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Influence of Seaweed Extract, Chitosan and Salicylic Acid on Yield Components and Seed Chemical Composition of Pea Plants

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Abstract: The present study was conducted at the experimental farm of Sadat City University during the two winter successive seasons of 2018-2019 and 2019-2020 to examined the role of the foliar spraying with seaweed extract, chitosan and salicylic acid on growth, yield components traits as well as seed chemical composition of the three pea cultivars; i.e. Master B, Entsar 1 and Entsar 2. The experiment was designed in split plot design with three replicates where the three pea cultivars were allocated in the main plots and the foliar spray treatments were randomly distributed in the sub-plots. The results showed wide differ among all tested cultivars in all seed yield components traits as well as seed quality. Master B cv. expressed the highest leaf content of N, P and K, pods number/plant, pod length and number of seeds/pod in both seasons. Master B cv. also, followed by Entsar 2 showed the highest seed content of N, P, K and total protein in both seasons. All used treatments significantly exceeded the control treatment in all growth and yield components traits. Pea plants that sprayed with seaweed extract had the highest leaf content of N, P and K, pods number/plant, pod length and number of seeds/pod and seed content of N, P, K and total protein in both seasons. The three tested cultivars differ in their response to the different used treatments. The pea cultivar Master B that sprayed with seaweed extract had the highest leaf content of N, P and K, pods number/plant, pod length and number of seeds/pod as well as seed content of N, P, K and total protein in both seasons.

Key words: Pea (*Pisum sativum*) · Seaweed · Chitosan · Salicylic acid · Seed yield components and seed quality

INTRODUCTION

Pea (*Pisum sativum* L.) is one of the important vegetables in the world and ranks among the top 10 vegetable crops. Pea is commonly used in human diet throughout the world and it is rich in protein ranged from 21-25% [1]. Peas are important for their nutritional values as it is constituent of high amount of protein, carbohydrates, vitamin A and B and has high levels of amino acids lysin and trypophan. Peas are source of minerals such as phosphorous, iron and zinc. It is a cheap source of protein and minerals especially important in developing countries where zinc deficiency is fifth major cause of diseases and even deaths [1]. There is a significant increase in the demand for peas in Egypt because of its nutritional value and acceptance by the Egyptian consumer. To meet this growing demand for peas, the Egyptian Ministry of Agriculture resorts to many solutions, including increasing the area planted with the crop, breeding new varieties with high yields, such as Entsar 1 and 2, or importing distinguished varieties from abroad, such as Master B. The Egyptian Ministry of Agriculture also resorts to developing agricultural practices and operations that lead to an increase in the yield through land service, fertilization and irrigation. Due to the expansion of pea cultivation in newly reclaimed lands, the composting process is emerging as one of the most important production inputs. Farmers usually resort to mineral fertilization with major elements (nitrogen, phosphorous and potassium) while reducing the dose of

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nitrogen fertilizer in the old lands due to the presence of rhizobia bacteria that fix atmospheric nitrogen. However, mineral fertilizers carry a lot of risks to the health of the consumer due to the direct consumption of peas, which necessitates the search for safe alternatives to mineral fertilizers. Many natural substances such as seaweed extract, Chitosan and Salicylic acid are used as safe alternatives to mineral fertilizers.

Seaweed extract is a new generation of natural organic fertilizer highly nutritious and encourage faster germination of seeds and enhance yield and resistant ability of several crops [2]. Seaweed are rich in macro and micro nutrients.

The seaweed resources are intensively to increase harvest quantity, quality in agriculture and horticulture. and improve plant growth and yield [3]. The influence is explained by content of plant growth promoting substances such as cytokinins, auxin, gibberellins, abscisic acid, ethylene, polyamines and betaines in algal extract [4]. Seaweeds are an important source of organic matter and fertilizer nutrients. Seaweed extracts have been used in agriculture as soil conditioners or plant stimulators. They are applied as foliar spray and are able to enhance plant growth, improving yield and productivity of several crops [5]. Seaweeds used for biostimulant production contain cytokinins and auxins or other hormone-like substances. They also contain many active mineral and organic compounds, including complex polysaccharides such as laminarin, fucoidan, alginates and plant hormones that contribute to plant growth [6]. Recently the potential application of micro-algae as plant biostimulants has been considered [7].

Chitosan, a common name to a deacetylated form of chitin, is a natural biodegradable materials derived from crustaceous shells, whose main attribute s corresponds to its polycationic nature [8]. Chitosan is of keen interest now a days and used in seed, leaf, fruit and vegetable coatings, as fertilizer and in controlled agrochemical release, to increase plant productivity [9, 10]. According to Malerba and Cerana, [11] the beneficial effect of Chitosan (CHI) on plant growth may be attributed to the promoting effects on nutrients uptake and nutritional status especially nitrogen, potassium and phosphorous which are essential for plant growth. Chitosan have insecticidal and disease preventive actions, also it helps plants to stimulate stress tolerance.

Salicylic acid (SA) is a plant growth regulator known as an endogenous marking molecule, which is implicated in different physiological processes, like growth regulation, photosynthesis, stomatal behavior, nutrient uptake and mechanisms of tolerance to abiotic stresses [12]. It plays physiological roles in plant including growth, thermogenesis, flower induction, nutrients uptake, ethylene biosynthesis, stomata movement, photosynthesis and enzymes activity [13]. SA can increase protein content and reduced adverse effects of salinity [14].

According to the previous descriptions the main objectives of this study were examined the role of seaweed extract, chitosan and salicylic acid on increase yield components traits in addition to seed quality of the three pea cultivar Entsar 1, Entsar 2 and Master B under sandy loamy soil conditions.

MATERIALS AND METHODS

To examine the impact of some plant stimulants seaweed extract (20ml/l), chitosan (250ppm) and salicylic acid (50ppm) compared with control (water) on seed yield components and seed quality of the three pea cultivars, i.e. Master B, Entsar 1 and Entsar 2 under Menofiya Governorate conditions. For this purpose a field experiment designed in a split plot design with three replicates was conducted at the experimental farm of Sadat City University, El-Menofya Governorate, Egypt during 2018 and 2019 seasons where the three pea cultivars were allocated in the main plots and the three used treatments and the control were randomly distributed in the sub-plots. This experiment included 12 treatments which were the combinations between three cultivars and four treatments as used as foliar applications.

Seeds of the three pea cultivars were sown on November 5th and 4th in both seasons, respectively. The plot size was four ridges each ridge was five meters long and 70 cm apart. Seeds were sown on the two side of the ridge at 20 cm hill spacing with one seed per hill. The plot area was 14 m^2 (including 196 plants). The wet planting method called (Herati) was used and all the other cultural practices (irrigation, fertilization and weed control) were followed as recommended. All treatments were applied as a foliar spray three times: the first one was in beginning of flowering, the second one was 10 days after the first on and the third was 10 days after the second one. Soil physical and chemical properties of the experimental site and analysis of irrigation water are presented in Table 1 and 2.

Studied Characters Were

Leaf Chemical Properties: Leaves contents of nitrogen, phosphorous and potassium were measured in fresh leaf at 90 days after seed sowing.

Table 1: Soil physical and chemical properties of the experimental site (Average two seasons)

Physical properties											
Sand %				Silt %			Clay %			Texture	
83				10			7			Sandy loamy	
Chemical properties											
		Soluble salts (mg/100g)									
PH	EC dS/m	Na^+	K^+	Ca^{++}	Mg^{++}	Cl^-	HCO_3^{--}	CO_3^{--}	SO_4^-	O.M	CO_3%
8.17	1.114	3.3	0.18	1.2	1.2	7.4	1.9	0	3.4	0.35	1.7

Table 2: Analysis of irrigation water

												Fe	Zn	Mn	Cu
pH	EC dS/m	Ca^{++}	Mg^{++}	Na^+	K^+	CO_3^{--}	HCO_3^{--}	Cl^-	SO_4^-	SAR	TDS	Ppm			
7.98	1.26	4.2	2.6	6.5	0.2	0	4	7	2.5	3.5	896	0.11	0.18	<0.01	<0.01

Seed Yield and its Components: Five random plants from each experimental plot were taken during harvest period to determine number of pods/ plant, pod length (cm), number of seeds/pod and 100-seed weight (g). Also, seed yield/plot was determined as the total harvested seed of plot (kg) over all season.

Seed Quality: Seed contents of nitrogen, phosphorous, potassium and total protein were measured in fresh seeds at harvest.

Determination of N, P and K Contents in Pea Leaf and Seed: Chemical analysis of leaf and seed N, P and K mineral contents were determined at 90 days after sowing for leaf and at harvest for seed. Total nitrogen was assayed according to Chapman and Pratt [15] and [16] using the micro kjeldahle apparatus. Phosphorous was determined by spectrophotometers as Cottenie *et al.* [16]. Potassium was determined photometrically, using flame photometer according to Jackson [17].

Determination of Total Protein (%): The calculated total nitrogen percentage was multiplied by the factor 6.25 to obtain the percentage of total protein.

Statistical Analysis: Results were expressed as mean. The data were analyzed by using two-way ANOVA followed by LSD test through SPSS 16 (version 4). The treatments means were compared using least significant difference (LSD) at significant levels of 5% as described by Gomez and Gomez [18].

RESULTS AND DISCUSSIONS

Leaf Chemical Properties

Cultivars Effects: The presented data in Table 3 cleared that leaf content of nitrogen phosphorus and potassium significantly differ in the three tested cultivars. Entsar 1 cv expressed the highest leaf contents of nitrogen (31.01 and 31.79 mg/100g fw), phosphorus (4.26 and 4.38 mg/100g fw) and potassium (25.19 and 25.87 mg/100g fw) in both seasons, respectively followed by Entsar 2 in the three previous traits. in the contrast of this Master B cultivar had the lowest leaf contents of nitrogen (28.10 and 28.53 mg/100g fw), phosphorus (3.83 and 3.89 mg/100g fw) and potassium (22.58 and 22.95 mg/100g fw.) in the first and second seasons, respectively.

In this study leaf content of nitrogen, phosphorus and potassium significantly differ in the three tested cultivars and Entsar 1 cv expressed the highest leaf contents of nitrogen, phosphorus and potassium. Also, Khan *et al*. [19] evaluated the performance of 13 peas genotypes and they showed that the highest leaf contents of total chlorophyll, N, P, K, Fe and Mn were observed in FS-21-87 and these values significantly exceeded all others genotypes.

Treatments Effects: All used treatments significantly increased leaf contents of nitrogen, phosphorus and potassium compared with control. The highest leaf contents of nitrogen (32.94 and 33.91 mg/100g fw), phosphorus (4.54 and 4.66 mg/100g fw) and potassium (26.89 and 27.74mg/100g fw) were obtained from pea plants that treated with seaweed extract in both seasons, respectively followed by chitosan and salicylic acid. On the other side pea plants under the control treatment had the lowest leaf contents of nitrogen (22.99 and 22.39 mg/g fw), phosphorus (3.04 and 3.00mg/100g fw) and potassium (17.66 and 17.12mg/100g fw) in the first and second seasons, respectively (Table 3).

Cultivars X Treatments Effects: Results in Table 3 indicated that leaf chemical properties of three tested cultivars differ significantly according to the different used treatments. The pea cultivar Entsar 1 that sprayed with seaweed extract had the highest leaf contents of:

Table 3: Effect of pea cultivars, foliar application treatments and their interactions on leaf chemical properties of pea at 90 days after sowing during 2018/2019 and 2019/2020 growing seasons

		Leaf content of N (mg/100g fw.)		Leaf content of P (mg/100g fw.)		Leaf content of K (mg/100g fw.)	
Factors		1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Cultivar							
Master B		28.10	28.53	3.83	3.89	22.58	22.95
Entsar 1		31.01	31.79	4.26	4.38	25.19	25.87
Entsar 2		28.66	29.11	3.91	3.97	23.05	23.44
LSD 5%		1.37	1.71	0.22	0.16	1.09	1.12
Treatments							
Seaweed extract		32.94	33.91	4.54	4.66	26.89	27.74
Chitosan		31.46	32.40	4.34	4.46	25.68	26.50
Salicylic acid		29.63	30.53	4.09	4.20	24.19	24.98
Control		22.99	22.39	3.04	3.00	17.66	17.12
LSD 5%		1.12	1.28	0.19	0.17	1.42	1.25
Cultivar	Treatments						
Master B	Seaweed extract	31.90	32.84	4.40	4.52	26.04	26.87
	Chitosan	30.79	31.71	4.25	4.36	25.14	25.95
	Salicylic acid	28.06	28.92	3.87	3.98	22.90	23.67
	Control	21.64	20.62	2.82	2.70	16.23	15.32
Entsar 1	Seaweed extract	33.06	34.03	4.56	4.68	26.99	27.83
	Chitosan	31.87	32.82	4.40	4.51	26.02	26.85
	Salicylic acid	32.78	33.74	4.52	4.64	26.76	27.60
	Control	26.34	26.57	3.57	3.68	20.99	21.19
Entsar 2	Seaweed extract	33.87	34.86	4.67	4.79	27.65	28.51
	Chitosan	31.72	32.66	4.37	4.49	25.89	26.71
	Salicylic acid	28.06	28.92	3.87	3.98	22.90	23.67
	Control	21.00	19.99	2.73	2.62	15.75	14.85
LSD 5%		1.85	2.16	0.28	0.28	1.74	2.06

nitrogen (33.87 and 34.86 mg/100g fw), phosphorus (4.67 and 4.79 mg/100g fw) and potassium (27.65 and 28.51 mg/100g fw) in both seasons, respectively followed by Entsar 2 and Master B under seaweed extract. On the other hand, Entsar 2 under the control treatment expressed the lowest leaf contents of: nitrogen (21.00 and 19.99 mg/100g fw), phosphorus (2.73 and 2.62 mg/100g fw) and potassium (15.75 and 14.85 mg/100g fw) in the first and second seasons, respectively.

In the present study all used treatments significantly increased leaf contents of nitrogen, phosphorus and potassium compared with control in all pea cultivars specially Entsar 1. Seaweed extract has been found to contain growth stimulators such as auxins, gibberellins and cytokinin. The extract also comprises growth promoting hormones (IAA and IBA), trace elements (Fe, Cu, Zn, CO2, Mo, Mn and Ni), vitamins and amino acids [20]. Our results are in harmony with those of Pramanick *et al.,* [21] who indicated that foliar applications improved crop quality and leaves contents of nitrogen (N), phosphorous (P) and potassium (K) was also observed with seaweed extract applications in green gram. Also, Sosnowski *et al.,* [22] found that application of the seaweed extract led to an increase in P, K, Zn and Mn in alfalfa aerial biomass, meanwhile the content of Mg, Ca, Cu and Mo did not change significantly.

All leaf content of nitrogen, phosphorus and potassium in this study significantly increased under chitosan treatment. Chitosan can lead to the induction of plant defense enzymes and the synthesis of secondary metabolites, for example polyphenolics, lignin, flavonoids and phytoalexins observed in many plant species [23]. Similar results was showed before by Malerba and Cerana [11] confirmed the beneficial effect of Chitosan (CHI) on plant growth may be attributed to the promoting effects on nutrients uptake and nutritional status especially nitrogen, potassium and phosphorous which are essential for plant growth.

Seed Yield and Yield Components

Cultivars Effects: The obtained data in Table 4 confirmed a wide differ among all tested cultivars in all seed yield and yield components traits. Master B cv. expressed the highest pods number/plant (26.15 and 26.40), pod length (7.43 and 7.68 cm), number of seeds/pod (7.16 and 7.41) and seed yield per plot (14.40 and 14.59 kg) in both

seasons, respectively followed by Entsar 2 in all previous traits. In contrast, Entsar 1 cv showed the lowest pods number/plant (21.90 and 20.53), pod length (6.46 and 6.69 cm), number of seeds/pod (6.34 and 6.39) and seed yield per plot (11.63 and 11.51 kg) in both seasons, respectively. The same cultivar showed the highest 100-seed weight with averages of 30.01 and 30.60 g in the first and second seasons, respectively.

In this study seed yield and yield component traits differ significant in all tested genotypes and Master B cv showed excellent values for all yield and yield components traits. In the previous studies a wide differ among pea genotypes were showed in most yield and yield components parameters and these differences may due to the wide genetic diversity of these genotypes. Our results are in agree with those of f Bozoglu *et al.* [24]; Khan *et al*. [19]; Datta and Das [25] and Greveniotis *et al.* [26].

Treatments Effect: Data in Table 4 showed that all used treatments significantly exceeded the control treatment in all yield and yield components traits i.e. pods number/plant, pod length and number of seeds/pod in both seasons of this study. Pea plants that sprayed with seaweed extract had the highest pods number/plant (29.75 and 31.36), pod length (8.12 and 8.38 cm), number of seeds/pod (7.75 and 8.01) and seed yield/plot (15.82 and 16.23 kg) in both seasons, respectively followed by chitosan and salicylic acid in all yield components traits. On the other side, pea plants under the control treatment had the lowest pods number/plant, pod length, number of seeds/pod and seed yield/plot in the first and second seasons, respectively. The same treatment showed the highest 100-seed weight in the first and second seasons, respectively.

Cultivars X Treatments Effects: Results in Table 4 revealed that the three tested cultivars differ in their response to the different used treatments. The pea cultivar Master B that sprayed with seaweed extract had the highest pods number/plant (31.22 and 32.86), pod length (8.51 and 8.78 cm), number of seeds/pod (8.08 and 8.34) and seed yield per plot (17.00 and 17.42 kg) in both seasons, respectively followed by Entsar 2 that sprayed with seaweed extract and chitosan. On the other hand, Entsar 2 under the control treatment expressed the lowest pods number/plant (16.50 and 14.21), pod length (5.20 and 5.41 cm), number of seeds/pod (5.04 and 4.74) and seed yield per plot (7.60 and 7.28 kg) in the first and second seasons, respectively. The same cultivar under the control treatment showed the highest 100-seed weight (32.56 and 33.32 g) in the first and second seasons, respectively.

Our findings indicated that all used treatments significantly exceeded the control treatment in all yield components traits. The three tested cultivars differ in their response to the different used treatments. The pea cultivar Master B that sprayed with seaweed extract had the highest yield measurements. Seaweed components providing an excellent source of bioactive compounds such as macro and micronutrients, essential fatty acids, amino acids, vitamins, cytokinins, auxins like growth promoting substances affecting cellular metabolism in treated plants leading to enhance growth and productivity [27]. Our results are in the same way with these of Nawar and Ibraheim [28], Mohammed and Hamdoon [29] and El-sharkawy *et al.* [30] who showed that spraying pea plants with algae extract at 10 or 15 % increased significantly yield and its components of pea. Similar results were showed before by Pramanick *et al.* [21] in green gram.

Also our result indicated that chitosan resulted in a large increase in seed yield and its components compared to control. Khan *et al.* [31] and Zakiullah *et al.* [32] indicated that chitosan significantly affected yield attributes of pea. The maximum number of pods (94.33), pod length (13.50 cm) were recorded with 80mg L^{-1}CHI. Similar result were obtained by Farouk *et al.* [33] in radish plant and Fawzy *et al.* [34] in garlic plant.

In this study also, salicylic acid increase all yield and yield component traits of pea plant. In this respect Ghulam [35]; El-Shraiy and Hegazi [36]; Gad El-Hak *et al.* [27]; Chame *et al.* [38] found that the maximum increase 1000 seed weight and pod yield pod diameter, fresh seeds weight/pod, number of fresh seeds/pod, green pod yield, seeds weight/dry pod and seed yield components was observed in the pea plants treated with SA. Also, EL-Afifi *et al.* [39] showed that the foliar treatment with salicylic acid 100ppm twice was most effective increase pea yield traits (pod yield, pod weight, number of seeds per pod and weight of 100 seeds).

Seed Quality Traits

Cultivars Effects: The presented data in Table 5 confirmed that seed content of nitrogen, phosphorus, potassium and total protein significantly differ in the three tested cultivars. Entsar 1 cv expressed the highest

Table 4: Effect of pea cultivars, foliar application treatments and their interactions on plants seed yield and yield components traits of pea during 2018/2019 and 2019/2020 growing seasons

		Number of pods/plant		Pod length (cm)		Number of seeds/pod		100-seed weight (g)		Seed yield/plot (kg)	
Factors		1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Cultivar											
Master B		26.15	26.40	7.43	7.68	7.16	7.41	27.66	28.00	14.40	14.59
Entsar 1		21.90	20.53	6.46	6.69	6.34	6.39	30.01	30.60	11.63	11.51
Entsar 2		24.44	24.72	6.99	7.23	6.74	6.85	28.20	28.56	12.89	13.03
LSD 5%		0.62	0.65	0.32	0.38	0.29	0.27	0.79	0.96	0.39	0.71
Treatments											
Seaweed extract		29.75	31.36	8.12	8.38	7.75	8.01	24.54	24.15	15.82	16.23
Chitosan		26.06	26.32	7.32	7.57	7.07	7.32	28.24	28.90	14.50	14.72
Salicylic acid		21.98	21.32	6.60	6.83	6.46	6.63	30.10	30.81	11.99	11.93
Control		18.87	16.53	5.80	6.02	5.71	5.58	31.62	32.35	9.58	9.31
LSD 5%		1.62	4.71	0.42	0.44	0.35	0.55	2.91	1.65	0.89	1.03
Cultivar	Treatments										
Master B	Seaweed extract	31.22	32.86	8.51	8.78	8.08	8.34	24.05	23.36	17.00	17.42
	Chitosan	28.41	30.00	7.76	8.02	7.45	7.70	26.63	27.26	15.80	16.21
	Salicylic acid	23.23	23.42	6.91	7.15	6.73	6.96	29.42	30.11	12.89	12.99
	Control	21.73	19.34	6.53	6.77	6.40	6.63	30.55	31.26	11.90	11.75
Entsar 1	Seaweed extract	28.01	29.59	7.66	7.91	7.36	7.61	26.31	26.49	15.20	15.59
	Chitosan	21.36	18.97	6.44	6.67	6.32	6.55	31.45	32.18	11.91	11.75
	Salicylic acid	19.86	17.51	6.06	6.28	6.00	6.04	30.52	31.24	10.19	9.81
	Control	18.37	16.04	5.68	5.89	5.68	5.36	31.73	32.47	9.25	8.90
Entsar 2	Seaweed extract	30.01	31.63	8.19	8.45	7.81	8.07	23.25	22.58	15.27	15.67
	Chitosan	28.41	30.00	7.76	8.02	7.45	7.70	26.63	27.26	15.79	16.20
	Salicylic acid	22.86	23.04	6.82	7.06	6.64	6.88	30.36	31.07	12.89	12.99
	Control	16.50	14.21	5.20	5.41	5.04	4.74	32.56	33.32	7.60	7.28
LSD 5%		0.56	1.63	0.15	0.15	0.12	0.19	1.59	1.65	1.09	1.33

seed contents of nitrogen (35.67 and 36.69 mg/100g fw), phosphorus (5.34 and 5.47 mg/100g fw), potassium (31.18 and 32.11 mg/100g fw) and total protein (22.30 and 22.93 %) in both seasons, respectively followed by Entsar 2 in the three previous traits. in the contrast of this Master B cultivar had the lowest seed contents of nitrogen (33.73 and 34.38 mg/100g fw), phosphorus (4.96 and 5.08 mg/100g fw) and total protein (21.08 and 21.49 %) in the first and second seasons, respectively.

In this study seed content of nitrogen, phosphorus, potassium and protein significantly differ in the three tested genotypes. The significant differences in pea genotypes performances may due to their genetic diversity our findings are in the same line with this of Bozoglu *et al.* [24] who found that pea seed contents of N, P, K, total carbohydrate, total sugar and total protein significant differ in all tested genotypes and Vilmoren genotype showed the large seed contents of nitrogen, phosphorus and protein while, Bolero had the highest seed contents of K, carbohydrates and sugars. Similar results were obtained before by Datta and Das [25].

Treatments Effects: All used treatments significantly increased seed contents of nitrogen, phosphorus, potassium and total protein compared with control. The highest seed contents of nitrogen (37.41 and 38.47 mg/100g fw), phosphorus (5.64 and 5.79 mg/100g fw), potassium (33.04 and 34.01 mg/100g fw) and total protein (23.38 and 24.04 %) were obtained from pea plants that treated with seaweed extract in both seasons, respectively followed by chitosan and salicylic acid. On the other side pea plants under the control treatment had the lowest seed contents of nitrogen (30.12 and 30.60 mg/100g fw), phosphorus (4.01 and 4.12 mg/100g fw), potassium (22.97 and 22.58 mg/100g fw) and total protein (18.83 and 19.12 %) in the first and second seasons, respectively (Table 5).

Cultivars X Treatments Effects: Results in Table 5 indicated that seed chemical properties of three tested cultivars differ significantly according to the different used treatments. The pea cultivar Entsar 2 that sprayed with seaweed extract had the highest seed contents of: nitrogen (38.13 and 39.20 mg/100g fw), phosphorus

Table 5: Effect of pea cultivars, foliar application treatments and their interactions on seed quality of pea during 2018/2019 and 2019/2020 growing seasons

		Seed content of N (mg/100g fw.)		Seed content of P (mg/100g fw.)		Seed content of K (mg/100g fw.)		Seed content of protein (%)	
Factors		1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season	1st Season	2nd Season
Cultivar									
Master B		34.33	35.33	4.87	5.00	28.34	28.77	21.46	22.08
Entsar 1		35.67	36.69	5.34	5.47	31.18	32.11	22.30	22.93
Entsar 2		33.73	34.38	4.96	5.08	28.85	29.30	21.08	21.49
LSD 5%		0.97	1.15	0.13	0.17	1.23	1.27	0.65	0.84
Treatments									
Seaweed extract		37.41	38.47	5.64	5.79	33.04	34.01	23.38	24.04
Chitosan		35.57	36.59	5.42	5.56	31.72	32.66	22.23	22.87
Salicylic acid		35.20	36.21	5.15	5.28	30.09	31.00	22.00	22.63
Control		30.12	30.60	4.01	4.12	22.97	22.58	18.83	19.12
LSD 5%		1.63	1.35	0.17	0.19	1.41	1.43	1.11	1.19
Cultivar	Treatments								
Master B	Seaweed extract	36.84	37.88	5.49	5.63	32.11	33.06	23.03	23.68
	Chitosan	34.87	35.87	5.32	5.46	31.13	32.06	21.79	22.42
	Salicylic acid	34.31	35.30	4.91	5.04	28.69	29.57	21.44	22.06
	Control	31.31	32.25	3.76	3.87	21.42	20.40	19.57	20.15
Entsar 1	Seaweed extract	37.27	38.32	5.66	5.80	33.14	34.11	23.29	23.95
	Chitosan	36.01	37.04	5.48	5.62	32.09	33.04	22.51	23.15
	Salicylic acid	36.98	38.02	5.62	5.76	32.90	33.86	23.11	23.76
	Control	32.44	33.39	4.59	4.71	26.61	27.45	20.27	20.87
Entsar 2	Seaweed extract	38.13	39.20	5.78	5.93	33.87	34.85	23.83	24.50
	Chitosan	35.85	36.87	5.46	5.60	31.95	32.89	22.40	23.04
	Salicylic acid	34.31	35.30	4.91	5.04	28.69	29.57	21.44	22.06
	Control	26.62	26.16	3.67	3.78	20.90	19.89	16.64	16.35
LSD 5%		1.78	1.91	0.29	0.33	1.90	1.93	1.11	1.19

(5.78 and 5.93 mg/100g fw), potassium (33.87 and 34.85 mg/100g fw) and total protein (23.83 and 24.50 %)in both seasons, respectively followed by Entsar 1 and Master B under seaweed extract. On the other hand, Master B under the control treatment expressed the lowest seed contents of: nitrogen (26.62 and 26.16 mg/100g fw), phosphorus (3.67 and 3.78 mg/100g fw), potassium (20.90 and 19.89 mg/100g fw) and total protein (16.64 and 16.35 %) in the first and second seasons, respectively.

Our results confirmed that all used treatments significantly increased seed contents of nitrogen, phosphorus, potassium and total protein compared with control and the highest seed contents of nitrogen, phosphorus, potassium and total protein were obtained from pea plants that treated with seaweed extract. Seaweed extract contains macronutrients (N, P and K) which are very essential for growth and development of the plant [40]. Our findings are in agree with these of Nawar and Ibraheim [28] who showed that spraying pea plants with algae extract at 10 or 15 % increased significantly seed content of nitrogen, phosphorous and protein of pea seeds. Also, Elsharkawy *et al.* [30] reported that pea plants that sprayed with seaweed extract at the rate 10 mll^{-1} gave the highest protein content of green seeds.

As for chitosan, Fawzy *et al.* [34] reported that using chitosan as foliar application improved garlic quality. In the present study salicylic acid showed positive effect in increase seed quality. Salicylic acid (SA) is an effective endogenous plant growth regulator. It plays physiological roles in plant including growth, thermogenesis, flower induction, nutrients uptake, ethylene biosynthesis, stomata movement, photosynthesis and enzymes activity [13]. Our results are in agree with those of Trachevsky *et al.* [41] who mentioned that foliar spray with SA on pea produced high protein content and P % of pea seeds. Gad El-Hak *et al.* [37] stated that foliar spray with salicylic acid produced the highest phosphorous percentages of pea seeds. Also, EL-Afifi *et al.* [39] and El-Saadony *et al.* [42] showed spraying plants with salicylic acid at (100ppm) had a positive significant effect in yield expressed as pods per plant, seeds per pod, seeds per plant and 100 -seeds weight and carbohydrates of pea plants.

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