VARIATION IN THE SUSCEPTIBILITY OF SOME POTATO (*SOLANUM TUBEROSUM* L.) CULTIVARS TO INFESTATION WITH CERTAIN PIERCING SUCKING INSECT PESTS

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ABSTRACT: Potato (*Solanum tuberosum* L.) is an economically important vegetable crop all over the world. The piercing sucking insect pests are a serious pests threatening potato plantations in many countries. The present investigation contributes to the knowledge on the susceptibility of certain potato cultivars to infestation with these insects in Beheira Governorate, Egypt. Five cultivars currently used in Egypt's potato production were evaluated through two successive seasons (summer plantations) in field experiments for their susceptibility to sucking insect infestation. None of the tested potato cultivars was immune or highly resistant to the tested insect pests. The cultivars Banba and Diamante were found quite resistance to piercing sucking insect pests. The cultivars Herms was found as moderately susceptible while Spunta and Cara were found to be the most susceptible cultivars. The green lacewing, *Chrysoperla carnea*; seven-spotted lady beetle, *Coccinella septempunctata*; eleven spotted lady beetle, *Coccinella undecimpunctata* and the pirate bug, *Orius* sp. are the most important predators in the potato cultivars.

KEY WORDS: Potato, sucking insect pests, aphids, thrips, whitefly, natural enemies

The potato (*Solanum tuberosum* L.) is the third most important world crop, after rice, and wheat (Visser et al., 2009). It is a major source of energy, contains high levels of carbohydrate, mineral and significant amounts of vitamins B and C (Abdel-Aal et al., 1977). Potato as an economic crop has been attacked by several pests especially piercing sucking insect pests. These insects are a major pests on the vegetable plants for their direct damages that are caused by the insect feeding on the plants and/or the indirect damages as a virus vector to these planting materials. Many researchers investigated the sucking insect pests and reported that the whitefly, *Bemisia tabaci* (Gennadius); the green peach aphid, *Myzus persicae* (Sulzer), potato leaf hopper, *Empoasca discipiens* (Paoli) and the onion thrips, *Thrips tabaci* Lindeman attacked potato plants just after the first appearance of seedlings until harvesting date (Mogahed, 2000; El-khawas & Shoeb, 2004; Musa et al., 2004; Saguez et al., 2005, 2010; Mogahed, 2015; Fernandes & Fernandes, 2015 and D'Auria et al., 2016). The whitefly, *B. tabaci* has a high reproductive capacity and destructive life habits in addition to feeding on more than 700 host plant species (Greathead, 1986). The leafhopper, *Empoasca* sp., usually associated with potato crop and many other crops around the world (Lamp et al., 1994). Aphids are among the most destructive pests on potato plants in the temperate regions (Nderitu & Mueke, 1986) as a vector for the many of plant viruses. The green peach aphid is represents one of the major insect pests affecting potato production, it is distributed worldwide and feeding on over than 400 species of host plants (Raman, 1984; Hooker, 1986; Cloyd et al., 1998). The control of piercing sucking insect pests in several crops has become a challenge to growers, because the damages caused by these insects have increased in various countries (including Egypt). Among control methods, the use of

resistant cultivars is very important, and it is considered the ideal method. Therefore, the present study was carried out to evaluate the susceptibility of five cultivars with respect to piercing sucking insect pest's infestation under the field conditions. Also to determine the role of beneficial species in suppressing potato piercing sucking insect pests populations.

MATERIALS AND METHODS

The present study was conducted at private farm in Abu El Matamir district (09°30′52.71″E, 56°30′16.98″N), Beheira Governorate, Egypt in summer plantation (the tubers were sown in Mid-January, 2017 and 2018 years). An area of about halve feddan was divided into 20 equal plots comprised the five cultivars (Herms, Diamante, Banba, Spunta and Cara) of potato of 4 replicates each at an inter-row distance of 75 cm and an intra-row distance of 25 cm. The experiment was designed in a completely randomized block design and the plots were separated by one meter non-cropped area. All plots received the normally recommended agricultural and kept free from any insecticidal application.

After five weeks from the sowing, samples of 40 leaves/ cultivar (10 leaves from each plot) were randomly selected and direct counts of *Bemisia tabaci* (adults) and *Empoasca decipiens* (adults), were carefully done in the early morning (when insects were less active) on both surfaces of these leaves. Also, the predators that associated with such insect pests were counted directly in the fields (in ten whole plants from each plot). Then, the investigated samples were picked and placed into paper bags and transferred to the laboratory for examine *B. tabaci* (nymphs), *E. decipiens* (nymphs), *Myzus persicae*, *Aphis gossypii*, *Thrips tabaci* (adults and nymphs) by the aid of stereoscopic microscope. Sampling continued until the crop harvest. The analysis of variance (F-test) was adopted and the L.S.D values were used to determine the significance between means of cultivars for both insect species and natural predators (SAS Statistical software, 1999).

RESULTS AND DISCUSSION

Data presented in Tables (1, 2) shows the means of weekly counts (adults and nymphs) of whitefly, onion thrips, leafhopper, cotton aphid and green peach aphid through the whole season on the leaves of five cultivars of potato plants namely, Herms, Diamante, Banba, Spunta and Cara. None of the tested potato cultivars was immune or highly resistant to the tested sucking insect pests. However, the different tested cultivars of potato showed different resistance capacity against piercing sucking insect pests.

Data presented in Table (1) and illustrated in Fig. (1) indicated that, among the different potato cultivars, Cara recorded the highest attraction of whitefly, *B. tabaci* with mean numbers of 8.89 individuals/ leaf which was significant ($P > 0.05$) than Banba (4.68 individuals/ leaf), and Diamante (3.6 individual/leaf) and insignificance with Spunta (7.91 individuals/ leaf) and Herms (8.76 individuals). Regarding to the onion thrips, *T. tabaci*, the L. S. D value was 0.44, accordingly there is no significant differences between Spunta cultivar and the four cultivars; Cara, Banba, Herms and Diamante. The lowest mean numbers of thrips /leaf were recorded in Diamante (0.44 individuals) while the highest mean of thrips /leaf was recorded in Spunta cultivar (1.02 individuals). Also the results in Table 1 reveals that the potato cultivars were arranged descendingly according to their susceptibility to potato leafhopper, *E. decipiens* as follow: Spunta (11.25

individuals/ leaf), Cara (8.56 individuals/ leaf), Herms (6.58 individuals/ leaf), Diamante (3.77 individuals/ leaf) and Banba (3.64 individuals/ leaf). The mean numbers of *M. persicae* ranged between 5.74 individuals / leaf in Spunta cultivar to 1.53 individuals/leaf in Diamante cultivar while the Cara cultivar recorded the highest number of cotton aphids (3.37 individuals). Generally, the obtained results in Table (1) showed that the tested potato cultivars showed significant variation in their susceptibility to the infestation by the sucking insect complex. Spunta cultivar was the most susceptible one because it was harbored the highly numbers of the piercing sucking insect pests especially leafhopper than the other cultivars while the Diamante cultivar was the lowest sensitivity cultivar.

Coexistence of sucking pests on different cultivars of potato plants on the summer plantation:

Data presented in Table 1 summarized the coexistence of five sucking insect pests infesting five potato cultivars during the summer plantation of 2017 season. The insects showed variable population densities and coexistence percentages. The most common and dominant sucking insect pests on Herms, Banba and Cara was the whitefly, *B. tabaci*, which was represented by 43.7, 34.98 and 32.77 %, respectively, followed by the leafhoppers, which was represented by 32.82, 27.2 and 31.55 %, respectively, of the total sucking insects population. Meanwhile, the most abundant sucking pest on Spunta and Diamante cultivars was the leafhopper, *E. decipiens* which coexisted by 38.47 and 36.43%, followed by *B. tabaci* (27.05% and 34.78) of the total population of sucking insects. Meanwhile the species of *T. tabaci* which had low values of dominance degrees (3.35, 3.39, 3.49, 4.25 and 5.46 % in Cara, Herms, Spunta, Diamante and Banba, respectively) is expected to be of little economic importance as it may cause a minor role as a pest in potato plantations.

The same trend of infestation was repeated on the 2nd season, 2018 with slightly variation, the obtained results (Table 2 & Fig. 2) indicated that there were no significant differences ($P > 0.05$) in the mean numbers of *B. tabaci* among Herms, Spunta and Cara varieties, then, the highest mean number of whitefly infestation was recorded on Herms (5.42 individual/ leaf) followed by Spunta (4.42 individual/ leaf). Concerning the leafhopper, *E. decipiens* the tested cultivars could be arranged in descending order according to intensity of infestation as follow: Spunta, Herms, Cara, Banba and Diamante, respectively. The highest significant differences ($P < 0.05$) in the mean of infestation of the green peach aphid, *M. persicae* and leafhopper, *E. decipiens* were recorded between Spunta and Diamante. On the other hand, the data in Table (2) show that, generally Spunta cultivar recorded the highest infestation by *M. persicae* through the period of study (6.11 individual/leaf) while Cara cultivar (4.34 individual/leaf) come in the second order. The lowest infestation with *M. persicae* (2.32) and *A. gosypii* (0.93 individual / leaf) was in Diamante Cultivar while Cara cultivar was the highest susceptibility cultivar to infestation with *A. gosypii* (2.35).

Data presented in Table 2 and illustrated in Fig. 2 show the coexistence of sucking pests on different cultivars of potato cultivars on the 2nd season, 2018, *E. decipiens* seems to be the most important economic pests on all the tested cultivars except Banba, it made up 37.77, 39.48, 32.48 and 34.19 % of the total piercing sucking insect complex in Herms, Spunta, Cara and Diamante cultivars, respectively. The green peach aphid had high abundance degrees (27.32, 27.47, 25.73 and 28.54) in Banba, Spunta, Cara and Diamante cultivars, respectively. Also, Table 3 shows that the *B. tabaci* made up 34, 28.32, 24.6, 22.63 and 19.87 of the total insect pests on Herms, Banba, Cara, Diamante and Spunta respectively.

Co-existents of predacious insects in potato varieties:

Results in Tables (3-4) showed predatory species found on potato plants cultivars during two seasons, 2017 and 2018 in summer plantation. During the 1st season (Table 3), the overall mean population of the green lacewing in potato cultivars was 4.61, 3.55, 3.16, 2.91 and 2.65 / plant in Spunta, Diamante, Cara, Banba and Herms, respectively. The highest mean number of the seven spotted lady beetle *C. septempunctata* was recorded in Spunta cultivar (2.48) while the lowest mean number of this species was recorded in Diamante (1.11 individuals/ plant). On the other hand, the overall mean population of *C. undecimpunctata* were 2.04, 1.87, 1.4, 1.3 and 0.82 per plant on Spunta, Cara, Banba, Herms and finally Diamante, respectively. The population of *Orius sp* varied non-significantly ($F_{0.05}$=1.713) with potato cultivars where's the overall mean population of *Orius sp* were 1.52 individuals/plant in Spunta cultivar followed by 1.13, 1.11, 0.84 and 0.71 in Cara, Diamante, Herms and Banba, respectively.

The same trend was repeated on the 2nd season (Table 4) where's the Spunta cultivar harbored the highest numbers of *C. carnea* (4.38), *C. septempunctata* (2.41), *C. undecimpunctata* (1.55) and *Orius* sp (1.32 individuals / plant). Followed by Cara cultivar (2.75, 1.36, 1.13 and 0.76 for *C. carnea*, *C. septempunctata*, *C. undecimpunctata* and *Orius* sp., respectively). The lowest mean of population density of *C. carnea* (1.32 individual / plant) was recorded in Herms cultivars while the lowest means population of *C. septempunctata* (2.41) and *C. undecimpunctata* (1.55) were recorded in Diamante cultivar.

DISCUSSION

The crop cultivars that are resistant to insect pests considered one of the most important items in integrated pest management system. Resistance cultivars may be less preferred by insects because their effect on the survival and normal development of these insects. (Hoffman & Frodsham, 1993). The resistance cultivars have been used greatly day after day to avoid the use chemical insecticides and their toxic effect. Many studies have investigated the susceptibility of different cultivars of different crops to several piercing insect pests such as Musa et al. (2004) who studied the sensitivity of two potato cultivars (Romano & Desiree) to *M. persicae* and Mogahed (2015) who studied the sensitivity of Nicola and Spunta cultivars to aphids, jassids and whitefly. Silva et al. (2008) evaluated the resistance of 24 potato genotypes to *B. tabaci* in five greenhouse experiments. They found that the cultivar Achat was the most resistant while clone NYL 235-4 was the most susceptible to *B. tabaci*.

Although no any cultivar showed 100% resistance against the sucking insect pests, the hypothesis of the planned work was verified on the present results that the different cultivars of potato plants have different resistance capacity against piercing sucking insect pests. Throughout the study, the most susceptible cultivar was Spunta followed by Cara; whereas, Diamante showed more resistance against sucking insect complex as compared to the other tested cultivars tested. In general, the mean number of whiteflies and leafhopper populations were more abundant compared to that of thrips or aphids populations. These results are in harmony with those recorded by Mogahed (2015) who found that each of the leaf hopper, *E. discipiens* and white fly, *B. tabaci* were more present on the potato plants than other piercing pests. In Pakistan, Ali et al. (2011) found that the population density of aphids per leaf of potato plants was more abundant than leafhopper and whitefly population before the treatment with some chemical against the aphids, jassids and whiteflies.

The results revealed that the maximum green peach aphid's population was observed on Spunta followed by Cara and were statistically similar to each other, while the minimum green peach aphids population was observed on Diamante cultivar. Musa et al. (2004) in Kosovo, found that the highest number of *M. persicae* was recorded on potato plants var. Romano (16.8 as a verage number of aphids/100 leaves), whereas the lowest number of this species was recorded on potato plants var. Desiree (2.2 aphids/100 leaves). Fréchette et al. (2009) found that the wild potato more resistant to *M. persicae* than the commercially cultivated *S. tuberosum* cv. Désirée. Mahmoud et al., 2011 studied the host preference of potato leaf hopper, *E. decipiens* from six plant species and find that the potato plants was the 2nd preferred host to this insect after broad bean plant and followed by squash, Pea, green bean and finally lupin. During this study the Spunta cultivar was the most susceptible for this insect while diamante was the less preferred potato cultivars. On the whole, it is clear that the total numbers of the *B. tabaci*, *T. tabaci*, *E. decipiens* and *A. gosypii* on the different cultivars were more abundant during the 1st season than the 2nd season. On the contrary, the green peach aphids was more abundant during the 2nd season than 1st seasn. These levels of infestation between the two seasons might be attributed to the differences in the weather factors. Also, the previous results revealed that the green lacewing, *C. carnea*; seven-spotted lady beetle, *C. septempunctata*; eleven spotted lady beetle, *C. undecimpunctata* and the pirate bug, *Orius* sp. were the most important predators in the potato plants. The green lacewing, *C. carnea* was the most prevailing pests on potato plant cultivars representing from 38.54 to 53.87% and from 35.11 to 47.22% of the total predators in the different cultivars during the 1st and 2nd seasns, respectively. In this respect, Sherief, *et al.* 2013 in sugar beet plants in Zagazig district in Sharkia Governorate found that the *Chersoperla carnea* represented about 54.75 and 45.05 % of the total predators in 1st and 2nd season, respectively. While these results are in disagreement with Hamouda (1993) who stated that the chrysopid predator represented 5.5-10.2% while the coccinellid predator species represented 78.5-90.1% of the total predator species in vegetable fields.

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Table 1. Seasonal mean numbers (and coexistence %) of certain sucking insect pests on different potato plant cultivars at Beheira Governorate during the summer plantation of 2017.

Cultivar	*B. tabaci*	*T. tabaci*	*E. decipiens*	*A. gosypii*	*M. persicae*	General mean
Herms	8.76±0.96^{a}	0.68±0.158^{ab}	6.58±0.76^{b}	1.66±0.16^{b}	2.37±0.41^{bc}	20.05±1.99^{b}
	(43.7)	(3.39)	(32.82)	(8.27)	(11.82)	(100 %)
Banba	4.68±0.55^{b}	0.73±0.161^{ab}	3.64±0.55^{bc}	1.56±0.18^{b}	2.77±0.27^{b}	13.37±1.46^{c}
	(34.98)	(5.46)	(27.2)	(11.66)	(20.7)	(100 %)
Spunta	7.91±0.72^{a}	1.02±0.174^{a}	11.25±0.95^{a}	3.32±0.4^{a}	5.74±0.63^{a}	29.24±2.16^{a}
	(27.05)	(3.49)	(38.47)	(11.35)	(19.63)	(100 %)
Cara	8.89±0.77^{a}	0.91±0.178^{a}	8.56±.97^{b}	3.37±0.41^{a}	5.4±0.56^{ab}	27.13±2.3^{a}
	(32.77)	(3.35)	(31.55)	(12.42)	(19.9)	(100 %)
Diamante	3.6±0.33^{c}	0.44±0.088^{b}	3.77±0.57^{c}	1.01±0.18^{b}	1.53±0.23^{c}	10.35±1.22^{c}
	(34.78)	(4.25)	(36.43)	(9.76)	(14.78)	(100 %)
$F_{0.05}$	12.419	2.088	17.363	14.208	17.7	19.44
L.S.D.	1.98155	0.4412	2.2133	0.8.199	1.2769	5.3247

Means followed by the same letter(s) within the same column are nonsignificantly different ($P \leq 0.05$)

Table 2. Seasonal mean numbers (and coexistence %) of certain sucking insect pests on different potato plant cultivars at Beheira Governorate during the summer plantation of 2018.

	B. tabaci	*T. tabaci*	*E. decipiens*	*A. gosypii*	*M. persicae*	General mean
Herms	5.42±0.95^{a}	0.25±0.05^{c}	6.02±0.78^{ab}	1.18±0.19^{cd}	3.07±0.47^{bc}	15.92±2.2^{b}
	(34)	(1.57)	(37.77)	(7.4)	(19.26)	(100 %)
Banba	3.11±0.58^{bc}	0.33±0.07^{b}	3.07±0.53^{b}	1.47±0.14^{bcd}	3±0.59^{bc}	10.98±1.75^{bc}
	(28.32)	(3)	(27.96)	(13.39)	(27.32)	(100 %)
Spunta	4.42±0.59^{ab}	0.9±0.16^{a}	8.78±0.88^{a}	2.03±0.32^{ab}	6.11±0.97^{a}	22.24±2.31^{a}
	(19.87)	(4.05)	(39.48)	(9.13)	(27.47)	(100 %)
Cara	4.15±0.49^{ab}	0.55±0.13^{b}	5.48±0.84^{ab}	2.35±0.28^{a}	4.34±0.74^{ab}	16.87±2.3^{ab}
	(24.6)	(3.26)	(32.48)	(13.93)	(25.73)	(100 %)
Diamante	1.84±0.34^{c}	0.26±0.07^{bc}	2.78±0.88^{b}	0.93±0.12^{d}	2.32±0.37^{c}	8.13±1.19^{c}
	(22.63)	(3.2)	(34.19)	(11.44)	(28.54)	(100 %)
$F_{0.05}$	4.792	6.805	11.18	6.846	5.15	7.535
L.S.D.	1.77	0.29905	2.08095	0.6411	1.8764	5.66935

Means followed by the same letter(s) within the same column are nonsignificantly different ($P \leq 0.05$)

Table 3. Coexistence of certain insect predators on different potato cultivars at Beheira Governorate during the summer plantation of 2017.

	C. carnea	*C. septempunctata*	*C. undecimpunctata*	*Orius sp*	General mean
Herms	2.65±0.53^{b}	1.4±0.4^{ab}	1.4±0.29^{ab}	0.84±0.17^{ab}	6.29±1.34
	(42.13)	(22.26)	(22.26)	(13.35)	(100 %)
Banba	2.91±0.57^{b}	1.35±0.34^{ab}	1.3±0.29^{ab}	0.71±0.2^{b}	6.26±1.28
	(46.41)	(21.53)	(20.73)	(11.32)	(100%)
Spunta	4.61±0.93^{a}	2.48±0.55^{a}	2.04±0.52^{a}	1.52±0.32^{a}	10.65±2.22
	(43.29)	(23.29)	(19.15)	(14.27)	(100%)
Cara	3.16±0.83^{ab}	2.03±0.51^{a}	1.87±0.3^{a}	1.14±0.26^{ab}	8.2±1.66
	(38.54)	(24.76)	(22.8)	(13.9)	(100%)
Diamante	3.55±0.81^{ab}	1.11±0.21^{b}	0.82±0.15^{b}	1.11±0.22^{ab}	6.58±1.3
	(53.87)	(16.84)	(12.44)	(16.84)	(100%)
$F_{0.05}$	1.035	1.803	2.088	1.713	1.38
L.S.D.	1.6737	1.19655	0.95325	0.6787	4.5505

Means followed by the same letter(s) within the same column are nonsignificantly different ($P \leq 0.05$)

Table 4. Coexistence of certain insect predators on different potato plant cultivars at Beheira Governorate during the summer plantation of 2018.

	C. carnea	*C. septempunctata*	*C. undecimpunctata*	*Orius sp*	General mean
Herms	1.32±0.38^{b}	1.03±0.3^{b}	0.67±0.22	0.74±0.2	3.75±0.97^{b}
	(35.11)	(27.39)	(17.82)	(19.68)	(100%)
Banba	2.37±0.53^{ab}	1.29±0.29^{ab}	0.84±0.24^{ab}	0.62±0.18	5.11±1.13^{b}
	(46.29)	(25.2)	(16.41)	(12.11)	(100%)
Spunta	4.38±1.03^{a}	2.41±0.67^{a}	1.55±0.39	1.32±0.28	9.65±2.2^{a}
	(45.34)	(24.95)	(16.04)	(13.66)	(100%)
Cara	2.75±0.76^{ab}	1.36±0.37^{ab}	1.13±0.38	0.76±0.2	6±1.58^{ab}
	(45.83)	(22.67)	(18.83)	(12.67)	(100%)
Diamante	2.46±0.78^{ab}	0.96±0.17^{b}	0.64±0.18	1.15±0.33	5.21±1.22^{b}
	(47.22)	(18.43)	(12.28)	(22.07)	(100%)
$F_{0.05}$	2.28	2.14	1.639	1.523	2.238
L.S.D.	2.08105	1.1323	2.081	0.689	4.223

Means followed by the same letter(s) within the same column are nonsignificantly different ($P \leq 0.05$)

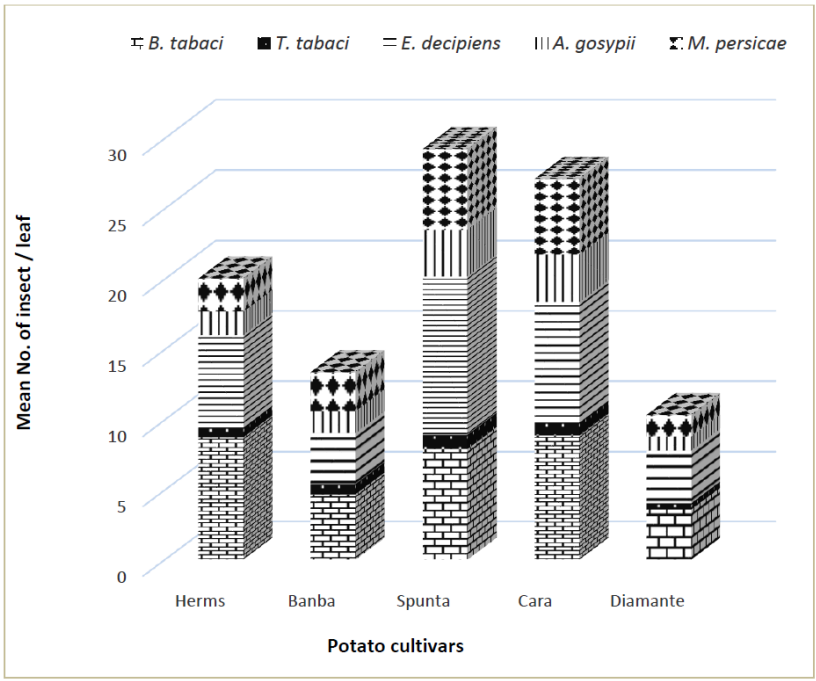

Figure 1. Susceptibility of different potato plant cultivars to certain sucking insect pests at Beheira Governorate during the summer plantation of 2017.

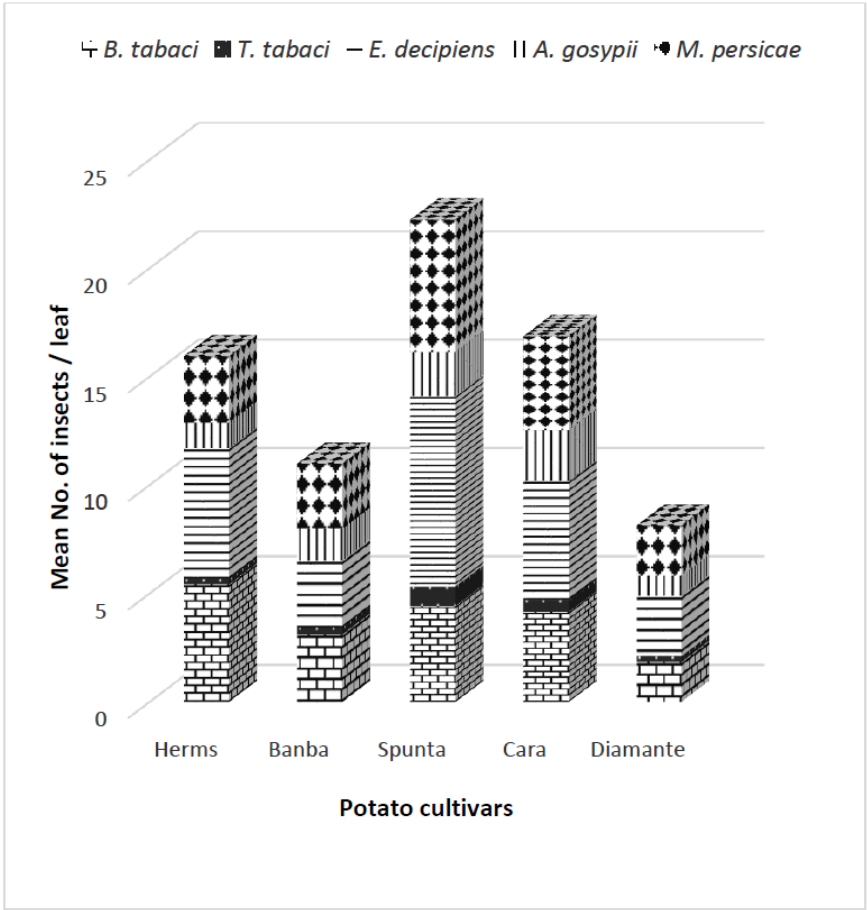

Figure 2. Susceptibility of different potato plant cultivars to certain sucking insect pests at Beheira Governorate during the summer plantation of 2018.