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Cotesia glomerata (Hymenoptera: Braconidae): A Potential Biocontrol Agent for Large White Butterfly, *Pieris brassicae* (Lepidoptera: Pieridae)

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ABSTRACT

Biotic stresses are among the several constraints that limit realization of full yield potential of oilseed *Brassica* crops. Although mustard aphid, *Lipaphis erysimi* (Kaltenbach) continues to pose serious threat to oilseed *Brassica* and is a major production constraint, the large white butterfly, *Pieris brassicae* (Linnaeus) is also emerging as an important pest. In the Punjab province, this species was earlier restricted to vegetable *Brassicas* only, however, for the past few years continuous occurrence is being reported on oilseed *Brassicas*. The pest is a voracious feeder and inflicts heavy damage to the leaves and inflorescence. In this part of the country, it generally starts infesting oilseeds *Brassicas* from 4th Standard Meteorological Week (SMW) and thereafter, the population remains upto the crop maturity. Observations at Punjab Agricultural University, Ludhiana, India have recorded larval population as high as 106.6 larvae/plant. Such a high incidence resulted in plants practically devoid of leaves, flowers and developing pods with only twigs left intact. In the event of lack of food even the twigs were scratched by larvae on some of plants. Since, *P. brassicae* is of regular occurrence on vegetable *Brassicas,* the possibility of a tritrophic interaction in oilseed *Brassicas* cannot be overruled. Native parasitoids/predators can prove to be a good component of biological control programmes, especially in area wide pest management. Therefore, three years' study during 2007-08, 2008-09 and 2009-10 crop seasons was carried out at Punjab Agricultural University, Ludhiana to find out potential parasitoids/predators of this pest. For this 10 egg masses and 50 grown up larvae were collected at weekly intervals and brought to the laboratory. These egg masses and larvae were kept until hatching and adult emergence, respectively, in glass jars to record emergence of parasitoid, if any. Field observations were also made to record for any predator feeding on eggs or larvae. While no egg and pupal parasitization was recorded during the three crop seasons, larval parasitization ranging from 6 to 86% was recorded during different SMWs. In 2007-08 crop season 37% larval parasitization was observed while in 2008-09 and 2009-10 it was about 53% each. Of the 600 larvae collected, 46.3 were parasitized. The parasitoid recovered was identified as *Cotesia glomerata*. Parasitization was recorded after 8th SMW till the population lasted on crop. Although, *P. brassicae* is causing substantial damage to the crop but, a considerably high level of larval parasitization by *C. glomerata* occurs under unsprayed field conditions. This native parasitoid can prove be an important component of area wide pest management programmes especially in the biological control of *P. brassicae*.

Key words: Cabbage caterpillar, *Cotesia glomerata,* oilseed *Brassica,* parasitization, *Pieris brassicae*

INTRODUCTION

Unlike most of the other oilseed producing countries, India grows a wide range of crops: rapeseed-mustard, groundnut, soybean, sunflower, sesamum, safflower, niger, castor, linseed, coconut, oil palm and a number of forest trees which yield oil. India holds an important position in the world's vegetable oil economy with oilseed Brassicas as second predominant group of oilseed crops after groundnut. Like many other oilseed crops, these energy rich crops in this country are grown under energy deprived conditions with limited inputs mostly by marginal farmers. In addition, a number of abiotic and biotic stresses add up in preventing the realization of full yield potential of these crops. Among the biotic constraints, insect-pests are the major ones that cause substantial yield losses. Although, mustard aphid, *Lipaphis erysimi* (Kaltenbach) (Homoptera: Aphididae) continues to pose serious threat to oilseed *Brassica* and is a major production constraint, the large white butterfly, *Pieris brassicae* (Linnaeus) (Lepidoptera: Pieridae) is also emerging as an important pest. *P. brassicae* is an oligophagous pest with wide host range and is known to infest 83 species of food plants belonging to Cruciferae, Tropaeolaceae, Capparaceae, Resedaceae and Papilionaceae (Feltwell, 1985). It has a Palearctic distribution from North Africa across Europe and Asia to the Himalayan Mountains (Higgins and Riley, 1970). It is mainly a pest of vegetable Brassica and develops faster on these hosts compared to oilseed Brassicas (Aslam and Suleman, 1999; Ali and Rizvi, 2007) with very high larva densities (Younas *et al*., 2004). In Punjab, this species was earlier restricted to vegetable Brassicas only, however, for the past few years continuous occurrence is being reported on oilseed Brassicas. The pest is a voracious feeder and inflicts heavy damage to the leaves and inflorescence. Larvae show preference for different brassica genotypes (Aslam *et al*., 2000). In heavily infested fields all the plant parts including pods are eaten up leaving only the twigs. Though, at present, the management of this pest is largely based on the use of synthetic insecticidal chemicals which have their own adverse effects such as development of insecticide resistance in the insect-pest, resurgence, pesticide residues in oil and cake besides environmental pollution. This necessitates the development of alternate control strategies such as to exploit natural control or augumentatively release natural enemies as a part of integrated pest management programmes. Though, a number of alternate control strategies such as bacterial, fungi, growth regulators and others are available for management of this pest on vegetable brassicas (Zafar *et al*., 2002) there have been limited studies on oilseed brassicas. Studies that identify natural enemies that coincide spatially and temporally with pest populations and therefore, have potential to control them, can suggest ways to minimize insecticide applications by targeting them more efficiently, thereby helping to conserve the natural enemies (Murchie *et al*., 1997; Holland *et al*., 1999). The present study was conducted keeping this objective in mind.

MATERIALS AND METHODS

The study was carried out during 2007-08, 2008-09 and 2009-10 crop seasons at the oil seeds research farm of Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana (30° 9'N, 75° 85'E, 244 m above msL), India to record the natural enemies that attack *P. brassicae* and the extent of mortality that this pest suffers from these natural enemies.

Rasing of the crop: The Indian mustard, *Brassica juncea* cv. PBR 91 (available from oil seeds section, Department of Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, India) was sown in plot size of 10×8 m in the last week of October. The row to row distance was

maintained at 30 cm while plant to plant distance was kept at 15 cm. The crop was kept unprotected for the infestation of insect-pests. All the recommended package of practices for raising a good crop were followed except for spray of insecticides.

Study of parasitization: For the study of parasitization, regular surveillance of the field was carried out at weekly intervals starting from 1st Standard Meteorological Week (SMW). The plant were monitored for the presence of eggs and/or larvae of *P. brassicae*. As and when the egg masses and larvae were observed in the field, these were brought to the laboratory. These were kept in the glass jar till hatching/pupation to record emergence of parasitoid, if any. Field observations were also made to record for any predator feeding on eggs or larvae.

RESULTS

During the three years study period no egg parasitoid was observed. However, larval parasitization ranging from 6 to as high as 86% was observed during different SMWs (Fig. 1). In 2007-08 crop season, the larval parasitization ranged from 6-86% during 9-13th SMW. Maximum larval parasitization (86.0%) was observed during 10th SMW. In 2008-09, it ranged from 44-66% during 9-13th SMW. The maximum parasitization (66.0%) was observed during 11th SMW. However, in 2009-10, larvae were observed late in the season from 11-13th SMW and consequently the larval parasitization. It ranged from 36% in 11th SMW to as high as 70% in 12th SMW. The mean larval parasitization during 2007-08, 2008-09 and 2009-10 crop season was 37.2, 53.0 and 52.7%, respectively. Only a single larval parasitoid, *Cotesia glomerata* (Hymenoptera: Braconidae) could be recovered from parasitized larvae. Of the 600 larvae collected, 46.3 were parasitized.

P. brassicae generally starts infesting oilseeds *Brassicas* from 4th SMW, though its infestation was observed late in the three years study period. Thereafter, the population remains upto the crop maturity with peak activity during 11-13th SMW. Field observations have recorded larval population as high as 106.6 larvae/plant (Fig. 2). Such a high incidence resulted in plants practically devoid of leaves, flowers and developing pods with only twigs left intact (Fig. 3). In the event of lack of food even the twigs were scratched by larvae on some of the plants. Parasitization was recorded after 8th SMW till the population lasted on crop. Though, generalist predators like

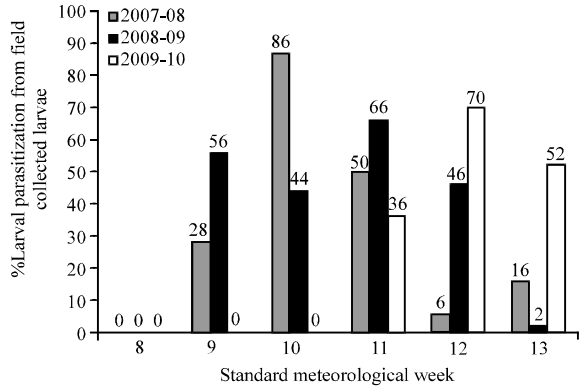

Fig. 1: Larval parasitization of *Pieris brassicae* during different years

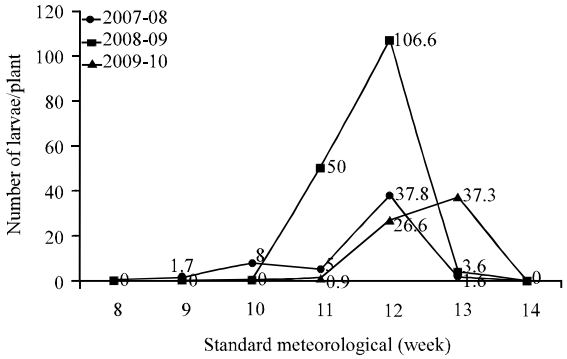

Fig. 2: Larval population of *Pieris brassicae* on oilseed *Brassica* in a three year study period from 2007-08 to 2009-10

Fig. 3: Severe damage by *Pieris brassicae* larvae. Note all the flower buds, flowers, pods and leaves (except a few) are eaten up by caterpillars

Coccinella septempunctata, Chrysoperla carnea and *Episyrphus balteatus* were present in the field, none of the predators was found to feed on eggs and larvae of *P. brassicae,* as large populations of *L. erysimi* were available to them.

DISCUSSION

Cotesia glomeratus is already reported as a major natural enemy of *P. brassicae* in the field (Feltwell, 1985). Kristensen (1994) in Denmark recorded larval parasitization of this pest as high

as 82%. It is a gregarious endoparasitoid that lays its eggs in the first/second instar of its host and the parasitoid larvae egress from the host halfway through its fifth instar (Laing and Levin, 1982), the host larvae die up to 3 days later but do not feed in the intervening period (Junnikala, 1966; Feltwell, 1985).

The *Brassica* agro-ecosystem, like the other agricultural ecosystems are often thought to be more prone to herbivore outbreaks than natural ecosystems. The monoculture and consequently, the lack of biodiversity was considered to be responsible for their instability by early ecologists (Pimentel, 1961; Van Emden and Williams, 1974). However, on the other hand, some detailed reviews have concluded that perhaps one or two particularly effective natural enemies are all that is needed for effective pest control (Hawkins *et al.*, 1999). Such issues come to the fore when a decision is to be made about whether to introduce one or several natural enemy species in an agroecosystem (Myers *et al.*, 1989; Denoth *et al.*, 2002) or to conserve the indigenous natural enemies (Landis *et al.*, 2000; Tscharntke *et al.*, 2005) as a part of Integrated Pest Management (IPM). The development of Integrated Pest Management strategies requires a better understanding of interactions among pests and their natural enemies (Alford *et al.*, 2003). An understanding of relationship between pests and their natural enemies in an agroecosystem is key to development of strategies to enhance conservation biological control in oilseed *Brassicas* (Williams, 2004, 2006). Conservation biocontrol has been defined as the 'modification of the environment or existing practices to protect and enhance specific natural enemies or other organisms to reduce the effects of pests' (Eilenberg *et al.*, 2001).

The plants from family Brassicaceae are known to produce a diverse array of secondary plant metabolites which have their role in plant defence (Ahuja, *et al.*, 2010). But during the course of evolution specialist herbivores like *P. brassicae* have developed mechanisms to cope with these defensive chemicals (Hopkins *et al.*, 2009). The previous work by Coleman *et al.* (1996) on cabbage has also shown that *P. brassicae* does not appear to be affected by any chemicals induced in damaged tissue. It does not show reduced growth on wounded tissue or move away from the site of damage. However, they have opined that indirect defense may be a possibility. If wounding plants results in elevated leaf chemicals (Edwards and Wratten, 1987), these may contribute to Herbivore Induced Synonomes (HIS), constituting a signal to parasitoids. This could be considered indirect mediation of wound induced defence, if the attraction of the parasitoid can be demonstrated to be beneficial to the plant. Such use of third trophic level to defend plant tissues may be called 'bodyguard hypothesis' (Dicke and Sabelis, 1988). Such involvement of third trophic level in plant-herbivore interactions is an evolved response by the plant. This is a suggestion put forth by many researchers (Dicke and Sabelis, 1988; Godfray, 1995; Turlings *et al.*, 1995), hence the term 'synonome', an infochemical (Dicke and Sabelis, 1990) of mutual benefit to the plant and the natural enemy.

CONCLUSION

In the present study, though, *P. brassicae* is reported to cause substantial damage to the crop but a considerably high level of larval parasitization by *C. glomerata* occurs under unsprayed field conditions. This native parasitoid can prove be an important component of area wide pest management programmes especially in the conservation biological control of *P. brassicae* (Kumar, 2011). Further, there is need for effective decision making for the delayed application of insecticides and measures to conserve the native parasitoid that is an important component of *Brassica* ecosystem.

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