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Effect of Foliar Application of some Organic Acids and Microelements on Pea (*Pisum sativum* L.) Yield and Seed Quality with Different Fertilizer Levels under Salt-Affected Soil Conditions

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ABSTRACT

A field experiment was carried out during two successive winter seasons 2017/2018 and 2018/2019 on pea plants Master-B cv. at Sakha Horticultural Research Station Farm, Agricultural research center, Kafr El-Sheikh governorate, Egypt to study the effect of (organic acids i.e., fulvic 3 g/l, humic 1 g/l, salicylic 0.25 g/l) and microelements 1 g/l as foliar applications compared with the control (spray with tap water), under five levels of NPK i.e., 0.00, 25, 50, 75 and 100% from the recommendation doses as soil application on some growth, yield and quality of peas under salt-affected soil condition to minimize the using of mineral fertilizers and reduce the production cost, hazards of soil and human health. Twenty-five treatments were arranged in a split plot system in randomized complete block design (RCBD) with three replicates. Results showed significant differences amongst different growth attributes, yield and pods quality due to NPK fertilization and foliar application of (fulvic; humic; salicylic) acids and microelements. The highest plant height, leaves plant^{-1} and branches plant^{-1} as well as pea yield were resulted by the application of 100 % followed by 75 % of NPK compared with the other NPK rates. Likewise, foliar applications with (humic or salicylic) acids or microelements significantly increased growth, yield and quality of peas in both seasons. Accordingly, this study recommended that the superiority of NPK fertilization at 75% from recommended doses and foliar spray with microelements or salicylic acid, which resulted the best growth, yield, pods quality of pea plants under salt affected soil.

Keywords: Pea, foliar application, fulvic acid, humic acid, salicylic acid, microelements, NPK levels and saline soil.

INTRODUCTION

Pea (*Pisum sativum* L.) is member of the *Fabaceae* family; it is an important legume vegetable crop grown during winter season in Egypt as well as it's grown for export and local consumption. The total cultivated area grown with peas gradually raised from season to another, it was 34,486 fed., which produced 149,374 tons, with an average 4.331 ton/fed. in 2019 as a green pod yield; while, it was 123 fed., which produced 206 ton, with an average 1.675 ton/fed. in 2019 as a dry seeds yield (MALR Statistics, 2019). Pea is the cheap and rich source of protein and carbohydrates, iron and calcium as well as vitamins (A and B), so this makes it one of the extreme remarkable sources in human feeding (Smykal *et al.*, 2015).

Soil affected by salinity is resulting from secondary salinized processes such as the application of mineral fertilizers excessively, irrigation with saline water and poor drainage system (Ennab, 2016). It is known that soil salinity is one of the most serious environmental factors limiting vegetables growth and productivity. The adverse effects of saline soil on vegetable crops growth and yield, cause to osmotic restraint of nutritional imbalance, water uptake by roots, accumulation of Na^+ and Cl^- and ion toxicity. So, strategies to alleviating adverse effect of salt stress on vegetable crops have been considered to be very important in order to sustain productivity from salt-affected soil and save it from degradation. It has been evaluated that worldwide 20 % (45 million ha) of total cultivated area and 33% of irrigated lands of agricultural are influenced by salinity (Shrivastava and Kumar, 2015). Salinity difficulties are specially related for semiarid and arid areas like Egypt. Nearly 33% of the cultured land and most expansion cultivated land in Egypt is perhaps salinized (Ghassemi *et al*., 1995). The decrease in yield of various crops due to salinity in nearly all of these regions is about 60% in comparison with natural soil. Salinity can distress plant growth in numerous ways. First, the subsistence of salt in the soil minimizes the plant water uptake capacity, and this reasons rapid decrease in the plant development and growth rates due to the osmotic result of the salt in soil solution, and creates a set of influences like to drought stress (Munns, 2002). Second, salinity decreases stomatal conductance extremly and consequently photosynthetic rate reduces (Munns and Tester, 2008). Moreover, the restraint of photosynthetic rate enjoined by stomatal closure may elevate an imbalance between photochemical action at photo system II (PSII) and electron needs for photosynthesis, leading to excess excitation and ulterior photo restrained damage of PSII reaction centers (Souza *et al*., 2004).

In the past few years, farmers count on inorganic fertilizers mostly nitrogen, phosphorus and potassium as well as organic and bio-fertilizers. Furthermore, inorganic fertilizers, organic manures and bio fertilizers play a serious role on plant development and its productivity (Hassan *et al.*, 2007). Also, utilizing high amount of inorganic fertilizers not causes only pollution, less productive and soil degraded, but posed also heavy environmental and health hazards (Mishra *et*

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al., 2010). The N, P and K fertilizers are counted as a paramount macronutrient which involved in many primary functions in plant life especially in energy transfer and storage (Belouchrani *et al*., 2020). Fertilizers usage is needed for enhancing the soil nutrients availability to gain optimal growth of plant. Most farmers utilize chemical fertilizers for improving crops growth and production due to its quick and easy availability to plants (Thy and Buntha, 2005). Generally, inorganic fertilizers (chemical forms) are the main factor to provide the nutrient requirement and rise yield of crops, but the continuously reliance on chemical fertilizers raised the crop production total costs, created incremented deterioration of soil fertility and pollution of agro-ecosystem (Marschner, 1995). The addition of fertilizers is one of the major methods for enhancement the availability of nutrients in soil to plants. Feeding NPK can positively change the plant traits, but heavy uses of chemical fertilizers have formed a variety of economic, environmental, and ecological problems. The application of fertilizer is considered to be one of the most essential factors to increase crop yield. The utilizing of chemical fertilizers in interaction with organic acids is capable to award the sustainable and desired yields crop than the sole utilize of chemical fertilizers (Masarirambi *et al*., 2011). In this connection, Buket *et al*. (2015) and Mishra *et al.* (2010) resulted highly significant effect due to NPK fertilizer forms and dosses on pod number per plant, seed number per plant, grain and biological yields of pea plants specially, when it associated with bio-fertilizer. Nitrogen is important for synthesis of enzymes, chlorophyll, amino acids and protein. Also, phosphorus is necessary for ATP, ADP formation, phospholipids, phospho-proteins and root growth. Potassium plays a necessary function in enhancing the protein synthesis and translocation of assimilates especially carbohydrates and the upgrading of enzyme activity (Zaghloul *et al.,* 2015).

Congruently, the pea production can be enhanced by using some biostimulants (organic acids) such as fulvic acid, humic acid and salicylic acid that had numerous enhancement effects on plant growth, yield and its components as indicated by Gad El-Hak *et al.* (2012). Utilizing of natural bio-stimulants as foliar feeding (Mahmood *et al*., 2017), and growth regulators of plant (Perez-Jimenez *et al*., 2015) have been newly inserted to enhance the growth, yield and quality of vegetable crops. Foliar spraying with fertilizers is a prevalent strategy of crop-management to maximize fruit quality and its yield (Haytova, 2013) and assist plants remuneration for nutrient uptake limitations, nutrient fixation and low soil fertility (Dada and Ogunsesu, 2016).

Humic acids (HA) are a highly active and useful constituent of soil organic matter. HA can sorb organic solutes, buffer pH, stimulate plant growth and bind metal ions. Humic acid binds metal ions either out of forming stabilized complexes with ligands or by simple action interchange reaction (MacCarthy *et al*., 1990). Humic substances have been found to impact plant growth both directly and indirectly, its direct impacts are attributed to its activity of metabolic in plant growth, but the indirect is enhance soil biological, physical and chemical conditions (Kumar *et al.,* 2013). Humic acids may improve the minerals uptake out of the microbiological activity stimulation (Schnitzer, 1986). Also, HA improve soil structure, aeration and drainage and increase buffering and exchange capacity (Qian *et al.,* 2015). Under water stress, leaf water retention increased by foliar fertilization with humic molecules and the antioxidant and photosynthetic metabolism (Fu Jiu *et al*. 1995). As well, humic substances have been presented to stimulate root and shoot development and vegetable crops nutrient uptake (Cimrin and Yilmaz, 2005); upsurge the plants fresh and dry weights (Chen *et al.,* 2004). In addition, humates effect on the amount of sugars, amino acids and the respiration process.

Under all pH conditions fulvic acid is water soluble, whereas when pH is about 2 humic acid is water soluble (Malcolm, 1990). Complexes of metal-fulvic and metal-humic acids may play an serious role in the metals availability to roots (Schnitzer, 1990). Humic and fulvic acids applications were reported to promote the plant growth (Canellas *et al.,* 2002), enhancing nutrient uptake and soil health by plants, mineral availability and fruit yield, etc., (Rahmat *et al.,* 2010 and Mauromicale *et al.*, 2011).

Salicylic acid (SA) be a member of phenolic compounds group in plant and being involved in regulating plant development, growth and resistance of disease, also it is a plant growth regulator, which is implicated in different physiological processes, like growth regulation, photosynthesis, stomatal behavior, nutrient uptake and transport as well as mechanisms of tolerance to biotic abiotic stresses (El-Tayeb, 2005; Maity and Bera, 2009; Hayat *et al*., 2010). It prevents the collection of reactive oxygen species (ROS) that resulted in guarding plant cells from death (Taiz and Zeiger, 2002 and Joseph *et al.* 2010). The participation of salicylic acid in systemic acquired resistance has also been demonstrated by Beckers and Spoel (2006). Also, SA plays an essential role in regulating many plant physiological processes, including seed germination, flowering, production and membrane permeability as well as defense responses (Hayat *et al.,* 2013). Several studies have showed the beneficial effect of fulvic acid, humic acid and salicylic acid in mitigation the salinity stress and its enhancement effects on plant growth and development, mineral status of plant, and the uptake of macro and micronutrients of pea plants and other vegetable crops (Neri *et al.,* 2002 and Farooq *et al.,* 2007).

Microelements are essential for plants, which raise the yield and improve the different vegetable crops quality (Sidhu *et al.,* 2019). So, foliar spraying of micronutrients to alleviate salinity stress and overcome micronutrient deficiency of plants (Noreen *et al.,* 2018). The enhancing impacts of micronutrients have been documented in inducing salt tolerance via accelerating their activities physiological processes such meristematic development, respiration, photosynthesis, chlorophyll biosynthesis, energy system, phenolic compounds and protein, by additionally micronutrients exogenous applications which accelerated growth, quality and yield in vegetable crops (Hussain *et al.,* 2018). Therefore, this investigation aims to study the effect of fulvic acid, humic acid, salicylic acid and microelements as foliar spray, in combined with five levels of NPK fertilization on growth, yield and green pod quality traits of pea plants under stress of salt-affected soil conditions.

MATERIALS AND METHODS

The present search was carried out on pea plants (*Pisum sativum* L.) Master-B *cv*. in the Experimental Farm of Sakha Horticultural Research Station, Kafr El-Sheikh governorate, Egypt during two consecutive winter seasons of

2017/2018 and 2018/2019 to investigate the effect of organic acids and microelements as foliar applications in combined to five levels of NPK fertilization as soil application under salt-affected soil condition. The mechanical and chemical analyses of the experimental soil were done according to the method described by Page *et al.* (1982) and are presented in Table (1).

Table 1. Mechanical and chemical analysis of experimental soil in 2017/2018 and 2018/2019 seasons.

Soil characters				2017/2018	2018/2019
Clayey texture	Particle size distribution	Clay	%	52.48	52.54
		Sand	%	16.02	15.76
		Silt	%	31.50	31.70
(mg kg^{-1})	Available macro-elements	N		46.00	46.08
		P		10.80	10.77
		K		250.56	251.73
Soluble cations (meq l^{-1})		Na^+		22.50	22.20
		K^+		0.38	0.39
		Mg^{2+}		9.18	9.17
		Ca^{2+}		5.86	5.84
Soluble anions (meq l^{-1})		SO_4^{-2}		22.75	22.76
		Cl^-		11.92	11.94
		HCO_3^-		4.58	4.61
		CO_3^-		0.00	0.00
EC: In soil paste extract				4.13	4.12
pH: 1:2.5 suspension				8.42	8.40

The treatments were organized in a split plot system under randomized complete block design (RCBD), with three replicates. NPK fertilization levels were assigned at random in the main plots, while foliar applications of organic acids and micronutrients were distributed in sub plots. So, the experiment included 25 combinations resulted from two factors as follow:

Main plot: Fertilization with five levels of NPK (F) were added to the soil in the forms of Ammonium sulphate (N 20.5 %) and calcium super phosphate (P_2O_5 15.5 %) as well as potassium sulphate (K_2O 48 %),

Sub plots: spraying with organic acids and microelements (T) at three times, starting 30 days after sowing and ten days intervals as follows:

Treatments	Details
Main plot	NPK fertilization
F_1	0 % NPK (without fertilizers)
F_2	25 % NPK (50 kg Ammonium sulphate + 50 kg calcium super phosphate + 25 kg potassium sulphate)
F_3	50 % NPK (100 kg Ammonium sulphate + 100 kg calcium super phosphate + 50 kg potassium sulphate)
F_4	75 % NPK (150 kg Ammonium sulphate + 150 kg calcium super phosphate + 75 kg potassium sulphate)
F_5	100 % NPK (200 kg Ammonium sulphate + 200 kg calcium super phosphate + 100 kg potassium sulphate)
Sub-plot	Spraying organic acids and microelements (T)
T_1	Control (tap water)
T_2	Fulvic acid (FA): Obtained by Shandong Jingfeng Humic acid Technology Co., Limitid, China - imported by El-Masa for import and export, Egypt) in solid form as potassium fulvate granule (60 % potassium fulvate, 12% potassium oxide) at the rate 3g l^{-1}.
T_3	Humic acid (HA): It produced and packed by Humintech, Germany) in solid form as potassium humate granule (85% potassium humate, 12% potassium oxide, 1% Iron, 0.9% organic nitrogen, 1.1% other compounds and with a pH=7.0) at the rate 1g l^{-1}.
T_4	Salicylic acid: Produced by Hebie Corvell Biotech Co., Ltd, China at the rate 0.25 g L^{-1}.
T_5	Microelements: Commercial name is Metaloside in powder form produced by Misr El-Dawlyia for agriculture development, Egypt) as (Fe EDTA 12%, Zn EDTA 13% and Mn EDTA 13%) at the rate 1 g L^{-1}.
F x T	Interaction between NPK fertilization (F) and organic acids or microelements (F)

The recommended doses of 100 % NPK were (200 kg Ammonium sulphate + 200 kg calcium super phosphate + 100 kg potassium sulphate) according to Egyptian Ministry of Agriculture and Land Reclamation 2017. Plants were sprayed with organic acids and microelements at three times, starting 30 days after sowing and ten days intervals.

Seeds of Pea (*Pisum sativum* L.) Master B *cv.* was sown on 15th and 20th of October in both seasons, respectively. Seeds were planted on one side of the ridge, 3 m length and 0.60 cm width. Plot area was 7.2 m^2 and included 4 ridges and the in-row spacing was 20 cm. All recommended pea production cultural practices were went after according to the Egyptian Ministry of Agriculture and Land Reclamation 2017.

The following data was recorded:

Vegetative Growth traits:

Ten plants from each plot were taken at random in the end of the growing season to determine plant height and branches and leaves plant^{-1} in both seasons.

Yield traits:

At harvest time, green pod yield was started on 15th and 20th of January in first and second season, respectively. Two rows from each experimental plot was harvested 3 times at 10 days intervals in two consecutive seasons and ten plants from each plot were taken at random and labeled before start harvested to evaluate average pod weight; pods plant^{-1}; green pods yield plant^{-1}and fed.$^{-1}$. Moreover, the other two rows leaved to the end of season and harvested after it fully dried on 15th and 20th February in both seasons, respectively and ten plants were randomly chosen to calculate the dry seeds yield plant^{-1} and dry seeds yield fed.$^{-1}$.

Qualitative pod traits:

At harvest time of green pod yield, sample of green pods were taken randomly and determined the following parameters: pod length; pod diameter; seeds pod^{-1} and protein percent in dry seeds (%) determined by multiplying N % in 6.25, according to Pregl (1945).

Statistical analysis:

The treatments were arranged in a split plot system under randomized complete block design (RCBD) with three replicates. The data were analyzed as split plot system with two factors: NPK fertilization (F) and foliar spray organic acids and microelements (T). The obtained data were statistically analyzed utilizing SAS software Version 9.1 according to Snedecor and Cochran (1990) and the differences among means were compared by utilizing Duncan's multiple range tests (DMRT) at 0.05 levels according to Duncan (1955).

RESULTS AND DISCUSSION

Vegetative growth:

Data in Tables 2 and 3 showed that, different fertilization rates, foliar applications of organic acids and microelements and their interaction had a significant effect on all vegetative growth parameters of pea plants in both seasons. As for the effect of NPK fertilization levels, it is clear from Table (2) that, NPK fertilization at different levels had a positive influence on all growth parameters in this study compared to control (F_1). The highest values of plant height and branches and leaves plant^{-1} were recorded with plants which received 100 % (F_5) followed by (F_4) 75 % of recommended NPK fertilization compared to control and other NPK levels in two seasons. These results are agreed with those of Ismail (2016) who reported that adding humic acid to common bean plants with the level of 50% from NPK recommendation produced the elevated values of plant growth parameters.

Table 2. Effect of fertilization rates and spray of some organic acids and microelements on vegetative traits of pea plants during 2017/2018 and 2018/2019 seasons.

Treatments	Symbol	Plant height (cm)		Branches plant^{-1}		Leaves plant^{-1}	
		1st	2nd	1st	2nd	1st	2nd
Main plot: NPK fertilization levels							
0.00	F_1	45.73^{c}	48.00^{d}	1.47^{e}	1.54^{d}	19.60^{c}	20.40^{c}
25%	F_2	48.13^{b}	51.00^{c}	1.60^{d}	1.63^{d}	21.20^{bc}	22.40^{b}
50%	F_3	48.87^{b}	52.00^{c}	1.73^{c}	1.81^{c}	22.27^{b}	23.33^{b}
75%	F_4	51.67^{a}	54.80^{b}	2.32^{b}	2.37^{b}	22.60^{ab}	23.60^{b}
100%	F_5	53.47^{a}	56.40^{a}	2.61^{a}	2.68^{a}	24.20^{a}	24.93^{a}
F. test		**	**	**	**	**	**
Sub plot: Organic acids and microelements							
Control	T_1	45.00^{d}	48.40^{d}	1.91^{c}	1.97^{c}	19.20^{c}	20.73^{c}
Fulvic acid	T_2	48.47^{c}	50.80^{c}	1.86^{cd}	1.92^{c}	22.20^{b}	22.80^{b}
Humic acid	T_3	48.40^{c}	51.00^{c}	1.82^{d}	1.91^{c}	22.67^{b}	22.73^{b}
Salicylic acid	T_4	51.20^{b}	54.00^{b}	2.00^{b}	2.05^{b}	21.80^{b}	23.53^{b}
Microelements	T_5	54.80^{a}	58.00^{a}	2.13^{a}	2.18^{a}	24.00^{a}	24.87^{a}
F. test		**	**	**	**	**	**

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$.

Table 3. The interaction effect of fertilization rates and spray of some organic acids and microelements on some vegetative traits of pea plants during 2017/2018 and 2018/2019 seasons.

Treatments		Plant height (cm)		Branches plant^{-1}		Leaves plant^{-1}	
NPK	Organic acids and microelements	1st	2nd	1st	2nd	1st	2nd
0.0 %	Control	42.00^{l}	43.00^{j}	1.42^{k}	1.50^{l}	18.00^{i}	19.00^{h}
	Fulvic acid	45.67^{hij}	49.00^{gh}	1.52^{jk}	1.60^{i-l}	21.00^{fg}	22.00^{efg}
	Humic acid	44.33^{jk}	46.00^{i}	1.49^{jk}	1.54^{kl}	20.00^{gh}	20.00^{gh}
	Salicylic acid	46.67^{hij}	49.00^{gh}	1.41^{k}	1.49^{l}	18.00^{i}	19.00^{h}
	Microelements	50.00^{ef}	53.00^{ef}	1.51^{jk}	1.56^{kl}	21.00^{fg}	22.00^{efg}
25 %	Control	43.33^{kl}	47.00^{hi}	1.44^{k}	1.50^{l}	19.00^{hi}	21.00^{fgh}
	Fulvic acid	46.33^{hij}	49.00^{gh}	1.60^{ij}	1.62^{i-l}	21.00^{fg}	22.00^{efg}
	Humic acid	46.67^{hij}	50.00^{g}	1.60^{ij}	1.60^{i-l}	21.00^{fg}	22.00^{efg}
	Salicylic acid	51.67^{de}	54.00^{de}	1.65^{i}	1.69^{ij}	22.00^{ef}	23.00^{c-f}
	Microelements	52.67^{cd}	55.00^{de}	1.68^{i}	1.72^{i}	23.00^{de}	24.00^{b-e}
50 %	Control	45.33^{ijk}	50.00^{g}	1.86^{h}	1.90^{h}	19.00^{hi}	21.00^{fgh}
	Fulvic acid	47.67^{ghi}	50.00^{g}	1.51^{jk}	1.57^{jkl}	22.00^{ef}	23.00^{c-f}
	Humic acid	46.00^{hij}	49.00^{gh}	1.42^{k}	1.65^{ijk}	23.00^{de}	23.00^{c-f}
	Salicylic acid	49.67^{efg}	53.00^{ef}	1.86^{h}	1.89^{h}	23.00^{de}	24.67^{bcd}
	Microelements	55.67^{b}	58.00^{bc}	1.99^{g}	2.03^{g}	24.00^{cd}	25.00^{bc}
75 %	Control	46.33^{hij}	51.00^{fg}	2.41^{de}	2.40^{e}	19.00^{hi}	20.00^{gh}
	Fulvic acid	51.33^{de}	53.00^{ef}	2.17^{f}	2.23^{f}	22.00^{ef}	23.00^{c-f}
	Humic acid	51.67^{de}	54.00^{de}	2.10^{f}	2.17^{f}	23.00^{de}	24.00^{b-e}
	Salicylic acid	53.33^{cd}	56.00^{cd}	2.37^{e}	2.43^{de}	24.00^{cd}	25.00^{bc}
	Microelements	55.67^{b}	60.00^{b}	2.57^{c}	2.63^{bc}	25.00^{bc}	26.00^{ab}
100 %	Control	48.00^{fgh}	51.00^{fg}	2.43^{de}	2.53^{cd}	21.00^{fg}	22.67^{def}
	Fulvic acid	51.33^{de}	53.00^{ef}	2.50^{cd}	2.57^{c}	23.00^{de}	24.00^{b-e}
	Humic acid	53.33^{cd}	56.00^{cd}	2.50^{cd}	2.60^{c}	24.00^{cd}	24.67^{bcd}
	Salicylic acid	54.67^{bc}	58.00^{bc}	2.70^{b}	2.73^{b}	26.00^{ab}	26.00^{ab}
	Microelements	60.00^{a}	64.00^{a}	2.90^{a}	2.97^{a}	27.00^{a}	27.33^{a}
F. test		**	**	**	**	**	**

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$

Foliar application of fulvic acid, humic acid, salicylic acid and microelements had significantly positive effect on all vegetative growth parameters in terms of plant height, branches and leaves plant^{-1} of pea plants as compared to control (tap water) in both seasons (Table 2). The highest values of vegetative growth parameters were obtained with microelements (Fe, Zn, Mn) followed by salicylic acid in both seasons. These results agreed with those of (Sarkar *et al.,* 2007; Zaghloul *et al.,* 2015) pointed out that micronutrients, particularly Fe, Mn and Zn applied as foliar spraying were significantly enhanced the vegetative growth parameters. Also, (Dhanavel and Girija (2009) on cowpea; El-Shraiy and Hegazi (2009) and Farooq *et al.* (2007) on peas, showed that the highest plant growth values were obtained foliar application of salicylic acid. Moreover, EL-Afifi *et al.* (2017)

on peas, Azoz and El-Taher (2018) on cowpea and Keshavarz *et al.* (2020) on corn plants found similar results.

While, humic acid and fulvic acid gave an intermediate values in this respect. These results agreed with those of Zaky *et al.* (2006) and Saeid (2018) on beans. The reason for the good influence of humic acid might be due to its stimulating role on cell respiration, plant growth and protein synthesis as well as enzyme activities and photosynthesis (Nardi, *et al.*, 2002, and Chen, *et al.* 2004). The increase in vegetative parameters due to NPK fertilizers rates confirmed the role of NPK minerals in endorsing vital vegetative growth of tomato and melons (Olaniyi, 2006; Olaniyi and Ajibola, 2008).

The positive effect of salicylic acid as safe compound on pea growth accomplished of reducing the abiotic stress effects (Khan *et al.* 2015) .Also, it increased the many crops yield and quality (Abdel Aziz *et al*., 2017 and Abd-El-Rhman *et al.,* 2017).

The data described in Table (3) show that, the interaction between different fertilization levels combined with foliar application of organic acids (fulvic acid, humic acid, salicylic acid) and microelements had a significant influence on growth characters of pea plants in both seasons. The highest values were belonged to treatment of 100 % NPK fertilization + microelements (F_5T_5) followed by 100 % NPK fertilization + salicylic acid (F_5T_4), 75 % NPK fertilization + microelements (F_4T_5) and 50 % NPK fertilization + microelements (F_4T_5), respectively. These results agreed with those of Gad El-Hak *et al.* (2012), they indicates that foliar application of salicylic acid at 200 ppm + 2 g humic acid produced the highest plant height and branches plant^{-1} in two seasons.

The increment of vegetative growth characters, as a result of organic acids treatments may be due to salicylic acid involved in thermogenesis of plant growth, ethylene biosynthesis, uptake of ions, adverse the impacts of ABA on leaf abscission, stomatal movement, improvement of the level of carotenoids and chlorophyll pigments, modifying the efficacy of some remarkable enzymes and photosynthetic rate as well as other functions assigned to SA (Abdel Ati *et al.*, 2000 and Popova *et al*., 2008). It works as an indirect signal stimulating various biochemical, molecular processes and physiological and therefore it impacts the plant development and growth (Shafeek *et al.,* 2014). In this manner, SA is an endogenous growth regulator with phenolic nature, which participates in various physiological processes regulation in plants, such as ion uptake, stomatal closure, reduces transpiration and restraint biosynthesis of ethylene (El-Shraiy and Hegazi, 2009) especially under high levels of NPK fertilization.

Yield traits:

Data presented in Tables 4 and 5 revealed that, yield as average pod weight, pods plant^{-1}, green pods plant^{-1} and feddan^{-1}, dry seeds yield plant^{-1} and dry seeds yield feddan^{-1} were significantly influenced by different fertilization levels and their combination with fulvic acid, humic acid, salicylic acid and microelements as compared with the control plants in both seasons. As for the effect of fertilization levels, data in Table (4) cleared that, fertilization with NPK at different levels led to significantly increase yield as average pod weight, pods plant^{-1}, green pods yield plant^{-1}, green pods yield feddan^{-1}, dry seeds yield plant^{-1} and dry seeds yield feddan^{-1} of pea plants compared to control treatment in both seasons. Fertilization with NPK at 100 and 75% showed the highest pea yield compared to control and other rates in both seasons. These results agreed with Ismail (2016).

The data in Table (4) also clarify that, all sprayed compounds cause a significant enhance in yield when compared with control plants which produced the lowest yield. Also, the highest yield was obtained from plants sprayed by microelements and salicylic acid in two seasons. These results agreed with those of (Andrzejewska, 2002 and Zaghloul *et al.*, 2015), they stated that the improve of seed yield resulted by microelement application Likewise, El Sayed Hamada (2012) found that foliar spraying with a mixture of microelements (Fe, Mn and Zn at 100 ppm) significantly enhanced yield components of peas. The highly yield production of peas was observed by foliar spray with salicylic acid (Gad El-Hak *et al.*, 2012; El-Afifi *et al.*, 2017) and El-Hendaway *et al.* (2011) in faba bean.

Whereas, sprayed humic acid cause an intermediate value in yield of pea plants. These results agreed with those of Saeid (2018). This positive influence might be due to the simulative role of humic acid on cell respiration, enzyme activities, protein synthesis, photosynthesis and plant growth (Nardi, *et al.,* 1996 and Chen *et al.*, 2004).

Table 4. Effect of fertilization rates and spray of some organic acids and microelements on some pea yield traits during 2017/2018 and 2018/2019 seasons.

Treatments	*Symbol*	Average pod weight (g)		Pods plant^{-1}		Green pods yield plant^{-1} (g)		Green pods yield fed.$^{-1}$ (ton)		Dry seeds yield plant^{-1} (g)		Dry seeds yield fed.$^{-1}$ (kg)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd	1st	2nd
Main plot: NPK fertilization levels													
0.0%	F_1	4.42^e	4.52^e	11.68^e	11.99^e	51.72^c	53.35^e	1.73^e	1.79^e	15.86^e	16.24^e	529.40^e	542.07^e
25%	F_2	4.84^d	4.93^d	13.05^d	13.36^d	64.33^c	65.73^d	2.09^d	2.20^d	19.35^d	19.90^d	650.73^d	659.07^d
50%	F_3	5.85^c	5.92^c	16.44^c	16.67^c	99.13^b	100.34^c	3.22^c	3.33^c	30.68^c	29.71^c	988.07^c	998.13^c
75%	F_4	6.39^b	6.44^b	17.99^b	17.97^b	107.54^{ab}	114.74^b	3.76^b	3.83^b	34.92^b	35.12^b	1163.53^b	1171.87^b
100%	F_5	6.62^a	6.77^a	18.45^a	18.52^a	120.73^a	121.69^a	4.03^a	4.05^a	37.00^a	37.15^a	1235.73^a	1241.67^a
F. test		**	**	**	**	**	**	**	**	**	**	**	**
Sub plot: organic acids and microelements													
Control	T_1	5.39^d	5.48^c	15.11^c	15.31^c	86.15^{ab}	86.90^e	2.82^c	2.88^d	26.09^c	26.46^c	866.33^e	875.13^e
Fulvic acid	T_2	5.56^{bc}	5.63^{bc}	15.45^b	15.59^b	88.12^{ab}	89.77^c	2.86^c	3.07^c	27.52^b	27.23^{bc}	888.40^d	901.53^d
Humic acid	T_3	5.47^{cd}	5.55^c	15.47^b	15.57^b	81.30^b	88.85^d	2.92^c	2.94^{cd}	26.96^{bc}	26.52^c	898.20^c	906.07^c
Salicylic acid	T_4	5.70^b	5.79^b	15.65^{ab}	15.91^a	91.97^{ab}	92.34^b	3.20^a	3.12^b	27.81^b	28.13^b	933.87^b	940.53^b
Microelements	T_5	5.99^a	6.13^a	15.93^a	16.14^a	95.91^a	97.99^a	3.20^a	3.26^a	29.43^a	29.78^a	980.67^a	989.53^a
F. test		**	**	**	**	**	**	**	**	**	**	**	**

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$.

Table 5. The interaction effect of fertilization rates and spray of some organic acids and microelements on some pea yield traits during 2017/2018 and 2018/2019 seasons

Treatments		Average pod weight (g)		Pods plant^{-1}		Green pods yield plant^{-1} (g)		Green pods yield fed.$^{-1}$ (ton)		Dry seeds yield plant^{-1} (g)		Dry seeds yield fed.$^{-1}$ (kg)	
NPK	**Organic acids and microelements**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**	**1st**	**2nd**
0.0 %	Control	4.30^{k}	4.43^{l}	11.30^{m}	11.70^{l}	50.80^{x}	51.20^{x}	1.74^{o}	1.73^{o}	15.55^{no}	15.80^{l}	499.67^{v}	522.00^{s}
	Fulvic acid	4.43^{klm}	4.53^{jkl}	11.70^{lm}	11.93^{kl}	51.27^{w}	53.43^{u}	1.73^{o}	1.77^{o}	15.80^{mno}	16.20^{kl}	525.00^{u}	544.67^{q}
	Humic acid	4.40^{lm}	4.47^{kl}	11.60^{lm}	11.67^{l}	50.40^{x}	52.30^{w}	1.72^{o}	1.76^{o}	15.43^{o}	15.83^{l}	525.00^{u}	532.67^{r}
	Salicylic acid	4.40^{lm}	4.53^{jkl}	11.70^{lm}	12.17^{jk}	51.43^{v}	52.70^{v}	1.75^{o}	1.76^{o}	15.73^{mno}	16.20^{kl}	536.00^{t}	540.33^{q}
	Microelements	4.57^{jkl}	4.63^{jkl}	12.10^{kl}	12.50^{ij}	54.70^{u}	57.10^{t}	1.91^{n}	1.92^{n}	16.80^{l-o}	17.17^{jkl}	561.33^{s}	570.67^{p}
25 %	Control	4.60^{jkl}	4.73^{ijk}	12.50^{jk}	12.77^{hi}	57.47^{s}	61.00^{q}	1.89^{hi}	2.02^{n}	17.70^{lm}	18.10^{jk}	595.00^{q}	600.67^{o}
	Fulvic acid	4.70^{j}	4.80^{ij}	12.70^{ij}	13.00^{h}	57.37^{s}	60.13^{r}	1.86^{hi}	2.15^{m}	17.50^{lmn}	18.40^{j}	585.67^{r}	601.33^{o}
	Humic acid	4.67^{jk}	4.73^{ijk}	12.47^{jk}	12.70^{hi}	59.87^{r}	59.77^{s}	1.94^{hi}	1.96^{n}	18.13^{kl}	18.20^{j}	600.67^{q}	604.00^{o}
	Salicylic acid	4.97^{i}	5.00^{i}	13.20^{i}	13.63^{g}	70.77^{o}	68.23^{p}	2.22^{gh}	2.27^{l}	19.97^{k}	20.43^{i}	685.00^{p}	688.00^{n}
	Microelements	5.27^{h}	5.37^{h}	14.37^{h}	14.70^{f}	76.20^{m}	79.53^{o}	2.52^{fg}	2.62^{k}	23.47^{j}	24.37^{h}	787.33^{o}	801.33^{m}
50 %	Control	5.57^{g}	5.70^{g}	15.40^{g}	15.57^{e}	90.30^{n}	90.07^{n}	2.84^{ef}	2.92^{j}	26.37^{i}	27.47^{g}	877.33^{n}	882.67^{l}
	Fulvic acid	5.87^{f}	5.93^{fg}	16.27^{f}	16.47^{d}	98.70^{l}	99.73^{l}	3.16^{de}	3.26^{h}	32.83^{g}	29.70^{f}	941.67^{m}	955.00^{k}
	Humic acid	5.80^{fg}	5.83^{g}	16.03^{f}	16.20^{d}	97.30^{m}	97.23^{m}	3.16^{de}	3.14^{i}	30.10^{h}	26.80^{g}	991.00^{l}	995.67^{j}
	Salicylic acid	5.80^{fg}	5.87^{g}	17.17^{e}	17.43^{c}	100.77^{kl}	103.30^{k}	3.32^{cde}	3.60^{g}	30.70^{h}	31.10^{f}	1024.67^{k}	1039.67^{i}
	Microelements	6.20^{e}	6.27^{e}	17.33^{de}	17.67^{c}	108.57^{j}	111.37^{j}	3.60^{a-d}	3.71^{f}	33.40^{fg}	33.47^{e}	1105.67^{j}	1117.67^{h}
75 %	Control	6.20^{e}	6.20^{ef}	18.10^{bc}	18.23^{b}	112.93^{hi}	112.70^{i}	3.75^{abd}	3.76^{ef}	34.40^{efg}	34.50^{de}	1143.33^{i}	1150.00^{g}
	Fulvic acid	6.27^{de}	6.33^{de}	18.17^{bc}	18.13^{b}	113.20^{g}	114.13^{h}	3.55^{bcd}	3.81^{ef}	34.67^{c-g}	34.97^{cde}	1156.33^{h}	1168.00^{f}
	Humic acid	6.17^{e}	6.23^{e}	18.40^{ab}	18.50^{ab}	111.23^{gh}	113.90^{h}	3.76^{abc}	3.79^{ef}	34.50^{d-g}	34.70^{cde}	1149.67^{hi}	1162.33^{f}
	Salicylic acid	6.50^{cd}	6.60^{cd}	17.73^{cd}	17.50^{c}	115.33^{f}	115.17^{g}	3.84^{ab}	3.86^{de}	35.23^{b-f}	35.40^{bcd}	1175.33^{g}	1179.67^{e}
	Microelements	6.80^{b}	6.83^{bc}	17.57^{de}	17.50^{c}	117.00^{f}	117.80^{f}	3.90^{ab}	3.93^{cd}	35.80^{a-e}	36.03^{a-d}	1193.00^{f}	1199.33^{d}
100 %	Control	6.27^{de}	6.33^{de}	18.27^{b}	18.27^{b}	119.27^{ab}	119.53^{e}	3.97^{ab}	3.97^{bc}	36.43^{a-d}	36.43^{abc}	1216.33^{e}	1220.33^{c}
	Fulvic acid	6.53^{c}	6.57^{cd}	18.43^{ab}	18.43^{ab}	120.07^{ab}	121.40^{c}	4.01^{ab}	4.05^{ab}	36.80^{ab}	36.90^{ab}	1233.33^{c}	1238.67^{b}
	Humic acid	6.33^{cde}	6.47^{de}	18.87^{a}	18.77^{a}	119.70^{ab}	121.07^{d}	3.99^{ab}	4.04^{ab}	36.63^{abc}	37.07^{ab}	1224.67^{d}	1235.67^{b}
	Salicylic acid	6.83^{b}	6.93^{b}	18.43^{ab}	18.80^{a}	121.57^{a}	122.30^{b}	4.05^{ab}	4.10^{a}	37.43^{a}	37.50^{a}	1248.33^{b}	1255.00^{a}
	Microelements	7.13^{a}	7.57^{a}	18.27^{b}	18.33^{b}	123.07^{a}	124.13^{a}	4.12^{a}	4.12^{a}	37.70^{a}	37.87^{a}	1256.00^{a}	1258.67^{a}
F. test		**	**	**	**	**	**	**	**	**	**	**	**

Means followed by the same letter within a column are not significantly different using DMRT at $P \leq 0.05$.

With regard to the interaction, it is clear from Table (5) that, yield components were significantly increased by combination among different fertilization rates and all sprayed compounds compared to control in both seasons. The highest yield was harvested from pea plants fertilized by 100% NPK combined with microelements spray (F_5T_5) followed by 100% NPK + Salicylic acid spray (F_5T_4) and 75% NPK + microelements spray (F_4T_5) respectively, while the least values were belonged to the control plants (F_1T_1). These results agreed with those of Gad El-Hak *et al*. (2012).

The obtained increase in yield, as a result of applied SA may be due to salicylic acid involved in plant growth thermogenesis, ethylene biosynthesis, uptake of ions, reverses the impacts of ABA on leaf abscission, stomatal movement, improvement of the level of carotenoid and chlorophyll pigments, modifying the activity of some important enzymes and photosynthetic rate (Abdel Ati *et al.*, 2000 and Popova *et al*., 2008). Moreover, salicylic acid might have promoted the CO2 fixation, encouraged activity of carbohydrate synthesizing enzymes combined with functional splitting of dry matters into reproductive sink as demonstrated by (Bera *et al.*, 2008). Furthermore, the best results of number of seeds per pods and number of pods per plant, might be due to the balanced metabolism preserved continuously inside the plant to subsequent phases of growth (Marimuthu and Surendran, 2015).

Qualitative traits:

Data in Table 6 showed highly significant effect of different NPK fertilization rates, foliar applications of organic acids and microelements on green pod quality in terms of pod length, pods diameter, and seeds pod^{-1}, as well as protein % in dry seeds of pea plants in both seasons. As for the NPK fertilization rates, it is clear that the highest pods quality values of all quality traits were resulted from plants fertilized with 100% NPK followed by those fertilized with 75% as compared with those harvested from other levels and control plants in both seasons (Table 6). On the other hand, the lowest values of pods quality traits were found in pods harvested from control plants. These results agreed with Ismail (2016).

Similarly, data in Table (6) showed that most pods quality parameters were significantly affected by different sprayed organic acids and microelements, it is clear that the highest quality traits of pods or seeds of pea plants were recorded from pods harvested from plants sprayed with microelements followed by salicylic acid compared to control and other foliar applications treatment in both seasons. These results agreed with those of El Sayed Hamada *et al.* (2012) on pea *cv* Master-B, they informed that the foliar spraying with a mixture of microelements (Mn, Zn and Fe each at 100 ppm) significantly enhanced pod quality characters (pod length, green seed number /pod and protein % in green seeds). Likewise, El-Shraiy and Hegazi (2009), Gad El-Hak *et al.* (2012) and EL-Afifi *et al.* (2017), and Azoz and El-Taher (2018) stated that foliar application of SA produced the highest pod length, pod diameter, seeds pod^{-1} and protein %. Moreover, foliar application by salicylic acid with boron improved quality of peas (Abdel-Aziz *et al.*, 2013). SA prevents the accumulation of reactive oxygen species (ROS) that resulted in protecting plant cells from death (Taiz and Zeiger, 2002 and Joseph *et al.,* 2010). Salicylic acid is too beholden as a natural plant hormone that delays the fruit senescence and prevents ethylene biosynthesis. The participation of SA in systemic gained resistance has also been stated by Beckers and Spoel (2006). There are many studies suggesting beneficial impacts of SA treatment of preserving fruit quality and reducing decay percentage (Ennab *et al.,* 2020; Gonchikari *et al.,* 2020 and Haider *et al.,* 2020).

Whereas, foliar spray of humic acid give the intermediate increases. These results agreed with those of Patill *et al*. (2010) and Saeid (2018). The purpose for this positive influence might be due to role of humic acid to stimulated protein synthesis, cell respiration, plant growth, enzyme activities and photosynthesis (Nardi, *et al* 1996, and Chen *et al* 2004).

Regards to the effect of interaction between fertilization rates and foliar application of organic acids and microelements on pod quality, it is clear from (Table 7) that pod quality traits were significantly affected by all combinations in both seasons.

Table 6. Effect of fertilization rates and spray of some organic acids and microelements on some pea quantitative traits during 2017/2018 and 2018/2019 seasons

Treatments	Symbol	Pod length(cm)		Pod diameter(cm)		Seedspod^{-1}		Protein content(%)	
		1st	2nd	1st	2nd	1st	2nd	1st	2nd
Main plot: NPK fertilization levels									
0.00	F_1	8.03^{d}	8.24^{d}	1.10^{c}	1.13^{c}	8.45^{d}	8.49^{d}	21.36^{d}	21.39^{d}
25%	F_2	8.55^{bc}	8.91^{b}	1.14^{bc}	1.21^{bc}	9.06^{c}	9.37^{c}	21.65^{d}	21.63^{d}
50%	F_3	8.49^{c}	8.59^{c}	1.19^{bc}	1.23^{bc}	9.23^{c}	9.43^{c}	22.17^{c}	22.24^{c}
75%	F_4	8.75^{b}	8.93^{b}	1.27^{ab}	1.31^{ab}	9.77^{b}	10.07^{b}	23.42^{b}	23.27^{b}
100%	F_5	9.31^{a}	9.47^{a}	1.38^{a}	1.39^{a}	10.33^{a}	10.46^{a}	23.82^{a}	24.17^{a}
F. test		**	**	**	**	**	**	**	**
Sub plot: organic acids and microelements									
Control	T_1	8.59^{b}	8.79^{b}	1.15^{c}	1.17^{b}	9.20^{ab}	9.26^{c}	22.45^{b}	22.30^{c}
Fulvic acid	T_2	8.61^{b}	8.82^{b}	1.27^{a}	1.27^{a}	9.51^{a}	9.61^{ab}	22.47^{b}	22.50^{bc}
Humic acid	T_3	8.33^{c}	8.54^{c}	1.19^{bc}	1.25^{a}	9.18^{b}	9.53^{b}	22.35^{b}	22.39^{c}
Salicylic acid	T_4	8.63^{b}	8.85^{b}	1.23^{ab}	1.30^{a}	9.46^{ab}	9.65^{ab}	22.44^{b}	22.64^{ab}
Microelements	T_5	8.95^{a}	9.14^{a}	1.26^{ab}	1.27^{a}	9.51^{a}	9.77^{a}	22.71^{a}	22.87^{a}
F. test		**	**	**	**	**	**	**	**

Means followed by the same letter within a column are not significantly different using DMRT at *P* ≤0.05

Table 7. The interaction effect of fertilization rates and spray of some organic acids and microelements on some pea quantitative traits during 2017/2018 and 2018/2019 seasons.

Treatments		Pod length(cm)		Pod diameter(cm)		Seeds pod^{-1}		Protein content(%)	
NPK	Organic acids and microelements	1st	2nd	1st	2nd	1st	2nd	1st	2nd
0.0 %	Control	8.00^{n}	8.03^{jk}	1.07^{f}	1.07^{i}	8.10	8.30^{j}	21.20^{l}	21.43^{ij}
	Fulvic acid	8.20^{m}	8.23^{ij}	1.10^{ef}	1.10^{hi}	8.50	8.60^{i}	21.40^{jkl}	21.30^{j}
	Humic acid	7.77^{o}	8.00^{k}	1.10^{ef}	1.13^{gh}	8.57	8.67^{i}	21.30^{kl}	21.20^{j}
	Salicylic acid	7.90^{no}	8.40^{hi}	1.13^{def}	1.23^{efg}	8.47	8.50^{ij}	21.40^{jkl}	21.50^{ij}
	Microelements	8.30^{klm}	8.53^{fgh}	1.10^{ef}	1.10^{hi}	8.63	8.40^{ij}	21.50^{i-l}	21.50^{ij}
25 %	Control	8.50^{h-k}	8.70^{efg}	1.13^{def}	1.20^{e-h}	9.03	9.10^{h}	21.60^{ijk}	21.47^{ij}
	Fulvic acid	8.40^{j-m}	9.20^{d}	1.27^{bcd}	1.20^{e-h}	9.23	9.63^{f}	21.70^{hij}	21.70^{i}
	Humic acid	8.27^{lm}	8.80^{e}	1.17^{c-f}	1.23^{efg}	8.93	9.30^{gh}	21.50^{i-l}	21.57^{ij}
	Salicylic acid	8.63^{ghi}	8.77^{ef}	1.07^{f}	1.23^{efg}	8.93	9.47^{fg}	21.80^{ghi}	21.73^{i}
	Microelements	8.93^{ef}	9.07^{d}	1.07^{f}	1.17^{f-i}	9.17	9.37^{fgh}	21.63^{ijk}	21.70^{i}
50 %	Control	8.40^{j-m}	8.50^{gh}	1.17^{c-f}	1.20^{e-h}	9.23	9.47^{fg}	21.80^{ghi}	21.40^{ij}
	Fulvic acid	8.60^{g-j}	8.70^{efg}	1.20^{c-f}	1.23^{efg}	9.53	9.27^{gh}	22.27^{ef}	22.50^{fgh}
	Humic acid	8.40^{j-m}	8.50^{gh}	1.13^{def}	1.23^{efg}	8.83	9.20^{gh}	22.13^{fg}	22.40^{gh}
	Salicylic acid	8.57^{g-j}	8.63^{e-h}	1.23^{cde}	1.27^{def}	9.27	9.60^{f}	22.03^{fgh}	22.20^{h}
	Microelements	8.47^{il}	8.63^{e-h}	1.23^{cde}	1.20^{e-h}	9.30	9.60^{f}	22.60^{e}	22.70^{efg}
75 %	Control	8.67^{ghi}	9.067^{d}	1.13^{def}	1.20^{e-h}	9.43	9.47^{fg}	23.57^{c}	23.20^{d}
	Fulvic acid	8.77^{fg}	8.767^{ef}	1.27^{bcd}	1.30^{cde}	9.97	10.07^{de}	23.40^{cd}	22.97^{de}
	Humic acid	8.50^{h-k}	8.600^{e-h}	1.27^{bcd}	1.27^{def}	9.67	10.13^{cde}	23.40^{cd}	22.80^{ef}
	Salicylic acid	8.57^{g-j}	8.767^{ef}	1.30^{bc}	1.37^{bcd}	10.17	10.30^{bcd}	23.57^{c}	23.73^{bc}
	Microelements	9.23^{cd}	9.467^{c}	1.40^{ab}	1.40^{abc}	9.63	9.97^{e}	23.17^{d}	23.63^{c}
100 %	Control	9.37^{c}	9.63^{bc}	1.23^{cde}	1.20^{e-h}	10.20	10.40^{bc}	24.07^{b}	24.00^{bc}
	Fulvic acid	9.10^{de}	9.20^{d}	1.50^{a}	1.50^{a}	10.30	10.50^{b}	23.60^{c}	24.03^{b}
	Humic acid	8.70^{gh}	8.80^{e}	1.27^{bcd}	1.37^{bcd}	9.90	10.37^{bc}	23.40^{cd}	23.97^{bc}
	Salicylic acid	9.60^{b}	9.70^{b}	1.40^{ab}	1.40^{abc}	10.47	10.37^{bc}	23.40^{cd}	24.03^{b}
	Microelements	9.80^{a}	10.00^{a}	1.50^{a}	1.47^{ab}	10.80	11.10^{a}	24.63^{a}	24.80^{a}
F. test		**	**	**	**	NS	**	**	**

Means followed by the same letter within a column are not significantly different using DMRT at *P* ≤0.05.

The highest values of green pod length, pods diameter, no. of seeds pod^{-1} and protein % in dry seeds attributed to the combined of 100% NPK fertilization plus microelements spray (F_5T_5) followed by 100% NPK fertilization + SA (F_5T_4) and 75% NPK fertilization + microelements (F_4T_5) in both seasons, respectively. These results agreed with those of Gad El-Hak *et al.* (2012).

Some studies realized on various saline soils and on different crops growing revealed that adding inorganic fertilizers may decrease the salinity influences and increase plant productivity (Rengasamy, 2010). Amongst the plant nutrients, potassium (K) has an essential role to decrease influences of high salinity conditions in soils, and aids to save water within plant itself. Its suitable rates in plants also can roots to absorb water from soils even under minimal moisture conditions (Tripathi *et al.*, 2014). The N, P and K fertilizers are considered as an primary macronutrient which involved in numerous functions in plant life essentially in energy storage and transfer (Belouchrani *et al.,* 2020).

CONCLUSION

As the previously mentioned results, it was clear the great role of NPK fertilization rates combined with microelements and/or salicylic acid as foliar applications for mitigation the harmful influences of saline stress on pea plants grown in salt-affected soil. So, under salt-affected soil stress the application of 100 or 75 % NPK combined with microelements and/or salicylic acid as foliar applications led to improving growth, yield and pods quality of pea plants as well as production of maximum yield and quality. Thus, this study recommended the superiority of NPK fertilization at 75% from recommended doses and foliar spray with microelements or salicylic acid, which gave the best growth, yield, pods quality of pea plants.

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تاثير الرش ببعض الأحماض العضوية والعناصر الصغرى على محصول البسلة وجودة البذور مع مستويات مختلفة من التسميد تحت ظروف الاراضى المتاثرة بالملوحة

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أجريت تجربة حقلية خلال الموسم الشتوى لسنوات 2018/2017 و 2019/2018 لنباتات البسلة صنف ماستر- بي، بمزرعة محطة بحوث البساتين بسخا، التابعة لمركز البحوث الزراعية, محافظة كفر الشيخ, مصر، لدراسة تاثير الرش الورقي ببعض الأحماض العضوية مثل حمض الفولفيك 3 جم / لتر , وحمض الهيوميك 1 جم / لتر, وحمض السالسيلك 0.25 جم / لتر والعناصر الصغري 1جم / لتر بالمقارنة بمعاملة الكنترول (الرش بماء الصنبور) مع خمسة مستويات من معدلات التسميد بالعناصر الرئيسية الكبري النيتروجين والفوسفور والبوتاسيوم كالتالي: صفر, و25, و50, و75, و100% من التسميد الموصي به في صورة إضافة أرضية على محصول البسلة وجودة البذورتحت ظروف الاراضى المتاثرة بالملوحة, لتقليل إستخدام الأسمدة المعدنية, وخفض تكلفة الإنتاج, وأضرارها علي التربة وصحة الإنسان. وزعت الـ 25 معاملة بنظام القطع المنشقة في قطاعات كاملة العشوائية بثلاث مكررات. وقد أظهرت النتائج وجود فروق معنوية بين الصفات الخضرية والمحصولية وصفات الجودة للقرون نتيجة التسميد بالنيتروجين والفوسفور والبوتاسيوم والرش الورقي لأحماض الفولفيك والهيوميك والساليسيليك, والعناصر الصغرى. نتج أعلى ارتفاع للنبات وعدد الأوراق والأفرع / نبات ومحصول قرون وبذور البسلة عند إضافة 100٪ تليها 75٪ من NPK مقارنة بمعدلات NPK الأخرى. كما أدى الرش الورقى بحمض الهيوميك أو حمض الساليسيليك أو العناصر الدقيقة إلى زيادة معنوية في نمو وإنتاج وجودة البسلة في كلا الموسمين. وبناءً عليه توصى الدراسة بتفوق معاملة التسميد NPK بنسبة 75٪ من الجرعات الموصى بها والرش الورقي مع العناصر الدقيقة أو حمض الساليسيليك ، مما أدى إلى أفضل نمو ومحصول وجودة قرون لنباتات البسلة تحت ظروف التربة المتأثرة بالملوحة.