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Effect of Phosphate Fertilization and Iron Spraying on Growth Parameter and Yield of Oat (Avena Sativa L.)

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Abstract

A field experiment was conducted during the agricultural season 2020-2021 at the Agricultural Research Station / College of Agriculture / University of Basra (Al-Haritha site) (20 km from the center of Basra Governorate). To study the effect of four levels of phosphate fertilizer (P0=0, P1=50, P2=100 and P3=150 Kg ha-1) and four concentrations of iron spray(F0=0,F1=1000,F2=2000 and F3=3000 PPM).on the growth, yield and quality of oats (Avena sativa L.) Janzania cultivar the experiment was carried out in a split-plot arrangementusinga randomized complete block design (RCBD) with three replications. Phosphate fertilizer levels occupied the main plot, and iron concentrations occupied the sub-plots. The results showed that the P3 level was significantly superior in all the studied traits, which gave the highest grain yield of 6.13 mcg ha-1. The concentration F2 was significantly superior in all the studied traits, which gave the highest grain yield of 5.29 mcg ha-1. The interaction also showed the superiority of the combination P3*F2 in plant height, flag leaf area, number of branches and grain yield, while the interaction was not significant in the trait of leaf area index and Net Assimilation rate and crop growth rate

Keywords: Oats, Avena sativa L., Iron, Phosphate fertilization.

1. Introduction

The oat(Avena sativa L.) is one of the annual plants that belong to the family Poaceae, the estimated cultivated area in the world is 9.30 million hectares, producing 22.48 million tons^{-1} [1]. It is used in human and animal nutrition and ranks sixth as a cereal crop in the world. Oats are rich in important nutrients (such as proteins, carbohydrates, calories, minerals, and vitamins). Oats are also rich in fats, starch and fiber (beta-glucan) and contain other nutrients such as iron, potassium, copper, magnesium, zinc, phosphorous, etc. It is a source of many compounds such as vitamin E, phenolic compounds and sterols that show antioxidant activity and consumption of oats helps in Fitness, lowering the level of cholesterol in the blood, improving blood sugar and boosting the immune system [2].

The provision of nutrients during the growth period of the crop is very important because of their major role in increasing vegetative growth, which is positively reflected in the increase in yield and the quality of the produced grains. Among these elements is large phosphorous quantities for its role in the vital processes inside the plant, including photosynthesis and respiration, as well as the formation and division of cells, the composition of seeds, and its contribution to the synthesis of energy compounds (ATP and ADP)and its entry into the synthesis of cellular membranes and nucleic acids [3].

To enrich the content of oats with microelements, including iron, especially if we know that nearly 2 billion people in the world suffer from malnutrition, especially in Asia and Africa [3]. Based on the importance of the previous and the lack of studies and research on the oats crop in the southern region in this field, this experiment was carried out with the aim of study of the response of oats to phosphate fertilization and foliar feeding with iron. Determine the best level of fertilizer to obtain the highest grain yield. And also determine the best binary overlap between the study factors to achieve the highest productivity.

2. Materials and Methods

A field experiment was carried during the 2020-2021 agricultural season at the Agricultural Research Station / affiliated to the College of Agriculture / University of Basra (Al-Hartha site), 20 km from the center of Basra Governorate, to study the effect of four levels of phosphate fertilization (P0=0, P1=50, P2=100 and P3=150 Kg ha-1) and four concentrations of iron spray(F0= 0,F1= 1000,F2= 2000 and F3= 3000 PPM) in the growth, yield and quality of oats (Avena sativa L.) According to as plit plot design using the R.C.B.D. with three replications, the experiment was carried out with three replications, P level occupied the main plot While, Fe concentration located in the sub-plots.

The area required to carry out the research was determined, and the soil was prepared for cultivation by plowing, smoothing and levelling it. Then the land was divided into three block each Block divided into 4 main plots. Each piece was divided into 4 sub-plot, the total number of experimental units to 48 experimental units with an area of 2 x 3 m, leaving a distance of 1 m between the experimental units and 50 cm between one repeater. Another seed rate of 100 kg ha-1 The cultivation was carried out in the form of lines Urea fertilizer (46%N) was added at a rate of 120 kg N ha-1 in two equal times, the first after seedling emergence (30 days after planting) and the second in the elongation phase While phosphate levels fertilizer was added at once when sowing at four levels (0, 50, 100 and 150 kg P2O5 ha^{-1}) in the form of DAP fertilizer (P2O5 46%), and potassium fertilizer was added at a rate of 120 kg K ha-1 in the form of potassium sulfate (50% K2O) when planting addition of all fertilizers (nitrogen, phosphate and potash fertilizers) were in lines between and parallel to the planting lines. As for iron foliar fertilizer, it was added in the form of ferrous sulfate (FeSo4.7H2o) in four concentrations (0, 1, 2, and 3 $g.L^{-1}$) on 22/12/2020 at the beginning of the tillering stage. Repeat the spraying process a month after the first addition at the elongation stage.

Table 1. Some chemical and physical properties of the study soil before planting.

Character	PH	E.C.	Available			clay	silt	sand	Soil texture
			N	P	Fe				
Value	7.1	12	37.00	12.75	2.17	340	590	70	Silty clay loam
unit		dSm-1	Mg Kg-1 soil			gm Km-1 soil			

2.1 Study characteristics

2.1.1 Plant height (cm)

Was calculated from an average of ten plants randomly selected from each experimental unit.

2.1.2 Flag leaf area (cm^2) FLA

The leaf area was calculated from the average of ten plants randomly selected in the flowering stage, according to the following equation:

$$\text{FLA} = \text{length of paper } \times \text{maximum width } \times 0.75 \quad [4].$$

2.1.3 Leaf Area Index (L.A.I)

It was calculated from the total area of plant leaves divided by the area of land occupied by the plant (30×30). Net Assimilation Rate(N.A.R):It was calculated from the following equation [5].

$$\text{N.A.R} = \frac{\text{W2} - \text{W1}}{\text{T2} - \text{T1}} \times \frac{\text{logLA2} - \text{logLA1}}{\text{LA2} - \text{LA1}}$$

W2=Dry weight in flowering stageW1=Dry weight in the elongation phase

T2= Number of days for flowering stageT1=Number of days for the elongation phase

LA2= leaf area (flowering)LA1= Leaf area (elongation)

2.1.4 Crop Growth Rate (C.G.R)

It was calculated from the following equation [5].

$$C.G.R = \frac{1}{A} \times \frac{W2 - W1}{T2 - T1}$$

A=Land areaW2=Dry weight in flowering stageW1=Dry weight in the elongation phaseT2= Number of days for flowering stageT1=Number of days for the elongation phase

2.1.5 Number of Tillers (m^{-2})

It was calculated at harvest from an area (0.30) m^2 and then converted to square metres

2.1.6 Grain yield (mcg ha^{-1})

Was calculated from the m2 converted into an (mcg ha-1)

2.2 Statistical analysis

Data were statistically analyzed using spss program (20), and means between treatments were compared by least significant difference (L.S.D.) test at 0.05 level of probility, $P < 0.05$ [6].

3. Results and discussion

3.1 Plant height (cm)

The results in Table 2 showed that the plant height was significantly affected phosphate fertilizer manimam plant height was observed when P level was 150kg ha-1 which gave the best valves of plant height83.98 cm increasing by 45.72 % compared with control treatment P0 which gave the lowest 57.63 cm. The is increase is due to the role of phosphorus in the development of roots, and their branches, which increased the absorption of nutrients and water, also have a role in energy compound (ATP) formation and acceleration of growth (ATP) formation and acceleration of growth [7]. The average plant height was significantly affected when treated with different iron concentrations as the F2 concentration recorded the highest mean 76.71 cm, increasing by 18.08% compared with control treatment F0, which gave the lowest 64.96 cm The reasons for the increase in height is attributed to the important role of iron in the formation of many cytochromes and ferredoxin compounds of great importance in the photosynthesis process, which leads to their rates and thus increase growth rates and this is reflected in the increase in plant height. Iron has a role in the formation of chlorophyll pigment, which led to an increase in the process Photosynthesis Also, the interaction between iron and phosphorous had a significant effect on this trait. We note from Table 2 that the combination F2 * P3 gave the highest average for this trait of 95.86 cm, while the combinationF3* P0gave the lowest average of 48.66 cm.

3.2 Flag leaf area (cm^2)

The results in Table 2 indicate the significant differences in the flag leaf area with different P fertilizer P3 treatment levels, leading to an increase in FLA and giving31.93 cm2with increasing of 51.90%compared with control 21.02 cm2. This may be attributed to the importance of phosphorus in the growth, development and division of cells and the formation of DNA and RNA important in protein formation. It is also important in forming chloroplasts and in the formation of some energy compounds such as (ATP) [8]. These results are in agreement with The results indicated [9,10]. Table 2 also showed that the treatment F2 increase in iron concentrations had a significant effect in increasing the flag leaf area, as the treatment F2 gave higher FLA29.41 cm2 with 33.86% increasing as compared with control treatment which gave 21.97cm2. The reason for this is due to the role of iron in increasing the efficiency of the photosynthesis process by increasing the content of plant pigments And the formation of energy compounds with the activation of a number of enzymes involved in this process, which increases the products of photosynthesis, and this provides a better opportunity for the growth and expansion of the area of the flag leaf, which has a significant role in the process of photosynthesis These results are in agreement with the findings [11]. Significant interaction occurred between P level and Fe conc. The FLA F2*P3 gave the highest FLA 40.50 cm2,while the combination F0*P0 gave the lowest average of 15.59 cm^2.

3.3 Leaf area Index (L.A.I)

The results of Table 2 showed that the levels of phosphate P3weresuperior, which gave the highest average of 5.97 with an increase of 47.77% compared to the comparison treatment P0, which gave the lowest mean of 4.04,The reason for the increase is due to the role of phosphorous in promoting many processes Physiological as well as promoting respiration cell amplification and cell division. These results are consistent with his findings [12,13]. They were spraying with iron conc. Had a significant effect, as the F2 conc. Gave the highest average of 5.42 with an increase of 17.06% compared to the F0conc,which gave the lowest mean of 4.63 (tables 2). The increase in leaf area index is attributed to the role of iron in the synthesis of chlorophyll, which participates in vital processes and intracellular division processes. This leads to raising the efficiency of the plant, increasing growth and increasing the leaf area. These results agree with [14]. Data presented in table 4 show a significant non- effect between the levels of phosphate fertilization and spraying with iron concentrations.

3.4 Crop Growth Rate. C.G.R (gm m^{-2} day^{-1})

The results in Table 2 indicate an increase in the growth rate of the crop by increasing the levels of P fertilizer. The level of P3 was significantly superior, which gave 3.57 gm m-2 day-1 with an increase of 30.29% compared to treatment P0, which gave 2.74 g m-2 day-1The reason for the increase may be because the addition of phosphate fertilizers stimulated and increased the growth parameters such as plant height, number of tillers, flag leaf area and leaf area index. Table 2 also showed that the concentration of iron F2treatment was significantly superior to the C.G.R. by giving the highest average of 3.69 gm m-2 day-1. An increase of 36.16% compared to F0, which gave 2.71 gm- 2 day-1The reason for the increase in the C.G.R. could be because spraying iron with different concentrations contributed to providing this element needed by the plant and at an early stage in the growth of the plant which promoted obtaining the best growth rate for the plant. Table 2 the characteristic of the crop growth rate did not show a significant effect of the interaction between the levels of phosphate fertilization and spraying with iron concentrations.

3.5 Net Assimilation Rate .N.A.R (gm m^{-2} day^{-1})

The results of Table 2 showed that the levels of phosphate fertilization had a significant effect on N.A.R as the levels of addition P1, P2 and P3 were significantly superior, which gave the highest averages of 1.50, 1.52 and 1.51gm m-2day-1respectivelywith an increase of 12.78, 14.28 and 13.53% compared with control P0 which gave the lowest mean of 1.33 gm m^{-2} day^{-1}.We also note from the results of Table 2 that iron conc. It had a significant effect on N.A.R. F1, F2,and F3, which gave the highest averages of 1.59, 1.52 and 1.44 gm m-2 day-1, respectively, with an increase of 22.30, 16.92 % compared to the comparison treatment. F0,which gave the lowest average of 1.30 gm m-2 day-1.We can explain the reason for the N.A.R. to the availability of these nutrients (P and F) early in the stage of plant growth, which contributed to the increase in vegetation cover, which led to the efficient exploitation of light and thus increased the length and efficiency of the photosynthesis process and decreased respiration rates which led to an increase in The accumulation of dry matter per unit area which positively affected the net products of photosynthesis [15]. There is no significant effect on N.A.R. of the interaction between the levels of phosphate fertilization and spraying with iron concentrations (Table 2)

3.6 Number of Tillers (m^{-2})

The results of Table 2 that treatment P3 gave the highest average 659.33 m-2 with an increase of 28.60% compared with P0,which gave 512.66 Tillersm-2. The increase in this characteristic is due to the importance of phosphate fertilizer in the formation of lateral roots. Root hairs strengthening the stems and increasing the number of Tillers being the main source for cell division and increasing plant growth and are concentrated in the most effective areas [16]. These results are in agreement with [17]. Table 2 also showed that the concentration F2 gave the highest average number of tillers m-2, 610.33 tiller m-2, with an increase of 12.12%. In contrast, the control treatment F0 gave the lowest average, 544.33 tillers m-2. The reason for the increase in this trait is that the spraying addition of iron at the beginning of the tillering stage led to an increase in the products of photosynthesis, which may have reduced the competition between the main stem and the formed tiller to provide the nutritional support necessary for the growth of the most significant number of tillers. These results are in agreement with [18]. Also, the interaction between phosphorous and iron had a significant effect F2*P3gave the highest mean 769.33 m-2 branches, while the combination F0*P1gave the lowest average of 510.66 tiller m-2 (Table 2).

3.7 Grain yield(mcg ha^{-1})

The results shown in Table 2 show that the P3 level was significantly superior. The highest average grain yield was 6.13 mcg ha-1 with an increase of 128.73 % compared with P0,the lowest average of 2.68 mcg ha-1. This can be attributed to the role of direct phosphorus in most processes, including the decomposition of carbohydrates resulting from photosynthesis to release the energy needed for vital processes Cell membranes such as starch, chloroplasts, plasma and mitochondria. It also contributes to the formation of nucleic acids and energy-rich compounds. It has a role in transporting sugars from the places of their formation to the seeds. Phosphorous is unique as it is a major compound in seeds as a source of energy stored in phytin. These results agree with the results of [19,20]. The concentration of iron F2 had a significant effect on the grain yield, which gave 5.29 mcg ha^{-1}, with an increased rate of 66.87% with a significant difference from the concentration F0,which gave 3.17 mcg ha^{-1}. This contrast to the role of Iron in the manufacture of chlorophyll is also a synthetic component of ferredoxin. This compound is the first reducing compound in the electronic transport chain of photosynthesis. It led to an increase in the products of photosynthesis and their distribution to the vegetative parts. These results agree with [13,16]. As for the interaction effect between phosphate fertilization and iron concentrations, there were significant differences, as the combination P3 * F2recorded the highest average grain yield of 8.10 mcg ha-1, with an increase of 41.35% compared to the combination P0*F0,which was recorded 2.07 mcg ha-1 (Table 2).

Table 2. The effect of phosphate fertilization and spraying with iron and the interaction between them on some growth parameters and yield of oats.

treatment		PH	FLA	LAI	C.G.R	N.A.R	Tiller No.	GY
		Cm	Cm^2		gm m^{-2} day^{-1}	gm m^{-2} day^{-1}	Tiller m^{-2}	mcg ha^{-1}
Phosphorous Levels	P0	57.63	21.02	4.05	2.74	1.33	512.66	2.68
	P1	68.96	24.45	4.70	2.88	1.50	563.50	4.07
	P2	70.10	26.57	5.22	3.24	1.52	585.33	3.89
	P3	83.98	31.93	5.97	3.57	1.51	659.33	6.13
LSD (P < 0.05)		4.44	2.60	0.61	0.37	0.10	39.23	0.55
Iron Concentrations	F0	64.96	21.97	4.63	2.71	1.30	544.33	3.17
	F1	71.40	24.96	5.11	3.13	1.59	597.33	4.06
	F2	76.40	29.41	5.42	3.69	1.52	610.33	5.29
	F3	67.60	27.63	4.78	2.90	1.44	568.83	4.25
LSD(P < 0.05)		1.99	1.35	0.45	0.23	0.09	34.00	0.41
P0	F0	55.26	15.59	3.38	2.43	1.07	532.00	2.07
	F1	60.73	21.91	4.47	2.58	1.46	536.00	2.55
	F2	65.86	23.87	4.49	3.39	1.52	516.00	2.90
	F3	48.66	22.70	3.83	2.66	1.28	466.66	3.20
P1	F0	65.46	23.87	4.42	2.61	1.30	510.66	3.41
	F1	66.46	24.19	4.86	3.01	1.68	692.00	3.47
	F2	71.53	25.29	5.10	3.35	1.54	576.00	5.74
	F3	72.40	25.45	4.45	2.56	1.47	475.33	3.66
P2	F0	66.46	23.17	5.09	2.91	1.42	510.66	2.74
	F1	74.73	26.92	5.39	3.25	1.62	600.00	3.85
	F2	73.60	27.96	5.40	3.64	1.49	580.00	4.43
	F3	65.60	28.22	4.99	3.17	1.54	650.66	4.52
P3	F0	72.66	25.26	5.63	3.01	1.33	624.00	4.46
	F1	83.66	26.82	5.73	3.69	1.60	561.33	6.36
	F2	95.86	40.50	6.70	4.39	1.54	769.33	8.10
	F3	83.73	35.15	5.84	3.22	1.46	682.33	5.62
LSD (P < 0.05)		3.98	2.70	N.S	N.S	N.S	68.00	0.83

PH=plant height, FLA=Flag leaf area, LAI=Leaf area index, C.G.R= Crop growth rate, N.A.R=Net assimilation rate, Tiller No.= Tiller number M-2, GY= Grain yield.

Conclusions

Through the results obtained from the study, we conclude that phosphate fertilization had a significant effect on most of the studied traits at the vegetative growth stage, yield harvest and the qualitative characteristics of oats. The treatment 150 kg P2O5 ha-1 was superior to most studied traits, giving the highest grain yield (6.13mcg ha-1).Also, spraying iron with a concentration of 2000 PPM led to a significant increase in most of the studied traits and an increase in grain yield (5.29mcg ha-1) compared to the control treatment.

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