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Effect of planting date and plant stage on the infestation rate of common bean plants *Phaseolus vulgaris* with certain pests in Egypt

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Abstract
Three planting dates, (Aug., 15th, Aug., 29th and Sep., 12th) and three plant stages (seedling, flowering and (flowering +fruiting) were evaluated during two successive years 2018 and 2019 to determine their effects on population densities of principal pests (*Bemisia tabaci* Genn., *Thrips tabaci* Lind., Aphids [*Aphis craccivora* Koch., *A. gossypii* and *Myzus persicae* Sulz.], leaf miner (*Melanagromyza phaseoli* Tryon), *Polyphagustarsonomus latus* and *Tetranychus urticae* Koch.), infesting the common bean (*Phaseolus vulgaris* L.) in Egypt. Results of both studied years revealed that planting of common bean seeds in the 1st and 2nd planting dates resulted in slight infestation with (*B. tabaci* Genn., *T. tabaci* Lind., Aphids [*A. craccivora* Koch., *A. gossypii* and *M. persicae* Sulz.], leaf miner [*Melanagromyza phaseoli* Tryon] and *P. latus*), and an increased infestation rate during 3rd one, and inversely, higher infestation rate with *T. urticae* Koch. in the 1st and 2nd planting dates and less rate during the 3rd one. The combined effect (E.V.%) of planting dates and plant stages on infestation rates with the investigated pests was calculated separately and altogether using multiple regression analysis and showed that the combined effect of different planting dates on pests' population densities were (30% and 29%),(16% and 35%) and (48% and 48%) for the three planting dates, while the combined effect of plant stages were (39% and 34%), (24% and 42%) and (61% and 19%), in the two years, respectively. The combined effects altogether were 31.50 and 38.69 % for tested planting dates, and 47.95% and 42.67% for tested plant stages in the two years, respectively indicating that plant stages may play a more important role in affecting the studied pests' population densities.

Keywords: common bean, (*Phaseolus vulgaris* L.), pests, planting date and plant stage

Introduction

Common bean (*Phaseolus vulgaris* L.) is an annual leguminous plant that belongs to the family Leguminoaceae and represents one of the most important crops in many countries worldwide including Egypt. It is widely cultivated throughout the tropics for its edible green leaves, green pods, mature or immature seeds for human food, and as a fodder for animal feed (De Luque and Creamer 2014) [7]. Common bean has a high protein content that is considered complete and could reaches up to 20-25 % when compared to other vegetables. It also represents an excellent source for energy, folic acid, dietary fiber, and complex carbohydrates beside, other important minerals including iron, copper, phosphorus, magnesium, zinc, calcium, potassium and vitamins accordingly, this crop is nominated as an excellent choice for providing people of lower socio-economic status in African and Latin American countries with an inexpensive sources of nutrients (Mojica and de Mejía, 2015) [18] and (Mwanauta *et al.*, 2015) [20].

As other leguminous plant species, common bean is susceptible to many biotic stresses that affect their productivity particularly in the tropics (Graham and Vance, 2003) [12]. And insect pest infestation ranks higher in causing significant yield reduction in legumes.

The common bean, at its different stages started from germination to harvesting stage, is liable to infestation by many phytophagous pests causing a significant damage and affect considerably both quantity and quality of the yield. Several insect pests, belonging to eight families and five orders, were recorded and considered as the most important pests including; the whitefly, (*Bemisia tabaci* (Genn); aphids, (mainly *Aphis craccivora* (Koch) and *Aphis gossypii* (Glover); leaf miners, (*Liriomyza trifolii* (Burgess) and *Ophiomyia phasoli* (Tryon); onion thrips (*Thrips tabaci* Lind.); leaf hopper (*Empoasca* spp.) and red spider mite *Tetranychus urticae* (Koch), and were found to cause the most serious damage to common bean plant. (Abd El-Gawwad, 2008; Saleh, 2011; Gamila *et al.*, 2016 and Ekram *et al.*, 2019) [1, 22, 11, 8]. The choice and adjusting of planting dates is not only influence the crop performance, due to changed biotic and abiotic factors, but also can sometimes help in avoiding infestation with certain insects consequently, reducing the application of chemical pesticides**,** and maximization of the crop yield (Dapoah *et al.*, 2000) [5].

Therefore, the present study aimed to evaluate the effect of planting dates and plant stages on reducing common bean infestation rate with the abovementioned recorded pests, and to identify the most susceptible plant stage to these pests, in order to design and manage common bean production programs that could help in reducing and /or suppression of different pests population densities and at the same time, maximize common bean yield production in Egypt.

Materials and Methods

Two experiments were carried out to study the effect of planting dates and plant stages on the population density of certain pests infesting common bean plants, *Phaselous vulgaris* L. (Neprasca cultivar) during the two successive years 2018 and 2019, at Werdan village, Giza Governorate.

The first experiment aimed to study the effect of planting dates on the population density of certain pests infesting common bean plants. An experimental area of about 1050 m^2 was divided into 9 replicates (plots) of *116*.5 m^2 each and three planting dates with 15 days intervals, on August 15th, on August 29th and on September 12th, in both years, were investigated. Each planting date was represented by 3 plots and all plots were distributed according to a randomized complete block design.

Randomized samples of 30 leaflet (10 leaflet x 3 replicates) were weekly taken early in the morning starting from the 3rd week after planting and for 10 weeks (the 13th week from planting). Samples transferred to the laboratory were investigated and presence of individuals of the following pests and their stages: *Bemisia tabaci* Genn. (eggs+ nymphs), *Thrips tabaci* Lind. (nymphs+ adults), Aphids [*Aphis craccivora* Koch, *A. gossypii* and *Myzus persica*] (nymphs+ adults), leaf miner (*Melanagromyza phaseoli* Tryon), *Polyphagustarsonomus latus* (eggs+ nymphs+ adults) and *Tetranychus urticae* Koch. (nymphs+ adults) were identified and counted using a stereomicroscope. The second experiment was conducted on an area of 262.5 m^2 divided into 3 plots of 87.5m^2 each, to determine the effect of different plant stages on population density of the abovementioned pests. Three plant stages were considered, the seedling stage starting from the 1st day of planting to the 42nd day, followed by the flowering stage started from 43rd to 84th day, then the fruiting stage, that include (flowering+ fruiting), and started from the 50th day after planting day to the end of growing season.

Relationship between mean number of the previously mentioned pests and different planting dates and plant stages (the two studied factors), were identified and simple correlation and partial regression were adopted to show changes in pests' population densities in relation to these two factors. All agricultural practices were realized according to the recommended common bean cultivation procedures and no pesticides were applied throughout the growing seasons in both years. Finally, obtained data were analyzed according to SAS program (2008) which was run under WIN computer system and mean separation was conducted by using F value and L.S.D in this program.

Result and Discussion

Effect of planting dates on infestation rates of common bean plants with certain pests.

A: *B. tabaci* Genn.

In 1st year (2018), recorded densities of white flies were varied according to the planting dates as shown in Table (1). The common bean plants sown in the (earliest) 1st planting date (Aug., 15th) were infested significantly by the lowest mean number of whitefly, *Bemisia tabaci* (4.20 individuals/ leaflet). While plants sown on the 2nd and 3rd planting dates (Aug., 29th and Sep., 12th), harbored the highest numbers of *B. tabaci* (8.20 and 7.08 individuals/leaflet, respectively). In the 2nd year (2019), obtained results showed to have the same trend as in the 1st year but with higher infestation rate of same insect pest where, the white fly mean numbers were (11.50, 18.75 and 13.05 individuals/ leaflet) for the three tested planting dates, respectively (Table, 2).

B: *T. tabaci* Lind.

As shown in Tables (1 & 2), the mean number of *T. tabaci* per plant, differ according to the sowing date in both years. The 1st planting date resulted in significantly lightest number of *T. tabaci* (0.75 and 0.05 individuals/ leaflet) while the 3rd one resulted in the highest infestation rate with thrips (3.7 and 1.25 individuals/ leaflet), followed significantly by the 2nd planting date where (0.92 and o.45 individuals/ leaflet) were recorded.

C: Aphids [*A. craccivora* Koch., *A. gossypii* and *M. persicae*]

As shown in Tables (1and 2) for both years, heaviest infestations with aphids (*Aphis craccivora*, *A. gossypii* and *M. persicae*) were recorded on plants of the 3rd planting date (74.50 and 75.10 individuals/ leaflet, respectively), while the lightest infestation (36.05 and 22.35 individuals/ leaflet, respectively) occurred during the 1st planting date, and the moderate infestation was during the 2nd one (54.85 and 34.90 individuals, respectively).

Table 1: Influence of the three different planting dates on the infestation rate with the certain pests infesting common bean plants during the 1st year 2018, at Giza Governorate.

Planting dates 2018	*B. tabaci*	*T. tabaci*	*Aphids (A. craccivora+ A. gossypii+ M. persicae)*	leaf miner (*M. phaseoli* Tryon)	*T. urticae*	*P. latus*
August, 15th	4.20[b]	0.75[b]	36.05[c]	1.50[c]	18.6[a]	4.32[c]
August, 29th	8.20[a]	0.92[b]	54.85[b]	4.05[b]	17.00[a]	7.01[b]
September, 12th	7.08[a]	3.70[a]	74.50[a]	6.70[a]	8.55[b]	9.15[a]
Mean	6.49	1.79	55.13	4.08	14.72	6.83
F. values	32.36	29.85	32.51	31.98	20.42	20.10
Prob.,	0.0006	0.0008	0.0006	0.0006	0.0021	0.0022
L.S.D	1.25	1.04	11.66	1.59	4.13	1.86

D: leaf miner (*M. phaseoli* Tryon).

As found for above recorded pests, the leaf miner (*M. phaseoli* Tryon) infestations also were significantly affected by different planting dates in both years. Data showed in Tables (1and 2), indicate that the highest infestation rate (6.70 and 8.05 individuals/ leaflet, respectively) was recorded on plants of the 3rd planting date, and the lightest infestation rate was recorded on those of the 1st planting date (1.50 and 2.10 individuals/ leaflet, respectively).while the 2nd planting date showed moderate degree of infestation (4.05 and 7.90 individuals/ leaflet, respectively).

Table 2: Influence of the three different planting dates on the infestation rate with the certain pests infesting common bean plants during the 2nd year 2019, at Giza Governorate.

Planting dates 2019	*B. tabaci*	*T. tabaci*	*Aphids (A. craccivora+ A. gossypii+ M. persicae)*	leaf miner (*M. phaseoli* Tryon)	*T. urticae*	*P. latus*
August, 15th	11.50 b	0.05 b	22.35 c	2.10 b	14.75 b	6.05 b
August, 29th	18.75 a	0.45 b	34.90 b	7.90 a	19.60 a	11.30 a
September, 12th	13.05 b	1.25 a	75.10 a	8.05 a	10.05 c	12.32 a
Mean	14.43	0.58	44.12	6.02	14.80	9.89
F. values	46.11	4.77	753.28	39.50	121.08	53.26
Prob.,	0.0002	0.0576	0.0001	0.0004	0.0001	0.0002
L.S.D	1.94	0.76	3.47	1.86	1.50	1.59

E: *T. urticae* Koch.

Contrary to infestation rates of abovementioned insect pests, the 1st planting date (Aug., 15th) caused the heaviest infestation with *T. urticae* (18.60 and 14.75 individuals/ leaflet, respectively). While the lightest infestation with *T. urticae* was recorded on plants of the 3rd planting date, showing 8.55 and 10.05 individuals/ leaflet respectively, in the two studied years.

F: *P. latus* (Banks).

Recorded data for *P. latus* were found similar to those previously found for *B. tabaci, T. tabaci,* aphids and leaf miner where, infestation with *P. Latus* was increasing with delaying of the planting date. The heaviest infestation in the two years, (9.15 and 12.32 individuals/ leaflet, respectively) was associated with the 3rd planting date and the lightest infestation (4.32 and 6.05, respectively) was recorded on the earliest planting date.

Our results going in line with those previously obtained by Hanafy (2004) [14], Emam *et al.* (2006) [9], and Abd El-Karim (2010) [3], who worked on cucumber, sweet pea and bean plants respectively, and reported that the infestation rate with *B. tabaci*is increased with delaying of planting date. Also Sariah and Makundi (2007) [24] stated that the early date for planting of common bean resulted in the lowest number of the bean stem maggot *Ophiomyia spencerelia* (Greathead) and *O. phaseoli* (Tyron), and vice versa, late sowing date caused significantly higher infestation rates.

In Egypt, Mohamed (2012) [17] reported that the population density of *B. tabaci* on cucumber plants was affected significantly by planting date and the earliest planting date resulted in plants that harbored the insect lowest populations, while, the latest planting dates resulted in the lightest numbers of *B. tabaci*. On Canola plants, Saeed and Razaq (2014) [21] stated that the population density of both aphids and white fly were increased on the latest planting date (mid November), while the lowest infestation were recorded at the two earliest planting dates (mid. October and early November). Similarly, Faragalla and Hassan (2018) [10] noticed that the population densities of aphids and thrips infesting fennel plants were higher in the latest planting dates, while the lightest one occurred during the earliest planting date.

Finally, Yadav and Acharya (2018) [27] studied the effect of five planting dates of pepper plants and found that the early transplanting date had the significantly lowest infestations with thrips (*Scirtothrips dorsalis* Hood), whitefly (*Bemisia tabaci* Genn.), aphid (*Aphis gossypii* Glover), jassid (*Amrasca biguttula biguttula* Ishida) and mite (*Polyphagotarsonemus latus* Banks), while the last transplanting date had a maximum infestation with these pests.

Effect of Different Plant Stages on their Infestation Rates with Certain common Bean Pests.

Data in Tables (3& 4) show the mean number of the six studied pests *B. tabaci., T. tabaci.*, aphids, leaf miner, *T. urticae* and *P. latus* on common bean plants throughout the three plant stages, the seedling stage starting from the 1st day of planting to the 42nd day, followed by the flowering stage started from 43rd to 84th day, then the fruiting stage, that include (flowering+ fruiting), and started from the 50th day after planting day to the end of growing season.

The obtained results revealed that the population densities of all studied pests were affected significantly by different plant stages during the two successive years (2018 and 2019).

A: *B. tabaci* Genn.

As shown in Tables (3& 4), results indicate a significant differences between mean number of *B. tabaci* in the two studied years. The significantly heaviest infestation with *B.* tabaci was recorded on plants during their (flowering + fruiting) stage, (being 44.17 and 309.83 nymphs/ leaflet in the years, respectively).

Contrary, the significantly lowest infestation occurred during the plant seedling stage (4.67 and 14.33 nymphs/ leaflet, respectively), and the moderate infestation rate recorded during the intermediate plant stage (flowering stage).

Statistical analysis of obtained data using F. and L.S.D values, indicated differences in infestation rates of the three plant stages with *B. tabaci*. Based on the L.S.D values, the three tested plant stages could be divided into three distinct groups as follow: (a) high infested group, (b) moderate infested group, and (c) the lowest infested group which are associated with the (flowering+ fruiting) stage, flowering stage and seedling stage, respectively.

B: *T. tabaci* Lind.

In the 1st year, the observed injury caused by *T. tabaci* was little and the significantly highest infestation was recorded in the last plant stage (flowering+ fruiting), followed significantly by the infestation of 2nd plant stage (flowering), and the significantly lowest infestation was recorded during 1st plant stage (seedling), while in the 2nd year, infestation did not lead to an economic significance (as no individuals were recorded in the 2nd one).

The Duncan multiple range test classified the infestation rate of *T. tabaci* during the three plant stages into; the 1st group (a) flowering+ fruiting stage that is heavily infested group, (5.17 individuals/ leaflet), followed by 2nd group (b) flowering stage (4.00 individuals/ leaflet) and 3rd group (c) plants in the seedling stage (0.33 individuals/ leaflet),

Tables (3 &4).

C: Aphids [*A. craccivora* Koch., *A. gossypii* and *M. persicae*].

In general, aphid infestation severities was higher during the 1st year, when compared to those estimated for the 2nd one in addition, infestation rates with aphids varied according to different plant stages where, a relatively small number of aphid were recorded during the seedling and flowering stages while plants at their 3rd stage (flowering+ fruiting), highly suffered from aphid infestation compared to other plant stages, (mean number 316.00 and 125.17 individuals/ leaflet in the two years, respectively). Therefore, and based on recorded aphid numbers in both years, the 3rd plant stage was considered as the most preferable stage for aphid infestation, followed significantly by the (flowering stage) which infested by moderate number of aphids, (219.00 and 4.67 individuals/ leaflet in the two years, respectively) and finally the (seedling stage) showed the lightest infestation rate with aphids, (67.33 and 0.00 individuals/ leaflet in the two years, respectively).

Table 3: Effect of plant stages on the infestation rate of common bean plants with certain pests during the 1st year 2018, at Giza Governorate.

Plant stages 2018	*B. tabaci*	*T. tabaci*	*Aphids (A. craccivora+ A. gossypii+ M. persicae)*	leaf miner (*M. phaseoli* Tryon)	*T. urticae*	*P. latus*
Seedling	4.67 c	0.33c	67.33 c	0.00b	0.00 b	4.00 c
Flowering	22.50 b	4.00 b	219.00 b	0.00 b	0.00 b	19.00 b
Flowering + fruiting	44.17 a	5.17 a	316.00 a	2.50a	28.50 a	26.50a
Mean	23.78	3.17	200.78	0.84	9.50	16.50
F. values	24.44	49.36	65.23	38.15	101.7	27.95
Prob.,	0.0001	0.0001	0.0001	0.0001	0.0001	0.0001
L.S.D	6.16	1.14	10.68	0.88	5.61	7.65

D: Leaf miner (*M. phaseoli* Tryon).

As shown in Tables (3 & 4), the infestation rates with leaf miner, varied from the 1st to the 2nd year. In the 1st year, the leaf miner didn't appear during the 1st and 2nd plant stages and only appeared in the 3rd one, while in the 2nd year, the leaf miner were found during all plant stages and reach its highest infestation rate during the last plant stage (flowering+ fruiting) with mean numbers 2.50 and 11.33 individuals/ leaflet in the two years respectively, and reach its lowest infestation rates on plants at their seedling stage (Tables, 3& 4). Based on statistical analysis of obtained infestation rates, the three plant stages could be arranged descending according to L.S.D values (0.88 and 2.28 in the two years, respectively) as follow; (flowering+ fruiting) stage > flowering stage > seedling stage.

Table 4: Effect of plant stages on the infestation rate of common bean plants with certain pests during the 2nd year 2019, at Giza Governorate.

Plant stages 2019	*B. tabaci*	*T. tabaci*	*Aphids (A. craccivora+ A. gossypii+ M. persicae)*	leaf miner (*M. phaseoli* Tryon)	*T. urticae*	*P. latus*
Seedling	14.33c	0.00	0.00c	2.33c	0.00c	0.33c
Flowering	66.50b	0.00	4.67b	5.00b	19.33b	10.50b
Flowering + fruiting	309.83a	0.00	125.17a	11.33a	167.67a	78.50a
Mean	185.56	0.00	79.89	6.11	62.33	37.33
F. values	132.67	0.00	98.60	90.02	107.00	202.40
Prob.,	0.0001	0.00	0.0001	0.0001	0.0001	0.0001
L.S.D	22.87	0.00	10.39	2.28	3.48	9.65

E: *T. urticae* Koch.

Similar to previously showed leaf miner infestation rates, the *T. urticae* did not appear during the 1st and 2nd plant stages in the 1st year or during the 1st plant stage in the 2nd year. While in the 3rd plant stage (flowering+ fruiting), plants were exposed to the significantly highest infestation of *T. urticae* in both years (28.50 and 167.67 individuals/ leaflet, respectively). (Tables, 3 & 4).

F: *P. latus* (Banks).

The highest infestation rates with *P. latus* were found on plants of the last stage (flowering+ fruiting) with mean numbers 26.50 and78.50 individuals/ leaflet in the two studied years respectively, and the lowest infestation was recorded on seedling stage (Tables 3 and 4). Based on the statistical analysis of obtained data, the *P. latus* infestation rates for the three tested plant stages could be arranged descending according to L.S.D values (7.65 and 9.65 in the two years, respectively), as follow: flowering+ fruiting > flowering > seedling stage.

Relationship between Main Pests' Infestation Rates and Common Bean both, Planting Dates and Plant Stages.

Data presented in Tables (5 and 6) show the relationship between different infestation rates with common been plants' main pests under the two studied factors; planting dates and plant stages, during the two successive years 2018 and 2019. The correlation coefficient factors (r) and explained variance are presented.

A: *B. tabaci*

Data recorded in Tables (1 and 2), indicate that *B. tabaci* infestation rate is affected significantly by planting date, (as the infestation increases by delaying of planting date). Correlation between *B. tabaci* infestation rates and the three planting dates revealed a significantly negative association between them in the two years, as the correlation coefficient factors (r) were (-0.58, -0.46 and -0.47) and (-0.54, -0.61 and -0.71) in 1st and 2nd years respectively, while relationship between with *B. tabaci* infestation rates and plant stages revealed a significantly positive relation with

the three tested plant stages in the two years, as the (r) value were 0.51, 0.28 and 0.46 & 0.49, 0.61 and 0.75, respectively (Tables, 5 and 6).

B: *T. tabaci*

The simple correlation analysis for varied population densities of *T. tabaci* in relation to different planting dates and plant stages is tabulated in Tables (5 and 6). Results of the 1st year clearly showed that the *T. tabaci* population densities were associated negatively with the 1st and 3rd planting dates and showed presence of the lowest and highest numbers of *T. tabaci*, 0.75 and 3.70 individuals/ leaflet respectively, as r values were -0.59 and -0.46 respectively, and were associated positively with the 2nd planting date that showed infestation with intermediate numbers of *T. tabaci* 0.92 individuals/ leaflet (r= 0.10). In the 2nd year, different results compared to those of the 1st years were obtained, as the population density of *T. tabaci* correlated negatively with common bean plants in the 1st and 2nd planting date showing infestation with lightest and intermediate numbers of *T. tabaci* (0.05 and 0.45 individuals/ leaflet) as the calculated (r) values were -0.28 and -0.49 respectively, and correlated positively with the 3rd (last) planting date which infested by the heaviest numbers of *T. tabaci* 1.25 individuals/ leaflet (r= 0.28) as shown in Table (2).

Regarding the relationship between the plant stages and the *T. tabaci* infestation, the results showed that in the 1st year 2018, the relationship between *T. tabaci* infestation rate and plant stage was negative in the 1st stage (seedling) which infested with low numbers of *T. tabaci* (0.33 individuals/ leaflet, Table, 3) as (r) value was -0.28, and was positive in the 2nd and 3rd plant stages which were infested by the highest numbers of *T. tabaci* (4.00 and 5.17 individuals/ leaflet, respectively), as the calculated r values were 0.54 and 0.55 respectively, while, in the 2nd year (2019), no relation was determined as no *T. tabaci* individuals were observed during the whole growing season.

C: Aphids

From data presented in Tables (5 and 6), the correlation coefficient values were insignificantly negative between the mean abundance of aphids and plants of the 1st and 2nd

Table 5: Simple correlation between, planting dates and plant stages, and population densities of certain pests infesting common bean plants during 1st year 2018, at Giza governorate.

Factors		Correlation Coefficient factor						E.V.%	E.V.%	E.V.%
		B. tabaci	*T. tabaci*	Aphids	Leaf miners	*T. urticae*	*P. latus*			
Planting dates	Aug., 15th	-0.58	-0.59	-0.08	-0.12	-0.80	-0.62	30	31.50	51.50
	Aug., 29th	-0.46	0.10	-0.57	-0.07	-0.66	-0.39	16		
	Sep., 12th	-0.47	-0.46	0.71	-0.48	-0.37	-0.69	48		
Plant stages	Seedling	0.51	-0.28	-0.54	0.00	0.00	0.42	39	47.95	
	Flowering	0.28	0.54	0.15	0.00	0.00	0.55	24		
	Flowering + Fruiting	0.46	0.55	0.76	-0.63	0.20	-0.49	61		

E.V. % = Explained variance

Planting dates which infested with limited numbers of aphids, as the (r) values were (-0.08 & -0.57) and (-0.09 & -0.72), in two studied years, respectively. On the other extreme, this relationship was significantly positive in the 3rd planting date which was infested by the highest number of aphids in the two studied years (Tables, 1 and 2). (r= 0.71 and 0.11, respectively, for the 1st and 2nd years), Tables (5 and 6).

Table 6: Simple correlation between, planting dates and plant stages, and population densities of certain pests infesting common bean plants during 2nd year 2019, at Giza governorate.

Factors		Correlation Coefficient factor						E.V.%	E.V.%	E.V.%
		B. tabaci	*T. tabaci*	Aphids	Leaf miners	*T. urticae*	*P. latus*			
Planting dates	Aug., 15th	-0.54	-0.28	-0.09	-0.27	-0.83	-0.59	29	38.69	43
	Aug., 29th	-0.61	-0.49	-0.72	-0.35	-0.75	-0.64	35		
	Sep., 12th	-0.71	0.28	0.11	-0.45	-0.26	-0.40	48		
Plant stages	Seedling	0.49	0.00	0.00	0.19	0.00	0.18	34	42.67	
	Flowering	0.61	0.00	0.49	-0.30	-0.28	0.43	42		
	Flowering +Fruiting	0.75	0.00	0.74	-0.51	-0.52	-0.54	19		

E.V. % = Explained variance

Accordingly, the simple correlation between aphids population and common bean plants stages, revealed insignificant positive correlation during the flowering stage which infested by higher number of aphids (Tables, 3 and 4), and significantly positive correlated in the (flowering and fruiting) stage which found infested with the highest numbers of aphids in the two studied years, as the calculated (r) values were 0.15 and 0.76 & 0.49 and 0.74, respectively. For the seedling stage, aphids associated significantly negative with plants at this stage (r= -0.54) in 1st year only, and didn't correlated with plants of seedling stage in the 2nd year as no individuals were observed during this period. r=0.00, (Table 6).

D: Leaf miner (*M. phaseoli* Tryon).

From data shown in Tables (5 and 6), the simple correlation between the mean numbers of leaf miner and the two factors (planting dates and plant stages), revealed an insignificantly negative correlation between the mean abundance of leaf miner and the three tested planting dates, as (r) values were (-0.12, -0.07 and -0.48) and (-0.27, -0.35 and -0.45) for the three tested planting dates in the two studied years, respectively.

In the 1st year, the correlation between mean count of leaf miner and the three plant stages, [seedling, flowering and (flowering+ fruiting)], indicated that the leaf miners are associated significantly negative with the 3rd planting stage (flowering+ fruiting) r values= -0.63, and no relation (zero) for the 1st and 2nd plant stages due to absence of leaf miners in these two plant stages. In the 2nd year, the population density of leaf miners was related positively in the 1st stage (r= 0.19), negatively and significantly negative in the 2nd and 3rd plant stages, (r= -0.30 and -0.51, respectively).

E: *T. urticae*

From correlation coefficient (r) values tabulated in Tables (5 and 6), it is clear that the population density of *T. urticae* on common bean plants was affected by both planting dates and plant stages. Statistical analysis of simple correlation indicated significantly negative relationship between *T. urticae* infestation and 1st & 2nd planting dates which found infested with the highest *T. urticae* population in the two studied years, (Tables 1 and 2) as r values were -0.80 and -0.66 & -0.83 and -0.75 respectively, and negatively correlated with 3rd planting date which infested by the lowest number of *T. urticae*, as (r) values were -0.37 and -0.26 in the two years respectively.

Regarding the correlation between the *T. urticae* infestations and plant stages, obtained results for the 1st year, showed no correlation in the 1st and 2nd plant stages, as no *T. urticae* individuals were recorded during these two plant stages, and positively correlated with the 3rd plant stage which found infested with 28.50 individuals/ leaflet (Table, 3) (r= 0.20). In the 2nd year, a clear relationship was identified where, zero relationship was estimated in the 1st stage, as no *T. urticae* individuals were detected, and negative relation in the 2nd and 3rd plant stages which found heavily infested with *T. urticae* (19.33 and 167.67 individuals/ leaflet, respectively) (Table, 4) r values= -0.28 and -0.52, respectively.

F: *P. latus.*

For *P. latus* in relation to planting dates and plant stages, obtained results found to take same trend previously identified for *B. tabaci*, aphids, leaf miners and *T. urticae*, and negative correlation between the *P. latus* population density and the three tested planting dates were found, as the calculated (r) values were -0.62, -0.39 and -0.69 for the three planting dates in the 1st year, and -0.59, -0.64 and -0.40 in the 2nd year, respectively.

Simple correlation analysis for *P. latus* infestations rates and plant stages indicated that *P. latus* population density is positively correlated with the 1st and 2nd plant stages (which showed the lowest and moderate numbers of *P. latus* individuals as shown in Tables (3 and 4), as (r) values were 0.42 and 0.55 & 0.18 and 0.43 in the two years respectively, and that *P. latus* population density was negatively correlated with the 3rd plant stage which found to be infested with the largest numbers of *P. latus* as the calculated (r) values were -0.49 and -0.54 in the two years, respectively.

The combined effect (E.V.%) of both factors, planting dates and plant stages, on infestation rates with six investigated pests was calculated separately and altogether using multiple regression analysis.

The combined effect of three tested planting dates on the population densities of *B. tabaci*, *T. tabaci*, aphids, leaf miners, *T. urticae* and *P. latus* were (30% and 29%),(16% and 35%) and (48% and 48%) for 1st, 2nd and 3rd planting dates in the two years respectively, while the combined effect of plant stages were (39% and 34%), (24% and 42%) and (61% and 19%), respectively.

The combined effect of the three tested planting dates, altogether, on the population densities of the abovementioned pests were 31.50 and 38.69 % in the two years, respectively. However, plant stages was found to play a more important role in affecting the pests' population densities because the combined effect of the three tested plant stages together was higher compared to the planting date, as (E.V.%) values were 47.95% and 42.67% in the two years, respectively.

The combined effect of the planting dates and plant stages altogether on the population density of the sixth studied pests were 51.50 and 43% in the two years, respectively.

Similar works that investigated effects and relationships between pests' population densities and plant stages were previously carried out for several crops worldwide including Egypt. Hanafy (2007) stated that the population density of *T. tabaci* on sweet pea plants was affected by climatic factors, plant age and planting dates. On garlic plants, Hussein *et al*., (2010) [16] found a positive relationships between *T. tabaci* population density and different plant developmental stages. Also Abdel Hamed *et al*., (2011) [2] found that the weather factors, mainly temperature, and plant age had significantly positive effect on population of *B. tabaci*, *T. tabaci*, *L. trifolii* and *T.urtica*. on okra plants.

In the same context, Afsah *et al.*, (2014), worked on the effect of plant stages of fenugreek plants on population density of leaf miner, *Liriomyza* spp. and found that *Liriomyza* spp. Increase with advancing of the plant age, and the lightest population was recorded during the vegetative stage, and the heaviest population was associated with the flowering and fruiting stages. In other work, Mukoye *et al.*, (2016) [19] noticed that the vegetative stage of common bean plants showed the highest incidence of black aphids (*Aphis fabae* Scopoli) while the lowest incidence was recorded at the pre- flowering stage. On pea plants, Shaalan and El-Ghanam (2016) [26], found that the infestation rate with *Liriomyza trifolii* increase as plant age increases until middle of flowering stage, and the highest infestation rates were recorded throughout the plant seedling and flowering stages, while the lowest one was recorded during fruiting stage.

On fennel plants, Hake *et al.*, (2018) [13], reported that the lightest incidence of aphids on plants was during the early planting date of Oct., 20th, followed by crop sown on Oct., 30th and Nov., 10th., and the maximum infestation was recorded plants that sown lately on Nov., 30th. In other work, Faragalla and Hassan (2018) [10], stated presence of positive correlation between fennel plant age and aphid infestation, and a slight positive correlation between *T. tabaci* and plant age of the same crop. Finally, a positive relationship between of common bean plant age and the bean fly leaf miner, *Melanagromyza phaseoli*, was also reported by Salem *et al.*, (2015) [23].

Finally, aspects of cultural practices such as site selection, crop rotation, and cultivar and seed selection, and preferential sowing date, may to a certain degree reduce the infestation of certain insect pests and the manipulation of planting time could help in minimizing different pests damage either through producing asynchrony between host plant and the pest or synchronizing insect pests with their

natural enemies or crop production with available alternate host plants of the pest (Mwanauta *et al.*, 2015 & Dey, *et al.*, 2017) [20, 6]. Therefore, results deduced from our work should be placed among other biotic and abiotic factors that affecting natural abundance of these common bean pests in Egypt.

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