through the compensation mechanism between the components. It may be due to its variation in the length of the rate and the duration of filling the grain, both of which help the seed to increase its final weight and its relationship to the physiological age of the cultivated cultivar. This explains the genetic variation of the cultivars in the weight of the grain, in addition to the fact that the chemical composition of the seeds, including carbohydrates, may contribute to the increase in the weight of the grain for that cultivar. These results agree with (Mesir, 2014; Grace et al.. 2018; Al-Fatlawi, 2020). Table (7) shows that there are no significant differences between the fertilizer combinations and their interaction with the factor of rice cultivars in the trait of the weight of 1000 grains.

Table 7. Effect of fertilizer combinations on the Weight of 1000 grains for three rice cultivars for the two seasons 2019 and 2020

Cultivars Combinations	Season 2019			Average
	Jasmine	Amber 33	Al-forat	
F1	19.44	19.13	23.55	20.71
F2	19.70	18.15	22.45	20.10
F3	19.61	18.64	22.17	20.14
F4	19.69	18.57	23.84	20.70
F5	19.56	18.40	23.74	20.57
F6	19.70	18.79	23.46	20.64
F7	19.61	19.31	23.30	20.74
Average	19.62	18.71	23.22	
LSD0.05	Cultivars	Combination	Combination ✕ cultivars	
	0.773	N.S	N.S	
Season 2020				
F1	18.53	18.54	24.02	20.36
F2	18.05	19.13	24.18	20.45
F3	18.71	19.45	23.69	20.62
F4	19.14	19.49	24.25	20.96
F5	19.15	19.20	23.55	20.63
F6	19.74	19.24	23.43	20.81
F7	18.99	19.28	23.73	20.67
Average	18.90	19.19	23.83	
LSD0.05	Cultivars	Combination	Combination ✕ cultivars	
	0.766	N.S	N.S	

Grain yield (tons.ha^{-1})

Table (8) shows that The fertilizer combinations had a significant effect on the grain yield, where the plants treated with the fertilizer combination F4 recorded the highest averages amounted to (7.61 and 8.03 tons.ha^{-1}) which differed significantly from the rest of the treatments, while the grain yield decreased when the fertilizer recommendation was reduced by half, where the F5 treatment gave the lowest average of grain yield amounted to (4.73 and 4.59 ton ha^{-1}), which did not differ significantly from treatment F6. The use of fertilizer combinations while reducing chemical fertilizers as much as possible increases the nutritional balance which reflected on the yield (Saha et al., 2013). In addition, the superiority of plants treated with the fertilizer combination F4 is attributed to the fact that they excelled in most of the traits of vegetative growth, including plant height, the number of branches, area of the flag leaf, and its content of chlorophyll, which was reflected on the yield components and then the final yield. Also, the growth regulators (auxin and cytokinin) present in seaweed extract and humic acid naturally increased grain yield by accelerating the metabolic and metabolic functions of the plant (Wang et al., 2016). These results agree with a number of researchers (Abdulkareem, 2018; Nayak et al., 2020). Table (8) shows that the cultivars differed significantly in grain yield, where Al-forat cultivar achieved the highest grain yield amounted to (6.96 and 7.01 tons.ha^{-1}) and differed significantly from the rest of the cultivars, followed by the Jasmine cultivar, which gave an average amounted to (6.18 and 6.35 tons.ha^{-1}) while the Amber 33 cultivar recorded the lowest average of grain yield amounted to (5.24 and 5.65 tons.ha^{-1}) for both seasons, respectively. The reason for the increase in the grain yield of Al-forat plants is due to the superiority in some traits of vegetative and reproductive growth, where it was noticed that the total number of branches and the number of dahlias increased in addition to the increase in the weight of 1000 grains, and this reflected on the increase in grain yield, which was better than the other two cultivars. These results agree with (Kashkool, 2014; Al-Anawy, 2015; Grace et al., 2018). The results indicated that there was a significant interaction between the two factors of the study in the second season only, where the plants of Al-forat cultivar treated with the fertilizer combination F4 achieved the highest average grain yield amounted to (9.11 tons.ha-1) and differed significantly from the rest of the interactions, while the lowest average was (3.56 tons.ha-1) for plants of Amber 33 cultivar treated with F5 fertilizer and it did not differ significantly from plants of the same cultivar treated with F6 fertilizer.

Table 8. Effect of fertilizer combinations on the Grain yield for three rice cultivars for the two seasons 2019 and 2020

Cultivars Combinations	**Season 2019**			**Average**
	Jasmine	**Amber 33**	**Al-forat**	
F1	6.120	5.160	6.572	5.951
F2	6.484	5.341	7.503	6.443
F3	7.122	5.878	7.456	6.819
F4	7.357	6.608	8.858	7.608
F5	4.752	3.874	5.570	4.732
F6	5.276	4.630	5.717	5.208
F7	6.154	5.188	7.055	6.132
Average	6.181	5.240	6.962	
LSD0.05	Cultivars	Combination	Combination × cultivars	
	0.693	0.544	N.S	
Season 2020				
F1	6.247	5.332	6.899	6.159
F2	6.585	6.241	7.968	6.931
F3	7.086	6.991	8.052	7.377
F4	7.625	7.356	9.114	8.032
F5	5.052	3.559	5.155	4.589
F6	5.660	4.306	5.109	5.025
F7	6.239	5.769	6.775	6.261
Average	6.356	5.650	7.010	
LSD0.05	Cultivars	Combination	Combination × cultivars	
	0.628	0.491	0.882	

Conclusions

We conclude from this study that the plants of fertilizer combination F4 have excelled in all the traits of vegetative growth, yield and its components for the rice cultivars under study. Also, the use of 50% of the fertilizer recommendation for rice with foliar spraying of seaweed extract and humic acid compensated for the deficiency of half of the recommendation, and this was confirmed by the results of the study, where this combination did not differ significantly with the control treatment in most of the traits of the field study.

References

Bahia, Kareem Mohammed, and Hussein Kamel Musa. 2014. Effect of the fertilizer combination (organic and mineral) on the growth and yield of rice (Oryza sativa L.) Jasmine cultivar. Kufa Journal of Agricultural Sciences 6(4): 185-201.

Al-Jawahiri, Ali Jaafar Baqer. 2019. Effect of concentrations of abscisic acid on the behavior of four rice genotypes. Master's Thesis, College of Agriculture, University of Baghdad.

Al-Aboudi, Ahmed Ali Abdel-Abbas. 2016. Effect of cultivation method and pattern on the growth and yield of rice (Oryza sativa L.). Master Thesis. College of Agriculture. Al-Qasim Green University.

Al-Atabi, Sabah Deraa Abd. 2008. Phenotypic stability of several rice cultivars. Ph.D. thesis. College of Agriculture, University of Baghdad.

Al-Anawy, Iyad Waad, 2015. Effect of heat accumulation and planting dates on growth and productivity of some rice cultivars. Master Thesis. College of Agriculture. Al-Qasim Green University.

Al-Fatlawi, Kholoud Kadhim Abdullah. 2020. Effect of spraying the amino acid phenylalanine on the growth, yield, and content of grains of anthocyanin compounds for some rice cultivars ex vivo. Master Thesis. College of Agriculture. Al-Qasim Green University.

Kashkol, Haider Razak. 2014. Effect of irrigation periods and seedling age on growth and yield of two rice cultivars. Master Thesis. College of Agriculture. University of Babylon.

Mohammed, Labeed Shatha, Shatha Ayed Yousif, Hussein Majeed Ali, Hazim Rahik Radi, and Amer Abdel Hadi. 2010. Response of Different Rice Genotypes to Potassium Fertilization under Salt Stress. Agricultural Science Studies, 37(1): 1-8.

Masir, Ayed Kadhim. 2014. The effect of organic matters on tow cultivars of rice (Anber-33 and Yassimen). Al-Qadisiyah Journal of Agricultural Sciences 2(4): 116-125.

Al-Mashhadani, Ahmed Shehab. 2010. Effect of seedling age and seedling distances on growth and yield of some rice cultivars. Ph.D. thesis. College of Agriculture. Baghdad University.

Abdul-Jabar, A.S., A.S. Hussein and A.A. Mohammad, 2012. Effect of the different seaweed extract (Seamino) concentrations on growth and seed chemical composition of two wheat varieties. Rafidain J. of Sci., 23(1): 100-113.

Abdulkareem, M.A. 2018. Influence of Perl Humus Levels on Growth and Yield of Irrigated Lowland Rice (Oryza sativa) Varieties.

Abou Khalifa, A.A., ELkhoby, W., & Okasha, E.M. 2014. Effect of sowing dates and seed rates on some rice cultivars. African J. of Agricultural Res., 9(2), 196-201.

Al-Fahdawi, R.S.G.K. 2017. The effect of spraying with Humic acid on the growth and yield attributes of barley variety Hordeum vulgare L. Mscthesis. Field crops dep. Agri. college, Alanbar Univ.

Aziz, Manal A.; Faiza K. Abd El-Fattah and Fatma A. Sherif. 2014. Effect of Cyanobacteria, Humic Substances and Mineral Nitrogen Fertilizer on Rice Yield and Its Components. J. Agric. Chem. and Biotechn., Mansoura Univ., 5(11): 253- 264.

Blunden G, Jenkins T, Liu Y 1997 Enhanced leaf chlorophyll levels in plants treated with seaweed extract. J Appl Phycol., 8: 535–543.

Grace F.S., Jalloh M.B., Rakib M.R.M., Elisa A.A and Mohd Dandan.2018. Effects of NPK fertilizer on growth and yield of several rice varieties grown in Sabah. Int. Conference on Sustainable Agri., 1-12.

Grouch IJ, Staden JV (1993). Effect of seaweed concentrate from Ecklonia maxima papenfuss on Meloidogyne incognita infestation on tomato. J. Appl. Phycol., 5: 37-43.

Hasanuzzaman, M., Ahamed, K.U., Nahar, K. and Akhter, N. 2010. Plant growth pattern, tiller dynamics and dry matter accumulation of wetland rice (Oryza sativa L.) as influenced by application of different manures. Nature Sci., 8(4): 1-10.

Hashim, M.A. 2018. The effect of Humic acid and potassium on the growth and yield of bread wheat (Triticum aestivum L.). The J. of Thi–Qar of agricultural Sci., 7(1).

Khatun, A., Sultana, H., Islam, A.J., Bhuiya, M.S.U., & Saleque, M.A. 2015. Seed Yield and Quality of Lowland Rice (Oryza sativa L.) as Influenced by Nitrogen from Organic and Chemical Sources. The Agriculturists, 13(1), 109-118.

Mitra B, Mandal BK. Influence of BIozyme on growth and yield performance of rice in rice-rice cropping sequence. Oryza-An Int. J. on Rice., 2012; 49(3): 189-194.

Naing A, Banterng P, Polthanee A, Trelo-Ges V. The effect of different fertilizers management strategies on growth and yield of upland black glutinous rice and soil property. Asian J. of Plant Sci., 2010; 9(7): 414-422.

Nayak, P., Biswas, S., & Dutta, D. 2020. Effect of seaweed extracts on growth, yield and economics of kharif rice (Oryza sativa L.). J. of Pharmacognosy and Phytochemistry, 9(3), 247-253.

Pramanick, B., Brahmachari, K., Ghosh, A., & Zodape, S.T. 2014. Effect of seaweed saps on growth and yield improvement of transplanted rice in old alluvial soil of West Bengal. Bangladesh J. of Botany, 43(1), 53-58.

Radhika, K., Hemalatha, S., Maragatham, S., & Praveenalathrine, S. 2013. Effect of foliar application of micronutrients on the yield components of rice and soil available micronutrients status. An. Asian. J. Soil. Sci., 2(8), 419-421.

Saha, R., Saieed, M.A.U., & Chowdhury, M.A.K. 2013. Growth and yield of rice (Oryza sativa) as influenced by humic acid and poultry manure. Universal J. of Plant Sci., 1(3), 78-84.

Sarkar, S.K., Sarkar, M.A.R., Islam, N., & Paul, S.K. 2014. Yield and quality of aromatic fine rice as affected by variety and nutrient management. J. of the Bangladesh Agricultural Univ., 12(452-2016-35812), 279-284.

Siavoshi M.A. Nasir, and Shankar, L. 2011. Effect of organic fertilizer on growth and yield components in rice (Oryza sativa L.). J. of Agricultural Sci., 3 (3): 217-224.

Singh SK, Thakur R, Singh MK, Singh CS, Pal SK .2015. Effect of fertilizer level and seaweed sap on productivity and profitability of rice (Oryza sativa). Indian J Agron., 60(3): 420–425.

Steel, R.G.D. and J.H. Torrie. 1980. Principles and procedures of statistics. McGraw-Hill, New York.

Thimann, K., Sachs, T. and Mathur, K. 1971. The Mechanism of Apical Dominance in Coleus. Physiol. Plant., 24: 68-72.

Wang Y, Fu F, Li J, Wang G, Wu M, Zhan J, Chen X, Mao Z.2016 Effects of seaweed fertilizer on the growth of Malus hupehensis Rehd. seedlings, soil enzyme activities and fungal communities under replant condition. Eur J Soil Biol., 75: 1–7.

Zadoks, J.C., T.T. Change and C.F. Knozak, 1974. A decimal code for the growth stages of cereals. Weed Res., 14: 415-421.