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Enhancing growth and dry seed production in peas (*Pisum sativum* L) by using new kinds of foliar phosphate fertilizers

Ismail, A. Y., A. B. Mohamed and T.G. Anany

Vegetable Crops Seed Production and Technology Department, Horticulture Research Institute, Agriculture Research Centre, Cairo, Egypt
Email: dr_ashraf129@yahoo.com

Abstract: The current investigation was carried out at Qaha Vegetable Research Farm (Qalubia Governorate), Horticulture Research Institute, Agriculture Research Center (A. R. C.), Egypt, during the two consecutive winter seasons of 2017/2018 and 2018/2019 to study the influence of some phosphorus sources; mono potassium phosphate (MKP) (KH_2PO_4) at 3 and 6 g /L, mono ammonium phosphate (MAP) ($NH_4H_2PO_4$) at 5 and 10 g /L, urea phosphate (UP) [$CO (NH3)_2PO_4$] at 5 and 10 g /L and calcium superphosphate (SP) at 10 and 20 g /L on growth, dry seed yield and its components as well as the chemical constituents of pea (*Pisum sativum* L.) cv. Master B. The experiment was arranged in a randomized complete block design with three replications. Seeds were sown on the 2nd week in October during the two winter seasons. The results mentioned that all foliar spraying with phosphorus sources significantly increased vegetative growth characteristics, dry seed yield and its components and chemical constituents in dry seeds as well as seed quality. Whereas, the superior treatment was obtained by foliar spraying with mono ammonium phosphate (MAP) at 5 or 10 g /L which markedly improved most of the studied characters and led to high a significant increased of all studied parameters under these conditions followed by foliar spraying with mono potassium phosphate (MKP) at 3 or 6 g /L, as compared with the other treated or the control calcium superphosphate (SP).

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1. Introduction

Pea (*Pisum sativum* L.) is one of the winter vegetables crops. It is considered the most important and popular legume vegetable crops grown in Egypt. Pea also is a member of the family *Fabaceae*. Field pea is primarily used for human consumption or as a livestock feed, has high levels of amino acids, lysine and tryptophan, which are relatively, low in cereal grains; it contains approximately 21-25 % protein and high carbohydrates, **Blaine and Gregory (2009)**.

Farmers used to apply the phosphate element in the form of super phosphate SSP (15.5% P_2O_5) or triple phosphate TSP (48% P_2O_5) as basic fertilizers which are takes a time to be available for the plants, As much as 90% of the P fertilizer applied in one year is retained in an insoluble form that is not available to the plants. Most soils contain substantial reserves of total P but less than 10% of soil P is normally available for plants use since the remainder is fixed (**Kucey *et al.*, 1989**), and also the precipitation of phosphors in the alkalized soil (pH<8) by reacting with many cations such as Magnesium, Calcium, Iron and Manganese to form precipitation salts i.e. Iron+++ or Calcium and Magnesium phosphate insoluble & unavailable for roots). Moreover, some farmers used Phosphoric Acid as a soil fertigation which is so difficult applying in furrow irrigation system and use it as a foliar on the leaves makes some problems (dangerous in handling, corrosive the metal sprayer, burn the plant's leaves and using SSP or TSP are logging the sprayer's nozzle.

Phosphorus is necessary for plant physiological processes such as photosynthesis, transfer of energy within the plant synthesis and breakdown of carbohydrates. Also, phosphorus plays an important role in sugar production and contributes in the being of nutrients essential for growth. Foliar spraying of phosphorus compounds can affect growth and sucrose percentage in plant roots, but concentration of spray and time of application are critical **(John and Jim, 1980** and **California Fertilizer Foundation, 2009). Fabrício *et al.*, (2012)**

illustrated that foliar application with phosphorus of common bean increased growth characteristics i.e.

root dry weight, shoot dry weight, and root to shoot ratio and chemical compounds concentration of N, K, Mg, B, Cu, Mn and Fe in shoot tissues. **Mauro *et al.*, (2005)** found that foliar application with phosphorus increased sugar beet photosynthesis (chlorophyll a, b and carotenoid). Moreover, **Fageria *et al.*, (2009)** pointed out that foliar application with phosphorus increased phytohormones and amino acids content.

Nowadays, there are new phosphorus fertilizers such as mono potassium phosphate (MKP) (KH_2PO_4), mono ammonium phosphate (MAP) ($NH_4H_2PO_4$) and urea phosphate (UP) [CO $(NH3)_2PO_4$] which are handling safety, High soluble in water, low pH and high absorption and penetration through plants leaves. Since long time that new fertilizers are apply as foliar spraying.

As for Mono Potassium Phosphate (MKP), which is a most effective and easily available fertilizers used in soil and foliar applications. MKP is the formulation with has the lowest salt index and thus it considered the best choice of foliar spraying for many crops (**Ankorion, 1998**). K is one of the macro elements required for plants, the main physiological functions of k are enzymes activation, protein synthesis, carbohydrate metabolism, osmoregulation, stomata movement, energy transfer, phloem transport, cation-anion balance and stress resistance, improves efficiency of plant water and sugar use for maintenance and normal growth functions. Potassium with phosphorus stimulates and maintains rapid root growth of plants (**Restrepo-Diaz *et al.*, 2008**; **Wang *et al.*, 2013** and **Salami and Saadat 2013)**.

Concerning with mono ammonium phosphate (MAP), MAP as a source of P-fertilizer contains N in the ammonium form (NH_4^+) which encourage the uptake of phosphorus (PO_4^{-3}) **(Tisdale and Nelson, 1975)**. According to the theory of anion-cation balance by (**Mengel and Kirkby 1982)** indicated that NH_4^+ acts as cations and PO_4^{-3} acts as anion, therefore, when plants took up NH_4^+ it need to take up PO_4^{-3} in order to keep the anion-cation balance in plant tissues. Added to that, MAP contains NH_4^+ and PO_4^{-3} in one compound which increase elements uptake of plants.

Regarding the influence of urea phosphate (UP), UP is a water soluble fertilizer in crystalline form, with a high level of purity and a high concentration of Urea, Ammonia and Phosphorus. It is recommended that it be used at the beginning of the vegetative development, when the plant requires large quantities of phosphorus to form a well developed root system. Urea phosphate is typically applied as a water-soluble fertilizer to treat phosphorus deficiency in high pH soils. UP special composition produces a strong acidifying effect meant to clean and remove any encrustation from the fertigation system, as well as to free trace elements needed by plants from soil colloidal particles. Its special formula determines a strong acidifying action that demobilizes the trace elements in the soil colloids, and helps to keep the irrigation system clean, preventing any blockage. Urea can be supplied to plants through the plant foliage which led to facilitate optimal nitrogen management, which minimizes nitrogen losses to the environment. Plants absorb foliar applied urea rapidly and decompose the urea in the cytosol (**Witte *et a*l., 2002**). Also, the beneficial effects of foliar urea applications, expressed as an increase in yield and an improvement of crop quality were mentioned in many vegetable crops (**Padem and Yildirim 1996** and **Kolota and Osinska 2001**).

Therefore, the main objective of this work was to investigate the effect of foliar spraying with new kinds of foliar phosphate fertilizers such as mono potassium phosphate (MKP), mono ammonium phosphate (MAP) and urea phosphate (UP) on pea vegetative growth, dry seed yield and its quality.

2. Materials and Methods

The present investigation was conducted at Kaha Research Farm, Qaliobia, Horticulture Research Institute, Agriculture Research Center during the two successive winter seasons of 2017/ 2018 and 2018/ 2019 to study the effect of foliar spraying with calcium superphosphate (SP), mono potassium phosphate (MKP)**,** mono ammonium phosphate (MAP) and urea phosphate (UP) on growth, dry seed yield and its components, seed quality and chemical constituents of pea (*Pisum sativum* L.) cv. Master B. The soil type of this experimental field was clay loam. Soil samples were taken randomly of each year, before planting at the depth of 30 cm to determine the physical and chemical analysis of soil which determined according to **(Black, 1965 and Page *et al.*, 1982)**. The physical and chemical analyses of soil are shown in Table (1).

Table (1): Physical and chemical analysis properties of the experiment soil.

PH	E.C (dS/ m)	$CaCO_3$ %	Soluble cations (M/L)				Soluble anions (M/L)				Macro elements (ppm)			Micro elements (ppm)			
			Ca^{+2}	Mg^{+2}	Na^+	K^+	CO_3^{-2}	HCO^{-3}	Cl^{-2}	SO_4^{-2}	N	P	K	Fe	Cu	Zn	Mn
7.7	2.44	3.64	6.13	3.77	16.0	0.20	-	2.43	10.3	13.6	83	6.3	58.6	3.1	6.7	2.20	2.21

The experiment was contained 8 treatments as following:

T1: Foliar spraying with calcium superphosphate (SP) at 10 g/L of water (control).

T2: Foliar spraying with calcium superphosphate (SP) at 20 g /L of water (control).

T3: Foliar spraying with mono ammonium phosphate (MAP) at 5 g /L of water.

T4: Foliar spraying with mono ammonium phosphate (MAP) at 10 g /L of water.

T5: Foliar spraying with mono potassium phosphate (MKP) at 3 g /L of water.

T6: Foliar spraying with mono potassium phosphate (MKP) at 6 g /L of water.

T7: Foliar spraying with urea phosphate (UP) at 5 g /L of water.

T8: Foliar spraying with urea phosphate (UP) at 10 g /L of water.

The studied treatments were arranged in a randomized complete block design with three replicates. The experimental plot area was 11.2 m^2 and included 4 ridges each of 0.7 m width and 4 m length. Seeds of Master B were sown on the 2^{nd} week in October during the two winter seasons of 2017/2018 and 2018/2019, respectively in hills on one side of ridges at 10 cm apart. Plants were sprayed three times at 25, 35 and 45 days after sowing. All required agricultural managements of pea's production such as irrigation, fertilization and pest control of the experimental area were followed according to the recommendations of Egyptian Ministry of Agriculture.

Data Procedures:-

1- Vegetative growth characteristics:

Five plants were chosen randomly from each plot at flowering stages; 50 days after sowing to determine vegetative growth characteristics such as, plant height (cm), number of leaves and branches as well as fresh weight per plant. Plant foliage (leaves, stems and branches) were dried at 70 C^o till constant weight and then dry weight/plant was evaluated.

2- Dry seed yield and its components:

At harvesting time (120 days after sowing), a random samples of 5 plants from one row of each experimental plot were taken to evaluate dry seed yield and its components; number of seeds /pod, seed index (100-seed weight (g), dry seed yield/plant,. Whereas, total dry seed yield per plot were evaluated as (kg/plot) and then calculated as kg /fed. Shell out% of dry pods was calculated using the following equation:

$$\text{Shell out \%} = \frac{\textbf{Weight of dry seeds}}{\textbf{Weight of dry pods}} \times \mathbf{100}$$

3- Chemical constituents of pea dry seeds:

Total N, P and K as well as crude protein content of dry seeds were evaluated. Protein content was calculated by multiplying N% with 6.25 according to **(A.O.A.C, 1990)**. Total nitrogen was determined according to **Pregl (1945)** using microkildahel method. Phosphorus was estimated colorimetrically due to the method described by **Murphy** and **Riley (1962)** as modified by **John (1970)**. Potassium was determined flame photo-metrically as described by **Brown and Lillelond (1946).**

4- Seed germination tests:

Four random samples (100 seed each) from each treatment were distributed on watered sheets of filtrated papers and incubated at $25C^0$ for calculating the following records; germination percentage (%), germination rate and sprout length (cm). Germination rate was calculated according to the following equation;

$$\text{Germination rate} = \frac{(\mathbf{G1\ xN1}) + (\mathbf{G2\ x\ N2}) + (\mathbf{Gn\ x\ Nn})}{\mathbf{G1 + G2 + Gn}} \times \mathbf{100}$$

Where: G = Number of germinated seeds in certain day, N = Number of this certain day. Sprout length was taken after germination beginning for 2 day intervals until finishing the incubation period (14 days).

5- Statistical Analysis:

The obtained data were subjected to statistical analysis as technique of randomized block design with three replicates in both growing seasons. All data were subjected to the analysis of variance according to **(Gomez and Gomez, 1984),** and L.S.D values were used for comparison.

3. Results and Discussion

1- Vegetative growth characteristics:

Concerning with the effect of foliar spraying with phosphorus fertilizer sources on vegetative growth characteristics of pea plants, Data in Table (2) indicated that all tested treatments significantly enhanced the all growth characteristics expressed as plant height, number of leaves and branches/plant, fresh and dry weight/plant compared to the control; foliar spraying with calcium superphosphate at 10 or 20g/L. It can said that, foliar spraying with mono ammonium phosphate (MAP) at the rate of 5 or 10 g /L was the best substance to gave the highest vegetative growth characteristics followed by foliar spraying with mono potassium phosphate (MKP) at the rate of 6g/L.

These results may be attributed to the beneficial effects of (MAP) which contains N in the ammonium form (NH_4^+) which encourage the uptake of phosphorus (PO_4^{-3}) **(Tisdale and Nelson, 1975)**. Also, (MAP) contains (NH_4^{+}) and (PO_4^{-3}) in one compound which increase elements uptake of plants. Therefore, when plants took up NH_4^{+} it need to take up PO_4^{-3} in order to keep the anion-cation balance in plant tissues. Added to that, MAP is given in granulated form, but super phosphate is given in a powder form which is easily adsorption or fixed on soil complex as compared with the granulated forms. These results are in agreement with those obtained by **Ismail (2001)** who works on common bean and pointed out that adding MAP or DAP significantly increased all vegetative growth characteristics i.e. plant height, number of leaves and branches/plant, fresh and dry weight/plant. **Mostafa *et al*., (2018)** mentioned that foliar application with MAP at the two levels (10 and 20 mM) significantly increased the all tested growth characteristics (i.e., shoot length, number of leaves per plant, area of leaves per plant, and shoot fresh and dry weights) of common bean plants compared to the controls. Also, **Abd El-All (1999)** on cauliflower who indicated that all used of P-sources encouraged plant growth and the highest growth was found in plants supplied with MAP or DAP as compared with SP or GTSP. Moreover, **Zennat and Sharma (1990) and Fontes (1992)** all working on tomato and found that MAP encouraged plant growth. Furthermore, **Ismail and Fayed (2020)** on broad bean reported that foliar spraying with mono potassium phosphate (MKP) at the rate of 6 g /L significantly increased vegetative growth characteristics; plant height, number of leaves and branches/plant, fresh and dry weight/plant.

Table (2): Vegetative growth characters in peas as affected by foliar spraying with phosphorus fertilization sources during the two seasons of 2017/ 2018 and 2018/ 2019.

Treatments	1st season					2nd season				
	Plant height (cm)	No. of leaves/ plant	No. of branches/ plant	Plant fresh wt. (g)	Plant dry wt. (g)	Plant height (cm)	No. of leaves/ plant	No. of branches/ plant	Plant fresh wt. (g)	Plant dry wt. (g)
T1	44.49	15.00	1.33	20.08	7.55	51.00	15.66	1.47	17.64	8.12
T2	48.12	16.33	1.72	20.46	8.00	55.12	16.42	1.66	21.27	9.33
T3	66.00	19.11	2.55	27.82	12.95	67.13	18.50	2.66	27.74	12.11
T4	69.22	20.33	2.66	30.65	14.97	69.18	20.17	3.00	32.71	15.00
T5	52.66	18.44	2.44	23.53	11.46	65.50	18.17	2.12	23.95	12.11
T6	55.88	18.75	2.00	23.92	10.40	67.50	17.16	2.00	24.91	11.80
T7	62.44	19.67	1.77	27.95	12.17	64.66	17.50	1.83	25.87	12.71
T8	62.88	17.33	2.11	23.38	10.20	68.83	17.17	2.21	26.85	12.13
L.S.D at 0.05	**4.10**	**2.92**	**1.16**	**6.87**	**3.09**	**3.88**	**2.65**	**1.38**	**6.73**	**1.81**

T1: Foliar spraying with calcium superphosphate (SP) at 10 g/L of water (control). **T2**: Foliar spraying with calcium superphosphate (SP) at 20 g /L of water (control). **T3**: Foliar spraying with mono ammonium phosphate (MAP) at 5 g /L of water. **T4**: Foliar spraying with mono ammonium phosphate (MAP) at 10 g /L of water. **T5**: Foliar spraying with mono potassium phosphate (MKP) at 3 g /L of water. **T6**: Foliar spraying with mono potassium phosphate (MKP) at 6 g /L of water. **T7**: Foliar spraying with urea phosphate (UP) at 5 g /L of water. **T8**: Foliar spraying with urea phosphate (UP) at 10 g /L of water.

2- Dry seed yield and its components:

The differences between phosphorus fertilizer sources; calcium superphosphate (SP), mono potassium phosphate (MKP), mono ammonium phosphate (MAP) and urea phosphate (UP) on pea dry seed yield and its components i.e. number of dry seeds/pod, dry seed weight/pod, shell out%, seed index (100-seed weight) and dry seed yield/plant as well as per fed are presented in Table (3). It is clear from such data that pea plants sprayed with MAP at the rate of 5 or 10 g /L significantly increased and gave the highest dry seed yield components followed by foliar spraying with mono potassium phosphate (MKP) at the rate of 6g/L. as compared with the other sources or foliar or the control; (calcium superphosphate at 10 or 20g/L.). This trend was true in both seasons except shell out% which didn't affect by foliar spraying with all phosphorus fertilizer sources in both seasons. In this concern, (MAP) was considered the best treatment followed by foliar spraying with mono potassium phosphate (MKP). The superiority of (MAP) may be attributed to that (MAP) contains N in the ammonium form (NH_4^{+}) which encourage the uptake of phosphorus (PO_4^{-3}).

On the other hand, Mono Potassium Phosphate (MKP) which is a most effective and easily available fertilizers used in soil and foliar applications. MKP is the formulation with has the lowest salt index and thus it considered the best choice of foliar spraying for many crops (**Ankorion, 1998**) Such results are in harmony with those obtained by **Ismail (2001)** on common bean who illustrated that adding MAP or DAP significantly increased all dry seed yield and its components i.e. number of dry seeds/pod, dry seed weight/pod, shell out%, seed index (100-seed weight) and dry seed yield/plant as well as per fed. **Mostafa *et al*., (2018)** found that foliar application with MAP at the two levels (10 and 20 mM) significantly increased the all tested dry seed yields characteristics [i.e., average pod weight, number of pods per plant, pods weight per plot, dry seed weight per plot and 100-seed weight] on common bean plants compared to the controls. Also, **Abd El-All (1999)** on cauliflower who reported that total dry seed yield / fed was increased by adding P-fertilizer source as DAP compared with SP or GTSP. Moreover, **Ismail and Fayed (2020)** on broad bean mentioned that foliar spraying with mono potassium phosphate (MKP) at the rate of 6 g /L significantly increased dry seed yield and its components; number of dry seeds/pod, dry seed weight/pod, shell out%, seed index (100-seed weight) and dry seed yield/plant as well as per fed.

Table (3): Dry seed yield and its components in peas as affected by foliar spraying with phosphorus fertilization sources during the two seasons2017/ 2018 and 2018/ 2019.

Treatments	1st season						2nd season					
	No. of seeds/pod	Dry seed weight (g/pod)	Seed index 100 seeds wt. (g)	Shell out %	Dry seed yield (g/plant	Dry seed yield (kg/fed)	No. of seeds/pod	Dry seed weight (g/pod)	Seed index 100 seeds wt. (g)	Shell out %	Dry seed yield (g/plant	Dry seed yield (kg/fed)
T1	6.25	1.19	15.63	77.60	11.59	762.3	6.81	1.46	17.63	78.60	15.59	784.2
T2	6.66	1.48	16.11	78.10	12.41	783.1	7.12	1.72	18.00	80.10	17.28	800.0
T3	8.14	2.00	17.34	81.81	18.88	971.4	9.25	2.69	20.57	84.94	20.23	1000
T4	8.33	2.42	19.57	84.82	20.23	1099	9.60	2.77	20.87	85.32	22.14	1113.1
T5	8.25	1.78	17.88	83.94	16.44	867.5	8.80	2.26	18.55	82.60	18.48	910.1
T6	8.16	1.97	17.92	79.80	17.00	900.2	8.66	2.45	18.80	84.68	19.26	933.2
T7	7.55	1.89	17.23	82.02	17.69	839.5	8.14	2.43	19.88	84.06	19.04	884.3
T8	8.14	1.98	18.87	82.51	18.1	873.5	8.55	2.54	20.00	84.51	19.10	900.0
L.S.D at 0.05	**1.16**	**1.08**	**2.24**	**N.S**	**3.59**	**55.2**	**0.93**	**0.41**	**2.14**	**N.S**	**2.57**	**61.1**

T1: Foliar spraying with calcium superphosphate (SP) at 10 g/L of water (control). **T2**: Foliar spraying with calcium superphosphate (SP) at 20 g /L of water (control). **T3**: Foliar spraying with mono ammonium phosphate (MAP) at 5 g /L of water. **T4**: Foliar spraying with mono ammonium phosphate (MAP) at 10 g /L of water. **T5**: Foliar spraying with mono potassium phosphate (MKP) at 3 g /L of water. **T6**: Foliar spraying with mono potassium phosphate (MKP) at 6 g /L of water. **T7**: Foliar spraying with urea phosphate (UP) at 5 g /L of water. **T8**: Foliar spraying with urea phosphate (UP) at 10 g /L of water.

3- Chemical constituents of pea dry seeds:

With regard to the effect of P-fertilizer source. i.e. calcium superphosphate (SP), mono potassium phosphate (MKP), mono ammonium phosphate (MAP) and urea phosphate (UP) on pea dry seed content from N, P, K and crude protein% and its uptake, data in Table (4) obviously revealed that plants supplied with MAP at the rate of 5 or 10 g /L contained higher N, P and K% and its uptake of pea seeds as well as crude protein% followed by foliar spraying with mono potassium phosphate (MKP) at the rate of 6g/L. than of those supplied with other sources or the control; (calcium superphosphate at 10 or 20g/L). These results were true in both experimental seasons. Such increment in N, P and K content by spraying plants with MAP may be due to the encouraging effect of the associated ammonium ions on P-uptake and consequently on N, P and K content. These results are in agreement with those reported by **Ismail (2001)** on common bean who found that adding MAP or DAP as spraying form significantly increased common bean dry seed from N, P, K and crude protein% and its uptake. **Mostafa *et al*., (2018)** illustrated that foliar application with MAP at the two levels (10 and 20 m) significantly increased the all tested from N, P and K%. Also, **Abd El-All (1999))** on cauliflower who showed that adding phosphorus as MAP or DAP gave higher N, P and K content than that of other source; SP or GTSP. Moreover, **Ismail and Fayed (2020)** on broad bean concluded that foliar spraying with mono potassium phosphate (MKP) at the rate of 6 g /L gave the highest values of N, P, K, Zn, B and crude protein content in dry seeds.

Seed germination tests:

As for the influence of some P-fertilizer sources application on seed germination tests. i.e. germination ratio, germination rate (days) and seedling length (cm) of pea dry seeds, it can be notice from the data Table (5) that all studied treatments led to significant enhanced in seed germination ratio, germination rate and sprout length. It is also mentioned that, foliar spraying with MAP at the rate of 5 or 10 g /L gave the highest seed germination tests followed by foliar spraying with mono potassium phosphate (MKP) at the rate of 6g/L. as compared with those supplied with other sources or the control; (calcium superphosphate at 10 or 20g/L). These results were true in both experimental seasons. These results are in harmony with those reported by **Ismail and Fayed (2020)** on broad bean reported that foliar spraying with mono potassium phosphate (MKP) at the rate of 6 g /L gave the highest values of germination ratio, germination rate and sprout length.

Table (4): N, P, K, Crude protein and Carbohydrates (%) of dry pea seeds as affected by foliar spraying with phosphorus fertilization sources during the two seasons2017/ 2018 and 2018/ 2019.

Treatments	1st Season					2nd Season				
	N (%)	P (%)	K (%)	Crude protein (%)	Carbo-hydrates (%)	N (%)	P (%)	K (%)	Crude protein (%)s	Carbo-hydrates (%)
T1	2.37	0.46	1.14	14.81	12.44	2.04	0.41	1.03	12.75	12.16
T2	2.70	0.75	1.98	16.87	13.10	1.95	0.67	1.72	12.18	13.05
T3	3.47	0.99	2.67	21.68	16.81	3.24	0.90	2.46	20.25	17.49
T4	3.80	1.04	2.70	23.75	16.32	3.37	0.97	2.83	21.06	16.00
T5	3.23	0.79	2.45	20.18	14.85	3.11	0.64	2.34	19.43	15.90
T6	3.27	0.84	2.62	20.43	15.63	3.21	0.72	2.81	19.44	15.33
T7	2.84	0.77	2.45	17.75	14.18	2.87	0.76	2.23	17.94	14.00
T8	3.39	0.82	2.59	21.17	14.50	2.91	0.81	2.35	18.18	14.45
L.S.D at 0.05	**0.37**	**0.15**	**0.28**	**1.85**	**1.35**	**0.26**	**0.33**	**0.11**	**2.07**	**1.78**

T1: Foliar spraying with calcium superphosphate (SP) at 10 g/L of water (control). **T2**: Foliar spraying with calcium superphosphate (SP) at 20 g /L of water (control). **T3**: Foliar spraying with mono ammonium phosphate (MAP) at 5 g /L of water. **T4**: Foliar spraying with mono ammonium phosphate (MAP) at 10 g /L of water. **T5**: Foliar spraying with mono potassium phosphate (MKP) at 3 g /L of water. **T6**: Foliar spraying with mono potassium phosphate (MKP) at 6 g /L of water. **T7**: Foliar spraying with urea phosphate (UP) at 5 g /L of water. **T8**: Foliar spraying with urea phosphate (UP) at 10 g /L of water.

Table (5): Germination ratio (%), germination rate (days) and seedling length (cm) of dry pea seeds as affected by foliar spraying with phosphorus fertilization sources during the two seasons2017/ 2018 and 2018/ 2019.

Treatments	1st season			2nd season		
	Germination ratio%	Germination rate (days)	Sprout length (cm)	Germination ratio%	Germination rate (days)	Sprout length (cm)
T1	77.1	6.62	22.4	76.9	6.60	22.9
T2	86.7	4.41	33.6	87	4.34	34.6
T3	84.1	4.86	31.2	84.1	4.75	31.8
T4	84.4	4.55	31.8	84.6	4.50	32.5
T5	83.3	5.54	28	83.7	5.48	28.8
T6	83.3	5.03	28.5	83.7	4.94	29.1
T7	82.2	5.53	26.5	82.6	5.47	27.3
T8	81.9	5.63	27	82.3	5.57	27.7
L.S.D at 0.05	**0.96**	**0.30**	**0.65**	**0.82**	**0.23**	**0.47**

T1: Foliar spraying with calcium superphosphate (SP) at 10 g/L of water (control). **T2**: Foliar spraying with calcium superphosphate (SP) at 20 g /L of water (control). **T3**: Foliar spraying with mono ammonium phosphate (MAP) at 5 g /L of water. **T4**: Foliar spraying with mono ammonium phosphate (MAP) at 10 g /L of water. **T5**: Foliar spraying with mono potassium phosphate (MKP) at 3 g /L of water. **T6**: Foliar spraying with mono potassium phosphate (MKP) at 6 g /L of water. **T7**: Foliar spraying with urea phosphate (UP) at 5 g /L of water. **T8**: Foliar spraying with urea phosphate (UP) at 10 g /L of water.

Conclusion

As a general recommendation from this study it can be said that, spraying pea plants with mono ammonium phosphate (MAP) at the rate of 5 or 10 g /L followed by foliar spraying with mono potassium phosphate (MKP) at the rate of 6g/L were the superior treatments to obtain the maximum values of vegetative growth, dry seed yield and its components as well as chemical constituents in pea dry seeds.

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