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Dispersal ability and parasitisation performance of *Trichogramma* spp (Hymenoptera:Trichogrammatidae) in organic *Basmati rice*

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Abstract

The dispersal/host searching capacity of *Trichogramma chilonis* Ishii and *Trichogramma japonicum* Ashmead was studied in organic *Basmati* rice during 2012 and 2013. Results showed that the level of parasitism was negatively correlated with the distance between host eggs and parasitoids' release point. Parasitisation rate was more (11.39-18.10% and 9.77-15.49% by *T. chilonis* and *T. japonicum,* respectively) near the release point (1-3m) with maximum parasitism at 1m by both the parasitoid species. A very low parasitism (0.05-0.47%) was recorded up to the distance of 8-9 m in two species. Among the two parasitoid species, *T. chilonis* showed higher parasitism (up to 18.10%) in different distance treatments in comparison to *T. japonicum* (up to 15.49%).

Key words

Dispersal, Parasitisation, Rice, *Trichogramma chilonis, Trichogramma japonicum*

Introduction

Rice (*Oryza sativa* L.) is one of the major contributor of total food grain production which, however, is now witnessing yield stagnation and declining productivity due to continuous use of high level of chemical fertilizers and pesticides (Rao *et al*., 2013). Further, these pesticides are often applied in inappropriate amount to paddy resulting in contamination of paddy with pesticide residues (Amir *et al*., 2012). This has led to increase awareness in providing ecologically safe produce. Organic farming, through augmentive biological control, provides an ecologically acceptable alternate way for residue free rice production.

In many agroecosystems, biological control is exercised largely by parasitoids. The egg parasitoids of genus *Trichogramma* are considered efficient biological control agents and are widely used commercially for controling lepidopterous pests in many crops like corn, cotton, sugarcane, fruit and vegetable crops in more than 50 countries (Pizzol *et al*., 2010). The species of this genus have several characteristics like long adult longevity in field and their ability to parasitize eggs of multiple Lepidopteran pest species that make them good egg parasitoids for biological control programs (Bueno *et al*., 2010). However, their suitability as biological control agents may vary due to considerable inter- and intra-specific variations in tolerance to environmental conditions, preferences for hosts, recognition and acceptance of crops, habitat location and host location.

Out of these attributes, host searching ability of the insect-parasitoids largely determines the performance of these bioagents under field conditions. The distance of potential host eggs from parasitoids' release point influences the rate of parasitisation as reported in crops like corn, cotton, sugarcane (Brar *et al*., 2000; Singh and Shehmar 2008; Wright *et al*., 2001). However, decisive information on the effect of distance on dispersal ability and parasitization efficiency of Trichogrammatids in paddy against lepidopteran pests is quite lacking.

This fact hampers efficient utilization of these egg parasitoids in rice especially under organic farming conditions. Hence, in the present study, the ability of the parasitoids to locate and parasitize potential host eggs, as influenced by the distance from the point of release, was assessed in the organic *Basmati* rice fields under Punjab conditions.

Materials and Methods

The present study was undertaken at the farmer's field at village in district Patiala, Punjab, India during the months of August, September and October in crop seasons of 2012 and 2013. The selected fields were under organic farming system for the last 10 years with predominantly wheat-paddy rotation. The experiment was conducted in transplanted *basmati* rice variety *Pusa* 1121 during both the crop seasons.

Cultures of parasitoids and their host : The cultures of *T. chilonis and T. japonicum* were mass maintained on laboratory host, *Corcyra cephalonica* Stainton in the Biocontrol Laboratory at the Department of Entomology, Punjab Agricultural University, Ludhiana. The factitious host *C. cephalonica* eggs were used as sentinel cards to record parasitism by dispersing parasitoids as the native hosts of the parasitoids *i.e.* eggs of yellow stem borer, *Scirpophaga incertulas* (Walker) and rice leaf folder, *Cnaphalocrocis medinalis* (Guenee) were unavailable in large numbers in field conditions.

Field releases : Sentinel cards (3×4 cm) with at least 100 inactivated and un-parasitized eggs of *C. cephalonica* were positioned on underside of the paddy leaves at distance 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10 m from the central point in all the four directions in two separate plots (400 m^2 each for *T. chilonis* and *T. japonicum*). The plots were isolated from each other by a distance of 50 m. On the same day, newly emerged adults of *T. chilonis* and *T. japonicum* (about 4000 each) were released at central release point in the respective plots. The stapled cards were removed after 24 hrs of release and kept in 12 dram plastic vials (55 × 37 mm). The recovered cards were maintained at ambient temperature of 27-30 ºC in biocontrol laboratory to record the percentage of parasitized eggs. The whole set of experiment was conducted thrice in the month of August, September and October during the crop seasons of 2012 and 2013.

Statistical analysis : The percentage data were transformed using arcsine transformation. Treatment means were analyzed using ANOVA LSD at p=0.05 level (Gomez and Gomez, 1984).

Results and Discussion

The per cent parasitism was influenced significantly by the distances from the release point. The data presented in Table 1 revealed that during August 2012, the parasitism of *C. cephalonica* eggs positioned at 1m from the release point was significantly higher (17.97%) as compared to other distances. The mean per cent parasitism went on decreasing with increase in the distance from the release point. However, this decrease was gradual up to the distance of 4m, decreased rapidly afterwards. There was no parasitism at 10 m from the release point. Among the two parasitoid species, significantly higher mean parasitism (6.23%) was recorded with *T. chilonis* as compared to *T. japonicum*, where parasitisation of 5.08 % was recorded as mean of all release points. During September 2012, the overall parasitism percentage was lower as compared to the previous month. Maximum mean parasitism (15.00%) was recorded at 1m distance which gradually decreased to 9.22 % at 3m distance from the release point. After that, there was sharp decline in per cent parasitism with no parasitism being recorded beyond 8m distance. Among the parasitoid species, higher parasitism was recorded with *T. chilonis* (5.24%) as compared to *T. japonicum* (4.11%). During October 2012, similar trend was followed *i.e.* decrease in parasitism with increase in distance from the release point though the overall percentage of parasitism was low in comparison to previous months. Significantly, higher parasitism was recorded at distance of 1m to 3m (12.27-8.23%) than in increased distances with no parasitism beyond 8 m. *T. chilonis* recorded higher mean parasitism (4.44%) as compared to *T. japonicum* (3.76%).

During 2013, there was slight increase in overall parasitism by two parasitoid species. The parasitism followed similar trend of decrease in percentage with increase in distance from the release point (Table 1). In the month of August, significantly higher parasitism was observed at 1m distance (22.41%) followed by 2m (18.95%). Per cent parasitism at 6m was at par with 7m and there was no parasitism after 8m distance from the release point. The mean per cent parasitisation by *T. chilonis* was significantly higher (7.85%) than *T. japonicum* (6.21%). During September, the mean per cent parasitism at 1m was 18.74, which was significantly higher than rest of the distances from the parasitoid release point. Distances of 8m and 9m were recorded with no parasitism by either of the parasitoid species. Among the two species, significantly higher parasitism was observed by *T. chilonis* (6.28%) in comparison to *T. japonicum* (5.51%). In October, the mean per cent parasitism was at par with each other at distances of 1m (14.39%) and 2m (13.23%). This was significantly better than other treatments and no parasitism was recorded beyond 8m distance from the release point. Egg parasitoid, *T. chilonis* recorded with higher mean parasitism (5.33%) as compared to *T. japonicum* (4.37%).

The pooled data of two years revealed that highest percentage of parasitism was observed at 1m from the parasitoid release point and was significantly better than other distance treatments (Fig. 1). The parasitisation trend showed decline with increase in distance from the release point. Higher parasitism was recorded at shorter distances *i.e.* up to 3m and there was no parasitism beyond 9m. Among the egg parasitoid species, *T. chilonis* was recorded with higher parasitism, ranging from 0.00 to 18.10 % at different distance treatments in comparison to *T. japonicum*, where parasitisation ranged from 0.00 to 15.49 %. However, both the species showed better parasitism at shorter distances.

An understanding of how generalist parasitoids interact with hosts of different species is crucial to their effective use in

Table 1 : Mean per cent parasitisation by *T. chilonis* and *T. japonicum* at different distances in organic *basmati* rice during 2012 and 2013

Treatment	2012			2013		
	August	September	October	August	September	October
Distance (m)*						
1	17.97(25.03)	15.00(22.71)	12.27(20.48)	22.41(28.21)	18.74(25.63)	14.39(22.26)
2	15.23(22.93)	12.62(20.76)	11.52(19.80)	18.95(25.75)	16.00(23.55)	13.23(21.30)
3	10.82(19.17)	9.22(17.64)	8.23(16.63)	13.48(21.51)	11.82(20.08)	9.89(18.29)
4	5.89(13.91)	4.45(12.02)	4.21(11.71)	7.54(15.76)	6.13(14.19)	5.27(13.17)
5	3.53(10.79)	3.09(9.98)	2.59(9.18)	4.44(12.08)	3.43(10.60)	3.13(10.14)
6	1.59(7.20)	1.21(6.24)	1.12(6.00)	1.94(7.80)	1.60(7.11)	1.27(6.36)
7	0.98(5.66)	0.86(5.30)	0.82(5.17)	1.18(6.13)	0.90(5.43)	0.90(5.40)
8	0.43(2.91)	0.27(1.80)	0.26(1.98)	0.37(2.71)	0.37(2.69)	0.43(2.90)
9	0.14(1.08)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
10	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)	0.00(0.00)
LSD (p=0.05)	(1.23)	(1.16)	(1.14)	(1.29)	(1.15)	(1.13)
Species#						
T. chilonis	6.23 (11.61)	5.24 (10.44)	4.44 (9.52)	7.85 (12.82)	6.28 (11.40)	5.33 (10.57)
T. japonicum	5.08 (10.11)	4.11 (8.85)	3.76 (8.68)	6.21 (11.17)	5.51 (10.45)	4.37 (9.39)
LSD (p=0.05)	(0.55)	(0.52)	(1.51)	(0.58)	(0.51)	(0.51)

* Observations based on four replications of 100 eggs (approx.) each and mean of two species; # Observations based on four replications of 100 eggs (approx.) each and mean of all release points; Figures in parentheses are arcsine transformed values

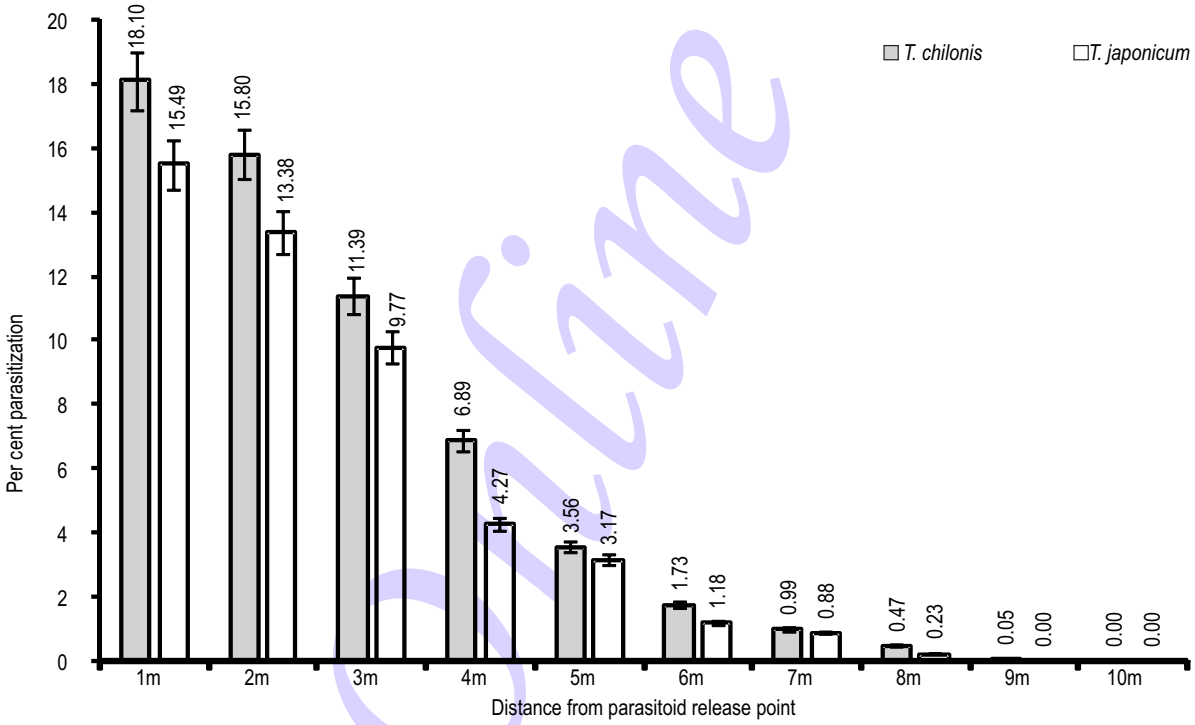

Fig. 1 : Host searching ability of *Trichogramma chilonis* and *T. japonicum* in organic basmati rice during 2012 and 2013 (Pooled). Vertical bars on each point represent ± SE at 5%

biological control. For example, their propensity to search for the particular pest species against which they are released would influence parasitism rates achieved in mass release biological control programs. Decrease in parasitization rate of *Trichogramma* was reported to be dependent on the distance from release points (Wang and Shipp, 2004). The present study documents the fact that distance influences the rate of dispersal of parasitoids, which in turn affects parasitisation of potential

hosts. Higher rates of parasitism in the host eggs positioned in the vicinity of the parasitoid species showed concentrated pattern of dispersal of the latter closer to the release point. Geetha and Balakrishnan (2010) studied the ability of laboratory-reared egg parasitoid, *T. chilonis* to disperse and locate sentinel egg cards of *C. cephalonica* in sugarcane field. They reported that distance had a clear proportional impact on dispersal probability of the parasitoid. The percent parasitism varied from 66.48 at 1m to 1.86 at 30m from release points with significant differences among them. Geetha and Balakrishnan (2011) also conducted an open field (crop-free) study wherein spatial dispersal of *T. chilonis* was assessed though parasitism of *C. cephalonica* placed at different distances from the point of release of parasitoids. The studies revealed that distance had a visible direct impact on dispersal. The mean dispersal rate, as indicated by the per cent parasitism, was quite high at 1m (73.78%) which decreased to 7.67 at 30m. Similarly, in cotton significantly higher parasitisation (5.92 to 17.58%) was recorded up to a distance of 1m from the point of release of *T. chilonis* than the increased distances (Wadhwa and Gill, 2006).

As the distance between the parasitoid species and host eggs is increased, the parasitism level declined gradually to a certain distance and then decreased sharply with no parasitism beyond 8 or 9m. The results of the present study are in line with earlier work on dispersal pattern of *Trichogramma* spp. in different crops and niches as affected by distance. Singh and Shenhmar (2008) while studying the dispersal/host searching ability of genetically improved strain of *T. chilonis* in sugarcane reported that maximum parasitisation was recorded at 1 m and least at 10 m from the release point.

The present study also provides evidence that shorter distances *i.e.* up to 3m from the parasitoid release points resulted in highest parasitisation efficiency of Trichogrammatids owing to their limited dispersal capacity. There was a gradual decrease in parasitism up to 5m from release point, beyond which, a sharp decline in parasitism was observed irrespective of two species. Brar *et al.* (2000) observed that *T. chilonis* could disperse up to 9 m in search of its host. However, maximum parasitisation was recorded up to 2 m. Another studies on the host searching capacity of *T. chilonis* on different cotton hybrids revealed that parasitoid could easily locate its host up to 5m and it could go as far as 9m to search its host eggs, though parasitism was very low (0.08 to 0.50%) in the latter distance (Wadhwa and Gill, 2006).

It is concluded that both the parasitoid species, *T. chilonis* and *T. japonicum* showed maximum parasitisation efficiency at 1m from the release points. *T. chilonis* maintained its supremacy over *T. japonicum* with higher mean parasitisation percentage. The present study may help in standardizing adequate number of release sites for innundative introductions to ensure uniform distribution of egg parasitoids throughout the crop to achieve maximum parasitism.

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