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Influence of Tomato Planting Dates on Population Density of the Tomato Leafminer *Tuta absoluta* and its Associated Predatory Insects

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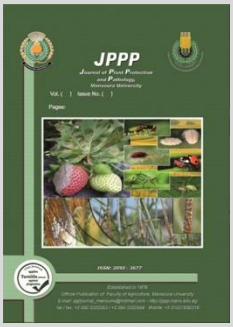

ABSTRACT

The tomato leafminer, *Tuta absoluta* is one the most important insect pests on tomato in both greenhouses and open field and can cause losses up to 80–100 % in tomato plants. Field study was carried out in a research farm located in Kafr El-Sheikh governorate during two successive years 2020 and 2021 to examine the influence of different tomato planting dates (February, June and September) on population density of *T. absoluta* and its predatory insects. The populations of *T. absluta* and its associated predators were affected by the date of plantation during both years. Using the direct count method, the highest peaks of *T. absoluta* larvae were recorded in June plantation during the first and second years (124 and 130 larvae/plant, respectively). Using male trap method, the highest peaks of *T. absoluta* male moths were recorded in June plantation during the first and second years (770 and 800 males/trap), respectively. By using both methods, September plantation of both years hosted the lowest average number of *T. absoluta* larvae and moths. In respect to the predatory insects of *T. absoluta*, the tomato bug, *Nesidiocoris tenuis* recorded the highest number in June plantation in the first and second years that represented by 300.0±70.5 and 286.9±89.9 individuals, respectively. Meanwhile, *Coccinella undecimpunctata* occupied the first rank in February plantation and represented by 3.4±0.7 and 3.0±0.5 individuals during the first and second years, respectively. September plantation came in the last category and recorded the lowest total average numbers of the predatory insects.

Keywords: Development, Density, Fecundity, Longevity, Zoophytophagous

INTRODUCTION

The tomato leafminer, *Tuta absoluta* (Meyrick) (Lepidoptera: Gelechiidae) is one of the most serious pests on tomato plants with great economic importance in Egypt (EPPO, 2008). The losses of tomato plantation by *T. absoluta* could reach to 100% in the open field production (Hassan *et al.*, 2015). In Egypt the first record of *T. absoluta* was in 2013 (Imam, 2013). This pest could produce more than 12 generations yearly and attack the tomato fields in all plantation dates (Hamed *et al*., 2017). The highest infestation of *T. absoluta* reached to 100% in July (Ata and Megahed, 2014). It attacks tomato plants all over the year (Hassan *et al.*, 2015; and Younes *et al.*, 2018; Awadalla *et al.* 2019 a and b).

The main predators of the tomato leafminer *T. absoluta* in Egyptian fields are the tomato bug, *Nesidiocoris tenuis* Reuter (Hemiptera: Miridae), the eleven spotted ladybird *Coccinella undecimpunctata* L. (Coleoptera: Coccinellidae), the green lacewing *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae), the predatory bug, *Macrolophus pygmaeus* Rambur (Hemiptera: Miridae), and the predaceous earwing, *Labidura riparia* (Pallas) (Dermaptera: Labiduridae) (El Khawas, 2005; El Arnaoty *et al.*, 2010; Taha *et al.*, 2014; Karman et al., 2017; darwish, 2018; Abd El Wahab *et al.*, 2018).

As it is known, planting dates affect populations of several insect pests with a certain date hosting low numbers of pest compared with others (e.g., Mohamed, 2011; Kethran, 2014; Saeed and Razaq, 2014, Awadalla *et al.* 2019 a and b). Determining the planting dates with lower number of pests and higher numbers of natural enemies is important in Integrated Pest Management programs. Therefore, this study aims to determine the suitable planting date for tomato plants.

MATERIALS AND METHODS

The president experiments were conducted to study the population density of the tomato leafminer, *T. absoluta* and its predatory insects in a farm located in Kafr El-Sheikh governorate, in three tomato planting dates; February, June and September, during two successive growing seasons (2020 and 2021). Field study was conducted in an experimental area about 1000 m^2. Seeds of tomato plants were sown in greenhouse before transferring to the field, since seedlings were 25-30 days old. These seedlings were sown in end of February, first of June and end of September. The normal agricultural practices, of land preparation, irrigation, and mechanical weeds control, were followed as recommended, whereas chemical control was neglected during both growing seasons.

Direct count method:

Sampling started one week after transplantation in field by using direct count method in which visual direct counting of *T. absoluta* larvae on the whole plant was recorded. Every week, 100 randomly tomato plants were visually inspected to record the number of *T. absoluta*

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larvae during the two growing seasons. The insect predators were also recorded directly on the same plants. The adults and immature stages of predators were weekly recorded on 100 plants before the sunset (6 PM) when these stages are more stable on the plants.

Male trap method:

Water + pheromone trap was used in massy trapping male moths using wooden basin water trap. The trap was suspended 0.6 meter above the soil. The first count was conducted a week after the suspension date of the traps. The trap was weekly visited to remove moths and replenish water and detergent. Lures of Phirodees 100% capsule (E3, z8 Tetradecadienyl acetate + E3, z8, z11-Tetradecacatrienyl acetate) were renewed every six weeks. This trap was set up at transplanting till harvest. The male moth captures were counted weekly and continued for 14 weeks.

Data analysis:

The numbers of *T. absoluta* larvae, male moths and the main predators that counted during different plantation dates were analyzed using one -way ANOVA and means separated using Duncan's Multiple Range test at 0.05 probability level. Further, simple correlation coefficient was used to determine the relation between numbers of different predator species and numbers of *T. absoluta*.

RESULTS AND DISCUSSION

Results

February plantation

Data presented in Figure (1) show the population density of the tomato leafminer *T. absoluta* on tomato crop during February plantation of 2020 and 2021 seasons. In the first season, the population of *T. absoluta* began with small numbers (7 larvae / plant by direct count and 2 moth/ trap by male trap method) and increased gradually to reach the maximum population density (56 larvae / plant and 375 moths / trap by direct count and male trap methods, respectively).

In the second season, the population of *T. absoluta* began with small numbers (3 larvae / plant by direct count and 2 moth/ trap by male trap method), then increased gradually to reach the maximum density represented by 54 larvae / plant and 380 moth / trap by direct count and trap male methods, respectively.

June plantation

Data presented in Figure (2) show the population density of the tomato leafminer *T. absoluta* on tomato crop that planted in June plantation during 2020 and 2021 seasons. In the first season, the population of *T. absoluta* began with few numbers (3 larvae / plant by direct count and 8 moths / trap by male trap method) and then increased gradually to reach the maximum density (124 larvae / plant and 770 moths / trap by direct count and male trap methods, respectively).

In the second season, the population of *T. absoluta* began with small numbers (30 larvae / plant by direct count and 10 moth/ trap by male trap method) and then increased gradually to reach the maximum population that represented by 130 larvae / plant and 780 moth / trap by direct count and male trap methods, respectively.

September plantation

Data presented in Figure (3) show the population density of the tomato leafmainer *T. absoluta* on tomato crop in September plantation during 2020 and 2021 seasons. In the first season, the population of *T. absoluta* began with small numbers (4 larvae / plant by direct count and 6 moths/ trap by male trap method) and then increased gradually to reach the maximum density that represented by 32 larvae / plant and 68 moths / trap by direct count and male trap methods, respectively.

In the second year, the population of *T. absoluta* began with small numbers (3 larvae / plant by direct count and 4 moths / trap by male trap method) and then increased gradually to reach the maximum density that represented by 22 larvae / plant and 64 moths / trap) by direct count and male trap methods, respectively.

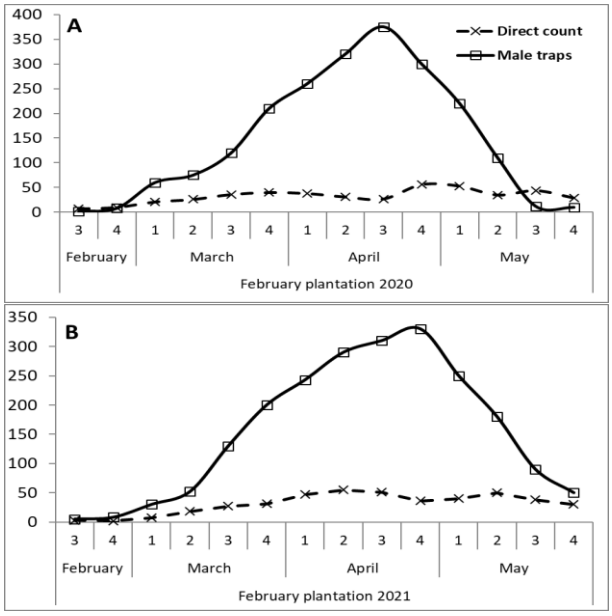

Fig .1. The population density of the tomato leafminer *T. absoluta* during February plantation of 2020 (A) and 2021 (B) seasons.

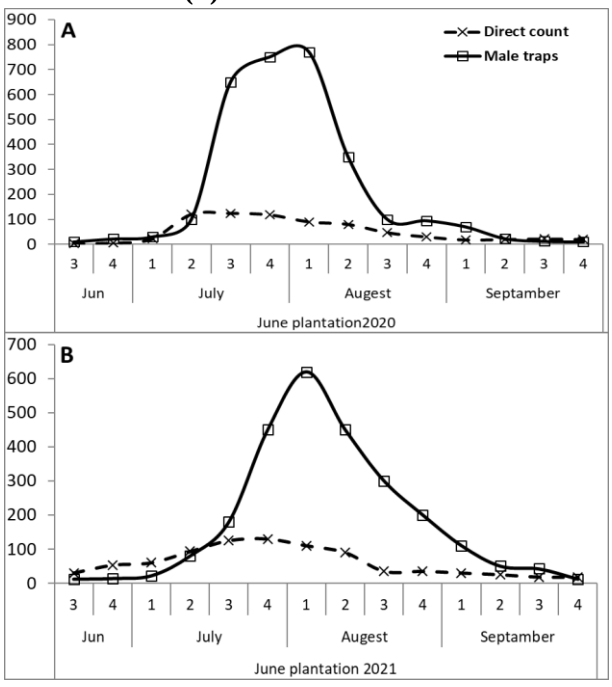

Fig .2. The population density of the tomato leafminer *T. absoluta* during June plantation of 2020 (A) and 2021 (B) seasons.

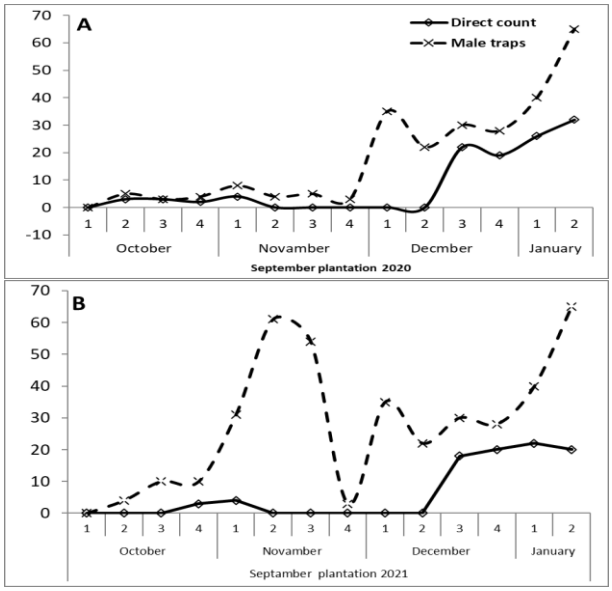

Fig .3. The population density of the tomato leafmainer *T. absoluta* during September plantation of 2020 (A) and 2021(B) season.

Data arranged in Table (1) show the average number of the tomato leafminer, *T. absoluta* in the three plantations of the first season (2020). It can be noticed that, June plantation came in the first category with using the two sample methods. It hosted 51.4 ± 12.0 larvae / plant and 200.0 ± 80.0 males / trap by the direct count and male trap methods, respectively. While, September plantation harboured the lowest average number (7.9 ± 3.1 larvae / plant and 18.0 ± 5.0 moths / trap by the two methods, respectively.

Table 1. The average number (± SE) of tomato leafminer, *T. absoluta* by direct count and male trap methods during the three plantation dates of 2020 season.

Method	Plantating dates		
	February	June	September
Direct count	32.3 ± 3.80 b	51.4 ± 12.0 a	7.9 ± 3.1 c
Male traps	156.0 ± 33.0 b	200.0 ± 80.0 a	18.0 ± 5.0 c

Means with the different letters in a row are significantly different at 0.05 level of probability (Duncan's Multiple Range Test)

Data arranged in Table (2) show the average number of the tomato leafminer, *T. absoluta* in the three plantations of the second season (2021). It can be noticed that, June plantation came in the first category with using the two sample methods. It hosted 60.9 ± 10.8 larvae / plant and 181.5 ± 53.1 males / trap by the direct count and male trap methods, respectively. While, September plantation harboured the lowest average number (6.2 ± 2.4 larvae / plant and 28.1 ± 5.7 moths / trap by the two methods, respectively.

Table 2. The average number (± SE) of tomato leafminer, *T. absoluta* by direct count and male trap methods during the three plantation dates of 2021 season.

Method	Plantating dates		
	February	June	September
Direct count	31.1 ± 4.8 b	60.9 ± 10.8 a	6.2 ± 2.4 c
Male traps	154.0 ± 31.3 a	181.5 ± 53.1 a	28.1 ± 5.7 b

Means with the different letters in a row are significantly different at 0.05 level of probability (Duncan's Multiple Range Test)

The present results illustrated in Table (3) show the predatory insects associated with *T. absoluta* in the three plantations during the first growing season (2020). It can be noticed that, the tomato bug, *N. tenuis* recorded the highest average number (300.0 ± 70.5 bugs), followed by *L. riparia* (8.5± 3.1 individuals) during June plantation of the first season. Meanwhile *C. undecimpunctata* came in the first category during February plantation and represented by 3.4 ± 0.7 beetles.

Table 3. The average number (± SE) of the predatory insects associated with the tomato leafminer, *T. absoluta* during the three plantation dates of the first growing season, 2020.

Predatory insects	Plantating dates		
	February	June	September
Nesidiocoris tenuis	2.1 ± 0.6 b	300 ± 70.5 a	2.8 ± 0.8 b
Coccinella undecimpunctata	3.4 ± 0.7 a	2.5 ± 0.8 ab	0.5 ± 0.2 b
Macrolophus pygmaeus	2.0 ± 0.5 a	0.0± 0.0 b	0.0 ± 0.0 b
Labidura riparia	0.0 ± 0.0 b	8.5± 3.1 a	0.0 ± 0.0 b
Chrysoperla carnea	0.9 ± 0.3 a	0.0 ± 0.0 b	0.0 ± 0.0 b
Total average	1.68 ± 0.42 b	60.54 ± 14.88 a	0.66 ± 0.2 b

Means with the different letters in a row are significantly different at 0.05 level of probability (Duncan's Multiple Range Test)

The present results illustrated in Table (4) show the predatory insects associated with *T. absoluta* in the three plantations during the first growing season (2021). It can be noticed that, the tomato bug, *N. tenuis* recorded the highest average number (286.9 ± 89.9 bugs), followed by *L. riparia* (7.6 ± 2.9 individuals) during June plantation of the second season. Meanwhile *C. undecimpunctata* came in the first category during February plantation and represented by 3.0 ± 0.5 beetles.

Statistical analysis revealed that there were significant differences between the three plantation dates in the average number of predatory insects of *T. absoluta* during the two growing seasons (2020 and 2021).

Table 4. The average number (± SE) of the predatory insects associated with the tomato leafminer, *T. absoluta* during the three plantation dates of the second growing season, 2021.

Predatory insects	Plantating dates		
	February	June	September
Nesidiocoris tenuis	1.4± 0.6 b	286 ± 89.9 a	2.8 ± 0.8 b
Coccinella undecimpunctata	3.0± 0.5 a	2.5 ± 0.8 ab	0.6 ± 0.3 b
Macrolophus pygmaeus	1.6 ± 0.7 a	0.4± 0.2 ab	0.0 ± 0.0 b
Labidura riparia	0.0 ± 0.0 b	7.6± 2.9 a	0.0 ± 0.0 b
Chrysoperla carnea	0.9 ± 0.3 a	0.0 ± 0.0 b	0.0 ± 0.0 b
Total average	1.38 ± 0.42 a	59.3 ± 18.8 b	0.68 ± 0.22 a

Means with the different letters in a row are significantly different at 0.05 level of probability (Duncan's Multiple Range Test)

Data represented in Table (5) show the simple correlation coefficient between the numbers of *T. absoluta* and its predators on tomato plants in three plantation dates during the two growing seasons (2020 and 2021). This relation varied from date to date and from season to season particularly to the tomato predatory bug, *N. tenuis*. The numbers of *N. tenuis* significantly correlated with those of *T. absoluta* during February and September plantations of the first season, but were during June and September plantations of the second season. In both seasons, the numbers of the eleven-spotted ladybird *C. undecimpunctata* significantly coincided with those of *T. absoluta* during February and June plantations, but not during September

plantation. The same significant relation was determined for *L. reparia* during June plantation of both growing seasons. The numbers of *M. pygemius* significantly correlated with those of *T. absoluta* during June plantation of the second season, whereas those of *C. carnea* inversely correlated, in a significant way, with numbers of *T. absoluta* during February plantation of the first season

Table 5. Simple correlation coefficient between *T. absoluta* and its predatory insects during different plantation dates of 2020 and 2021 seasons.

Predator insects	Plantating dates (2020)			Plantating dates (2021)		
	Feb.	June	Sep.	Feb.	June	Sep.
Nesidicoris teuis	0.43*	-0.45^{ns}	0.84***	0.13^{ns}	0.64**	0.88***
Machrolophus pygemius	NT	0.01^{ns}	-0.14^{ns}	NT	0.39*	0.22^{ns}
Coccinella undecimpunctata	0.49*	0.75***	0.27^{ns}	0.73**	0.66**	0.14^{ns}
Chrysoperla carnea	0.29^{ns}	NT	NT	-0.37*	NT	NT
Labidura riparia	NT	0.98***	NT	NT	0.88***	NT

*** Correlation is significant at the 0.05 level, ** Correlation is high significant at the 0.01 level, ***Correlation is highly significant at the 0.001 level, and ^{ns} Correlation is not significant. NT is not tested due to the few numbers of predator or its absence**

Results indicated that *T. absoluta* larvae and moths were found in the three plantations, but June plantation hosted the highest numbers followed by February plantation, whereas September plantation harboured the lowest numbers. These results agree with those obtained by Megahed (2014), Hassan *et al.* (2015) and Younes *et al.* (2018). The tomato predatory bug, *N. tenuis* recorded the highest numbers during June plantation of both growing seasons. These findings are in consistent with those of Karman *et al.* (2017); Darwish (2018) and El Wahab *et al.* (2018).

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تاثير تواريخ عروات الطماطم علي كثافة تعداد نافقة أوراق الطماطم توتا أبسلوتا ومفترساتها الحشرية

سمير صالح عوض الله [1] ، محمد حسن بيومي [1] ، اكرام عبده [2] ، مصطفى فاروق عليمي[2] و نسرين الموافى[2]

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تعد حشرة صانعة انفاق الطماطم ، أهم الآفات الحشرية على الطماطم فى الصوبات الزراعية والحقول ، حيث انها احدى حشرات حرشفية الاجنحة التي تصيب محصول الطماطم فى مواعيد الزراعة المختلفة و تسبب خسارة كبيرة من 80 الى 100 % من محصول الطماطم. اجريت الدراسة الحقلية فى المزرعة البحثية التابعة لمحطه البحوث الزراعية بسخا بمحافظة كفر الشيخ فى العامين 2020 و2021 لدراسة تأثير مواعيد الزراعة المختلفة (فبراير - يونيو -سبتمبر) علي الكثافة العددية لصانعة انفاق الطماطم ومفترساتها الحشرية. اظهرت النتائج ان المجموع العددي لصانعة انفاق الطماطم والمفترسات المصاحبة لها تأثرت بمواعيد الزراعة خلال كلا سنتي الدراسة. باستخدام طريقة العد المباشر اوضحت النتائج ان اعلي ذروات ليرقات الحشرة كانت في عروة يونيه خلال الموسم الاول والثاني من الزراعة مسجلة اعداد 124 و 130 يرقة لكل نبات علي التوالي. اما باستخدام طريقة اصطياد الذكور فان النتائج اوضحت ان اعلي تعداد لذكور الفراشة كان في عروة يونيه (770 و 880 ذكر/مصيدة). اما باستخدام كلا الطريقتين فان عروة سبتمبر سجلت اقل متوسط عددي لكل من يرقات وذكور الحشرة خلال كلا موسمي الدراسة. اما بالنسبة للمفترسات الحشرية لحشرة صانعة انفاق الطماطم فان بقة الطماطم سجلت اعلي متوسطات للتعداد في عروة يونية في السنة الاولي والثانية مسجلة منوسطات 300 ± 70.5 و 286.9 ± 89.9 بقة علي التوالي. اما تعداد مفترس ابو العيد 11 نقطة احتل المركز الاول في عروة فبراير مسجلا متوسطات اعداد 3.4 ± 0.7 و 3.0 ± 0.5 فرد خلال السنة الاولي والثانية علي التوالي. اما عروة سبتمبر جاءت في المركز الاخير مسجلة اقل متوسط اعداد للمفترسات الحشرية المرتبطة بصانعة انفاق الطماطم.