Performance of Broad Bean (*Vicia faba* L.) as Influenced by Salicylic Acid and Phosphorus Fertilization

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***Abstract*—A Field experiment was carried out in the winter season of 2017 on broad bean AL-Shamiya cv., in Musaib/Babylon/Iraq, to investigate the influence of salicylic acid at (0, 100 and 200) gm/L and soil applied phosphorus at (0, 15, 30 and 45) Kg/ha, and their interaction on some growth characters (plant height, branches no, Leaf area, and chlorophyll Content) and Yield and Yield Components (pods/ plant, seed no./ pod, 100 seed weight, pods Yield (kg/ha) and protein content of seed) using split plot in RCBD with three replicates Main plots were salicylic acid and sub plot were allocated phosphorus fertilizers. The data collected were analyzed by ANOVA test. means however, were compared at 5% level of Probability. Results of this work indicated that Salicylic acid at 100gm/L increased significantly all the parameters studied in obtained due to the application of phosphorus as at 30Kg/ha, on the other hand the interaction of these levels of the factors of this investigation gave the highest means of the studied traits.**

***Index Terms*—*Vicia faba*, vegetative characteristic yield and its component**

I. Introduction

Broad bean (*Vicia faba* L.) belonging to Fabaceae family references referred to faba bean, others called it horse bean and some field bean, among the world oldest crops and occupies the fourth place of the important crops to mankind [1] and third most important Legume, a good crop for human food as fresh or dried [2]. It is also important source of some mineral elements. as K, Fe and vitamins such as A and C [3] some references confirm that it is a good source of protein as well [4], Broad bean is a rich source of Carbohydrates, and play a vital role in crop rotation due to its capability to fix air nitrogen and provide a high level of nitrogen to the soil by symbiotic relation with the nitrogen fixation bacteria (Rhizobium), and then boosting soils fertility and properties. Broad bean is a Common winter Legume crop cultivated in winter in Iraq inters in man food list and used also for animal husbandry. Growth hormones are a naturally occurring in plant tissues bio-signals influence plant growth and development. They are most important factor for Yield and growth in plants. Salicylic acid, a naturally occurring phytohormone has various and many effects on plant growth and productivity, it triggers many physiological processes and growth of plant [5]. This hormone was shown to enhance plant growth and augment crop production of many field crops. using of salicylic acid has reported to increase plant height, number of branches/plant, number of pod/plant, number of seeds/pod, 100 seed weight, seed weight/plant. and seed yield (ton/ha) [6]. on the other hand in broad bean [7] reported a significant increase in nitrogen level and seed protein percentage of pea seeds [8] also reported a significant increase in bean growth and development by different Salicylic acid concentration. Phosphorus is needed for growth of Legumens besides its rol in promoting growth and productivity of Legumens. Phosphors possess a vital role in nitrogen fixation in soils [9]. This element, has a role in physiological functions in plant processes including photosynthesis, respiration, energy transfer and storage, cell division and enlargement and nutrient movement in the plant [10], [11]. Legumes require a relatively high levels of phosphorus for their growth and productivity [12], [13]. reported that maximum plant height, no. of pod/plant, no. of seed/pod, seed and yield of broad bean were associated with the highest level of phosphorus. significant increase in means of plant height, no. of branches/plant, leaf area, no. of pod/plant, and yield of broad bean was reported by [14] by phosphorus fertilization under the light of the above mention facts, This research was Laied out to assess the impact of salicylic acid, phosphorus fertilization and their interaction on performance of broad bean grown in the middle part of Iraq (i.e. Musaib/Babylon) and extract a suitable concentration of the low factors for maximum growth and development of this important crop and finally try to boosting its yield, qualitatively and quantitatively.

II. Material and Methods

Afield experiment was conducted in Musaib/Babylon/Iraq during winter season of 2017 to find out the effect of Salicylic Acid levels (0, 100, and 200 gm/L(ppm)) and phosphorus fertilization (0, 15, 30 and 45kg/ha) on the broad bean (CV. Al-shamiya) and the impact of that on some vegetative qualities and yield

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and yield components. Experiment design was split in RCBD with three replicates. Main plots were Salicylic acid levels while phosphorus fertilization occupied the sub-plot. Data were analyzed using ANOVA Test and means were compared at 5% level of probability [15] (Al-Sahooky and Whaeed, 1990). Weeds were controlled by spraying herbicide triflian 44% (1.25L/ha) after plowing. The following measurements were recorded from five randomly guarded plants from each plot:

1) Plant height (cm)
2) Number of branches/plant
3) Leaf area (cm^2): recorded at 100% flowering by leaf area meter system
4) Chlorophyll content (SPAD): recorded at 100% for flowering by SPAD (chlorophyll meter SPAD -502 plus
5) Number of pod per plant
6) Number of seeds per pods
7) Weight of 100 seed (gm)
8) Pods yield (kg/ha)
9) Protein content/seed

III. Results and Discussion

Data in (Table I) shows a significant differences in plants height due to Salicylic acid and phosphorus levels and their interaction. Salicylic acid at level (100) gm/L gave the highest mean of plant height (142.27 cm), while control recorded the lowest mean (137.10cm). phosphorus level (30kg/ha) resulted in higher plants height (141.55cm) and the lowest mean (139.27cm) resulted by the control treatment. This interaction of the experiment factors (100g/L and 30kg/ha) gave higher mean of plants height (144.52cm) while control treatment recorded the lower mean (134.92cm) Data in the same table replay also that the Salicylic acid and phosphorus levels treatments affected significantly the branches number per plant. Higher mean of this trait (18.76 branches per plant) was recorded by the (100gm/L salicylic acid) and the control gave the lowest mean (13.90) branches per plant. A significant increase in branches per plant was given by the (30kg/ha phosphorus level) as compared to the control treatment (18.06 and 15.64) branches per plant respectively. The (100gm/L and 30kg/ha) (salicylic acid and phosphorus level) resulted in high mean (20.67 branches per plant. control treatment gave the lowest mean of branches (12.30) branches per plant. The data also indicates that (100 and 200) gm/L Salicylic acid increased significantly Leaf area, they gave (5677.8 and 5684.6cm^2) respectively with no significantly with the control treatment that gave (4195.2cm^2). The treatment (30kg/ha) phosphorus recorded (5404.2cm^2) leaf area and differ significantly with the other levels. Interaction between (100gm/L×30kg/ha) resulted the higher means (5904.8cm^2) as compared with the control treatment that gave the lowest mean (3818.4cm^2) Leaf chlorophyll content treatment was significantly increased by (100gm/L) salicylic acid and gave (48.04 spad) as compared to the other levels. As for phosphors treatment. (30kg/ha) significantly alleviated the mean of this quality (45.5 spad) as compared to all other levels. The interaction results show that (100mg/L×30 kg /ha) increased significantly leaf chlorophyll content (50.46 spad) comparing to other treatments. Lowest content, hence, was due to treatment with control treatment. Number of pods per plant is an important trait attributing to dry pod yield of faba bean production. There were significant differences among the Salicylic acid levels (Table II) The maximum number of pods was produced by (100gm/L). Treatment (43.57pod plant-1) as compared with the other levels especially control treatment (0 ppm SA) that gave the lowest mean of this trait (38.35 pod plant-1). Pod plant-1 was influenced by the phosphorus treatment, higher mean was recorded by (30kg/ha) (42.0 pod plant-1 as compared to other levels. on the other hand the interaction treatment (l00gm/L×30 kg/ha) gave the highest mean (45.8 pod plant-1 in comparing to that of the interactions. Data in (Table II) reflects the effect of salicylic acid and phosphorus Fertilizer on number of seeds pod-1 the highest mean recorded by (0gm/L SA) (4.8 seed pod-1), whereas, (100gm/L SA) gave the lower mean (4.3 seeds pod-1). Phosphorus fertilizers level (15Kg/ha) recorded the higher mean (4.6 seeds pod-1) with no significant differences among the other levels. Interaction between (0 gm/L SA X 0 phosphorus F.) (Control) resulted in the higher means (4.9 seeds pod-1) as compared with the other treatments. This might be due to the compensation between the yield Components. Significant incensement of 100 seed weight by (100gm/L salicylic acid) treatment (148.1gm) in Comparing to the other levels is given in Table II. Data in this table reflect that (30kg/ha phosphorus Fertilizer) is also significantly augmented the mean of this trait (146.0gm) with no significant differences with (15kg/ha P) and (45kg/ha P). As for interaction treatment, however, (l00gm/L×30kg/ha) recorded the higher value (150.0gm) while (0gm/L×0kg/ha) (Control) resulted in (132.4gm).

From (Table II) it could be observed that (100gm/L SA) significantly increased the pods yield/ha (4331.0 pods/ha) compared to the other levels of this factor. Phosphorus fertilizer also increases pods yield/ha (4248.4 Pods/ha), this figure, hence, is significantly different from the other figures given by the phosphorus levels. High pods yield/ ha is given by (100gm/L SA×30Kg/ha phosphorus) treatment of interaction (4535.0 pods/ha) while the lowest value recorded by control treatment that gave (3781.7) pods/ha.

Data in (Table III) show that Salicylic acid treatment (100gm/L) significantly raised the mean of protein content (33.6%) as compared to the other treatment levels. And control treatment recorded the lowest mean (30kg/ha) resulted in higher protein content (32.7%), while lower protein content (32.2%) recorded by control treatment High protein content in seed was due to the interaction (100gm/L×30kg/ha) that resulted in (34.0%), where control treatment for, Experiment factor recorded the lowest content (30.6%).

TABLE I. EFFECT OF SALICYLIC ACID AND PHOSPHORUS FERTILIZATION ON BROAD BEAN (*VICIA FABA* L.) VEGETATIVE CHARACTERISTICS FOR GROWING SEASON 2017

Salicylic acid (gm/L)	Phosphorus fertilization (kg/ha)	Plant height (cm)	Branches number/plant	Leaf area (cm2)	Chlorophyll content /SPAD
0	0	134.92	12.30	3818.4	33.37
100		141.01	17.45	5412.7	45.58
200		141.78	17.19	5277.5	43.37
0	15	136.88	13.35	3945.7	37.20
100		142.24	18.15	5571.9	48.00
200		143.10	19.39	5888.3	44.44
0	30	137.91	14.30	4433.3	40.53
100		144.52	20.67	5904.8	50.46
200		142.23	19.22	5874.6	44.48
0	45	138.72	15.66	4583.3	42.95
100		141.32	18.75	5822.1	48.10
200		139.88	18.34	5698.1	42.33
LSD		0.81	0.38	50.34	2.15
Salicylic acid (gm/L)	0	137.10	13.90	4195.2	38.51
	100	142.27	18.76	5677.8	48.04
	200	141.74	18.53	5684.6	43.65
LSD		0.46	0.17	22.17	1.14
Phosphorus fertilization (kg/ha)	0	139.23	15.64	4836.2	40.77
	15	140.74	16.96	5135.3	43.21
	30	141.55	18.06	5404.2	45.15
	45		17.58	5367.7	44.46
LSD		**0.49**	**0.23**	**27.93**	**1.48**

TABLE II. EFFECT OF SALICYLIC ACID AND PHOSPHORUS FERTILIZATION ON BROAD BEAN (*VICIA FABA* L.) YIELD AND ITS COMPOSITIONS FOR GROWING SEASON 2017

Salicylic acid (gm/L)	Phosphorus fertilization (kg/ha)	Number of Pods (pod/plant)	Number of seeds (seed/pod)	100 seeds weight (g)	Pods yield (kg/ha)
0	0	36.3	4.9	132.4	3781.7
100		42.0	4.5	146.1	4237.8
200		42.3	4.3	147.0	4055.5
0	15	37.7	5.0	139.6	4027.6
100		43.2	4.3	147.8	4287.7
200		43.1	4.5	148.0	4063.7
0	30	39.3	4.8	142.0	4058.3
100		45.8	4.1	150.0	4535.0
200		40.9	4.7	146.0	4152.1
0	45	40.1	4.6	144.7	4078.2
100		43.3	4.3	148.5	4263.6
200		40.9	4.4	141.2	4042.4
LSD		2.07	1.84	2.32	46.08
Salicylic acid (gm/L)	0	38.4	4.8	139.6	3986.5
	100	43.6	4.3	148.1	4331.0
	200	41.8	4.5	145.5	4078.4
LSD		1.02	0.09	1.23	23.17
Phosphorus fertilization (kg/ha)	0	40.2	4.5	141.8	4025.0
	15	41.3	4.6	145.1	4126.3
	30	42.0	4.5	146.0	4248.4
	45	41.4	4.4	144.8	4128.0
LSD		1.27	1.13	1.57	26.62

TABLE III. EFFECT OF SALICYLIC ACID AND PHOSPHORUS FERTILIZATION ON BROAD BEAN (*VICIA FABA* L.) PROTEIN CONTENT SEED % FOR GROWING SEASON 2017

Salicylic acid (gm/L)	Phosphorus fertilizer (Kg/ha)				Mean
	0	15	30	45	
0	30.6	31.3	32.1	32.2	31.50
100	33.6	32.9	34.0	34.0	33.6
200	32.4	33.0	32.2	31.6	32.3
Mean	32.2	32.4	32.7	32.6	

It is clear from the results of this work that salicylic acid (100mg/L) significantly influenced growth traits of broad bean as well as Yield and Yield components. Salicylic acid involved in different physiological processes during plant growth [5], [6]. It encourages cell division and elongation which could boost levels of Auxins and Cytokinins in plant cells and ultimately increases growth rates [16]. Cytokinin has a vital role in increasing branch numbers [17] and therefore, provides a wide green area and high photosynthetic products leading to ideal rates of growth. As the number of branches increases, the number of pods is increasing. Increasing in green area and increasing in chlorophyll Content (Table I) means efficient source. Efficient source is there by means ideal flow of growth factors to the sink (seed). This may explain the increase of vegetative parameters and Yield by salicylic acid application. The results of our results are in agreement with findings of [8], [18]-[20]. who recorded an increase in growth parameters of broad bean by application of Salicylic acid and also with those obtained by [21]. They reported a significant increase in pods Yield due to Salicylic acid application. on the other hand, the results of this work reflect an increase in growth parameters was obtained by phosphorus fertilization. phosphorus triggers different plant physiological processes. It increases rates of nitrogen fixating in soil with the association with the bacteria responsible for this process (Sara, *et al*., 2013) and involves in respiration, energy transfer and Storage in plant tissues. Therefore, increases rates of growth of plants particularly increases Chlorophyll (Table I) and leaf area (Table I) which appear to increase Yield and its components (Table II). The increase of yield Could be, hence, attributed to the high levels of food and growth materials manufacturing in the leaf (which is the main source) and rapid flow of these growth substances and hormones to the growth sink in plant (seeds) and thereby increasing Yield Components and total yield. These results agreed with the results obtained by [22], [23] that phosphorus increased vegetative traits of broad bean and also agreed with the result reported by [23]-[26] that phosphorus increases yield and yield Component of broad bean. In the light of the outcomes of the present study, the interaction effect of application of Salicylic acid and phosphorus fertilizer has efficient role in broad bean growth, development and productivity, through increasing plants vigorous via boosting means of plant height, branches number, Leaf area, chlorophyll contact, yield and yield Components (No. pods/plant, 100 seeds weight, number of seeds per pod). Therefore, it could be recommended to use Salicylic acid in 100mg/L, plus Fertilization with phosphorus at 30Kg/ha in broad bean fields of middle Iraqi regions.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

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