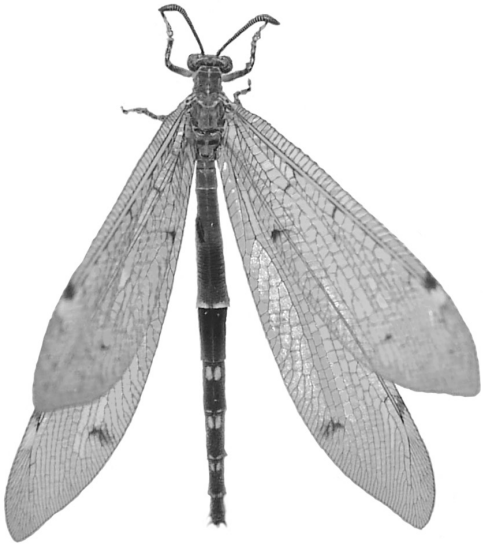
РОССИЙСКАЯ АКАДЕМИЯ НАУК
Южный научный центр

RUSSIAN ACADEMY OF SCIENCES
Southern Scientific Centre

Кавказский Энтомологический Бюллетень

CAUCASIAN ENTOMOLOGICAL BULLETIN

Том 14. Вып. 1
Vol. 14. No. 1



Ростов-на-Дону
2018

Observations on blackheaded fireworm *Rhopobota naevana* (Hübner, 1817) (Lepidoptera: Tortricidae) from apple orchards of Kashmir Himalayas

Наблюдения за *Rhopobota naevana* (Hübner, 1817) (Lepidoptera: Tortricidae) в яблоневых садах Кашмира (Гималаи)

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Key words: Lepidoptera, Tortricidae, *Rhopobota naevana*, pest of apple, phenology, India, Kashmir Valley.
Ключевые слова: Lepidoptera, Tortricidae, *Rhopobota naevana*, вредитель яблок, фенология, Индия, Кашмирская долина.

Abstract. Blackheaded fireworm *Rhopobota naevana* (Hübner, 1817) was observed for its infestation levels in apple orchards of the Kashmir Valley, India. The moth is emerging as one of the serious pests of young apple seedlings with high levels of cumulative incidence (75%) and severity rates (28%). Seasonal occurrence, some elements of biology and morphological detailing of the pest is provided herewith. The damage caused on apple seedling treated for feather induction has also become has also become a matter of great concern. Young apple seedlings treated with different concentration of 6-benzyladenine for development of maximum feathers at desirable heights with appropriate length and crotch angle. It was found that the larvae completely nullify such advantages with high levels of infestations. They completely destroy apical bud of main shoot and thus affect main shoot growth and ultimately feather induction.

Резюме. Проведены наблюдения за уровнем заражения яблони черноголовой листоверткой *Rhopobota naevana* (Hübner, 1817) в Кашмире (Индия). Черноголовая листовертка – один из серьезных вредителей молодых саженцев яблони с высоким уровнем кумулятивной заболеваемости (75%) и тяжести повреждений (28%). Изучены фенология, некоторые вопросы биологии и морфологические особенности этого вредителя в условиях региона. Наибольшую опасность представляют повреждения гусеницами молодых листьев саженцев. Молодые саженцы яблони обрабатывали 6-бензиладенином разной концентрации для максимального развития листьев на желательных высотах с соответствующей длиной и углом листовой пазухи. Установлено, что личинки в случае высокого уровня заражения полностью сводят на нет преимущества таких саженцев. Они полностью разрушают вершинный бутон основного побега и таким образом влияют на его рост и, соответственно, на формирование листьев.

Introduction

Among Lepidoptera species, 88 tortricid species are known as pests of apple plantation across the globe [Meszaros et al., 1984; Cross, 1996]. Out of 64 tortricid moths prevalent in temperate region of Jammu and Kashmir region, only two, codling moth *Cydia pomonella* (Linnaeus, 1758) and Archips moth *Archips termias* (Meyrick, 1918) are reported as pests of apple crop [Wadhi, Sethi, 1975; Razowski, 2006; Bhagat et al., 1994]. However, in recent time blackheaded fireworm *Rhopobota naevana* (Hübner, 1817) is observed to cause considerable damage to young apple seedlings [Ganai, Khan, 2017a, b]. The species is the sole representative of the genus *Rhopobota* Lederer, 1859 from Kashmir Himalayas with many probably awaiting to be discovered. The genus consists of 61 described species distributed in the Holarctic, Oriental, Australian and Neotropical regions [Razowski, 2009; Razowski, Becker, 2010; Gilligan et al., 2014]. Various aspects of bionomics of the species have been detailed by many researchers from different parts of the world [Cockfield, Mahr, 1992; Fitzpatrick, Troubridge, 1993; Cockfield et al., 1994; Cross, 1996).

The pest overwinters as eggs that hatch in early spring and the larvae feed primarily on terminal foliage, webbing the terminals together, frequently destroying buds, and skeletonising leaves severely, which eventually appear as burned top of trees. The larvae of the species are polyphagous known to feed variety of host plants belonging to several genera including Vaccinium, Erica, Ilex, Malus, Crataegus, Sorbus, Prunus, Pyrus and Rhamnus.

The present study forms part of the series of papers [Ganai, Khan, 2017a, b] dealing with the pest from the Kashmir Valley.

DOI: 10.23885/1814-3326-2018-14-1-77-82

Material and methods

These studies were carried in Division of Entomology, Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir, Shalimar (34°14′ N / 74°87′E, 900 m a.s.l.) and Plant Protection Division, Central Institute of Temperate Horticulture (33°58′N / 74°48′E, 1644 m a.s.l.). Population dynamics and biological stages of the pest were studied in the field and laboratories using standard protocols as illustrated in Ganai and Khan [2017a, b]. In one of the field experiment carried at Indian Council of Agricultural Research-Central Institute of Temperate Horticulture, Srinagar (2016), observations were made on incidence and severity rates of the pest on young seedlings treated with summer sprays of 6-BA. The main aim of the study was to produce high quality feathered nursery trees used in high density apple plantations (HDP). The one-year-old 'Gala Mast' apple trees grafted on MM-106 rootstock and spaced at 90 × 60 cm were selected. These apple seedlings were treated with varying doses of 6-benzyladenine and 6-benzyladenine plus gibberellic acid (1 : 1) (200, 300, 400, 500, 600 and 700 ppm). The first treatment was applied when the growth of the central leader reached 70–80 cm. During the second vegetative period, the apical section of the main shoot was sprayed (15, 12 and 10 cm in length in the first, the second and the third spray, respectively) using hand sprayer until run-off. Three spray treatments were performed during one week apart. The experiment was set up in randomized block design with four replication and five trees per replication for a total of 20 trees per treatment. The pest infestation was recorded in the treated and controlled plants and preliminary results generated are discussed in the paper.

All the material is deposited in Biosystematics Laboratory of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (collection of M.A. Ganai) and Entomology Laboratory of Central Institute of Temperate Horticulture (collection of S.A. Akbar).

Rhopobota naevana (Hübner, 1817)

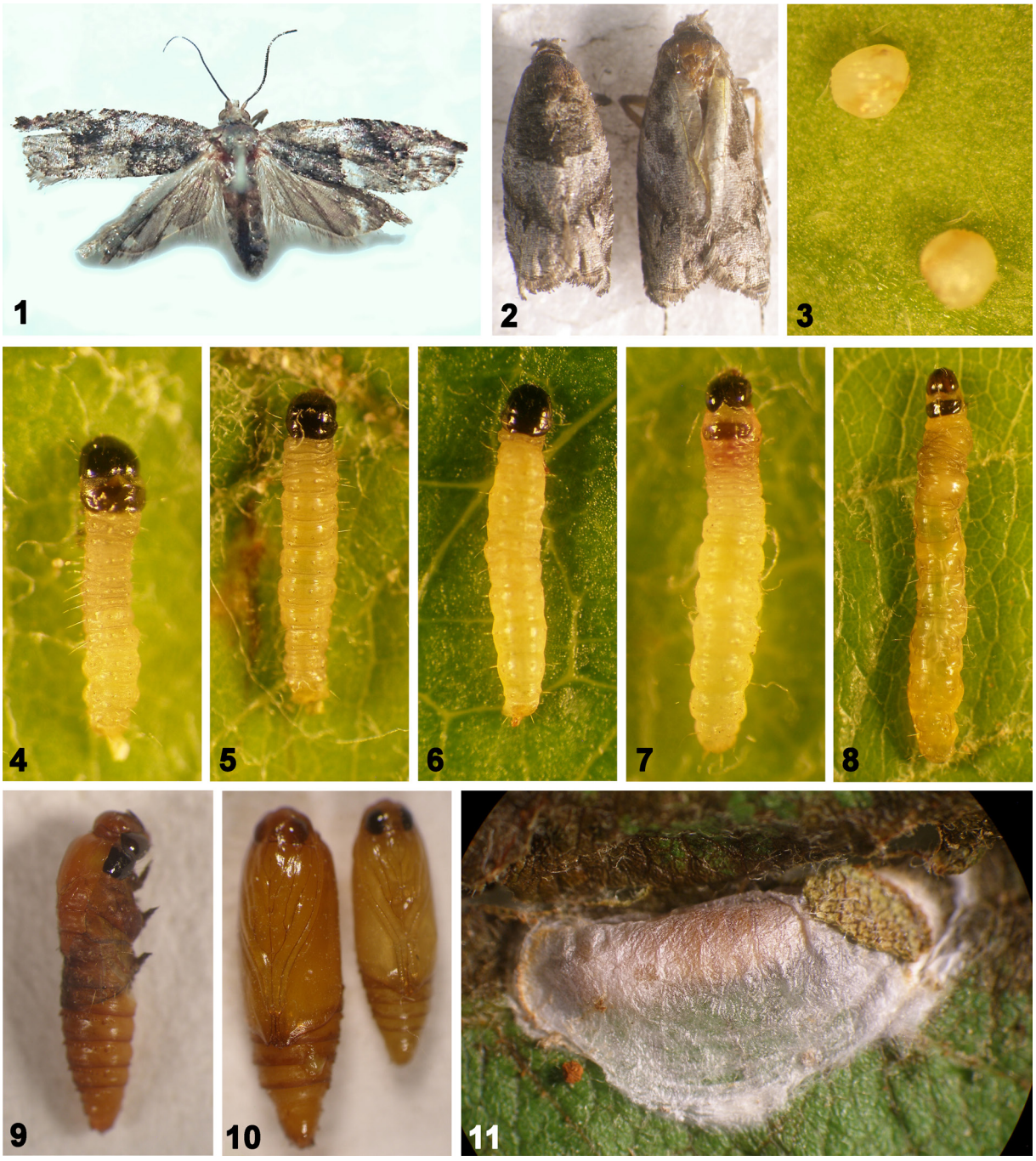
Material. India: Akingam, 5♂, 1♀, 6.06.2010; Kangan, 2♂, 2♀, 9.06.2010, 3♂, 2♀, 10.06.2011, 12♂, 4♀, 21.08.2011, 1♂, 16.09.2012; Lolab, 3♂, 1♀, 14.06.2010, 10♂, 4♀, 12.07.2011, 3♂, 1♀, 16.09.2011, 11♂, 5♀, 28.08.2012; Gund, 6♂, 3♀, 10.07.2010, 7♂, 3♀, 15.07.2012; Gawran, 6♂, 4♀, 14.07.2010; Kupwara, 8♂, 4♀, 20.07.2010, 3♂, 2♀, 19.09.2012; Sonamarg, 9♂, 3♀, 5.08.2010; Aru, 12♂, 3♀, 11.08.2010, 5♂, 2♀, 16.08.2012; Handwara, 11♂, 4♀, 21.08.2010, 13♂, 3♀, 30.07.2012; Aishmukam, 3♀, 8.09.2010; Gutlibag, 2♂, 11.09.2010, 5♂, 3♀, 8.07.2011, 3♂, 1♀, 9.09.2011; Dardpora, 3♂, 2♀, 16.09.2010; Brariangan, 7♂, 1♀, 14.06.2011; Kundalgam, 5♂, 3♀, 21.06.2011, 14♂, 6♀, 26.08.2011; Batkoot, 9♂, 6♀, 23.07.2011; Thimran, 12♂, 7♀, 31.08.2011; Salia, 2♂, 2.09.2011; Kanalwan, 4♂, 2♀, 6.06.2012; Ganderbal, 2♂, 1♀, 15.06.2012; Karnah, 4♂, 3♀, 29.06.2012; Tangwani, 9♂, 5♀, 5.07.2012; Deesu, 8♂, 5♀, 9.08.2012; Hutmurah, 3♂, 1♀, 4.09.2012; Srinagar, Central Institute of Temperate Horticulture, 5♂, 6.07.2016, 15♂, 20♀, 22.06.2017.

Diagnosis (Figs 1–2). Adult female moth (12.23 ± 0.32 mm) is larger than male (11.52 ± 0.31 mm), white to ochreous white in colour with plumbeous and sparsely strigulated brown or fuscous brown markings, fore wings subfalcate with a distinct notch below apex; hind wings grey or light fuscous, darker apically with a patch of violaceous-grey scales on cell area and a similar conspicuous patch of coarse grey black scales on underside. Male genitalia with uncus well developed, bifid apically with two wide-set projections, valva expanded apically, dorsally convex with short clasper at mid-point. Corpus bursae of female genitalia oval with distal sclerotized portion short and thin and with two small thorn shaped signa; ductus bursae short, highly striated, simple and weakly sclerotized towards ostium bursae.

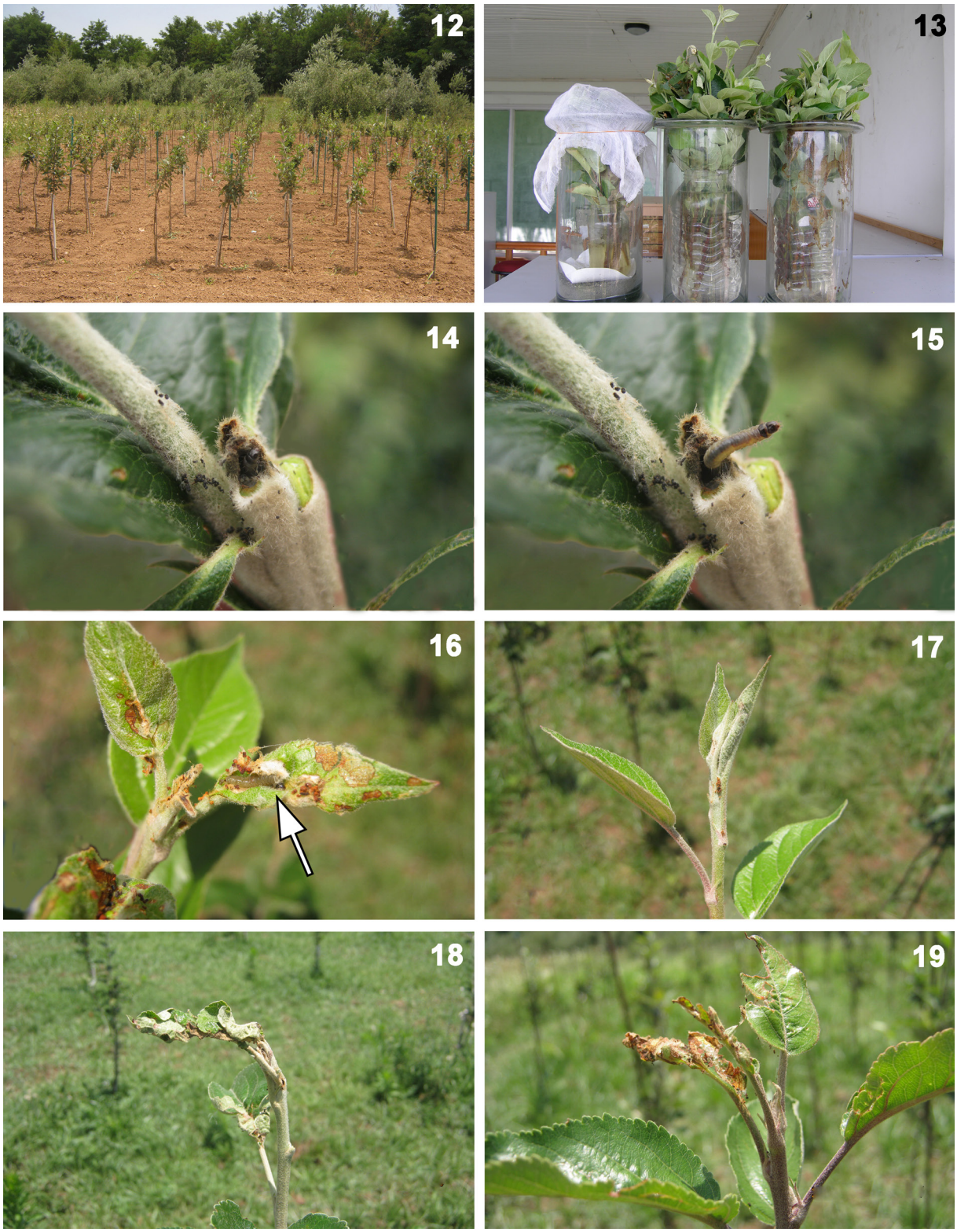
Phenology and bionomics (Figs 3–11). The pest hibernates for 6 months (November to April) as overwintering eggs laid on the bark of current season growth. The pest remains active from May to October during which it completes three generations. The first generation larvae hatch from overwintering eggs and are of general occurrence from late May to early June and the subsequent adults emerge and lay eggs from late June to early July. The second generation eggs are laid on the underside of leaves or on the tips of current season twigs, larvae occur from mid July to early August and adult fly from early to mid August. The third generation eggs are laid in mid August, larvae occur from late August to early September and adult fly from mid to late September. On an average the life cycle is complete in about 38.29–47.8 days. Males and females live approximately 5.41 ± 0.73 and 7.22 ± 0.8 days respectively. Once mated, female lays 78.94 ± 13.2 whitish disc shaped, small eggs (0.84 ± 0.05 mm) singly or in small groups on terminal leaves and shoots for about 3.37 ± 0.15 days. These start to hatch after incubation period of 4.18 ± 0.4 days. Life cycle consists of eggs, 5 larval instars, prepupa, pupa and adult stage. The larval period is completed within 18.94–22.17 days with each stage lasting for about 2.29 ± 0.07, 3.47 ± 0.17, 4.27 ± 0.38, 4.78 ± 0.41 and 6.18 ± 0.79 days, respectively. The newly hatched larvae are greenish coloured with black head capsule and prothoracic plate, greenish anal plate and black anal comb while the full grown larva is greyish in colour with more prominent spiracles. Soon the fully grown larvae form a sluggish light brown prepupa (7.44 ± 0.63 mm in length); wrinkled with suspended feeding and movements and remain silked within tent of rolled leaves or within the trash layer below the trees for about 2.8–3.66 days. Dark brown fully hardened pupa once formed lasts for about 8.41 ± 1.21 days and appears distinct with its anal segment having four thorns like spines extending beyond abdomen, three pairs of setae dorsally, two pairs of setae ventrally and a small bump behind the anal silt. Pupae of females are larger than males (6.48 ± 0.48 mm and 3.43 ± 0.3 mm; 6 ± 0.6 mm and 3 ± 0.12 mm respectively). The adult moths are small, weak fliers, nocturnal, active at dusk for a couple of hours soon after sun set and remain hidden during day time under leaves or cling on stem and branches of trees. Per cent damage done during cropping season indicated that twig damage started in 2nd (2.75%) and 3rd (2.56%) week of May in unmanaged and managed orchards, respectively, reached its highest value (75 and 20%) in unmanaged and managed orchard, respectively during 3rd week of July and afterwards went on decreasing [Ahmad, 2015].

Effect of larvae on feathering plants (Figs 12–19). Plant growth regulators were used to promote feathering

in one year apple plants. The study aimed to produce high quality nursery tree with enough feathers (a feather is a branch that is produced in the same year as the leader and provides sites for the first spur blossom clusters and also the primary limbs for future structure of the tree) developed at desired heights, achieving appropriate length and crotch angle (the angle between a branch and the trunk; normally greater than 45 degrees is desirable). Maintaining an adequate growth rate of the main shoot is essential in apple trees, as the feathering mainly occurs during the rapid growth of the main shoot [Tromp, 1996]. However in hindsight of this experiment there were observed intense infestation rates of backheaded fireworm on the seedlings. The larvae completely destroy apical bud of main shoot and thus affect main shoot growth and ultimately feather induction. It was observed that larvae



Figs 1–11. *Rhopobota naevana*, stages of development.
1 – female with spreaded wings; 2 – male and female; 3 – eggs; 4–8 – larval instars; 9 – prepupa; 10 – pupae; 11 – pupal case.
Рис. 1–11. *Rhopobota naevana*, стадии развития.
1 – самка с расправленными крыльями; 2 – самец и самка; 3 – яйца; 4–8 – гусеницы разных возрастов; 9 – предкуколка; 10 – куколки; 11 – кокон.



Figs 12–19. Apple feathering block with damage, larvae of *Rhopobota naevana*.
12 – feathering seedlings; 13 – laboratory rearing setups; 14–16 – feeding larvae; 17–19 – stages of damage.
Рис. 12–19. Саженцы яблонь с повреждениями, гусеницы *Rhopobota naevana*.
12 – саженцы с листьями; 13 – лабораторные установки для выращивания саженцев; 14–16 – питающиеся гусеницы; 17–19 – саженцы с повреждениями.

cause considerable damage to the newly planted apple seedlings. In order to evaluate the degree of damage, 100 newly planted seedlings were observed for degree of infestation. The observed plants were grouped as zero infestation, little infestation, moderate infestation, and high infestation. In addition to this, the damage caused was also categorized as single locus, and multi loci having 1, 2, 3, 4 and <5 feeding spots which more or less correspond to number of active feeding larvae on the plant. These natures of damage were predefined, sample photographed and used as standard while observing other seedlings. The percentage infestation was found to be 53% having 30.2%, 34.01% as little and moderate infestations and 28.3% having severe infestations. Out of the total infestation observed 43.4% was of single locus nature confined to the aerial developing shoot; 26.41% consisted of two feeding spots with aerial main shoot and the second adjacent leading shoot involved; plants with three and four feeding spots corresponded to 32% and 13.2% respectively while only 1.9% plants were observed to have more than five feeding spots or active feeding larvae on them. There may be a possible co-relationship between the chemicals used and frequency of infestation occurrence; with some combination of chemicals presumably having more effects than others. However, the data obtained needs to be reassessed, concurred and then statically evaluated. As, any analogues generated here will effect further use and recommendations of these chemicals.

Discussion

Horticulture pest dynamics of the Kashmir Valley is yet not fully explored with several new observations been made recently [Lin et al., 2017; Akbar et al., 2018; Ballal et al., 2018; Dar et al., 2018; Maqbool et al., 2018; Wachkoo et al., 2018]. Nothing much is known about the economic importance of *Rhopobota naevana* from the region. There are no threshold or severity limits of the pest defined with very little literature available on the pest. While carrying studies on various aspects of the pest from the region, it was observed that it has started to emerge as one of the major pests of apple seedlings with high incidence and severity rates. This emerge can be attributed to two factors; lack of any thorough study on the pest as well as the shift in the plantation practice in the region. HDP is becoming very popular among apple growers of India. Feathered tree with 1.6–1.8 m height and large size caliper (14–15 mm) form ideal high density planting material. A well feathered tree with large caliper and wide crotch angle eventually will result in earlier production, higher yield, balanced vegetative growth and easy and cost effective canopy management [Yıldırım, Kankaya, 2004; Robinson, 2007]. However, these young feathered plants with number of first year lateral branches appear ideal host plant for blackheaded fireworm. Dwarf plantation, reduced spacing and low natured flight habit of the moth idealize high infestation rates. There is also possible suspicion about occurrence of shift in the range of host of the pest from the region which however requires more depth investigation.

Acknowledgements

The authors are thankful to Directors of the Central Institute of Temperate Horticulture (India) and Entomology Division of Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir (India) for facilities made available. S.A. Akbar would also like to thank the Department of Science and Technology, Government of India, New Delhi for research encouragement and financial assistance rendered via; N-PDF Fellowship program: File No: PDF/2015/000866. The authors are also thankful to the anonymous reviewers for helpful suggestions.

References

Ahmad M. 2015. Diversity and taxonomy of tortricid moths (Lepidoptera: Tortricidae) in Kashmir and Ladakh. Ph.D. (Thesis). Division of Entomology, SKUAST-K. Jammu and Kashmir, India.

Akbar S.A., Dar M.A., Mahendiran G., Wachkoo A.A. 2018. The first record of pear psylla *Cacopsylla bidens* (Hemiptera: Psyllidae) from India along with notes on seasonal occurrence and some elements of its biology. *Oriental Insects*. 52(1): 101–111.

Ballal Ch.R., Akbar S.A., Yamada K., Wachkoo A.A., Varshney R. 2018. Annotated catalogue of the flower bugs from India (Heteroptera: Anthocoridae, Lasiochilidae). *Acta Entomologica Musei Nationalis Pragae*. 58(1): 207–226.

Bhagat K.C., Masoodi M.A., Koul V.K. 1994. Note on the incidence of Archips pomivora Meyrick Lepidoptera: Tortricidae as a new pest of apple in Kashmir. *Journal of Insect Science*. 71(1): 112–113.

Cockfield S.D., Mahr D.L. 1992. Flooding cranberry beds to control blackheaded fireworm (Lepidoptera: Tortricidae). *Journal of Economic Entomology*. 85(6): 2383–2388.

Cockfield S.D., Olson J.B., Mahr D.L. 1994. Blackheaded fireworm (Lepidoptera: Tortricidae) larval phenology model based on diet-specific developmental rates. *Environmental Entomology*. 23(2): 406–413.

Cross J.V. 1996. A pheromone trap survey of tortricid moths (Lepidoptera: Tortricidae) in apple orchards in England subject to different insecticide management. *Entomologist*. 115(3/4): 168–180.

Dar M.A., Akbar S.A., Khan Z.H. 2018. *Acronicta rumicis* (Linnaeus, 1758), Emerging Pest of Apple Plantation in Kashmir Valley. *National Academy Science Letters*. https://doi.org/10.1007/s40009-018-0730-2.

Fitzpatrick S.M., Troubridge J.T. 1993. Fecundity, number of diapause eggs, and egg size of successive generations of the Blackheaded fireworm (Lepidoptera: Tortricidae) on Cranberries. *Environmental Entomology*. 22(4): 818–823.

Ganai M.A., Khan Z.H. 2017a. Biology and larval instar determination of blackheaded fireworm, *Rhopobota naevana* (Hubner) (Lepidoptera: Tortricidae). *The Bioscan*. 12(2): 867–872.

Ganai M.A., Khan Z.H. 2017b. Population dynamics of Blackheaded fireworm, *Rhopobota naevana* (Hubner) (Lepidoptera: Tortricidae) in temperate region of Jammu & Kashmir, India. *Journal of Pharmacognosy and Phytochemistry*. 6(5): 2348–2354.

Gilligan T.M., Baixeras J., Brown J.W., Tuck K.R. 2014. T@RTS: Online World Catalogue of the Tortricidae (Ver. 3.0). Available at: http://www.tortricidae.com/catalogue.asp (accessed 17 July 2017).

Lin M.-Y., Dar M.A., Akbar S.A. 2017. Taxonomy and distribution of *Glenea beesoni* Heller, 1926 (Coleoptera: Cerambycidae: Lamiinae: Saperdini) from Indian Himalayas. *Oriental Insects*. Published online: 13 November 2017. DOI: 10.1080/00305316.2017.1397565.

Maqbool A., Akbar S.A., Wachkoo A.A. 2018. First record of the genus *Ficobracon* (Hymenoptera: Braconidae) from India, with description of new species. *Zootaxa*. 4379(3): 421–428.

Mészáros Z., Ádám L., Balázs K., Benedek I.M., Csikae Cs., Draskovits A.D., Kozár F., Lövei G., Mahunka S., Meszleny A., Mihályi F., Mihályi K., Nagy L., Oláh B., Papp J., Papp L., Polgár L., Radwan Z., Rácz V., Ronkay L., Solymosi P., Soós A., Szabó S., Szabóky Cs., Szalay-Marzsó L., Szarakán I., Szelényi G., Szentkirályi F., Sziráki Gy., Szöke L., Török, J. 1984. Results of faunistical and floristical studies in Hungarian apple Orchards (Apple Ecosystem Research No. 26). *Acta Phytopathologica Academiae Scientiarum Hungaricae*. 19: 91–96.

Razowski J. 2006. Tortricidae (Lepidoptera) from Kashmir and Ladakh. *Acta Zoologica Cracoviensia*. 49B(1–2): 115–135.

Razowski J. 2009. Oriental *Arotrophora* Meyrick (Lepidoptera: Tortricidae) and its species. *Polish Journal of Entomology.* 78(1): 33–57.
Razowski J., Becker V.O. 2010. Neotropical *Rhopobota* Lederer (Lepidoptera: Tortricidae). *Polish Journal of Entomology*. 79(2): 171–186.
Robinson T.L. 2007. Recent advances and future directions in orchard planting systems. *Acta Horticulturae.* 732: 367–381.
Tromp J. 1996. Sylleptic shoot formation in young apple trees exposed to various soil temperature and air humidity regimes in three successive periods of the growing season. *Annals of Botany.* 77(1): 63–70.
Wachkoo A.A., Kurahashi H., Khurshid N., Akbar S.A. 2018. First record of *Dryomyza pakistana* Kurahashi, 1989 (Diptera, Dryomyzidae) from India. *Oriental Insects*. 52(1): 96–100.
Wadhi S.R., Sethi G.R. 1975. Eradication of codling moth – a suggestion. *Journal of Nuclear Agriculture and Biology.* 4: 18–19.
Yıldırım F.A., Kankaya A. 2004. The spontaneous growth and lateral branch habit of new apple cultivars in nursery. *International Journal of Agriculture and Biology.* 6(3): 492–494.

Received / Поступила: 30.08.2017
Accepted / Принята: 15.02.2018