Journal of Natural Sciences Research www.iiste.org
ISSN 2224-3186 (Paper) ISSN 2225-0921 (Online)
Vol.6, No.11, 2016

Effect of Different Hosts on the Biology of Trybliographa Daci (Hymenoptera brachonidae) Under Lab Conditions

Farman Ali Soomro[1] Nehal Khan Bugti[1] Arif Ali[2] Syed Ali Haider Shah[1] Sana Ullah Baloch[2]
Shahbaz Khan Baloch[2] Zafar Ullah[4] Abdul Qadir Baloch[5] Waseem Bashir[1] Hafeez Noor Baloch[1]
Sumera Anwar[2,3*] Abdul Muhammad Rafique Khetran[1]
1. Sindh Agriculture University Tandojam, Pakistan
2. Huazhong Agricultural University, Wuhan Hubei, China.
3. Department of Botany GC, University, Faisalabad, Pakistan
4. Balochistan Agriculture Quetta, Balochistan,Pakistan.
5. Pakistan Agriculture Research Council, Islamabad, Pakistan.

Abstract
The present studies on the effect of different hosts on the biology of *Aganaspis daci* previously known as *Trybliographa daci* (Weld) (Hymenoptera: Brachonidae now known as Eucoilidae) were carried out in the fruitfly and their parasitoids lab, Plant Protection Division, Nuclear Institute of Agriculture (NIA), Tandojam. Four different kinds of hosts namely, *Bactrocera zonata, Bactrocera dorsalis,* and *Bactrocera cucurbitae* and *Carpomya vesuviana* were used in the experiment. Data on number of un-emerged, parasitized pupae, sex ratio and longevity of the parasitoid were recorded.The different parameters of *T. daci* were significant ($P<0.05$) affected by the provision of different hosts. However, maximum mean parasitization was recorded when *T. daci* were offered with the larvae of *B. zonata* (11.40±0.96) and minimum in *C. vesuviana* (4.60±0.96). Moreover, maximum mean emergence was observed when *T. daci* were offered with the larvae of *B. zonata* (8.90±0.87) and minimum in *C.vesuviana* (3.30±0.94). Moreover, maximum male emergence were recorded when *T. daci* were offered with the larvae of *B. zonata* (3.70±0.50) and lowest in *C. vesuviana* (1.00±0.21). Similarly maximum mean female emergence was recorded, when adults *T. daci* were offered with larvae of *B. zonata* (5.20±1.45) and maximum in larvae of *C. vesuviana* (2.00±0.87). Our results established that *B. zonata* is preferred host of *T. daci* in term of preference, parasitization, emergence and longevity. These results could be exploited for the mass rearing and management of *B. zonata* in variety of orchard agro-ecosystem.
Keywords: Trybliographa Daci, Hosts, fruit flies and parasitization potential

Introduction

Fruit flies in the family Tephritidae are high profile insects among commercial fruit and vegetable growers, marketing exporters, government regulatory agencies, and the scientific community. Locally, producers face huge losses without some management scheme to control fruit fly populations. (McPheron and Steck 1996) Fruit flies attack fruits and vegetables and not only reduce their yield but also affect the quality. Damage to fruits cause loss of about 7 billion rupees to farmers annually in Pakistan besides the losses to traders, retailers and exporters. The host fruits and vegetables attacked by fruitflies like Bactrocera zonata and Bactrocera dorsalis include guava, plum, peach, apricot, loquat, bitter gourd, citrus, mango, sponge gourd and pear. Some fruits such as guava were severely damaged by fruit flies causing up to 100% loss of harvested fruits at Huripur, Kohat. In Pakistan, sole reliance has been made on pesticides for the control of fruit flies which has created environmental contamination, residues problem, killing of non-target organisms, development of resistance against pesticides in insects etc, however, in some instances, the use of male lures and protein baits are being fostered for the control of fruitfly. These control measures are not practiced in integrated manner (Khan, 1997). Among various species of pest insects attacking the fruits, fruitflies (Tephritidae: Diptera) have great economic importance due to their heavy losses to fruits in Pakistan. The incidence of fruitflies reduces both yield and quality of fruits when females puncture and lay eggs. The larvae or maggots after hatching tunnel into the fruits for feeding on the pulp and render them unfit for human consumption. In certain fruits, rotting starts at the puncture points. The losses caused to fruits by fruit flies varied according to species and the host fruit plant species. In the scientific literature the most serious pest species reported is the oriental fruit fly (B.dorsalis). Highest loss of 80 percent in guava fruit was reported by Jalaludin et al. (1999) reported 60-80 percent loss in guava fruit by Bactrocera correcta (Bezzi). The peach fruitfly (B.zonata) is another insects pest species found most abundantly in all climatic regions of Pakistan and cause 3-100 percent loss in defferent fruits.The ber fruitfly (Carpomya vesuviana) can cause 90-100 percent damage to ber fruit (Kapoor, 1993). Fruitflies are controlled by different techniques such as male annihilation technique (MAT) with methyl eugenol baited traps. It has been very successful in eradication of oriental fruitfly from Rota Island, Amami Island and Okinawa Island. Sterile insect technique (SIT) was also used to eradicate B.dorsalis from the Ogasawara Islands and B.cucurbitae from Kume Island, Japan (Shiga, 1989).

The farmers spray toxic chemicals on vegetables, oilseeds and fruit crops in order to avoid the pest

infestation. Due to the intensive and indiscriminate use of many pesticides' poison, people suffer from many diseases, and some of these are chronic for human beings. Use of pesticides has resulted in the environmental pollution on large scale. Besides contaminating food and food products, pesticides have been accumulating in the soil, air and water to a critical stage. This calls for a safe and cheap control method of these insect pests; and which can only be achieved by the practice of Integrated Pest Management (IPM); a pest control management which ensures environmental safety (Solangi, 2004).

Classical biological control of tephritid fruitfly by pests using parasitoids has been successful in a few subtropical and tropical regions (Wharton 1997, Purcell 1998, Ovruski 2000). Biological control in this regard occupies a central position in Integrated Pest Management (IPM) Programs. Because biological control of invertebrate pest and weeds has enormous and unique advantages, it is safe, permanent and economical. Trybliographa daci (Weld) was first collected in Malaysia and Borneo, and introduced into Hawaii as a potential biocontrol agent for B. dorsalis (Hendel). Biological control of fruit flies has been attempted mainly with braconid parasitoids (Hymenoptera). In several parts of the world, species of the genus Diachasmimorpha (5 Biosteres 5 Opius) have been introduced for the classical biological control of these pests (Wharton, 1997). Augmentative biological control, the mass release of parasitoids at appropriate times and places, has been proposed as a new approach for fruitfly suppression (Knipling, 1992). The Present study was therefore, to evaluate the parasitization on different fruit flies. Determine parasitization potential of Trybliographa daci.

Materials and Methods

Insect Colony and hosts

Studies were carried out on effect of different hosts on the biology of Trybliographa daci (Hymenoptera: Brachonidae) in the fruit fly and their parasitoids laboratory, Plant Protection Division, Nuclear Institute of Agriculture (NIA) Tandojam. For the experiment larval parasitoid Trybliographa daci was obtained from the parasitoid rearing laboratory. Moreover, the hosts Bactrocera zonata, Bactrocera dorsalis, and Bactrocera cucurbitae were obtained from the fruit fly laboratory. However, Ber fruit fly Carpomya vesuviana was collected and reared from the collection of infested fruit. All the hosts were reared in the laboratory and then offered to T. daci, and were maintained in cages (3 x 1.5 x 3 ft). Adults of the fruit flies had access to sugar, protein hydrolysate, casein and water soaked. Maggots of fruit flies were reared in enamel trays and were provided with mixed diet of wheat shorts, sugar, yeast, methy para hydro-oxy benzoate, sodium benzoate and Hcl. Pupae were collected and sieved from pupal substrate (2.5 x 3 x 2.5 ft). Rearing conditions for stock cultures of fruit flies were 25 ± 2°C and a photoperiod of 16L: 8D, 65±5% RH.

Four pairs of the T.daci were released in the cage and afterwards 2nd instars of the each host larvae were placed in Petri dishes containing artificial diets for 24 hours in each of jar. After 24 hours larvae were reared as mentioned for colony maintenance Pupae were collected and sieved from pupal substrate the pupae were kept for recording the counting adult emergence. Emerged an adults were kept in jars to record their longevity. Adult parasitoids were provided with honey as described above for colony.

To study the host suitability

Four kinds of hosts namely B.zonata, B.dorsalis, B. cucurbitae and C.vesuviana were offered to T. daci for 24 hour. Each pair of T. daci was kept in separate jar. Forty larvae of the each host were offered to the parasitoid upto the female natural death. Observation on parasitization, weight, width and length of parasitized pupae, number of emerged adults and sex ratio was recorded.

Effect of different hosts on the longevity and fecundity of T.daci

Freshly emerged adults of T. daci were paired and kept in cages (26 x 20 x 23 cm) and were provided with adult diet as described above for colony maintenance. To examine fecundity and fertility of T. daci fed with different host larvae were provided upto mortality of the female. Males were replaced with new males. Observation on adult longevity, fecundity and fertility were recorded. In each treatment 15 pairs of the T. daci were tested. The temperature and humidity were maintained as described above for colony.

Results

Effect of different hosts on parasitization of *T. daci*

The parasitization by the *T. daci* on different hosts was significantly differed ($P < 0.05$) as represented in Fig 1. Results revealed that maximum parasitization (11.40±0.96) was documented in *B. zonata* followed by *B. dorsalis,* and *B. cucurbitae* (8.90±1.19 and 6.70±0.94), respectively. However, minimum parasitizations were recorded in *C. vesuviana* (4.60±0.96).

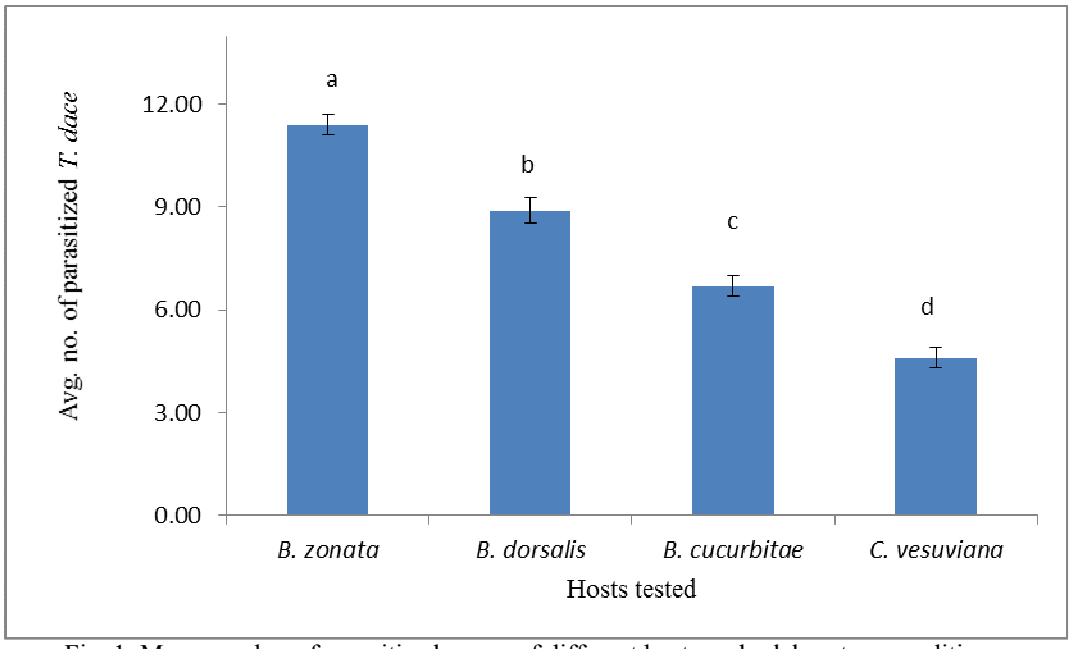

Fig. 1. Mean number of parasitized pupae of different hosts under laboratory conditions.

Effect of different hosts on emergence of *T. daci*

The emergence of the parasitoids from different hosts were significantly ($P < 0.05$) affected as shown in Fig. 2. Results revealed that maximum number of emerged adults (8.90±0.87) was recorded in *B. zonata* followed by *B. dorsalis,* and *B. cucurbitae* (6.60±1.17 and 4.80±1.30), respectively. However, minimum numbers of emerged adults were recorded in *C. vesuviana* (3.30±0.94).

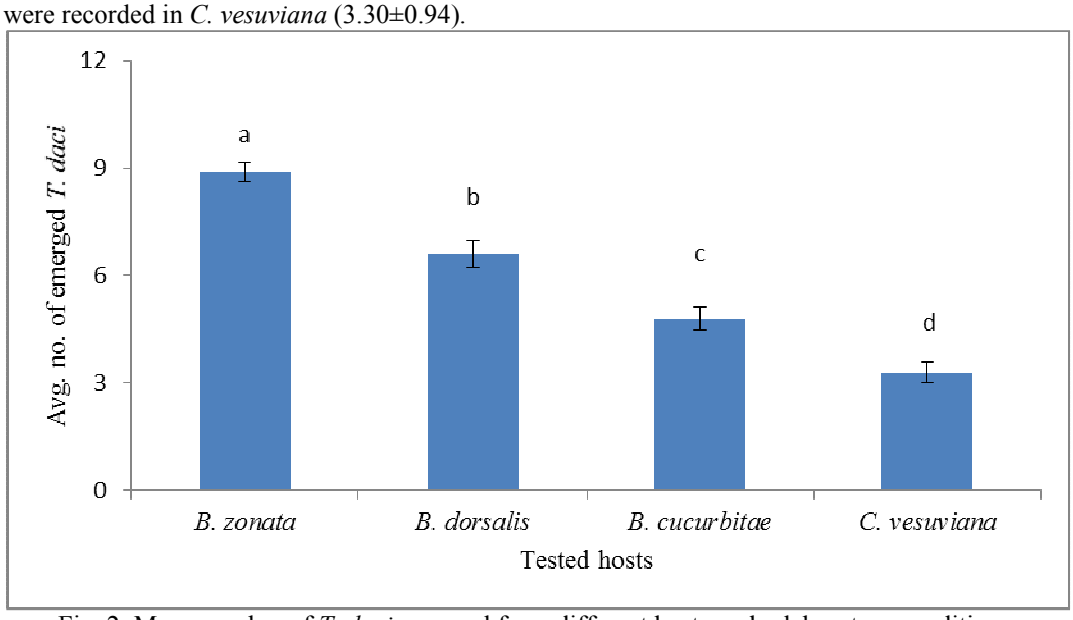

Fig. 2. Mean number of *T. daci* emerged from different hosts under laboratory conditions.

Effect of different hosts on unemerged pupae

The unemerged parasitoids from different hosts were statically fluctuated ($P < 0.05$) Fig. 3. Results revealed that maximum number of un-emerged *T. daci* (10.50±2.11) was recorded in *C. vesuviana* followed by *B. cucurbitae* and *B. dorsalis,* (8.30±1.17 and 6.10±1.02), respectively. However, least numbers of un-emerged adults were recorded in *B. zonata* (3.06±0.09).

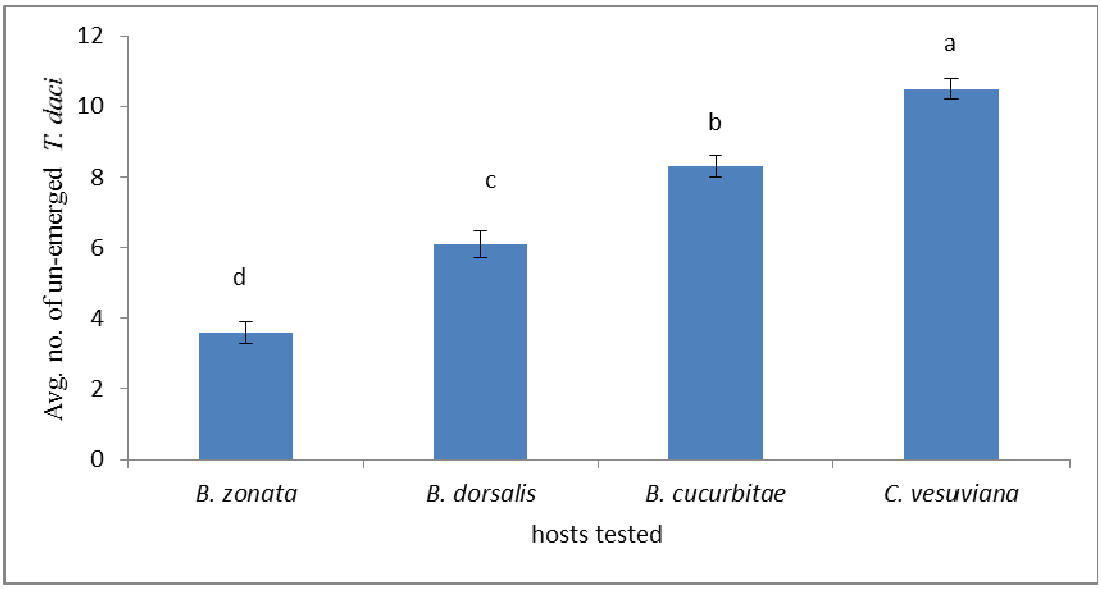

Fig. 3. Mean number of un-emerged *T. daci* from different hosts under laboratory conditions.

Effect of different hosts on emergence of males *T. daci*

There were significantly ($P < 0.05$) differences on the emergene of the male *T. daci* from different hosts as shown in Fig. 4. Results revealed that maximum male emeregence was recorded in hosts of *B. zonata* (3.70 ± 0.05) followed by *B. dorsalis* (2.90±1.09) and lowest number of males was observed in *B. cucrbitae* and *C. vesuviana* (2.0±0.27 and 1.0±0.21), respectively.

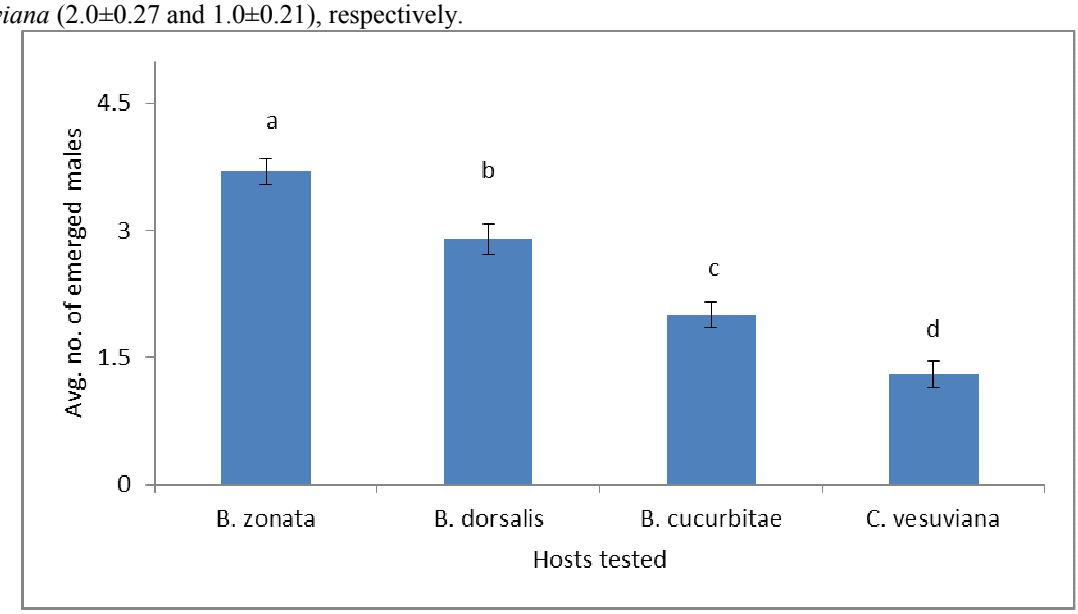

Fig. 4. Mean number of males *T. daci* emerged from different hosts under laboratory conditions.

.

Effect of different hosts on female *T. daci* emergence

There were no significantly ($P < 0.05$) differences on the emergence of the females' *T. daci* from different hosts as shown in Fig. 5. Results revealed that maximum female emeregence was recorded in hosts of *B. zonata* (5.20± 1.45) followed by *B. dorsalis, B. cucurbitae* and *C. vesuviana* (3.70±0.90, 2.90±1.05 and 2.00±0.87), respectively.

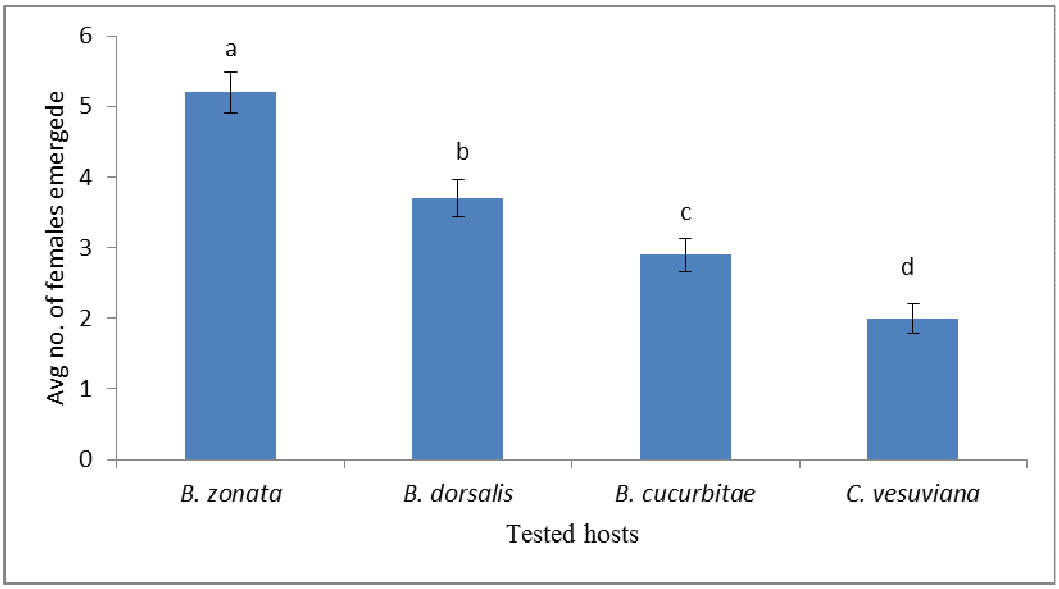

Fig. 5. Mean number of females *T. daci* emerged from different hosts under laboratory conditions.

Effect of different hosts on adult longevity *T. daci* emergence

Adult longevity of *T. daci* were significantly affected ($P < 0.05$) by the hosts (Fig. 6 and 7) maximum female longevity (9. 30 ± 2.05 days) was recorded when the *T.daci* were provided with *B. zonata*; the minimum (7.90 ± 2.51days) when fed on *C. vesuviana*. However, maximum male longevity (7.70± 1.89 days) was recorded when the *T.daci* were provided with *B. zonata*; the minimum (6.00 ± 1.09 days) when fed on *C. vesuviana*.

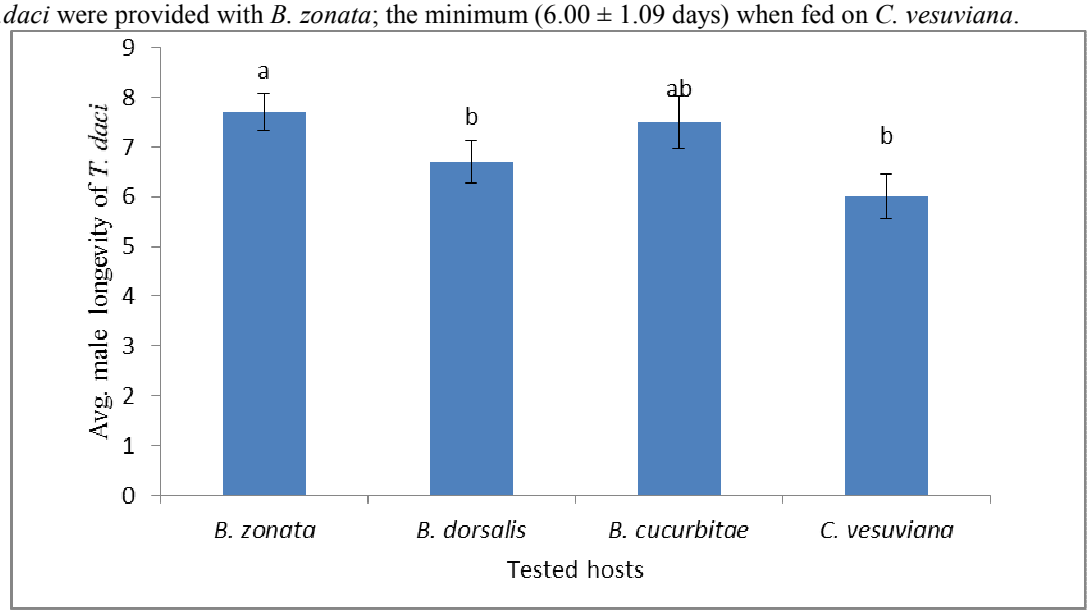

Fig. 6. Mean longevity of males *T. daci* emerged from different hosts under laboratory conditions.

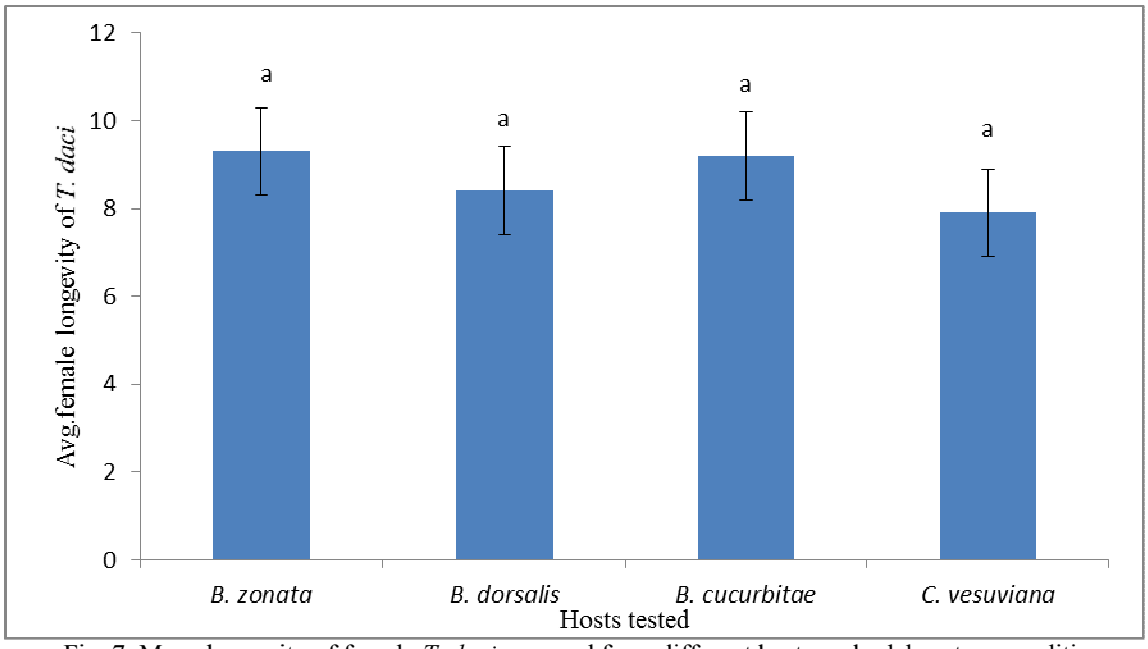

Fig. 7. Mean longevity of female *T. daci* emerged from different hosts under laboratory conditions.

Discussion

Fruit flies in the family Tephritidae are high profile insects among commercial fruit and vegetable growers, marketing exporters, government regulatory agencies, and the scientific community. Locally, producers face huge losses without some management scheme to control fruit fly populations (McPheron & Steck, 1996). Fruit flies attack fruits and vegetables and not only reduce their yield but also affect the quality. The host fruits and vegetables attacked by fruitflies like Bactrocera zonata and Bactrocera dorsalis include guava, plum, peach, apricot, loquat, bitter gourd, citrus, mango, sponge gourd and pear.

In the present study reveals that the highest number of parsitized pupae, total number of emerged parasitoid, total number of male parasitoid and total number of female parasitoid pupae were recorded by fruit fly Bactrocera zonata (11.40±00.96, 8.90±0.87, 3.70±0.05 and 5.20±1.45 percentage), respectively, which were reduced to 8.90±1.19, 6.60±1.17, 2.90±1.09 and 3.70±0.9 percentage, respectively under Bactrocera dorsalis and further reduced to 6.70±0.94, 4.80±1.30, 2.00±0.27 and 2.09±1.05 percentage under Bactrocera cucurbitae, respectively. While the lowest number of unemerged and parsitzed pupae, total number of emerged parasitoid, total number of male parasitoid and total number of female parasitoid pupae were recorded from fruitfly Carpomya vesuviana (4.60±0.96, 3.30±0.94, 1.0±0.2 and 2.00±0.87 percentage), respectively under laboratory condition. Adult Longevity of T. daci maximum female longevity (9. 30 ± 2.05 days) was recorded when the T. daci were provided with B. zonata; the minimum (7.90 ± 2.51days) when fed on C. vesuviana. However, maximum male longevity (7.70± 1.89 days) was recorded when the T. daci were provided with B. zonata; the minimum (6.00 ± 1.09 days) when fed on C. vesuviana.

The similar results are supported by Gupta et al. (1990) studied seasonal fluctuation of Dacus zonatus (Bactrocera zonatus) and D. dorsalis (B. dorsalis). They caught more B. zonatus adults. Liu and Chen (1992) reported that protein hydrolysate against B. dorsalis was the most effective bait attracting 45.4% of adult females and 35.6% of males. Cohen and Yuval (1995) reported that the fruit flies have been the subject of experimentation for many years. High fruit fly populations and the abundance of fruits throughout the year contribute to the status of fruitflies as the major pest of cultivated fruits. Allwood and Drew (1996) reported that the seasonal activity of Dipterophagus daci was dependent on the availability of its host and rainfall. They further reported that the population increased with the onset of higher temperatures and moisture level. Mahmood et al. (1996) reported that fruit flies of economic importance are Bactrocera dorsalis, B. zonata, B. cucurbitae, Dacus ciliatus and Myiopardalis pardalina. Pablo Montoya et al. (2000) recorded highly significant differences in percentage parasitism were found in release and control zones in backyard orchards. Ovruski et al. (2000) addressed the need for much more intensive research on the bioecology of native fruit fly parasitoids. Mohsin et al. (2003) recorded fecundity was 135 offspring/ female and mean parasitoids /host puparium was 21.1. It was also developed in the laboratory on the Mediterranean fruitfly, Ceratitis capitata (Wiedemann), with an average life span of 23 days in both host species. Nikos et al. (2003) reported that the high parasitism rates were recorded in the Mediterranean fruit fly, Ceratitis capitata (Wiedemann) (Diptera: Tephritidae) in pupae derived from field infested figs, on the Greek island of Chios in 1999 and 2000. Adult parasitoids were identified

as Aganaspis daci (Weld) (Hymenoptera: Eucoilidae), previously known as Trybliographa daci (Weld). Approximately 45% of C. capitata pupae yielded adult parasitoid in both years and the total mortality of pupae due to the parasitoid was 62-65%. Development of male A. daci at 25 °C, reared on 3rd instar larvae of C. capitata, was shorter than that of the female (≈34 and 37 days respectively). Average adult male longevity was 4-5 days longer than female (16-17 to 11-12 days, respectively) and almost identical in wild and F1 parasitoids of both sexes. Babu and Shashidar (2003) reported that Bactrocera dorsalis was the dominant fruit fly among the 4 species (including B. zonata, B. correctus and B. cucurbitae) captured in methyl eugenol traps established in mango orchards. They recorded maximum infestation reached 30% (0.75 larvae per fruit). B. zonata and B. correctus populations had significant correlation with temperature, while B. dorsalis and B. cucurbitae populations had non-significant correlation with weather parameters (including relative humidity and rainfall). Shahata et al. (2008) indicated that most of B. zonata adults emerged between 6 a.m and 12 at noon but the maximum emergence took place between 9 a.m and 11 a.m. Andleeb et al. (2010) determined the importance of Aganaspis daci (Trybliographa daci) and Diachaishmimorpha longicaudata parasitoids in the use of fruit fly control, biology of Aganaspis daci was studied under controlled temperature and humidity conditions. A. daci was found to be more dominant and easy to use as a biological control agent than the D. longicaudata. Sabater et al. (2012) discussed the several specimens of A. daci were recovered from medfly larva collected from fig and citrus fruits in summer 2009. Analysis of COI and ITS sequences confirmed the taxonomical identification of Spanish specimens as belonging to the Aganaspis daci species by comparison to individuals from Greece, Israel, Hawaii and Egypt. Close species Aganaspis pellenaroi (Brethes) and Ganaspis xanthopoda (Ashmead) were used as outgroup for the phylogenetic analysis. Since 2011 a year round surveillance was established with medfly infested sentinel apples as larval parasitoid attraction trap. Aganaspis daci was first detected late in June. Laboratory experiments showed that parasitism rate is modulated by host density, and fertility is greater than D. longicaudata. Low temperatures seem to induce quiescence, and increase mortality rates at immature stages. Implications for mass rearing of A. daci, as well as the implementation of biological control based on this parasitoid were discussed.

Conclusion

It was concluded from the studiesthat B. zonata was the most suitable host for the economical and efficient mass production of T. daci in terms of preimaginal growth, pupal measurement, parasitization and adult emergence. Moreover, bigger adults were recorded when T. daci was provided with the larvae of B. zonata as a host.

Sugessions

Based on results it is suggested that B. zonata could be exploited as host for the mass production of T. daci under laboratory conditions. However, more studies should be conducted on the lab as field performance of the parasitoids reared on different hosts.

References

(Dip: Tephritidae). Ph.D. Thesis. Deptt. Agri. Entomol., Univ. Agri., Faisalabad (Pakistan). PP ., 282.

Allwood, A. J. and R. A. I. Drew, 1996. Seasonal abundance, distribution, hosts and taxonomic placement of Dipterophagus daci. (Strepsiptera: Dipterphagidae). Australian Entomol.,23 (2): 61-72.

Aluja M., J. Guillen, P. Liedo, M. Cabrera, E. Rlos 1990 Fruit infesting tephritids [dipt. : tephritidae] and associated parasitoids in chiapas, mexico. Entomophaga 35 (I), 39-48

Andleeb, S., M. S. Shahid and R. Mehmood, 2010. Biology of Parasitoid Aganaspis daci (Weld) (Hymenoptera: Eucoilidae) Pak. J. Sci. Ind. Res. 2010 53 (4) 201-204.

Babu, K. S., and Shashidar Viraktamath, 2003. Species diversity and population dynamics of fruit flies (Diptera: Tephritidae) on mango in northern Karnataka. Pest Management and Economic Zoology 11:(2) 103-110.

Bale, J.S. and F. Bigler. 2008. Biological control and sustainable food production. Phil. Trans. R. Soc. 363 (1492) : 761-776.

Baranowski R., Holly G. and John S. Biological Control of the Caribbean Fruitfly (Diptera: Tephritidae). Florida Entomologist 72(2), Univ. of Florida Research 91: 245-250.

Clausen, C.P., D.W. Clancy, and Q.C. Chock, 1965. Biological control of the oriental fruit fly (Dacus dorsalis Hendel) and other fruit flies in Hawai. United States Department of Agriculture Technical Bulletin, 1322: 102 pp.

Cohen. H and B. Yuval. 1995. Suppressing medfly population , by the mass trapping strategies in fruit orchards and bio control agents. Alon Hanotea.54(6); 212-216.

Glenn, H. and R. M Baranowski, (1987) Establishment of Trybliographa daci (Eucoilidae: Hymenoptera) in Florida. Florida Entomologist 70(1), 183.

Gupta, D. A. K. Verma and O.P. Bhalla, 1990. Population of fruit flies (Dacus zonatus and D. dorsalis) infesting

fruit crops in North-Western Himalayan region Indian J. Agri. Sci., 60(7):471-474.
Jallaluddin, S.M., K. Natarajan, S. Sada Kathulla and S. Balasubramaniyan. 1999. Discovery of the guava furitfly Bactrocera correcta (Bezzi). Entomon., 24(2); 195-196.
José T. and Francisco B. 2009 The Preimaginal Phases and Development of Pachycrepoideus vindemmiae ~Hymenoptera, Pteromalidae on Mediterranean Fruit Fly, Ceratitis capitata ~Diptera, Tephritidae. Microsc. Microanal. 15, 422–434.
Kapoor, V. C., 1993. Indian fruit flies (Insecta: Diptera: Tephridae). Oxford and IBH Pub. Co. Pvt., India, 228PP.
Khan, L. 1997. Bionomics and control of the melon fruitfly, Decus cucurbitae Coq.
Knipling, F. E. 1992. "Principles of Insect Parasitism Analyzed from New Perspectives." Agriculture Handbook 693, pp. 1–159, USDA, ARS.
Kolgore, W .E and Dontt. 1967. Pest control Biological physical and selected chemical methods, pp.3. academic press, New York and London..Insect Environment,
Liu, Y. C., and J. S. Lin 1992. The attractiveness of 10% M./C. to melonfly, Dacus cucurbitae Coquillett. Pl.. Protec. Bull. (Taipei), 34 (4):307-315.
Liu, Y. C., and W.H.Chen, 1992. Improvement of proteinaceous attractants for Dacus dorsalis Hendel. Pl. Protec Bull. (Taipei). 34(4):316-325.
Mahmood, T. S. I. Hussain, Khokhar, KM and M. A Hidayatullah 2002. Studies on methyl eugenol as a sex attractant for fruit fly, Dacus zonatus (Saund) in relation to abiotic factors in peach orchard. Asian Journal of Plant Sciences 4: 401-402.
Mahmood. R. M, Murtaza. and S.K.Kazimi. 1996. Notes on biology and ecology of parasitoids of fruitflies of economic importance in Pakistan, Publisher: PARC Collation: p. 10-11.
Makhmoor, H. D. and S. T. Singh, 1999. Effect of cultural operations on pupal mortality and adult emergence of guava fruitfly, Dacus dorsalis Hendel. Ann. Pl. Protec. Sci., 7(1):33-36.
McPheron, B.A. and G.J. Steck (eds).1996. Fruit FIy Pests: A World Assesment of their Biology and Management. Delray Beach,F L. USA, StoL ucie Press,5 86 p.
Mohsen R., A. B. Ganta, R. Vargas and N. Papadopoulos 2007 Potential of Aganaspis daci (Hymenoptera: Eucoilidae) for biological control of tephritid fruit flies. Journal of Insect Science 7 (16), 20-20.
Mohsin M. R. and H. M Russell 2003. A Survey for Potential Biocontrol Agents of Bactrocera cucurbitae (Diptera: Tephritidae) in Thailand Proc. Hawaiian Entomol. Soc. (2003) 36:115-122.
Nikos T.P. and I. K. Byron. 2003. Field parasitism of Ceratitis capitata larvae by Aganaspis daci in Chios, Greece, Biocontrol 48: 191-195. Kluwer academic Publishers.
Ovruski S. M. and Pablo 2012 Schliserman, Biological Control of Tephritid Fruit Flies in Argentina: Historical Review, Current Status, and Future Trends for Developing a Parasitoid Mass-Release Program Insects, 3, 870-888; doi:10.3390/insects3030870
Ovruski S. M. and Aluja. 2000 Hymenopteran parasitoids on fruit-infesting Tephritidae (Diptera) in Latin America and the southern United States: Diversity, distribution, taxonomic status and their use in fruit fly biological control. Integrated Pest Management Reviews 5: 81–107,
Pabalo M. P. Betty B. S. John and A. Martin 2000. Biological Control of Anastrepha spp. (Diptera: Tephritidae) in Mango Orchards through Augmentative Releases of Diachasmimorpha longicaudata (Ashmead) (Hymenoptera: Braconidae) Biological Control 18, 216–224.
Sabater, M. B., V. F. Depedro, J. Tormos, J.D. Asis, N.T. Papadopoulos, M.J. Verdu, and F.J. Beitia 2012. First record, surveillance and biological parameters of Aganaspis daci (Hymenoptera: Figitidae), as parasitoid of Ceratitis capitata (Diptera: Tephritidae) in spain, Biological Control And Systems Approaches. 117.
Shahata, N. F. M.W. Younes, and Y. A Mahmoud, (2008). Biological Studies on the Peach Fruit Fly, Bactrocera Zonata (Saunders) in Egypt. Journal of Applied Sciences Research, 4(9): 1103-1106,
Shiga, M., 1989. Control; sterile insect technique (SIT); current programme in Japan. In: Fruitflies, Their Biology, Natural Enemies and Control, World Crop Pests, A. S. Robinson and G. Hooper (eds.), 3(B): pp. 365-374, Elsevier, Amsterdam.
Solangi, B.K. 2004. Biological control through natural enemies. Model Farming, Pakistan.com. pp. 1-5.
Solter. 1997. Host Specificity of Microsporidia from European Populations of Lymantria dispar to Indigenous North American Lepidoptera. J. Invert. Pathology, 69(2): 135-150.
Syed, R.A., M.A. Ghani, Murtaza, M. 1970. Studies on the trypetids and their natural enemies in West Pakistan, further observations on Dacus dorsalis, Hendel. Common Wealth Institute of Biological Control Technical Bulletin, 13: 17-30.
Victoria Y. Y., A. Pedro Rendón and J. Sivinski 2006. Biological control of olive fruit fly (Diptera: Tephritidae) by releases of Psyttalia cf. concolor (Hymenoptera: Braconidae) in California, parasitoid longevity in presence of the host, and host status of Walnut Husk Fly. 7th International Symposium on Fruit Flies

of Economic Importance 10-15 September 2006, Salvador, Brazil pp. 157-164

Victoria Y. Y., E. Carlos 2010 Field performance and fitness of an olive fruit fly parasitoid, Psyttalia humilis (Hymenoptera: Braconidae), mass reared on irradiated Medfly, Biological Control 54 (2010) 90–99

Wang X. G, R. H Messing 2004b Potential interactions between pupal and egg- or larval-pupal parasitoids of tephritid fruit flies. Environ Entomol.

Wang, X. G., A.H.Bokonon M. M Ramadan and R. H. Messing 2004 Egg–larval opiine parasitoids (Hym., Braconidae) of tephritid fruit fly pests do not attack the flower head-feeder Trupanea dubautiae (Dipt., Tephritidae). JEN 128(9/10) doi: 10.1111/j.1439-0418,00920.716–722.

Wharton, R. A. 1997. Classical biological control of fruit Tephritidae, pp. 303 Ð 313. In A. Robinson and G. Harper (eds.), World crop pests, fruit ßies: their biology, natural enemies, and control, vol. 3b. Elsevier, Amsterdam.

Xing W. And H. M, Russell 2004 Potential Interactions Between Pupal and Egg- or Larval-Pupal Parasitoids of Tephritid Fruit Flies. Environ. Entomol. 33(5): 1313Ð1320.