Asian Journal of Plant Sciences

ISSN 1682-3974

science alert

ANSInet
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Asian Journal of Plant Science 3 (5): 647-650, 2004
ISSN 1682-3974

Effect of Host and Parasitoid Density on Parasitism Efficiency of *Trichogramma chilonis* (Ishii)

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Abstract: Studies were carried out at Nuclear Institute for Food and Agriculture in July 2002 to find out the effect of different host and parasitoid density levels on the efficiency of *Trichogramma chilonis*. Eggs of *Sitotroga cerealella* were used as a host for *Trichogramma chilonis*. Four different host densities viz., 5, 10, 20 and 40 eggs were provided to single pair of *Trichogramma chilonis*. Percent parasitism was highest (48.25%) at 20 eggs/single pair, whereas percent emergence was highest (88.89%) from 5 eggs but all treatments were statistically similar. Female ratio was also highest at 5 eggs/female. The longevity was highest at 20 eggs/pair. So 20 eggs/pair were suggested for rearing at laboratory condition. For parasitoid density, four treatments e.g. 1, 2, 3 and 4 pairs of *T. chilonis* were compared against 50 eggs of *Sitotroga cerealella*. Parasitism percentage was highest at 4 pair of *Trichogramma*, which was 49.6%. Percent emergence and longevity remained similar among all the 4 treatments. Female ratio was highest at 3 pair (49.92%) therefore, 3 pair is suggested for about 50 eggs.

Key words: Parasitoid and host density, parasitism efficiency, *Trichogramma chilonis*

INTRODUCTION

Increasing reliance on pesticides for plant protection is leading to serious problems including nonselective killing of other forms of life, instability in the environment, water, mutagenic and carcinogenic effects, development of resistance in pest population and resurgence of treated population and out break of secondary pest etc. This also increases the cost of production. According to estimation, pesticides adversely affect health of about 4,00,000 to 20,00,000 people every year, out of these 1,000 to 40,000 die mostly in developing countries[1].

Biological control is a very important component of an IPM program. It is an environmentally sound and effective means of reducing or mitigating pests and pest effects through the use of natural enemies (predators, parasites and pathogens). Since many natural enemies are host specific or restricted to a few closely related species, therefore, it is unlikely that non-target species are affected. Efficient natural enemies often continue to have an effect year after year with little or no assistance from man. Biological control is also relatively permanent, safe, economical and environment friendly[2].

Trichogramma spp are the most widely used biological control agents. *Trichogramma* wasps belong to the family Trichogramitidae of order Hymenoptera; these are tiny (0.5 mm long) parasitoid that attack the eggs of over 200 species (mostly Lepidopterus). The tiny females drill into the host egg to lay their own egg within. They occur naturally but in most crops production systems the number of caterpillar eggs destroyed by the native population of *Trichogramma* is not sufficient to prevent pest population from damaging level. *Trichogramma* wasp are reared and released in the field[3].

The female *Trichogramma* examine the host eggs, drill its ovipositor and lays one or more eggs depending on size of host egg. The developing *Trichogramma* larvae consume the egg contents therefore the harmful caterpillars does not emerge. The larva goes through three developmental stages and pupates inside the host egg due to which parasitized host eggs turn black[4].

Target pests of *Trichogramma* include *Heliothis* spp, fruit borer, codling moth, oriental fruit borer, Macadamia flower caterpillar, light brown apple moth and cabbage moth. *Trichogramma* spp are specially being released on tomato, corn, sugarcane, capsicum, French beans, cut flowers, lettuce, strawberries, grapes, sugar cane and tree crops like apple and pear etc. Almost 18 different species of *Trichogramma* are being mass reared to control pest in sugarcane, rice, cotton, Soya bean, sugar beet, vegetables and pine on about 18 million ha in about 16 countries[5].

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Trichogramma chilonis (Ishii) is usually mass reared by using factitious host like *Sitotroga cerealella*. The culture of *Sitotroga cerealella* can be established on cereal grains. During rearing the quality of the parasitoid is very important. Parasitoid and host density are amongst the important factors affecting the quality of parasitoids. Higher densities of parasitoids may cause super parasitism and thus reducing the fitness of surviving parasite larvae.

The aim of conducting this experiment was to determine the efficient combination (of host and parasitoid) on which the quality of parasite is not affected. Parasite quality was determined by its percent parasitism, percent emergence, sex ratio and adult longevity. So the efficiency of *T. chilonis* on fluctuating host and parasitoid density was investigated by evaluating the effect of host density on *Trichogramma* parasitism and the effect of parasitoid density under fixed host density was also observed.

MATERIALS AND METHODS

Rearing of *Sitotroga Cerealella* (Olive): *Sitotroga cerealella* was reared on wheat grains in transparent glass Jars (22x55 cm). Two mg of *S. cerealella* eggs were mixed in the jar containing ½ kg of wheat, grains. The Jars were kept at 25-30°C and 60-70%. R.H. covered with muslin cloth. On emergence *S. cerealella* adults were collected and shifted to oviposition jars (14x15 cm) with 20 size mesh braus wire gauze at the bottom. The oviposition Jars were placed on maize starch on plastic trays. Sieving the starch through 50 and 70 size mesh eggs were collected. These eggs were used for further moth propagation and *Trichogramma* production.

Rearing of *Trichogramma chilonis* (Ishii) on *S. cerealella* (Olive): The eggs of *Sitotroga cerealella* were glued on hard paper card (8x3 cm) but depends on the availability of no. of eggs) and were put in glass Jars (55x12 cm) having *Trichogramma chilonis* for parasitization. After parasitization, cards were removed and kept in incubator at 25-30°C for 7-8 days for parasitoid development. The parasitoid sp were identified through taxonomic keys as well as by Dr. Abid Farid, Senior Scientific Officer and Trichogramma Specialist at NIFA. Then the parasitoid were further used for experimentation.

Effect of fluctuating host density on *Trichogramma* efficiency: Fresh eggs of *S. Cerealella* were glued on the card at densities of 5, 10, 20 and 40 with the help of gum. The no. of replicates were 20 but these were handled five at a time for convenience. The cards were placed into small vials (10x1 cm).

One-day-old *Trichogramma* pair was released in each vial containing card. For sexing, the *Trichogramma* was observed under light microscope (20 x) in a small capsule (2.5x0.4 cm) made of transparent plastic straw. After releasing the couple of *Trichogramma*, the vials were covered with muslin cloth and tightened with rubber band. These vials were then shifted to incubator with temperature of 25-30°C for 24 h then the adult *Trichogramma* were removed and the vials were again shifted to incubator. After 3-4 days the number of parasitoid eggs were counted and percent parasitism was recorded.

Effect of fluctuating parasite density under fixed host numbers: Fifty fresh eggs of *S. cerealella* were glued on each card and put in the vial. The no of replications was 20 but these were divided in four lots for easy handling.

After sexing, 1, 2, 3 and 4 couples of one-day-old *Trichogramma* were released in the vials covered with muslin cloth with rubber band and were placed in the incubator. After 24 h exposure, the adult *Trichogramma* were removed and after 3-4 days the data of percent parasitism, percent emergence, sex ratio and adult longevity were recorded.

RESULTS AND DISCUSSION

Effect of different host densities on % parasitism, % emergence, longevity and female ratio of *Trichogramma chilonis* (Ishii): Table 1 revealed that the percent parasitism by single pair of *Trichogramma* varied from 35, 31.5, 48.25 and 47.5 from host densities of 5, 10, 20 and 40 eggs, respectively. Highest parasitism was obtained from 20 eggs but as the comparison of treatment group showed that different host densities had no significant effect on % parasitism.

Vorgas[6] observed that the parasitized species and the relative density of hosts affected the number of parasitized eggs. The percentage of parasitized eggs was independent of host density at low densities of parasitoids and was inversely dependant at high densities, but Thorpe[7] reported that rates of parasitism were significantly higher at the highest wasp density on all arenas and the effect of host density was not consistent among the arena.

Percent emergence from 5, 10, 20 and 40 eggs of *Sitotroga* was 88.89, 83.49, 77.38 and 80.2, respectively. Although 5 eggs had the highest emergence of 88.89%, but treatments group comparison showed that there was no significant effect on the percent emergence of *Trichogramma* by the host density.

As Table 1 showed that longevity of *Trichogramma* emerged from 20 eggs was significantly highest (1.75 days) followed by 40 eggs (1.4 days) and 10 eggs (1.35 days), 5 eggs had the lowest adult longevity of 1.15 days. This may be due to the superparasitism, the number of adults emerged from low number of eggs having not enough food for the growth of hymenopterous (Larvae) may result in the underweight larvae, pupae and adults. These adults therefore may not live long.

As Table 1 showed that percent female ratio (60) was significantly highest at 5 eggs of *Sitotroga cerealella* and decreased with the increase in the host density/Female. This showed that in less number of eggs all the eggs were laid on first day and therefore the ratio of females was high. Kon[8] reported somewhat similar ratio of females to males in the progeny of *Trichogramma*, which showed that female ratio is dependent on the rate of oviposition. Among adults developing from eggs laid on the 1st day of oviposition there were significantly more females than males, while among those developing from eggs laid subsequently the proportion of females was progressively reduced as through shortage of sperm, more unfertilized eggs were laid. Oviposition in host eggs in a compact cluster led to high preponderance of females than it took place on eggs that were more widely spaced apart. It was observed a 2 fold increase in the number of female progeny, when parasite density was reduced from 8 to 2 and also when the host density was increased from 150 to 1200 eggs[9].

Effect of parasite density on percent parasitism, percent emergence longevity and female ratio of *Trichogramma chilonis* (Ishii): The maximum percent parasitism of *Sitotroga cerealella* eggs was (49.6) for 4 pair of *Trichogramma* released on 50 *Sitotroga cerealella* eggs this was followed by 3 pair, 2 pair and lowest (22.1) from single pair (Table 2). Comparison of treatments group showed that 4 pair of *Trichogramma* had a high significant parasitism than 3, 2, 1 pair. Henderson[10] reported somewhat similar results where he found that a single pair of parasite parasitized <20 eggs. The number of eggs parasitized significantly increased with egg density, tending to stabilize at densities above 30 eggs/parasitoid. Super parasitism occurred at 5-10 egg/parasitoid but was really observed at densities above 20 eggs.

Maximum % emergence was (68.14%) for single pair of *Trichogramma* following by 3 pair, 4 pair and 2 pair but the comparison of treatments group showed that different densities of parasitoids had no significant effect on % emergence of *Trichogramma chilonis*. Since only the parasitized eggs were studied, so non-significant results do carry a meaning (Table 2).

Longevity of *Trichogramma chilonis* was also not affected by different densities of parasitoid, as the treatment mean showed that there was no significant difference on the longevity of adult emerged.

Female ratio for 1, 2, 3 and 4 pair of parasitoids was 28.53, 36.4, 49.97 and 41.22%, respectively (Table 2). These values showed that female ratio increases with increasing the parasitoid density up to a limit but after 3 pair the percent female ratio became low.

Babault[11] reported that the proportion of female increased with increased density. Also the ratios of female to males in the progeny of *Trichogramma* depend on the rate of oviposition. Among adults developing from the egg laid on the 1st day of oviposition there would be significantly high number of females, while among those developing from eggs laid subsequently the proportion of females would be progressively reduced as through shortage of sperms more unfertilized eggs were laid, which would lead to the development of males[8]. As reported by Kon and Handerson[12] that early deposited eggs turned to be females while the subsequent progeny is mostly males. As the number of available *Sitotroga cerealella* eggs reduced the possibility of females in the colony increases. Discrepancy was noted in the 4 pair/50 eggs, we were expecting the highest percent of females. No scientific or logical explanation could be produced to justify the observed data. It is, therefore, suggested that at least 3-4 pairs of *Trichogramma chilonis* should be released/50 *Sitotroga cerealella* eggs to maximize the female production in the progeny. Similarly Henderson[10] reported that mated females deposited significantly more eggs on the 1st day of exposure to hosts than unmated females. On subsequent days unmated females parasitized significantly more host than mated females. Mated female

Table 1: Percent parasitism, percent emergence, female ratio and adult longevity in response to host densities

Host densities	% Parasitism	% Emergence	Female ratio	Adult longevity
5	35.00a	88.89a	60.00a	1.15b
10	31.50a	83.49a	59.53a	1.35ab
20	48.25a	77.38a	38.29b	1.75a
40	42.50a	80.20a	42.92b	1.40ab

Means with in a column followed by same letter(s) are non-significantly different at 5% level of probability

Table 2: Percent parasitism, percent emergence, percent female ratio and adult longevity in response to parasite densities

Parasitoid densities	% Parasitism	% Emergence	Female ratio	Adult longevity
1	22.1c	68.14a	28.53b	1.25a
2	30.8bc	58.67a	36.40ab	1.70a
3	41.0ab	67.56a	49.92a	1.40a
4	49.6a	61.02a	41.22ab	1.25a

Means with in a column followed by same letter(s) are non-significantly different at 5% level of probability

laid 82.4% of their eggs on first day of oviposition while unmated female laid 58.3%. No significant differences in the emergence between the off spring of mated and unmated females parasitized eggs were observed.

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