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Effect of Planting Dates, Climatic Factor Changes on Pea Aphid, *Acyrthosiphon pisum* Population as Well As Aerial Application of Potassium Silicate with Special Interest to Pea Green Pods Under Open Field Conditions

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ABSTRACT

These experiments were conducted under field conditions on Pea, *Pisum sativum* L. plants along two seasons (2019 - 2020) and (2020 - 2021) to investigate the effect of climatic factors, potassium silicate as a fertilizer and sowing dates on aphid numbers. Pea seeds were sown at El-Qanater Research Station Farm in Qalubiya Governorate, Egypt**.** The obtained results revealed that Pea aphid, *Acyrthosiphon pisum* Harris is the major insect pest of *Pisum sativum* L., the highest numbers were recorded in mid-September followed by 1 October and 1 November. Aphid populations peaked at different times during the two years of the study. The highest populations occurred during the mid-September planting date in the two seasons recording 155, and 220 individuals per plant, respectively. Pea aphid population dynamics were affected by weather conditions. The number of aphids significantly and positively correlated with maximum temperature, but were significantly and negatively correlated with relative humidity. The effect of minimum temperatures on pea aphids was non-significant where the correlation was negative. Pea aphid infestation resulted in losses of total seed weight for pea plants. Using Potassium silicate as a foliar spray decreased *A. pisum* population, as well as enhanced the crop resistance to biotic and abiotic stresses. Spraying potassium silicate on pea plants reduced the target pest population by 45 to 64 % along the two seasons of study. Potassium silicate could be listed in the integrated pest management program of pea plants to keep the aphid population under control. The planting date of October as well as potassium silicate spraying gave the highest yield of pea pods in both growing seasons.

INTRODUCTION

Pea, *Pisum sativum* L. is one of the most important leguminous vegetable crops grown along winter season in Egypt, it plays a significant role in both local consumption and export. Pods have high levels of protein and carbs found in pea pods, pea is one of the most significant suppliers of these nutrients in human food, El-Desuki, 2010. The total cultivated area in Egypt is 34486 feddan, concentrated in the old land of Delta Egypt as 56908 feddan with total production of 149374-ton MALR, EAS (2019). Climatic conditions play an important role in pea growth characters, as well as pest population, distribution and control.

Ali *et al*. (2016) studied the effect of different planting dates (November 10, 20, 30 and December 10, 20, 30) on vegetative characters, yield and seed quality of garden pea and found that November 20 or 30 planting date was the optimum time to obtain maximum yield with quality seed production of garden pea in Bangladesh. Potassium as a major element plays an essential role in enzyme activation, protein synthesis, photosynthesis, osmoregulation, stomata movement, energy transfer, phloem transport, cation-anion balance, and stress resistance, Wang *et al*. (2013). Spraying different rates of potassium silicate on pea plants significantly increased yield, biomass, seed weight and element accumulation as compared to unsprayed plants Merwad (2018). Silicon application can significantly enhance insect pest and disease resistance in plants, with consequent yield increases Laing *et al*. (2006). For commercial pulse growers, *Acyrthosiphon pisum* is a serious concern because it can harm crops directly by sucking sap from their leaves, stems, and pods, as well as indirectly by serving as a vector for over 30 plant viruses, such as the bean leaf roll virus, cucumber mosaic virus, beet yellows virus, pea enation mosaic virus, and beet yellows virus Paudel *et al*. (2018), Rashed *et al*. (2018).

Numerous host plants are infested by *Acyrthosiphon pisum*, which results in stunted plants, nutritional shortages, and chlorotic damage with curling and wilting of the leaves. Additionally, by injecting saliva that is phytotoxic to plants into cells after puncturing them with its needle-shaped stylus, these aphids do indirect and significant damage. Wang *et al*. (2017). Additionally, the aphid honeydew causes sooty mold to grow on the host plant's leaves, which hinders photosynthesis Lu and Kuo (2008).

The biotic stresses (insect and diseases) reduce green pod and seed yields, of pea, where pea aphid, *Acyrthosiphon pisum* (Hemiptera: Aphididae) was observed for the first time in Europe and spread worldwide under temperate climate recording a serious pest due to it reduces both weight and caloric content of young pea plants by as much as 64 and 100%, respectively, depending on the number of feeding aphids Harrison and Barlow (1973). Wale (2002) reported that field pea yield loss was 49% in 1997 whereas yield loss increased up to 59% in 1999 by increasing aphid population year by year. Limited work has been done in Ethiopia on the influence of planting times on *A. pisum*, and found that delayed planting (late June) rather than early planting (mid-May) reported to manage pea aphid in Ethiopia. Similarly, many other crops that grow in pea production often face several abiotic limiting factors, such as high temperatures during pod filling, and cold temperatures in winter at high elevations.

The pea aphid feeds on the sap of tender leaves, stems, and pods, causing direct damage to the plants. Young leaves and growth points are where it mostly colonizes, and more significantly, it spreads plant viruses. The aphid infestation causes plants to develop more slowly, turn yellow, and become stunted. The yield is also reduced since fewer and smaller seeds are produced. Environmental differences in general, with temperature being the most important one, are important factors for insect survival, behavior, abundance, and distribution. The population of pea aphids was positively and significantly impacted by temperature, according to many studies by Harrison and Barlow (2012).

From the previous preview, the purpose of this work was to investigate the relationship between climatic factors and the pea aphid, *A. pisum* population, which attacks pea plants in open field conditions, as well as the effect of potassium silicate on this pest with special interest to green pods yield.

MATERIALS AND METHODS

Field experiments were carried out on pea plants *Pisum sativum* L. Sweet 1 along two successive growing seasons of 2019/2020 and 2020/2021 at El-Qanater Research Station

Farm in Qalubia Governorate, affiliated to Horticulture Research Institute, Agriculture Research Center, Egypt to study the Effect of climatic factors on sowing dates, variety and fertilizer on the population dynamics of pea aphid and yield pea plants.

Experimental Design:

Three replicates were used in split plot experimental design. The main plot was 3 planting times (mid-September, 1st October and 1st November). The subplot was the foliar application of potassium silicate compared with tap water as a control. The total number of experimental plots were 18 (3 planting dates x 2 spraying agents x 3 replicates) each plot area was about 10 m^2 (2 m width x 5 m length). Soil was prepared well before planting by tillage. Each plot (10 m^2) was divided four rows (50 cm width x 5 m length). The distance between plants was 0.15 cm and planted at the two ridges, the density was 272 plant / plot. Thirty m^3 compost, 200 kg calcium super phosphate, 200 kg ammonium sulphate, and 100 kg potassium sulphate were used as fertilizers during each growing season per feddan (MALR Bulletin no. 1088, 2007) Fertilizers were applied three times during the season, the first before planting, the second before 1st irrigation and the third at flowering period. Thirty days from seed planting, weekly leaf samples were taken in paper bags and transferred to the laboratory. The aphid stages of *Acyrthosiphon pisum* were counted with the help of magnifying lens 10x. In each season, plots were monitored starting from seedling stage to determine the start of infestation by pea aphids. Ten leaves were picked randomly from three levels of plant parts (upper, middle and lower). The reduction percentages in aphid population over control were computed according to the following formula:

$$\text{Reduction \%} = \frac{\text{n in treated}}{\text{n in control}} \times 100$$

Effect of Agricultural Practices on Aphid Infestation to Pea Plants as well as on Green Pods:

Seeds of pea Variety sweet 1 were planted in mid-September, 1st October, and 1st November. Spraying potassium silicate as fertilizer on pea plants was conducted one month after planting with the aid of a manual sprayer.

Effect of Potassium Silicate and Planting Dates on Pea Plant Characters:

A field experiment was carried out to examine the effects of three planting dates and foliar fertilizer potassium silicate on vegetative pea characters. Three replicates of split plots were used in the experimental design. The main plot was planting dates i.e., mid-September, 1st October and 1st November. Whereas, the subplot was the foliar application of potassium silicate (K_2O_3Si) at 250 ppm concentration and control (tap water). Thirty days from seed planting, fertilizer was applied and replicated biweekly until harvesting.

In order to ascertain the physical characteristics, soil samples from the experimental area were collected and dried in the room temperature. Another sample was dried at 105 ^oC in the oven, and its chemical composition was established. Physical and chemical properties of the experimental soil.

Physical analysis						
Sand (%)	Silt (%)	Clay (%)	Soil texture	FC (%)	AW (%)	WP (%)
17.20	29.20	53.80	Clay loam	43.0	20.3	20.9
Chemical analysis						
Available nutrients (mg / Kg)				EC dS / m	PH (1:25)	$CaCo_3$
683.0	338.0	448.8		1.9	3.65	3.65

Climatic Data:

The Central Laboratory for Agricultural Climate (CLAC) meteorological station supplied us with the climatic data of the two growing season: maximum and minimum air temperatures (^oC) as well as relative humidity (%).

Vegetative Growth:

After 45 days from planting, three replicates from each plot were harvested, yielding five plants per replicate. Plant length (cm), number of leaves, number of branches, stem diameter (mm), plant fresh weight (g), and plant dry weight (g) were identified as growth characters. After drying at 70 °C in the oven, the average dry weight of the plant sample was determined.

Yield and Its Components:

Pea plants were collected at the end of the season and the no. of pods per plant, pods fresh weight (g / plant), no. of seeds per pod, average 100 seed weight (g), total fresh pods yield (kg / fed.) and total seeds yield (kg / fed.) for each treatment during the two seasons was determined.

Statistical Analysis:

The obtained data were subjected to analysis of variance (ANOVA) using Costat Software, Version 6.4 (2008). The mean differences were compared by Least Significant Difference (L.S.D. 5%). All obtained data were subjected to statistical analysis for variance using split plot as mentioned by Gomez and Gomez (1983) for calculating the least significant differences (LSD) among treatments. CoHort Software program, Copyright © 1998- 2008 CoHort Software 798 Lighthouse Ave. PMB 320 Monterey CA, 93940 USA was used for statistical analysis.

RESULTS AND DISCUSSION

1- Effect of Planting Dates, K_2O_3Si Application on Aphid Populations Attacking Pea Plants:

The results in Tables (1,2 and 3) recorded the average numbers of aphid populations attacking pea plants in the field along two successive seasons as affected by planting dates, and fertilization by K_2O_3Si as spray treatment.

The obtained results in Table (1) recorded that the highest numbers of aphid stages were at the seedling stage (September month) 301 aphid stages per plant followed by November 287, and October 254 compared with 195, 162, and 143 individuals per plant at plants treated with K_2O_3Si as spray application after one month of seed planting at the first season, whereas at the second season, the highest numbers of aphid stages were recorded as 220,160,183 individuals per plant treated with K_2O_3Si as spray application one month after seed planting.

The obtained results in Table (2) recorded that the highest numbers of aphid stages were present at the seedling stage (1 October month) as 257 stages per plant followed by mid-October 218 and mid-November 143, compared with 135, 110, and 75 aphid stages per plant at plants treated with K^2O^3Si as spray application after one month of seed planting at the first season, whereas at the second season, the highest numbers of aphid stages were recorded as 150,130,95 individuals per plant at treatments of K_2O_3Si sprayed one month after seed planting.

Table 1. Effect of spraying pea plants by Potassium silicate (250 ppm) on pea aphid, *A. pisum* population, planted at mid-September along two successive seasons.

Treatments	Mean No. of aphids per plant							
	Sampling dates							
	2019/2020				2020/2021			
	15 Sept.	1 Oct.	1 Nov.	Total	15 Sept.	1Oct.	1Nov.	Total
K_2O_3Si	195± 53 f	143±55.5 i	162±62.5 h	500	220±62.5 e	160±50 h	183±55.5 e	563
Control	301±53 b	254±55.5 d	287±55.5 c	842	345±62.5 a	260±50 d	294±55.5 bc	899
Mean	248	198.5	224.5	671	282.5	210	238.5	731
Reduction %	64.78	56.29	56.44	59.38	63.67	61.53	62.24	62.62
LSD 5%	7.55							

Duncan's multiple-range test have no significant differences across means with the same letter at p<0.05.

Table 2. Effect of spraying pea plants, cultivated on 1st October by Potassium silicate (250 ppm) on pea aphid, *A. pisum* population along two successive seasons.

Treatments	Mean No. of aphids per plant							
	Sampling dates							
	2019/2020				2020/2021			
	1 Oct.	15 Oct.	15 Nov.	Total	1 Oct.	15 Oct.	15 Nov.	Total
K_2O_3Si	135± 61 ef	110±54 g	75±34 i	320	150±56.5 d	130±47.5 f	95±45 h	375
Control	257±61 a	218±54 b	143±34 de	618	263±56.5 a	225±47.5 b	185±45 c	673
Mean	196	164	109	469	206.5	177.5	140	524
Reduction %	52.52	50.45	52.44		57.03	57.77	51.35	
LSD 5%	9.82							

Duncan's multiple-range test have no significant differences across means with the same letter at $p<0.05$.

The obtained results in Table (3) recorded that the highest numbers of aphid stages were present at the seedling stage (1 November month) as 165 stages per plant followed by mid-November 145 and mid-December 110, decreased to 95, 75, and 50 individuals per plant at plants treated with K_2O_3Si as spray application after one month of seed planting at the first season, whereas at the second season, the highest numbers of aphid stages were recorded at treatments of K_2O_3Si sprayed one month after seed planting as 105,100,83 individuals per plant, compared with 185, 167, and 148 individuals per plant.

Table 3. Effect of spraying pea plants, cultivated 1st of November by Potassium silicate (250 ppm) on pea aphid, *A. pisum* population along two successive seasons.

Treatments	Mean No. of aphids per plant							
	Sampling dates							
	2019/2020				2020/2021			
	1 Nov.	15 Nov.	15 Dec.	Total	1 Nov.	15 Nov.	15 Dec.	Total
K_2O_3Si	95± 53 d	75±36 e	50±30 f	220	105±32.5 d	100±33.5 d	83±32.5 e	288
Control	165±53 b	145±36 c	110±30 d	420	185±32.5 a	167±33.5 b	148±32.5 c	500
Mean	130	111	80	321	145	133.5	115.5	394
Reduction %	57.57	51.72	45.45		56.57	59.88	56.8	
LSD 5%	11.67							

Duncan's multiple-range test have no significant differences across means with the same letter at $p<0.05$.

As for reduction percentages of pea aphid, *A. pisum* as affected by K_2O_3Si, along the three planting dates, results in Tables (1,2 and 3) indicated that it ranged between 45 % and 59 %. It could be concluded that the third planting date (1 November) recorded the least number of target pest due to the great changes in temperature degrees and humidity, therefore, it could be recommended November month as a suitable month for planting pea plants to avoid the preferable conditions for pea aphid, *Acyrthosiphon pisum.*

According to Saucke *et al*. (2009) early sowing may be dangerous since the crop may be exposed to early aphid flight activity, giving the pest more opportunity to develop larger colonies on the crop. Silicon is known to improve crop tolerance to biotic and abiotic stressors through physical and allele-chemical mechanisms. In addition, Shah *et al*. (2019) over a experiment of two years, independent studies were conducted to assess the technical grade of foliar potassium silicate (technical grade) knockdown and residual toxicity against whiteflies and aphids infesting potato crops. The population of whiteflies decreased by 53.27% and 61.42% after 3 and 7 days of treatment, respectively, while the population of aphids decreased by 57.81% and 48.98%, respectively, with foliar application of potassium silicate @ 0.3%. However, no significant knockdown effect was linked with potassium silicate. Sprays of potassium silicate considerably raised the leaf silicon concentration.

Potassium silicate is compatible with organic farming, it might be incorporated into the pest management section of organic potato farming, where a weekly application of potassium silicate @ 0.3% could keep the population of whiteflies and aphids and the associated viral incidence in check. These results are in harmony with those of Clement *et al.* (2010) who suggested that in the Pacific Northwest, greater winter temperatures may increase pest outbreaks and aphid-induced yield losses on spring-sown grain legumes.

Generally, *A. pisum* can have decreased fertility, longevity, and generation time at high temperatures. Wale *et al*. (2000) reported that correlation and regression analysis of pooled data of two years revealed that the aphid population during its ascending phase showed positive correlation with the maximum, minimum, and mean temperatures while a negative association was achieved with the relative humidity. Furthermore, regression analysis of pooled data of two years revealed that the aphid population during its ascending phase showed significant correlation with the maximum, minimum, and mean temperatures while a negative association was achieved with the relative humidity. At 25°C, aphid population growth and survival were negatively impacted, while at 30°C, aphid fertility and reproduction were decreased (Wale and others, 2000). The highest development threshold for this aphid in Taiwan may be over 35°C, according to Lu and Kuo's (2008) who reported that *A. pisum* development increased constantly with rising temperatures. The highest temperature threshold for *A. pisum* development in Canada, according to Siddiqui *et al*. (1973) and Campbell and Mackauer (1975) was 26 to 30 °C. *A. pisum* outbreaks in the US Pacific Northwest are influenced by various ecological parameters in addition to temperature, according to Clement *et al.* (2010). Natural enemies, agricultural techniques, and plant quality of biotic and abiotic elements may have an impact on *A. pisum* life-history. In the Pacific Northwest, springtime rain and windstorms have the power to lower *A. pisum* numbers by washing or knocking individuals from host plants. However, rainfall in the fall and spring is crucial for maintaining moisture in the host plants, which affects the growth of the *A. pisum* population. Winds can significantly affect the timing and course of winged *A. pisum* migrations in the spring and subsequent outbreaks in eastern Washington, Clement (2006). According to McVean *et al*. (1999) cold winters in the United Kingdom can increase *A. pisum* mortality and delay the development of the aphid population and also delaying the planting of pea crops, which increases *A. pisum* populations throughout the growing season. However, Saucke *et al*. (2009) found no evidence of a continuous relationship between early sowing and *A. pisum* infestations on faba bean varieties within years.

2-Correlation Between Aphid Population Attacking Pea Plants and Temperature& Humidity Along the Whole Period of Experiments:

The calculated results in Table (4) indicated that there was positive correlation between the grand mean values of pea aphid and mean of maximum temperatures along all sampling dates of the first and second seasons recording r= 0.948 & 0.8926, respectively.

As for minimum temperature degrees, the correlation between grand mean values of pea aphid and mean of minimum temperatures were positive at all sampling dates of the two seasons recording r = 0.7386 & 0.9252, respectively.

While, as for relative humidity, the correlation was negative along all sampling dates of the first and second seasons.

Table 4. Correlation between climatic changes (°C, humidity) and aphid stages per plant.

Sampling dates	Grand Mean aphid / plant	Max °C	r	p(r=o)	Min °C	r	p(r=o)	R.H %	r	P (r=o)
First season 2019/2020										
Sept.	301 a	36 a	0.9480	0.00***	23.5 a	0.7386	0.0061***	58 a	0.5513	0.0631 ns
Oct.	243 b	33 a	SE. r of r 0.0100		19 b	SE. r of r 0.2131		55 b	SE. r of r 0.2638	
Nov.	191 c	27 b			14.5 c			59 a		
Dec.	110 d	20 c			12 c			52 b		
Grand mean		32			19			57.3		
Second season2020/2021										
Sept.	345 a	37 a	0.8926	0.001***	25 a	0.9252	0.00***	59.5a	0.2707	0.3946 ns
Oct.	249 b	35a	0.1425		23.5 a	0.1199		60 a	0.3044	
Nov.	215 c	29 b			16 b			64 a		
Dec.	148 c	20 c			12 c			57 b		
Grand mean		33.6			21.5			61.1		

ns= not significant *= significant **= high significant ***= very high significant r= correlation coefficient p= probability means in each column followed by the same letter did not differ at p<0.05 duo to Duncan multiple-range test.

3- Meteorological Data:

3-1- Maximum and Minimum Air Temperature °C:

Data illustrated in Figures 1 & 2 show how planting dates affected the range of maximum and minimum air temperatures. In general, during both growth seasons, the average maximum and minimum air temperatures declined for all planting dates. Additionally, the months of September and October had the greatest average maximum and lowest air temperatures.

The planting date of November gave the lowest average of maximum and minimum air temperatures during the two seasons of study. It`s noted that the average minimum air temperature was increased in the November planting date in the middle of season (50 DAP days after planting) and reached the average minimum air temperature of October planting date. On the contrary, the average minimum air temperature decreased during September planting date and reached the average at October planting date in the same growing season.

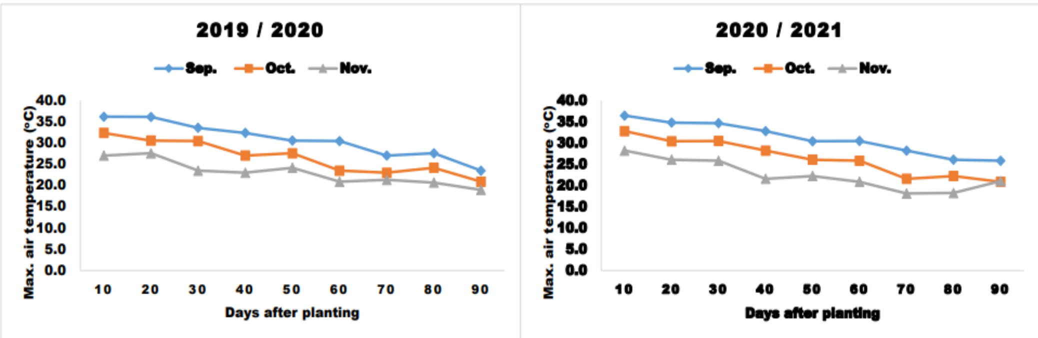

Fig. 1. Maximum air temperature during different planting dates of pea in 2019/2020 and 2020/2021 growing seasons.

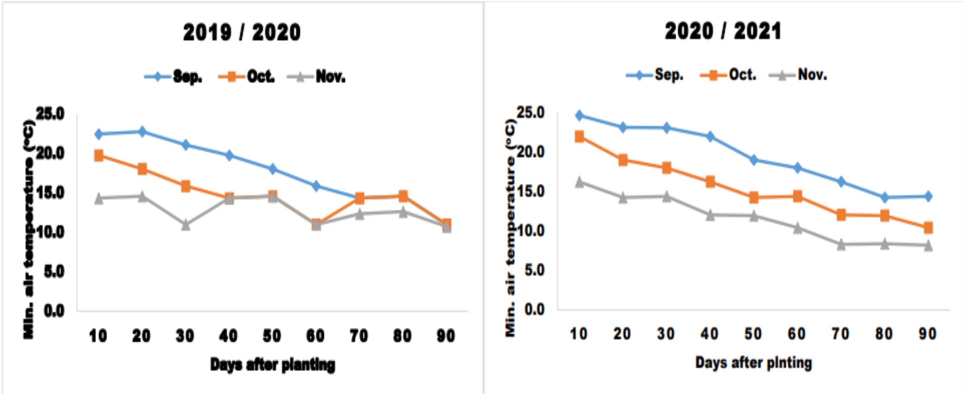

Fig. 2. Minimum air temperature during different planting dates of pea in 2019/2020 and 2020/2021 growing seasons.

3-2-Relative Humidity %:

Data illustrated in Figure 3 show the effect of planting dates on average relative humidity % during the two growing seasons. The average relative humidity % was low at the beginning of the growing season, then increased up to the end of season in all planting dates. In general, the average relative humidity was highest around planting time in November, then increased again in the middle of each growth season (50–60 DAP). In other ways, the lowest average of relative humidity was recorded during September month as planting date, but increased at the end of the experiment. The increasing rate of relative humidity % was almost stable during October planting date, while it decreased a little after 30 days after planting in the two experimental seasons.

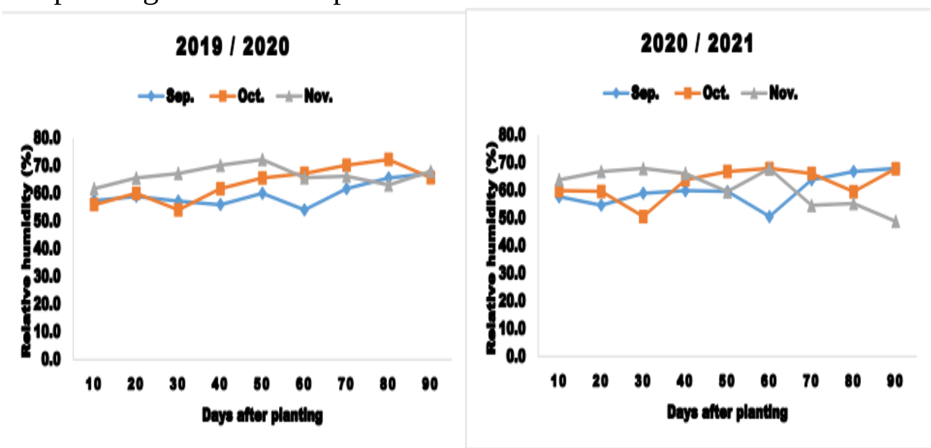

Fig. 3. Relative humidity (%) during different planting dates of pea in 2019/2020 and 2020/2021 growing seasons.

3-3- Vegetative Growth:

Data presented in Tables (5 & 6) conclude the effect of different planting times, foliar application of potassium silicate (K_2O_3Si) and their interaction on growth parameters of pea plant i.e., plant length, no. of branches, no. of leaves, stem diameter, fresh and dry weight. The planting date had a significant impact on all measured growth parameters, October planting date gave the highest values followed by November whereas, the planting date of September resulted in the lowest values for growth parameters during the two growing seasons. Regarding the effect of foliar application of potassium silicate, the plants sprayed with potassium silicate gave the highest growth values in different planting dates compared with irrigation water (control) during the two years of study. The interaction between the planting date and potassium silicate application was significant during the two seasons. The highest growth values were obtained by planting at October combined with foliar application of potassium silicate. On the contrary, planting at September and spraying with irrigation water gave the lowest growth values during the two seasons of study.

3-4-Yield and Its Components:

The presented data in Table (7) cleared that there were a significant effect between planting dates and the foliar application of potassium silicate (K_2O_3Si) as well as their interaction on yield characters of pea plant i.e., no. of pods, pods fresh weight, no. of seeds in pod, 100 seeds weights and total pod and seeds yield (kg / feddan). The obtained results indicated that October month as planting date was the best one and gave the highest yield values in the two growing seasons followed by November month, whereas the planting date at September was the worst one compared with other periods along the two seasons. Foliar application of potassium silicate enhanced the pea yield and its components compared with control (irrigation water). All yield components as well as total yield even pods or seeds were increased by planting at October and the foliar application of potassium silicate. On the contrary, September as a planting date combined with spraying irrigation water gave the lowest yield of pea plants along the two growing seasons.

Table 5. Effect of planting date, potassium silicate foliar application and their interaction on plant length, no. of branches, no. of leaves and stem diameter of pea plant during 2019/2020 and 2020/2021 growing seasons.

Planting dates (A)	Foliar application (B)					
	Plant length (cm)					
	2019 / 2020			2020 / 2021		
	K_2O_3Si	Control	Mean A	K_2O_3Si	Control	Mean A
September	65.8	54.5	60.1	66.5	55	60.7
October	94.3	89.3	91.8	95.2	90.2	92.7
November	85.3	77.8	81.5	86.1	78.6	82.3
Mean B	81.8	73.8		82.6	74.6	
LSD A	6.4			6.4		
LSD B	15.6			15.8		
LSD AB	9.1			9.2		
	No. of leaves/plant					
September	75	63.4	69.2	76.5	64.7	70. 6
October	15.3	13.8	14 .5	15 .4	13 .5	14.4
November	13.7	12.2	12.4	14 .4	12 .6	13
Mean B	12.6	10.8		12 .1	10 .9	
LSD A	1.1			1.1		
LSD B	8.1			8.3		
LSD AB	4.7			4.8		
	Number of branches/plants					
September	3.2	2.4	2.8	3.2	2.4	2.8
October	4.2	3.1	3.6	4.2	3.1	3.7
November	3.8	2.8	3.3	3.8	2.8	3.3
Mean B	3.7	2.8		3.7	2.8	
LSD A	0.7			0.7		
LSD B	0.3			0.3		
LSD AB	0.2			0.2		
	Stem diameter (mm)					
September	4.3	2.6	3.4	4.3	2.6	3.5
October	6.9	5.6	6.2	6.9	5.6	6.32
November	6.4	5	5.7	6.5	5	5.8
Mean B	5.8	4.4		5.9	4.4	
LSD A	0.8			0.8		
LSD B	1.7			1.7		
LSD AB	1			1		

Table 6. Effect of planting date, potassium silicate foliar application and their interaction on plant fresh weight, plant dry weight, no. of pods/plant and pods fresh weight of pea plant during 2019/2020 and 2020/2021 growing seasons.

Planting dates (A)	Foliar application (B)					
	Plant fresh weight (g)					
	2019 / 2020			2020 / 2021		
	K_2O_3Si	Control	Mean A	K_2O_3Si	Control	Mean A
September	18.8	13 .7	15 .2	18 .4	13 .5	16 .4
October	29.9	25 .5	27 .2	30 .7	25 .5	27 .6
November	26.6	22 .6	24 .1	27	23 .2	25 .1
Mean B	24.4	20.6		25.4	21 .1	
LSD A	2.6			2.7		
LSD B	10.7			10.9		
LSD AB	6.2			6.3		
	Plant dry weight (g)					
September	43.8	33.1	38.4	44.7	33.7	39.2
October	70.4	60.4	65.4	71.8	61.6	66.7
November	64.7	54.5	59.6	66	55.6	60.8
Mean B	59.6	49.3		60.8	50.3	
LSD A	1.44			1.4		
LSD B	6.3			6.4		
LSD AB	3.7			3.8		
	No. of pods/plant					
September	10	7.8	8.9	10.1	7.96	9.03
October	17.9	16.3	17.1	18.1	16.5	17.3
November	15.3	12.9	14.1	15.5	13	14.3
Mean B	14.4	12.3		14.6	12.5	
LSD A	0.6			0.6		
LSD B	2			2		
LSD AB	1.1			1.1		
	Pods F.W (g / plant)					
September	33.3	21.6	27.5	34	22	28
October	64.2	50.6	57.4	65.5	51.6	58.5
November	49.2	39.7	44.5	46.1	40.5	43.3
Mean B	48.9	37.3		48.5	38	
LSD A	7.8			1.6		
LSD B	26			6.5		
LSD AB	15.2			3.8		

Pea (*Pisum sativum* L.) is a promised vegetable crop in Egypt due to high nutrition value of protein as well as it's a favorite food for consumers. On the other hand, climate became the highest enemy to crop production worldwide. Suitable climate conditions increase plant characters and yield as well as decrease pest population during the growing season. Pea crop is a winter season crop and rising air temperature effect negatively on vegetative growth, and productivity and increases the pest population and infection. This study aimed to determine how alternative planting dates and foliar potassium silicate applications affected the growth and pest management of pea crops. Cultivation of pea was delayed in Egypt duo to the highest increase in the average of air temperature year after year so, the September planting date became not suitable for pea cultivation under Egyptian conditions. October and November were the suitable months for pea cultivation, respectively. Delaying cultivation after November may hurt the pea plants because of the low temperature in this period. So that the cultivation of pea during October and November gave the highest values of growth parameters and yield. These results agree with those of Olivier & Annandale, (1998); Xiao *et al*., (2009); Mukherjee *et al*., (2013); Ali *et al*., (2016); Haq & Ahmed (2021). Generally, using fertilizer like potassium silicate as foliar spraying on plants plays an important role in plant growth, production as well as plant protection from different pests and diseases. Potassium silicate is a duple agent used as fertilizer because the importance of potassium (K) and its role in plant metabolism which improves flowering, fruit set and yield. The foliar application of potassium is producing healthier plants. Besides. Silicon is an important element for plant protection because of silicon element increases the structure of plant cells and gives it hardness to able to resist the infected pest and diseases then produce high yield with good quality. These findings corroborate those of Laing *et al*., 2006; Fathy *et al*., 2009; Wang *et al*., 2013; Merwad, 2018; Shafeek *et al*., 2018.

Table 7. Effect of planting date, potassium silicate foliar application and their interaction on no. of seeds/pod, 100 seed weight, total pods yield and total seeds yield of pea plant during 2019/2020 and 2020/2021 growing seasons.

Planting dates (A)	Foliar application (B)					
	No. of seeds/pod					
	2019 / 2020			2020 / 2021		
	K_2O_3Si	Control	Mean A	K_2O_3Si	Control	Mean A
September	6.3	4.2	5.2	6.4	4.2	5.3
October	12.5	9.9	11.2	12.6	10	11.3
November	9.1	8.2	8.6	9.2	8.3	8.7
Mean B	9.3	7.4		9.4	7.5	
LSD A	**0.3**			**0.3**		
LSD B	**3.2**			**3.2**		
LSD AB	**1.9**			**1.9**		
	100 seed weight (g)					
September	29.6	19.5	24.6	29.9	19.7	24.8
October	51	43	47	51.5	43.4	47.5
November	44.1	38.7	41.4	44.5	38.1	41.3
Mean B	41.6	33.7		42	33.7	
LSD A	1.96			**3.6**		
LSD B	7.75			**8.92**		
LSD AB	4.54			**5.22**		
	Total pods yield (kg/fed.)					
September	21.66	14.3	17.5	22.10	14.5	18.3
October	41.3	32.89	27.8	42.8	33.8	28.7
November	29.2	25.8	37.2	29.9	26.5	38.8
Mean B	30.7	24.4		31.6	24.9	
LSD A	10 .4			11.5		
LSD B	42			43.4		
LSD AB	24 .9			25.8		
	Total seeds yield (kg/fed.)					
September	14.10	12.95	13.5	14.1	13.9	13.66
October	20 .3	18.3	16.7	20.7	19.2	16.3
November	18 .3	16.3	19.3	18.9	16	1982
Mean B	17 .9	16.2		17.5	16.4	
LSD A	11 .5			27		
LSD B	39 .5			28.4		
LSD AB	23 .6			16 .8		

Conclusion

The aim of this study was to examine the changes in pea aphid population fluctuation (*Acyrthosiphon pisum*) changed depending on when it was planted and how that affected yield losses. Additionally, a correlation study will be carried out to determine the degree to which weather elements have an impact on the dynamics of the aphid population over the course of two seasons. Additionally, during the 2019/2020 and 2020/2021 growing seasons, it is important to investigate the effects of planting date, potassium silicate foliar spray, and their interactions on pea aphid stages. In addition, the impact of planting date and potassium silicate spraying were significant. It could be recommended that planting pea in October with potassium silicate spraying gave the results.

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ARABIC SUMMARY

تأثير مواعيد الزراعة وتغير عوامل المناخ على تعداد حشرة من البسلة بجانب استخدام سيليكات البوتاسيوم مع الاشارة الى محصول البسلة من القرون الخضراء تحت ظروف الحقل المفتوح

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أجريت هذه التجارب على نبات البسلة .*Pisum sativum* L صنف Sweet 1 لموسمين متتاليين بمحطة بحوث البساتين بالقناطر الخيرية التابعة لمركز البحوث الزراعية بمحافظة القليوبية، مصر بغرض دراسة تأثير مواعيد الزراعة وتغير عوامل المناخ على تعداد حشرة من البسلة بجانب استخدام سيليكات البوتاسيوم مع الاشارة الى محصول البسلة من القرون الخضراء تحت ظروف الحقل المفتوح.

أظهرت النتائج المتحصل عليها أن حشرة من البسلة *Acyrthosiphon pisum* Harris تعتبر آفة رئيسية تصيب نبات البسلة والتي تتبع رتبة نصفية الأجنحة. أظهرت نتائج فحص أعداد حشرة من البسلة تحت تأثير العوامل المناخية والتسميد ومواعيد الزراعة ان أعلى نسبة تواجد للحشرة تحت الدراسة هو عند الزراعة في منتصف شهر سبتمبر متبوعا بالأول من أكتوبر والأول من نوفمبر على التوالي لعامي الدراسة 2019-2020/2020-2021 حيث بلغ تعداد الحشرة ذروته عند الزراعة في ميعاد منتصف سبتمبر وسجلت النتائج خلال موسمي الدراسة 345 ، 301 فردا على التوالي.

أظهرت درجات الحرارة تأثيرا إيجابيا على تعداد الحشرة أما بالنسبة للرطوبة فكان التأثير سلبيا، كما كان التأثير سلبيا على محصول القرون الخضراء ووزن البذور لنبات البسلة.

بالرغم من عدم وجود تأثير معنوي كبير على أعداد حشرة من البسلة مرتبط باستخدام سيليكات البوتاسيوم رشا على نباتات البسلة الا انه تسبب فى انخفاض تعداد حشرة المن بنسبة تراوحت بين 45 – 64 ٪ مما يتيح إمكانية استخدام سيليكات البوتاسيوم كأحد العناصر الهامة في برامج إدارة مكافحة الآفات لنباتات البسلة والتي يمكن أن تحافظ على أعداد حشرات المن تحت السيطرة. خلصت الدراسة الى ان زراعة نباتات البسلة في شهر أكتوبر مع رش النباتات بمحلول سليكات البوتاسيوم اعطى أعلي محصول من قرون البسلة في كل من موسمي الزراعة.