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Muhammad Sulaman Shah
Department of Entomology, The University of Agriculture, Peshawar, KPK, Pakistan.

Imtiaz Ali Khan
Department of Entomology, The University of Agriculture, Peshawar, KPK, Pakistan.

Muhammad Salman
Nuclear Institute for Food & Agriculture (NIFA), Tarnab, Peshawar, KPK, Pakistan.

Junnaid Ahmad
Zoology Department, Hazara University, Mansehra, KPK, Pakistan.

Ilyas Akbar
Department of Plant Protection, The University of Agriculture, Peshawar, KPK, Pakistan.

Jawad Ali Shah
Department of Agriculture, University of Swabi, Ambar, KPK, Pakistan.

Gul Zamin Khan
Nuclear Institute for Food & Agriculture (NIFA), Tarnab, Peshawar, KPK, Pakistan.

Muhammad Sarwar
Nuclear Institute for Food & Agriculture (NIFA), Tarnab, Peshawar, KPK, Pakistan.

Correspondence
Muhammad Sulaman Shah,
Department of Entomology, The University of Agriculture, Peshawar, KPK, Pakistan.

Study on different life parameters of *Trichogramma chilonis* (Ishii) on eggs of *Sitotroga cerealella* (Olivier) fed on old and new varieties of wheat, maize and sorghum

Muhammad Sulaman Shah, Imtiaz Ali Khan, Muhammad Salman, Junnaid Ahmad, Ilyas Akbar, Jawad Ali Shah, Gul Zamin Khan, Muhammad Sarwar

Abstract
The study on different life parameters of *Trichogramma chilonis* (Ishii) on eggs of *Sitotroga cerealella* (Olivier) fed on old and new varieties of wheat, maize and sorghum revealed that *S. cerealella* adult's emergence was higher (88 adults) on wheat new variety (Atta Habib). In old varieties, *T. chilonis* parasitism was highest (41.20%) on wheat, while lowest (34.80%) on sorghum. On new varieties, parasitism was minimum (44.60%) on wheat, while maximum (59.80%) on maize. The *T. chilonis* adult's emergence (85.40%) was highest on eggs derived from wheat old variety, whereas, in new varieties, lowest adults emergence of 73.20% was recorded in wheat. The *T. chilonis* male's emergence was highest (41.40%) on maize old variety, while lowest (34.20%) on wheat old variety. On new varieties, male's emergence of 22.80 was recorded on wheat, whereas value of 30.40 was recorded for maize and sorghum. The results revealed that maximum parasitism and adults emergence by the wasp were observed in maize new and highest females counted from the wheat new variety.

Keywords: Atta Habib, *T. chilonis,* new varieties, adult emergence, parasitism, wheat, maize, sorghum.

1. Introduction

Trichogramma chilonis, Ishii (Hymenoptera: Trichogrammatidae) occurs naturally in almost every terrestrial habitat and some aquatic habitats as well. They parasitize insect eggs, mostly eggs of moths and butterflies. Some of the most important caterpillar pests of field crops, forests, and fruit and nut trees are attacked by *Trichogramma* wasps. However, in most crop production systems, the number of caterpillar eggs destroyed by native populations of *Trichogramma* is not sufficient to prevent the pest from reaching damaging levels. Recognizing the potential of *Trichogramma* species as biological control agents, entomologists in the early 1900s began to mass rear of *Trichogramma* for insect control [1, 2, 3].

Today, *Trichogramma* species are the most widely used insect natural enemy in the world, partly because they are easy to mass rear and these attack many important crop insect pests *Trichogramma* wasps parasitize eggs of butterfly and moth (Lepidoptera). Although, certain species of *Trichogramma* also parasitize eggs of flies (Diptera), beetles (Coleoptera), other wasps (Hymenoptera), true bugs (Heteroptera) and lacewings (Neuroptera) [4, 5, 6].

In Pakistan, *T. chilonis* has also been recorded from *Helicoverpa armigera, Chilo infuscatellus, Agrotis ipsilon, C. partellus, Autographa nitgrisigna, Emmalocera depressella, Antigona steniellus* and *Spodoptera litura* [7]. *Trichogramma* can be reared commercially on different hosts including *Ephestia kuehniella*, *S. cerealella*, *Corcyra cephalonica* and *Bombex morie*. *S. cerealella* is one of the most familiar factitious hosts used for rearing parasitoid *Trichogramma* and can capably be reared on maize, rice, wheat, sorghum and barley [8, 9].

Various factors affect the mass rearing and quality production of *T. chilonis*, i.e., temperature, relative humidity, photoperiod, host and parasite eggs densities, and host egg value. For the purpose of rearing *T. chilonis* on a profitable scale, it is essential to use a factitious rearing host. The choice of factitious rearing host is often directed by the simplicity of rearing and not essentially by factors associated to the likely accomplishment of the wasps being produced. Hosts are carefully chosen on the simplicity of their mass production, systematization of rearing procedures and budget of production related with that of using the target pest [10]. As the host value can influence developmental time, longevity, parasitism, adult emergence and sex ratio [11]. Therefore the present study was designed with the objective to evaluate the development of *T. chilonis* on eggs of *S. cerealella* reared on old and new varieties of wheat, maize and sorghum.

2. Materials and Methods

The present studies were conducted in the Biological Control Laboratory at Sugar Crops Research Institute (SCRI), Mardan, during 2012. The experiment was conducted at controlled laboratory conditions of 27±2 °C, 65±5% R.H., and 16: 8 h light: dark photoperiod.
For experimentation, the following procedure was followed:-

2.1 Seed collection and preparation

One kg seeds of wheat, maize and sorghum were purchased from the local grain market at Mardan, Khyber Pakhtunkhwa. The seed grains were put in separate trays. The seeds were washed in water to remove the dust and weak seeds. The trays were left in the sun for drying. The sundried grains were then separately put in plastic bags and kept in autoclave at 70 °C for 30 min for sterilization, to kill the stored grain insects (if any). After sterilization and cooling, the grains were ready for rearing of *S. cerealella* culture.

2.2 Rearing of *S. cerealella*

S. cerealella was reared separately on seeds of wheat, maize and sorghum. The seeds were kept separately in glass jars of 2 liters capacity. Fresh eggs of *S. cerealella* were obtained from the Biological Control Laboratory, SCRI, Mardan. The eggs were observed under microscope for the mite's infestation. One gram of eggs was introduced into each glass jar containing sterilized seeds. The jars were covered with muslin cloth and kept at 27±2 °C and 65±5% R.H., in the controlled lab conditions for *S. cerealella* development.

2.3 Collection of *S. cerealella* adults

The freshly emerged *S. cerealella* adults were collected from the jars with the help of electric vacuum pump and shifted to plastic oviposition jars having wire gauze at the bottom. Wheat flour was placed at the bottom of the jars allowing *S. cerealella* to lay eggs on it.

2.4 Collection of *S. cerealella* eggs

After one day exposure of wheat flour to *S. cerealella* adults, the flour was dusted away from the jar and sieved through 80 meshes to get the cleaned eggs. Fresh eggs of *S. cerealella* were thus daily made available as host for *Trichogramma* for parasitization.

2.5 Identification of sex of adult parasitoids

S. cerealella parasitized eggs were kept in transparent plastic bottles for adults emergence. The freshly emerged *T. chilonis* adults were sexed under a high power microscope.

2.6 Preparation of *S. cerealella* cards

S. cerealella fresh eggs were collected from the culture and placed in petri dish. Fresh 40 eggs per card were sprinkled on glued hard paper card (3×8 cm), so as to get uniform placement. These cards were left for some time to become dry and then introduced for 24 hrs in a glass jar having *T. chilonis*. After exposure to the parasitoid, the cards were kept in separate jars at 27±2 °C and 65±5% R.H.

2.7 Percent parasitism and ovipositional preference

The percent parasitism was calculated by the following formula:-

$$\frac{\text{No of eggs parasitized}}{\text{Total No. of eggs on card}} \times 100$$

Ovipositional preference was recorded on the basis of percent parasitism.

2.8 Data collection

The data collection started one day after the installation of cards and continued for two days.

2.9 Statistical design and data analyses

The experiments were carried out in Completely Randomized Design (CRD) with three treatments and five replications. Least significant test (LSD) was used for mean comparison. The Statistical Package, MSTATC (Michigan State University, USA) was utilized for computing both the ANOVA and LSD [12].

3. Results & Discussion

3.1. *S. cerealella* adults emergence on old varieties of wheat, maize and sorghum

The result of *S. cerealella* adults emergence on old varieties of wheat, maize and sorghum is presented in Figure (1). It was observed that the larvae of *S. cerealella* infested grains of all the three hosts were able to complete development successfully. It was found that adults emergence was affected by the hosts, where it continuously remained higher on wheat variety (Saleem, 2000) and lower on maize variety (Azam). Highest adults emergence was recorded on 12th day on Saleem 2000 with 88 adults, on 10th day in Sorghum 1 with 65 adults and on 8th day in Azam with 47 adults. On the 15th days recorded period, a total of 812 adults emerged from the infested grains of wheat, 675 adults from maize and 431 from Sorghum.

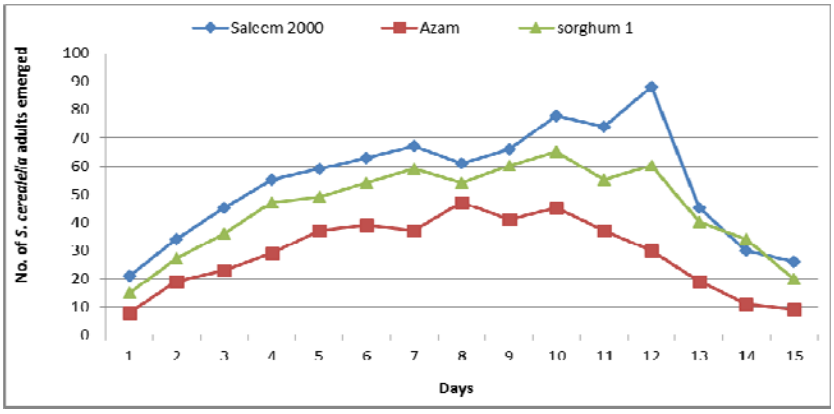

Fig 1: *S. cerealella* adult's emergence on old varieties of wheat, maize and sorghum during 2012.

3.2. *S. cerealella* adults emergence on new varieties of wheat, maize and sorghum

S. cerealella adults emergence on new varieties of wheat, maize and sorghum is presented in Fig. 2. It was observed that *S. cerealella* larvae infested grains of all the three hosts and were able to complete development successfully. It was found that adults emergence was affected by the hosts, where it continuously remained higher on wheat variety (Atta Habib) and lower on maize variety (Sada Bahar). Highest adults emergence was recorded on 11th day on Atta Habib with 60 adults, on 10th day on Sada Bahar with 54 adults and on 10th day on Pioneer 3025 with 40 adults. On the 15 days recorded period, a total of 556 adults emerged from the infested grains of Atta Habib, 483 adults from Sada Bahar and 311 from Pioneer 3025.

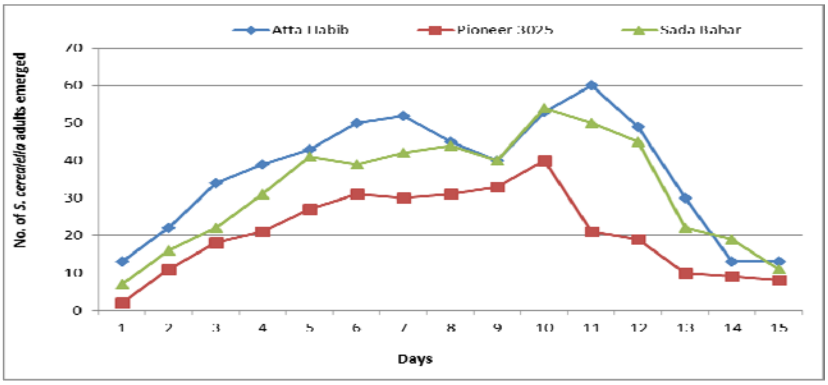

Fig 2: *S. cerealella* adult's emergence on new varieties of wheat, maize and sorghum during 2012.

The results revealed that *S. cerealella* infested grains of all the three hosts, was able to complete development successfully and emerged as adult. On the 15 days recorded period, more numbers of adult (812 adults) were emerged from the infested grains of wheat and lowest (431 adults) from Sorghum 1. These results are contradictory to the findings of Hamid and Nadeem (2012) who reported that *S. cerealella* adults emergence was significantly higher on Sorghum (1665.8 adults) than on corn (246.5 adults) [13].

3.3. Different life parameters of *T. chilonis* on *S. cerealella* eggs Parasitism (%)

Table (1) shows *T. chilonis* parasitism (%) and adults emergence (%) on *S. cerealella* prey eggs reared on old varieties (Saleem 2000, Azam, Sorghum) and new varieties (Atta Habib, Pioneer 3025, Sada Bahar) of wheat, maize and sorghum, respectively. The results revealed that *T. chilonis* female's parasitization on *S. cerealella* prey eggs was significantly different ($P < 0.05$) for different hosts. On the old varieties, *T. chilonis* parasitism was significantly higher (41.20%) on *S. cerealella* reared on wheat (Saleem 2000) and lower (34.80%) on sorghum. On new varieties parasitism was highest (59.80%) on maize (Pioneer 3025), while lowest (44.60%) on wheat (Atta Habib). Whereas, Perveen and Sultan (2012) in a study on *T. chilonis* documented that the highest rate of parasitism was (85.0±2.44), while the lowest (77.5±1.33) for the eggs of *S. cerealella* [14].

3.4. Adults emergence (%)

T. chilonis adults emergence was significantly affected by *S. cerealella* prey eggs reared on the old and new grain varieties of wheat, maize and sorghum (Table 1) ($F= 9.86$; $df= 2,12$; $P= 0.0029$). The parasitoid's emergence was significantly higher on its prey eggs reared on old wheat variety (85.40%) than new variety (73.20%). While on maize and sorghum it was significantly higher (each 83.80%) on new than the old varieties (75.00%; 72.60%), respectively. The present results are similar to those of Hamid and Nadeem (2012). They reported that *T. chilonis* adults emergence was highest from eggs of adults developed on maize (94.5%) than on wheat (91.3%) and barley (90.7%) [13].

Table I: *T. chilonis* parasitism (%) and adults emergence (%) on *S. cerealella* prey fed on old and new varieties of wheat, maize and sorghum, during 2012.

Treatment	Parasitism (%)		Adults emergence (%)	
	Old variety	New variety	Old variety	New variety
Wheat	41.20a	44.60b	85.40a	73.20b
Maize	36.20b	59.80a	75.00b	83.80a
Sorghum	34.80b	54.60a	72.60b	83.80a
LSD values	4.84	7.58	7.29	7.38

Means in columns followed by dissimilar letters are significantly different from each other at P = 0.05, One Way ANOVA.

3.5. Sex ratio

T. chilonis female to male sex ratio was significantly affected by *S. cerealella* prey eggs reared on old and new host varieties of wheat, maize and sorghum (Table 2). It is clear from the results that female ratio was significantly higher than males on old as well as new host varieties. Male ratio was higher on old than new host varieties, while female ratio was lower on old than new host varieties. More females emerged on old (65.80) and new (77.20) wheat varieties than the old and new varieties of other hosts. On the other hand, on old varieties, more males emerged on maize (41.40) than on wheat and sorghum, whereas male emergence was higher on maize and sorghum (30.40 each) than on wheat (22.80). These results are in conformity with those of Hamid and Nadeem (2012). They reported that female's percentage was relatively higher in larger sized eggs from adults reared on corn and three times more than males [13].

Table 2: *T. chilonis* adults sex ratio emerged from *S. cerealella* eggs fed on old and new host varieties of wheat, maize and sorghum, during 2012.

Treatment	Sex ratio			
	Old variety		New variety	
	Female	Male	Female	Male
Wheat	65.80 ⌂	34.20 ⌂	77.20 ⌂⌂	22.80 ⌂⌂
Maize	58.60 □	41.40 □	69.60 □□	30.40 □□
Sorghum	64.60 ∆	35.40 ∆	69.60 ∆∆	30.40 ∆∆

Means in columns followed by dissimilar letters are highly non-significant from each other at P = 0.05, One Way ANOVA.
⌂ denotes wheat old variety, Saleem 2000.
⌂⌂ denotes wheat new variety, Atta Habib.
□ denotes maize old variety, Azam.
□□ denotes maize new variety, Pioneer, 3025.
∆ denotes sorghum old variety, Sorghum 1.
∆∆ denotes sorghum new variety, Sada Bahar.

3.6. *T. chilonis* adult's longevity
T. chilonis adult's longevity emerged from *Sitotroga* eggs reared on old and new varieties of wheat, maize and sorghum is given in Fig. 3. The results revealed that *T. chilonis* adult's longevity, emerged from *Sitotroga* eggs, on old host varieties were longest on wheat (4.2 days) and lowest on sorghum 1 (2.4 days). Similarly, on the new host varieties, it was longest on wheat (4.7 days) and shortest on sorghum (3.2 days). Generlaly, *T. chilonis* adult's longevity was longer on new than old host varieties. Whereas, Perveen and Sultan (2012) in a study on *T. chilonis* recorded that the highest adult's longevity was 3.2±0.23 days, while the lowest as 3.0±0.32 days for the eggs of *S. cerealella* [14].

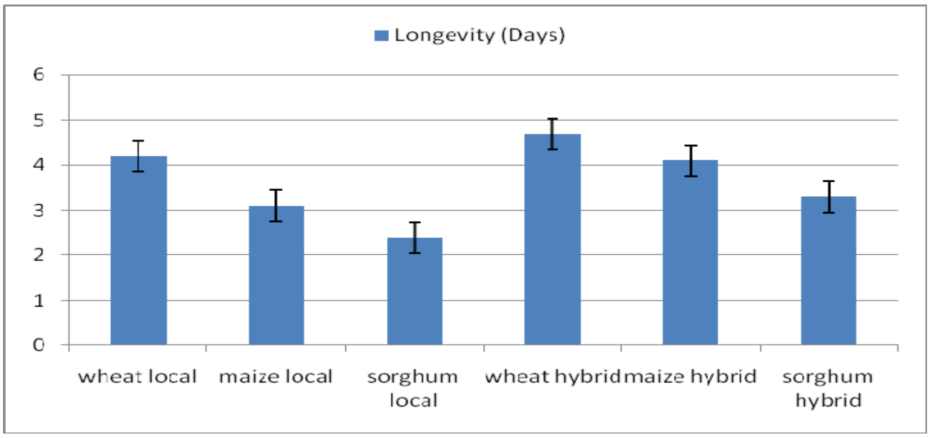

Fig 3: *T. chilonis* adult's longevity emerged from *Sitotroga* eggs reared on old and new varieties of wheat, maize and sorghum, during 2012.

4. Conclusion
The results revealed that *S. cerealella* completed development on all the grains, but greatest number of adults emergence was observed in the new varieties than in old varieties. Maximum rate of parasitism by the wasp was recorded in maize new variety. Maximum adults emergence was observed in maize new variety, and highest females were counted from the wheat new variety.

5. Acknowledgement
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6. Competing Interest
The authors declare that they have no competing interests.

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