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The Effect of Biofertilizer of Azola, Phosphate and Nitrogen Fertilizers on Yield and Grain Quality of Rice

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Abstract. A field experiment was carried out during the summer season of 2019 in one of the fields of Al-Tahiniah village - Al-Mahanawiya district which is 36 km away from the Diwaniyah governorate center, to study the effect of Azola, phosphate and nitrogen fertilizers and the interactions between them on yield components, yield and grains quality of the rice grown in water logging conditions. The experiment was arrangement as factorial experiment according to Randomized Complete Blocks Design (RCBD) at three replications. The experiment included three factors, the first factor included the application of Azolla (*Azolla pinnata* L.) at 20 tons ha^{-1} and the control treatment (without application of Azolla), while the second factor included application three levels of phosphate fertilizer (21, 42 and 84 kg P ha^{-1}) as well as the control treatment (without application of phosphate fertilizer), whereas the third factor included application two levels of nitrogen fertilizer (92 and 184 kg N ha^{-1}) as well as the control treatment (without application of nitrogen fertilizer). The results showed that the application of *Azolla pinnata* L. achieving the highest results of the number of panicles per plants, number of grains per panicle and grain yield by 30.30, 6.37 and 7.80% respectively compared with control treatment that achieved the lowest results for all traits respectively. Also, the application of phosphate fertilizer at half recommended amount (42 kg P ha^{-1}) was significantly superior and gave the highest results of the number of panicles per plant, number of grains per panicle and grain yield with a significant increase of 35.29, 4.76 and 7.55 respectively compared with control treatment. In addition to, the application of nitrogen fertilizer at the recommended amount (184 kg N ha^{-1}) had the highest results of the number of panicles per plant and number of grains per panicles by 48.29 and 5.75% respectively, without significant difference on the application of nitrogen fertilizer at half the recommended amount (92 kg N ha^{-1}) which had the highest mean of the grain yield by 4.94% compared with control treatment which had the lowest results for all traits respectively. The interaction between the application of Azola and the levels of phosphate fertilizer, application of Azola and the levels of nitrogen fertilizer, application of phosphate and nitrogen fertilizers as well as the tri-interaction between three factors had significant effect in all the studied traits except the weight of 1000 grains. We can concluded that the application of *Azolla pinnata* L. reduced the amounts of phosphate and nitrogen fertilizer by 50% of Recommended amounts and led to improvement the yield and yield components of rice in addition to grain rice quality.

I. INTRODUCTION

The food problem has become more complicated as a result of the widening gap between agricultural production, especially cereal crops, and the large increase in the population of these countries, accompanied by low productivity per unit area due to adopting non-scientific methods in agriculture, which requires better use of agricultural lands and a scientific approach in cultivating crops including rice. [1]. The nutrient management system in agricultural soils is one of the most important factors affecting the growth and productivity of rice because the soil is one of the important natural constituents in agriculture and a source of natural wealth, and the extent of its quality plays an important role in rice cultivation, however, agricultural intensification associated with the addition of high levels of fertilizers Chemical affect negatively on the physical, chemical and biological properties of soil [2].

As it is known, nitrogen and phosphorus are among the elements by which soil fertility can be judged, and they are among the major elements of the plant as a result of the physiological roles that each element performs within the plant tissue. the nitrogen use excessive led to loss it from the soil through volatilization and leaching with rain water and abundant irrigation [3]. As well as the unexamined additions of phosphate fertilizers as a result of exposure of phosphorus in Iraqi soils to precipitation as complex compounds and transformation of phosphate fertilizers that are well-soluble in water to less soluble and ready to plant and adsorption on the surfaces of clay minerals led to the

imbalance of the readiness of the elements in the soil and the negative impact of that on its fertile state [4]. Therefore, to reduce these effects and the problems resulting from them must take into account the indicators of environmental management safty by reducing pollutants and replacing chemical fertilization or part of it with biological fertilizers such as azola when growing crops, especially rice [5].

Azolla pinnata L. is a fern plant belonging to the Azollaceae family, and it is widespread in different regions of the world. These plants are distinguished by their ability to exploit a wide range of water and double their biomass every two to three days [6], and that the blue-green algae symbiotic With Azolla stabilizes nitrogen at a higher rate than legumes, and also stimulates the activity of micro-organisms in the soil [7], as well as being a rich source of nutrients necessary for plants, which will positively affect the fertility of the soil and increase the readiness of nutrients for the plant [8]. As a result of the characteristics of Azolla, research has tended to cultivate it as a plant accompanying rice to reduce environmental pollution, maintain biological balance, improve soil properties and increase its content of organic matter, as well as increase the readiness of a large part of the important nutrients for plants, which will positively affect plant growth and development and improve its economic yield and quality [5]. Due to the limited information available, this study was carried out in order to find out the effect of azola, phosphate and nitrogen fertilizers and the interactions between them on yield components, yield and grains quality of the rice grown in water logging conditions.

II. MATERIALS AND METHODS

A field experiment was carried out during the summer season of 2019 in one of the fields of Al-Tahiniah village - Al-Mahanawiya district which is 36 km away from the Diwaniyah governorate center in in a soil as shows their physical and chemical properties in Table 1, to study the effect of azola, phosphate and nitrogen fertilizers and the interactions between them on yield components, yield and grains quality of the rice grown in water logging conditions. The experiment was arrangement as factorial experiment according to Randomized Complete Blocks Design (RCBD) at three replications. The experiment included three factors, the first factor included the application of azolla (*Azolla pinnata* L.) at 20 tons ha^{-1} as shows their chemical properties in table 2 and the control treatment (without application of azolla), while the second factor included application three levels of phosphate fertilizer (21, 48 and 84 kg P ha^{-1}) as well as the control treatment (without application of phosphate fertilizer), whereas the third factor included application two levels of nitrogen fertilizer (92 and 184 kg N ha^{-1}) as well as the control treatment (without application of nitrogen fertilizer).

TABLE 1. Physical and chemical soil properties.

Trait	Value	Unit
Sand	19.02	
Loam	45.95	%
Clay	35.03	
Bulk density	1.46	-----
Ec_e	2.92	ds m^{-1}
pH	7.53	-----
CEC	19.06	-----
O.M	0.96	%
Available N	19.83	
Available P	3.56	mg Kg^{-1} Soil
Available K	118.61	
Ca^{2+}	12.67	
Mg^{2+}	10.41	
Na^{+}	20.04	
Cl^{-}	28.42	mmole L^{-1}
SO_4^{2-}	13.19	
HCO_3^{-}	11.08	
CO_3^{2-}	Nill	
Total Fe	1107.57	mg L^{-1}
Total Mn	221.09	

Soil management especially plowing were carried out as required, the net area of sub plot was (3 m long x 5 m width) 15 m^2 which contained 15 lines, 0.20 m apart. A distance of 1 m was left between the experimental units and 2 m between the replicates. The seeds of rice (Dusht cv.) were sown on 17th July 2019 at a seeding rate 120 Kg ha^{-1} [9]. At harvest time the number of panicles per $plant^{-1}$ and number of grins per panicles were calculated. Weight of 1000 grain (g) calculated after mixing the grain of the harvested plants from each experimental unit and taking 1000 grain from them randomly and then weighed.

TABLE 2. Chemical properties of *Azolla pinnata* L.

Trait	Value	Unit
Crude Lipids	3.41	%
Crude Protein	24.86	
Sugars	3.17	
Carbohydrates	6.05	
Fiber	10.96	
Chlorophyll	0.33	
Ash	12.28	
Calcium	1.51	mg L^{-1}
Phosphorous	0.39	
Potassium	2.56	
Iron	1534.04	
Zinc	312.59	
Manganese	2327.47	
Boron	27.62	
Copper	8.04	
Cobalt	7.84	

Soil management especially plowing were carried out as required, the net area of sub plot was (3 m long x 5 m width) 15 m^2 which contained 15 lines, 0.20 m apart. A distance of 1 m was left between the experimental units and 2 m between the replicates. The seeds of rice (Dusht cv.) were sown on 17th July 2019 at a seeding rate 120 Kg ha^{-1} [9]. At harvest time the number of panicles per $plant^{-1}$ and number of grins per panicles were calculated. Weight of 1000 grain (g) calculated after mixing the grain of the harvested plants from each experimental unit and taking 1000 grain from them randomly and then weighed. A sample of 1 m^2 of each experimental unit was harvested and the straw was isolated from the grain, weighed and converted from g m^{-2} to ton ha^{-1} for grain yield. A grain content of protein was calculated by the following equation:

Grain content of Protein (%) = Grain content of Nitrogen x 6.25

The recorded data were statistically analyzed according to the analysis of variance at $p < 0.05$ by using the Gnestat software. The least significant difference (LSD) at the level of 0.05 probability was employed to compare the differences among treatment means [10].

III. RESULTS AND DISCUSSION

- **Number of panicles per plant**

The results at the table 3 showed that the application of azolla had significant effect on the number of panicles per plant and gave the highest mean (30.1 panicle $plant^{-1}$) compared without application of azolla which gave the lowest mean (23.1 panicle $plant^{-1}$). The reason of an increasing may be due to the azola content of the elements necessary for the growth and development of the rice plant (Table 2), and then the increase in the physiological activities including photosynthesis and an increasing the transfer and accumulation of its metabolites to the reproductive parts and then an increasing number of panicles per plant [11]. The results at the table 3 indicated that the number of panicles per plant was significantly affected by phosphorous fertilizer levels (0, 21, 42 and 84 Kg P ha^{-1}), the application of 42 Kg P ha^{-1} had the highest mean (29.9 panicle $plant^{-1}$) compared with others especially control treatment which had the lowest mean (22.1 panicle $plant^{-1}$). The reason of the an increasing may be due to the role of phosphorous in an increasing the content of the rice plant of the elements necessary for growth and development and then increasing the efficiency of the photosynthesis process and its metabolites and their transfer to the reproductive parts which was positively reflected in the number of sinks and then an increasing number of panicles. Also, the results at the table 3 showed that there are significant difference among nitrogen fertilizer levels (0, 92 and 184 Kg N ha^{-1}) in the number of panicles per plant, the application of 184 Kg N ha^{-1} recorded the highest mean (30.4 panicle $plant^{-1}$) with non-significant difference with 92 Kg N ha^{-1} (29.0 panicle $plant^{-1}$) while the control treatment recorded the lowest mean (20.5 panicle $plant^{-1}$). The reason of the an increase may be attributed to the role of nitrogen fertilizer application in stimulating vegetative growth, encouraging the growth of branches and prolonging the life of the leaves, which led to the production of high rates of dry matter which will increase the growth rate of the crop and the formation of fruiting branches of the plant [12]. These results are in agreement with Islam et al., [13] and Gewaily et al., [14] who indicated that the number of panicles per plant were significantly increased with application of nitrogen. The interaction between application of azolla and phosphorous fertilizer levels had significant effect on the number of panicles per plant (Table 3), the application of azolla with 42 Kg P ha^{-1} had the highest mean (34.3 panicle $plant^{-1}$) whereas the control treatment (without azolla + 0

Kg P ha^{-1}) had the lowest mean (16.4 panicle plant^{-1}). Also, The interaction between application of azolla and nitrogen fertilizer levels had significant effect on the number of panicles per plant (Table 3), the application of azolla with 92 Kg N ha^{-1} gave the highest mean (34.7 panicle plant^{-1}) while the control treatment (without azolla + 0 Kg N ha^{-1}) gave the lowest mean (17.3 panicle plant^{-1}). The interaction between application of phosphorous and nitrogen fertilizer levels had significant effect on the number of panicles per plant (Table 3), the application of phosphorous at level 42 Kg P ha^{-1} and nitrogen fertilizer at level 184 Kg N ha^{-1} had the highest mean (34.7 panicle plant^{-1}) with non-significant difference with 42 Kg P ha^{-1} + 92 Kg N ha^{-1} (32.2 panicle plant^{-1}) whereas the control treatment (0 Kg P ha^{-1} + 0 Kg N ha^{-1}) had the lowest mean (15.7 panicle plant^{-1}). The results at the table 3 indicated that the interaction between three factors had significant effect on the number of panicles per plant, the application of azolla with 42 Kg P ha^{-1} and 92 Kg N ha^{-1} gave the best result (38.3 panicles plant^{-1}) with non-significant difference with application of azolla with 21 Kg P ha^{-1} and 92 Kg N ha^{-1}(37.3 panicle plant^{-1}) and application of azolla + 42 Kg P ha^{-1} + 184 Kg N ha^{-1} (37.0 panicle plant^{-1}) while the control treatment gave the lowest mean (12.7 panicle plant^{-1}).

TABLE 3. Effect of Azolla Bio-fertilizer and phosphorous and nitrogen fertilizer on number of panicles per plant.

(BF) Bio fertilizer	Phosphorous fertilizer levels (Kg P ha^{-1})	Nitrogen fertilizer levels (Kg N ha^{-1})			BF x P
		0	92	184	
Without Azolla	0	12.7	16.3	20.3	16.4
	21	13.7	19.7	26.7	20.0
	42	18.0	26.0	32.3	25.4
	84	25.0	31.3	35.7	30.7
With Azolla	0	18.7	34.0	30.7	27.8
	21	21.3	37.3	33.3	30.7
	42	28.0	38.3	37.0	34.4
	84	26.7	29.0	27.0	27.6
LSD 0.05			4.3		2.5

BF x N

Bio fertilizer (BF)	Nitrogen fertilizer levels (Kg N ha^{-1})			BF Means
	0	92	184	
Without Azolla	17.3	23.3	28.8	23.1
With Azolla	23.7	34.7	32.0	30.1
LSD 0.05		2.2		1.3

P x N

Phosphorous fertilizer levels (Kg P ha^{-1})	Nitrogen fertilizer levels (Kg N ha^{-1})			P Means
	0	92	184	
0	15.7	25.2	25.5	22.1
21	17.5	28.5	30.0	25.3
42	23.0	32.2	34.7	29.9
84	25.8	30.1	31.3	29.1
LSD 0.05		3.1		1.8
N Means	20.5	29.0	30.4	
LSD 0.05		1.5		

- **Number of grains per panicle**

Table 4 revealed that the application of azolla had significant effect on number of grains per panicle and gave the highest mean (206.83 grain panicle^{-1}) compared without application of azolla which gave the lowest mean (193.44 grain panicle^{-1}). These results are in agreement with Krock [11] who indicated that the number of grains per panicle were significantly increased with application of azolla. The results at the table 4 indicated that the number of grains per panicle was significantly affected by phosphorous fertilizer levels, the application of 42 Kg P ha^{-1} had the highest mean (205.22 grain panicle^{-1}) compared with control treatment which had the lowest mean (195.89 grain panicle^{-1}). Similar results obtained by Sharma et al., [15] who reported that there are significant effect of phosphorous fertilizer application on the number of grains per panicle. The results at the table 4 showed that the nitrogen fertilizer levels (0, 92 and 184 Kg N ha^{-1}) were significant effect on number of grains per panicle, the application of 184 Kg N ha^{-1} recorded the highest mean (204.62 grain panicle^{-1}) with non-significant difference with 92 Kg N ha^{-1} (203.79 grain panicle^{-1}) whereas the control treatment recorded the lowest mean (193.55 grain panicle^{-1}). These results are in

agreement with [16,17], who indicated that the number of grains per panicle were significantly affected by nitrogen application.

TABLE 4. Effect of Azolla Bio-fertilizer and phosphorous and nitrogen fertilizer on the number of grains per panicle.

(BF) Bio fertilizer	Phosphorous fertilizer levels (Kg P ha^{-1})	Nitrogen fertilizer levels (Kg N ha^{-1}) 0	92	184	BF x P
Without Azolla	0	180.33	192.67	195.00	189.33
	21	187.00	194.00	198.33	193.11
	42	190.33	196.00	202.00	196.11
	84	195.00	199.67	203.00	199.22
With Azolla	0	194.67	208.67	204.00	202.44
	21	195.67	213.00	207.67	205.44
	42	205.33	220.33	217.33	214.33
	84	199.67	206.00	209.67	205.11
LSD 0.05			3.75		2.17

BF x N

Bio fertilizer (BF)	Nitrogen fertilizer levels (Kg N ha^{-1}) 0	92	184	BF Means
Without Azolla	188.17	195.58	199.58	194.44
With Azolla	198.83	212.00	209.67	206.83
LSD 0.05		1.88		1.08

P x N

Phosphorous fertilizer levels (Kg P ha^{-1})	Nitrogen fertilizer levels (Kg N ha^{-1}) 0	92	184	P Means
0	187.50	200.67	199.50	195.89
21	191.33	203.50	203.00	199.28
42	197.83	208.17	209.67	205.22
84	197.33	202.83	206.33	202.17
LSD 0.05		2.65		1.53
N Means	193.50	203.79	204.62	
LSD 0.05		1.33		

The interaction between application of azolla and phosphorous fertilizer levels had significant effect on number of grains per panicle (Table 4), the application of azolla with 42 Kg P ha^{-1} had the highest mean (205.44 grain panicle^{-1}) whereas the control treatment (without azolla + 0 Kg P ha^{-1}) had the lowest mean (189.33 grain panicle^{-1}). Also, The interaction between application of azolla and nitrogen fertilizer levels had significant effect on the number of grains per panicle (Table 4), the application of azolla with 92 Kg N ha^{-1} gave the highest mean (212.00 grain panicle^{-1}) while the control treatment (without azolla + 0 Kg N ha^{-1}) gave the lowest mean (188.17 grain panicle^{-1}). The interaction between application of phosphorous and nitrogen fertilizer levels had significant effect on the number of grains per panicle (Table 4), the application of phosphorous at level 42 Kg P ha^{-1} and nitrogen fertilizer at level 184 Kg N ha^{-1} had the highest mean (209.67 grain panicle^{-1}) with non-significant difference with 42 Kg P ha^{-1} + 92 Kg N ha^{-1} (208.17 grain panicle^{-1}) whereas the control treatment (0 Kg P ha^{-1} + 0 Kg N ha^{-1}) had the lowest mean (187.50 grain panicle^{-1}). The results at the table 3 indicated that the interaction between three factors had significant effect on the number of grains per panicle, the application of azolla with 42 Kg P ha^{-1} and 92 Kg N ha^{-1} gave the best result (220.33 grain panicle^{-1}) with non-significant difference with application of azolla with 42 Kg P ha^{-1} and 184 Kg N ha^{-1} (217.33 grain panicle^{-1}) while the control treatment gave the lowest mean (180.44 grain panicle^{-1}).

- **1000 Grain weight**

The results at the Table 5 showed that no significant effect of azolla application, phosphorous and nitrogen levels and the interactions between studied factors on the 1000 grain weight of rice. [18], reported that the application of azolla was non-significant effect on 1000 grain weight. Also, [17], indicated that the weight of 1000 grain was non-significantly affected by nitrogen application.

TABLE 5. Effect of Azolla Bio-fertilizer and phosphorous and nitrogen fertilizer on the 1000 grain weight (g)

(BF) Bio fertilizer	Phosphorous fertilizer levels (Kg P ha^{-1})	Nitrogen fertilizer levels (Kg N ha^{-1}) 0	92	184	BF x P
Without Azolla	0	20.24	20.15	20.07	20.15
	21	20.21	19.73	19.25	19.73
	42	20.03	19.35	19.11	19.50
	84	19.92	19.00	18.79	19.24
With Azolla	0	20.40	20.21	20.12	20.24
	21	20.32	19.81	19.56	19.90
	42	19.97	19.38	19.04	19.46
	84	19.24	19.09	18.91	19.08
LSD 0.05			N.S		N.S

BF x N

Bio fertilizer (BF)	Nitrogen fertilizer levels (Kg N ha^{-1}) 0	92	184	BF Means
Without Azolla	20.10	19.56	19.30	19.65
With Azolla	19.98	19.62	19.41	19.67
LSD 0.05		N.S		N.S

P x N

Phosphorous fertilizer levels (Kg P ha^{-1})	Nitrogen fertilizer levels (Kg N ha^{-1}) 0	92	184	P Means
0	20.32	20.18	20.09	20.20
21	20.27	19.77	19.40	19.81
42	20.00	19.36	19.08	19.48
84	19.58	19.04	18.85	19.16
LSD 0.05		N.S		N.S
N Means	20.04	19.59	19.36	
LSD 0.05		N.S		

- **Grain yield (ton ha^{-1})**

The results at the table 6 showed that the application of azolla had significant effect on grain yield and recorded the highest mean (3.993 ton ha^{-1}) compared without azolla application which recorded the lowest mean (3.704 ton ha^{-1}). The reason of an increasing may be due to superior of azola application treatment in number of panicles per plant (Table 3) and number of grains per panicle (Table 4). These results are in agreement with [19,20] who found an increase in the grain yield of rice when application of azolla. Table 6 indicated that the application of phosphor fertilizer levels was significantly effected on the grain yield, the application of 42 Kg P ha^{-1} gave the highest mean (3.946 ton ha^{-1}) compared with others especially control treatment which gave the lowest mean (3.669 ton ha^{-1}). This superiority may be due to the role of phosphorous application at level 42 Kg P ha^{-1} in an increasing two of rice yield components, i.e, number of panicles per plant and number of grains per panicle (Tables 3 and 4). Similar results obtained by [15] and [21] who reported that there are significant effect of phosphorous fertilizer application on the grain yield of rice. Also, the results at the table 6 revealed that the grain yield was significantly affected by nitrogen fertilizer levels, the application of 92 Kg N ha^{-1} recorded the highest mean (3.906 ton ha^{-1}) compared with control treatment which recorded the lowest mean (3.738 ton ha^{-1}). These results are in agreement with [14] and Haque and Haque [16] when application of nitrogen fertilizer.

The interaction between application of azolla and phosphorous fertilizer levels had significant effect on the grain yield (Table 6), the application of azolla with 42 Kg P ha^{-1} had the highest mean (4.118 ton ha^{-1}) whereas the control treatment (without azolla + 0 Kg P ha^{-1}) had the lowest mean (3.500 ton ha^{-1}). Also, The interaction between application of azolla and nitrogen fertilizer levels had significant effect on the grain yield (Table 6), the application of azolla with 92 Kg N ha^{-1} gave the highest mean (4.056 ton ha^{-1}) while the control treatment (without azolla + 0 Kg N ha^{-1}) gave the lowest mean (3.589 ton ha^{-1}).

The interaction between application of phosphorous and nitrogen fertilizer levels had significant effect on the grain yield (Table 6), the application of phosphorous at level 42 Kg P ha^{-1} + nitrogen fertilizer at level 84 Kg N ha^{-1} had the highest mean (3.973 ton ha^{-1}) with non-significant difference with 42 Kg P ha^{-1} + 184 Kg N ha^{-1} (3.968 ton ha^{-1}) whereas the control treatment (0 Kg P ha^{-1} + 0 Kg N ha^{-1}) had the lowest mean (3.326 ton ha^{-1}).

TABLE 6. Effect of Azolla Bio-fertilizer and phosphorous and nitrogen fertilizer on the grain yield (ton ha^{-1}).

(BF) Bio fertilizer	Phosphorous fertilizer levels (Kg P ha^{-1})	Nitrogen fertilizer levels (Kg N ha^{-1})			BF x P
		0	92	184	
Without Azolla	0	3.114	3.690	3.697	3.500
	21	3.693	3.763	3.769	3.742
	42	3.766	3.774	3.781	3.774
	84	3.783	3.801	3.813	3.799
With Azolla	0	3.537	3.995	3.978	3.837
	21	3.982	4.015	3.995	3.997
	42	4.028	4.171	4.155	4.118
	84	4.001	4.042	4.020	4.021
LSD 0.05			0.028		0.016

BF x N

Bio fertilizer (BF)	Nitrogen fertilizer levels (Kg N ha^{-1})			BF Means
	0	92	184	
Without Azolla	3.589	3.757	3.765	3.704
With Azolla	3.887	4.056	4.037	3.993
LSD 0.05		0.014		0.008

P x N

Phosphorous fertilizer levels (Kg P ha^{-1})	Nitrogen fertilizer levels (Kg N ha^{-1})			P Means
	0	92	184	
0	3.326	3.843	3.838	3.669
21	3.838	3.889	3.882	3.870
42	3.897	3.973	3.968	3.946
84	3.892	3.922	3.917	3.910
LSD 0.05		0.020		0.012
N Means	3.738	3.906	3.901	
LSD 0.05		0.010		

The results at the table 6 indicated that the interaction between three factors had significant effect on the grain yield, the application of azolla with 42 Kg P ha^{-1} and 92 Kg N ha^{-1} gave the best result (4.171 ton ha^{-1}) with non-significant difference with application of azolla with 42 Kg P ha^{-1} and 184 Kg N ha^{-1} (4.155 ton ha^{-1}) while the control treatment gave the lowest mean (3.114 ton ha^{-1}). The results show the positive role of azolla application in raising the efficiency of rice's use of nitrogenous and phosphate fertilizers by reducing 50% of its added amounts and the positive effect of this in stimulating plant growth and development by increasing the availability of the necessary nutrients and creating a balance in the absorption of these elements by the plant during the critical stages of growth and raise the efficiency of the photosynthesis process and produce high rates of dry matter in the vegetative growth stage and an increasing the transfer and accumulation of dry matter in the reproductive parts of the plant, which was reflected positively on the an increasing the number of panicles per plant, reducing the percentage of ovules abortion, increasing the rate of pollination and fertilization of florets, an increasing the number of grains per panicles and then an increasing the grain yield.

- **Grain content of protein (%)**

The results at the table 7 showed that the application of azolla had significant effect on the grain content of protein and gave the highest mean (7.83%) compared without application of azolla which gave the lowest mean (6.44%). The results at the table 7 indicated that grain content of protein was significantly affected by phosphorous fertilizer levels, the application of 42 Kg P ha^{-1} recorded the highest mean (7.91%) compared with control treatment which recorded the lowest mean (6.07%). Also, the results at the table 7 showed that there are significant difference among nitrogen fertilizer levels in the grain content of protein, the application of 184 Kg N ha^{-1} recorded the highest mean (7.93%) with non-significant difference with 92 Kg N ha^{-1} (7.88%) while the control treatment recorded the lowest mean (5.58%). The interaction between application of azolla and phosphorous fertilizer levels had significant effect on the grain content of protein (Table 7), the application of azolla with 42 Kg P ha^{-1} gave the highest mean (9.24%) whereas the control treatment (without azolla + 0 Kg P ha^{-1}) gave the lowest mean (5.51%). These results are in agreement with [22] when application of nitrogen fertilizer. Also, The interaction between application of azolla and nitrogen fertilizer levels had significant effect on the grain content of protein (Table 7), the application of azolla with 92 Kg N ha^{-1} gave

the highest mean (9.36%) while the control treatment (without azolla + 0 Kg N ha^{-1}) gave the lowest mean (5.49%). The interaction between application of phosphorous and nitrogen fertilizer levels had significant effect on the grain content of protein (Table 7), the application of phosphorous at level 42 Kg P ha^{-1} and nitrogen fertilizer at level 184 Kg N ha^{-1} had the highest mean (9.34%) with non-significant difference with 42 Kg P ha^{-1} + 92 Kg N ha^{-1} (8.86%) and 84 Kg P ha^{-1} + 92 Kg N ha^{-1} (8.52%) whereas the control treatment (0 Kg P ha^{-1} + 0 Kg N ha^{-1}) had the lowest mean (4.92%). The results at the table 7 indicated that the interaction between three factors had significant effect on the grain content of protein, the application of azolla with 42 Kg P ha^{-1} and 92 Kg N ha^{-1} gave the best result (11.10%) with non-significant difference with application of azolla with 42 Kg P ha^{-1} and 184 Kg N ha^{-1} (10.77%) while the control treatment gave the lowest mean (4.53%). These results demonstrate the positive role of the three factors in improving the nutritional value of the rice grain as a result of the role of these complementary factors in stimulating the growth of the rice root system and increasing the absorption of the elements necessary for growth and its effect on stimulating the enzymes responsible for the photosynthesis process, which contributed to prolonging the growth period, delaying the aging of leaves and increasing the production of dry matter and its transfer to grains, thus improving the quality of grains.

TABLE 6. Effect of Azolla Bio-fertilizer and phosphorous and nitrogen fertilizer on the grain content of protein (%).

(BF) Bio fertilizer	Phosphorous fertilizer levels (Kg P ha^{-1})	Nitrogen fertilizer levels (Kg N ha^{-1})			BF x P
		0	92	184	
Without Azolla	0	4.53	5.75	6.24	5.51
	21	6.71	6.06	6.69	6.49
	42	5.20	6.62	7.91	6.58
	84	5.52	7.21	8.81	7.18
With Azolla	0	5.30	7.60	6.96	6.62
	21	5.56	8.90	8.31	7.59
	42	5.85	11.10	10.77	9.24
	84	5.99	9.82	7.77	7.86
LSD 0.05			1.21		0.69

BF x N

Bio fertilizer (BF)	Nitrogen fertilizer levels (Kg N ha^{-1})			BF Means
	0	92	184	
Without Azolla	5.49	6.41	7.41	6.44
With Azolla	5.67	9.36	8.45	7.83
LSD 0.05		0.60		0.35

P x N

Phosphorous fertilizer levels (Kg P ha^{-1})	Nitrogen fertilizer levels (Kg N ha^{-1})			P Means
	0	92	184	
0	4.92	6.68	6.60	6.07
21	6.13	7.48	7.50	7.04
42	5.52	8.86	9.34	7.91
84	5.75	8.52	8.29	7.52
LSD 0.05		0.85		0.49
N Means	5.58	7.88	7.93	
LSD 0.05		0.43		

REFFERENCES

[1] Muhammad Ali, K. I.; A. A. Aljubori; M. H. K. Al-Baldawi and Z. A. Abdul Al-Majeed. 2010. Field Crops Production. 1st Edn., Modern Al-Waqif Press. pp. 285.
[2] Allen, V. B. and D. J. Pilbeam. 2006. Plant Nutrition. Department of Plant Sci. Unin. of Massa-Chusetts. p. 293-328.
[3] Bronson, K. 2004. Nutrition management for Texas high plains cotton production. The agriculture program. The texas A & M. University System. Crop Sci. 33: 4-10.
[4] Havlin, J. L.; J. D. Beaton; S. L. Tisdale and W. L. Nelson. 2005. Fertility and fertilizers "An Introduction to Nutrient Management". 7th Edn. Prentice Hall. New Jersey, USA. pp. 515.
[5] Wagner, G. M. 1997. Azolla: A review of its biology and utilization. Bot. Rev. 63: 1-26.

[6] Cohen, M. F.; T. Meziane; M. Tsuchiya and H. Yamasaki. 2002. Feeding deterrence of *Azolla* in relation to deoxyanthocyanin and fatty acid composition. Aquatic Bot. 74(2): 181-187.
[7] Gopalaswamy, G. and S. Kannaiyan. 2000. Influence of phosphorus on the growth of Azolla hybrids.Proceedings of National Seminar on Agricultural Scenario Challenges and Opportunities. Coll. of Agric., Gwalior, Madhya Pradesh. p. 55-56.
[8] Awodun, M. A. 2008. Effect of Azolla on Physiochemical properties of the soil. World J. of Agric. Sci. 4(2): 157-160.
[9] Ministry of Agriculture. 2018. Guidance Paper on rice cultivation. The General Commission of Agricultural Extension, Ministry of Agriculture.
[10] Steel, R. G. and Y. H. Torrie. 1980. Principles and Procedures of Statistics. Mc Grow - Hill Book Co., Inc. New York. pp. 480.
[11] Krock, T.; J. Alkamprt and I. Watanabe. 1988. Effect of *Azolla* application and plant spacing on rice yield. J. Agron. And Crop Sci. 160: 266-270.
[12] Mae, T. and S. Shoji. 1994. Studies on the rate of fertilizer nitrogen in rice plant and paddy by using N^{15} as astracer in northeastern. Japan(Special Issue). 6: 77-94.
[13] Islam, S. S. M.; A. Khatun; F. Rahman; A. T. M. S. Hossain; U. A. Naher and M. A. Saleque. 2015. Rice response to nitrogen in tidal flooded non-saline soil. Bangladesh Rice J. 19(2): 65-70.
[14] Gewaily, E. E.; A. M. Ghoneim and M. M. A. Osman. 2018. Effects of nitrogen levels on growth, yield and nitrogen use efficiency of some newly released Egyptian rice genotypes. Open Agric. 3: 310–318.
[15] Sharma, S. N.; R. Prasad; Y. S. Shivay; M. K. Dwivedi; S. Kumar And D. Kumar. 2009. Effect of rates and sources of phosphorus on productivity and economics of rice (*Oryza sativa*) as influenced by crop-residue incorporation. Indian J. of Agron. 54(1): 42-46.
[16] Haque, A. and M. M. Haque. 2016. Growth, yield and nitrogen use efficiency of new rice variety under variable nitrogen rates. Amer. J. of Plant Sci. 7: 612-622.
[17] Jan, R.; F. A. Aga; F. A. Bahar; T. Singh and R. Lone. 2018. Effect of nitrogen and silicon on growth and yield attributes of transplanted rice (*Oryza sativa* L.) under Kashmir conditions. J. of Pharmacognosy and Phytochem. 7(1): 328-332.
[18] Oyange, W. A.; G. N. Cheminingwa; J. I. Kanya and P. N. Njiruh. 2019. Effects of Azolla and inorganic nitrogen application on growth and yield of rice in mwea irrigation scheme. Int. J. Agron. Agri. Res. 14(3): 1-8.
[19] Singh, S.; S. Swami and G.N. Gurjar. 2018. Effect of nitrogen application through urea and azolla on growth and biological yield of rice (*Oryza sativa* L.) in acidic soil of Meghalaya. Int. J. Curr. Microbiol.Appl. Sci. 7(7): 3135-3140.
[20] Setiawati, M. R.; P. Suryatmana; D. Herdiyantoro; A. M. Ramdani and N. N. Kamaluddin. 2020. Yield of organic rice as affected by azolla and biofertilizer amendment to rice straw as organic fertilizer for sustainable lowland rice production. Inter. J. Agric., Environ., and Bio. Res. 5(1): 319-328.
[21] Massawe, P. I. and J. Mrema. 2017. Effects of different phosphorus fertilizers on rice (O*ryza sativa* L.*)* yield components and grain yields. Asian J. of Adv., Agric. Res. 3(2): 1-13.
[22] Javeed, A.; M. Gupta And V. Gupta. 2017. Effect of graded levels of N, P and K on growth, yield and quality of fine rice Cultivar (*Oryza sativa* L.) under subtropical conditions. Scientific Soc. of Adv. Res., and Soc. Change. 3(1): 1-8.