Evaluation of *Mentha spicata* and *Carissa macrocarpa* Plant Extracts for the Control of *Myzus persicae* on Eggplant (*Solanum melongena* L.)

Riham Kareem Alwan Ghadeer Abduljabbar Rdhaiw Alaa Sadoon Abbas
Al-Mussaib Technical College, Al-Furat Al-Awsat Technical University
Email: com.riham@atu.edu.iq gader.abdaljabar.tcm@atu.edu.iq
alaa.sadoon@atu.edu.iq

Abstract

A laboratory study evaluated how aqueous and ethanolic extracts from *Mentha spicata* and *Carissa macrocarpa* affect the mortality of nymphal and adult stages of *Myzus persicae*.The extracts were tested at concentrations of 5, 10, and 20 mg/ml, and mortality was assessed after 72 hours of exposure. The alcoholic extract of *M. spicata* produced dose-dependent mortality in nymphs (45.6%, 74.0%, 90.1%) and adults (44.3%, 57.7%, 78.9%) at 5, 10 and 20 mg/ml, respectively. The aqueous extract of *M. spicata* resulted in lower but substantial mortalities: nymphs (41.0%, 55.0%, 77.5%) and adults (28.6%, 41.3%, 67.9%) at the same concentrations. For C. macrocarpa, the alcoholic extract induced mortalities of 56.7%, 72.2% and 84.5% in nymphs and 43.3%, 61.9% and 72.9% in adults at 5, 10 and 20 mg/ml, respectively; its aqueous extract yielded mortalities of 40.1%, 53.3% and 73.3% (nymphs) and 15.7%, 28.9% and 40.0% (adults). In all treatments, the highest mortality was observed at 20 mg/ml after 72 hours. Overall, mortality increased with extract concentration; alcoholic extracts were generally more active than aqueous ones, and nymphs were more susceptible than adults. These results indicate that both plant extracts—particularly their alcoholic fractions—have potential as botanical agents against *M. persicae*.

Keyword*:* Nymphal stage of the insect, Adult stage of the insect, east Significant Difference (LSD) test, Concentration of bioactive extract, aqueous extract, alcoholic extract, biological control.

Introduction

Eggplant (*Solanum melongena* L.) ranks third in nutritional value among Solanaceae crops after potato and tomato and supports human health with high levels of vitamins and minerals [28, 10, 11]. Its native range is China and India, and it is an important vegetable crop in Iraq and tropical areas to which its cultivation spread from those origins. [16]. Eggplant is cultivated in open fields, tunnels, and greenhouses, and Iraq holds a prominent position among the countries producing this crop, with a total production of approximately 56.62 million tons according to FAO data[12]. Eggplant is cultivated for its fruits, which are consumed after cooking. It is also used in the preparation of pickles and can be preserved frozen or canned for export purposes. The fruits of eggplant possess medicinal properties, as they are beneficial in the treatment of asthma, diabetes, cholera, and severe diarrhea, and they also help reduce blood cholesterol levels and treat certain liver disorders[22]. The green peach aphid, *Myzus persicae*, is a major global pest that attacks about 40 plant families, including many vegetable crops, fruit trees, and ornamentals [8]. The green peach aphid, *Myzus persicae*, is an

ISSN 2072-3857

economically significant insect with a very wide host range and is distributed across various regions of the world. It typically resides on the undersides of leaves, where it extracts plant sap, causing wilting, yellowing, and leaf curling, as well as damage to the tender parts of the plant. Additionally, the aphid secretes honeydew, which leads to dust accumulation on the leaves, interfering with photosynthesis and attracting other insects such as ants, flies, and wasps [15]. The green peach aphid, *Myzus persicae*, infests a broad range of plants and shrubs, and numerous plant species have been documented as hosts in central Iraq, including peach, orange, lettuce, hibiscus, mulberry, purslane, carnation, sesame, and sunflower[21].The green peach aphid (*Myzus persicae*) is one of the most widespread aphid species, possessing an extremely broad host range of over 400 plant specie [26] . It is distinguished by its remarkable efficiency in transmitting viral diseases. [31] This aphid also has a remarkable capacity for rapid reproduction due to high offspring numbers per individual and a short developmental period. It reproduces both sexually and asexually in alternation [20]. Many aphid species are present in Iraq, such as Rhopalosiphum padi L. and Schizaphis [2]..Botanical insecticides, especially plant extracts, provide an effective alternative because they contain compounds similar to synthetic pesticides, show high toxicity to pests, and break down quickly without leaving harmful residues [27].Plant extracts are considered rich sources of bioactive compounds that can affect one or more pest species through various mechanisms. Many of these compounds have been reported to act as feeding deterrents, oviposition inhibitors, repellents, or direct toxins against a range of pests[11,19].Recent studies have highlighted the potential of using plant extracts and essential oils as effective and environmentally friendly alternatives to synthetic chemical pesticides for controlling numerous harmful pests Previous research has also demonstrated the efficacy of several plant extracts in insect management and their potential integration into integrated pest management programs [9].These extracts are widely applied in pest control due to their plant origin, rapid environmental degradation, and low toxicity to humans, animals, and natural enemies [7,30].This study tests ethanolic and aqueous extracts of *Mentha spicata* and *Carissa macrocarpa* on selected life-history traits of *M. persicae* under laboratory conditions.

Materials and Methods

Plant Material Collection

We collected samples of *Mentha spicata* and *Carissa macrocarpa* in July 2025 from Al-Musayyib, Babylon, Iraq. We washed the material to remove dust and debris, air-dried it at room temperature with occasional stirring to prevent fungal growth, and ground it in an electric grinder for 15 minutes to obtain a fine powder. We stored each powder separately in tightly sealed glass containers (27 cm height × 9 cm diameter) and refrigerated them until use.

Preparation of Aqueous Extracts

Aqueous extracts were prepared following the method described by Harborne [17], with modifications. Ten grams of the dried powder from each plant were placed in a 500 ml glass beaker, to which 200 ml of distilled water was added. The mixture was stirred with a magnetic stirrer for 15 minutes to enhance extraction, then kept in a tightly closed container for 24 hours at room temperature. The mixture was filtered several times through filter paper, and the filtrate was centrifuged at 3000 rpm for 10 minutes. The resulting residues were collected, placed in small glass bottles, sealed tightly, and stored under refrigeration until use.

We placed ten aphid nymphs or adults individually into plastic Petri dishes (1.6 × 9 cm) containing a minimal food medium, sprayed each dish with 3 ml of the prepared extract and left them to air-dry for two minutes; three replicates were performed for each concentration and for the control (distilled water), and dishes were incubated at 25 ± 2 °C with mortality recorded at 24, 48, and 72 hours.

Preparation of Alcoholic Extracts

Alcoholic extracts of *Mentha spicata* and *Carissa macrocarpa* were prepared using a Soxhlet apparatus as described in [18]. Ten grams of dried plant powder were extracted with 200 ml of ethyl alcohol at 45 °C for 24 hours. The extracts were then concentrated using a rotary evaporator, and the dry residues were collected in pre-weighed, sealed glass containers. The residues were further dried in an electric oven at 40–45 °C to remove any remaining moisture and stored in a refrigerator until use.

For bioassays, we dissolved 6 g of dried extract residue in 3 ml ethanol and 3 ml dispersing agent, then brought the volume up to 100 ml with distilled water to make a 6% stock solution (60 mg/ml). From that stock we prepared working concentrations of 5, 10, and 20 mg/ml. The control contained 3 ml ethanol, 3 ml distilled water, and the dispersing agent.

Statistical Analysis

The experiments were conducted using a completely randomized design (CRD) in a factorial arrangement. Data were analyzed using the Least Significant Difference (LSD) test at a 0.05 probability level to determine the significance of differences among treatments. Mortality percentages were corrected according to Abbott's formula [1]:

Corrected mortality (%) = ((Mortality in treatment − Mortality in control) / (100 − Mortality in control)) × 100

Results and Discussion

Table 1 shows a clear dose- and time-dependent effect of *Mentha spicata* extracts on *Myzus persicae* nymph mortality.The alcoholic extract produced the highest mortality (90.1%) at 20 $mg·ml^{-1}$ and the lowest mortality (31.7%) at 5 $mg·ml^{-1}$. The aqueous extract was less active, with mortalities of 77.5% and 18.8% at 20 and 5 $mg·ml^{-1}$, respectively. Mortality increased with exposure time and concentration: for the alcoholic extract, mean mortalities at 24, 48 and 72 h across 5, 10 and 20 $mg·ml^{-1}$ were 42.9%, 48.0% and 52.4%, respectively; the corresponding values for the aqueous extract were 28.4%, 35.2% and 43.3%. Overall mean mortality was higher for the alcoholic fraction (47.7%) than for the aqueous fraction (35.6%). The maximum observed effect (90.1%) occurred with the alcoholic extract at 20 $mg·ml^{-1}$ after 72 h. Statistical analysis (CRD, factorial arrangement; LSD, $P \leq 0.05$) indicated that concentration, exposure time and their interaction had significant effects on aphid mortality.

ISSN 2072-3857

These findings are consistent with previous reports of strong insecticidal activity in alcoholic plant extracts, for example the high toxicity of Chrysanthemum cinerariifolium alcoholic extract against *M. persicae* and Plutella xylostella [29]. Variation in efficacy among plant species and extract types has also been documented [4], and similar dose-dependent increases in aphid mortality were observed with neem seed oil [25].

Table 1. Mortality (%) of *Myzus persicae* nymphs after 24, 48, and 72 hours of exposure to aqueous and alcoholic extracts of *Mentha spicata*.

Extract type	concentration mg/ml	24	48	72	Concentration Mg/Ml	average
Aqueous Extract	Control	0.0	0.0	0.0	0.0	35.6
	5	18.8	23.2	41.0	27.6	
	10	35.8	53.9	55.0	48.2	
	20	59.0	63.7	77.5	66.7	
average time periods		28.4	35.2	43.3		
Alcoholic Extract	Control	0.0	0.0	0.0	0.0	47.7
	5	31.7	38.9	45.6	38.7	
	10	60.1	67.3	74.0	67.1	
	20	79.9	86.0	90.1	85.3	
Average Mortality Over Time		42.9	48.0	52.4		
$LSD_{0.05}$ Between Extract Types		2.1				
$LSD_{0.05}$ Between Concentrations		5.8				
$LSD_{0.05}$ Between Time Intervals		6.0				
$LSD_{0.05}$ For Interaction (Extract × Concentration × Time)		7.4				

Table 2 demonstrates a clear dose- and time-dependent effect of Mentha spicata extracts on adult *Myzus persicae* mortality. The alcoholic extract produced the highest mortality (78.9%) at 20 mg·ml^{-1} and the lowest mortality (23.3%) at 5 mg·ml^{-1}. The aqueous extract was less active overall, with mortalities of 67.9% and 10.0% at 20 and 5 mg·ml^{-1}, respectively. Mortality consistently increased with both exposure time and extract concentration: alcoholic-extract mortality values spanned low to intermediate levels up to 72.5% across treatments, while the aqueous extract showed corresponding increases (18.8%, 37.0% and 58.8% at the examined concentrations/time points).

Overall mean mortality was greater for the alcoholic fraction (39.8%) than for the aqueous fraction (28.6%). The maximal effect (78.9%) was observed with the alcoholic extract at 20 mg·ml^{-1} after 72 h. Statistical analysis indicated that differences among concentrations, exposure times and extract types were significant (CRD, factorial arrangement; LSD, $P \leq 0.05$), and that the interaction of these factors influenced adult mortality.

These results align with prior reports showing superior insecticidal activity of

ISSN 2072-3857

alcoholic plant extracts—for example, ethyl-alcohol extracts of Lantana camara showed higher toxicity than some comparative plant extracts against aphid nymphs [16]. The present findings suggest that bioactive constituents soluble in ethanol are more efficacious (or more bioavailable) against adult *M. persicae* than water-soluble fractions. To strengthen the toxicological profile, further work should include LC_{50} /LC_{90} estimations, presentation of means ± SE (or 95% CIs), and assessments of phytotoxicity and field performance.

Table 2. Mean mortality (%) of adult *Myzus persicae* following treatment with *Mentha spicata* extracts at varying exposure times

Extract Type	Concentration Mg/Ml	24	48	72	Concentration Mg/Ml	Average
Aqueous Extract	Control	0.0	0.0	0.0	0.0	28.6
	5	10.0	17.9	28.6	18.8	
	10	30.1	39.6	41.3	37	
	20	48.7	60.0	67.9	10	
Average Time Periods		22.2	29.3	32.0	20	
Alcoholic Extract	Control	0.0	0.0	0.0	0.0	39.8
	5	23.3	34.1	44.3	33.9	
	10	49.9	51.1	57.7	52.9	
	20	65.5	73.3	78.9	72.5	
Average Mortality Over Time		34.6	39.6	45.2		
$LSD_{0.05}$ Between Extract Types		2.7				
$LSD_{0.05}$ Between Concentrations		3.0				
$LSD_{0.05}$ Between Time Intervals		4. 6				
$LSD_{0.05}$ For Interaction (Extract × Concentration × Time)		5.4				

Table 3 demonstrates a marked dose- and time-dependent effect of *Carissa macrocarpa* extracts on *Myzus persicae* nymph mortality. The alcoholic extract produced the highest mortality (84.5%) at 20 mg·ml^{-1} and the lowest mortality (50.8%) at 5 mg·ml^{-1}. The aqueous extract was less active overall, with mortalities of 73.3% and 30.0% at 20 and 5 mg·ml^{-1}, respectively. Mortality increased with both exposure time and extract concentration: for the alcoholic extract recorded mortalities were 53.6%, 68.5% and 80.4% at 24, 48 and 72 h, respectively, corresponding to increasing concentrations of 5, 10 and 20 mg·ml^{-1}. The aqueous extract showed parallel but lower responses (34.5%, 50.5% and 65.5% at 24, 48 and 72 h, respectively, for 5, 10 and 20 mg·ml^{-1}). Overall mean mortality was greater for the alcoholic fraction (50.6%) than for the aqueous fraction (37.5%). The maximum effect (84.5%) occurred with the alcoholic extract at 20 mg·ml^{-1} after 72 h. Statistical analysis indicated that differences among concentrations, exposure times and extract types were significant (CRD, factorial arrangement; LSD, $P \leq 0.05$), and that interactions between these factors influenced nymph mortality.

ISSN 2072-3857

Phytochemical studies indicate that *C. macrocarpa* contains numerous secondary metabolites—phenolics (flavonoids, tannins, anthraquinones), terpenoids (saponins, triterpenoids), steroids and variable amounts of carbohydrates—which may underlie the observed bioactivity[23]. Similarly, alkaloid-rich extracts from related species have been reported to shorten nymphal duration and reduce adult fecundity in other aphids, supporting the notion that specific secondary metabolites can affect multiple life-history traits of aphids. [6].

Table 3. Mortality of *Myzus persicae* nymphs under different exposure times to *Carissa macrocarpa* extracts

Extract Type	Concentration Mg/Ml	24	48	72	Concentration Mg/Ml	Average
Aqueous Extract	Control	0.0	0.0	0.0	0.0	37.5
	5	30.0	33.3	40.1	34.5	
	10	46.7	50.0	53.3	50.0	
	20	60.0	63.3	73.3	65.5	
Average Time Periods		34.1	36.7	41.7		
Alcoholic Extract	Control	0.0	0.0	0.0	0.0	50.6
	5	50.8	53.3	56.7	53.6	
	10	64.1	69.3	72.2	68.5	
	20	76.7	80.0	84.5	80.4	
Average Mortality Over Time		47.9	50.6	53.3		
LSD0.05 Between Extract Types		3.47				
LSD0.05 Between Concentrations		5.74				
LSD0.05 Between Time Intervals		6.70				
LSD0.05 For Interaction (Extract × Concentration × Time)		7.94				

Table 4 presents adult mortality of *Myzus persicae* exposed to aqueous and alcoholic extracts of Carissa macrocarpa at three concentrations (5, 10 and 20 mg·ml^{-1}) and three exposure times (24, 48 and 72 h). The alcoholic extract produced the highest mortality (78.9%) at 20 mg·ml^{-1} and the lowest mortality (23.3%) at 5 mg·ml^{-1}. The aqueous extract showed lower activity overall, with mortalities of 67.9% and 10.0% at 20 and 5 mg·ml^{-1}, respectively. A clear dose–response and time-dependent pattern was observed: for the alcoholic extract, mortality increased with concentration and exposure time, reaching 33.9%, 52.9% and 72.5% at 5, 10 and 20 mg·ml^{-1} after 24, 48 and 72 h, respectively. The aqueous extract followed a similar but less pronounced trend (18.8%, 37.0% and 58.8% at 5, 10 and 20 mg·ml^{-1} after 24, 48 and 72 h, respectively).

Overall mean mortality was greater for the alcoholic extract (40.4%) than for the aqueous extract (18.4%). The maximum effect (78.9%) was observed with the alcoholic extract at 20 mg·ml^{-1} after 72 h. Statistical analysis (CRD, factorial arrangement; LSD, $P \leq 0.05$) indicated

ISSN 2072-3857

that concentration, exposure time and extract type significantly affected adult mortality, and that their interaction contributed to the observed variability.

These results corroborate previous reports that the insecticidal efficacy of botanical extracts depends on plant species and extraction solvent [4]. Phytochemicals present in some plant extracts can interfere with insect digestive enzymes (e.g., midgut proteases) and alter hemolymph constituents such as proteins and sugars, potentially forming indigestible complexes that disrupt metabolism and reduce survivorship [24]. Comparable solvent-dependent activity has been reported for other species—for example, organic solvent extracts of C. nerme (jasmine) showed differential efficacy against M. persicae, with hexane extracts often being most active, followed by ethyl acetate and ethanol extracts [3]. Finally, several studies note that prolonged exposure intensifies effect sizes, a pattern consistent with the time–dose relationship observed here (see also references 4, 8, 10, 17)

Table 4. Mean mortality (%) of adult *Myzus persicae* following treatment with *Carissa macrocarpa* extracts at various exposure times

Extract Type	Concentration Mg/Ml	24	48	72	Concentration Mg/Ml	Average
Aqueous Extract	Control	0.0	0.0	0.0	0.0	18.4
	5	10.0	14.2	15.7	13.3	
	10	20.1	24.7	28.9	24.6	
	20	31.1	35.6	40.0	35.6	
Average Time Periods		15.3	18.6	21.1		
Alcoholic Extract	Control	0.0	0.0	0.0	0.0	40.4
	5	33.8	39.9	43.3	39.0	
	10	51.1	58.1	61.9	57.0	
	20	63.1	66.6	72.9	67.5	
Average Mortality Over Time		37.0	41.2	44.5		
$LSD_{0.05}$ Between Extract Types		2.47				
$LSD_{0.05}$ Between Concentrations		4.74				
$LSD_{0.05}$ Between Time Intervals		5.70				
$LSD_{0.05}$ For Interaction (Extract × Concentration × Time)		7.94				

Conclusion:

The findings of the present study demonstrated that leaf extracts of *Mentha spicata* and *Carissa macrocarpa* exhibited significant bioactivity against the green peach aphid (*Myzus persicae*). Both extracts caused noticeable mortality in the target insect population, indicating their potential as botanical insecticides. Among the tested solvents, the ethanolic extracts of both plant species showed superior insecticidal efficacy compared with the aqueous

ISSN 2072-3857

extracts, suggesting that ethanol is more efficient in extracting active phytochemical constituents responsible for insect toxicity .A dose- and time-dependent relationship was observed, as mortality increased progressively with higher concentrations and longer exposure periods. The maximum mortality rate was recorded at a concentration of 20 mg/mL after 72 hours of exposure .Furthermore, the nymphal stages of *M. persicae* were found to be more susceptible to the plant extracts than the adult stages, highlighting the importance of application timing and target stage selection in integrated pest management (IPM) strategies.

Recommendation:

Further investigations are recommended to evaluate the bioactive compounds present in the ethanolic leaf extracts of *Mentha spicata* and *Carissa macrocarpa* against insect species belonging to different orders. Additionally, efforts should be directed toward isolating and synthesizing the active constituents responsible for the insecticidal activity observed in the ethanolic extracts.Moreover, integrating these botanical extracts into integrated pest management (IPM) programs is strongly encouraged, as they can serve as eco-friendly alternatives to conventional synthetic insecticides, thereby reducing environmental risks and pesticide resistance.

ISSN 2072-3857

References:

1- Abbott, W. S. (1925). A method of computing the effectiveness of an insecticide. Journal of Economic Entomology, 18, 265–267.
2- Al-Fatlawi, M.K., A.H. Al Hamadani, A.A. Kareem and M.A. Alhar. (2021). Estimation of population density and percentage of infection with two species of aphids in wheat fields in Muthanna desert for the season 2020- 2021. IOP Conference Series: Earth and Environmental Science, 923(1):012016.
3- Al-Hattab, A. S. (2008). Comparative study on the effect of some pest control methods used in integrated pest management on certain life performance aspects of the green peach aphid Myzus persicae (Sulzer) (Homoptera: Aphididae) [Master's thesis, University of Kufa]. College of Agriculture.
4- Al-Jasman, O. K. K. S., Ali, K. A., Suha, H., & Kazem, B. F. (2016). Evaluation of the efficiency of some plant extracts and the fungal suspension Beauveria bassiana in controlling the green peach aphid on pepper plants. Al-Furat Journal of Agricultural Sciences, 8(2), 213–221.
5- Al-Mansour, N. A. A. (1995). Effect of different extracts of Ibicella lutea (Staph.) Van Eslet (Martyniaceae) on the life performance of the whitefly Bemisia tabaci (Genn.) (Homoptera: Aleyrodidae) [Doctoral dissertation, University of Basrah]. College of Science.
6- Al-Salami, W. M. (1998). Effect of extracts from Convolvulus arvensis and Ipomea cairica on the life performance of the wheat aphid Schizaphis graminum [Doctoral dissertation, University of Babylon]. College of Science.
7- Benelli, G., R. Pavela, R. Petrelli, L. Cappellacci, A. Canale, S. Senthil-Nathan and F. Maggi. (2018). Not just popular spices! Essential oils from Cuminum cyminum and Pimpinella anisum are toxic to insectSyzygium aromaticum, Tephrosia vogelii, and Croton dichogamus against M. persicae on Brassica oleracea in Northern Tanzania. Psyche:AJournal of Entomology, 2021:2525328 https://doi.org/10.1155/2021/2525328 .
8- Blackman, R. L., & Eastop, V. F. (2000). Aphids on the world's crops: An identification and information guide (2nd ed.). John Wiley & Sons.
9- Campolo, O., G. Giunti, A. Russo, V. Palmeri and L. Zappalà.(2018). Essential oils in stored product insect pest control. Journal of Food Quality, 2018:6906105. https://doi.org/10.1155/2018/6906105.
10- Chapman, M. A. (2020). Eggplant breeding and improvement for future climates. In C. Kole (Ed.), Genomic designing of climate-smart vegetable crops (pp. 257–276). Springer.
11- Da Silva, M.R.M. and E. Ricci-Júnior. (2020). An approach to natural insect repellent formulations: from basic research to technological development. Acta Tropica, 212:105419. https://doi.org/10.1016/j.actatropica.2020. 105419
12- Docimo, T., Francese, G., Ruggiero, A., Batelli, G., De Palma, M., & Bassolino, L. (2016). Phenylpropanoids accumulation in eggplant fruit: Characterization of biosynthetic genes and regulation by a MYB transcription factor. Frontiers in Plant Science, 6, 1233.
13- Food and Agriculture Organization & World Health Organization. (2020). Pesticide residues in food 2019: Report 2019 – Joint FAO/WHO Meeting on Pesticide Residues. FAO.
14- George, R. A. T. (2011). Tropical vegetable production. MPG Books Group.
15- Hamman, P. J. (1985) Aphids on trees and shrubs. L-1277. Texas agricultural ex-

tension service house and landscape pests. College station, 1-3.
16- Hamza, A. G. (2017). Efficacy of some alcoholic extracts and boiled and cold-water extracts of Cinnamomum zeylanicum (Cinnamon) and Lantana camara L. in controlling the black bean aphid Aphis fabae. Al-Kufa Journal of Agricultural Sciences, 9(1), 123–134.
17- Harborne, J. B. (1973). Phytochemical methods. Halsted Press.
18- Harborne, J. B. (1984). Phytochemical methods (2nd ed.). Chapman and Hall.
19- Heinz-Castro, R.T.Q., R. Arredondo-Valdés, S. Ordaz- Silva, H. Méndez-Cortés, A. Hernández-Juárez and J.C. Chacón-Hernández. (2021). Evaluation of ethanol extract of Moringa oleifera Lam. as acaricide against Oligonychus punicae Hirst (Trombidiformes: Tetranychidae). Insects, 12(5):476. https://doi.org/10.3390/insects12050476.
20- Jean-Christophe S., S. Solenn and T. Denis.(2010). Evolutionary and functional insights into reproductive strategies of aphidsVariation du mode de reproduction chez les pucerons: aspects évolutifs et fonctionnels. Comptes Rendus Biologies, 333(6-7):488-496. https://doi.org/10.1016/j.crvi.2010.03.003.
21- Kaddou, I. K. (1966) Aphidae from Iraq. Bullient, Biology Center, 2: 21-42.
22- Kashyap, V., Kumar, S., Collonier, C., Fusari, F., Haicour, R., Rotino, G., Sihachakr, D., & Rajam, M. V. (2003). Biotechnology of eggplant. Scientia Horticulturae, 97(1), 1–25. http://www.apeda.com.
23- Khalil, E., Aljeshi, Y. M., & Saleh, F. A. (2015). Authentication of Carissa macrocarpa cultivated in Saudi Arabia: Botanical, phytochemical, and genetic study. Journal of Pharmaceutical Science and Research, 7(6), 497–508.
24- Klock, J., & Chan, B. (1982). Effect of cotton condensed tannin on feeding and digestion in the cotton pest. Journal of Insect Science, 28, 911–915.
25- Lowery, D. T., & Isman, M. D. (1994). Insect growth regulating effects of neem extracts and azadirachtin on aphids. Entomologia Experimentalis et Applicata, 72(1), 77–84.
26- Mohammed. A.A. (2016) . Interactions between the entomopathogenic fungus Lecanicillium muscarium and the parasitoid Aphidius colemani for the control of green peach aphid M. persicae under laboratory and field conditions Ph.D. thesis, University of Reading, Reading, U.K.
27- Rahman, S., Biswas, S. K., Barman, N. C., & Ferdous, T. (2016). Plant extract as selective pesticide for integrated pest management. Biotechnology Research Journal, 2(1), 6–10.
28- Ranjan, R. K., Singh, D., & Rai, D. (2021). Postharvest diseases of potato and their management. In Postharvest handling and diseases of horticultural produce (pp. 305–326).
29- Stein, U., & Klingauf, F. (1990). Insecticidal effect of plant extracts from tropical and subtropical species: Traditional methods are good as they are effective. Journal of Applied Entomology, 114(2), 160–166.
30- Yadi, M., E. Mostafavi, B. Saleh, S. Davaran, I. Aliyeva, R. Khalilov and M. Milani. (2018). Current developments in green synthesis of metallic nanoparticles using plant extracts: A review. Artificial cells, nanomedicine, and biotechnology, 46(sup3):S336-S343. https://doi.org/10.1080/21691401.2018.1492931.
31- Yattara A.A., A.K. Coulibaty and F. Francis.(2014).Diversite et abondance des pucerons (Homoptera: Aphididae) et lair impact dans la dissémination des virus infectant la pomme de terre au Mali

Phytoprotection, 94:1-7. https://doi.org/10.7202/1024719ar.

ISSN 2072-3857