http://www.pjbs.org

PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 10 (10): 1728-1732, 2007
ISSN 1028-8880

Application of Mating Disruption Approach to Control Codling Moth (*Cydia pomonella* L.) Damage to Apple Crops in Azad Kashmir, Pakistan

[1]M. Ashraf, [1]M. Asif, [1]M. Adrees, [1]Wajahat Hanif and [2]Ch. Muhammad Ishtiaq
[1]University College of Agriculture, Rawalakot, Azad Kashmir, Pakistan
[2]Department of Biology, Key Laboratory of Taxonomy and Ethnobotany,
Quaid-e-Azam University, Islamabad, Pakistan

Abstract: Various techniques are applied to control the pest damage to (pome) crops in different countries of the world. Among the integrated pest management programmes (IPCP), mating disruption (MD) approach has its own advantages over pesticide techniques being less hazardous to environment. An exhaustive systematic field trial surveys were conducted to explore the seasonal activities of Codling Moth (CM) *Cydia pomonella* under natural conditions and the (MD) method was applied to Control Maling Disruption (CM) damage to apple (pome) crops in area of Azad Jammu and Kashmir, (Pakistan). Mating Disruption (MD) technique offers several advantages over pesticide sprays methods and, MD reduces CM damage. The present study describes the assessment of time of pest infestation, peak flight temporal and spatial variation of CM (*Cydia pomonella*) in two different experimented habitats by the use of pheromone trap approach. For experimental data, two distinct flight periods of CM were recorded, suggesting two generations per year. The pest population density was observed to be the highest in the first weeks of May and July. It was concluded that by application of the MD technique a better growth of pome crops can be obtained. Hence, for sustainable and comprehensive fruit farming, a more widespread use of pheromones technique (Mating Disruption- MD) may be useful step to enhance the agricultural yield of apple (pome) crops.

Key words: Plant-pests, *Cydia pomonella*, mating-disruption, sex-pheromones, traps monitoring, Azad Kashmir, Pakistan

INTRODUCTION

Fruit crops (Pome family) play vital and an important role in human health and economics. Apple (Pome family) fruits have significant importance in human daily life and usually it is an essential part of desserts on the tables. But these cash crops are confronted with risks of different types of pests. Among these, Codling Moth (CM) *Cydia pomonella* L. is a key pest of European apple, Asian pear and Persian walnut (Barnes *et al*., 1992). This CM has world-wide ecological close association with the cultivation of apple, pear and walnut (Shel'deshova 1967). This pest is generally recorded in all apple growing countries. Its infestation ratio ranges between 20-95% apple crops (Gordon, 1980; Metcalf and Luckmann, 1982; Flint, 1995).

Among pome fruits, apple is one of the most leading crops which contributes 4% towards gross income of the Azad Kashmir (Pakistan). This state has ideal climatic conditions for apple production (Gardesi and Manzoor-ul-Haq, 1985). The apple growing areas are located ca. 1500-2000 m above sea level (Farooq Ahmad *et al*., 1999). More than 80% apple growing areas are rain fed and extreme cold winter season with an annual precipitation is 750-1600 mm. Apple (pome) trees are infested by a large and diverse number of phytophagous and entomophagous arthropod fauna. More than 500 insects were reported which feed on apple crops worldwide (Metcalf and Luckmann, 1982). Among the most common pest species include; Codling moth, (*Cydia pomonella*) Sanjose scale (*Quadraspiditus pernicious*), Spider mite (*T. urtiale*), red spider mite (*Panonychus ulmi*), Apple wooly aphid *Erosoan langerum*) and muscle scale (*Lepious ulmil*), cause major loss of apple fruit (Gonzalez, 1984; Gergely, 1994).

Several methodologies are being applied as an Integrated Pest Management Programme (IPMP) to obstacle the pest (insects) damage to the cash crops. Among commonly applied strategies of IPMP, application of sex pheromone as Mating Disruption tool (MD) has been frequently applied in agriculture fields in different areas of the world (Judd *et al*., 1997).

Due to the identification of the sex pheromone of the codling moth *Cydia pomonella* (Roelofs *et al*., 1971), it was convenient to the use pheromone traps (MD) as a useful tool for insect detection and monitoring how MD is an appropriate method for pest (CM) control on apple

Corresponding Author: Ch. Muhammad Ishtiaq, Department of Biology, Key Laboratory of Taxonomy and Ethnobotany, Quaid-e-Azam University, Islamabad, Pakistan

crops. The term pheromone was firstly coined by (Karlson and Butenandt (1959), referring to the substances emitted by one individual and eliciting a specific reaction in a second individual of the same species. Pheromones are natural chemicals, usually produced by the female of a species to communicate and signal her presence to potential mates. Based on this normal biological function, pheromones are quite simply defined as, chemical sex attractants. Latter on, Butenandt *et al.* (1961) identified the first pheromone trans-10, cis-12-hexadecadien-1-ol in commercial silk worm.

The pheromone-baited traps are more routinely used to monitor the flight periods of several adult lepidopteron pests of field and fruit crops (Wilson and Trammel, 1980; Vincent *et al.*, 1990; Delisle, 1992). The strategy can be successfully applied in order to monitor the seasonal activities of CM. Female CM release sex pheromone consist of E.E 8,10-dodecadien-1-01 and Tetradecan-1-01, into the environment enable the male moth to locate them by following the female trial (Brawn *et al.*, 1992).

Very little is known about the performance of pheromone traps (MD technique) under Azad Kashmir conditions or in many other parts of Pakistan. The present study describes the effectiveness of Mating Disruption (MD) technique to control the CM loss on apple (Pome) crops in Azad Kashmir (Pakistan). In this research, data were formulated by assessment of time of pest infestation, peak flight temporal and special variation of CM in two experimented sites A and site B by the use of pheromone traps in order to elucidate the mechanism of application and affectivity of the of Mating Disruption (MD) technique.

However, it is concluded that sexual confusion technique is useful in the context of Integrated Pest Control Programs (IPCP). This study will help farmers of Azad Kashmir to develop effective pest management strategies in apple growing as well as a modal for other apple growing areas of Pakistan and other countries of world.

MATERIALS AND METHODS

Planned field experiments were conducted at two sites of different heights in selected orchards in Azad Kashmir (Rawalakot) in order to monitor the activities of CM on apple (pome) crops. The experiment was conducted during April to September 2004. The biogeographical data of the surveyed orchid are presented in four synthetic pheromone traps (California USA, imported) were installed at two different sites on different heights in two apple orchards. Rubber capsule containing 1 mg of codlemone (trans-8, trans-10-dodecadein-1-01) was suspended in the center of the trap. At the bottom of trap cardboard sheet with sticky material was placed in order to prevent the moth from escaping.

Table 1: Biogeographical data of the surveyed orchid during the study

Farmer	Height m	No. of trees	Type of plants
S. Abbasi	1676	95	Star king
Site A	1678	105	Golden
S. Abbasi	1780	85	Golden
Site B	1795	115	Kashmir

Each pheromone was hung at about on head height in the middle of orchard. The trapped moths were counted and removed on each observation. The codlemone capsules were replaced on after each month. The simultaneous observations were made for all collected moths on all sites of the same locality. Weekly observations were conducted between 11-12 am and data were recorded. An analysis of variance was carried out using (GLM) to compare the mean number of collections of CM on each sampling data between site A and B.

RESULTS AND DISCUSSION

The data indicate that population of CM collected was higher ca. 61 moth in the month of May, as compared with data of September ca. 5 moths, in S. Abbasi orchard A (Table 2). The table also indicates that there was higher population tendency of CM entrapped in May, ca. 78 moths as comparing it with data of September ca. 5 CM, in orchard B. The Table 1 also elucidates clear difference in pest population spatially and temporally. Over the 22 weeks of experiment 4 traps were used on two different sites, two in each orchard. An average of 4.36 and 6.36 moth/trap/week were recorded from site A and B, respectively. So, average number of moth is 5.37 moth/trap/week, which is inline with the findings of (Cranham, 1979).

Comparison between site and date of sampling of CM:

An ANOVA test was used to measure the seasonal variation of CM, which showed some significant variation between site and date of sampling (Table 3). The overall population appeared more significant ($p<0.005$) at site B than site A. In present results more number of moths ca. 281 were record from site B and low number of moths 193 from site A and these results congruently support the previous research (Farooq Ahmad *et al.*, 1999).

The monthly activity appeared highly significant $p<0.001$ on each sampling date, in month of May population density of CM was higher while less number of population was record in month of September. These results are inline with previous findings (Zaki, 2002; Fadamiro, 2004).

It was recorded that there was no effect of height within the orchard which was an agreement with previous research (Farooq Ahmad *et al.*, 1999) in which it was described that there were no significant differences between caught moths in trap position either at the top of tree or at head height (Table 4).

Table 2: Overall population of codling moth *C. pomonella* on apple trees at different experimented sites

Month	S. Abbasi Site A, Height 1	S. Abbasi Site A, Height 2	Total	S. Abbasi Site B, Height 1	S. Abbasi Site B, Height 2	Total
April	20	29	`49	26	19	45
May	30	31	61	32	46	78
June	13	10	23	28	17	45
July	21	15	36	28	42	70
August	11	8	19	20	16	36
September	2	3	5	2	3	5
Total	97	96	193	136	145	281

Table 3: Population of CM with respect to site and height interaction

Source of variation	df	SSS	F-value	p-value
Sights	1	9.011	13.14	0.002*
Orchard height	1	0.557	0.08	7.778
Dates	21	1602.875	11.14	0.000**
Sites *Orchard height	1	1.375	0.20	0.659
Site *Dates	21	148.239	1.03	0.473
Error	21	143.875		
Total	87	2058.625		

** = Significant at 1% level *= Significant at 5% level

Table 4: Effects of heights on number of CM collected in Trial

Observations	No.	Mean	S. Mean
Site A-Height 1	22	4.409	0.904
Site A-Height 2	22	4.32	1.07
Site B-Height 1	22	6.189	0.977
Site B=Height 2	22	6.59	1.15

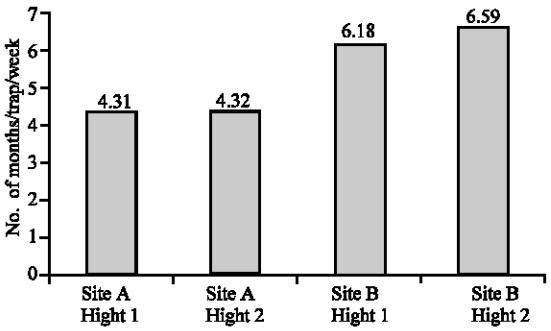

Fig. 1: Population of codling moth *C. pomonella* with respect to site and height interaction

When we compare the results of these two sites A and B it becomes clear that there is no a great difference in moth catchments in the site A and B, which means that inter-traps position show no effect within the orchard but it show great variation at different orchard sites.(Fig. 1).

The experiment results demarcated that number of moth collection reached to its highest peak ca. 61 and 78 moth/trap/week during the first week of May from site A and B, respectively. The second highest peak population with 36 and 70 number of CM was obtained in July from the same site. These results are at par with the findings of Stribu (2000). From the above findings both peak and manolarche activities in two sites indicate that there are two generations of codling moth in experimental area. (Fadamiro, 2004). Hence, it was concluded that CM invasion was more severe in May and July as in comparison with September time. (Fig. 2).

Mechanism of action of MD approach: The mechanism of action of MD technique is based the phenomenon that presence of excessive pheromone confuses male codling moths. Firstly, male moths follow the false pheromone trails created by the release of synthetic pheromone into the wind, thereby making themselves unavailable for mating. Secondly, male moths exposed to high concentrations of pheromone become so desensitized to pheromone that they no longer smell it, or respond. Normally, an insect's nose, that is it's antennae, detects the pheromone and sends a message to the brain. However, after long exposure to pheromone, neither the antennae nor the brain respond; this is known as Habituation Phenomenon (HP). Thirdly, the highly concentrated synthetic pheromone trails released from dispensers, mask or camouflage, the weaker, natural pheromone trails of female codling moths.

Some constraints of MD technique and suggestions for their solution: As results have explained that higher populations are not a problem if good orchard sanitation precedes pheromone treatment, or if growers apply one cover spray of Guthion at the correct time during the first flight of the season. Mating Disruption has not worked as well in orchards with trees taller than 12-15 ft., unless you also apply a cover spray. We know this is related to the larger canopy volumes in larger trees, which simply means more pheromone is required in taller trees or a lower population to start with. It is more effective to apply a cover spray than it is to put out more pheromone. The major limiting factor to successful use of MD is population density. If initial populations are low enough, most of the problems listed above become unimportant, so everybody should apply that first cover spray the first year they use MD. In the second year of use the spray will probably not be needed.

In general, this technique expounds that MD can be valuable tool to check the pest (CM) attack on apple (pome) crops of Azad Kashmir (Pakistan), if it is explicitly and precisely applied. Albeit, this technique

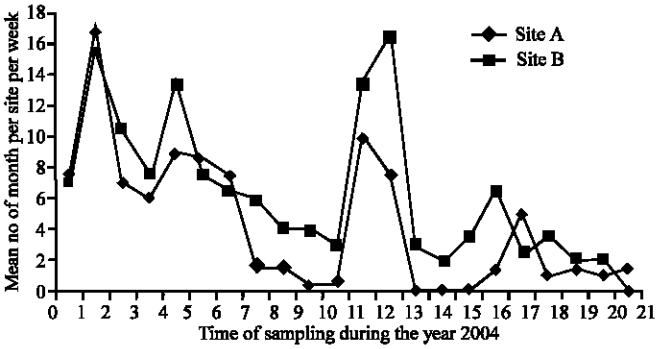

Fig. 2: Relationship between number or CM and time of sampling

is the most favorable one and environment friendly in IPMP approaches, yet it has some of its limitations. So, detailed mechanism of action of MD technique should be studied and as well as its suitability to the particular habitat should be surveyed prior to its usage. But, sharing and distribution of knowledge about its mechanism of action to the common masses will enhance its utility ratio and affectivity. However, this approach hitherto needs further research for a more widespread use of pheromone application in controlling of CM in pome (apple) crops in Azad Kashmir and Pakistan in order to make this methodology more reliable and more economic to lay man which will boost up the economy at individual, regional and nation wide of the country.

REFERENCES

Barnes, D.F., T.G. Milla, P.A. Kirsch and D.C. Haws, 1992. J. Econ. Entomol., pp: 1274-1277.

Brawn, M., Wand and M.V. Welker, 1992. Development of the phytophagous arthropod community on apple as affected by orchard management. Environ. Entomol., 21:485-492.

Butenandt, A., *et al*., 1961. Uber den Seuallockstoff des Seidenspinners. II. Konstitution und Kongfihuration des Bombykols. Hoppe-Seyler's Z. Physiol. Chem., pp: 324- 84.

Cranham, J.E., 1979. Monitoring of codling moth with pheromone trap. Rev. Applied Entomol., pp: 67-342.

Delisle, J., 1992. Monitoring the seasonal male ßight activity of *Choristoneura rosaceana* (Lepidoptera: Tortricidae) in eastern Canada using virgin females and several pheromone blends. Environ. Entomol., 21: 1007-1012.

Farooq-Ahmed, K.M.I., Baig and S.G. Mustfa, 1999. Spatial distribution and phenology of adult *Chilochorus infernalis* (Mulsant); (coccinellid; coleoptra). on apple trees in Kashmir, Pakistan. Sarhad J. Agric., pp: 343-344.

Flint, M.L., 1995. Pest of the Garden and Small Farm; UC. Pest Management Guidelines, University of California, Agriculture Natural Resources Publication, 3332, Okland.

Fadamiro, H.Y., 2004. Monitoring the Seasonal Flight Activity of *Cydia pomonella* and *Argyrotaenia velutinana* (Lepidoptera: Tortricidae) in Apple orchards by using pheromone-baited traps. Environ. Entomol., 33: 1711-1717.

Gardesi., S.D.A. and Manzoor-ul-Haq, 1995. Some studies on biology of codling moth (*Cydia pomonella,* L. In Azad Jammu Kashmir Pakistan. Pakistan Entomologist., pp: 55-64.

Gergel, I., 1994. Neelum and Jhelum valley community development project. I. F. S. D/01 and UNDP/ OPS? PAK /92 /005. Report on the consultancy of FAD. Improvement of fruit husbandry, pp: 1-5.

Gordon, P.W., 1980. Codling moth leaf roller, Ministry of Agriculture, Fisheries and Food 42:6 pp. Rev. APF. Entomol., pp: 69: 887.

Gonzalez, R.H., 1984. Seasonal development of insects and pests on apples. Revista-fruiticola, 5:1, 3-9.

Judd, G.J.R., M.G.T. Gardiner and D.R. Thomson, 1997. Control of codling moth in organically-managed apple orchards by combining pheromone-mediated mating disruption, post-harvest fruit removal and tree banding. Entomologia Experimentalis et Applicata, 83: 137-146.

Karlson, P. and A. Butenandt, 1959. Pheromones (ectophermones) in insects. Ann. Rev. Entomol., pp: 4-39.

Metcalf, R.L. and W.H. Luckmann, 1982. Introduction of Insect Pest Management. John Willey and sons. N.Y. pp: 577.

Roelofs, W.L., A. Comeau, A. Hill and G. Milicevic, 1971. Sex attractant of the codling moth: Characterization with electroantennogram Technique. Sci., 174: 297-299.

Shel'deshova, G.G., 1967. Ecological factors determining distribution of the codling moth *Laspeyresia pomonella* L. (Lepidoptera: Tortricidae) in the northern and southern hemisphere. Entomol. Rev., 46: 349-361.

Stribu, M. and Manolarche-A., 2000. Establishing flight dynamics in some Lepidoptera injurious to apple tree by synthetic sex pheromone trap under fruit growing research station. Cercetari-Agronomice in Moldova, 2000, 33, 1-2, 93=97.

Vincent, C., M. Mailloux, E.A.C. Hagley, W.H. Reissig, W.M. Coli and T.A. Hosmer, 1990. Monitoring the codling moth (Lepidoptera: Olethreutidae) and oblique banded leaf roller (Lepidoptera: Tortricidae) with sticky and non sticky traps. J. Econ. Entomol., 83: 434-440.

Willson, H.R. and K. Trammel, 1980. Sex pheromone trapping for control of codling moth, oriental fruit moth, lesser apple worm and three tortricid leaf rollers in a New York apple orchard. J. Econ. Entomol., 73: 291-295.

Zaki, F.A., 2002. Incident and biology of codling moth (*Cydia pomonella,* L.) in Ladakh (AJK) Applied Biological Res., 1: 75-78.