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Impact of planting dates, spaces and varieties on infestation of cucumber plants with whitefly, *Bemisia tabaci* (Genn.)

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Abstract Field experiments were conducted to study the effectiveness of three cucumber planting dates (March, 15th; April, 15th and May, 15th), three planting spaces (20, 30 and 40 cm) between cucumber seeds and three varieties of cucumber (Prince, Al-Wafeer and Medina) on the population densities of *Bemisia tabaci* (Genn.) during 2010 and 2011 seasons. The results indicated that, the three variables (planting dates, spaces and varieties) had pronounced effects on the numbers of *B. tabaci* nymphs on cucumber plants. The population density of *B. tabaci* nymphs was affected significantly by the tested planting date, the earliest planting date (March, 15th) harboured the lowest population of *B. tabaci* nymphs (7.35 and 6.94 nymphs/in.^{2}) in the two seasons, respectively. Cucumber plants cultivated at the longest planting space (40 cm) were infested by the highest rate of *B. tabaci* nymphs (7.50 and 6.21 nymphs/in.^{2}) in the two seasons, respectively. The tested cucumber varieties showed significant differences in the infestation rates by *B. tabaci* nymphs. Al-Wafeer variety was the least infested by *B. tabaci* nymphs (11.04 and 8.78 nymphs/in.^{2}) for the two seasons, respectively. The results revealed that the lowest seasonal mean of infestation was 2.13 and 1.33 nymphs/in.^{2} during the two tested seasons, respectively on cucumber plant (Al-Wafeer variety) sown at the largest space (40 cm) during earliest planting date (March, 15th) while the highest infestation levels (39.58 and 36.22 nymphs/in.^{2} in the two seasons, respectively) occurred on cucumber plants (Medina variety) planted at the closest planting space (20 cm) during last planting date (May, 15th).

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Introduction

Cucurbits represent an important part of vegetable production and are considered very important in agricultural crops in Egypt. They are cultivated in wide areas either old lands or newly reclaimed lands.

Cucumber, *Cucumis sativus* L. is one of the most important cucurbitaceous vegetable crops in Egypt, as it is cultivated

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under different environmental conditions, open fields and greenhouses for local consumption and exportation.

The whitefly, *Bemisia tabaci* (Genn.) considered one of the most important pests infesting cucumber plants during its three growth stages, seedling, flowering and fruiting. The behaviour of this insect makes chemical control difficult, i.e. adult feeding, mating and oviposition and larval development occur on the abaxial (lower) surface of the leaves (Coudriet et al., 1985). Nowadays, control strategies must be developed to control vegetable pests without using insecticides. The nymphal and adult stages of this pest feed on phloem sap and excrete honeydew that hamper photosynthesis and render fruits unmarketable (Lenteren Van and Noldus, 1984). The planting seasons and plant varieties play an important role in the change of the population density levels of pests attacking the plants. So, the planting date can be an effective pest management tactic because it results in a synchrony between the pests and crop (Albuquerque, 1993).

The present study was carried out to shed light on the effectiveness of planting dates, planting spaces and varieties on the population density of *B. tabaci* nymphs on cucumber plants during two successive seasons, 2010 and 2011.

Materials and methods

Field experiments were carried out throughout two successive seasons (2010 and 2011) during summer plantation in El-Kanater El-Khaireia, Qualubia governorate.

These experiments were cultivated with three different cucumber varieties, *C. sativus* L. (Prince, Al-Wafeer and Medina) in three planting dates (March, 15th; April, 15th and May, 15th). Seeds of each planting date were sown in three consecutive planting spaces (20, 30 and 40 cm between hills on row). Each treatment was planted in three replicates (each was 20 m^2).

The experimental plots were laid out in a randomized complete block design with split-plot treatments. Main plots were planting dates and subplots were planting spaces. Normal agricultural practices were followed except for keeping the whole area free from any pesticides. Sampling started after 15 days of sowing and continued weekly for 12 weeks. Weekly samples of cucumber leaves (30 leaves/plot) were randomly picked up from different levels of plant, and then kept in tightly closed paper bags to be transferred to the laboratory for inspection by the aid of a stereomicroscope and the number of *B. tabaci* nymphs/in.^{2} from the middle of the leaf lower surface was counted. Analysis of variance for each experiment was conducted by *F*-test and the means were compared according to Duncan's multiple range tests (Snedecor and Cochran, 1971).

Results and discussion

Effect of planting dates

Data in Table 1 show the effect of planting dates on the population density of *B. tabaci* nymphs during two successive seasons of 2010 and 2011, regardless of the effect of planting spaces and cucumber varieties. There were significant differences between the number of the pest on the plant throughout the different planting dates of 2010 and 2011 seasons.

The obtained data showed that, during 2010 season, the infestation by *B. tabaci* nymphs was heavier as the planting date was delayed, the heaviest infestation rates were recorded in the latest date (May, 15th), as the seasonal mean counts were 23.30 nymphs/in.^{2}. These counts were higher than recorded from intermediate planting date (April, 15th) 14.20 nymphs/in.^{2}. The lowest means of infestation by *B. tabaci* nymphs recorded on plants of the earliest planting date March, 15th were 7.35 nymphs/in.^{2}. Data show in the same table that the population of *B. tabaci* nymphs on cucumber plants in the second season of study 2011, was nearly of the same trend of results as observed for the plants of the third planting dates (May, 15th) showed higher infestation levels compared to the plants of the other planting dates recording 20.46 nymphs/in.^{2}.

The population of *B. tabaci* nymphs increased by delaying the planting date. During the first planting date (March, 15th) cucumber leaves harboured the lowest seasonal mean count of *B. tabaci* 6.94 nymphs/in.^{2}. On the contrary, the latest date (May, 15th) recorded the highest population 20.46 nymphs/in.^{2}. Sowing on (April, 15th) led to intermediate infestation as a leaf harboured mean of 11.95 nymphs/in.^{2}.

The general mean counts of *B. tabaci* nymphs for two seasons on leaves of cucumber plants from the three planting dates confirmed that the earliest planting date (March, 15th) could be considered the best treatment, as it harboured the lowest population of 7.15 nymphs/in.^{2} of leaf.

Regardless of the effect of planting spaces and cucumber varieties, it could be observed that, the cucumber plants cultivated in the late planting date harboured a relatively higher number of *B. tabaci* nymphs. Meanwhile, the plants of the early planting date harboured relatively lower numbers of the pest. Varieties of seasonal plantation can control pests, most of which show some seasonal frequency, either by crop avoiding the egg-laying period of the pest or by allowing the plants to have aged to resistant stage by the time the pests were increasing (Van Emden, 1977).

These results agree with Rizk et al. (1990) on soybean, El-Refai and Emam (1994) on cotton, Hanafy (2004) on cucumber, Bairwa et al. (2005) on okra, Emam et al. (2006) on sweet pea plants and Abd El-Karim (2010) on bean plants, as they reported, the infestation rate of *B. tabaci* increased by delaying planting date.

Table 1 Effect of planting dates on the population of *Bemisia tabaci* nymphs on cucumber plants during 2010 and 2011 seasons at Qalubia governorate.

Planting date	Mean no. of nymphs/in.^{2}/season		
	2010	2011	General mean
March, 15th	7.35c	6.94c	7.15
April, 15th	14.20b	11.95b	13.08
May, 15th	23.30a	20.46a	21.88
LSD at 0.05	3.22	2.05	–

Means followed by the same letter in each column are not significantly different at 0.05 level of probability.

Table 2 Effect of planting space on the population of *Bemisia tabaci* nymphs on cucumber plants during 2010 and 2011 seasons at Qalubia governorate.

Planting space	Mean no. of nymphs/in.^{2}/season		
	2010	2011	General mean
20 cm	23.11a	20.82a	21.97
30 cm	14.25b	12.33b	13.29
40 cm	7.50c	6.21c	6.86
LSD at 0.05	2.56	1.87	–

Means followed by the same letter in each column are not significantly different at 0.05 level of probability.

Table 3 Effect of cucumber varieties on infestation rates by *Bemisia tabaci* nymphs during 2010 and 2011 seasons at Qalubia governorate.

Variety	Mean no. of nymphs/in.^{2}/season		
	2010	2011	General mean
Al-Wafeer	11.04b	8.78c	9.91
Prince	13.84b	12.54b	13.19
Medina	19.98a	18.04a	19.01
LSD at 0.05	2.92	1.46	–

Means followed by the same letter in each column are not significantly different at 0.05 level of probability.

Effect of planting spaces

Data in Table 2 show that the rate of infestation by *B. tabaci* nymphs increased by decreasing planting space in the two investigated seasons regardless of the effect of planting dates and varieties. The highest mean numbers of *B. tabaci* nymphs (23.11 and 20.82 nymphs/in.^{2}) were recorded on cucumber plants planted at the shortest space (20 cm between hills) in the two seasons, respectively. On the other extreme, the lowest level of infestation with *B. tabaci* nymphs on cucumber plants occurred on the plants sown at the longest space (40 cm), recording 7.50 and 6.21 nymphs/in.^{2} for the two seasons, respectively.

For the planting space (30 cm) between plants, an intermediate infestation was recorded, as the whole seasonal mean numbers were 14.25 and 12.33 nymphs/in.^{2} in the two seasons, respectively.

The general mean counts of *B. tabaci* nymphs for the two seasons together indicated that the closest planting space (20 cm) associated with the heaviest infestation rate (21.97 nymphs/in.^{2}), while cucumber plants in the largest space (40 cm) were infested by the highest rate of *B. tabaci* (6.86 nymphs/in.^{2}).

Obtained results are in agreement with those recorded by Abd El-Malak and Salem (2002) on sweetpotato, who stated that the sucking pest, *B. tabaci* was abundant in the narrow spacing (20 cm) than the larger spaces (25 and 30 cm). Emam et al. (2006) in regard to sweetpea plants in Egypt recorded that the largest sowing space (40 cm) harboured significantly the lowest seasonal mean number of *B. tabaci*.

Effect of cucumber varieties

Data in Table 3 show that the differences in infestation rates by *B. tabaci* nymphs to the tested cucumber varieties during 2010 and 2011 seasons, regardless of the effect of planting dates and spaces were significantly different. The obtained data on *B. tabaci* nymphs abundance throughout 2010 and 2011 seasons, clearly show higher infestation rates occurred on Medina variety which was infested by 19.98 and 18.04 nymphs/in.^{2} for the two seasons, respectively. Prince variety was less infested, as they harboured 13.84 and 12.54 nymphs/in.^{2} for the two seasons, respectively while, Al-Wafeer variety was the least infested showing a seasonal mean of 11.04 and 8.78 nymphs/in.^{2} for the two seasons, respectively.

The general mean counts of *B. tabaci* nymphs for the two seasons together indicated that the studied varieties may be categorized into three groups: the high infestation by *B. tabaci* nymphs, which is represented by Medina variety (19.01 nymphs/in.^{2}), the moderate infestation rate contributed with Prince variety (13.19 nymphs/in.^{2}) and low infested variety, which are observed in Al-Wafeer (9.91 nymphs/in.^{2}). These results are in agreement with those obtained by Hanafy (2004) and Amro (2008), as they reported that the tested cucurbit varieties showed different susceptibility degrees to the whitefly, *B. tabaci* infestation. Also, El-Lakwah et al. (2010) found that there were differences between infestation levels of *B. tabaci* to the tested common bean varieties.

Table 4 Combined effect of planting dates, spaces and cucumber varieties on the population density of *Bemisia tabaci* nymphs/in.^{2} infesting cucumber plants during 2010 season at Qalubia governorate.

Planting date	Mean no. of nymphs/in.^{2}/season									
	Al-Wafeer			Prince			Medina			Average
	20 cm	30 cm	40 cm	20 cm	30 cm	40 cm	20 cm	30 cm	40 cm	
March, 15th	9.05	4.23	2.13	10.23	5.62	3.08	16.71	8.54	6.63	7.35
April, 15th	18.70	6.11	4.02	21.90	11.48	5.32	28.04	20.33	11.89	14.20
May, 15th	31.23	18.67	5.25	32.55	24.15	10.20	39.58	29.12	18.98	23.30
Total	58.98	29.01	11.40	64.68	41.25	18.60	84.33	57.99	37.50	44.85
Average	19.66	9.67	3.80	21.56	13.75	6.20	28.11	19.33	12.50	
	11.04			13.84			19.98			14.95

LSD at 0.05 = 3.50.

Table 5 Combined effect of planting dates, spaces and cucumber varieties on the population density of *Bemisia tabaci* nymphs/in.^{2} infesting cucumber plants during 2011 season at Qalubia governorate.

Planting date	Mean no. of nymphs/in.^{2}/season									
	Al-Wafeer			Prince			Medina			Average
	20 cm	30 cm	40 cm	20 cm	30 cm	40 cm	20 cm	30 cm	40 cm	
March, 15th	8.45	4.17	1.33	9.92	4.72	1.95	15.56	8.81	7.54	6.94
April, 15th	12.12	6.25	2.65	19.98	9.87	4.77	27.81	15.36	8.73	11.95
May, 15th	25.57	14.33	4.12	31.75	20.61	9.24	36.22	26.77	15.56	20.46
Total	46.14	24.75	8.10	61.65	35.28	15.96	79.59	50.94	31.83	39.35
Average	15.38	8.25	2.70	20.55	11.76	5.32	26.53	16.98	10.61	
	8.78			12.54			18.04			13.12

LSD at 0.05 = 2.70.

The interaction effects between planting dates, spaces and cucumber varieties on the population density of B. tabaci nymphs infesting cucumber plants

Data in Tables 4 and 5 clearly show the effect of the three variables on the population density of *B. tabaci* nymphs during seasons, 2010 and 2011. Data in Table 4 indicate that the highest population densities of the pest were recorded on Medina variety (39.58, 29.12 and 18.98 nymphs/in.^{2}) and planting spaces (20, 30 and 40 cm, respectively) with the planting date of May, 15th while, the lowest numbers of the pest were recorded on Al-Wafeer variety (9.05, 4.23 and 2.13 nymphs/in.^{2}) with the planting date of March, 15th and planting spaces (20, 30 and 40 cm, respectively).

In the second season, 2011, data in Table 5 clearly indicate that the same trend of results was observed. The highest infestation rate was recorded on leaf samples picked from cucumber plants (Medina variety) planted at the shortest space (20 cm) during the planting date (May, 15th), as they are infested by 36.22 nymphs/in.^{2} followed by plants cultivated with the same variety and distance in the planting date (April, 15th) with a mean number of 27.81 nymphs/in.^{2}.

The lowest seasonal mean count 1.33 nymphs/in.^{2} was counted on cucumber plants (Al-Wafeer variety) sown at the longest space (40 cm) during the earliest planting date (March, 15th). Highest infestation levels generally occurred on cucumber plants (Medina variety) planted at the shortest planting space (20 cm) during last planting date (May, 15th) than the other tested treatments. In general, the rate of infestation by *B. tabaci* nymphs on cucumber plants varied according to planting dates, spaces and varieties in the two investigated seasons.

Finally, this work may add some information to be used in integrated pest management programs for controlling cucumber insects.

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