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International Journal of Current Research
Vol. 6, Issue, 11, pp.10042-10045, November, 2014

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

DETERMINATION OF HOST PARASITOID RATIO FOR DIAMOND BACK MOTH *PLUTELLA XYLOSTELLA* (LINNAEUS) AND ITS PARASITOID *COTESIA VESTALIS* HALIDAY

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ARTICLE INFO

Article History:
Received 24th August, 2014
Received in revised form
16th September, 2014
Accepted 10th October, 2014
Published online 30th November, 2014

Key words:
Host-Parasitoid ratio,
Parasitism,
Plutella xylostella,
Cotesia vestalis

ABSTRACT

The *In vitro* studies were carried out at 26+1°C and 65% to determine the optimum host-parasitoid ratio for the diamondback moth, *Plutella xylostella* and its endolarval parasitoid *Cotesia vestalis.* A single female of *C, vestalis* has the potential to parasitise 100 larvae effectively with 80.0 to 86.0 % parasitism, during an average female longevity of 12.9 days. The mean adult emergence was 88.56%, Mass production of the parasitoid would therefore be more effective with a host parasitoid ratio of 100 larvae : 1 female parasitoid. Field evaluation of the ratio would determine the dosage for inundative releases of the parasitoid for effective suppression of *Plutella xylostella***.**

INTRODUCTION

The diamond back moth (DBM), *Plutella xylostella* (L) is the most destructive pest of crucifer crops across the world (Talekar and Shelton, 1993). Crucifer crops affected include cabbage, chinese cabbage, chinese kale, cauliflower, broccoli, mustard,,radish, pak-choy, and several others (Haseeb *et al.,* 2004; Hemachandra and Singh, 2007, Patra *et al.,* 2013, Ruth Kahuthia-Gathu, 2013). In India, an yield loss of 52% has been reported due to the pest (Krishnamoorthy, 2004). A conservative estimate of total costs associated with diamondback moth management was 4-5 billion USD (Myron *et al.,* 2012). Indiscriminate use of insecticides had lead to the development of resistance and the pest has developed resistance to almost every class of insecticide (Zhao *et al.,* 2002, Mohan and Gujar, 2003, Sarfraz *et al.,* 2005, Dhumale *et al,* 2009, Santos *et al*., 2011). The ecological hazards due to insecticidal resistance, had necessitated reliance on biological control of the pest using natural enemies (Lui *et al.,* 2000; Li and Lui, 2001). Endoparasitoids are widely used for biological control of DBM. Among the parasitoids, the solitary endolarval parasitoid *Cotesia vestalis (Haliday)* (=*Cotesia plutellae* (Kurdjumov) (Hymenoptera: Braconidae), is an important (Liu *et al.,* 2000., Zu-Hua Shi *et.al.,* 2002; Venkateshwarlu *et al*., 2012).

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Varying degree of parasitism of DBM larvae have been reported, 16-52% (Jayarathnam, 1977), 71.7% (Yadav *et.al*., 1975), 30-50% (Walden, 2008), 36.8% (Hemachandra and Singh, 2007), 34% (Mitchell *et al*, 1997). 53-56% (Seenivasagan *et al.,* 2010), 50% (Nofemola, 2013) 78.8% (Alizadeh *et al.,* 2011), 90-95% under pesticide free conditions (Hasseb *et al.,* 2004) have been documented. Nadia kermani *et al.* (2014) reported that parasitism, reduced feeding damage by killing the later instar larvae which cause severe damage Selection of appropriate strains of biocontrol agents is necessary to have high performance on target pest to co-exist under stressed conditions (Wajnberg and Hassan, 1994., Liu and Jang, 2003., Nofemola and Kfir, 2005) Parasitoids in nature are prone to several abiotic stresses, resulting in their mortality to a greater extent. This necessities augmentative releases of parasitoids for effective suppression of the pest. The quantum of parasitoids required for field releases and optimum dosage depend up on the ratio of host density to parasitoid population. Optimisation of host-parasitoid ratio facilitates effective utilisation of the host in mass rearing the parasitoid for augmentative field releases. *In-vitro* studies were therefore contemplated to determine the optimum host to parasitoid ratio for *P.xylostella* and *C,vestalis* necessary for field releases.

MATERIALS AND METHODS

Mass rearing C.vestalis

The stock culture of Diamondback moth (DBM), *Plutella xylostella* was maintained on mustard seedlings raised in ice cream cups (55.2x68.9x45.1mm) containing vermiculite. Mustard seeds were sprinkled as a layer and allowed to germinate by maintaining proper moisture. Seedlings thus raised in cups were placed in acrylic cages (24x24x24") and DBM moths were released in the cages for oviposition. After 24-48 hours, the cups were removed and kept in trays for egg hatch and larval development. Fresh seedlings were again provided for the moths to oviposit. The mustard seedlings containing 2nd instar larvae of *P.xylostella* are placed in oviposition cages (24x24x24") and were exposed to mated female adults of the parasitoid for 24-48 hours and kept back in trays to permit the development of the parasitoid. Cocoons of the parasitoid were collected and transferred to plastic containers for adult emergence. The adult parasitoids were fed with 10% honey solution. The rearing was carried out at 25$\pm$1^{o}C and 60-65% relative humidity. The adult parasitoids were again provided with fresh batch of 2nd instar larvae and the process was continued till its longevity.

Optimization of host –parasitoid ratio for potential parasitism

The parasitism potential of *C. vestalis* was studied by exposing the second instar larvae of DBM reared on mustard seedlings kept in acrylic (30 x 30 x 30cm size) cages. A pair of freshly emerged male and female parasitoids was left overnight for mating. After 24 hrs, the gravid females were offered a precise number of uniformly grown second -third instar larvae (maintained on mustard seedlings in a rearing cage) to parasitize for 24-48 hours. The seedlings with parasitized larvae were then removed and kept in trays in cages for development. Observations were recorded on percent parasitism and adult emergence. There were three replications for each host –parasitoid ratio. The per cent parasitism was calculated by using the formula.

$$\% \text{ parasitism} = \frac{\text{Number of parasitized larvae}}{\text{Total number of host larvae offered}} \times 100$$

The data was statically scrutinized by completely randomized design one factor analysis after arcsine transformation.

RESULTS AND DISCUSSION

The percentage parasitism ranged from 60- 86.60 in the different host parasitoid ratios. An increase in the host density from 10- 100 did not contribute to a significant increase in percent parasitism. The percent parasitism (80.35-86.60) declined from 100 larvae per female proving it to be the optimum host density per female parasitoid. Parasitism of 60% was registered when the host density of 150 larvae per female were offered (Table 1). Earlier, parasitism of 90.7% was reported with a host parasitoid ratio of 100:1 (Reena and Basavannagoud, 2002) and 100-125: 1 (Seenivasagan *et al.,* 2010). More than 50% parasitism was recorded when the host density was greater than 20 second instar larvae (Nofemela, 2013). Our observations corroborate with the findings of these workers. Augmentative releases of parasitoids are required to supplement the natural population for effective pest suppression particularly in areas of high pesticide usage. Timing of release and optimum dosage of parasitoid releases are crucial in all integrated pest management strategies. Determination of optimum dosage for field releases requires standardization of host –parasitoid ratios. Our current studies had indicated that a single female of *C,vestalis* has the potential to parasitise 100 larvae effectively with 80.0 to 86.0 % parasitism during an average female longevity of 12.9 days, with a mean adult emergence of 88.56%, Mass production of the parasitoid would therefore be more effective with a host parasitoid ratio of 100:1.

Table 1. Host –parasitoid ratio (*Plutella xylostella*: *Cotesia vestalis*) and parasitism

Treatment	Host –parasitoid ratio	Mean parasitism (%)
T1	10:1	86.00
T2	20;1	85.00
T3	30:1	84.40
T4	40:1	82.50
T5	50:1	80.00
T6	60:1	83.33
T7	70:1	84.28
T8	80:1	85.00
T9	90:1	80.35
T10	100:1	80.00
T11	110:1	76..36
T12	120:1	72.50
T13	130:1	67.69
T14	140:1	63.34
T15	150:1	60.00

S,Em: 2.465 CV% 7.246 CD at 5% 7.15.007 CD at 1% 9.64

Field parasitism may vary over those under laboratory conditions (Wang and Keller, 2002). In the present studies, the proximity of the host and its availability under ambient conditions (25-27^{o}C and 60-65% RH) resulted in greater foraging ability and parasitism. Under field conditions, where the predisposing ecological factors, host searching ability of the parasitoid, range of dispersal and susceptibility to insecticides govern the parasitism. Earlier, decreased percent parasitism to host with an increase in distance was reported in *Trichogramma evanescens* (Abdurrahman *et al*., 2008) and *Trichogramma chilonis* (Nadeem *et al.,* 2004). Decreased parasitism of 27% less than caged conditions was observed in *C.vestalis* (Seenivasagan *et al.,* 2010). Our studies had established an optimum host-parasitoid ratio (100:1), for enhanced mass rearing of the parasitoid that enables augmentative field releases for successful management of DBM

CONCLUSION

Optimum host parasitoid ratios are essential for determining enhanced cost effective mass rearing of the parasitoids under *in vitro* conditions. Determination of optimum dosage for field releases requires standardization of host –parasitoid ratios. The optimum host – parasitoid ratio for *Plutella xylostella* and *Cotesia vestalis* is 100:1. A maximum of 86.0 % parasitism with a mean adult emergence of 89% can be obtained with the optimum ratio. Augmentative releases of parasitoids can be successful possible with the optimum ratio for effective pest suppression of diamondback moth.

ACKNOWLEDGEMENT

The author wishes to thank the Director, National Bureau of Agricultural Insect Resources, for providing the necessary facilities for carrying out the work.

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