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Compatibility of Jamama Oil (*Eruca sativa* L.*)* with Different Stages of *Trichogramma chilonis* (Ishii) (Hymenoptera: Trichogrammatidae)

Ahmad-Ur-Rahman Saljoqi,[1]* Qasim Zia,[1] Faqir Gul[2] and Sadur-Rehman[3]
[1]*Department of Plant Protection, Khyber Pakhtunkhwa Agricultural University, Peshawar, Pakistan*
[2]*Sugarcane Research Centre, Mardan, Khyber Pakhtunkhwa, Pakistan*
[3]*Agricultural Research Institute, Tarnab, Peshawar, Pakistan*

Absract.- *Trichograma chilonis* (Ishii) is an effective egg parasitoid of lepidopterous pests. It controls pests in eggs stage prior to its damaging to crop. The parasitoid is vulnerable to insecticides or oil sprays applied to the crops. The present study was intended to evaluate the compatibility of Jamama oil (*Eruca sativa* L.) with *T. chilonis* under the controlled laboratory conditions. Different Jamama oil concentrations *i.e.* 1.25, 1, 0.75, 0.5, 0.25% were tested on the different stages of *T. chilonis.* In pre-oviposition preference of *T. chilonis* experiment, all the studied parameters including percent parasitism, adult emergence and longevity were found significantly reduced while emergence time significantly increased by all the concentrations of Jamama oil as compared with the control. The results showed that the highest concentration of Jamama oil (1.25%) gave the minimum percent of parasitism, adult emergence and longevity (1, 0.75, 0.5 and 0.25% respectively). Lowest emergence time was recorded by utilizing the lowest concentration of Jamama oil (0.25%) followed by 0.5, 0.75, 1 and 1.25%, respectively. Same trend was also observed in all these parameters in post oviposition of *T. chilonis* in eggs stage, larval stage and pupal stage by utilizing the different concentration of Jamama oil. In the post oviposition of *T. chilonis* in adult stage, the highest concentration (1.25%) significantly reduced the adult longevity followed by the lower concentrations respectively. Highest longevity was recorded by using the lowest concentration of Jamama oil (0.5%). These studies showed that Jamama oil adversely affected percent parasitism, adult emergence, emergence time, and longevity of *T. chilonis* more in the pre-oviposition stage as compared with the post ovisposition stages of *T. chilonis*. Moreover, lowest concentrations of Jamama oil were found least toxic to *T. chilonis* and more effective in terms of percent parasitism, adult emergence, emergence time and longevity of *T. chilonis*. The results also showed that in the post oviposition stage of *T. chilonis*, in pupal stage the different concentrations of Jamama oil gave better results in all the studied parameters as compared to all other stages. This shows that Jamama oil can be combined more effectively with the *T. chilonis* in the pupal stage.

Key words: Jamama oil, *Eruca sativa*, *Trichogramma ishii*, egg parasitoid.

INTRODUCTION

Use of chemical insecticides induces resistance in insects; destroy natural enemies and causes environmental and human risks. Therefore alternatives to insecticides are receiving much attention (Shahid, 2003). Biological control is relatively safe, longer lasting, economical and environmental friendly pest control strategy. Many natural enemies are host specific or restricted to a few closely related species; it is unlikely that non-target species are affected (Shenhmar *et al*., 2003).

Trichogramma spp. are small tiny wasps which can parasitize eggs of over 200 species (mostly Lepidopterous insect's pests) (Youssef *et al*., 2004). Larvae hatch from these eggs and feed inside the contents of host eggs. Fully mature larvae pupate inside the same egg and emerge as parasitic wasp. Normally in the field *Trichogramma* occur naturally. But in most crops production systems the number of caterpillar eggs destroyed by the native population of *Trichogramma* spp. is not sufficient to prevent pest population from damaging level. In such cases the mass reared population of *Trichogramma* are applied in the field to overcome the pest attack. *Trichogramma* species are being mass reared to control pests of sugarcane, rice, cotton, sugar beet, fruits, vegetables and pine in 16 countries of the world (Hassan, 1993).

Trichogramma chilonis (Ishii) (Hymeoptera; Trichogrammatidae) is the typical gregarious egg parasitoid and are widely distributed throughout the world. In Pakistan it has been recorded from *Chilo infuscatellus* Snellen, *Chilo partellus* (Swenhoe),

* Corresponding author: drsaljoqi@yahoo.com
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Helicoverpa armigera (Hubner), *Agrotis ipsilon* (Hufnagel), *Spodoptera litura* (Fabricius) and *Bisstetia steniellus* (Hampson) (Gul, 2007).

Botanical insecticides are promising alternatives for use in insect management, because it has comparatively lower toxic effect on natural enemies as compared to broad spectrum insecticides. These insecticides degrade rapidly in sunlight, air, and moisture and are rapidly broken down by detoxification enzymes. The rapid degradation of botanical insecticides and their action as stomach poisons make them more selective in some instances against pest insects and hence less harmful to beneficial insects. There are many botanical insecticides which are safe to use in pest management along with biological control agents (Regnault, 1997).

Jamama plant *(Eruca sativa* L.) is an annual herb found in tropical and subtropical regions. It is native of south Europe but now available in many countries. It shows some insecticidal properties to control the rice pests, stored grain pests and nematode etc. (Riga *et al.*, 2006). As the generic name implies, the herb Jamama plant (rocket) is high in erucic acid. Other crops which are high in erucic acid are oilseed rape seed and crambe. The essential oil (Jamama oil) obtained from the leaves of *Eruca sativa* contain 67 volatile components, representing 96.52% of the oil, which are characterized by the main constituent's 4-methyl-thiobutylisothiocyanate (60.13%) and 5-methylthio-pentanonitrile (11.25%). The essential oil from the leaves of *E. sativa* is characterized by a high content of sulfur- and nitrogen-containing compounds. *Eruca* is also sometimes referred to as rocket, true rocket, rocket salad, arugula, roquette or white pepper (Miyazawa *et al*., 2002).

The Jamama oil also have useful enzymes Methylsulphinylbutyl isothiocyanate inducing enzymes which have anti-cancer activity and are found in Eruca but not in oilseed rape. The enzyme glucosinolate has much greater potency than those of isothiocyanates available in oilseed rape. It may therefore be possible to alter the flavor composition and the nutritional value of oilseed rape through the introgression of *Eruca* genes (Magrath and Mithen, 2001).

There is no work available on the compatibility of *E. sativa* with beneficial insects particularly side effects of *E. sativa* on *T. chilonis.* The present work was, therefore, conducted on the compatibility of *E. sativa* with different stages of *T. chilonis,* under laboratory conditions.

MATERIALS AND METHODS

The study on compatibility of Jamama oil (*E. sativa*) with different stages of *Trichogramma chilonis* was conducted in the controlled laboratory conditions. Completely Randomized Design (CRD) was used in all experimental work having five replications with six treatments. Small glass vials were used as replications which were fixed in steel stand. Each glass vial was having an egg card of about sixty eggs of *S. cereallela.* The data were analyzed by using Statistical computer package and treatment means were separated through LSD test (Gomez and Gomez, 1984).

Rearing host, S. cerealella *(Olivier)*

Sitotroga adults were obtained from the infested grains and kept in oviposition jars having lid on the top while bottom of each jars was cut out and mesh no. 25-30 or 35-40 were fixed on their bottom. The oviposition jars were placed in a dish containing starch for oviposition. The eggs laid in the starch were separated daily by using a sieve (with mesh no. 50-70). The eggs obtained were spread out in sterilized grains, kept in glass jars or in host rearing chambers for larval and adult's emergence. The host eggs used for mass production of *T. chilonis* was stored at 25-30°C and 70-80% relative humidity.

Rearing of Trichogramma *on* S. cereallela

Gum was spread uniformly on a piece of hard paper. The host eggs (*S. cerealella*) were sprinkled on the sticky cards. These eggs cards were placed in UV radiation for one hour, to kill the larvae present inside the eggs. Then the egg cards were transferred to glass jars containing adults of *T. chilonis* for 1-3 h for parasitism. After 1-3 h, the cards were removed and were kept in incubator at 25-30°C and 60-70% RH for parasitoid development. When the parasitoid emerged, these were used for further parasitization of host eggs.

Preparation of concentrations of Jamama oil

Different concentrations (0.25%, 0.50%, 0.75%, 1%, 1.25%) of Jamama oil was prepared, for which one gram surf was mixed in each concentration as surfactant, while water + surf in the same ratio were used as check. The experiment was conducted in the laboratory under 25-30°C and 60-70% relative humidity.

Treatment of pre-oviposition stage of T. chilonis

To study the effect of Jamama oil concentrations on pre-oviposition stage of *T. chilonis*, sixty eggs were sprinkled on six glued cards and sprayed with different concentrations of Jamama oil, then shifted these cards to vials. After treatment one pair of *T. chilonis* was allowed in each vial for parasitisation for six hours.

Data on percent parasitism, adult emergence, emergence time, and longevity were recorded.

Treatment of T. chilonis *egg stage*

Cards having of *S. cereallela* eggs were fixed in vials having a pair of *T. chilonis* for six hrs. 24 hrs after parasitism the egg cards were treated with different concentrations of Jamama oil with the help of spray gun. Data on percent parasitism, adult emergence, emergence time and longevity were recorded.

Treatment of T. chilonis *larval stage*

To see the effect of Jamama oil on the larval stage of *T. chilonis*, three days after parasitism the egg cards were treated with different concentrations of Jamama oil. Data on the above mention parameters were recorded as usual.

Treatment of T. chilonis *Pupal stage*

The parasitoid was released on *S. cereallela* eggs on trichocards. After five days the color of the parasitoid eggs turned black which was the pupal stage of parasitoid. The parasitoid at this stage on trichocards was treated with the above concentrations of Jamama oil. Data were recorded on the above parameters accordingly.

Treatment of T. chilonis *adult stage*

The adult emerged from the parasitoid eggs were shifted to glass vials with rolled card already treated with different concentrations of Jamama oil. Data were recorded on adult longevity only.

RESULTS

Pre-oviposition preference of T. chilonis *after spray of different concentrations of Jamama oil on* S. cereallela *eggs*

Results presented in Table I showed that percent parasitism of *Trichogramma* on *S. cereallela* eggs were 26.69, 28.78, 32.30, 35.02 and 39.92% in T1, T2, T3, T4 and T5, respectively. All these treatments were not significantly different from one another. Highest percent parasitism (57.13) was observed in control. The data showed that parasitism was significantly increased by increasing the Jamama oil concentrations (T1 – T5).

Table I.- Pre-oviposition performance of *Trichogramma chilonis* (Ishii) after spray of different concentrations of Jamama oil on host eggs of *Sitotroga cereallela* (Olivier).

Treatments (Jamama oil concentration)	Parasitized eggs (%)	Adult emergence (%)	Emergence time (days)	Adult longevity (Hours)
1.25% (T1)	26.69 e	41.45 f	14.00 a	31.41 d
1.00% (T2)	28.78 de	46.17 e	13.25 a	33.09 cd
0.75% (T3)	32.30 cd	50.98 d	12.61 a	34.62 cd
0.50% (T4)	35.02 c	56.97 c	11.63 a	37.32 bc
0.25% (T5)	39.92 b	60.88 b	11.24 a	41.67 b
Control (T6)	57.13 a	77.37 a	10.03 a	56.13 a
LSD	4.02	3.29	21.19	5.75

Numbers in columns having same letters are non-significantly different at 5% level of probability, using LSD Test.

The lowest percent adult emergence (41.45%) was recorded by using the highest concentration (T1) followed by 46.17, 50.98, 56.97 and 60.88% in T2, T3, T4 and T5 respectively. Highest adult emergence (77.37%) was recorded in check (T6). The adult emergence was found on increasing rate by decreasing the concentrations of Jamama oil (T2-T5). Data in Table I further reveal that, adult emergence time in days was recorded highest (14.00 days) in the highest concentration of Jamama oil (T1) while lowest (11.24) in the lowest concentration (T5). The adult longevity time was found progressively increased by decreasing the concentrations of Jamama oil (Table I).

Post-oviposition performance of T. chilonis *after spray of different concentrations of Jamama oil on* S. cereallela *eggs*

Egg stage

Lowest percent parasitism of *T. chiloni* (42.54%) was recorded in highest concentration of Jamama oil (T1) followed by 45.25, 48.11, 51.85 and 56.84% in T2, T3, T4 and T5 respectively. Highest parasitism (62.85%) was recorded in the control (T6). Same trend was also observed in the adult percent emergence rate. Significantly highest emergence time in hours (11.65 days) was recorded in the highest concentration of Jamama oil (T1). It decreased by decreasing the Jamam oil concentration rate. Highest adult longevity (59.47 h) in check (T6) as compared with all other concentrations. The data showed that as the concentration was increased, the adult longevity was found decreased (Table II).

Larval stage

All concentrations of Jamama oil significantly affect the percent parasitism, percent emergence, emergence time and longevity of *Trichogramma* as compared with the control. Significantly minimum percent parasitism of *T. chilonis* (44.90%) was recorded in the highest concentration of Jamama oil (T1) followed by 48.13, 50.39 and 53.14 in T2, T3 and T4, respectively, while highest percent parasitism (56.15%) was recorded in the lowest concentration (T5). Same trend was also observed for percent adult emergence and longevity of *Trichogramma*, where highest concentrations of Jamama oil reduced their performance as compared with the reduced concentrations. Highest adult emergence time (13.59 days) was recorded in the highest concentration of Jamama oil (T1) followed by 12.64, 11.96, 10.99 and 10.14 days in T2, T3, T4 and T5 respectively (Table III).

Pupal stage

Lowest percent adult emergence (45.57%) was recorded by applying the highest concentration of Jamama oil (T1) followed by 47.41, 56.63, 60.14 and 64.77% in T2, T3, T4 and T5, respectively. The data showed that, significantly highest adult emergence (79.35%) was noted in control (T6) as compared with all other treatments. The adult emergence percentage was found on increasing rate by decreasing the concentrations of Jamama oil (T1-T5). Lowest percent adult emergence (45.57%) was recorded by applying the highest concentration of Jamama oil (T1) followed by 47.41, 56.63, 60.14 and 64.77% in T2, T3, T4 and T5 respectively The data also showed that the highest adult emergence time (11.14 days) was recorded in the highest concentration of Jamama oil (T1) and it was progressively decreased by decreasing the concentration of Jamama oil (Table IV).

Adult stage

Figure 1 shows the adult longevity with

Table II.- Performance of *Trichogramma chilonis* (Ishii) after spray of different concentrations of Jamama oil concentrations on host eggs of *Sitotroga cereallela* (Olivier) during egg stage.

Treatments (Jamama oil concentration)	Parasitized eggs (%)	Adult emergence (%)	Emergence time (days)	Adult longevity (Hours)
1.25% (T1)	42.54 e	55.43 d	11.65 a	37.50 d
1.00% (T2)	45.25 de	59.05 cd	10.65 abc	41.00 cd
0.75% (T3)	48.11 d	61.94 c	10.84 ab	43.23 c
0.50% (T4)	51.85 c	68.88 b	10.18 bc	43.78 bc
0.25% (T5)	56.84 b	71.29 b	10.16 bc	48.15 b
Control (T6)	62.85 a	78.25 a	9.54 c	59.47 a
LSD	3.357	4.85	1.24	4.66

Numbers in columns having same letters are non-significantly different at 5% level of probability, using LSD test.

Table III.- Performance of *Trichogramma chilonis* (Ishii)after spray of different concentrations of Jamama oil on host eggs of *Sitotroga cereallela* (Oloivier) during larval stage.

Treatments (Jamama oil concentration)	Parasitized eggs (%)	Adult emergence (%)	Emergence time (days)	Adult longevity (Hours)
1.25% (T1)	44.90 e	49.23 e	13.59 a	37.11 d
1.00% (T2)	48.13 de	51.40 de	12.64 ab	41.18 c
0.75% (T3)	50.39 cd	54.67 d	11.96 abc	42.82 c
0.50% (T4)	53.14 bc	59.48 c	10.99 bc	46.99 b
0.25% (T5)	56.15 b	64.00 b	10.14 c	49.41 b
Control (T6)	60.44 a	76.10 a	11.90 abc	58.54 a
LSD	3.78	3.73	1.86	3.49

Numbers in columns having same letters are non-significantly different at 5% level of probability, using LSD test.

increasing concentration of Jamama oil. Highest adult longevity (56.15 h) was recorded in control (T6), while lowest adult longevity (42.67 h) was recorded in the highest concentration of Jamama oil (T1).

Table IV.- Performance of *Trichogramma chilonis* (Ishii) after spray of different concentrations of Jamama oil on host eggs of *Sitotroga cereallela* (Olivier) during pupal stage.

Treatments (Jamama oil concentration)	Adult emergence (%)	Emergence time (days)	Adult longevity (Hrs)
1.25% (T1)	45.57 d	11.14 a	39.93 c
1.00% (T2)	47.41 d	10.27 ab	40.53 c
0.75% (T3)	56.63 c	9.75 ab	42.12 bc
0.50% (T4)	60.14 bc	9.78 ab	45.32 b
0.25% (T5)	64.77 b	9.39 b	45.89 b
Control (T6)	79.35 a	8.890 b	55.65 a
LSD	2.72	0.66	2.76

Numbers in columns having same letters are non-significantly different at 5% level of probability, using LSD test.

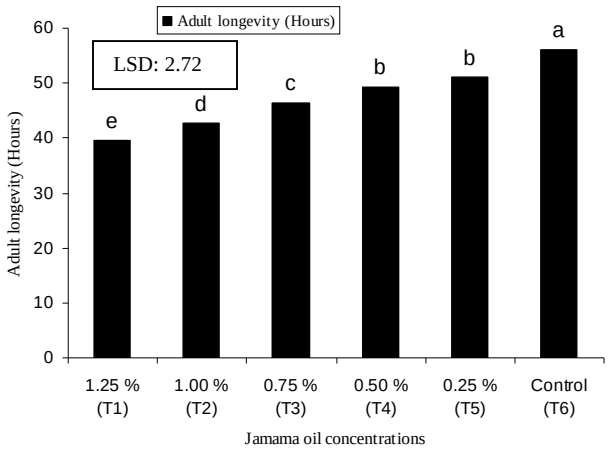

Fig. 1. Performance of *T. chilonis* after spray of different concentrations of Jamama oil on its adult stage.

DISCUSSION

The present work showed that percent parasitism, emergence time, adult emergence and longevity in pre-ovipositon preference stage of *T. chilonis* were found significantly higher in (T6) as compared to all other concentrations of Jamama oil. Highest concentration of Jamama oil reduced the percent parasitism, emergence time, adult emergence and longevity of *T. chilonis* as compared with all other concentrations. Our results are in agreement with Reguraman and Singh (2000), Rao *et al.* (2002) and Lannacone and Lamas (2003) who used different botanical formulations and found reduced percent parasitism, adult emergence rate, longevity of *Trichogramma* and increased adult emergence time by utilizing the highest concentrations of the formulations as compared with their reduced concentrations.

Study regarding post-oviposition performance of *T. chilonis* after spray of *S. cereallela* eggs with different concentrations of Jamama oil during egg stage showed that significantly higher number of black eggs was observed in control. The different concentrations of Jamama oil were proved to be toxic when used in higher concentrations. The same trend was also observed in percent parasitism, emergence time and adult longevity. Our findings are in line with those previously reported (Lakshmi *et al*., 2004; Lyons *et al.,* 2003). They reported that, Aztin Ec and Neem Ec significantly affect the parasitism of *T. chilonis* after 24 h by using their higher concentrations as compared with the lowest ones. Rao *et al.* (2002) reported that neem formulations, while Lannacone and Lamas (2003) reported that rotenone as well as neem both at highest doses significantly affected longevity of *T. chilonis.*

The present findings regarding Post-oviposition performance of *T. chilonis* after spray of different concentrations of Jamama oil on *S. cereallela* eggs during larval stage of *T. chilonis* showed that at high concentration the percent parasitism was reduced and it took maximum time for emergence at high concentration as compared to all other reduced concentrations and check where percent parasitism and longevity was found higher than other concentrations. Our results show conformity with Rao *et al.* (2002) who reported that neem formulations significantly affected parasitism and emergence time of *T. chilonis* at highest dosage rates while Lannacone and Lamas (2003) reported that, rotenone and neem at highest doses significantly affected longevity of *T. chilonis.*

Present study regarding the post-oviposition performance of *T. chilonis* after spray of different

concentrations of Jamama oil on *S. cereallela* eggs during pupal stage show that in case of pupal stage less number of *T. chilonis* adults emerged from eggs treated with higher concentration of Jamama oil as compared with all other reduced concentrations. *T. chilonis* took maximum emergence time in higher concentrations. Also the present data reveal that in adult stage longevity was adversely affected by using higher concentrations of Jamama oil as compared with all other reduced concentrations. Our results are in conformity with the previous work of Raguraman and Singh (2000), Rao *et al*. (2002), Lannacone and Lamas (2003), Lakshmi *et al*. (2004) and Dabela *et al*. (2005) who reported that rotenone and neem at highest doses significantly affect longevity of *T. chilonis* compared with their reduced doses.

CONCLUSIONS

Based on the results of the present findings and some previous investigations by other researchers, it is imperative to save the best performance of *T. chilonis* in nature with no indiscriminate use of any products, which are having the insecticidal properties including Jamama oil. Very little work has been conducted in this area of research. Further study is required in this field.

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