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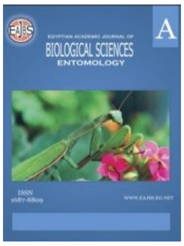

Developmental Stages and Life Table Parameters of the Two Spotted Spider Mite, *Tetranychus Urticae* Koch (Acari: Tetranycidae) On Different Eggplant Genotypes.

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ABSTRACT

The two-spotted spider mite, *Tetranychus urticae* Koch. (Acari: Tetranychidae) is considered one of the most serious pests all over the world and attacked about 1200 species of plants. It causes damage to vegetables, beans, peas, hops, grapes, deciduous fruit trees and many other fruit and flowers. Also, it prefers some genotypes of a plant to other genotypes of the same plant. This study is concerned mainly with evaluating the less favorite eggplant genotype to *T. urticae* and the best type for agriculture and find out the possible reason behind this preference. The longest life cycle was recorded for Rima F1 that was11.20 days and the shortest was 8.93 days for Rondona F1. Also, Rima F1 had the longest generation of 12.37 days and Rondona F1 had the shortest generation 10.37 days. The fecundity of females feed on leaves of Rondona F1 was the highest at 101.14 eggs/ female. So the results proved that Rima F1 was less affected by *T. urticae*. The possible reason for this preference is that Rima F1 had the highest percentage of potassium in their leaves that provides a mechanical resistance against piercing-sucking pests including *T. urticae*.

INTRODUCTION

The eggplant (*Solanum melongena* L.) is an important vegetable crop which grown in wide climate conditions covering most of the world (Sihachakr *et al*. 1994). It belongs to the family Solanaceae and it is a good source of vitamins B1 and B6 and potassium although it is very low in fats and calories (Lester and Hasan, 1991). Eggplant crops are attacked by more than thirty mite species around the world (Brar *et al*., 2003). In 2014, the total areas cultivated with eggplant reached 49713 hectares produced 1257913. Among many obstacles including insects, nematodes, fungi, bacteria and viruses in cultivating solanaceous crops, phytophagous mites are considered as major pests of these crops (Adango *et al*., 2006). On the other hand, *Tetranychus urtica* (Acari: Tetranychidae) are important polyphagous pests that can cause remarkable damage to the majority of economic plants including eggplant (Grewal 1992) and (Kumral 2016). These mites mostly attack plants because of the favorable conditions for their development (Maluf *et al*., 2010). Host-plant resistance to arthropod pests is an effective, economical, and environmentally friendly method of pest control and a central component of any pest management strategy along with natural enemies and cultural practices (Sharma and Ortiz 2002). Using resistant host plants is one of the most important components of integrated pest management programs. *T. urticae* attacks eggplants and sucks plant sap and then plants lose their green appearance and quality (Musa *et al*., 2021). Both nymphs and adults feed primarily on the underside of the leaf, and then the upper surface of the leaf becomes stippled with little dots which are feeding punctures. In case of high mite density, the leaves may have a bronze appearance and some leaves even dying off as a result of the intense feeding. So, a large amount of silk webbing is produced by the mite and may completely cover the infested areas of leaves (Zhang 2003). Plant resistance makes the plants can avoid or inhibit host selection. Several studies indicated that the two-spotted spider mite does not accept all plants to the same degree (El-Sadan 2018). Many factors play an important role in plant acceptance (Kumral *et. al*., 2017). Understanding the reproductive parameters of a pest is one of the key components in the development of an integrated pest management strategy (Kasap 2002). The aim of this study is to evaluate the preference of *T. urticae* to different eggplant genotypes and find out the possible reason behind this preference.

MATERIALS AND METHODS

Rearing Mites:

T. urticae were collected from eggplant leaves of unsprayed fields then, leaves were examined under a stereomicroscope. After confirming the identity of the mite, the leaves were placed with the upper surface down on a cotton pad soaked with water in Petri dishes of 9 cm diameter. Each leaf was surrounded by a cotton strip saturated with water; leaves were changed every four days to avoid leaf deterioration and consequent mall nutrition. The culture was kept under laboratory conditions, at 27± 2° C and 65± 5%RH.

Eggplant Cultivars and Grown:

Seeds of different eggplant genotypes were obtained from Syngenta Egypt S&G Company. Five seedlings of eggplant genotype were planted to use in *T. urticae* rearing. The three genotypes were Mileda F1, Rima F1 and Rondona F1. The seedlings were irrigated every three days with tap water and fertilized weekly with 100 mL water-soluble fertilizer containing (7% phosphorus, 3% total nitrogen, 4.5% potassium, 0.25% iron, 0.1% zinc, 0.1% sulphur, 0.01% copper and 0.1% manganese).

Application Method:

Three pettri dishes were used, one for each type. In each plate, three discs of each genotype were prepared and three females of *T. urticae* were put over the prepared three discs, one female on each disc. Then, the daily laid eggs were evaluated and counted carefully for life table detection.

Oviposition and Life Table Parameters:

After emerging a new generation of females, durations of preoviposition,oviposition, postoviposition, daily fecundity and longevity of each female were recorded daily during her life. The net reproductive rate (R_0), Intrinsic rate of increase (r_m), the finite rate of increase (exp $_{rm}$), the mean generation time (T) and the doubling time (DT) were calculated based on Birch (1948) method.

Plant Analysis:

Plant analysis of the eggplant genotypes leaves was carried out at (NOUR for agriculture consultant's tests of soil fertility and plant nutrient lap) at Mansoura city, to confirm the possible reasons for this preference.

Statistical Analysis:

Results were analysed by life table program (Abou- Setta *et al.*, 1986), Standard error (SE) was calculated by Excel program.

RESULTS AND DISCUSSION

I- Biological aspects:

1.Survival and development:

Data in **Table (1)** cleared that, the incubation period of *T. urticae* increased with Rima F1 genotype host plant recording 4.39 days, followed by Mileda F1 that records 3.75 days and then Rondona F1 that records 3.66 days. Also, the total immature stages (larvae, proto- nymph and duto- nymph) were longest with Rima F1 genotype and recorded 6.81 days followed by Mileda F1 that was 5.62 days and then Rondona F1 that recorded 5.27 days. So, the total life cycle was long also with Rima F1 that was 11.2 days, then Mileda F1 that was 9.37 days and the shortest period was for Rondona F1 (8.93) days. From the previous results, we can conclude that the eggplant genotype Rima F1 was more suitable for *T. urticae* rearing, so, it's the most genotype infected by *T. urticae* while Rondona F1 was the least infected genotype by *T. urticae*. And so, Rondona F1 is more suitable for planting (Nabi *et al.*, 2019) and (Khanamani *et al.*, 2013) mentioned that some eggplant genotypes were more preferred than other types and recorded longest days than the other not preferred types. Also, **Table (1)** showed that the generation of Rima F1 had the longest days and recorded 12.37 days followed by Mileda F1 that recorded 10.77 days then Rondona F1 that recorded 10.37 days.

Table 1: Duration of different stages of *T. urticae (Koch)* female when fed on leaves of three eggplant genotypes.

Eggplant genotypes		Mileda F1	Rima F1	Rondona f1
Incubation period		3.75 ± 0.07	4.39 ± 0.09	3.66 ± 0.06
Immature stages (days)	**larvae**	1.74 ± 0.08	2.02 ± 0.15	1.54 ± 0.06
	Proto-nymph	2.00 ± 0.07	2.15 ± 0.12	1.40 ± 0.07
	Duto- nymph	1.88 ± 0.09	2.64 ± 0.23	2.33 ± 0.09
Total immature stages		5.62 ± 0.18	6.81 ± 0.35	5.27 ± 0.15
Life cycle		9.37 ± 0.15	11.20 ± 0.27	8.93 ± 0.18
Generation period		10.77± 0.22	12.37± 0.16	10.37± 0.12

2.Adult Longevity and Fecundity:

Results in **Table (2)** cleared that, the pre- oviposition period was shortest with the genotype Rondona F1 (1 day) than the other two genotypes Rima F1 and Mileda F1, however, Mileda F1 recorded the highest period that was 1.84 days. On the contrary, Rondona F1 during the oviposition period recorded the highest period that was 16.15 days compared with the other tested genotypes Mileda F1 and Rima F1 that recorded (12.64 and 11.83 days, respectively). Thus the longevity of *T. urticae* on Rondona F1 was the highest period and recorded 20.38 days followed by Mileda F1 that was 16.14 days and then Rima F1 that had the lowest period and recorded 14.50 days. It's noteworthy that, Rondona F1 recorded the highest rate of egg lying that was 101.14 eggs/ female, however, Mileda F1 had 81.92 eggs/ female and the lowest rate was recorded by Rima F1 recording 45.50 eggs/ female; so, the daily rate of laid eggs was the highest with Mileda F1 (6.48) followed by Rondona F1 (6.26) and Rima F1 (3.85). Rondona F1 had the longest oviposition period with the highest rate of egg-laying, which mad Rondona F1 genotype most favorable for *T. urticae*. (Musa *et al*., 2021) noticed that the periods of pre- oviposition, oviposition and post oviposition differed among eggplant genotypes; they also noted the difference in female egg rates among the genotypes.

Table 2: Adult female longevity and fecundity of *T. urticae (Koch)* when fed on leaves of three eggplant genotypes.

Eggplant genotypes		Mileda F1	Rima F1	Rondona f1
Average duration (days)	Pre oviposition Period	1.84 ± 0.07	1.17 ± 0.31	1.00 ± 0.25
	Oviposition period	12.64 ± 1.49	11.83 ± 1.35	16.15 ± 1.34
	Post oviposition Period	2.50 ± 0.44	1.50 ± 0.96	2.39 ± 0.49
Longevity (Days)		16.14 ± 1.01	14.50 ± 0.86	20.38 ± 1.25
Fecundity	Egg / Female	81.92 ± 7.77	45.50 ± 6.28	101.14 ± 7.37
	Daily Rate	6.48 ± 0.15	3.85 ± 0.27	6.26 ± 0.18

3.The Survival Rate of The Developmental Stages of *T. urticae*:

Data in **Table (3)** showed that the hatching percentage was 93.41% for Rondona F1 and this was the highest percentage followed by Mileda F1 and recorded 86.81% then Rima F1 recorded the lowest hatching percentage that had 81.82%. However, *T. urticae* larvae survival rate was the highest with Rondona F1 followed by Rima F1 and then Mileda F1 and they recorded 94.12%, 92.06% and 81.18%, respectively. Proto-nymph percentage was the highest for Rondona F1 and recorded 95.00% followed by Mileda F1 that had 82.50% and then Rima F1 that was 75.86%. However, the duto- nymph survival percentage was the highest with Rondona F1 followed by Rima F1 then Mileda F1 and they recorded 97.38%, 94.55% and 72.09%, respectively.

Also, **Table (3)** cleared the survival percentage of the life cycle for *T. urticae* on the three genotypes and demonstrated that Rondona F1 had the highest percentage (92.52%) followed by Mileda F1 (75.61%) and then Rima F1 (71.43%). These results indicated that Rondona F1 had the highest survival rate percentage for all developmental stages of *T. urticae*. (Nabi *et al*., 2019) and, (Musa *et al*., 2021) proved similar results as the obtained results.

Table 3: survival rate percentage of all developmental stages of *T. urticae* when fed on leaves of three eggplant genotypes.

Eggplant genotypes	Mileda F1	Rima F1	Rondona f1
Number of eggs started with	**80**	**45**	**100**
Hatching %	86.81 ± 0.07	81.82 ± 0.31	93.41 ± 0.25
Larvae %	81.18 ± 1.49	92.06 ± 1.35	94.12 ± 1.34
Proto-nymph %	82.50 ± 0.44	75.86 ± 0.96	95.00 ± 0.49
Duto- nymph %	72.09 ± 7.77	94.55 ± 6.28	97.38 ± 7.37
Life cycle %	75.61 ± 0.15	71.43 ± 0.27	92.52 ± 0.18

II. Life Table:

Data in **Table (4)** showed the generation time (T), net reproduction rate (R_o), intrinsic rate of increase (r_m), finite rate of increase (exp $_{rm}$) and generation doppling time (G.D.T.). The net reproduction rate (R_o) was 42.69, 42.09 and 26.74 days within a single generation on leaves of the three eggplant genotypes Mileda F1, Rondona F1 and Rima F1, respectively.

The duration of one generation of *T. urticae* as mentioned in the same table lasted about 0.26, 0.24 and 0.22 days on leaves of Rondona F1, Mileda F1 and Rima F1, respectively.

The value of the intrinsic rate of increase (r_m) which expresses the relationship between fecundity, generation time and its survival differed from one genotype to another. The eggplant genotype Rondona F1had the highest value that was 12.37 then Mileda F1 had 10.77 followed by Rima F1 that was 10.37. The higher value of (r_m) is attributed to the greater rate of fecundity per female (R_o) and shorter generation time (r_m =log R_o /T) at the favorable genotype than the other. Contrary, when the values of the (r_m) were converted to the finite rate of increase (exp $_{rm}$) it is clear that the population of *T. urticae* had a capacity to multiply about 1.30, 1.27 and 1.24 on Rondona F1, Mileda F1 and Rima F1 genotypes, respectively. The fraction of eggs reaching maturity was higher on Rondona F1 genotype that was 92.52 followed by the genotype Mileda F1 that was 75.61 and then Rima F1 that was 71.43. The generation doppling time (G.D.T.) had values 6.49, 5.84 and 5.46 to Rima F1, Mileda F1 and Rondona F1, respectively; which the eggplant genotype Rima F1 leaves have higher result than the two others. (Nabi *et al.*, 2019) proved similar results on the life table of *T. urticae* on bean varieties. Also, (Kasap 2002) proved similar results on the life table of *T. urticae* on eggplant genotypes.

Table 4: Influence of three eggplant genotypes on life table parameters of *T. urticae* female.

Parameters	Mileda F1	Rima F1	Rondona f1
Net reproduction rate (Ro)	42.69	26.74	42.09
Mean generation time (T)	0.24	0.22	0.26
Intrinsic rate of increase (rm)	10.77	10.37	12.37
Finite rate of increase (exp $_{rm}$)	1.27	1.24	1.30
Fraction of eggs reaching maturity	75.61	71.43	92.52
Generation doubling time (days)*	5.84	6.49	5.46

- Generation doubling time (days) = $\ln_2 / r_m$

III- Plant Analysis:

Data in **Table (5)** showed that Rima F1 had the lowest Nitrogen and phosphorus levels (4.4, 1.3) followed by Mileda F1 (5.5, 1.7), and the highest percentages were (5.8, 2.6) for Rondona F1, respectively. The potassium percentage was highest in Rima F1 (4.9) followed by Mileda F1 (4.1) and the lowest level was (3.2) for Rondona F1.

The role of potassium in mitigating crop damage due to insects is complex. Potassium plays an important physiological role including a build-up of resistance to pests. Adequate amounts of K have been reported to decrease the incidence of pest damage considerably. Plants well supplied with nitrogen and insufficient potassium have soft tissue with little resistance to piercing-sucking pests. (Nabi *et al.*, 2019).

Adequate levels of potassium in plants lead to a reduction in carbohydrate accumulation, lowering the likelihood of attracting pests. A sufficient potassium supply tends to harden plant structures, strengthening cell walls, leading to thicker and harder stems and leaves. This hardening of plant structures improves mechanical resistance to the feeding of pests especially piercing-sucking ones such as two-spotted spider mites.

Potassium also has a negative impact on the growth and development of piercing-sucking pests. Higher plant potassium levels resulted in a decline in occurrence, population levels, rate of population increase and net reproductive rate, these results agree with Brodbeck *et al.* (1990), Bruulsema *et. al*., (2010) and Walter and Difonzo (2007).

Table 5: Plant analysis (%) of three eggplant genotypes

Eggplant genotypes	Mileda F1	Rima F1	Rondona f1
Nitrogen (N) %	5.5 ± 0.64	4.4 ± 0.22	5.8 ± 0.72
Phosphorus Pg gk	1.7 ± 0.42	1.3 ± 0.26	2.6 ± 0.35
Potassium K %	4.1 ± 0.63	4.9 ± 0.14	3.2 ± 0.55

CONCLUSION

From the obtained results, we can conclude that the eggplant genotype Rondona F1 is more suitable for the reproduction of *T. urticae*, so this type is not favorable in agriculture; on contrary, the genotype Rima F1 that is less suitable for reproduction of *T. urticae* so it's more favorite type in agriculture because it can be naturally protected from the infection of *T. urticae***.**

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