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# EFFICACY OF INSECTICIDES AGAINST GREEN APPLE APHID *APHIS POMI* DE GEER

Mohd Abas Shah[1]*, Sheikh Aafreen Rehman[1] and Hafsa Ajaz Tramboo[1]

[1]ICAR-Central Institute of Temperate Horticulture, Rangreth 190007, Srinagar, UT of J&K, India
*Email: mabas.shah@icar.gov.in (corresponding author): ORCID ID 0000-0002-6420-4534

## ABSTRACT

**The efficacy of neonicotinoid insecticides was evaluated for managing green apple aphid (GAA), *Aphis pomi*, in apple orchards, compared to traditional organophosphates. Organophosphates showed limited knockdown effects (51.51–68.12% reduction over control) and dropped below 50% efficacy by 7 and 14 days after treatment (DAT). In contrast, imidacloprid 17.8 SL @ 0.04% reduced GAA populations by 87.30–91.18% at 7 DAT and 73.59–74.76% at 14 DAT. Thiamethoxam 25 WG @ 0.02% achieved 79.69–79.95% and 69.76–72.02% reductions at 7 and 14 DAT, respectively. Thiacloprid 240 SC @ 0.04% showed neither significant knockdown nor residual effect. Bifenthrin 8% SC @ 0.075% showed moderate efficacy against GAA, with better initial knockdown than sustained control. Neem oil 1500 ppm @ 0.25% gave good initial control but lacked persistence at 14 DAT (52.34–58.90%). Among combination products, thiamethoxam + lambda-cyhalothrin (12.6% + 9.5% ZC @ 0.04%) and imidacloprid + lambda-cyhalothrin (6% + 4% @ 0.06%) maintained significant control up to 14 DAT. The results support replacing organophosphates with newer chemistries like neonicotinoids. Therefore, it is concluded that the use of organophosphate insecticides should be discontinued and switch over to insecticides like neonicotinoids etc. is recommended.**

**Key words:** *Aphis pomi*, synthetic pyrethroids, neonicotinoids, organophosphates, insecticide resistance, efficacy, imidacloprid, thiamethoxam, bifenthrin, thiacloprid, neem oil, lamda cyahalothirn, persistence

The green apple aphid (GAA), *Aphis pomi* DeGeer (Hemiptera: Aphididae) is one of the most abundant and widespread herbivore pests in apple orchards of Europe, North America, and the Middle East (Blackman and Eastop, 2000). The incidence of GAA on apple trees from various regions in India is on record for a long time (Menon and Pawar 1958; Behura 1963; Rishi 1979; Bhagat et al. 1988; Khan and Shah, 2017). It is a holocyclic and monoecious aphid species that is widespread in the temperate region of Jammu and Kashmir (Khan and Shah, 2018). However, from the last few years the incidence of GAA has been recorded in outbreak situation from all major apple growing areas of Kashmir. Infestation with *A. pomi* results in stunted plant growth and stimulates lateral shoot growth, especially on young, non-bearing plants with high infestation levels on shoot tips. Mature trees are mostly affected by the honeydew production of the aphids dripping onto foliage and fruit. Honeydew stimulates sooty mold growth, which hinders key leaf functions and fruit ripening (Stoeckli et al., 2008). The extent of incidence and distribution of GAA has been so high for the last few years that it has assumed the status of most important pest of apples in J&K and up to four additional insecticide sprays are need for its proper management. Other than the quantitative and qualitative losses in apple production; general weakening of the apple plants and distortion of apical shoots due to devitalisation of the terminal buds is a wide spread phenomenon now. Currently, organophosphates like dimethoate and chlorpyriphos are recommended for the management of aphid incidence (Anonymous, 2018). However, there are frequent reports of control failures after the spray of these insecticides. Further, the quick re-infestation of the pest population after initial decline following insecticide application is commonly associated with these insecticides. To assess the current effectiveness of commonly used organophosphate insecticides and to explore the potential of newer and alternative chemistries for managing green apple aphids, the present study was undertaken. This evaluation aimed to identify more reliable and sustainable control options in light of reported field-level control failures and growing concerns over resistance and environmental safety.

## MATERIALS AND METHODS

The field trials were set up in the experimental apple orchard at ICAR-Central Institute of Temperate Horticulture, Srinagar (Jammu and Kashmir; 33°59'06.0" N 74°47'47.0" E) for two years, 2023 and 2024. The orchard consisted of multiple apple cultivars on MM106 rootstock, 4-5 years old in early bearing stage, laid out with a spacing of 3 x 2 sq. m. The experiments were conducted on the variety Coe Red Fuji as it sustains high populations of GAA. Experiments were laid out in randomized complete block design with thirteen treatments and three replications. Each replication consisted of two trees. The treatments included neonicotinoids like thiacloprid 240 SC @ 0.04%, imidacloprid 17.8 SL @ 0.04%, and thiamethoxam 25 WG @ 0.02%, and their combination products like thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 0.04%, and imidacloprid 6% + lambda cyhalothrin 4% @ 0.06% in comparison to currently recommended insecticides including chlorpyriphos 20 EC @ 0.25%, dimethoate 30 EC @ 0.1% and quinalphos 25 EC @ 0.2% and their combination product chlorpyriphos 50% + cypermethrin 5% EC @ 0.2%. In addition, some alternate chemistry insecticides like neem oil 1500 ppm @ 0.25%, horticulture mineral oil (HMO) summer oil @ 0.5%, and bifenthrin 8% SC @ 0.075% were also evaluated. The insecticides were applied at label rates with the help of motorized knapsack sprayer.

The experiments were conducted from 08 June to 23 June during 2023, and 03 June to 19 June during 2024. The average daily maximum temperature ranged from 24 to 31.8°C, and average daily minimum temperature ranged from 11.3 to 17.3°C during the period (averaged over both the years). Relative humidity ranged from 41 to 75% and no rain fall was recorded. Observations on the incidence of GAA was taken from the most infested leaf of five randomly selected terminal shoots on each plant one day before treatment (pre-count) ensuring almost uniform incidence, and 3, 7 and 14 days after insecticide treatments. Data on phytotoxicity was recorded during the period pf study and continued two weeks after last reading. Data on leaf necrosis, chlorosis, deformation, and vein discoloration was noted in all plots. The % reduction in pest population size over control was calculated using the Henderson-Tilton formula (Henderson and Tilton, 1955). The data on number of insects and % reduction over control were subjected to ANOVA after appropriate transformation. The treatment means were separated by least significant difference (LSD, p = 0.05).

## RESULTS AND DISCUSSION

The average incidence of GAA varied over the two years significantly; hence the data were analyzed separately. The average incidence ranged from (mean± SE) 69.57± 17.69 to 91.7± 13.39 aphids per leaf at pre-count during 2023 (Table 1), and from 115.96± 7.02 to 158.70± 12.05/ leaf during 2024 (Table 2). During both the years, a general increasing trend in aphid population was noted in the control, although a decline in incidence was noted at 3 days after insecticide treatment. Significant knockdown effect was associated with neem oil 1500 ppm @ 0.25%, bifenthrin 8% SC @ 0.075%, imidacloprid 17.8 SL @ 0.04%, thiamethoxam 25 WG @ 0.02%, chlorpyriphos 50% + cypermethrin 5% EC @ 0.2%, thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 0.04%, and imidacloprid 6% + lambda cyhalothrin 4% @ 0.06% with more than 70% reduction in aphid incidence at 3 DAT. For currently recommended insecticides, the % reduction in aphid population at 3 DAT ranged from 51.51 to 68.12% over control. The residual activity of the traditional insecticides declined significantly over 7 DAT and 14 DAT during both the years. For chlorpyriphos 20 EC @ 0.25%, the % reduction in aphid population was noted as 46.05% at 7 DAT and 35.62% at 14 DAT during 2023, and 42.65% at 7 DAT and 29.74% at 14 DAT during 2024. Similarly for dimethoate 30 EC @ 0.1%, % reduction in aphid population was noted as 54.74% at 7 DAT and 25.17% at 14 DAT during 2023, and 46.39% at 7 DAT and 35.14% at 14 DAT during 2024. Similar trend was noted for quinalphos 25 EC @ 0.2% during both the years. On the other hand, neonicotinoid insecticides continued to provide satisfactory suppression of GAA incidence till 14 DAT. For imidacloprid 17.8 SL @ 0.04%, the % reduction in GAA population was noted as 91.18% at 7 DAT and 73.59% at 14 DAT during 2023, and 87.30% at 7 DAT and 74.76% at 14 DAT during 2024. Similarly, for thiamethoxam 25 WG @ 0.02%, the % reduction in aphid population was noted as 79.69% at 7 DAT and 69.76% at 14 DAT during 2023, and 79.95% at 7 DAT and 72.02% at 14 DAT during 2024. In case of thiacloprid 240 SC @ 0.04%, neither a significant knockdown (55.02% at 3 DAT during 2023, and 67.87% during 2024), nor significant residual activity was noted during both the years. During 2023, 60.95% reduction in pest population at 7 DAT and 46.05% at 14 DAT, and 61.25% reduction at 7 DAT and 51.33% at 14 DAT were achieved during 2024 for thiacloprid 240 SC @ 0.04%.

The % efficacy of neem oil 1500 ppm @ 0.25% despite of the significant knockdown effect failed to provide sustained control till 14 DAT. The % population reduction reduced to 58.90% at 7 DAT and 61.02% at 14 DAT during 2023, and 62.25% at 7 DAT and 52.34% at 14 DAT during 2024. Bifenthrin 8% SC @ 0.075% performed slightly better with 84.53% population reduction at 3 DAT, 73.37% at 7 DAT and 47.58% at

Table 1. Efficacy of new chemistry insecticides in comparison to traditional insecticides for the management of *Aphis pomi* (2023)

| No. | Treatment details | Pre-count | 3 DAT | | 7 DAT | | 14 DAT | |
|---|---|---|---|---|---|---|---|---|
| | | Number | Number | % reduction | Number | % reduction | Number | % reduction |
| T1 | Chlorpyriphos 20 EC @ 0.25% | 86.06± 6.47 (9.31) | 14.68± 0.29 (3.95) de | 63.53 | 41.58± 2.63 (6.51) efg | 46.05 | 83.55± 9.33 (9.16) ef | 35.62 |
| T2 | Dimethoate 30 EC @ 0.1% | 82.02± 10.74 (9.07) | 16.6± 1.88 (4.18) de | 57.86 | 35.17± 0.87 (6.01) def | 54.74 | 91.17± 3.76 (9.59) fgh | 25.17 |
| T3 | Quinalphos 25 EC @ 0.2% | 91.04± 2.97 (9.59) | 15.28± 1.12 (4.03) de | 65.76 | 49.66± 5.79 (7.09) fg | 43.16 | 9.15± 16.31 (9.88) gh | 31.60 |
| T4 | Neem oil 1500 ppm @ 0.25% | 83.61± 6.06 (9.18) | 7.3± 0.89 (2.87) cd | 82.47 | 28.01± 5.29 (5.34) cde | 58.90 | 47.01± 4.38 (6.91) bcd | 61.02 |
| T5 | HMO (Summer Oil) @ 0.5% | 90.3± 12.18 (9.51) | 34.53± 8.51 (5.86) fg | 31.05 | 70.72± 14.56 (8.37) gh | 22.29 | 124.5± 26.31 (11.06) h | 12.82 |
| T6 | Bifenthrin 8% SC @ 0.075% | 91.7± 13.39 (9.58) | 6.55± 0.66 (2.74) bcd | 84.53 | 19.7± 1.27 (4.54) bcd | 73.37 | 64.27± 5.21 (8.06) cde | 47.58 |
| T7 | Thiacloprid 240 SC @ 0.04% | 87.12± 7.75 (9.36) | 19.46± 1.59 (4.51) ef | 55.02 | 32.15± 1.0 (5.75) cdef | 60.95 | 70.03± 8.31 (8.40) de | 46.05 |
| T8 | Imidacloprid 17.8 SL @ 0.04% | 90.57± 7.75 (9.55) | 2.87± 0.48 (1.95) ab | 94.07 | 7.53± 1.09 (2.90) ab | 91.18 | 39.0± 9.61 (6.21) bc | 73.59 |
| T9 | Thiamethoxam 25 WG @ 0.02% | 69.57± 17.69 (8.27) | 5.21± 0.29 (2.49) bcd | 82.39 | 11.93± 1.39 (3.58) abc | 79.69 | 24.73± 2.93 (5.05) a | 69.76 |
| T10 | Chlorpyriphos 50% + Cypermethrin 5% EC @ 0.2% | 84.1± 8.28 (9.20) | 6.67± 0.41 (2.76) bc | 83.46 | 10.97± 1.88 (3.43) abc | 85.19 | 46.5± 7.23 (6.85) bcd | 62.49 |
| T11 | Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 0.04% | 73.3± 9.62 (8.58) | 1.03± 0.54 (1.40) a | 95.09 | 4.27± 0.35 (2.29) a | 92.73 | 24.83± 2.04 (5.07) a | 71.21 |
| T12 | Imidacloprid 6% + lambda cyhalothrin 4% @ 0.06% | 89.05± 5.57 (9.48) | 5.34± 0.5 (2.51) bc | 88.12 | 11.62± 0.92 (3.54) abc | 86.39 | 29.08± 3.64 (5.46) ab | 76.41 |
| T13 | Control | 85.93± 20.65 (9.19) | 42.87± 3.44 (6.61) g | 0.00 | 79.5± 3.35 (8.96) h | 0.00 | 125.07± 9.91 (11.21) h | 0.00 |
| | C.D. | NA | 0.73 | | 1.02 | | 1.51 | |
| | SE(m) | 0.58 | 025 | | 0.35 | | 0.51 | |

Pre-count = Pretreatment count; DAT = days after treatment; % reduction = % reduction over control; values in parentheses square root transformed as √x+0.5; NA = Not applicable; Figures followed by the same letter in a column not significantly different at p = 0.05.

Table 2. Efficacy of new chemistry insecticides in comparison to traditional insecticides for the management of *Aphis pomi* (2024)

| No. | Treatment details | Pre-count | 3 DAT | | 7 DAT | | 14 DAT | |
|---|---|---|---|---|---|---|---|---|
| | | Number | Number | % reduction | Number | % reduction | Number | % reduction |
| T1 | Chlorpyriphos 20 EC @ 0.25% | 138.63± 16.77 (11.77) | 30.62± 1.97 (5.61) fg | 62.95 | 62.44± 2.30 (7.96) fg | 42.65 | 79.86± 7.28 (8.97) cd | 29.74 |
| T2 | Dimethoate 30 EC @ 0.1% | 139.67± 6.53 (11.85) | 41.36± 5.27 (6.48) gh | 51.51 | 59.96± 5.79 (7.79) efg | 46.39 | 75.42± 4.59 (8.73) cd | 35.14 |
| T3 | Quinalphos 25 EC @ 0.2% | 115.96± 7.02 (10.80) | 22.08± 2.26 (4.79) def | 68.12 | 46.61± 10.69 (6.80) defg | 49.85 | 58.28± 4.88 (7.68) bc | 39.45 |
| T4 | Neem oil 1500 ppm @ 0.25% | 134.74± 3.83 (11.64) | 21.33± 2.05 (4.71) def | 73.81 | 40.60± 3.58 (6.43) def | 62.25 | 52.97± 7.25 (7.31) bc | 52.34 |
| T5 | HMO (Summer Oil) @ 0.5% | 127.21± 7.74 (11.31) | 43.53± 2.45 (6.66) gh | 42.36 | 64.05± 8.16 (8.03) fg | 33.97 | 81.59± 5.21 (9.07) cd | 22.82 |
| T6 | Bifenthrin 8% SC @ 0.075% | 118.96± 9.72 (10.93) | 17.23± 0.90 (4.26) cde | 75.95 | 33.08± 2.52 (5.82) cde | 64.91 | 56.61± 8.62 (7.54) bc | 42.97 |
| T7 | Thiacloprid 240 SC @ 0.04% | 124.32± 10.87 (11.17) | 23.83± 0.74 (4.98) ef | 67.87 | 38.17± 2.76 (6.25) cdef | 61.25 | 48.76± 9.93 (6.98) bc | 51.33 |
| T8 | Imidacloprid 17.8 SL @ 0.04% | 135.20± 29.31 (11.53) | 6.03± 1.95 (2.60) a | 92.91 | 12.09± 0.45 (3.61) a | 87.30 | 29.50± 8.73 (5.41) a | 74.76 |
| T9 | Thiamethoxam 25 WG @ 0.02% | 158.70± 12.05 (12.62) | 16.73± 2.77 (4.18) cde | 82.64 | 25.20± 1.23 (5.11) bc | 79.95 | 37.37± 2.07 (6.18) ab | 72.02 |
| T10 | Chlorpyriphos 50% + Cypermethrin 5% EC @ 0.2% | 157.40± 26.28 (12.50) | 14.13± 1.64 (3.87) bcd | 84.13 | 30.13± 2.63 (5.56) bcd | 73.13 | 49.23± 3.94 (7.07) bc | 61.02 |
| T11 | Thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 0.04% | 144.00± 5.55 (12.03) | 9.43± 1.61 (3.21) abc | 89.24 | 15.93± 2.64 (4.08) ab | 86.38 | 26.88± 4.19 (5.25) a | 77.92 |
| T12 | Imidacloprid 6% + lambda cyhalothrin 4% @ 0.06% | 153.67± 16.62 (12.40) | 6.43± 0.97 (2.71) ab | 93.12 | 11.96± 1.34 (3.59) a | 90.13 | 28.25± 1.52 (5.40) a | 77.78 |
| T13 | Control | 139.77± 8.66 (11.85) | 84.47± 4.77 (9.23) h | 0.00 | 112.03± 9.95 (10.61) g | 0.00 | 117.90± 1.30 (10.90) e | 0.00 |
| | C.D. | NA | 0.73 | | 1.00 | | 1.29 | |
| | SE(m) | 0.61 | 0.25 | | 0.34 | | 0.44 | |

Pre-count = Pretreatment count; DAT = days after treatment; % reduction = % reduction over control; values in parentheses square root transformed as $\sqrt{x+0.5}$; NA = Not applicable; Figures followed by the same letter in a column not significantly different at $p = 0.05$.

14 DAT during 2023, and 75.95% reduction at 3 DAT, 64.91% at 7 DAT and 42.97% at 14 DAT during 2024. The HMO summer oil did not provide significant control at any instance. Among the combination products, thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 0.04%, and imidacloprid 6% + lambda cyhalothrin 4% @ 0.06% continued to provide significant reduction in aphid population till 14 DAT. For thiamethoxam 12.6% + lambda cyhalothrin 9.5% ZC @ 0.04%, % reduction in aphid incidence was noted as 92.73% at 7 DAT and 71.21% at 14 DAT during 2023, and 86.38% reduction at 7 DAT and 77.92% at 14 DAT during 2024. For imidacloprid 6% + lambda cyhalothrin 4% @ 0.06%, % reduction in aphid incidence was noted as 86.39% at 7 DAT and 76.41% at 14 DAT during 2023, and 90.13% reduction at 7 DAT and 77.78% at 14 DAT during 2024. For chlorpyriphos 50% + cypermethrin 5% EC @ 0.2%, significant reduction was noted till 7 DAT however, its efficacy declined significantly by 14 DAT. % reduction in aphid population was noted as 85.19% at 7 DAT and 62.49% at 14 DAT during 2023, and 73.13% at 7 DAT and 61.02% at 14 DAT during 2024. No phytotoxicity symptoms were noted for any of the sprayed insecticides.

Vesilev (2024) reported 100 % reduction in the incidence of GAA at 7 DAT after spraying the neonicotinoid acetamiprid 20 SG @ 0.025%. Khan (2020) reported 60-70% reduction in adult population of GAA at 7 DAT after spraying azadirachtin @ 0.3%. Khan and Reyaz (2018) reported that imidacloprid 17.8 SL @ 0.28% was the most effective among a series of insecticides with 87.16% cumulative reduction in the incidence of GAA over 14 days of time. They further reported that currently recommended insecticides dimethoate 30 EC and chlorpyriphos 20 EC did not perform up to mark with cumulative reduction in the range of 70.58-71.68% over a period of 14 days. Tamas et al. (2012) reported that acetamiprid 20 SP @ 0.025% was highly effective in reducing the population incidence of GAA. They further reported that chlorpyriphos 48 EC @ 0.15% performed well for the management of GAA with >90% control at 7 DAT and >80% reduction at 14 DAT; however, dimethoate 40 EC @ 0.15% did not perform up to mark with 70.8% reduction at 7 DAT and 52.6% reduction at 14 DAT. The failure of the organophosphate insecticides (dimethoate, chlorpyriphos and quinalphos) to provide satisfactory control of the GAA incidence points at possible development of insecticide resistance in the target pest population. Numerous cases of insecticide resistance in GAA have been reported across multiple countries against organophosphates, carbamates and synthetic pyrethroids (Hogmire et al., 1992; Qin et al., 2002; Tamas et al., 2015; Erdogan et al., 2023). The cases of resistance reported are for the insecticides that have been applied over the years for the management of GAA and other pests of apple e.g., chlorpyriphos, diazinin, primicarb, parathion, beta-cyfluthrin etc.

Keeping in view the inability of the currently recommended insecticides to control the GAA incidence, it is advisable to discontinue their use and switch over to the new chemistry insecticides like neonicotinoids etc. Currently recommended insecticides round the world for GAA include dormant horticulture mineral oil (HMO), imidacloprid, acetamiprid, clothianidin, flonicamid, spirotetramat and thiamethoxam (Alston et al., 2010; Smirle et al., 2010; Beers et al., 2015). Therefore, studies need to be initiated to evaluate these insecticides for their efficacy across multiple locations in the country to standardize their dosage along with residue analysis studies.

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**AUTHOR CONTRIBUTION STATEMENT**

MAS conceived and designed research. MAS, SAR and HAT conducted experiments. MAS and SAR analyzed data. MAS and HAT wrote the manuscript. All authors read and approved the manuscript.

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**CONFLICT OF INTEREST**

No conflict of interest.

**REFERENCES**

Alston D, Reding M, Murray M. 2010. Apple aphids - Utah Pests Factsheet. ENT-143-98. Published by Utah State University Extension and Utah Plant Pest Diagnostic Laboratory.

Anonymous. 2018. Temperate Fruits- Package of Practices (Manual), Vol. 1. Directorate of Extension, SKUAST-K, Shalimar, pp. 123.

Beers E H, Hoyt H C, Willett M J. 2015. Apple Aphid and Spirea Aphid, UC IPM Pest Management Guidelines: Apple. UC ANR Publication 3432.

Bhagat K C, Masoodi M A, Koul V K. 1988. Some observations on the incidence of arthropod natural enemies of *Aphis pomi* de Geer (Homoptera: Aphididae) occurring in apple orchard ecosystem. Journal of Aphidology 2(1, 2): 80-89.

Blackman R L, Eastop V F. 2000. Aphids on the world's crops. An identification guide (second edition). J. Chichester, 466 pp.

Erdogan C, Ozdem A, Alpkent Y N, Demiroz D. 2023. Resistance to common insecticides and mechanisms of resistance in *Aphis pomi* de Geer (Hemiptera: Aphididae), in apple orchards in Turkey. Phytoparasitica 51(2): 323-335.

Henderson C F, Tilton E W. 1955. Tests with acaricides against the brown wheat mite. Journal of Economic Entomology 48: 157-161.

Hogmire H W, Brown M W, Schmitt J J, Winfield T M. 1992. Population development and insecticide susceptibility of apple aphid and spirea aphid (Homoptera: Aphididae) on apple. Journal of Entomological Science 27(2): 113-19.

Khan A A, Riyaz S. 2018. Bioefficacy of pesticides against green apple aphid *Aphis pomi* De Geer and biosafety to natural enemies in apple orchards. Indian Journal of Entomology 80(2): 315-319.

Khan A A, Shah M A. 2017. Records of aphids and their natural enemies in agro-ecosystem with special reference to horticultural ecosystem of Kashmir. Journal of Entomology and Zoology Studies 5(4): 189-203.

Khan A A, Shah M A. 2018. Population dynamics of green apple aphid Aphis pomi De Geer (Homoptera: Aphididae) and its natural enemies in apple orchard of Kashmir. Indian Journal of Entomology 80(2): 320-329.

Khan A A. 2020. Bio-efficacy of botanical pesticides against green apple aphid (*Aphis pomi*) and biosafety against its natural enemies in apple orchard of Kashmir. Journal of Entomology and Zoology Studies 8(4): 1445-1448.

Qin X, Jiucai H, Shanxi T. 2002. Resistance monitoring of *Aphis pomi* DeGeer from Shanxi province to pyrethroids. Journal of Shanxi Agriculture University 22(1): 39- 41.

Smirle M J, Zurowski C L, Lowery T D, Foottit R G. 2010. Relationship of insecticide tolerance to esterase enzyme activity in *Aphis pomi* and *Aphis spiraecola* (Hemiptera: Aphididae). Journal of Economic Entomology 103(2): 74-378.

Stoeckli S, Mody K, Dorn S. 2008. *Aphis pomi* (Hemiptera: Aphididae) population development, shoot characteristics, and antibiosis resistance in different apple genotypes. Journal of Economic Entomology 101(4): 341-1348.

Tamas N, Dojnov B, Margetic A, Vujcic M, Spirovic B, Miletic N, Stevic M, Vujcic Z. 2015. Resistance to common organophosphate and carbamate insecticides in *Aphis pomi* (Hemiptera: Aphidiade). Fruits 70(3): 135-142.

Tamas N, Miletić N, Elezović I. 2012. Efficacy of insecticides of different mode of action in green apple aphid (*Aphis pomi* De Geer) control in apple orchards. Biljni Lekar (Plant Doctor) In Serbian 40(6): 489-498.

Vasilev P. 2024. Biological efficacy of selected insecticides for the control of the green apple aphid *Aphis pomi* (De Geer, 1773) on apple in Bulgaria. Agricultural Sciences 16(42): 22-26.

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