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Enhancement Yield and Quality of Faba Bean Plants Grown under Salt Affected Soils Conditions by Phosphorus Fertilizer Sources and Some Organic Acids

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ABSTRACT

Two field experiments were carried out at Experimental Farm of Tag El-Ezz Agricultural Research Station (30º 59\ N latitude, 31º 58\ E longitude´), Agriculture Research Center, Dakahlia Governorate, Egypt. Split plot design with three replicates was used during the two successive winter seasons of 2018/19 and 2019/20 to study the effect of four phosphorus fertilizer sources (without addition, super phosphate (SP), phosphoric acid (PA) and di ammonium phosphate (DAP)) as the main plots and four organic acids treatments (control, citric acid (CA), salicylic acid (SA) and ascorbic acid (ASA)) as foliar application in the sub plots on growth, yield and its components of faba bean plants (*Vicia faba L.*) cv. Giza 716 which grown under salt affected soil. Available elements N, P and K in the experimental soil were determined after harvesting. The obtained results could be summarized as follow: DAP gave the highest values of vegetative growth, yield and its components compared to other phosphorus sources. ASA as a foliar application has a superior effect on all studied parameters compared to the other foliar treatments. The interaction between DAP and ASA achieves the highest values of vegetative growth criteria, yield and its components of the faba bean plant. The highest residual N, P and K (mg kg^{-1}) in the soil were recorded with the interaction of SP and CA application comparing with the other phosphorus fertilizers and organic acids treatments. The highest P use efficiency values were obtained by the combination of PA and ASA foliar application.

Keywords: Di ammonium phosphate, phosphoric acid, Salinity, Organic acids and Faba bean.

INTRODUCTION

Faba bean (*Vicia faba* L.) is one of the most important winter legume crops and a major source of protein for both human and animal nutrition. Mature seeds of faba bean are good sources of protein, fat, carbohydrate, starch, cellulose, vitamin C, and minerals (Katell *et al.*, 2010). Bean yield and its productivity depend on fertilization as well as other crops. Faba bean is considered as a moderately sensitive legume to salinity (Mahdi, 2016). According to FAO (2000), *Vicia faba* tolerant the soil salinity till 1.7dSm^{-1}, where the raising of soil salinity more than 1.7dSm^{-1} causes decline the yield. For example, yield of *Vicia faba* grown on soil having ECe of 4.2dSm^{-1} reduce to 75%.

Salinity is the accumulation of dissolved mineral salts present in soil solution and waters (Isayenkov, 2012). Salt stress affects negatively on plant metabolism, reduce photosynthesis, reduce growth via different ways i.e. osmotic stress by reducing water uptake, cytotoxicity as a result of an accumulation of Na^+ and Cl^- ions, nutritional imbalance and oxidative stress due to generation of reactive oxygen species (ROS) (Roy *et al.*, 2014; Sallam *et al.*, 2014) as well as reduce mineral uptake consequently, reduce plant yield and its productivity (Jebara *et al.*, 2005). Salinization has adverse the effect not only on agricultural production of plants but also, on soil physiochemical properties (Hu and Schmidhalter, 2002).

Phosphorus is an important major nutrient for plants, its availability in soil depends on soil pH where, the highest availability recorded in 6 to 7 pH range (Gulmezoglu and Dughan, 2017). It plays an effective role in releasing energy during cellular metabolism which important for biological nitrogen fixation. Moreover, it stimulates root growth, photosynthesis, increase flower formation, fruit production and inter in many organic compounds formation as well as increasing salt tolerance in plants (Rafat and Sharifi, 2015; Fouda, 2017).

Super phosphate is the dominant phosphorus fertilizer used. When it added to soil moisture attracted to its granule, converted the soluble P within the granules into phosphoric acid and a less soluble form of P, di-calcium phosphate which converted into an insoluble tri-calcium phosphate in alkaline soil (Shen *et a*l., 2011).

Phosphoric acid also an excellent source of P but it's more expensive. It can be applied by injection directly to soil especially alkaline one, or added to irrigation water as occur in this search. Its application decreases pH of alkaline soil and increases the availability of soil nutrients (George *et al.*, 2016).

Di ammonium phosphate is an excellent source of P and N for the plant where it dissolves quickly in the soil to release available phosphate and ammonium. This ammonium act as a nitrogen source that converted to nitrate by soil bacteria which consequently decreases soil pH. Leading to an increase in the availability of nutrients and increasing nutrient uptake by plants (George *et al.*, 2016).

Citric acid is a vital organic acid act as an enzyme co-factor in plants, important for the respiratory cycle and other physiological processes (Raka, 2017). Citric acid application improves salinity tolerance by the plant where it affects positively on membrane stability, induces transporter enzyme

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activities, eliminates free radicals produced in plants under salinity stress as well as improves growth and consequently increases plant yield (El-Tohamy *et al.*, 2015).

Salicylic acid is a natural phenolic phytohormone compound that acts as an endogenous regulator in the plant. It has a positive effective role in several plant physiological processes (Ramzan *et al*., 2018). Abdelaal, (2015) reported that, application of salicylic acid regulates plant growth , development and flowering as well as it enhances enzyme activities as amylase and nitrate- reductase, it is accumulated osmotic adjustment solutes (protein, sugars and glutathione), increases antioxidant enzyme activities (catalase and peroxidase and decreases ROS level and lipid peroxidation (Ahmad *et al.*, 2018).

Ascorbic acid naturally occurs in the chloroplast and cell wall of the plant, it acts as a growth regulating factor and enzymatic antioxidants that reduce ROS production in plants by providing electron donors (Sadak *et al*., 2010). Also, it plays a critical role in several physiological processes in a plant as antioxidant defense, photosynthesis regulation, cell division and enlargement, growth and plant development (Dolatabadian and Saleh Jouneghani, 2009).

This work aims to study the enhancement effect of the application of P- fertilization sources and foliar application of some organic acids on yield and quality of faba bean plants grown under salt affected soil conditions**.**

MATERIALS AND METHODS

Two field experiments were conducted during two successive winter seasons of 2018/19 and 2019/20 at the farm of Tag El-Ezz, Agricultural Research Station, Agricultural Research Center, Dakahlia Governorate, Egypt, (located at 30º 59\ N latitude, 31º 58\ E longitude´) to study the effect of P- fertilization sources and foliar application of some organic acids on growth, yield and its components as well as chemical composition of faba bean plants grown under salt affected soil. Seeds of faba bean (*Vicia faba* L.) cv. (Giza 716) were obtained from the Legumes Crops Research Department, Ministry of Agriculture, Egypt. Random disturbed soil samples from the surface of the soil (at the depth 0-30 cm) were collected before planting. Some physical and chemical properties of the experimental soil were determined according to Page *et al*., (1982) and Klute (1986) as shown in Table (1).

Table 1. Average values of physical and chemical properties of the experimental soil.

Particle size distribution (%)				**Textural class**		**EC, dSm^{-1}***	**pH ****	**SSP**	**SAR**	**ESP**
C.sand sand	**F.sand**	**Silt**	**Clay**	**Clay**				**(%)**		
4.07	15.45	38.20	42.28			4.64	7.96	54.09	8.59	10.24
Soluble ions(mmol L^{-1})								Available elements, mg Kg $^{-1}$		
Soluble cations				Soluble anions						
Ca^{++}	Mg^{++}	Na^{+}	K^{+}	CO_3^{--}	HCO_3^{-}	Cl^{-}	SO_4^{--}	N	P	K
8.80	8.31	25.10	4.20	0.00	2.00	20.41	24.00	49.62	8.77	241.35

*** Soil Electrical Conductivity (EC) and soluble ions were determined in saturated soil paste extract.**

**** Soil pH was determined in soil suspension (1: 2.5).**

Experiment description.

The experiments included sixteen treatments resulting from the combinations of four P fertilizer sources (without addition, super phosphate (SP), phosphoric acid (PA), and di ammonium phosphate (DAP)) as the main plots and four organic acids treatments (control, citric acid (CA), salicylic acid (SA) and ascorbic acid (ASA)) as the sub plots on faba bean (*Vicia faba* L.) var. Giza (716) plants growth, yield, its components and chemical constituents. The experimental design was a split- plot with three replications. The experimental area consisted of 48 plots. The sub plot area was 14 m^2 (4m ×3.5m).

Prior to sowing, faba bean seeds were inoculated with the liquid culture of rhizobium bacteria which obtained from the Agricultural Research Center (ARC) at the rate of 800 g fed^{-1}. Arabic gum was added to the liquid culture as an adhesive agent. Seeds of faba bean were sown in hills spaced 25 cm apart at both sides of the ridge at 25th, October during the two growing seasons. Thinning was carried out when the plant height becomes 15 cm leaving two plants per hill. With regard to the soil applied treatments, super phosphate [$Ca(H_2PO_4)_2$) 15.5% P_2O_5] fertilizer was added to the soil during soil preparation while di ammonium phosphate [($(NH_4)_2HPO_4$) 46% P_2O_5, 18% N] and phosphoric acid [(H_3PO_4) 60% P_2O_5] fertilizers divided into three equal portions and added at three times: at sowing, 21and 45 days from sowing at the rate of 15 kg P_2O_5 fed^{-1}. Nitrogen was added as urea (46.5% N) at the rate of 15 kg N fed^{-1}, with regard to decreasing the amount of nitrogen in DAP from the dose added and Potassium was added as potassium sulphate (48% K_2O) at the rate of 25 kg K_2O fed^{-1} according to recommendation by the Ministry of Agriculture and Soil Reclamation (MASR).The plants were sprayed with organic acids twice at 45 and 70 days of planting with freshly prepared solutions of citric acid (CA), salicylic acid (SA) and ascorbic acid (ASA) at the rate 200 mg L^{-1} individually. Meanwhile, untreated plants were sprayed by distilled water to serve as a control.

Data recorded.

1- Growth parameters:

Plant samples were collected from each sub plot at maximum vegetative growth stage for measurement of some growth parameters (shoot length (cm), root length (cm), No. of branches, plant fresh weight (g) and plant dry weight (g)). Chlorophyll a, chlorophyll b, and total chlorophyll (mg g^{-1} fresh weight of leaf) were determined using a method described by Nayek *et al.*, (2014). Total N, P and K content were determined according to the methods described by Chapman and Pratt (1961) and Buresh (1982), respectively. Nutrients uptake was determined according to the following formula

$$\textbf{Nutrients uptake} = \frac{\textbf{\textit{Nutrient concentration}}\ \textbf{x dry weight}}{\textbf{100}}$$

2- Harvest stage:

At harvest, the following characters, pods number plant^{-1}, Pods weight (g plant^{-1}), seeds number plant^{-1}, 100 seeds weight (g), seed and straw yields (ton fed^{-1}) were recorded at a random of ten guarded plants from each plot. The seeds yield were cleaned and crushed to determine total N, P and K components. Protein percentage was estimated by multiplying nitrogen percentage by the factor (6.25) according to A.O.A.C. (1990). Proline was extracted in 3% sulphosalicylic acid and was determined calorimetrically according to the method of Bates *et al.*, (1973). In straw, P was determined calorimetrically. Nutrients uptake was determined according to the following formula

$$\textbf{Nutrients uptake} = \frac{Nutrient\ concentration \text{ x } yield}{100}$$

Phosphorus use efficiency.

Agronomic and recovery efficiency as well as partial factor productivity of phosphorus were calculated using following equations according to Naeem *et al.* (2017).

$$\textbf{Agronomic use efficiency(AE)} = \frac{Seed\ yield\ of\ treated\ - Seed\ yield\ of\ control}{Fertilizer\ (P)\ applied}$$

$$\textbf{P recovery effeciency \% (RE)} = \frac{Total\ P\ uptake\ of\ treated\ - Total\ P\ uptake\ of\ control}{Fertilizer\ (P)\ applied} \times 100$$

$$\textbf{Partial Factor Productivity (PFP)} = \frac{\textbf{Seed yield}}{\textbf{Fertilizer P applied}}$$

3- Residual nutrients in soil:

Surface soil samples (0-30 cm) from each sub plot were collected after harvesting to determine the available N, P and K (mg kg^{-1}).

Economics.

Total cost of cultivation as well as gross return was calculated on the basis of prevailing market rates for different practices and produces. The total cost of cultivation per feddan was subtracted from the gross income for computing net returns from each treatment.

Net return (£. fed^{-1}) = Gross return ((£. fed^{-1}) - Cost of cultivation (£. fed^{-1})

Benefit cost ratio (BCR) was calculated treatment wise as below.

$$\textbf{Benefit Cost Ratio (BCR)} = \frac{\textbf{Gross return}}{\textbf{Cost of cultivation}}$$

Statistical analysis

Results from identical experiments of the 2 years were combined for analysis. Significant differences among treatments means were determined at $P \leq 0.05$ by using LSD test and Duncan's Multiple Comparisons Test. Data of the present study were statistically analyzed using CoSTATE Computer Software, according to Gomez and Gomez, (1984).

RESULTS AND DISCUSSION

1- Plant Growth Parameters.

Presented data in Table 2 show the effect of treating faba bean plants with different P fertilizer sources and foliar application of some organic acids as well as their interactions on vegetative growth characters of faba bean plants (shoot height (cm), root length (cm), No. of branches $plant^{-1}$, plant fresh weight (g) and plant dry weight(g)) under salinity stress condition. Data indicated that all the treatments have a significant effect on all bean plants studied parameters.

It is obvious from data recorded in Table 2 that DAP fertilizer recorded the highest significant values of all studied vegetative growth parameters. This may be due to DAP rather solubility than SP and less reactions with the other soil components than PA, the same result was recorded by Turuko and Mohamed, (2014). While, ASA foliar application gave the highest values of all mentioned parameters. This may be due to absorption of ASA led to decrease plant soap pH which increase nutrients activities, this result in matching with that recorded by Khan *et al.*, (2011).

Table 2. Mean effect of P fertilizer sources and some organic acids and their interactions on vegetative growth parameters of faba bean grown under salinity stress.

Treatments		Shoot height	Root length	No. of branches	Fresh weight	Dry weight
		cm		$plant^{-1}$	g $plant^{-1}$	
Phosphorus Fertilizer sources						
Without addition		100.08^{d}	14.1^{d}	3.51^{d}	226.16^{d}	26.94^{d}
Superphosphate (SP)(control)		103.41^{c}	15.0^{c}	3.66^{c}	256.58^{c}	28.82^{c}
Phosphoric acid (PA)		108.16^{b}	16.1^{b}	3.75^{b}	287.16^{b}	32.49^{b}
Di ammonium phosphate (DAP)		116.75^{a}	17.66^{a}	3.83^{a}	321.83^{a}	38.26^{a}
Foliar Applications						
Cont.		108.58^{d}	14.83^{d}	3.75^{d}	259.00^{d}	30.19^{d}
Citric acid (CA)		109.08^{c}	15.90^{c}	3.80^{c}	265.75^{c}	30.95^{c}
Salicylic acid (SA)		109.58^{b}	15.91^{b}	3.85^{b}	277.91^{b}	31.64^{b}
Ascorbic acid (ASA)		111.16^{a}	16.41^{a}	3.91^{a}	289.08^{a}	33.73^{a}
Interactions						
Without addition	Cont.	97.33^{i}	12.33^{m}	3.33^{e}	215.23^{p}	26.36^{l}
	CA	100.00^{h}	13.00^{l}	4.33^{b}	216.23^{o}	26.87^{k}
	SA	103.00^{g}	14.00^{k}	3.33^{e}	233.56^{n}	27.21^{j}
	ASA	107.54^{e}	14.66^{j}	4.33^{b}	239.23^{m}	27.31^{j}
SP (control)	Cont	100.00^{h}	15.02^{i}	4.00^{c}	241.00^{l}	27.85^{i}
	CA	102.33^{g}	15.33^{h}	4.00^{c}	257.00^{k}	28.40^{h}
	SA	107.30^{e}	15.53^{g}	3.66^{d}	261.33^{j}	28.64^{h}
	ASA	108.00^{e}	16.33^{f}	3.33^{e}	267.00^{i}	30.38^{g}
PA	Cont	102.33^{g}	16.30^{f}	3.33^{e}	272.33^{h}	30.55^{g}
	CA	105.00^{f}	17.00^{e}	4.00^{c}	279.33^{g}	30.87^{f}
	SA	110.33^{d}	17.50^{d}	4.00^{c}	291.66^{f}	33.45^{e}
	ASA	115.00^{c}	18.01^{c}	4.33^{b}	305.33^{e}	35.08^{d}
DAP	Cont	102.66^{g}	17.50^{d}	3.00^{f}	307.23^{d}	35.98^{c}
	CA	117.66^{b}	18.00^{c}	3.33^{e}	310.23^{c}	37.42^{b}
	SA	119.00^{b}	21.00^{b}	3.30^{e}	325.00^{b}	37.50^{b}
	ASA	120.63^{a}	21.33^{a}	4.66^{a}	344.66^{a}	42.15^{a}

Also, data revealed that the lowest values of all previously studied parameters were recorded under salinity stress (without P fertilizer and without foliar application), this reduction may be due to the negative effect of salinity which promotes accumulation of certain ions and deficiency of others (Abdul Qados, 2011). Excess of salts has an inhibitory effect on metabolic activities of cell wall leading to deposition of various materials that decrease cell wall elasticity consequently cell wall becomes rigid and turgor pressure efficiency in cell enlargement is decreased (Patel *et al*., 2010).

On the other hand, faba bean plants gave the highest values of shoot height, root length, No. of branches plant^{-1}, plant fresh weight and plant dry weight in case of interaction of DAP fertilizer and foliar application with ASA under salinity stress condition where, phosphorus plays a vital role in cell division activity and improve salt tolerance leading to the increase of plant height, No. of branches and consequently increased plant dry weight (Tesfay *et al*., 2007). As well as ASA inhibits the effect of salt stress, increases physiological availability of water and nutrients that regulate root elongation, cell vacuolation and cell expansion as well as increases the content of (IAA) that induce cell division and enlargement leading to an increase in plant growth.

2- Chlorophyll Content.

It is evident from Table 3 that the average of chlorophyll content (Chl. a, Chl. b and total Chl.) are decreased under salinity stress (without P fertilizer and foliar application), this reduction may be due to the negative effect of accumulated ions on the biosynthesis of chlorophyll (Stoeva and Kaymakanova, 2008). Also, salinity affects the forces binding the pigment – protein- lipid complex in chloroplast structure which leads to a reduction in chlorophyll , as well as it generates reactive oxygen species (ROS) such as H_2O_2 which causes chlorophyll degradation (Hamada and El-Anany,1994).

Table 3. Mean effect of P fertilizer sources and some organic acids and their interactions on chlorophyll content on vegetative growth of faba bean grown under salinity stress.

Treatments		(mg g FW^{-1}) Chlorophyll a	Chlorophyll b	Total chlorophyll
hosphorus Fertilizer sources				
Without addition		0.468^{d}	0.176^{d}	0.651^{d}
Superphosphate (SP)(control)		0.478^{c}	0.287^{c}	0.796^{c}
Phosphoric acid (PA)		0.512^{b}	0.379^{b}	0.918^{b}
Di ammonium phosphate (DAP)		0.634^{a}	0.402^{a}	1.110^{a}
Foliar Applications				
Cont.		0.448^{d}	0.283^{d}	0.743^{c}
Citric acid (CA)		0.497^{c}	0.291^{c}	0.822^{b}
Salicylic acid (SA)		0.570^{b}	0.307^{b}	0.883^{b}
Ascorbic acid (ASA)		0.577^{a}	0.365^{a}	0.957^{a}
Interactions				
Without addition	Cont.	0.270^{l}	0.093^{k}	0.369^{g}
	CA	0.400^{k}	0.135^{j}	0.540^{f}
	SA	0.460^{j}	0.141^{j}	0.609^{f}
	ASA	0.494i	0.213^{i}	0.712^{e}
SP Control	Cont.	0.501^{h}	0.243^{h}	0.751^{e}
	CA	0.505^{h}	0.250^{gh}	0.773^{de}
	SA	0.510^{g}	0.260^{fg}	0.777^{de}
	ASA	0.511^{g}	0.271^{f}	0.797^{de}
PA	Cont.	0.519^{f}	0.317^{e}	0.841^{d}
	CA	0.525^{f}	0.401^{d}	0.933^{c}
	SA	0.527e	0.426^{c}	0.959^{c}
	ASA	0.530^{e}	0.429^{c}	0.963^{c}
DAP	Cont.	0.589^{d}	0.441^{bc}	1.044^{b}
	CA	0.615^{c}	0.454^{b}	1.075^{b}
	SA	0.664^{b}	0.471^{a}	1.138^{b}
	ASA	0.746^{a}	0.474^{a}	1.225^{a}

DAP as a phosphorus fertilizer source recorded the highest significant values of chlorophyll pigments content as Darwesh *et al*., (2013) recorded, while, ASA achieved the highest significant values of chlorophyll content compared with the other foliar application treatments, the same result concluded by (Nicholas and Wheeler, 2000).

On the other hand, the interaction between DAP fertilizer and ASA foliar application gave the highest significant effective values of chlorophyll pigments content in faba bean plants grown under salinity stress where phosphorus fertilizer enhanced cell division and increased chlorophyll development as well as playing a role in respiration, cellular energy transfer and photosynthesis as well as induced uptake and accumulation of Mg^{2+} which important for chlorophyll synthesis (Bertrand *et al*., 2003). Shubhra *et al*., (2004) reported that, phosphorus application protecting photosynthetic machinery from salt-induced ROS through acting as a free radical scavenger.

ASA has an effective role in chlorophyll biosynthesis, protecting chloroplast from oxidative damage that occurred as a result of salt stress as well as inducing photosynthetic activities (Sadak *et al*., 2010).

3- Nutrients Concentration and Their Uptake by Shoots.

It is obvious from the average results in Table 4 that, salinity reduces nutrient content in leaves and their uptake especially nitrogen may be due to salinity causes nutrients unbalance or / and decreasing water absorption, the same result reported by Abd EL-Mawgoud *et al*., (2010). Reduction in nitrogen concentration value is due to a decrease in the transpiration rate that transport N from roots to shoots (Pessaraki *et al*., 1989).

Stoeva and Kaymakanova, (2008) showed that increasing salt concentration leading to a decreasing of P content as well as K content and their uptakes which may be attributed to the difference between osmotic pressure around the root zone and plant tissue and decreasing of P and K mobility under salt stress condition.

DAP fertilizer recorded the highest values of NPK content as Darwesh *et al*., (2013) recorded. On the other hand, ASA foliar application gave the highest values of NPK content where it reduces salinity stress effect and increasing nutrients availability leading to increasing nutrient uptake by the plant (Al quriany, 2007).

Interaction of DAP and ASA achieved the highest values of NPK concentration in vegetative growth stage under salinity stress, this increments may be due to the role of phosphorus fertilizer in enhancing nutrients balance and the competitive between phosphate and chloride as well as ascorbic acid which adverse negative effect of salinity (Mustafa *etal*., 2004).

4- Yield and Its Components.

The data presented in Table 5 and Fig. 1 indicate the average of seed and straw yields (ton fed^{-1}) and yield components [i.e. pods No. plant^{-1}, pods weight (g plant^{-1}), seeds No. plant^{-1} and 100 seed weight (g)]. It records that salinity reduces yield and its components as Garcia *et al*., (2019) recorded.

Reduction of yield under salt stress condition may be attributed to reduction of chlorophyll pigments thus, reduce photosynthetic rate, decreasing rhizobia activity which decrease nitrogen fixation as well as reduce efficiency of filling the developing seeds consequently decline seeds No. plant^{-1} and dry matter yield (Ahmed, 2009).

DAP fertilizer as a source of phosphorus fertilizer gave the highest values of seed and straw yields and yield components, this is the same result obtained by Osman *et al*., (2012). Application of phosphorus fertilizer to soil improves the nutrients balance, enhances shoot growth, promotes efficiency the formation of nods and pods in legumes and it's important for seed formation (Shubhra *et al*., 2004).

Table 4. Mean effect of P fertilizer sources and some organic acids and their interactions on nutrient content (%) and their uptake (mg plant^{-1}) of faba bean shoots grown under salinity stress.

Treatments		Nutrients N	P	K	Nutritional elements uptake N	P	K
		%			(mg plant^{-1})		
		Phosphorus Fertilizer sources					
Without addition		3.10^{d}	0.401^{d}	1.970^{d}	840^{d}	106^{d}	517^{d}
Superphosphate (SP)(control)		3.38^{c}	0.437^{c}	2.251^{c}	954^{c}	122^{c}	629^{c}
Phosphoric acid (PA)		3.55^{b}	0.452^{b}	2.384^{b}	1149^{b}	145^{b}	769^{b}
Di ammonium phosphate (DAP)		3.64^{a}	0.459^{a}	2.449^{a}	1432^{a}	178^{a}	969^{a}
		Foliar Applications					
Cont.		3.21^{d}	0.417^{b}	2.096^{b}	1010^{d}	129^{d}	668^{d}
Citric acid (CA)		3.40^{c}	0.435^{ab}	2.257^{b}	1059^{c}	133^{c}	690^{c}
Salicylic acid (SA)		3.50^{b}	0.443^{ab}	2.328^{a}	1100^{b}	139^{b}	731^{b}
Ascorbic acid (ASA)		3.55^{a}	0.452^{a}	2.372^{a}	1206^{a}	150^{a}	795^{a}
		Interactions					
Without addition	Cont.	3.01^{o}	0.389^{i}	1.916^{l}	793^{p}	100^{l}	503^{k}
	CA	3.08^{n}	0.397^{hi}	1.946^{k}	82^{o}	104^{k}	476^{k}
	SA	3.17^{m}	0.403^{gh}	1.976^{k}	862^{n}	108^{jk}	536^{j}
	ASA	3.22^{l}	0.413^{fg}	2.040^{jk}	879^{m}	112^{j}	552^{j}
SP Control	Cont	3.22^{l}	0.422^{ef}	2.103^{ij}	896^{l}	117^{i}	585^{i}
	CA	3.28^{k}	0.426^{ef}	2.165^{hi}	939^{k}	120^{hi}	618^{h}
	SA	3.34^{j}	0.430^{de}	2.210g^{hi}	949^{j}	122^{h}	628^{h}
	ASA	3.39^{i}	0.437^{de}	2.253^{fgh}	1030^{i}	131^{g}	683^{g}
PA	Cont	3.44^{h}	0.442^{cd}	2.296^{efg}	1050^{h}	134^{fg}	699^{fg}
	CA	3.49^{g}	0.447^{cd}	2.353^{def}	1077^{g}	136^{f}	725^{f}
	SA	3.54^{f}	0.452^{bc}	2.403^{cde}	1184^{f}	156^{e}	803^{e}
	ASA	3.67^{d}	0.455^{bc}	2.426^{cd}	1285^{e}	158^{d}	849^{d}
DAP	Cont	3.61^{e}	0.462^{ab}	2.460^{bcd}	1299^{d}	165^{c}	885^{c}
	CA	3.72^{c}	0.467^{ab}	2.516^{abc}	1392^{c}	172^{b}	939^{b}
	SA	3.75^{b}	0.472^{a}	2.556^{ab}	1406^{b}	176^{b}	956^{b}
	ASA	3.87^{a}	0.479^{a}	2.603^{a}	1631^{a}	198^{a}	1096^{a}

Table 5. Mean effect of P fertilizer sources and some organic acids and their interactions on yield and yield components of faba bean grown under salinity stress at harvest stage.

Treatments		pods No. plant^{-1}	Pods Weight (g plant^{-1})	Seeds No. plant^{-1}	100 seed weight (g)	Seed Yield (ton fed^{-1})	Straw Yield (ton fed^{-1})
		Phosphorus Fertilizer sources					
Without addition		14.35^{d}	139.96^{d}	40.33^{d}	64.34^{d}	1.130^{d}	3.806^{d}
Superphosphate (SP)(control)		15.25^{c}	150.16^{c}	40.83^{c}	69.47^{c}	1.395^{c}	4.484^{c}
Phosphoric acid (PA)		15.50^{b}	159.57^{b}	47.08^{b}	69.83^{b}	1.466^{b}	4.782^{b}
Di ammonium phosphate (DAP)		18.41^{a}	189.38^{a}	49.75^{a}	78.41^{a}	1.536^{a}	4.932^{a}
		Foliar Applications					
Cont.		13.41^{d}	149.29^{c}	42.00^{d}	65.24^{c}	1.276^{d}	4.291^{d}
Citric acid (CA)		15.75^{c}	153.49^{b}	42.92^{c}	68.14^{b}	1.349^{c}	4.452^{c}
Salicylic acid (SA)		16.16^{b}	155.80^{ab}	45.00^{b}	70.85^{b}	1.421^{b}	4.551^{b}
Ascorbic acid (ASA)		18.16^{a}	186.48^{a}	47.16^{a}	77.82^{a}	1.482^{a}	4.710^{a}
		Interactions					
Without addition	Cont.	11.67^{p}	109.66^{g}	32.66^{m}	62.96^{g}	0.995^{k}	3.538^{o}
	CA	11.70^{o}	110 .23^{f}	35.00^{l}	63.96^{g}	1.102^{j}	3.754^{n}
	SA	12.00^{n}	112.76^{f}	36.00^{l}	64.05^{g}	1.194^{i}	3.908^{m}
	ASA	12.33^{m}	118.35^{f}	39.33^{k}	64.12^{g}	1.232^{h}	4.022^{l}
SP Control	Cont	13.67^{l}	129.95e^{f}	40.33^{jk}	64.18^{fg}	1.300^{g}	4.339^{k}
	CA	14.33^{k}	147.47^{de}	41.33^{ij}	65.97^{ef}	1.367^{f}	4.451^{j}
	SA	14.43^{j}	149.36^{de}	43.00^{hi}	66.11^{e}	1.417^{e}	4.513^{i}
	ASA	15.00^{i}	150.98^{de}	44.66^{gh}	66.29^{e}	1.496^{c}	4.633^{g}
PA	Cont	15.33^{h}	151.02^{de}	45.66^{fg}	70.00^{d}	1.367^{f}	4.568^{h}
	CA	16.00^{g}	154.52^{d}	46.66^{ef}	70.73^{d}	1.426^{de}	4.712^{f}
	SA	17.00^{f}	168.35^{cd}	47.33^{ef}	71.42^{d}	1.509^{c}	4.861^{e}
	ASA	17.33^{e}	179.05^{c}	48.00^{de}	74.21^{c}	1.587^{b}	4.988^{b}
DAP	Cont	17.35^{d}	180.20^{c}	49.66^{cd}	77.15^{b}	1.442^{d}	4.717^{f}
	CA	18.67^{c}	215.04^{b}	50.33^{c}	77.16^{b}	1.503^{c}	4.890^{d}
	SA	20.00^{b}	231.32^{ab}	53.66^{b}	77.62^{b}	1.567^{b}	4.922^{c}
	ASA	27.33^{a}	248.06^{a}	58.33^{a}	92.28^{a}	1.635^{a}	5.197^{a}

While, ASA recorded the highest significant values of seed and straw yields and yield components [i.e. pods No. plant^{-1}, pods weight (g plant^{-1}), seeds No. plant^{-1} and 100 seed weight (g)] comparing with other organic acids foliar application.

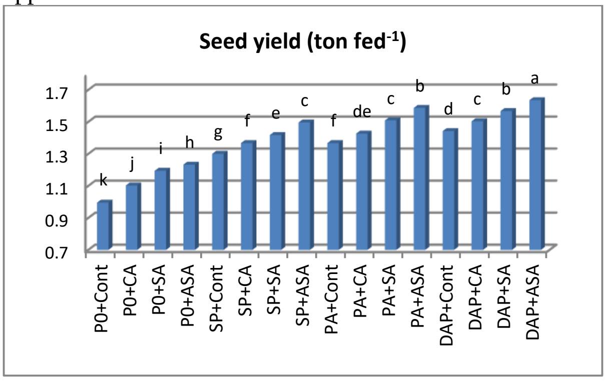

Fig. 1. Interaction effects of P fertilizer sources and some organic acids on seed yield (ton fed^{-1}) of faba bean grown under salinity stress.

ASA is an antioxidant molecule which adverse negative effect of salinity through detoxification of reactive oxygen entities (Khan *et al*., 2011) as well as it induces plant growth, photosynthetic rate, transpiration and improving activities of superoxide dismutase (SOD), peroxidase (POD) and catalase (CAT) anti oxidative enzymes consequently improving growth, yield and yield components of plants (Akram *et al*., 2017).

On the other hand, data recorded that interaction of DAP and ASA under salinity conditions gave the highest values of seed and straw yields and yield components. Phosphorus application alleviates the plant cytotoxicity that occurred by salinity stress where, it promotes the natural anti oxidative defense system of plant and it has a positive effect in mitigating the salt that induced damage in plants (Bargaz *et al.*, 2016). All of these effective roles improve tolerance of salinity by plants leading to increases in plant growth and its yield.

5- Chemical Composition of Yield at Harvest Stage.

Data in Table 6, Figs. 2 and 3 showed the mean effect of different P fertilizer sources and some organic acids foliar application as well as their interactions on NPK in seeds, P in straw, protein, proline content and nutrients uptake of faba bean under salinity stress condition.

DAP gave the highest values of NPK in seeds, P in straw, protein, proline content and nutrients uptake, also, ASA achieved the highest significant values of previously studied parameters.

Interaction of DAP and ASA foliar application recorded the highest values of NPK content, protein, proline content and nutrients uptake. The same results were recorded by Darwesh *et al*., (2013) and Akram *et al*., (2017).

Table 6. Mean effect of P fertilizer sources and some organic acids and their interactions on yield components and their uptake (kg fed^{-1}) of faba bean seeds grown under salinity stress at harvest stage.

Treatments		Nutrients in seeds N (%)	Nutrients in seeds P (%)	Nutrients in seeds K (%)	P in straw (%)	Nutritional elements uptake N in seeds (Kg fed^{-1})	P in seeds (Kg fed^{-1})	K in seeds (Kg fed^{-1})	P in straw (Kg fed^{-1})	Protein (%)	Proline (µmol.g^{-1} FW)
Phosphorus Fertilizer sources											
Without addition		1.91^{d}	0.193^{d}	1.619^{d}	0.103^{d}	21.69^{d}	2.19^{d}	18.37^{d}	3.93^{d}	11.94^{d}	6.862^{d}
Superphosphate (SP)(control)		2.29^{c}	0.237^{c}	1.913^{c}	0.120^{c}	32.75^{c}	3.39^{c}	28.08^{c}	5.68^{c}	13.93^{c}	7.798^{c}
Phosphoric acid (PA)		2.37^{b}	0.251^{b}	2.060^{b}	0.139^{b}	33.21^{b}	3.52^{b}	29.86^{b}	6.70^{b}	14.83^{b}	8.184^{b}
Di ammonium phosphate (DAP)		2.45^{a}	0.260^{a}	2.126^{a}	0.147^{a}	37.79^{a}	4.15^{a}	32.80^{a}	7.28^{a}	15.32^{a}	8.401^{a}
Foliar Applications											
Cont.		2.07^{d}	0.206^{d}	1.717^{d}	0.113^{d}	26.14^{c}	2.66^{c}	22.09^{c}	4.90^{d}	12.67^{d}	7.21^{d}
Citric acid (CA)		2.23^{c}	0.232^{c}	1.928^{c}	0.128^{c}	30.44^{b}	3.18^{b}	26.31^{b}	5.27^{c}	13.97^{c}	7.83^{c}
Salicylic acid (SA)		2.31^{b}	0.245^{b}	2.01^{b}	0.136^{b}	34.17^{a}	3.63^{a}	29.59^{a}	6.26^{b}	14.48^{b}	8.01^{b}
Ascorbic acid (ASA)		2.38^{a}	0.252^{a}	2.06^{a}	0.139^{a}	35.69^{a}	3.79^{a}	30.14^{a}	6.65^{a}	14.90^{a}	8.17^{a}
Interactions											
Without addition	Cont.	1.75^{l}	0.181^{p}	1.52^{j}	0.096^{o}	17.45^{j}	1.81^{j}	15.20^{m}	3.42^{o}	10.95^{l}	6.62^{m}
	CA	1.92^{k}	0.191^{o}	1.61^{i}	0.100^{n}	21.2^{i}	2.11^{i}	17.76^{l}	3.78^{n}	12.02^{k}	6.78^{lm}
	SA	1.94^{k}	0.198^{n}	1.63^{i}	0.106^{m}	23.98^{h}	2.42^{h}	20.18^{k}	4.14^{m}	12.14^{k}	6.94^{kl}
	ASA	2.02^{j}	0.202^{m}	1.70^{h}	0.109^{l}	24.17^{h}	2.44^{h}	20.36^{k}	4.38^{l}	12.64^{j}	7.10^{jk}
SP Control	Cont.	2.07^{i}	0.207^{l}	1.75^{g}	0.112^{k}	27.52^{g}	2.84^{g}	23.32^{j}	4.89^{k}	12.97^{i}	7.26^{ij}
	CA	2.22^{g}	0.229^{i}	1.91^{f}	0.127^{h}	32.48^{f}	3.27^{f}	27.30^{h}	5.68^{i}	13.87^{g}	7.87^{g}
	SA	2.28^{f}	0.237^{h}	1.95^{f}	0.130^{g}	35.12^{e}	3.72^{d}	30.39^{f}	5.90^{h}	14.29^{f}	8.02^{fg}
	ASA	2.33^{ef}	0.246^{g}	2.01^{e}	0.135^{f}	36.40^{cd}	3.72^{d}	31.68^{de}	6.27^{g}	14.58^{ef}	8.05^{fg}
PA	Cont.	2.11^{hi}	0.214^{k}	1.78^{g}	0.119^{j}	28.83^{g}	2.89^{g}	24.80^{j}	5.45^{j}	13.22^{hi}	7.43^{hi}
	CA	2.37^{de}	0.252^{f}	2.06^{d}	0.140^{e}	32.68^{f}	3.45^{e}	28.26^{g}	6.61^{f}	14.85^{de}	8.17^{ef}
	SA	2.47^{c}	0.266^{d}	2.17^{b}	0.147^{c}	35.79^{d}	3.86^{c}	31.37^{ef}	7.16^{d}	15.47^{c}	8.48^{cd}
	ASA	2.52^{b}	0.272^{c}	2.21^{b}	0.152^{b}	37.04^{b}	4.08^{b}	33.52^{c}	7.50^{c}	15.79^{b}	8.65^{bc}
DAP	Cont.	2.16^{h}	0.220^{j}	1.79^{g}	0.124^{i}	31.2^{g}	3.28^{f}	25.89^{i}	5.86^{h}	13.52^{h}	7.55^{h}
	CA	2.42^{d}	0.257^{e}	2.12^{c}	0.143^{d}	36.43^{bc}	3.87^{c}	32.92^{cd}	7.02^{e}	15.14^{d}	8.34^{de}
	SA	2.56^{b}	0.282^{b}	2.27^{a}	0.160^{a}	40.15^{a}	4.54^{a}	36.26^{b}	7.87^{b}	16.04^{b}	8.76^{ab}
	ASA	2.65^{a}	0.289^{a}	2.31^{a}	0.161^{a}	42.63^{a}	4.62^{a}	37.17^{a}	8.37^{a}	16.58^{a}	8.93^{a}

On the other hand, salinity induce proline production in the plant where, these increments is important for osmotic adjustment of plant and increasing membrane stability (Abd El-mawgoud *et al*., 2010).

Application of phosphorus fertilizers to soil improves root growth, increasing root hair length, increasing root surface area, enhancing shoot growth that leads to increasing the yield component as well as it induces proline production and reducing sugar that plays an effective role in osmotic adjustment and improves salinity tolerance (Osman *et al.*, 2012).

ASA is an antioxidant molecule that protects protein from oxidation under salt stress through improving activities of anti-oxidative enzymes (Akram *et al.*, 2017). Also, it promotes proline synthesis which important for providing organic carbon, inhibition of ROS and act as an enzymatic regular under stress condition (Sadak *etal.*,2010).

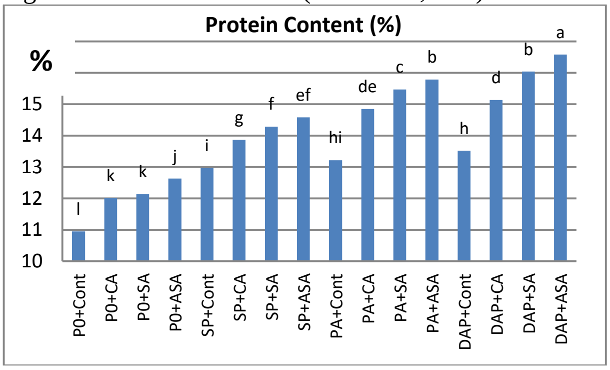

Fig. 2. Interaction effects of P fertilizer sources and some organic acids on protein content of faba bean grown under salinity stress at harvest stage.

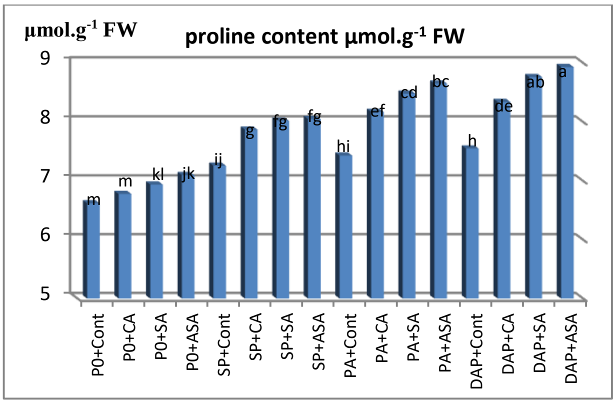

Fig. 3. Interaction effect of P fertilizer sources and some organic acids on proline content of faba bean grown under salinity stress at harvest stage.

6- Available Concentrations of N, P and K in Soil after Harvesting.

As shown in Table 7 the highest values of N, P and K (mg kg^{-1}) of soil at the harvest stage were recorded with phosphorus fertilization by super phosphate comparing with other sources, this may be due to single super phosphate less in solubility and less reaction with the soil components comparing with DAP and PA which still in the soil long time this lead to increase soil microorganisms, increase nitrogen fixation and phosphorus solubility. P element is a macro-nutrient responsible for crop growth and yield, it is needed in many physiological processes in the plant such as nitrogen fixation, energy transformation and seed formation (Faiyad, 2009).

Phosphoric acid (60% P_2O_5) also an excellent source of P in the new irrigation methods but it's more expensive. It can be applied by injection directly to soil especially alkaline one as a reclaimed, or added to irrigation water as occur in this search. Its application decreases pH of alkaline soil and increases the availability of soil nutrients (George *et al.*, 2016).

DAP fertilizer (di ammonium phosphate (46% P_2O_5), (18% N)) is an excellent source of P and N for the plant where it dissolves quickly in the soil to release available phosphate and ammonium. This ammonium act as a nitrogen source that is converted to nitrate by soil bacteria which consequently decreases soil pH. Leading to an increase in the availability of nutrients and increasing nutrient uptake by (George *et al.*, 2016).

On the other hand, organic acids cause a decrease in the availability of N, P and K in the soil after harvesting and this may be related to the role of organic acids in improving salt stress tolerance by plant, consequently increasing nutrients uptake by faba bean plants according to (Al quriany, 2007; El-Tohamy *et al.*,2015 and Ahmad *et al.*,2018).

Interaction of SP and CA application gave the highest values of available N, P and K in the soil compared with the other interaction treatment applications i.e. the other phosphorus fertilizers (PA and DAP) and the organic acids foliar applications.

Table 7. Mean effect of P fertilizer sources and some organic acids and their interactions on available concentrations of N, P and K (mg kg^{-1}) in the soil after harvesting.

Treatments		N	P	K
			mg kg^{-1}	
Phosphorus Fertilizer sources				
Without addition		75.27^{a}	12.10^{b}	308.85^{a}
Superphosphate (SP) (control)		61.06^{b}	14.30^{a}	255.94^{b}
Phosphoric acid (PA)		53.63^{c}	9.92^{c}	241.27^{c}
Di ammonium phosphate (DAP)		49.43^{d}	7.02^{d}	240.27^{d}
Foliar Applications				
Cont.		69.60^{a}	11.84^{a}	292.29^{a}
Citric acid (CA)		60.45^{b}	10.74^{b}	281.98^{b}
Salicylic acid (SA)		55.9^{c}	10.40^{b}	264.33^{c}
Ascorbic acid (ASA)		53.3^{d}	10.28^{b}	254.71^{d}
F. significance		***	NS	***
LSD at 5%		0.233	1.202	3.167
Interactions				
Without addition	Cont.	79.66^{a}	12.92^{bcd}	361.96^{a}
	CA	76.22^{b}	12.39^{cde}	342.42^{b}
	SA	73.74^{c}	11.81^{de}	330.89^{c}
	ASA	71.46^{d}	11.30^{e}	320.10^{d}
SP Control	Cont	69.06e	15.16^{a}	311.22^{e}
	CA	66.08^{f}	14.61^{a}	300.79^{f}
	SA	63.62^{g}	14.01^{ab}	281.86^{h}
	ASA	60.77^{h}	13.43^{abc}	271.67^{i}
PA	Cont	58.16^{i}	10.76^{ef}	291.19^{g}
	CA	56.26^{j}	9.50^{fg}	264.24^{j}
	SA	54.32^{k}	9.03^{gh}	255.86^{k}
	ASA	53.49^{l}	8.81^{gh}	247.76^{l}
DAP	Cont	48.83^{m}	8.53^{gh}	238.54^{m}
	CA	46.06^{n}	8.11^{gh}	228.58^{n}
	SA	43.13^{o}	7.66^{h}	216.24^{o}
	ASA	39.66^{p}	7.36^{h}	205.91^{p}

Phosphorus Use Efficiencies:

Total P uptake, agronomic P use efficiency (AE), P recovery efficiency (RE) and partial factor productivity (PFP) for faba bean plant under different phosphorus fertilizer sources has been tabulated in Table 8.

Phosphorus use efficiency (PUE) is an indicator to absorption, accumulation and utilization of P for seeds and straw production, it's related to phosphorus fertilizer source, environmental factor as well as soil and crop management (Bationo, 2002).

From recorded data it's clear that total P-uptake (seeds + straw) significantly, increased with DAP fertilizer compared to others, where the plants treated with phosphoric acid come in the second order then super phosphate and lately control treatment (without P- fertilizer).

Agronomical P use efficiency (AE), P recovery efficiency (RE) and partial factor productivity (PFP) were significantly increased with phosphoric acid fertilizer followed by DAP then super phosphate and lately control treatment. That may be due to the amount of PA needed for feddan (20Kg) is the lowest one where it contains P units more than others .

The superior treatment for total P-uptake and most P-use efficiencies i.e. RE and PFP was ascorbic acid followed by salicylic acid, citric acid and control, respectively. While it had a reverse effect on agronomical P use efficiency (AE).

In general, the results show that the interaction effects of phosphate fertilizer sources and foliar applications on the utilization efficiencies gave different responses. A significant interaction values were recorded in all studied parameters. The highest value of total P-uptake was obtained with DAP and ASA. While, the highest values of most P-use efficiencies were obtained by combination of phosphoric acid and ascorbic acid foliar application comparing with the other interaction treatments.

Table 8. Mean effect of P fertilizer sources and some organic acids and their interactions on total P uptake, P use efficiency and partial factor productivity of faba bean yield grown under salinity stress at harvest stage.

Treatments		Total P uptake (kg fed^{-1})	AE (kg/kg)	RE %	PFP (kg/kg)
Phosphorus Fertilizer sources					
Without addition (control)		6.12^{d}	0	0	0
Superphosphate (SP)		9.07^{c}	4.06^{c}	2.97^{c}	15.37^{c}
Phosphoric acid (PA)		10.27^{b}	16.78^{a}	20.75^{a}	73.30^{a}
Di ammonium phosphate (DAP)		11.35^{a}	8.80^{b}	17.75^{b}	46.50^{b}
Foliar Applications					
Cont.		7.61^{d}	8.31^{a}	7.87d	31.50^{d}
Citric acid (CA)		8.94^{c}	7.26^{b}	10.27^{c}	32.97^{c}
Salicylic acid (SA)		9.90^{b}	6.69^{bc}	11.27^{b}	34.55^{b}
Ascorbic acid (ASA)		10.37^{a}	7.39^{b}	12.05^{a}	36.15^{a}
Interaction					
Without addition (control)	Cont.	5.23^{l}	0	0	0
	CA	5.89^{k}	0	0	0
	SA	6.56^{jk}	0	0	0
	ASA	6.82^{j}	0	0	0
SP	Cont	7.73^{i}	4.47^{g}	2.50^{i}	14.42^{j}
	CA	8.95^{h}	4.01^{g}	3.06^{h}	15.03^{j}
	SA	9.62^{f}	3.73^{g}	3.06^{h}	15.67^{ij}
	ASA	9.99^{e}	4.03^{g}	3.17^{h}	16.35^{i}
PA	Cont	8.34^{hi}	18.60^{a}	15.55^{f}	68.35^{d}
	CA	10.06^{e}	16.20^{c}	20.85^{c}	71.30^{c}
	SA	11.02^{d}	15.62^{d}	22.20^{b}	75.30^{b}
	ASA	11.68^{c}	16.75^{b}	24.30^{a}	78.35^{a}
DAP	Cont	9.14^{g}	10.17^{e}	13.03^{g}	43.33^{h}
	CA	10.89^{de}	8.83^{f}	16.67^{e}	45.57^{g}
	SA	12.41^{b}	7.43^{g}	19.50^{d}	47.23^{f}
	ASA	12.99^{a}	8.80^{f}	20.56^{c}	49.87^{e}

Benefit: Cost Ratio.

Economics of faba bean as affected by phosphorus fertilizer sources and some organic acids foliar application has been given in Table 9. The highest total cost of cultivation (£. fed^{-1}) was noticed with all treatments of PA followed by DAP treatments. The cost of cultivation for control (super phosphate fertilizer and no foliar application) was 11050 £. fed^{-1}. This clears that phosphoric acid and di ammonium phosphate recorded more cost of cultivation as compared to the same doses of phosphorus applied through super phosphate.

The maximum gross income of 38865 £. fed^{-1} of bean crop was recorded under combination of DAP and ASA applied treatment followed by interaction of DAP and SA applied treatment with gross income of 36841 £. fed^{-1}. The gross income for super phosphate fertilizer without any organic acid foliar application applied treatment was 30700 £. fed^{-1}. The highest net return of 27475 £. fed^{-1} was obtained from DAP and ASA applied treatment followed by DAP and SA applied treatment with net return 25546 £.fed^{-1}. The lowest net return 19650 £. fed^{-1} noticed in super phosphate and no foliar application of organic acid treatments. The highest B:C ratio 3.41 was recorded from DAP and ASA applied treatment which was followed by DAP and SA applied treatment with 3.26 B:C ratio. The B:C ratio of super phosphate and no foliar application was 2.78.

The cost of cultivation of phosphoric acid treatments and di ammonium phosphate treatments were higher than that of super phosphate treatments because of price of PA and DAP. For phosphoric acid feddan required 12 L and cost 17.00 £. for one liter while DAP with cost 14 £. for one kilo gram and feddan required 30 kg. On the other hand, PA and DAP enhanced seed yield and recorded higher net return than super phosphate fertilizer treatments. Among PA and DAP treatments there was much difference in B:C ratio, the DAP and ASA applied treatment recorded higher net return and B:C ratio could be a good alternative to other treatments and viable option for enhancing crop yield and farmers income.

Table 9. Cost of cultivation, gross and net return, and benefit : cost ratio of different treatments.

Treatments		Total coast (£. fed^{-1})	Gross return (£. fed^{-1})	Net return (£. fed^{-1})	B:C Ratio
Without addition	Cont.	10850	23685	12835	2.18
	Citric acid (CA)	10863	26146	15283	2.41
	Salicylic acid (SA)	10870	28262	17392	2.60
	Ascorbic acid (ASA)	10970	29136	18166	2.66
Super Phosphate (control)	Cont.	11050	30700	19650	2.78
	Citric acid (CA)	11062	32241	21179	2.91
	Salicylic acid (SA)	11075	32464	21389	2.93
	Ascorbic acid (ASA)	11170	33391	22221	2.99
Phosphoric acid	Cont.	12175	33598	21423	2.76
	Citric acid (CA)	12187	33966	21779	2.79
	Salicylic acid (SA)	12200	35208	23008	2.89
	Ascorbic acid (ASA)	12295	35369	23074	2.88
Di ammonium phosphate	Cont.	11270	35438	24168	3.14
	Citric acid (CA)	11283	36795	25512	3.26
	Salicylic acid (SA)	11295	36841	25546	3.26
	Ascorbic acid (ASA)	11390	38865	27475	3.41

CONCLUSION

The results indicated that di ammonium phosphate (DAP) fertilizer is the best phosphorus source in almost studied faba bean plant growth parameters in these soil conditions; in respect to spraying ascorbic acid (ASA) foliar application is the best organic acid application used. Finally, the interaction of DAP and foliar application of ASA record the highest growth, yield, yield components and P total uptake of the faba bean plants.

The highest residual N P K (mg kg^{-1}) in the soil was recorded with the interaction of super phosphate (SP) and citric acid (CA) application comparing with the other phosphorus fertilizers and organic acids treatments.

Also, the highest values of recovery efficiency (RE) and partial factor productivity (PFP) were obtained by combination of phosphoric acid (PA) and ASA foliar application. While, Interaction of PA and no foliar application obtained the highest values of Agronomical P use efficiency (AE).

Finally, the DAP and ASA applied treatment ratio could be a good alternative to other treatments and viable option for enhancing crop yield and farmers income.

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تحسين إنتاجية وجودة الفول البلدي النامي تحت ظروف الأراضي المتأثرة بالأملاح بالتسميد بمصادر مختلفة من الأسمدة الفوسفاتية والرش ببعض الأحماض العضوية

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أجريت تجربتان حقليتان فى محطة البحوث الزراعية بتاج العز بمحافظة الدقهلية- مركز البحوث الزراعية- مصر في تصميم قطع منشقة مرة واحدة في ثلاث مكررات، فى الموسمين الشتويين لعامي ٢٠١٨/ ٢٠١٩ و ٢٠١٩/٢٠٢٠ بهدف دراسة تأثير أربعة مصادر مختلفة من التسميد الفوسفاتى (بدون اضافة، سوبر الفوسفات ، حمض الفوسفوريك و فوسفات ثنائي الأمونيوم) كمعاملات رئيسية و فى وجود أربعة معاملات رش ببعض الأحماض العضوية (كنترول ، حمض الستريك، حمض السلسليك وحمض الإسكوربيك) كمعاملات منشقة و التداخلات بينهم على صفات النمو الخضري و المحصول ومكوناته لنبات الفول البلدي صنف جيزة ٧١٦ النامي تحت ظروف الأراضي المتأثره بالاملاح. وكذلك دراسة المتبقي فى التربة من النيتروجين و الفوسفور و البوتاسيوم بعد مرحلة الحصاد ويمكن تلخيص أهم النتائج المتحصل عليها فيما يلى:1- كان أفضل الأسمدة الفوسفاتية فى معظم القياسات الخضرية وفى الانتاجية وجودة المحصول هو سماد فوسفات ثنائي الأمونيوم. 2- أعطي حمض الإسكوربيك أفضل نتائج لمعاملات الرش لكل الصفات تحت الدراسة مقارنة بالأحماض العضوية الأخرى المستخدمة. 3- التفاعل بين فوسفات ثنائي الأمونيوم وحمض الإسكوربيك حقق أعلى نمو و انتاجية فى محصول الفول البلدي بالمقارنة بباقي المعاملات. فى التربة كانت أعلى قيم للنيتروجين و الفوسفور و البوتاسيوم المتبقي في حالة التداخل بين معاملات سماد سوبر فوسفات وحمض الستريك مقارنة بباقي معاملات الأسمدة الفوسفاتية و الأحماض العضوية محل الدراسة.4- في معظم قياسات كفاءة الفوسفور المستخدم حققت معاملة حامض الفوسفوريك مع حمض الإسكوربيك أعلى القيم الناتجة.