

See discussions, stats, and author profiles for this publication at: <https://www.researchgate.net/publication/358070955>

# THE EFFICIENCY OF SALICYLIC ACID WITH DELTAMETHRIN AND FLUPYRADIFURONE INSECTICIDES FOR THE CONTROL OF MYZUS PERSICA (SULZER) ON BROCCOLI

Article · January 2022

CITATIONS

0

READS

36

3 authors, including:



**Khalid W. Ibade**

University of Anbar

39 PUBLICATIONS 7 CITATIONS

SEE PROFILE

Some of the authors of this publication are also working on these related projects:



evaluation of bioactivity of Citrullus colocynthis seed oil against some agricultural pests [View project](#)



efficiency of herbicide on weeds and effect on growth and yield of maize ( zea mays L . ) [View project](#)



**ORIGINAL ARTICLE**

## THE EFFICIENCY OF SALICYLIC ACID WITH DELTAMETHRIN AND FLUPYRADIFURONE INSECTICIDES FOR THE CONTROL OF *MYZUS PERSICA* (SULZER) ON BROCCOLI

Muhammad A. Ali Al-Hassan\*, Ziyad Shihab Ahmed and Khalid W. Ibade

Department of Plant Protection, College of Agriculture, University of Tikrit, Iraq.

E-mail: mohammedagriculture92@gmail.com

**Abstract:** The results of the study showed the possibility of using Salicylic acid in interference with Deltamethrin and Flupyradifurone in reducing the population density of green peach aphid insect *Myzus persica* on the broccoli plant *Brassica oleracea* var. *italica*, where the Salicylic acid showed an effective role in controlling on the insect with the concentration of 200 mg.L<sup>-1</sup> and reducing the population density of the insect to 2.04 and 1.86 insect leaf<sup>-1</sup> after 7 days of completing the first and second sprays, respectively, The both pesticides Deltamethrin and Flupyradifurone contributed in reducing the average of the population density of the insect from 7.58 insect leaf<sup>-1</sup> in control treatment to 0.52 and 0.45 insect leaf<sup>-1</sup>, respectively. The interference of the Salicylic acid at concentration of 200 mg.L<sup>-1</sup> with Deltamethrin and Flupyradifurone had a significant effect on controlling on the insect, where the population density of the insect reduced to 0.8 and 0.5 insect leaf<sup>-1</sup>, respectively after 3 days of the first spray compared to 10.76 insect leaf<sup>-1</sup> in the control treatment. The effect of Salicylic acid and the two pesticides Deltamethrin and Flupyradifurone and their interference among them were also reflected positively on some of the chemical characteristics on the leaves broccoli plant, that were represented by the ratio of Protein and the concentration of enzyme of Peroxides compared to the control treatment.

**Keywords:** Salicylic acid, Deltamethrin, Flupyradifurone, Green peach aphid, Peroxides enzyme.

### Cite this article

Muhammad A. Ali Al-Hassan, Ziyad Shihab Ahmed and Khalid W. Ibade (2021). The efficiency of salicylic acid with Deltamethrin and Flupyradifurone insecticides for the control of *Myzus persica* (Sulzer) on Broccoli. *International Journal of Agricultural and Statistical Sciences*. DocID: <https://connectjournals.com/03899.2021.17.2213>

### 1. Introduction

The plant of broccoli *Brassica oleracea* var. *italica* belongs to the Brassicaceae family, which is an ideal food for its high content of Carbohydrates, Vitamins and Nutrient ingredients such as Phosphorus, Calcium, Iron, Sodium and Potassium [Hassan (2004)]. The broccoli crop suffers from many agriculture pests that reduce its growth and productivity, including green peach aphid *Myzus persica* (Sulzer), where its economic importance lies in its absorption of the plant juice and the formation of the honey dew addition to transporting many virus diseases that greatly affect the plant growth and yield, causing significant economic losses. Many chemical pesticides were used in controlling the insect. In recent years many studies and

scientific researchers conducted about induction of plant resistance against insects, especially plant growth regulators, where growth regulators act as catalysts that help inactivate the other important physiological and vital processes in plant growth and development, Salicylic acid is considered one of the plant hormones of a phenol nature [Dawood *et al.* (2012), AL-Bayati (2019)]. There are many types of researches that indicate the role played by the Salicylic acid in reinforcement the Acquired Systemic Resistance (ASR) inside the plant against pathogens and insects as well as increasing the effectiveness of insecticides against sucking pest through the production of secondary metabolic compounds such as phenols, alkaloids and other toxic compounds of pests inside the

plant [Maleck *et al.* (2000), Abd AL-Hseen and Manea (2020)]. Damodaram *et al.* (2015) found that the treatment of Mango fruits with Salicylic acid caused a moral decrease in the number of eggs placed by the *Bactrocera dorsalis* and he also observed a moral increase in antioxidant enzymes such as peroxides enzymes. The spraying of Salicylic acid on the plant of *Brassica napus* L. with different concentrations led to decrease the *Brevicoryne brassicae* and its colonies on the flowers [El- hamahmy *et al.* (2016)] and in another study on the effect of some insecticidal chemicals alone or in interference with Salicylic acid against the whitefly insect *Bemisia tabaci* on the cotton crop *Gossypium* showed the high efficiency of Salicylic acid in reducing the numerical density of the insect [El-Sherbeni *et al.* (2019), Manoj *et al.* (2012)]. Therefore, the research aimed to study the role of Salicylic acid and the two pesticides Deltamethrin and Flupyradifurone and the interference among them in controlling on green peach aphid *Myze persica* (Sulzer) on broccoli crop and some chemical characteristics of the broccoli plant.

## 2. Materials and Methods

The practical experiment was conducted within Randomized Complete Block Design (RCBD) with two factors: The first factor is Salicylic acid and the second factor is the two pesticides Deltamethrin and Flupyradifurone in a farm located in Al-Anbar Province for the winter agriculture season 2020-2021 to study the efficiency role of the acid and the two pesticides in controlling on green peach aphid *Myzus persica* Sluzer on broccoli crop. The soil of the field allocated for the experiment was prepared and the land was divided into three repeaters to include each repeater 9 experimental units, where each experimental unit contains four lines with length 3 meters and the distance between one line and the other is 0.75 meter. The seeds of broccoli of Firus class were planted, which is an early mature hybrid produced by Horton company in 13/8/2020 in cork dishes and after the seedlings reached the stage of four and five leaves, they were transferred to the field in 25/9/2020 after watering the dishes with the pesticide Propamocarb 72.2% with concentration 1.5 ml.L<sup>-1</sup> in order to prevent the roots of seedlings from being infected with fungi that may occur during the cutting of some roots during the transfer process, after 10 days of planting the plants were treated with a Carbendazim 50% with concentration 1.5 ml.L<sup>-1</sup> to protect plants from

fungal injuries after that the plants were planted in lines with 8 plants in a line and the distance between one plant and the other is 40 cm with 32 plants in each experimental unit. The experiment was conducted in three sprays from acid with the two concentrations 100 and 200 mg.L<sup>-1</sup>, where the first spray was in 1/11/2020 after 35 days of planting the seedlings while the second and third sprays were interfering with the used chemical pesticides (Deltamethrin and Flupyradifurone) in 20/11/2020 and 28/11/2020. The rate of insect density was taken one day before the treatment and after 1, 3, 7 days with the Salicylic acid and the chemical pesticides by direct counting using magnifying of the nymphs and adults of green peach aphid insect on five infected plants selected randomly. Three plants were selected randomly from each experimental unit to study the effect of Salicylic acid and the two pesticides Deltamethrin and Flupyradifurone in some chemical growth properties of broccoli plant and the percentage of protein and the enzyme of beroxides in the leaves of broccoli plant were estimated and the data were analyzed according to the (RCBD) by using the statistical program GenStat and the then the arithmetic averages were compared by using L.S.D at a probability level of 0.05.

## 3. Results and Discussion

### 3.1 The efficiency of Salicylic acid with Deltamethrin, Flupyradifurone pesticides and the interference among them in the population density of *Myzus persica* on broccoli of the first spray

The results in Table 1 pointed out after one day of treatment that there were no significant differences in the concentration effect of Salicylic acid 100 and 200 mg L<sup>-1</sup> in the average of population density of the green peach aphid insect, where the population density reached 2.66 and 2.48 insect leaf<sup>-1</sup>, respectively compared to 5.20 insect leaf<sup>-1</sup> in control and there were no significant differences between the effects of the two pesticides Deltamethrin and Flupyradifurone. The same table showed a significant effect of the whole interference treatments between the chemical pesticides and Salicylic acid, where the concentration of 200 mg.L<sup>-1</sup> from the acid with the interference with the pesticide Flupyradifurone gives the highest reducing ratio reached 0.74 insect leaf<sup>-1</sup>. The same table showed after 3 days of treatment that the two concentrations 100 and 200 mg.L<sup>-1</sup> of the Salicylic acid had a significant effect in reducing the population density of the insect

**Table 1:** The efficiency of Salicylic acid with Deltamethrin, Flupyradifurone pesticides and the interference among them in the population density of *Myzus persica* on broccoli after 1, 3 and days from the first spray.

Pesticides	Concentration ml.L <sup>-1</sup>	Population density (insect leaf <sup>1</sup> ) after 1 day			Average
		salicylic acid (mg.L <sup>-1</sup> )			
		0.0	100	200	
Deltamethrin	0.2	2.94	1.14	1.25	1.78
Flupyradifurone	0.6	3.28	1.33	0.74	1.78
Control		9.39	5.51	5.45	6.78
L.S.D. 0.05		N.S.			0.71
Average		5.20	2.66	2.48	
L.S.D. 0.05		0.71			
Pesticides	Concentration ml.L <sup>-1</sup>	Population density (insect leaf <sup>1</sup> ) after 3 day			Average
		salicylic acid (mg L <sup>-1</sup> )			
		0.0	100	200	
Deltamethrin	0.2	2.82	0.97	0.80	1.53
Flupyradifurone	0.6	2.77	0.85	0.50	1.37
Control		10.67	5.92	5.21	7.27
L.S.D. 0.05		1.45			0.84
Average		5.42	2.58	2.17	
L.S.D. 0.05		0.84			
Pesticides	Concentration ml.L <sup>-1</sup>	Population density (insect leaf <sup>1</sup> ) after 7 day			Average
		salicylic acid (mg L <sup>-1</sup> )			
		0.0	100	200	
Deltamethrin	0.2	2.86	0.57	0.35	1.26
Flupyradifurone	0.6	2.29	0.59	0.41	1.10
Control		12.20	7.79	5.35	7.79
L.S.D. 0.05		1.55			0.89
Average		5.78	2.32	2.04	
L.S.D. 0.05		0.89			

to 2.58 and 2.17 insect leaf<sup>1</sup>, respectively. while the effect of the two pesticides Deltamethrin and Flupyradifurone contributed in decreasing the population density of the insect to 1.53 and 1.37 insect leaf<sup>1</sup> respectively, while the concentration of Salicylic acid 200 mg.L<sup>-1</sup> exceeded, with its interference with Deltamethrin and Flupyradifurone, in reducing the numbers of the insect to 0.80 and 0.50 insect leaf<sup>1</sup> respectively. We also find that the Salicylic acid after 7 days of treatment has reduced the density of the insect significantly to 2.32 and 2.04 insect leaf<sup>1</sup> for both concentrations 100 and 200 mg.L<sup>-1</sup>. The two pesticides Deltamethrin and Flupyradifurone contributed also in decreasing the density to 1.26 and 1.10 insect leaf<sup>1</sup> respectively. The same table showed a significant effect of the concentration of the Salicylic acid 200 mg.L<sup>-1</sup> with its interference with the two pesticides Deltamethrin and Flupyradifurone in population density of the insect 0.35 and 0.41 insect leaf<sup>1</sup> respectively.

### 3.2 The efficiency of Salicylic acid with Deltamethrin, Flupyradifurone pesticides and the interference among them in the population density of *Myzus persica* on broccoli of the second spray

The results in a Table 2 after one day of treatment showed the role of Salicylic acid in decreasing the rate of population density of the green peach aphid significantly for the two concentrations 100 and 200 mg.L<sup>-1</sup> to 1.77 and 1.95 insect leaf<sup>1</sup> respectively on the control treatment in which the rate of the population density of the insect reached 5.21 insect leaf<sup>1</sup>. The pesticides Deltamethrin and Flupyradifurone also contributed to a significant decline in the numbers of aphids insect, where the density rate had been decreased to 0.41 and 0.51 insect leaf<sup>1</sup> respectively. As for the interference of the chemical pesticides with Salicylic acid, the acid concentration of 100 mg.L<sup>-1</sup>

**Table 2:** The efficiency of Salicylic acid with Deltamethrin, Flupyradifurone pesticides and the interference among them in the population density of *Myzus persica* on broccoli after 1, 3 and days from the second spray.

Pesticides	Concentration ml.L <sup>-1</sup>	Population density (insect leaf <sup>1</sup> ) after 1 day			Average
		salicylic acid (mg.L <sup>-1</sup> )			
		0.0	100	200	
Deltamethrin	0.2	0.48	0.29	0.47	0.41
Flupyradifurone	0.6	0.68	0.44	0.40	0.51
Control		14.49	4.59	4.99	8.02
L.S.D. 0.05		2.42			1.40
Average		5.21	1.77	1.95	
L.S.D. 0.05		1.40			
Pesticides	Concentration ml.L <sup>-1</sup>	Population density (insect leaf <sup>1</sup> ) after 3 day			Average
		salicylic acid (mg.L <sup>-1</sup> )			
		0.0	100	200	
Deltamethrin	0.2	0.52	0.33	0.70	0.52
Flupyradifurone	0.6	1.03	0.93	0.21	0.72
Control		14.50	5.69	4.70	8.29
L.S.D. 0.05		2.56			1.47
Average		5.35	2.32	1.87	
L.S.D. 0.05		1.47			
Pesticides	Concentration ml.L <sup>-1</sup>	Population density (insect leaf <sup>1</sup> ) after 7 day			Average
		salicylic acid (mg.L <sup>-1</sup> )			
		0.0	100	200	
Deltamethrin	0.2	0.44	0.65	0.48	0.52
Flupyradifurone	0.6	0.63	0.29	0.42	0.45
Control		13.31	4.76	4.67	7.58
L.S.D. 0.05		2.30			1.33
Average		4.79	1.90	1.86	
L.S.D. 0.05		1.33			

decreased the density to 0.29 insect leaf<sup>1</sup> with the pesticide Deltamethrin followed by the treatment with the concentration of 200 mg.L<sup>-1</sup> of the acid with the pesticide Flupyradifurone to 0.40 insect leaf<sup>1</sup> compared to 14.49 insect leaf<sup>1</sup> in the control treatment. It is also noted in the results of the same table after 3 days of treatment that Salicylic acid has an important role in controlling an insect of green peach aphid, where the population density rate of the insect has decreased to 2.32 and 1.87 insect leaf<sup>1</sup> at the two concentrations 100 and 200 mg.L<sup>-1</sup> respectively compared to 5.35 insect leaf<sup>1</sup> at control treatment, the chemical pesticides have a significant effect in reducing the population density of the insect to 0.52 and 0.72 insect leaf<sup>1</sup> with treatment with each pesticide Deltamethrin and Flupyradifurone respectively. The interference treatments among the pesticides and Salicylic acid had the lowest population density rate of the insect that reached 0.21 insect leaf<sup>1</sup> at treatment with 200 mg. liter

<sup>1</sup> of Salicylic acid and Flupyradifurone pesticide then followed by treatment 100 mg.L<sup>-1</sup> of Salicylic acid with Deltamethrin pesticide, which reached 0.33 insect leaf<sup>1</sup>. The mentioned results in the same table after 7 days of treatment pointed out that there was no significant differences in the effect of Salicylic acid with the two concentrations of 100 and 200 mg.L<sup>-1</sup>, where the rate decrease of population density of the insect reached 1.90 and 1.86 insect leaf<sup>1</sup> respectively. As for the effect of the two pesticides Deltamethrin and Flupyradifurone that had a significant effect in reducing the rate population density of the insect from 7.58 insect leaf<sup>1</sup> in comprised treatment to 0.52 and 0.45 insect leaf<sup>1</sup> respectively. While the interference effect among the chemical pesticides and Salicylic acid, the two concentrations 100 and 200 mg.L<sup>-1</sup> from Salicylic acid and Flupyradifurone had an effect in reducing the population density of the insect to 0.29 and 0.42 insect leaf<sup>1</sup> respectively.

The results shown in Tables 1 and 2 pointed out to the great effectiveness of the chemical pesticides Deltamethrin and Flupyradifurone and their ability in controlling the green peach aphid insect. The reason is due to the toxic effect mechanism of chemical pesticides against sucking piercing insects. The pesticide Deltamethrin is considered one of the pesticides that work with contact which plays an important role in effecting on the essential proteins of the nervous system in insects through inhibiting energy production and composition and failure of the oxidative phosphorylation process by inhibiting the action of the energy enzyme AT. Pase [Ware (2000)]. As for the efficiency of the Flupyradifurone pesticide, it is considered a systematic pesticide that affects Steel Collen receptor (nACHRs) in the insect's nervous system, which hinders the transmission of nerve impulses and thus the occurrence of disorders of the nervous system causing paralysis and subsequent death of insects treated with this material [Colares *et al.* (2017)]. These results agreed with the study of Singh and Bhardwaj (2017) about the effect of the active material Flupyradifurone on an insect of *Eriosomalnigerum* apples and with the results of U [Sreedhar (2020)], which indicate the high efficiency of the active material Flupyradifurone in decreasing the

numerical destiny of the green peach aphid insect.

Plant growth regulators are also considered one of the toxic compounds for many different insect pests and they also cause distortion, reduce weight and delay the growth of the insects. The results indicate the effective role played by the Salicylic acid in inducing Acquired Systemic Resistance (ASR) inside the plant against various agriculture pests such as sucking piercing insects as well as increasing the efficiency of the chemical pesticides integrated with them in controlling on the population destiny of the insects by regulating some physiological processes inside the plant such as transpiration, opening and closing of stomata and photosynthesis [El- Sherbeni *et al.* (2019), Dawood *et al.* (2012)].

### 3.3 The efficiency of Salicylic acid with Deltamethrin, Flupyradifurone pesticides and the interference among them in some chemical characteristics of broccoli

**The ratio of protein in the leaves of the broccoli plant (%):** The results of the statistical analysis in the Table 3 showed that there are significant differences between the effect of the two concentrations of 100 and 200 mg.L<sup>-1</sup> of Salicylic acid

**Table 3:** The efficiency of Salicylic acid with Deltamethrin, Flupyradifurone pesticides and the interference among them in protein ratio in the leaves of broccoli (%).

Pesticides	Concentration ml.L <sup>-1</sup>	Protein ratio (%)			Average
		salicylic acid (mg.L <sup>-1</sup> )			
		0.0	100	200	
Deltamethrin	0.2	10.73	15.73	15.13	13.86
Flupyradifurone	0.6	11.00	14.76	14.40	13.38
Control		10.36	12.83	11.83	11.67
L.S.D. 0.05		0.46			0.26
Average		10.70	14.44	13.79	
L.S.D. 0.05		0.26			

**Table 4:** The efficiency of Salicylic acid with Deltamethrin, Flupyradifurone pesticides and the interference among them in concentrating the peroxides enzyme in the leaves of broccoli (Micromol Gm<sup>-1</sup>.Min<sup>-1</sup>).

Pesticides	Concentration ml.L <sup>-1</sup>	Concentrating the peroxides enzyme (Micromol Gm <sup>-1</sup> Min <sup>-1</sup> )			Average
		salicylic acid (mg.L <sup>-1</sup> )			
		0.0	100	200	
Deltamethrin	0.2	14.90	16.66	17.46	16.34
Flupyradifurone	0.6	15.03	16.86	17.26	16.38
Control		6.26	51.76	16.06	12.70
L.S.D. 0.05		0.11			0.06
Average		12.06	16.43	16.93	
L.S.D. 0.05		0.06			

in protein ratio with the exceeding of the first concentration treatment with increased ratio reached 14.44% of the control treatment and 13.79% for the treatment with concentration 200 mg.L<sup>-1</sup> from the acid. As for the effect of the two chemical pesticides, the treatment of the pesticide Deltamethrine exceeded the treatment of the pesticide Flupyradifurone and gave protein ratio reached 13.86, while 13.38 when treated with the pesticide Flupyradifurone, the two pesticides also exceeded on the control treatment, which the ratio in it reached 11.67%. As for the effect of the interference among the chemical pesticides and Salicylic acid. The results in the same table showed that the whole interfering treatment exceeded significantly upon the control treatment with the highest protein value where it reached 15.73% when treated with Salicylic acid at a concentration of 100 mg.L<sup>-1</sup> with the pesticide Deltamethrin with concentration of 0.2 mg.L<sup>-1</sup> and the lowest value is 14.40% when treated with Salicylic acid with concentration of 200 mg.L<sup>-1</sup> with the pesticide Flupyradifurone with concentration 0.6 mg.L<sup>-1</sup>, then the ratio of protein significantly decreased at the control treatment to reach 10.36%.

#### 3.4 The concentration of peroxides enzyme in the leaves of the broccoli plant (Micromol Gm<sup>-1</sup> Min<sup>-1</sup>)

The results shown in Table 4 indicated to the significant effect of the Salicylic acid and its two concentrations 200 and 100 mg.L<sup>-1</sup> in increasing the rate of peroxides enzyme to 16.93 and 16.43 Micromol Gm<sup>-1</sup> Min<sup>-1</sup> respectively, compared to 12.06 Micromol Gm<sup>-1</sup> Min<sup>-1</sup> in the control treatment, as well as there were significant differences between the treatment of the two chemical pesticides and control treatment, where the rate of peroxides enzyme increased to 16.34 and 16.38 Micromol Gm<sup>-1</sup> Min<sup>-1</sup> when the plants treated with the two pesticides Deltamethrin and Flupyradifurone respectively.

As for the bilateral interference treatments between the two chemical pesticides and Salicylic acid, the whole treatment exceeded significantly upon the comparison treatment, while the concentration of 200 mg.L<sup>-1</sup> with the interference of the two pesticides Deltamethrin and Flupyradifurone gave the highest values reached 17.46 and 17.26 Micromol Gm<sup>-1</sup> Min<sup>-1</sup> respectively, were significantly increased on control treatment which gave rate 6.26 Micromol Gm<sup>-1</sup> Min<sup>-1</sup>.

The previous results indicated the role of the

Salicylic acid alone or interfering with the pesticide in reducing the population destiny of the green peach aphid, may be due to its role in increasing the concentrations of the peroxides enzyme and the ratio of protein in the leaves of broccoli plant as shown in our research through Tables 3 and 4. The peroxides enzyme is considered one of the mechanisms that stimulating resistance in the plant, it is also considered one of the types of protein and its concentration increases after developing pathogens or by any external stimulator, including plant growth regulators [Stroble *et al.* (1999)]. This enzyme plays an important role in its participation in building the cell wall of plant family by oxidizing the phenolic compounds and adding lankin that interferes with the proteins that making the cellular wall form multiply compounds that increases the durability and hardness of the cellular wall of the plant family [Harish *et al.* (2009)]. This enzyme may be the reason of making the plants that have an increase in concentration of peroxides enzyme due to their treatment with Salicylic acid less preferable of the insect of green peach aphid *Myzus persicae* (Sulzer) compared to the plants that are not treated with this acid.

#### 4. Conclusion

The spraying of Salicylic acid (100 and 200 mg.L<sup>-1</sup>) and the two pesticides Deltamethrin (0.2 ml.L<sup>-1</sup>) and Flupyradifurone (0.6 ml.L<sup>-1</sup>) and the interference among them have a positive effect in controlling the green peach aphid insect *Myzus persicae* Sluzer on broccoli plant *Brassica oleracea* var. *Italica*. They recorded the best results in controlling insects and improving the most chemical characteristics of broccoli plant represented by the ratio of protein and the concentration of peroxides compared to the control treatment.

#### References

- AL-Bayati, H.J.M. (2019). Growth and yield of Cauliflower as affected by boron and fertilizer type. *International Journal of Agricultural and Statistical Sciences*, **15(2)**, 595-599.
- Abd AL-Hseen, Z.E. and A.I. Manea (2020). Effect of biofertilizer and organic extracts in two hybrids of cauliflower (*Brassica Oleracea* var. *Botrytis*). *International Journal of Agricultural and Statistical Sciences*, **16(Supplement 1)**, 1651-1659.
- Colares, F., J.P. Michaud, C.L. Bain and J.B. Torres (2017). Relative toxicity of two aphicides to *Hippodamia convergens* (Coleoptera: Coccinellidae): implications for

- integrated management of sugarcane aphid, *Melanaphis sacchari* (Hemiptera: Aphididae). *J. Econ. Entomol.*, **110**, 52-58.
- Damodaram, K.J.P., R.M. Aurade<sup>1</sup>, V. Vivek Kempraj<sup>1</sup>, T.K. Tapas Kumar Roy, K.S. Shivashankara and I.A. Verghese (2015). Salicylic acid induces changes in mango fruit that affect oviposition behavior and development of the oriental fruit fly, *Bactrocera dorsalis*. *PLOS ONE.*, **10(9)**, e0139124. <https://doi.org/10.1371/journal.pone.0139124>
- Dawood, M., M. Sadak and M. Hozayan (2012). Physiological role of salicylic acid in improving performance, yield and some biochemical aspects of sunflower plant growth under newly reclaimed sandy soil. *Aust. J. Basic and Appl. Sci.*, **6(4)**, 82-89.
- Elhamahmy, M.A.M., M.F. Mahmoud and T.Y. Bayoumi (2016). The effect of applying exogenous salicylic acid on aphid infection and its influence on histophysiological traits and thermal imaging of canola. *Cercetări Agronomice în Moldova*, DOI:10.1515/cerce-2016-0016
- El-Sherbeni, A. El-Dmerdash, S.K. Mohamed, A.A. Sabry and S.M.A. Ola (2019). Effect of some insecticides alone and in combination with salicylic acid against aphid, *aphid gossypii* and whitefly *Bemisia tabaci* on the cotton field. *Bulletin of the National Research Centre*, **43**, 57. <https://doi.org/10.1186/s42269-019-0103-0>
- Hassan, A.A. (2004). Vegetable production, series vegetable crops: advanced production technology and agricultural practices. part one. The first edition. Arab House for Publication and Distribution, Iraq.
- Harish, S., M. Kavino, N. Kumar, P. Balasubramanian and R. Samiyappan (2009). Induction of defense-related proteins by mixtures of plant growth promoting endophytic bacteria against Banana bunchy top virus. *Biological Control*, **51**, 16-25.
- Manoj, K., M.K. Jatav, V.K. Dua and K. Sushil (2012). Fertility status of potato growing pockets and nutrient recommendations based on yield targeted equations for potato crop in Bihar. *International Journal of Agricultural and Statistical Sciences*, **8(1)**, 111-117.
- Maleck, K., A. Levine and T. Eulgem (2000). The transcriptome of arabidopsis thaliana during systemic acquired resistance. *Nature Genetics*, **26**, 403-410.
- Singh, J. and S. Bhardwaj (2017). Efficacy of some new insecticides against aerial form of the apple wooly aphid, *Eriosoma lanigerum* (Hausmann). *Indian Journal of entomology*, **80(3)**, 822-824.
- Strobel, N.E., S. Gopalan, J.A. Kuc and S.X. He (1999). Induction of systemic acquired resistance in cucumber by *Pseudomonas syringae* pv. *Syringae* 61 Hrpzps protein. The plant journal. Sunflower seed hulls as a main nutrient source for cultivating *Ganoderma lucidum*. *Micol Aplicada Int.*, **14**, 19-24.
- USreedhar (2020). Field efficacy of new insecticides for management of tobacco aphid, *Myzus persicae* nicotianae (Blackman) and impact on natural enemies in flue cured Virginia tobacco. *Journal of Entomology and Zoology Studies*, **8(5)**, 1662-1666.
- Ware, G.W. (2000). *An Introduction to Insecticides*, 3rd ed. University of Arizona. Tucson, Arizona, USA.