www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277- 7695
ISSN (P): 2349-8242
NAAS Rating 2017: 5.03
TPI 2017; 6(12): 164-168

www.thepharmajournal.com
Received: 11-10-2017
Accepted: 17-11-2017

Hadi Husain Khan
Regional Plant Quarantine Station, Amritsar, Punjab, India

M Shafiq Ansari
Department of Plant Protection, Faculty of Agricultural Sciences, Aligarh Muslim University, Aligarh, U.P., India

Huma Naz
Department of Plant Protection, Faculty of Agricultural Sciences, Aligarh Muslim University, Aligarh, U.P., India

Correspondence
Hadi Husain Khan
Regional Plant Quarantine Station, Amritsar, Punjab, India

Impact of different plant extracts and insecticides on the biology of *Pieris brassicae* (Linn.) on cabbage - A review

Hadi Husain Khan, M Shafiq Ansari and Huma Naz

Abstract
Vegetables are the important source of proteins, carbohydrates, vitamins and minerals contributing a significant role in nutritionally balanced diet of predominantly vegetarian population of our country. Cabbage (*Brassica oleracea* var. *capitata* L.) is one of the most important winter vegetable in India. Its center of origin is Mediterranean. There are many insect pests on cole crops which includes cabbage white butterfly, *Pieris brassicae* (Linn.) (Lepidoptera: Pieridae), diamondback moth (DBM), *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae) and leaf webber. Among them cabbage white butterfly, *Pieris brassicae* (Linn.) is one of the most destructive pests causing damage at all the growing stages such as seedling, vegetative and flowering stage. The pest management strategy in India is mainly relying on chemical pesticides. Insecticide application against the larval stage of the *P. brassicae* is the primary method of control. In review El-Lakwah results investigating the effects of two plant extracts in acetone (Datura leaves and Black pepper, *Piper nigrum* seeds), botanical insecticide NeemAzal-T/S and organophosphorus insecticide, chlorpyrifos-methyl (alone or in combination with the three previously mentioned treatments at its half recommended rate) on cabbage-infesting insects (cabbage aphid *Brevicoryne brassicae*), cabbage butterfly (*Pieris brassicae*). Luik and Viidalepp investigated that the effect of NeemAzal-T/S (neem preparation) on cabbage butterfly (*Pieris brassicae*) larvae. Newly hatched larvae were fed with fresh cabbage leaves, and treated with 0.5 and 0.1% NeemAzal-T/S at the third-instar stage. NeemAzal-T/S exhibited a strong antifeedant activity against the third-instar larvae of *P. brassicae*. Such effect was found to be concentration-dependent and increased with increasing concentration of NeemAzal-T/S. Treatment with 0.1% NeemAzal-T/S resulted in 100% larval mortality during 4 days following treatment.

Keywords: Insecticide, NeemAzal-T/S, Cabbage, *Pieris brassicae*

Introduction
Vegetables are intensively grown throughout the year in different states of India. There are many insect pests on cole crops which includes cabbage white butterfly, *Pieris brassicae* (Linn.) (Lepidoptera: Pieridae), diamondback moth (DBM), *Plutella xylostella* (L.) (Lepidoptera: Yponomeutidae) and leaf webber. Among them cabbage white butterfly, *Pieris brassicae* (Linn.) is one of the most destructive pests causing damage at all the growing stages such as seedling, vegetative and flowering stage. They are subject to the attack by a number of insect pests and are often severely damaged *P. brassicae* is one of the major insect pests of *Brassica* vegetables. It has a Palearctic distribution from North Africa across Europe and Asia to Himalayan Mountains (Higgins and Riley 1970) [10]. It has been reported as a major pest of rapeseed and cruciferous vegetables in the entire Himalayan ranges including the foot hills and North-Eastern hilly states of India (Sachan and Gangawar, 1980, 1990) [18, 19] and in plains. It has been reported from Punjab, Haryana, Utter Pradesh, West Bengal, Bihar, Andhra Pradesh and Orissa.

Effect of different plant extracts and insecticide on *Pieris brassicae* (Linn.)
El-Lakwah *et al.*, (1998) [5] presented the results investigating the effects of two plant extracts in acetone (Datura leaves and Black pepper, *Piper nigrum* seeds), botanical insecticide NeemAzal-T/S and organophosphorus insecticide, chlorpyrifos-methyl (alone or in combination with the three previously mentioned treatments at its half recommended rate) on cabbage-infesting insects (cabbage aphid *Brevicoryne brassicae*), cabbage butterfly (*Pieris brassicae*) and diamondback moth (*Plutella maculipennis* and *P. xylostella*).
Metspalu *et al.*, (1999) [16] collected the egg of *P. brassicae* from the fields and the incubated.

larvae were feeded with cabbage leaf treated with an insect growth regulator (IGR) and NeemAzal-T/S formulation (including 1% of the active ingredients) water dilutions of 0.1% and 0.01% by weight (w/w) (referred to as 0.1% NAZ and 0,01% NAZ respectively). All WLB larvae of the first and second instars fed with cabbage leaves treated with 0.1% NAZ died before moulting into the subsequent instar. 0.1% NAZ also resulted in high mortality of the third and fourth instars (78% and and 98% respectively). The lengthening of the instar duration was characteristic of the individuals who escaped the direct lethal toxic action of NAZ The larval development of these individuals was lengthened about two times as compared with the control. In addition to the development retardation of the fifth instar 0.1% NAZ caused the lethal failures of the larval-pupal ecdysis, which are typical for insecticides possessing morphogenetic activity commonly referred to as IGR-activity. From the recent results it was concluded that very low concentrations of the NeemAzal-T/S such as 1000 ppm and 100 ppm (0.1% NAZ and 0.01% NAZ) of active ingredients resulted in high mortality of the WLB caterpillars fed with the neem-treated cabbage leaves. NeemAzal-T/S formulation was commonly regarded as a typical IGR possessing only inessential direct toxicity. Several modes of action of this botanical insecticide were observed in the study: the direct toxic action, deterrent or antifeedant action like a typical IGR effects. NeemAzal-T/S appeared to be a perspective botanical insecticide for WLB control on the cabbage.

Meadow and Seljasen (1999) [15] evaluated neem extracts (extracts from seeds of the neem tree, *Azadirachta indica*) for the control of lepidopteran pests of cabbage. Promising results were obtained in laboratory experiments in which neem extracts were tested against larvae of *Mamestra brassicae*, *Plutella xylostella*, *Pieris rapae* and *P. brassicae*. In addition to possessing activity as an insect growth regulator (IGR), neem extracts have a repellent effect that can reduce oviposition. Antifeedant effects of neem on larvae were also demonstrated, as was systemic activity through water uptake by plants. When sprayed onto the plants, concentrations of azadirachtin (the most active ingredient in neem extracts) above 2 ppm prevented larval development. Concentrations above 8 ppm prevented plant damage. After being sprayed, the plants were effectively protected from damage for 1-2 weeks.

Luik and Viidalepp (2001) [14] investigated the effect of NeemAzal-T/S (neem preparation) on cabbage butterfly (*Pieris brassicae*) larvae. Newly hatched larvae were fed with fresh cabbage leaves, and treated with 0.5 and 0.1% NeemAzal-T/S at the third-instar stage. NeemAzal-T/S exhibited a strong antifeedant activity against the third-instar larvae of *P. brassicae*. Such effect was found to be concentration-dependent and increased with increasing concentration of NeemAzal-T/S. Treatment with 0.1% NeemAzal-T/S resulted in 100% larval mortality during 4 days following treatment.

Two insecticides (diflubenzuron and cartap hydrochloride) were evaluated against the pupae of *Pieris brassicae* and *Plutella xylostella*, serious pests of cabbage and cauliflower by Sharma *et al.* (2001a) [21]. Pupae of *Pieris brassicae* when dipped in diflubenzuron (37.5-300 p.p.m.), had 18-84% mortality. For *Plutella xylostella*, diflubenzuron (25-200 p.p.m). gave mortality of 22-86% compared with 6% mortality in the control treatment. New pupae (0- to 12-h-old) of *Pieris brassicae* dipped in cartap hydrochloride (31.250-250 p.p.m.) had 16-88% mortality, while for *Plutella xylostella*, the mortality varied from 18 to 86% following treatment with cartap hydrochloride (25-150 p.p.m.)

Sharma *et al.*, (2001) [22] found that Cartap hydrochloride (0.075%) and diflubenzuron (0.05%) were the most effective against *Pieris brassicae* while azadirachtin was the least effective. For the control of *Plutella xylostella*, cartap hydrochloride at 0.05 and 0.075%, diflubenzuron at 0.075% and 0.025 and 0.05% were the most effective. Azadirachtin (6.0 ppm) gave 65.01% mortality but were phytotoxic to the cabbage leaves.

Zarinysh (2002) [27] evaluated the efficiency of 7 bio-preparations (Fitoekols-IF [botanical fungicide from *Pinus sylvestris* and *Picea abies*], Mycostop [*Streptomyces griseoviridis*], Phytoverm [*Streptomyces avermitilis*], NeemAzal-T/S [neem extract], Neko (botanical insecticide), Virin-KS and Virin-KB (viral insecticides)) against various pathogens and pests of tomatoes, cucumbers and cabbages in Latvia. Both fungicides (Fitoekols-IF and Mycostop) were effective against *Phytophthora infestans*, *Botrytis cinerea* and *Pseudoperonospora cubensis*. Pesticides, Phytoverm, NeemAzal-T/S, Neko, Virin-KS, Virin-KB were effective against plant pests (*Trialeurodes vaporariorum*, *Thrips tabaci*, *Myzodes persicae* [*Myzus persicae*], *Tetranychus urticae*, *Hylemya brassicae [Delia radicum*], *Pieris brassicae*, *Pieris rapae*, *Mamestra brassicae*, *Plutella maculipennis* [*P. xylostella*] and *B. brassicae*) on the crops at the covered and open areas. The mentioned pesticides and fungicides were harmlessness to beneficial inhabiting these agro-ecosystems.

Gupta *et al.*, (2002) [7] showed that Biobit, Biolep, Delfin, Halt and Hill BTK showed 20, 40, 10, 90 and 20% mortality of *Pieris brassicae*, respectively in 48 h; and these increased to 8, 80, 60, 80 and 100% in 120 h when the cabbage leave treated with the above insecticides were fed to them.

Singh *et al.*, (2003) [24] evaluated the laboratory efficacy of five new insecticides (profenofos at 0.05%, carbosulfan at 0.05%, Polytrin C (profenofos+cypermethrin) at 0.05%, imidacloprid at 0.007% and koranda (fenvalerate+acephate) at 0.05%), four conventional insecticides (endosulfan at 0.07%, quinalphos at 0.05%, monocrotophos at 0.04% and dichlorvos at 0.075%) and four neem based formulations (neem [*A.indica*] oil, Nimbicidine, Neemarin and Achook, each at 0.50%) against the early III instar larvae of cabbage butterfly, *P. brassicae*. All the treatments were significantly superior over the control in reducing larval population. All the insecticides caused 100 % larval mortality after 72 h of spraying and were significantly superior compared to the neem-based formulations. Among the neem-based formulations, Neemarin gave the maximum larval mortality (50.00%) and was significantly effective to other neem products after 72 h of spraying. Neem oil was the least effective, exhibiting 16.66% larval mortality after 72 h.

Wawrzyniak (2004) [26] studied on insecticides classified to the group of pro-ecological plant protection products, biological activity of methoxyfenozide preparation was tested on the large cabbage white butterfly (*Pieris brassicae*). It was demonstrated that under field conditions the preparation had negative influence on the process of laying eggs by large cabbage white and caused 100% mortality of larvae at L3 stage in experiment and under field conditions. However, the preparation has not shown an antifeedant effect on feeding larvae at the L4 stage. Toxicity of the preparation to *Apanteles glomeratus* [*Cotesia glomerata*] was also not confirmed.

Duchovskiene *et al.*, (2005) [4] studied the effects of biopesticide, NeemAzal-T/S (10 g/litre azadirachtin A) on the abundance of sucking and chewing cabbage pest in ecologically grown white cabbages. Biological insecticide, NeemAzal-T/S, at 0.5% water spraying solution, was effective against cabbage aphids *B. brassicae*, caterpillars of *P. maculipennis* (*Plutella xylostella*) and *P. brassicae*. The mortality of pests was high. In the case of covering with agro-film, the risk of *B. brassicae*, *P. maculipennis* and *P. brassicae* infestation remains. NeemAzal-T/S at 0.5%, affected cabbage aphids on non-fertilized and covered cabbages by 85.10-77.46% after 5 days and 100-94.23% at 10 days after treatment. NeemAzal-T/S 0.5% affected cabbage aphids on fertilized and covered cabbages by 77.81-49.90% at 5 days and by 100-79.65% at 10 days after treatment. No statistical differences of aphid number were found between aphids on non-fertilized covered and fertilized covered cabbages. In 2003, the biological efficiency of applications with NeemAzal-T/S to control *P. maculipennis* ranged from 53.33 to 66.67% in non-fertilized and fertilized cabbages and from 66.67 to 93.33% in non-fertilized and fertilized covered cabbages, respectively. In 2004, the biological efficiency of applications with NeemAzal-T/S to control *P.brassicae* was near 100% in non-fertilized and fertilized covered cabbages. Phytotoxicity symptoms of NeemAzal-T/S on plants were not found.

Grisakova *et al.*, (2006) [6] investigated the effects of Neem EC (1% azadirachtin) were assessed on the Large White Butterfly, *P.brassicae*, a major pest of cruciferous plants. The duration of the larval stage, mortality of larvae and pre-pupae, and weight of pupae were studied. The time needed for completion of the larval stages by individuals fed on treated cabbage increased significantly, compared with the control: 16-37 days in the test variant versus 11-18 days in the control. Neem EC also induced high mortality, caused by lethal failures of larval-larval and larval-pupal ecdysis, which were typical for insecticides possessing morphogenetic activity commonly referred to as IGR activity. The mortality of larvae and pre-pupae in the test variant was significantly higher than in the control. Considerably fewer pupae were gained in the test variant than in the control variant. The pupae of larvae that had been feeding on the control were significantly heavier than those of the larvae feeding on the treated plants. The experiment revealed that Neem EC had both toxic and antifeedant/deterrent effects but also acted as a growth regulator for *P. brassicae* larvae.

Hafeez *et al.*, (2007) [8] revealed that the pest appeared in the standard week of 43 and remained active up to standard week of 7, with the peak population (58.10 larvae per plant) in the standard week of 50. However, the pest population was not significantly correlated with the abiotic factors. All insecticide treatments (endosulfan, carbaryl, malathion, dimethoate, chlorpyrifos, *B. thuringiensis* var. *kurstaki*, and neem oil) resulted in significant reduction of pest and increased in marketable yield of the crop. Dimethoate 0.05% proved to be most effective in terms of cost benefit ratio (1:26.93), followed by chlorpyrifos 0.07% (1:24.59) and endosulfan 0.07% (1:24.21). Neem oil 0.03 and 0.04% and *Bacillus thuringiensis* var. kursatki 0.40% significantly suppressed the pest population but had low cost benefit ratio of 1:6.72, 1:7.49 and 1:10.42, respectively.

Jogar *et al.*, (2008) [11] found that the non-treated pupae of *P. bassicae* displayed discontinuous gas exchange cycles (DGC) with a trend coinciding with the bursts of carbon dioxide (CO_2) release, active tracheal ventilation, and the heartbeat periods. Two independent forms of tracheal ventilation were observed, relatively vigorous abdominal shaking movements and weak abdominal pulsations. The ability to respond to mechanical excitation with abdominal movements was entirely lost on the 2nd day after treatments with Neem EC, and also a reduced tendency to use a DGC was observed. During 2-3 days after treatments, the DGCs and gas exchange microcycles were entirely lost, as was active ventilation. Before treatments, body mass loss, that is, water loss, was 0.6-0.9 mg g-1 day-1. After the treatments, water loss increased to 3-5 mg g-1 day-1. The pupae remained alive for 10-15 days after the treatments and died after having lost about 50% of their initial body mass. The absence of heartbeats measured during at least 4-5 h was the main criterion for ascertaining death of pupae. The results suggested that respiratory failures, that is, the loss of cyclic gas exchange, evoked by Neem EC were the primary cause of lethal desiccation. Thus, the hypothesis that the cyclic gas exchange is an adaptation for restricting water losses in insects was supported.

Devjani and Singh (2008) [1] evaluated the efficacy of malathion (0.05%), phosalone (0.05%), dichlorvos (0.05%), fenvalerate (0.01%) and phosphamidon (0.03%) against *P. brassicae*. only phosphamidon resulted in 50% mortality in the field. The effects of the insecticide on the natural enemies of *P. brassicae* in the field were also investigated. The prominent natural enemies of *P. brassicae* were *Cotesia glomerata*, *Apanteles obliquae*, *Brachymeria bengalensis* and *B. lasus*, which resulted in a total pest mortality of up to 17% during February/March. Among the insecticides, phosalone, dichlovos and fenvalerate were the most harmful to these biological control agents. The efficacy of a non-spore-forming *B. thuringiensis* formulation (Bioasp) against the larvae of *P. brassicae* was evaluated in the laboratory. Spraying of 0.025% Bioasp to first- and second instar larvae, and of 0.1% Bioasp to third-instar larvae induced high levels of mortality for up to 48 h after treatment. However, for later stages, only the higher concentrations of Bioasp resulted in substantial mortality.

Dhingra *et al*., (2008) [3] the relative toxicity of emulsions of various pyrethroids against the third instar larvae of *P. brassicae* in the laboratory. Except fenvalerate, the synthetic pyrethroidsviz, deltamethrin, lambda-cyhalothrin, alphamethrin [alpha-cypermethrin], bifenthrin, enpropathrin and beta -cyfluthrin were found to be highly toxic, their relative toxicity values being 23.2, 14.5, 10.5, 8.92, 7.73 and 6.12 times more compared to cypermethrin. Regardless of the method of application, relative efficacy of various synthetic pyrethroids was the same. A comparison of the relative resistance based on LC_{50} values of *P. brassicae*, *Spilarctia obliqua* and *S. litura* to various synthetic pyrethroids indicated higher susceptibility to *P. brassicae* amongst these three pests. The base line data thus generated would provide a record for detecting the resistance level of *P. brassicae* to various synthetic pyrethroids.

The ethanol extract of potential plants were further tested for their biological activity against P. *brassicae*. The aqueous extract of *A. indica* and *M. azedarach* resulted in statistically higher larvicidal (killing 20.9% and 19.2% larvae of *S. litura* by *A. indica* and *M. azedarach*, respectively and 18.5% and 19.6% larvae of *P. brassicae* by *A. indica* and *M. azedarach*, respectively) effect against *S.litura* and *P. brassicae* as compared to other plant extracts. In case of ethanol extract seed extract of *A. indica* and *M. azedarach* were highly effective against *S. litura* and *P. brassicae* giving statistically higher larvicidal (22.2% and 25% and 13.2-50% and 10.5-39.5%, respectively) effect, as compared to other plant extracts (Sharma and Mehta, 2009) [25].

Nishi *et al.,* (2009) [17] treated leaf discs of cabbage with different insecticides were fed to the larvae of different age groups of *Pieris brassicae.* and observations were recorded on the mortality. All the treatments were significantly superior over the untreated check. The extract of NSKE 5% caused highest larval mortality (48.0%), showing significant difference from other indigenous products, while dichlorvos 0.05% was statistically on par with endosulfan 0.07%. Botanical extracts were found to be least effective. However, with the increase in the age of larvae, the toxicity of insecticides decreased and the mortality was enhanced at 72 hrs exposure.

Kowalska (2010) [12] found the influence of spinosad and azadirachtin on viability of cabbage pests; large white butterfly and cabbage moth. For limiting their population insecticides were used with trade name of NeemAzal-T/S (a.i. 10 g.l-1 of azadirachtin A) and Biospin 120 SC (a.i. 120 g.l-1 of spinosad). Both substances were very high in efficacy in controlling of tested pests and can be used in different doses and applications.

Sahak *et al.,* (2010) [20] determined the toxicity of carbaryl, pirimicarb (pirimor) and commercial formulation of neem using leaf dip and larval-dip techniques against second and third instars of *Pieris brassicae* L. Larval mortality rates were significantly higher with carbaryl and pirimor compared to the neem in the larval-dip bioassays 24-h after treatment. In the leaf-dip bioassays, the highest concentrations of carbaryl and pirimor caused 80% to 100% mortalities of larvae. Neem exhibited a significant lethal and antifeedant effects on second and third instars larvae, although the effect was slow and varied among the different larval instars. Quick cessation of food consumption of larvae on treated leaves was observed. Consequently, there was a negligible damage on the insecticide treated leaves. Based on the data collected in the current study it could be speculated that carbaryl and pirimor may have unduly residue on treated plants, therefore; neem extract is merit to be considered as a suitable control agent against *P. brassicae* larvae.

Dhawan *et al.,* (2010) [2] evaluated the toxicity of insecticides against third instar larvae of cabbage butterfly, *Pieris brassicae* Linnaeus. All the treatments were significantly superior over untreated control in causing larval mortality. Among novel insecticides, spinosad and chlorantraniliprole proved more toxic. Endosulfan also proved to be toxic whereas, *Bt* formulation showed the least toxicity.

Kowalska (2011) [13] showed the insecticidal efficacy of spinosad (0.2%), neem (0.5%), rape oil (0.1%) and garlic extract (2%) under field conditions. Treatments were applied 2 times with spray intervals of 7 days. In this experiment the caterpillars of *P. brassicae, P. rapae, M. brassicae* and colonies of *B. brassicae* were observed. Pest presence and percentage defoliation due to feeding by insect pests were assessed. The degree of effectiveness of the treatments was related to changes in leaf consumption and yield. The efficacy of spinosad and neem treatments was the best, whereas two applications of rape oil or garlic extract were insufficient to protect of plants. Tests with microbial protection were involved also. A commercial product containing *Trichoderma asperellum* was used. *Trichoderma* treatments increased cabbage head weight and decreased symptoms of disease compared to untreated plants.

Hasan and Ansari (2011) [9] fourneem-based insecticides, NeemixReg. (0.25% EC @ 20 mg azadirachtin/liter), EcozinReg. (3% EC @ 20 mg azadirachtin/liter), AgroneemReg. (0.15% EC @ 4.8 mg azadirachtin/liter) and Neem oil (0.25% EC azadirachtin @ 20 mg azadirachtin/liter) and a non-commercial neem leaf powder, were evaluated for oviposition deterrence, antifeedant effect to larvae and toxicity to eggs and larvae of *P. brassicae* (Linn.) on cabbage leaves. The concentrations tested were within the ranges of recommended field rates. Oviposition deterrence in no-choice, two-choice and six-choice assays was observed for all the treatments. They exhibited significant (P<0.01) oviposition deterrence on *P. brassicae* when compared with a non-treated control. Cabbage leaves treated with the neem-based insecticides were used as an egg-laying substrate. Numbers of eggs oviposited by *P. brassicae* adults on treated cabbage leaves were significantly lower than those treated with water, but no significant differences were detected among the neem insecticides. They also deterred feeding by *Pieris* larvae and exhibited significant antifeedant effects. Larvae of *P. brassicae* on treated leaves stopped feeding and dropped from the leaf, resulting in no or minimal damage. Direct contact with neem-based insecticides decreased the survival of eggs. Survival of larvae fed for 9 days on leaves treated with neem-based insecticides was reduced to 51%, 49%, 48%, 24% and 18% in the Neem oil, Neemix, Agroneem, Ecozin and neem leaf powder treatments, respectively. Therefore, it can be concluded from the present investigations that neem-based insecticides had oviposition deterrence, antifeedant and toxic effect to *P. brassicae.*

Shirzad *et al.,* (2011) [23] found that the LC_{50} values of neem extract and combination with citowett oil for second and third instars larvae were estimated at 4.40, 3.89 and 3.38, 2.16 ppm, respectively. The combination of neem extract with citowett increased the larval mortality rate up to 15%. This implies that the application of the mixture is a sound measure for enhancing lethality impacts. Based on collected data it could be concluded that combination of these two less hazardous chemicals is merit to be considered as a candidate control agent against *P. brassicae.*

Reference

1. Devjani P, Singh TK. Management of cabbage large butterfly, *Pieris brassicae* (Linn.) in cauliflower ecosystem. (Insect and Environment VIII), 2008; I:175-180.
2. Dhawan AK, Amandeep Kaur, Rajinder Singh, Shaonpius Mondal, Gurpreet Kaur. Relative toxicity of novel insecticides against cabbage butterfly, *Pieris brassicae* Linnaeus. J. Insect Sci). 2010; 23:(3):318-321.
3. Dhingra SS, Chitra B, Jha JKAN, Jaydeep H. Pesticide Research Journal. 2008; 20(1):114-116.
4. Duchovskiene L, Sodininkyste IR, Darzininkyste. Effect of bioinsecticide NeemAzal-T/S on the most widely spread cabbage pests. 2005; 24(4):172-181.
5. El-Lakwah FA, Darwish AA, Abdel-Wahab HA, Shaalan HS. Efficacy of two plant extracts, neemazal-T and their mixtures with chlorpyrifos-methyl against some insect pests of cabbage plants. Ann Agric Sci, Moshtohor. 1998; 36(2):1171-1209.
6. Grisakova M, Metspalu L, Jogar K, Hiiesaar K, Kuusik A, Poldma P. Effects of biopesticide Neem EC on the

Large White Butterfly, *Pieris brassicae* L. (Lepidoptera, Pieridae). Agron Res. 2006; 4:181-186.
7. Gupta Sood PR, Anil. Incidence, natural mortality factors and management of the cabbage butterfly, *Pieris brassicae* (Linnaeus) by *Bacillus thuringiensis* subsp. kurstaki in mid-hills of Himachal Pradesh. SympBiol Control of Lepidopteran Pests, July 17-18, Bangalore, India. 2002, 255-260.
8. Hafeez Ahmad, Uma Shankar, Monobrullah M, Sunil Singh, Abrol DP, Kaul V. Seasonal incidence and management of cabbage butterfly *Pieris brassicae* (Linn.) in Jammu. Enviro and Ecol. 2007; 25(2):429-434.
9. Hasan F, Ansari MS. Toxic effects of neem-based insecticides on *Pieris brassicae* (Linn.). Crop Protec. 2011; 30(4):502-507.
10. Higgins LG, Riley ND. Field guide to the butterflies of Britain and Europe. Collins, London. 1970, 380.
11. Jogar K, Kuusik A, Metspalu L, Hiiesaar K, Grishakova M, Luik A. Effects of Neem EC on gas exchange, tracheal ventilation, and water loss in diapausing pupae of *Pieris brassicae*. Entomol Exp Appl. 2008; 126(2):165-173.
12. Kowalska J. Using of azadirachtin and spinosad in protection of organic cabbage crops. Fragmenta Agronomica. 2010; 27(4):56-61.
13. Kowalska J. The possibilities of protection of organic cabbage crops in Poland. Bulletin. 2011; 65:77-83.
14. Luik A, Viidalepp V. On different modes of action of NeemAzal T/S in cabbage butterfly. International Workshop, Tartu, Estonia, 2001; 24-25:68-72.
15. Meadow R, Seljasen R. Neem extracts for controlling caterpillars attacking cabbage. Bulletin OILB/SROP, 1999; 22(5):213-217.
16. Metspalu L, Hiiesaar K, Kuusik A, Poldmaa P. Preoral action of the Neem-Azal T/S on caterpillars of the large white butterfly (*Pieris brassicae* L.). [Estonian]. Transactions of the Estonian Agricultural University, Agronomy. 1999; 203:129-135.
17. Nishi S, Mishra MS, Ram Lal. Age related response of *Pieris brassicae* (Linn.) to biorational insecticides. Ann of Pl Protec Scie. 2009; 17(1):72-74.
18. Sachan JN, Gangwar SK. Vertical distribution of important pest of cole crop in Meghalya as influenced by environment factors. Ind J. Entomol. 1980; 42:414-421.
19. Sachan JN, Gangwar SK. Seasonal incidence of insect pest of cole crops. Indian J. Entomol. 1990; 52(1):111-123.
20. Sahak B, Pourmirza AA, Ghosta Y. Toxicity of selected insecticides to *Pieris brassicae* L. (Lepidoptera: Pieridae). Munis Entomology & Zoology. 5: Supplement, 2010; 1048-1053:23.
21. Sharma Sanjeev Verma AK, Sood Pankaj. Field efficacy of some new insecticides against lepidopteran pests infesting cabbage in mid hills of Himachal Pradesh. J. Insect Scie. 2001a; 14(½):95-96.
22. Sharma Sanjeev, Verma AK, Sood Pankaj. Ovicidal effect of some newer insecticides on *Pieris brassicae* Linn. And *Plutella xylostella* Linn. J. Insect Scie. 2001b; 14:(½):49-52.
23. Shirzad V, Sahak B, Pourmirza AA, Ghosta Y. Study on the combined impact of citowett and commercial neem extract against *Pieris brassicae* L. under laboratory conditions (Lepidoptera: Pieridae). Munis Entomol & comp; Zoology. 2011; 6(1):460-463.
24. Singh SS, Tiwari BC, Rao VK. Comparative efficacy of some modern insecticides and neem based formulations against cabbage butterfly, *Pieris brassicae*. I. J. Entomol. 2003; 65(2):264-267.
25. Suman Sharma Mehta PK. Evaluation of plant extracts on the larval weight, pupation and adult emergence activities of cabbage butterfly. Rese on Crops, 2009; 10(1):94-97.
26. Wawrzyniak M. Influence of methoxyphenozide on feeding and development of large cabbage white butterfly (*Pieris brassicae* L.). Pestycydy, 2004; ¾:63-68.
27. Zarinysh I. Efficiency of some plant protection bio preparations. [Belorussian] AAS RB V.F. Samersov Minsk-Prilukii, 2002; 15-17:242-245.