

**“BIOEFFICACY OF DIFFERENT INSECTICIDES AGAINST
SUCKING PESTS OF POMEGRANATE”**

By

Mr. Solankar Rahul Dajiram

(Reg. No. 019/151)

A Thesis submitted to the
**MAHATMA PHULE KRISHI VIDYAPEETH
RAHURI – 413 722, DIST. AHMEDNAGAR
MAHARASHTRA, INDIA**

in partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRICULTURAL ENTOMOLOGY



DEPARTMENT OF AGRICULTURAL ENTOMOLOGY

**POST GRADUATE INSTITUTE
MAHATMA PHULE KRISHI VIDYAPEETH
RAHURI – 413 722, DIST. - AHMEDNAGAR
MAHARASHTRA, INDIA.**

2021

**“BIOEFFICACY OF DIFFERENT INSECTICIDES AGAINST
SUCKING PESTS OF POMEGRANATE”**

By

Mr. Solankar Rahul Dajiram

(Reg. No. 019/151)

A Thesis submitted to the
**MAHATMA PHULE KRISHI VIDYAPEETH
RAHURI – 413 722, DIST. AHMEDNAGAR
MAHARASHTRA, INDIA.**

in partial fulfillment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRICULTURAL ENTOMOLOGY

APPROVED BY

Dr. A.R. Walunj

(Chairman and Research Guide)

Dr. G.B. Kabre
(Committee Member)

Dr. S.S. Kulkarni
(Committee Member)

Dr. P.E. More
(Committee Member)

**DEPARTMENT OF AGRICULTURAL ENTOMOLOGY
POST GRADUATE INSTITUTE
MAHATMA PHULE KRISHI VIDYAPEETH
RAHURI – 413 722, DIST. - AHMEDNAGAR
MAHARASHTRA, INDIA.**

2021

CANDIDATE'S DECLARATION

I hereby declare that this thesis or part
there of has not been submitted
by me or other person to any
other University or Institution
for a Degree or
Diploma

Place : MPKV, Rahuri

Date : / /2021

(R.D. Solankar)

Dr. A. R. Walunj
Scientist-I (Entomology),
AICRP on Arid Zone Fruits,
Department of Horticulture,
Mahatma Phule Krishi Vidyapeeth,
Rahuri- 413722, Dist. Ahmednagar,
Maharashtra State, INDIA

CERTIFICATE

This is to certify that the thesis entitled, “**BIOEFFICACY OF DIFFERENT INSECTICIDES AGAINST SUCKING PESTS OF POMEGRANATE**” submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri Dist. Ahmednagar (M.S.) in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRICULTURAL ENTOMOLOGY**, embodies the results of a piece of *bona fide* research work carried out by **Mr. SOLANKAR RAHUL DAJIRAM**, under my guidance and supervision and that no part of the thesis has been submitted for any other degree or diploma.

The assistance and help received during the course of this investigation have been duly acknowledged.

Place : MPKV, Rahuri

(A.R. Walunj)

Date : / /2021

Research Guide

Dr. C.S. Patil

Head,
Department of Agricultural Entomology,
Mahatma Phule Krishi Vidyapeeth,
Rahuri-413 722, Dist. Ahmednagar,
Maharashtra State, INDIA

CERTIFICATE

This is to certify that the thesis entitled, “**BIOEFFICACY OF DIFFERENT INSECTICIDES AGAINST SUCKING PESTS OF POMEGRANATE**” submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri Dist. Ahmednagar (M.S.) in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRICULTURAL ENTOMOLOGY**, embodies the results of a piece of *bona fide* research work carried out by **Mr. SOLANKAR RAHUL DAJIRAM**, under the guidance and supervision of **Dr. A. R. WALUNJ**, Scientist-I (Entomology), AICRP on Arid Zone Fruits, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri and that no part of this thesis has been submitted for any other degree or diploma.

Place : MPKV, Rahuri

Date : / /2021

(C.S. Patil)

Dr. P.N. Rasal

Associate Dean,
Post Graduate Institute,
Mahatma Phule Krishi Vidyapeeth,
Rahuri-413 722, Dist. Ahmednagar,
Maharashtra State, INDIA

CERTIFICATE

This is to certify that the thesis entitled, “**BIOEFFICACY OF DIFFERENT INSECTICIDES AGAINST SUCKING PESTS OF POMEGRANATE**” submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri Dist. Ahmednagar (M.S.) in partial fulfillment of the requirements for the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRICULTURAL ENTOMOLOGY**, embodies the results of a piece of *bona fide* research work carried out by **Mr. SOLANKAR RAHUL DAJIRAM**, under the guidance and supervision of **Dr. A. R. WALUNJ**, Scientist-I (Entomology), AICRP on Arid Zone Fruits, Department of Horticulture, Mahatma Phule Krishi Vidyapeeth, Rahuri and that no part of this thesis has been submitted for any other degree or diploma.

Place : MPKV, Rahuri

Date : / /2021

(P.N. Rasal)

ACKNOWLEDGEMENT

I avail this golden opportunity to express sense of gratitude and indebtedness towards the man of golden heart and respected chairman of advisory committee Dr. A.R. Walunj, Scientist-I (Entomology) AICRP on Arid Zone Fruits, Department of Horticulture, MPKV, Rahuri. I owe to him for his constant inspiration, talented and well versed advice and keen criticism, prompt suggestions, constant encouragement and sympathetic attitude throughout the course of investigation and the completion of thesis.

I enrol my esteem and in estimate gratitude with great respect to the advisory committee member, Dr. G.B. Kabre, Professor, Department of Entomology, College of agriculture, Dhule, Dr. S.S. Kulkarni, Horticulturist, AICRP on Arid Zone Fruit, Department of Horticulture, MPKV, Rahuri, Dr. P.E. More, Assistant Professor, Department of Pathology, MPKV, Rahuri, for their valuable suggestions and kind co-operation in the conduct of this research.

I sincerely thank to Dr. P.G. Patil, Vice Chancellor, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dr. A.L. Pharande, Ex-Dean Faculty of Agriculture, M. P. K. V., Rahuri and Dr. P.N. Rasal, Dean Faculty of Agriculture and Associate Dean, Post Graduate Institute, MPKV, Rahuri for providing necessary facilities for successful completion of my research work. It's my great pleasure to express my sincere thanks to Dr. C.S. Patil, Head, Department of Agril. Entomology, MPKV, Rahuri, Dr. S.R. Kulkarni, Associate Professor, Dr. P.R. Palande, Assistant Professor, Dr S.T. Aghav, Assistant Professor and all the staff of Department of Agril. Entomology, MPKV, Rahuri for their immense help during the conduct of this research works.

I express my regards to Prof. A.B. Deshmukh, University Librarian, MPKV, Rahuri and his office staff for their kind cooperation during the course of my post graduate study. I am thankful to my teachers Dr. D. A. Sonawane and Dr. S. A. More sir, College of Agriculture, Pune. I am also thankful to my seniors Shri.Vaibhav Sarate, Rahul Menkundale, Tushar Gorad, Mahesh Bad, Roshan Khandagale, Sangram Jadhav, Rahul Lad, Lalit Raut, Rushikesh Waykule, Ramu Mali, Prityesh Gangurde, Siddhanath Shendekar, Dhaneshwar Patil sir and Radhika Wasu madam for their kind co-operation and suggestions during this investigation. I am extremely thankful to all my batch mates Mr. Pravin, Sachin, Vaibhav, Suraj, Yasinkha, Atul, Anil, Nitin, and Miss. Dipali, Tejaswee, Vishakha, Rupali and Rajshri for their excellent company and valuable help.

I am also thankful to Chemate madam, Nangare madam, Sonali, for their valuable help while performing laboratory work. I sincerely thank to Dhage mama and Gayake mama for their help during field work and observation.

The words are small trophies to express my feeling of affection and indebtedness of my dear friends, Ajit Khatal, Avinash Narale, Rishikesh Dange, Wahid Pirjade,

Pramod Patil, Nityanand Bhosale, Vaibhav Dhore, Ram Gavhane, Sushant Dhanawade and Ganesh Mane. Words are not worthy to express my heartiest reverence to my beloved parents, Baba (Shri. Dajiram Solankar), Aai (Sau.Uma Solankar), Pradip, Yuvraj and Santosh Solankar (Brother)& Sarika Solankar (Vahini) for their never-ending love, care and support in buildup of my educational carrier.

I bow my head before LORD SADGURU and VITTHAL for giving me wisdom and strength required to complete my post graduate programme successfully.

I also express my deep gratitude towards lovable person whom I shared my delight and worries. They encourage and inspired me in all moments of life and who give me cheerful life. While travelling on this path of education many hands pushed me forth, learned hearts put me on the right track enlightened by their knowledge and experience. I ever rest thanks to all of them.

Place : MPKV, Rahuri

Date : / /2021

(Rahul D. Solankar)

CONTENTS

CANDIDATE'S DECLARATION		iii
CERTIFICATES		iv
1.	Research Guide	v
2.	Head of the Department	vi
3.	Associate Dean	vii
ACKNOWLEDGEMENT		viii
CONTENTS		ix
LIST OF TABLES		xii
LIST OF FIGURES		xiii
LIST OF PLATES		xiv
LIST OF ABBREVIATIONS		xv
ABSTRACT		xvii
1.	INTRODUCTION	1
2.	REVIEW OF LITERATURE	5
2.1	Pest Management of Horticultural Crops	5
2.1.1	Fruit crops	5
2.1.2	Vegetables	9
2.2	Pest Management of other than Horticultural Crops	10
2.3	Compatibility of Insecticides with Fungicides, Herbicides, Entomopathogenic fungi, Plant Growth Regulators and Fertilizer	12
3.	MATERIAL AND METHODS	18
3.1	Material Required	18
3.1.1	Selection of pomegranate orchard	18
3.1.2	Details of evaluated treatments	18
3.1.3	Preparation of spray fluid	20
3.1.4	Application of insecticide	20
3.1.5	Care in treatments	20
3.2	Methods	20
3.2.1	Details of experiments	21

		3.2.2	Treatment details	21
		3.2.3	Methods of recording observations	22
		3.2.4	Statistical analysis of data	22
	3.3	Compatibility of Insecticide with Fungicides and Water Soluble Fertilizer		22
		3.3.1	Material	22
		3.3.2	Details of experiment	23
	3.4	Methods		23
		3.4.1	Jar test	23
		3.4.2	Method of recording observations	25
4. RESULTS AND DISCUSSION				26
	4.1	Bioefficacy of New Insecticide Molecule Against Pest Complex of Pomegranate		26
		4.1.1	Efficacy of different insecticide treatment against aphids after first spray on pomegranate	26
		4.1.2	Efficacy of different insecticide treatment against aphids after second spray on pomegranate	29
		4.1.3	Efficacy of the different treatments against aphids per twigs after two spray on pomegranate (Pooled)	31
	4.2	4.2.1	Efficacy of different insecticide treatment against thrips after first spray on pomegranate	34
		4.2.2	Efficacy of different insecticide treatment against thrips after second spray on pomegranate	36
		4.2.3	Efficacy of different treatments against thrips after two sprays on pomegranate (Pooled)	39
	4.3	Effect of Treatment on Natural Enemies on Pomegranate		42
	4.4	Compatibility of New Insecticide Molecule With Fungicide and Soluble Fertilizers		44
	4.5	Effect of Insecticide Treatment in Spraying Solution		44
		4.5.1.1	Colour	44
		4.5.1.2	Foaming	45
		4.5.1.3	Sedimentation	45
		4.5.1.4	Phytotoxicity	45
	4.6	The Effect of Insecticide Treatment in Spraying Solution Mixture on pH and EC with Fungicides and Soluble Fertilizers		45

5.	SUMMARY AND CONCLUSIONS		50
	5.1	Summary	50
	5.1.1	Efficacy of insecticides against aphid (<i>A. punicae</i>) on pomegranate	50
	5.1.2	Efficacy of insecticides against thrips (<i>S. dorsalis</i>) on pomegranate	51
	5.1.3	Effect of treatments on natural enemies on pomegranate	51
	5.2	Compatibility of New Insecticide Molecule with Fungicide and Soluble Fertilizers	52
	5.3	Conclusions	52
6.	LITERATURE CITED		54
7.	VITA		60

LIST OF TABLES

Table No.	Title	Page
1.	Bioefficacy of the new insecticide molecules against aphids on pomegranate after 1 st spray	27
2.	Bioefficacy of the new insecticide molecules against aphids on pomegranate after 2 nd spray	30
3.	Bioefficacy of the new insecticide molecule against aphids on pomegranate (Pooled)	32
4.	Bioefficacy of the new insecticide molecule against thrips on pomegranate after 1 st spray	35
5.	Bioefficacy of the new insecticide molecule against thrips on pomegranate after 2 nd spray	38
6.	Bioefficacy of new insecticide molecule against thrips on pomegranate (Pooled)	40
7.	Effect of different treatments on lady bird beetle after spraying on pomegranate	43
8.	Effect of different insecticide treatments in spray solution mixture on colour, foaming and sedimentation	46
9.	Studies on phytotoxicity effects of different insecticide treatments on pomegranate	47
10.	Effect of different insecticide treatments in spray solution mixture on pH and EC	48

LIST OF FIGURES

Figures No.	Title	Between pages
1.	Layout of experiment	19-20
2.	Bioefficacy of the new insecticide molecules against aphids on pomegranate after 1 st spray	27-28
3.	Bioefficacy of the new insecticide molecules against aphids after 2 nd spray on pomegranate	31-32
4.	Bioefficacy of new insecticide molecules against aphids on pomegranate (Pooled)	33-34
5.	Bioefficacy of new insecticide molecules against thrips after 1 st spray on pomegranate	35-36
6.	Bioefficacy of new insecticide molecules against thrips after 2 nd spray on pomegranate	39-40
7.	Bioefficacy of new insecticide molecules against thrips on pomegranate (Pooled)	41-42
8.	Effect of different treatments on lady bird beetle after spraying on pomegranate	43-44
9.	Effect of different insecticide treatments in spray solution mixture on pH and EC	49-50

LIST OF PLATES

Plate No.	Title	Between pages
1.	General view of experimental field	19-20
2.	Thrips infestation and its symptoms	21-22
3.	Aphid infestation and its symptoms	21-22
4.	Preparation of insecticides solution and spraying	23-24
5.	Study of compatibility of insecticide with fungicide and water soluble fertilizer in laboratory	25-26

LIST OF ABBREVIATIONS AND SYMBOLS

a.i. /A.I.	:	Active Ingredient
a.m.	:	Ante meridian
⁰ C	:	Degree celcius
CD	:	Critical Difference
Cf	:	Commercial Formulation
Cm	:	Centimetre (s)
cm ²	:	Square Centimetre
DAS	:	Days after spraying
DS	:	Dissolved Solvents
cv.	:	Cultivar
EC	:	Emulsifiable concentrate
e.g.	:	Exempli gratia, For example
<i>et al.</i>	:	Etalia and others
etc.	:	Etcetera
g	:	Gram (s)
G	:	Granule (s)
ha	:	Hectare (s)
hr	:	Hour (s)
i.e.	:	Idest, that is
kg	:	Kilogram (s)
lit.	:	Litre (s)
M	:	Meter
m ²	:	Square meter
mg	:	Milligram (s)
ml	:	Milliliter (s)
MPKV	:	Mahatma PhuleKrishiVidyapeeth
MW	:	Meterological Week
MT	:	Metric tonne(s)
NS	:	Non- significant

Qt	:	Quintal (s)
SC	:	Soluble concentrate
Rh	:	Relative humidity
WP	:	Wettable powder
WDG	:	Water Dispersible Granules
S.E.	:	Standard Error
sp./spp.	:	Specie (s)
T	:	Tonne (s)
<i>viz.</i> ,	:	Uidelicet (Namely)
w/w	:	Weight by weight
%	:	per cent
/	:	per
@	:	at the rate of
+, -	:	Plus, minus

ABSTRACT

BIOEFFICACY OF DIFFERENT INSECTICIDES AGAINST SUCKING PESTS OF POMEGRANATE

by

Mr. SOLANKAR RAHUL DAJIRAM

A candidate for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRICULTURAL ENTOMOLOGY

Mahatma Phule Krishi Vidyapeeth, Rahuri - 413 722

2021

Research Guide	:	Dr. A.R. Walunj
Department	:	Agricultural Entomology

Resent research work on “Bioefficacy of different insecticides against sucking pests of pomegranate” was conducted during “*ambia*” bahar of 2020-21 at All India Co-ordinated Research Project on Arid Zone Fruit, Department of Horticulture, M.P.K.V., Rahuri (M.S.). With twelve treatments, including an untreated control, a field experiment was conducted to evaluate the bio-efficacy of new insecticide molecules in combination with fungicides and soluble fertilizer against the pest complex infesting pomegranate viz., aphids and thrips.

During the experiment, all of the treatments were found to be significantly superior for controlling sucking pest (aphids and thrips) than the untreated control.

Among the different treatment, it was evident that, the treatment of cyantraniliprole 10.26 per cent OD @ 0.9 ml was found most effective for the control of aphids and thrips and recorded least average survived aphids (i.e.15.3 aphids and 3.11 thrips per 5 cm twigs) as against (29.8 and 16.19 per 5 cm twigs) in untreated control during the period of experimentation, respectively. The combination treatment of lambda cyhalothrin 4.9 CS (each at 0.3ml + propineb 50 WP 1gm + water soluble fertilizer (00:52:34) 5 g per lit water) was also found equally effective for the control of aphids and thrips and recorded least average survived pest population.

The effect of all treatments on the population of lady bird beetles was evidently non-significant among the combination treatments of insecticides with fungicides, fertilizers and among the sole insecticide treatment.

From the cumulative data, it was revealed that the spray treatment with the treatment of lambda cyhalothrin 4.9 CS (each at 0.3ml + propineb 50 WP 1gm + water soluble fertilizer (00:52:34) 5 g) shows (0.78) and the treatment of cyantraniliprole 10.26 per cent OD @ 0.9 ml (0.87) coccinellids were observed as compared to (1.36) in untreated control. Both the treatments also found safe to natural enemies population. The maximum population was recorded in control (1.36) and minimum population of coccinellids was recorded in sole treatment of lambda cyhalothrin 4.9 CS @ 0.3 ml per litre (0.77).

As regards to the compatibility tests, it was evident that the compatibility treatments under investigation did not show any incompatibility symptoms regarding the foaming effect, discoloration and sedimentation at 1, 24 and 48 hrs after preparation of spray fluid. Whereas, the treatment with cyantraniliprole 10.26 per cent OD @ 0.9 ml per litre showed optimum pH in the range of 7.5 to 7.9 after 1 hr, same trend was found after 24 hr and 48 hr. observation after the preparation of spray fluid and combined treatment of lambda cyhalothrin 4.9 CS (each at 0.3ml + propineb 50 WP 1gm + water soluble fertilizer (00:52:34) 5 g) shows pH range of 5.2 to 5.5 after 1 hr and same trend was found after 24 hr and 48 hr. after preparation of spray fluid found most compatible and effective for the control of pests.

However, all the treatment with insecticide in combination with fungicides and alone showed slightly change in pH towards alkaline nature showed pH in the range of 7.8 to 8.0 and EC above 1.55 to 1.9 dSm⁻¹ at 1 to 48 hrs.

During the investigation, none of the treatments with the combination or alone showed any phytotoxicity or adverse effects on leaf injury on tips and leaf surface, yellowing, wilting necrosis, flower bud, vein clearing, and fruit setting on the pomegranate crop.

1. INTRODUCTION

The pomegranate, *Punica granatum* Linnaeus. is a fruit that belonging to the Punicaceae family . Pomegranate is one of the favourite table fruit from ancient times in tropical as well as sub-tropical regions of the world and it is originated from Iran, where it was first time cultivated around 2000 BC and spread to the Mediterranean countries. Pomegranate is a well-known arid-zone horticultural crop that is widely grown around the world, but particularly in Mediterranean countries such as Spain, Afghanistan and to some extent in Russia, Japan, China and United States. It has been grown all over India. Pomegranate is the most adaptable subtropical minor fruit crops, commonly known as *anar*, *dalim* or *dalimbe* and belonging to one of the smallest families i.e. punicaceae of the plant kingdom.

The fruit is the symbol of abundance and this is valued for its medicinal properties as well as its cold, refreshing juice. Pomegranate juice which is high in tannins and has anti-atherosclerotic property, due to its effective anti-oxidative properties also lowers blood pressure (Aviram and Dornfeld, 2001). Because it contains valuable components in various parts of the fruit that have functional and medical properties, the pomegranate fruit might be considered as a functional food. These can act as antioxidant, as anti- humoral or anti-hepatotoxic agents, improve cardiovascular health, antimicrobial, anti-inflammatory, antiviral, antidiabetic properties and they can improve skin and oral health. They help to prevent Alzheimer's disease and improve qualities of sperm and erectile dysfunction in male patients. (Khan *et al.*, 2017).

For leather curing, all components of the pomegranate tree have been utilized as tannin sources. The properties of anticancer have also been found in fruit juice, peel, and oil including interference with cell cycle, angiogenesis, tumour cell proliferation and invasion (Lanskya *et al.* 2006). It showed the way for growing the area under pomegranate in India due to its high versatile adaptability, hardy nature, low maintenance cost, consistent but high yields, better keeping quality, fine table and therapeutic value and the capability to survive the plant throughout rest periods when irrigation potential is generally low.

India ranking first in area (261'000 ha) and production (2315'000 MT) of pomegranate with the average productivity was 8.86 t ha⁻¹ during year 2019-20. Maharashtra ranks first in India, with 1,47.91'000 ha and 1789.46'000 MT produced, contributing for 62.91 % pomegranate area, followed by Gujrat (30510 ha) and Karnataka (25970 ha). However, when compared to other pomegranate-growing states, Maharashtra's crop production is 12.10 t/ha, which is much lower (Anonymous, 2019).

Farmers are interested in growing this crop because of its export potential. Presently, India produces sufficient quantity fruits and exports to United Arab Emirates, Saudi Arab, The Netherland, Nepal, Bangladesh, United Kingdom and other countries. The exportation trade from India is 80547.74MT (worth 96,190,548.00 US\$) during year 2019-20 (Anonymous, 2019). Pomegranate export demand is expected to rise in the future.

Several insect and non-insect pests, along with diseases, damages such a valued fruit crop. In India, 91 insects, a snail pest and 6 mites have been identified causing problems on the pomegranate crop. Thrips (*Scirtothrips dorsalis* Hood.) and aphids (*Aphis punicae* Passerini.) are the most common pests in the pomegranate area throughout different fruiting seasons which cause serious damage by desapping as well as scaring the rinds of fruit which has resulted into threatening the export quality of fruits (Balikai *et al.*, 2011).

Several earlier workers used insecticides such as imidacloprid, emamectin benzoate, fipronil, spinosad, lambda-cyhalothrin, and tolfenpyrad on pomegranate and found them to be effective against thrips, aphids, and fruit borer (Kadam *et al.*, 2012; Walunj *et al.*, 2015; Appala Raju *et al.*, 2021).

Furthermore, growers particularly in commercial agriculture use a variety of pesticide combinations which is extensively followed by most professional fruit, flower and vegetable producers or growers. Insecticides combined with fungicides as well as liquid fertilizer are used for controlling pests and diseases in pomegranate cultivation. The application of such pesticides separately requires huge number of labours, spraying equipments and vast quantity of water.

The ability to select compatible agrochemical combinations for effective management of insect pests, diseases and weeds requires a good understanding of

agrochemical compatibility. Combining pesticides is a labor-saving shortcut but it requires a thorough study and knowledge of pesticide compatibility to avoid adverse effects viz., phytotoxicity, flowers/ buds/fruits scorching as well as drops which may arise from combinations of some pesticides. Physical, chemical, or phytotoxic incompatibility in pesticide combinations may result in undesirable outcomes. When two or more pesticides are mixed together, one or all of the components declines or loses potency and the active ingredient is deactivated. Chemical incompatibility is influenced by temperature, spray fluid pH and the length of application time the combination rests before being used. As a result, it's best to avoid mixing highly acidic and alkaline materials in same tank, as this could causes issues of chemical compatibility. Availability of the information on the compatibility of various agrochemicals is limited, but it is critical for field use.

Many factors can influence pesticide effectiveness spray coverage, application frequency, interval between applications, pesticide type and age, application rate and timing, and the pH of the water or spray solution. Greenhouse producers understand pH in relation to water quality and growing medium but can not know the effect of pH on pesticide activity. A pesticide may lose efficiency when combined with water. Insecticides tend to be more susceptible to alkaline hydrolysis than fungicides or plant growth regulators. Insecticides in the chemical classes organophosphate (acephate, chlorpyrifos and malathion), carbamate (carbaryl and methiocarb), and pyrethroid (bifenthrin, cyfluthrin, fluvalinate and lambda-cyhalothrin) are most sensitive to alkaline hydrolysis or “high” pH solutions; however, certain pesticides, such as fenbutatin oxide, are not affected by water pH. To maximize pesticide effectiveness, be prepared to monitor spray solution pH and adjust if necessary. For most insecticides and miticides, the ideal pH is between 5 and 7 (Raymond Cloyd, 2015).

Keeping in view, the newly synthesized molecule Lambda-cyhalothrin 4.9 per cent CS, which is with zeon technology sets a new standard in insecticide technology from synthetic pyrethroid group having a label claim on pomegranate was tested against the pests like thrips and aphids on pomegranate. Zeon technology consists of a unique water-based, quick-release microencapsulation formulation. Along with unsurpassed spectrum of control of the most destructive pests on a variety of crops, the product now

offers reduced toxicity hazard and improved residual activity. The active ingredient is lambda-cyhalothrin. Insecticides of Pyrethroid group act on both peripheral nerves together with the central nervous system of insect pests, causing irreversible nerve damage.

Therefore, the present investigation was made to study effectiveness of new insecticide molecule in combination with fungicides and liquid fertilizer for pest control in pomegranate as a sustainable pest management strategy. Taking into the consideration the above facts, the study was planned with following objectives:

1. To find out the efficacy of new insecticide molecule against sucking pest on pomegranate.
2. To study the effect of insecticides on natural enemies.
3. To study the compatibility of Lambda-cyhalothrin 4.9 CS with fungicides and soluble fertilizer.

2. REVIEW OF LITERATURE

Summary of the literature pertaining to the topic under study has been studied here under different heads:

2.1 Pest Management of Horticultural Crops

2.1.1 Fruit Crops

Sreedevi and Verghese (2007) observed the infestation of aphids *Aphis punicae* P. in pomegranate from December to March, with highest population in January and February . and then it was decreased after March.

Ananda *et al.* (2009a) carried out a series of experiments to manage sucking pests of the pomegranate and identified that new generation insecticides, such as thiamethoxam 25 WG @ 0.2 g/l and imidacloprid 200 SL at 0.25 ml/l, were the most efficient in controlling aphids, with incidences reduced by 85.90 and 83.54 per cent over control, respectively. These two treatments also reduced the thrips population by 84.37 and 79.38 per cent, respectively, and white flies by 78.97 and 78.50 per cent

Ananda *et al.* (2009b) conducted fortnightly surveys of pomegranate orchards in and around Bagalkot and noticed the presence of 11 sucking insects and 2 mite pests. Seven of these were Homoptera, one was Hemiptera, three were Thysanoptera, and two were Acarine pests. 10 natural enemies (predators and parasitoids) were also found. Among, 5 belongs to coleoptera, one each to neuropteran and hymenoptera, 3 species of preying mantid were noticed.

Kotikal *et al.* (2009) recorded the greatest activity of aphids of pomegranate during the 2nd fortnight of December and evaluated the occurrence of key sucking pests of pomegranates. Thrips infestations were at their peak in the second half of March. Whitefly population density peaked in the 2nd fortnight of February and the 1st fortnight of March.

Balikai *et al.* (2011) reported 91 insects, 6 mites, and a snail pest infesting on pomegranate crops.

Kadam *et al.* (2012) studied the bioefficacy of insecticides against thrips on pomegranate and reported that fipronil 25 g a.i., spinosad 56.25 g a.i., imidacloprid 27

g a.i. or lambda-cyhalothrin @ 12.5 g a.i. per hectare can be included in the spray schedule of insecticide for controlling thrips on this crop.

Yadav *et al.* (2012) evaluated the efficiency of cyantraniliprole at various doses to that of recommended insecticides against thrips, *Scirtothrips dorsalis* Hood., *Rhipiphorothrip scruentatus* Hood. and red spider mite, *Tetranychus urticae* Koch. in the grapes for table purpose. In field experiments, cyantraniliprole @ 70 g a.i. ha⁻¹ found significantly superior and at par with higher dose of 80 g a.i./ha as well as standard checks of spinosad and thiamethoxam. The cyantraniliprole doses were not shown any phytotoxic symptoms.

Kambrekar *et al.* (2013) investigated newer insecticides for the controlling of the pomegranate aphid, *Aphis punicae* Passerini. Thiamethoxam 25 WG at 0.2 g/l was shown to have the greatest population reduction, followed by imidacloprid 70 WG @ 0.3 g/l. The trees sprayed with thiamethoxam (9105 kg/ha) and imidacloprid (9038 kg/ha) resulted highest quantity of marketable fruits. Thus, thiamethoxam and imidacloprid recorded highest gross returns, net returns and maximum B:C ratio.

Abd Ella (2015) conducted field studies to compare the efficiency and selectivity of neonicotinoids (acetamiprid, imidacloprid, thiamethoxam, and dinotefuron), organophosphate (malathion) and carbamate (pirimicarb) insecticides against pomegranate aphid and the associated predators, *Coccinella undecimpunctata* Linnaeus., *Chrysoperla carnia* Stephans. and *Syphus corolla* Fab. The greatest control of *A. punicae* was achieved by thiamethoxam followed by acetamiprid, imidacloprid, pirimicarb, dinotefuron and malathion.

Kambrekar and Biradar (2015) reported thiamethoxam 25 WG at 0.2 g/l had the significant reductions in aphid population after both spray intervals, followed by imidacloprid 70 WG at 0.3 g/l. During the first year, the mean reduction in aphid population with thiamethoxam was 90.19 and 94.10 % after the 1st and 2nd spray, whereas during the second year, the reduction was to the extent of 91.19 and 93.42 %, respectively. Similarly, after the first and second sprays imidacloprid reduced the of population aphid by 87.92 and 90.39 per cent, respectively and after the second year, it was 89.73 and 93.42 per cent. Pomegranate trees sprayed with thiamethoxam (9105

kg/ha) and imidacloprid (9038 kg/ha) yielded the highest quantity of marketable fruits of pomegranate.

Walunj *et al.* (2015) studied the efficacy of new molecule Cyazpyr in comparison to Imidacloprid and Spinosad against thrips (*Scirithrips dorsalis* Hood.) and whitefly (*Siphoninus phillyreae* Haliday.) infesting pomegranate cv. Bhagwa, at Arid Zone Fruit Research Project, Departemnt of Horticulture, MPKV, Rahuri during 2011. Among the tested dose of Cyazpyre 10% OD, the treatment dose of Cyazpyr at 90 g a.i./ha provided significant control of thrips and whiteflies as against rest of the treatments. Significant differences were noticed in registering least survival of thrips and whiteflies population. The treatment of cyzapyr 10% OD at 75 g a.i./ha was also found better and it gave at par results with cyzapyr 10% OD at 75 g a.i./ha, also considered for the control of thrips and whitefly population.

Walunj *et al.* (2015) compared the efficiency of the new insecticide tolfenpyrad 15 % EC to neonicotinoids and synthetic pyrethroids against thrips (*S. dorsalis*) infesting pomegranate variety Bhagwa during the *ambe bahar* of 2011-12 and 2012-13. All the treatments were found significantly superior over untreated control. The treatment of new chemical compound tolfenpyrad 15% EC at 150 g a.i./ha resulted in significantly least survived population of thrips on 5th, 7th and 10th days after spray and showing least fruit scaring damage as compared with other treatments at the harvesting time.

Dongarjal *et al.* (2018) studied the different newer insecticides were acephate, buprofezin, clothianidin, diafenthiuron, fipronil, flonicamid, spiromesifen and thiamethoxam were used. *Ambia* and *Hasta* bahar's combined results revealed that fipronil was statistically superior to other treatments and equally effective with thiamethoxam and clothianidin. The next promising treatment were flonicamid, acephate, diafenthiuron, buprofezin and spiromesifen. Control treatment recorded significantly maximum population of aphids on pomegranate.

Jaggivar *et al.* (2018) conducted experiments on bio efficacy of Thiacloprid 240 SC against thrips and natural enemies in pomegranate at Krishi Vigyan Kendra, Vijayapur, Karnataka. At 1 day after first spray lowest number of thrips per 10 cm tender new shoots (2.15) was recorded in higher dose (1.50 ml/l) of Thiacloprid 240

SC. This higher dose of Thiacloprid 240 SC (1.25 ml/l) and Cyantraniliprole 10.26 % OD @ 0.75 ml/l treatments were on par with each other in reducing thrips populations. At 3 days after the first spray the higher dose Thiacloprid 240 SC (1.50 ml/l) and Cyantraniliprole 10.26 % OD @ 0.75 ml/l recorded 2.00 and 2.13 thrips population per 10 cm tender new shoots of pomegranate, respectively and they were statistically at par with each other.

Lad *et al.* (2018) stated that the combined treatment of Cyantraniliprole 10.26 % OD @ 0.3 ml + Propineb 50 WP @ 1 g + soluble fertilizer (0:52:34) @ 5 g/lit water was found most effective treatment for the control of aphids, thrips as well as fruit borers and the next effective treatment was the combination treatment of Cyantraniliprole 10.26 % OD @ 0.2 ml + Carbendanzim 50 WP @ 1 g + soluble fertilizer (0:52:34) @ 5 g/lit water in pomegranate.

Jadhao *et al.* (2019) examined the effectiveness of insecticides against pomegranate aphids (*A. punicae* Passerini.) viz., spinosad 45 SC, nitenpyram 10 WSG, clothianidin 50 WDG, lamda-cyhalothrin 5 EC, imidacloprid 17.8 SL, acetamiprid 20 SG, fipronil 5 SC, thiamethoxam 25 WG, thiacloprid 21.7 SC and dinotefuran 20 SG revealed that all these were significantly superior. The most effective was clothianidin followed by thiamethoxam and imidacloprid. Dinotefuran and lamdacyhalothrin treatment was observed least effective but it was significantly most effective over the untreated control.

Vinothkumar *et al.* (2019) examined the efficacy of the thiacloprid 240 SC for controlling pomegranate thrips, *S. dorsalis* Hood. Thiacloprid 240 SC was evaluated in different three doses (0.24, 0.30 and 0.36 g a.i./lit), along with cyantraniliprole 10.26 % OD at 0.075 g a.i./lit as standard check and an untreated control. The results found that thiacloprid 240 SC at 0.36 g a.i./ lit significantly reduced thrips population, with reduction of mean population more than 95 per cent compared against the untreated control, and that thiacloprid 240 SC at 0.30 ga.i/lit significantly reduced population thrips. The thrips population in the untreated check was 22.38/twig/tree. Thiacloprid 240 SC did not harm coccinellids or spiders in the agroecosystem of pomegranate at any of the trial doses. Pomegranate that was sprayed with thiacloprid 240 SC @ 0.36 and 0.72 g a.i./lit had no phytotoxic effects.

Anonymous (2020) reported the bioefficacy of new molecule from anthranilic amide insecticide the cyantraniliprole 10.26 % OD against sucking pest (aphid and thrip) infesting pomegranate was conducted under AICRP on Arid Zone Fruits, Department of Horticulture, M.P.K.V., Rahuri during *ambia bahar* of 2016-17 to 2019 on *var.* Bhagwa. It was found that ,the treatment with cyantraniliprole 10.26 % OD at 75 to 90 g a.i./ha observed equally effective for the controlling of thrips and aphids during entire period of investigation. The treatment with cyantraniliprole 10.26 % OD registered least survived pooled mean population of aphids and thrips in the range of (i.e. 2.1 to 6.18)and (1.74 to 3.65) as against (24.9 and 14.47) per twig in untreated control respectively, on 5th,10th and 15th days.Whereas the treatment of fipronil 5 % EC, Spinosad 45 SC were found less effective for the controlling of pest. Therefore, it is recommended that 2 sprays of cyantraniliprole 10.26 % OD at 90 g a.i./ha at an interval of fifteen days on incidence of pest.

Khandare *et al.* (2020) evaluate the bio-efficacy of seven newer insecticide molecules viz., cyantraniliprole 10.26 % OD @ 75 gm a.i./ha, buprofezin 25 SC @ 250 g a.i./ha, spinosad 45 SC @ 73 g a.i./ha, lambda-cyhalothrin 5 EC @ 15 g a.i./ha, flonicamid 50 WG at 75 g a.i./ha, fipronil 5 SC at 75 g a.i./ha, thiamethoxam 25 WG @ 50 g a.i./ha against thrips on pomegranate. Treatments comprised of spinosad 45 SC, cyantraniliprole 10.26 % OD and fipronil 5 SC were insecticides found the most effective to minimize the incidence of pomegranate thrips.

Appala Raju *et al.* (2021) evaluated the performance of newer pesticide molecules against pomegranate aphids was investigated, and it was reported that Spirotetramat + Imidacloprid 240 SC was the better treatment in keeping aphid populations at a minimum (3.99 aphids/shoot).The next effective treatments in the increasing order of superiority were fipronil 5 SC (4.30), Cyantraniliprole 10.26 % OD (4.40), Tolfenpyred 15 EC (6.27), Thiocloprid 240 SC (6.29), Imidacloprid 200 SL (7.26) and Acetamiprid 20 SP (7.58).

2.1.2 Vegetables

Burt and Karr (2008) reported cyantraniliprole (HGW86) 10 % OD is active against a wide range of insects, including lepidopterans and sucking insects.

Patra *et al.* (2015) examined the bioefficacy of Lambda-cyhalothrin 4.9 CS against chilli thrips and chilli fruit borers. The Lambda-cyhalothrin treatment registered the lowest average thrips score of 0.75 and 1.19 in two years. Lambda-cyhalothrin 4.9 CS @ 25g a.i./ha treated plots attained the maximum yield.

Misra (2015) assessed the bioefficacy of cyantraniliprole (cyazypyr), a new anthranilic diamide, for controlling major sucking pests and *Helicoverpa armigera* Hubner. infesting tomato, and its safety to coccinellid predators.

Yaligar *et al.* (2016) investigated the efficacy of cyantraniliprole (cyazypyr), a new anthranilic diamide with a 10.26 % OD, at various dosages for the control of brinjal insect pests (*Solanum melongena* L.). For comparison, standard insecticides such as chlorantraniliprole (18.5 % SC), spinosad (45 % SC), and imidacloprid (17.8 % SL) were used. Overall, the field trials exhibited that cyantraniliprole 10.26 % w/w OD at 90 g a.i./ha providing cross-spectrum insect pest control, with the lowest number of hoppers (0.26/leaf), whitefly (0.40/leaf), and thrips (5.16/leaf) at 10 days after application, as well as the lowest per cent fruit damage by shoot and fruit borer (1.09 per cent) and the highest yield of 49.70 ton/ha.

Thangavel *et al.* (2018) studied a pooled analysis of two seasons' data on the bio-Efficacy of Alika 247 ZC (Thiamethoxam 12.6 % + Lambda-cyhalothrin 9.5 %) on onion and noticed that three rounds of foliar application of Alika 247 ZC @ 150 ml/ha starting 30 days after planting was significantly superior in reducing *Thrips tabaci* nymphs and adults.

Rabee Ali (2018) studied to evaluate the bio-efficacy of certain insecticides (spinosad, Indoxacarb, chlorpyrifos, chlorfenapyr and emamectin benzoate) against *Thrips tabaci* and their chemical compatibility when combination with mancozeb as fungicides and spray against *Thrips tabaci* on the Onion field. Spinosad was the superior in reduction per centage infestation with thrips followed by chlorfenapyr, emamectin benzoate, indoxacarb and chlorpyrifos, respectively.

Sanghamitra *et al.* (2018) evaluated bioefficacy of flubendiamide 24 % + thiacloprid 24 % against shoot and fruit borer and its safety to non target organisms in brinjal Tamil Nadu Agricultural University, Coimbatore. Results revealed that among the treatments, flubendiamide 24 % + thiacloprid 24 % @ 84 + 84 g a.i./ha were found more

effectual above 90 per cent reduction of target pests i.e. brinjal shoot and fruit borer, aphids and thrips. This combination of two molecules with different chemistry and target was also safer to non-target organisms like spider, coccinellids and does not interfere in their function of pest management.

2.2 Pest Management of other than Horticultural Crops

Elanchezhian *et al.* (2008) studied Lambda-cyhalothrin at 50 and 25 g a.i. ha⁻¹ were slightly harmful to the green mirid bugs in the rice ecosystem. Lambda-cyhalothrin at 12.5 g a.i. ha⁻¹ exhibited significant pest control and also not harmful to the natural enemy. Hence, this dose can be recommended for management of the brown plant hopper in rice.

Vinothkumar *et al.* (2010) studied ready-to-use formulations of newer pesticide compounds ‘flubendiamide + thiacloprid 480 SC’ were evaluated in different concentrations in the field for control of bollworms and sucking pests of cotton. The new technique for reducing insect resistance development is to combine two chemicals with different modes of action. When compared to standard checks, ‘flubendiamide + thiacloprid 480 SC’ at 120 g a.i ha⁻¹ reduced bollworm damage and increased population control of bollworms, aphids, whitefly, and leaf hoppers. indoxacarb 14.5 SC + imidacloprid 200 SL @ 75+30 g a.i. ha⁻¹ and spinosad 45 SC + imidacloprid 200 SL at 90 + 30 g a.i./ha. Cotton plants treated with ‘flubendiamide + thiacloprid 480 SC’ @ 120, 240 and 480 g a.i./ha doses did not show any phytotoxic symptoms like leaf injury, epinasty, wilting, vein clearing, hyponasty, and necrosis.

Stephen *et al.* (2012) reported that cyantraniliprole is currently the only anthranilic diamide (IRAC MoA 28) insecticide controlling aphid species such as *Myzus persicae* Sulzer. and *Aphis gossypii* Glover. There is no evidence that suggest the activity of this compound is affected by commonly occurring mechanisms that confer resistance to other insecticide formulations. Cyantranilliprole is therefore a important tool for management of insecticide resistance in these globally important pests.

Leila Lucia Fritz *et al.* (2013) studied impact of lambda-cyhalothrin on arthropod natural enemy population in irrigated rice fields. Lambda-cyhalothrin was represent to be a rapid acting insecticide, with a significant initial decrease in natural

enemy populations followed by a rapid recovery beginning at 2 weeks after the application of the insecticide.

Patel *et al.* (2014) examined the field bio-efficacy of a newer molecule cyantraniliprole 10 % OD (Cyazypyr @ 45, 60, 75, 90 and 105 g a.i. ha⁻¹) along with indoxacarb 14.5 SC (Avaunt at 75 g a.i./ha) and endosulfan 35 EC (Thiodanat 350 g a.i./ha) as standard checks against the cotton thrips, aphids and whitefly. The two higher doses of cyantraniliprole 10% OD @ 90 and 105 g a.i./ha was found highly effective for the management of the population of aphid, thrips and whitefly compared to indoxacarb and endosulfan. The yield of seed cotton was recorded significantly higher in treatments cyantraniliprole 10 % OD @ 90 (31.97 q/ha) and 105 (33.33 q/ha) g a.i./ha with an increase of 50.80 and 52.81 per cent over untreated control, respectively.

Patel *et al.* (2015) assessed the response of natural enemies to cyantraniliprole 10 % OD sprayed to control the cotton insect pest. The population of coccinellids, spiders and green lacewings did not differ significantly from that of control after applications indicating the safety of cyantraniliprole 10 OD (45, 60, 75, 90 and 105 g a.i./ha) to these predators. Among the insecticides, the higher population of natural enemies was registered in plots sprayed with cyantraniliprole 10 OD.

Farag Malhat and Nagla M. Loutfly (2016) assessed and compared exposure of lambda-cyhalothrin to acceptable daily intake (ADI). The assessment of consumers' exposure was based on the international estimated daily intake (IEDI) compared to acceptable daily intake (ADI). The long-term risk assessment was performed by calculating the hazard quotient (HQ). Since the HQ Chronic of lambda-cyhalothrin never exceeded 1.2 per cent, the tomato fruits could be considered safe for human consumption 14 days after application of lambda-cyhalothrin at the recommended dose.

Nicressi *et al.* (2019) lambda-cyhalothrin is highly toxic to *Nile tilapia Oreochromis niloticus* Linnaeus. juveniles in comparison with acetamiprid and that Acer 35 EC is more toxic than the simple mixture of both components. Also, the mixture of lambda-cyhalothrin and acetamiprid reduces the toxicity, suggesting an antagonistic action in fish.

2.3 Compatibility of Insecticides with Fungicides, Herbicides, Entomopathogenic fungi, Plant Growth Regulators and Fertilizers

Schenck and Adlerz (1963) examined the compatibility of 72 insecticides, fungicide, and foliar fertilizers combinations on watermelon. Disease control was better with zineb-maneb and maneb alone in these studies. Disease control was much lower with thiodan-containing combinations than with non-thiodan-containing mixtures.

Finlayson (1969) investigated the compatibility of insecticides alone or in combination with fungicides, acidic or basic starter solutions when used in the transplanting water to control *Hylemya brassicae* Bouche., *Plasmodiophora brassicae* Woronin. and *Rhizoctonia solani* Kuhn. in cauliflower. Periodic counts to determine phytotoxicity, uprooting wilted plants to determine maggot damage or wire stem by counting marketable and unmarketable heads by uprooting the plants at harvest and grading the maggot damage and incidence per club-root were used to measure the effects. In crops without insecticides, maggot damage was significant.

Prakash Reddy (1984) stated that, the emulsion stability of fenvalerate was influenced by increased sedimentation when mixed with mancozeb, but not with carbendazim, Decamethrin, on the other hand, was shown to be physiologically compatible with carbendazim and mancozeb.

Muthiati *et al.* (1991) examined a mixture of 0.67 per cent fenvalerate and 0.5 per cent carbendazim was efficient against the groundnut pest *Spodoptera litura* Fabricius. and late leaf spot (*Mycosphaerella berkeleyi* Jenkins.), resulting in maximum pod yield. *Asproaerema modicella* Deventer. and *M. berkeleyi* Jenkins. were found in the smallest numbers when 0.15 per cent dichlorvos was mixed with 0.2 per cent mancozeb.

Lakshminarayana and Subbaratnam (2000) studied the wettability of mancozeb and carbendazim was improved in the presence of insecticides monocrotophos, methamidophos and acephate. However, when the fungicides carbendazim and mancozeb were combined with insecticides, they took less time to submerge in ordinary hard water than when the fungicides were used alone. Monocrotophos and methamidophos emulsion and solution stability were also affected.

Kalaiselvi *et al.* (2007) studied the compatibility of tank mix of lambda-cyhalothrin (LCH) (Karate Zeon® 5 CS), with foliar nutrients urea and magnesium

sulphate and fungicide carbendazim (Bavistin®) was evaluated by assessing the emulsion stability and phytotoxicity. No creaming matter and sediment formation at bottom was recorded in any of the combinations of LCH at different doses with urea 2 per cent, magnesium sulphate 5 per cent and carbendazim 50 WP 0.1 per cent and none of the combination treatments caused any phytotoxic effect.

Annemiek Schielder (2008) stated that most pesticides are most stable when pH of solution is at about 5. In general, insecticides (particularly organophosphates and carbamates) are more susceptible to alkaline hydrolysis than are fungicides, herbicides or growth regulators. He also stated that the compound lambda-cyhalothrin i.e. Matador has optimum pH 6.5 and this compound stable at pH 5-9.

Bhuvaneswari and Krishnam Raj (2013) stated chlorantraniliprole @ 0.3 ml/l in combination with hexaconazole @ 2 ml/l (6.96 % WE) resulted in reduced sheath blight incidence (8.3 %) and severity (12.8 %), as well as leaf folder and lesser stem borer damaged leaves per hill.

Anonymus (2013) stated that, DuPont™ Benevia® pesticide is compatible with a wide range of fungicides, liquid fertilisers, herbicides, insecticides, and biological control agents. The recommended mixing sequence is water soluble bags, dry flowable or water dispersible granules, wettable powders, water based suspension concentrates, water soluble concentrates, oil dispersion concentrates (DuPont™ Benevia® insecticide), emulsifiable concentrates, adjuvants and surfactants, and soluble fertilisers.

Siddartha *et al.* (2014), evaluate the efficiency of seven insecticides in combination with Saaf®, a fungicide. Five insecticides (flubendiamide, profenophos novaluron, Proton®, and chlorantraniliprole) worked synergistically against *Plutella xylostella* Linnaeus. larvae, while two insecticides (indoxcarb and Hamla®) worked antagonistically. In this line, a laboratory study was carried out for assessing the insecticidal effects of several fungicides on *P. xylostella* third instar larvae at five different doses. According to the findings, fungicides have insecticidal effects, and larger concentrations result in much increased mortality. At a concentration of 1875 ppm, Saaf® (mancozeb + carbendazim) caused the highest mortality of 28.91 per cent among the fungicides. However, there has been no more research of this nature published

in the literature. Contact fungicides, such as mancozeb and carbendazim, which are components of Saaf® utilized in this research, exhibit varying levels of toxicity for some insects, according to the published literature.

Bo Cui *et al.* (2015) studied a novel formulation of lambda-cyhalothrin, a solid nanodispersion, was successfully prepared by a combination of melt-emulsification and high-speed shearing. More importantly, the formulation is environmentally friendly due to its lack of organic solvents and the reduced use of surfactant in the composition. Therefore, the application of solid nanodispersions in crop production is helpful to reduce the residues in food as well as environmental pollution from pesticides.

Raymond Cloyd (2015) reported that insecticides tend to be most susceptible to alkaline hydrolysis than fungicides or plant growth regulators. The rate of alkaline hydrolysis increases as water pH increases. The speed with which a pesticide breaks down depends on chemical properties of the pesticide, the temperature of the water, and the amount of time a pesticide mixture remains in the sprayer. Insecticides in the chemical classes organophosphate (acephate, chlorpyrifos, and malathion), carbamate (carbaryl and methiocarb) and pyrethroid. (bifenthrin, cyfluthrin, fluvalinate, and lambda-cyhalothrin) are most sensitive to alkaline hydrolysis or “high” pH solutions; however, certain pesticides, such as fenbutatinoxide, are not affected by water pH. Also declared that to maximize pesticide effectiveness, for most of insecticides the ideal pH is in between 5 and 7.

Vasundara *et al.* (2015) assessed the *Trichoderma viridae* Pers. compatibility of two insecticides, three fungicides, and their combinations. At recommended doses for field trials, it showed varying responses to the pesticides (insecticides and fungicides) tested and their combinations. Mancozeb (3000 ppm), imidacloprid (2000 ppm), and a combination of mancozeb (3000 ppm) + imidacloprid (2000 ppm) showed high compatibility with *T. Viridae*, inhibiting growth by 7, 11 and 11 per cent, respectively. The treatment of Carbendazim (1000 ppm) + chloropyriphos (6000 ppm), tebuconazole (1000 ppm) + imidacloprid (2000 ppm), and tebuconazole (1000 ppm) + chloropyriphos (6000 ppm) all showed high compatibility with 100 per cent growth inhibition.

Suneel Kumar *et al.* (2016) tested the compatibility and bioefficacy of a recently released insecticide and fungicide alone and in combination against the defoliator pest *A. modicella* Deventer., *S. Litura* Fabricius., and late leaf spot of groundnut during *Rabi* 2012-2013. Only at recommended doses, Thiodicarb 75 WP + Hexaconazole 5 EC, Flubendiamide 20 WG + Hexaconazole 5 EC and Chlorfenapyr 10 SC + Hexaconazole 5 EC showed slight phytotoxic symptoms with phytotoxic score of one i.e. (0 to 10 %). At the recommended dose, spinosad 45 SC + mancozeb 75 WP, Spinosad 45 SC + hexaconazole 5 EC, flubendiamide 20 WG + hexaconazole 5 EC and Chlorfenapyr 10 SC + Hexaconazole 5 EC were found to be superior to the other combinations, with a mean per cent *A. modicella* larval population reduction of 87.5, comparable to insecticide alone.

Visalakshmi *et al.* (2016) reported that among the several insecticide and fungicide combinations utilised to reduce sheath blight, leaf folder, Flubendamide @ 0.25 mL/L in combination with Trifloxystrobin 25 per cent + Tebuconazole 50 per cent was the most effective (Nativo 75 per cent) With paddy, 0.4 g/L resulted in lower sheath blight incidence (27.33 %) and leaf folder damage (2.0 % leaf damage).

Singh and Kaur (2017) studied that propiconazole in combination with imidacloprid or thiamethoxam, did not reduce efficacy. Wheat aphids and stripe rust were effectively controlled with the insecticide and fungicide alone or in combination.

Joshi *et al.* (2018) studied the compatibility of entomopathogenic fungi *Beauveria bassiana* Balsamo. and *Metarhizium anisopliae* Metschn. with selected insecticides. Profenophos 50% EC was the highest toxic insecticide to the linear growth, per cent inhibition and spore germination. Chlorantraniliprole 18.5 % SC was found compatible with *B. bassiana* Balsamo. where as in *M. anisopliae* Metschn. at different concentration (0.6, 0.3, 0.15, 0.075 %) showed detrimental effect on spore germination whereas only at lowest conc. (0.037 %), 76.00 per cent spore germination was observed.

Suneel Kumar *et al.* (2018) evaluated the physical compatibility of test insecticide and fungicide combinations in the laboratory and noticed that when Mancozeb 75 WP was combined with Chlorfenapyr 10 SC, Thiodicarb 75 WP and Spinosad 45 SC, a pale yellow colour was observed, whereas when Flubendiamide 20 WG was used, the colour was dark yellow with a moderate pH of 7.41 and 7.80,

respectively, the fungicide was smoothly mixed with Spinosad 45 SC and Flubendiamide 20 WG after stirring, and clumps were not seen. With an alkaline pH of 8.64 and 8.70, respectively, little precipitation was seen with chlorfenapyr 10 SC and thiodicarb 75 WP. Except for thiodicarb 75 WP, where precipitation was seen, the fungicide was easily soluble with all of the insecticides. The pH level was moderate, ranging between 7.82 and 8.32.

Sain *et al.* (2019) studied the compatibility of entomopathogenic fungi with insecticides and their efficacy for IPM of *Bemisia tabaci* Gennadius. in cotton. The maximum overall biological efficacy index was observed with Ij-102, after that Bb-4511 and Ij-089.

3. MATERIALS AND METHODS

The research on bioefficacy and compatibility studies of newer insecticide molecules with fungicides and water soluble fertilizer against sucking pests of pomegranate was conducted at experimental farm of All India Co-ordinated Research Project on Arid Zone Fruits, Depart. of Horticulture, MPKV, Rahuri, Dist.- Ahmednagar (MS). Along with this the laboratory experiment on compatibility of different insecticide combinations with fungicides and soluble fertilizer (00:52:34) for their physical properties and the chemical parameters study done in well equipped laboratory were at Eco-friendly Lab, Department of Entomology, MPKV, Rahuri.

The material used and methods adopted for these studies are presented in this chapter.

3.1 Material Required

3.1.1 Selection of Pomegranate Orchard

The study on bioefficacy of new insecticide molecule with fungicides and water soluble fertilizers against sucking pests of pomegranate (3 year old) orchard at All India Co-ordinated Research Project on Arid Zone Fruits, MPKV, Rahuri was conducted. Three separate blocks each consisting of twelve pomegranate plants of variety 'Bhagwa' was maintained for fruits production in the *ambe bahar* season. The spacing of plantation maintained was 4.5 x 3.0 m. Before reaching a sufficient pest population, all of the experimental plants in the block were kept free of insecticides. All other agronomical practices were carried out in accordance with recommendations of MPKV, Rahuri.

3.1.2 Details of Evaluated Treatments:

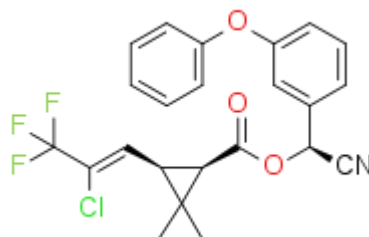
The details of various insecticide utilized for the experiment with its common name, formulation, and source given as below:

The newly synthesized molecule "Lambda-cyhalothrin 4.9 per cent CS", which is with zeon technology sets a new standard in insecticide technology from synthetic pyrethroid group having a label claim on pomegranate was tested against the pests like thrips and aphids on pomegranate. Zeon technology consists of a unique water-based, quick-release microencapsulation formulation. Along with unsurpassed spectrum of control of the most damaging pests on various crops, the product now offers reduced

toxicity hazard and improved residual activity. The active ingredient is lambda-cyhalothrin. Pyrethroid insecticides acting on both peripheral nerves and the central nervous system of insect pests, causing irreversible nerve damage.

Sr. No.	Common name and group	Trade formulation	Chemical name (IUPAC)	Source
1	Cyantraniliprole 10.26 % OD	Benevia	3-Bromo-1-(3-chloro-2-pyridinyl)-N-[4-cyano-2-methyl-6-(methylcarbamoyl)phenyl]-1H-pyrazole-5-carboxamide	M/s. Dupont Pvt. Ltd., Mumbai
2	Lambda - cyhalothrin 4.9 % CS	MATADOR	(R)- α -cyano-3-phenoxybenzyl (1S)-cis-3-[(Z)-2-chloro-3,3,3-trifluoropropenyl]-2,2-dimethylcyclopropanecarboxylate and (S)- α -cyano-3-phenoxybenzyl (1R)-cis-3-[(Z)-2-chloro-3,3,3-trifluoropropenyl]-2,2-dimethylcyclopropanecarboxylate	M/s. Syngenta India Limited
3	Spinosad 45 SC	Tracer	(2R,3aS,5aR,5bS,9S,13S,14R,16aS,16bR)-2-(6-deoxy-2,3,4-tri-O-methyl- α -Lmannopyranosyloxy)-13-(4-dimethylamino-2,3,4,6-tetra-deoxy- β -Derythro-pyranosyloxy)-9-ethyl-2,3,3a,5a,5b,6,7,9,10,11,12,13,14,15,16a,16bhexadecahydro-14-methyl-1H-8-oxacyclododeca[b]as-indacene-7,15-dione and 50-5% spinosyn D	M/s. Dow Agro Science, Mumbai
4	Flubendiamide 1 9.92 % + Thiachloprid 19.92 SC	Belt Expert	1-N-[4-(1,1,1,2,3,3,3-heptafluoropropan-2-yl)-2-methylphenyl]-3-iodo-2-N-(2-methyl-1-methylsulfonylpropan-2-yl)benzene-1,2-dicarboxamide	M/s. Bayer Crop Science, Mumbai.
5	Propineb 50 WP	Antracol	polymeric zinc 1,2-propylenebis(dithiocarbamate)	M/s. Bayer Crop Science, Mumbai
6	00:52:34	Sol. Fertilizer	Monopotassium Phosphate 52% Phosphate & 34% potassium	M/s. Deepak Fertilizer Ltd., Pune
7	Fipronil 5 % SC	Regent	(RS)-5-Amino-1-[2,6-dichloro-4-(trifluoromethyl)phenyl]-4-(trifluoromethylsulfinyl) pyrazole-3-carbonitrile	M/s. Bayer Crop Science, Mumbai
8	Imidacloprid 17.80 SL	Tatamida	N-{ 1-[(6-Chloro-3-pyridyl)methyl]-4,5-dihydroimidazol-2-yl }nitramide	M/s. Rallies India Limited

Structural formula of Lambda Cyhalothrin:



[(R)-cyano-(3-phenoxyphenyl)methyl] (1S,3S)-3-[(Z)-2-chloro-3,3,3-trifluoroprop-1-enyl]-2,2-dimethylcyclopropane-1-carboxylate

3.1.3 Preparation of Spray Fluid

For each treatment 5 litre spray solution was prepared by taking into consideration spray fluid @ 1000 lit./ha.

3.1.4 Application of Insecticide

Battery Powered Knapsack Sprayer having the hollow cone nozzle was used for doing spraying operation. During each treatment, the plant was fully sprayed from all directions at each spray.

There were twelve different treatments performed including untreated control. Two sprayings were done at an interval of 15 days. First spray was done in end of February and second in the start of March. The first and the second spraying was applied during the vegetative stage of the crop.

3.1.5 Care in Treatments

Spraying was done in the morning hours to ensure that all of the target plants were completely covered. To avoid contamination of one treatment product with another, the spray pump was washed twice with clean water. Spraying was done while wearing full clothing and a mask over the mouth to avoid poisoning from spray drift.

3.2 Methods

The methods adopted for studying the bioefficacy of different insecticides against sucking pest of pomegranate were described as below:

3.2.1 Details of Experiments

The experiment for bioefficacy study against sucking pest of pomegranate was conducted with RBD (randomized block design) during the year 2020-21 on 3 year old orchard (cv. Bhagwa) of pomegranate at research field of All India Co-ordinated Research Project on Arid Zone Fruits, Department of Horticulture, MPKV, Rahuri.

a.	Location	All India Co-ordinated Research Project on Arid Zone Fruits, M.P.K.V., Rahuri.
b.	Crop	Pomegranate
c.	Variety	Bhagwa
d.	Design	R.B.D. (Randomized Block Design)
e.	Spacing	4.5 x 3.0 m
f.	Age of orchard	3 years
g.	Treatment	12
h.	Replication	3
i.	Date of bahar	<i>Ambe bahar</i>
j.	Date of treatments	First spray taken 23 February and second spray done on 10 March 2021, at vegetative phase
k.	Fertilizers dose	625 :250:250 kg (NPK)/ha

3.2.2 Treatment Details

Tr. No.	Treatment details	Dose g or ml (per lit.)
T ₁	Lambda-Cyhalothrin 4.9 CS	0.3
T ₂	Lambda-Cyhalothrin 4.9 CS	0.4
T ₃	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 + 1.0 g
T ₄	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP + Soluble fertilizer 0:52:34	0.3 +1.0 g + 5.0 g
T ₅	Flubendiamide19.92 %+ Thiocloprid 19.92 SC	0.3
T ₆	Flubendiamide19.92 %+ Thiocloprid 19.92 SC	0.4
T ₇	Cyantraniliprole 10.26 % OD	0.75
T ₈	Cyantraniliprole 10.26 % OD	0.9
T ₉	Fipronil 5 SC	1.0
T ₁₀	Spinosad 45 SC	0.25
T ₁₁	Imidacloprid 17.80 SL	0.3
T	Untreated control	-

3.2.3 Methods of Recording Observations

The methods for recording observations on aphids and thrips were described below:

a. Sucking Pest Complex

The observations on sucking pest's viz., aphids (*A. punicae*) and thrips (*S. dorsalis*) were recorded (both nymph and adult) from newly emerged early 5 cm apical twigs of each pomegranate plant under observation. On each plant, five twigs were selected. Observations were recorded on this twig to count the number of aphids and thrips on a 5 cm section of each twig. For the pest infestation evaluation, an average of 5 twigs represented the count of average survived aphids and thrips per twig.

b. Natural Enemies

The natural enemies recorded i.e. lady bird beetle (coccinellids) at 7 days interval after last spray on 3 plants per treatments and presented data per 5 twigs per plant basis.

3.2.4 Statistical Analysis of Data

The experimental data were statistically analysed using the randomised block design method of statistical analysis. The values of aphid and thrips survival populations were converted to angular transformed values (T) using the formula $T = \sqrt{n+0.5}$, where n = natural count of aphid and thrips survived population, and statistical analysis was performed.

3.3 Compatibility of Insecticides with Fungicides and Water Soluble Fertilizer

3.3.1 Material

The facilities of various instruments like glasshouse electronic weighing balance, mortar and pestal, glassware's beakers, jars, measuring cylinders, conical flask glass rod, pH metre, EC metre, bulb sucker and pipettes were required and also provided by the Ecofriendly Laboratory, Department of Entomology, M.P.K.V., Rahuri.

3.3.2 Details of the Experiment

Treatment Details

Tr. No.	Treatment details	Dose g or ml (per lit.)
T ₁	Lambda-Cyhalothrin 4.9 CS	0.3
T ₂	Lambda-Cyhalothrin 4.9 CS	0.4
T ₃	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 + 1.0 g
T ₄	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP + Soluble fertilizer 0:52:34	0.3 +1.0 g + 5.0 g
T ₅	Flubendiamide 19.92 % + Thiocloprid 19.92 SC	0.3
T ₆	Flubendiamide 19.92 % + Thiocloprid 19.92 SC	0.4
T ₇	Cyantraniliprole 10.26 % OD	0.75
T ₈	Cyantraniliprole 10.26 % OD	0.9
T ₉	Fipronil 5 SC	1.0
T ₁₀	Spinosad 45 SC	0.25
T ₁₁	Imidacloprid 17.80 SL	0.3
T ₁₂	Untreated control	-

3.4 Methods

The effect of insecticide mixed with fungicide and water soluble fertilizers were assessed with their physical parameters and also chemical parameters in laboratory by using glass jar. The insecticides *viz.*, Lambda-Cyhalothrin 4.9 CS, with one fungicide Propineb 50WP and liquid fertilizer 00:52:34 were used to test physical compatibility *viz.*, colour, sedimentations of solution and also foaming of the solution etc. and tests of chemical compatibility *viz.*, pH, EC, were taken under laboratory conditions and phytotoxicity observations recorded on plants after spraying on the crop.

3.4.1 Jar Test

Observations regarding the compatibility of new insecticide with fungicides and liquid fertilizer were recorded and compatibility tests were assessed using jar test as follows:

Add the required amount of insecticide, fungicide and fertilizer in the order suggested by the label or dealer. If there are no instructions given for tank mixing the products, always go from dilute to concentrate, not vice versa.

The standard jar test were performed as follows:

1. Add 1 pint of carrier (water, liquid fertilizer) to each of 2 one-quart jars.
2. To one of jars add 1/4 teaspoon or 1.2 milliliters of aagent compatibility approved for this use, such as compex or unite (1/4 teaspoon is equivalent to 2 pints per 100 gallons of spray). Shake or stir gently to mix.
3. Add each product to the jar in the ratio and order that you will add them to the spray tank. Use the W-A-L-E-Ssequence when tank-mixing herbicides :
 - i. Wettable powders or water dispersible granules
 - ii. Agitate then add adjuvants such as anti-foaming compounds, buffers
 - iii. Liquids (flowable liquids)
 - iv. Emulsifiable concentrates
 - v. Surfactants
4. Invert the jar 10 times after each addition to simulate continuous agitation.
5. When all ingredients have been added, invert the jar 10 times and let stand for 30 minutes or so. Then, inspect the mixture for precipitates, sludges or separations of liquid phases, all of which may indicate incompatibility.
6. If, after standing for 30 minutes, the components in the jar are dispersed, the fertilizer and herbicide are compatible. If the components are not dispersed in jar, the herbicide-fertilizer mixture is not compatible and should not be used.
7. Determine if the compatibility agent is needed in the spray mixture by comparing the two jars. If either mixture separates but can be remixed readily, the mixture can be sprayed as long as good agitation is used. If the mixtures are incompatible, test the following methods of improving compatibility: (A) slurry the dry herbicide(s) in water before addition, or (B) add 1/2 of the compatibility agent to the fertilizer and the other 1/2 to the emulsifiable concentrate or flowable pesticides before addition to the mixture.

8. A jar test only tests physical incompatibilities, not chemical incompatibilities. The best way to test for chemical incompatibility is to spray the mixture in a small area and check for crop damage or reduced performance.

3.4.2 Method of Recording Observations

1. Physical Compatibility Parameters

- a. **Colour** : The colour of mixed solutions were recorded after 1 hr, 24 hr and 48 hrs as milky white, pale white, pale yellow, and pearl white.
- b. **Sedimentation** : Settled lumps or gels formation was recorded after 1 hr, 24 hr and 48 hrs of mixed combinations of chemicals.
- c. **Foaming** : Foaming also recorded immediately after preparation of spray solution.

2. Chemical Compatibility Parameters:

- a. **pH** : The pH of water was recorded before mixing the chemicals and then chemical changes in the solutions were recorded by using hand pH meter after 1 hr, 24 hr and 48 hrs.
- b. **EC** : Chemical changes in the solutions were recorded by using hand EC meter after 1 hr, 24 hr and 48 hrs.
- c. **Phytotoxicity Effect** : Leaf spot disease and damage severity of fruit were recorded based on standard description and disease scoring was performed using modified 9 point scale method . One week after spraying of insecticides, phytotoxicity symptoms on plants were recorded. Observations for specific parameters like vein clearing, necrosis, chlorosis, wilting, hyponasty and epinasty were taken using the 0-9 scale as 0 - No phytotoxicity; 1 – 0 to 10 per cent, 2 – 11 to 20 per cent, 3 – 21 to 30 per cent, 4 – 31 to 40 per cent, 5 – 41 to 50 per cent, 6 – 51 to 60 per cent, 7 – 61 to 70 per cent, 8 – 71 to 80 per cent, 9 – 81 to 90 per cent, 10 – 91 to 100 per cent phytotoxicity. The data recorded corresponding to each treatment were subjected for statistical analysis after suitable transformation.

4. RESULT AND DISCUSSION

The results of current studies on the bioefficacy of new insecticide molecule with fungicides and water-soluble fertilizer against pest complex infesting pomegranate viz., aphids and thrips are recorded in this chapter. The aspects of compatibility of the new molecule lambda-cyhalothrin 4.9 CS with fungicide (propineb) and water-soluble fertilizer (00:52:34) in spray solution under field and in the laboratory conditions which has been reported for physical and the chemical parameters like colour, foaming, sedimentation, pH and EC in final spray solution.

4.1 Bioefficacy of New Insecticide Molecule against Pest Complex of Pomegranate

It is observed from the pooled data presented in Table. 1 to 6 and depicted in Fig. 2 to 7 that, all the treatments found effective over untreated control in reducing the aphids and thrips infestation during the period of experimentation.

It is observed that, significant differences were not noticed in pre-counts of aphids and thrips. The corresponding pest population was in the range of 32.66 to 37.67 and 10.37 to 12.23 per 5 cm apical twigs; respectively,

4.1.1 Efficacy of Different Insecticide Treatments against Aphids after First Spray on Pomegranate

Among the treatment doses, the combination treatment of fungicide and water-soluble fertilizer and alone, it was evident that significant difference were noticed among the treatment doses during period of the experimentation i.e., 1st, 3rd, 7th, 10th and 15th days after spray observations (Table. 1 and depicted in Fig. 2).

On 1st day after spray, significant differences were not noticed. Among the different treatments, cyantraniliprole 10.26 percent OD at 0.9 ml, lambda-cyhalothrin 4.9 CS each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g and Flubendiamide 19.92 per cent + Thiacloprid 19.92 SC at 0.4 ml were found to be equally effective in minimising the aphid population and registered less survived aphid i.e., (23.7, 24.0 and 24.7) per 5 cm twig, respectively. Whereas, the treatment of fipronil 5 percent SC and imidacloprid 17.80 SL were found next effective treatment for control of aphid population as against rest of the treatment including untreated control.

Table 1. Bioefficacy of the new insecticide molecules against aphids on pomegranate after 1st spray

Tr. No.	Treatments	Dose ml/g (/ lit.)	Precount	Average number of survived aphids / 5 cm twig after first spray					
				1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	Mean
T ₁	Lambda-Cyhalothrin 4.9 CS	0.3	34.54 (5.91)	29.7 (5.49)	20.3 (4.56)	25.7 (5.11)	27.0 (5.24)	29.0 (5.43)	26.3 (5.17)
T ₂	Lambda-Cyhalothrin 4.9 CS	0.4	34.10 (5.88)	28.7 (5.39)	19.0 (4.41)	18.3 (4.34)	25.0 (5.05)	28.0 (5.34)	23.8 (4.91)
T ₃	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 +1.0 g	32.66 (5.76)	34.0 (5.86)	18.0 (4.30)	17.0 (4.18)	31.3 (5.64)	30.3 (5.55)	26.1 (5.11)
T ₄	Lambda-Cyhalothrin 4.9 CS + Propineb 50 WP + Soluble fertilizer 00:52:34	0.3 + 1.0 g + 5.0 g	35.73 (6.02)	24.0 (4.95)	16.0 (4.06)	14.0 (3.81)	14.0 (3.80)	24.3 (4.98)	18.5 (4.32)
T ₅	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.3	34.67 (5.93)	28.7 (5.40)	20.3 (4.56)	15.7 (4.02)	19.3 (4.45)	26.3 (5.18)	22.1 (4.72)
T ₆	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.4	36.67 (6.09)	24.7 (5.01)	17.0 (4.18)	14.0 (3.81)	15.0 (3.94)	26.7 (5.21)	19.5 (4.43)
T ₇	Cyantranilprole 10.26 % OD	0.75	37.67 (6.18)	26.3 (5.18)	17.7 (4.26)	13.7 (3.76)	19.3 (4.45)	29.0 (5.43)	21.2 (4.62)
T ₈	Cyantranilprole 10.26 % OD	0.9	36.00 (6.04)	23.7 (4.91)	15.3 (3.98)	12.0 (3.53)	13.2 (3.68)	22.7 (4.81)	17.4 (4.18)
T ₉	Fipronil 5 SC	1.0	34.29 (5.89)	28.7 (5.40)	18.0 (4.30)	20.3 (4.56)	24.3 (4.98)	28.7 (5.40)	24.0 (4.93)
T ₁₀	Spinosad 45 SC	0.25	36.30 (6.06)	31.7 (5.67)	20.7 (4.60)	20.0 (3.95)	17.3 (4.22)	27.7 (5.31)	23.5 (4.75)
T ₁₁	Imidacloprid 17.80 SL	0.3	35.67 (6.01)	28.7 (5.40)	18.3 (4.34)	18.0 (4.30)	20.7 (4.60)	28.3 (5.37)	22.8 (4.80)
T ₁₂	Untreated control	-	35.34 (5.99)	34.0 (5.86)	39.0 (6.28)	27.7 (5.31)	27.3 (5.27)	28.7 (5.40)	31.3 (5.62)
	S.E.±		0.12	0.16	0.10	0.14	0.13	0.12	-
	CD at 5 %		NS	0.48	0.30	0.41	0.39	0.34	-

*Figures in the parenthesis are ($\sqrt{X+0.5}$) transformed values.

DAS – Day After Spray.

On 3rd days after spray, the treatment of cyantraniliprole 10.26 percent OD at 0.9 ml was found most effective in registering least survived population of aphids in the range of 15.3 per 5 cm apical twigs. However, this treatment was also found on par with lambda- cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g) and Flubendiamide 19.92 per cent + Thiacloprid 19.92 SC at 0.4 ml and recorded least survived aphid population in the range of 16.00 to 17.00 as against 39.00 per twig in untreated control. Whereas, the rest of the treatment were found less effective. However, on the 7th days after spray similar trend was noticed.

On 10th days after spray, it is observed from the data presented in the table. 1 that, similar trend was noticed and showed the cyantraniliprole 10.26 percent OD at 0.9 ml was found most effective in registering least survived population of aphids i.e. 13.2 per 5 cm twigs as against 27.3 per twig in untreated control. Whereas, this treatment was also found on par with lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g) and Flubendiamide 19.92 per cent + Thiacloprid 19.92 SC at 0.4 ml and registered aphid in the range of 14 to 15 /twig. However, the treatment of lambda-cyhalothrin 4.9 CS at 0.3 ml and 0.4 ml, fipronil 5 per cent SC at 1.0 ml, Spinosad 45 SC at 0.25ml per lit. of water were found less effective for control of aphids.

On 15th day after spray it is revealed from the data that, the treatment with cyantraniliprole 10.26 percent OD at 0.9 ml and with lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g) were found equally effective in registering least survived population of aphids in the range i.e. 22.7 to 24.3 against 28.7 per 5 cm twigs in untreated control. Whereas, the rest of the treatment were found non-significant as compared with the untreated control.

The average cumulative mean population of aphids after first spray indicated that, the treatment cyantraniliprole 10.26 percent OD at 0.9 ml and the lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g) were found equally effective and recorded least number of aphids 17.4 and 18.5 as against 31.3 per 5 cm apical twig in untreated control, respectively.

4.1.2 Efficacy of Different Insecticide Treatments against Aphids After Second Spray on Pomegranate

It could be observed from the data presented in Table 2 and depicted in Fig. 3 that, the precount was to be non-significant. On 1st day after spray, all of the treatments were found effective against aphids as compared to untreated control. The treatment of cyantraniliprole 10.26 percent OD at 0.9 ml/lit was found most effective against aphids in recording least survived aphids i.e.15.3 per twig which was found on par with lambda-cyhalothrin 4.9 CS each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g and Flubendiamide 19.92 per cent + Thiacloprid 19.92 SC at 0.4 ml and cyantraniliprole 10.26 percent OD @0.75 ml/lit. and recorded the average survived aphids in the range of 15.3 to 18.7 per 5 cm twig whereas, the rest of the treatment viz. (Spinosad 45 SC, Imidacloprid 17.80 SL) were found less effective against aphids as 33.0 in untreated control.

On 3rd day after spray, the treatment with cyantraniliprole 10.26 percent OD at 0.9 ml was found most effective in registering least survived population of aphids i.e., 11.0 per 5 cm apical twigs. However, this treatment was also found on par with combined treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g/lit. of water and Flubendiamide 19.92 per cent + Thiacloprid 19.92 SC @ 0.4 ml and recorded least survived aphid population in the range of 11.3 to 11.7 as against 27.3 per twig in untreated control. Whereas, the rest of the treatment were found less effective as compared to the untreated control. However, on the 7th days after spray similar trend was noticed.

On 10th days after spray, it is seen that, similar trend was noticed and showed the treatment of cyantraniliprole 10.26 per cent OD @ 0.9 ml found significantly superior and suppressed aphid population up to 9.0 per twig. The combat treatment of lambda-cyhalothrin 4.9 CS each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g/lit. of water was found next effective treatment and reduced aphid population up to 13.7 per twig as against 27.7 in untreated control.

Table 2. Bioefficacy of the new insecticide molecules against aphids on pomegranate after 2nd spray

Tr. No.	Treatments	Dose ml/g (/ lit.)	Average number of survived aphids / 5 cm twig after second spray					
			1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	Mean
T ₁	Lambda-Cyhalothrin 4.9 CS	0.3	25.0 (5.04)	16.0 (4.06)	19.7 (4.49)	26.3 (5.18)	30.7 (5.58)	23.5 (4.87)
T ₂	Lambda-Cyhalothrin 4.9 CS	0.4	18.7 (4.38)	15.7 (4.02)	13.3 (3.72)	25.7 (5.11)	29.7 (5.49)	20.6 (4.54)
T ₃	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 +1.0 g	18.3 (4.34)	17.0 (4.18)	12.7 (3.62)	24.7 (5.01)	28.3 (5.36)	20.2 (4.50)
T ₄	Lambda-Cyhalothrin 4.9 CS + Propineb 50 WP + Soluble fertilizer 00:52:34	0.3 +1.0 g + 5.0 g	15.7 (4.02)	11.3 (3.43)	10.0 (3.24)	13.7 (3.76)	21.3 (4.67)	14.4 (3.82)
T ₅	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.3	18.7 (4.38)	16.0 (4.06)	13.3 (3.71)	18.3 (4.34)	28.7 (5.40)	19.0 (4.38)
T ₆	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.4	16.0 (4.06)	11.7 (3.49)	13.7 (3.76)	15.7 (4.02)	22.0 (4.74)	15.8 (4.01)
T ₇	Cyantraniliprole 10.26 % OD	0.75	18.7 (4.28)	15.3 (3.98)	10.0 (3.24)	12.0 (3.52)	26.0 (5.15)	16.4 (4.05)
T ₈	Cyantraniliprole 10.26 % OD	0.9	15.3 (3.98)	11.0 (3.38)	8.0 (2.91)	9.0 (3.07)	22.7 (4.81)	13.2 (3.63)
T ₉	Fipronil 5 SC	1.0	23.3 (4.87)	15.0 (3.93)	19.7 (4.49)	12.0 (3.53)	22.7 (4.81)	18.0 (4.27)
T ₁₀	Spinosad 45 SC	0.25	21.3 (4.67)	20.3 (4.56)	24.3 (4.98)	13.0 (3.66)	28.3 (5.36)	21.5 (4.65)
T ₁₁	Imidacloprid 17.80 SL	0.3	20.0 (4.53)	15.7 (4.02)	13.0 (3.67)	15.3 (3.98)	31.0 (5.61)	19.0 (4.36)
T ₁₂	Untreated control	-	33.0 (5.78)	27.3 (5.27)	22.3 (4.78)	27.7 (5.30)	31.3 (5.64)	28.3 (5.35)
	S.E.±	-	0.12	0.14	0.11	0.16	0.15	-
	CD at 5 %	-	0.35	0.41	0.32	0.47	0.46	-

*Figures in the parenthesis are ($\sqrt{X+0.5}$) transformed values.

DAS – Day After Spray

On 15th days after spray, it revealed from the data that, the combination treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g/lit. of water) was found most effective in registering least survived population of aphids i.e. 21.3 as against 31.3 per 5 cm twigs in untreated control and found on par with the treatment dose of cyantraniliprole 10.26 percent OD @ 0.9 ml and Flubendiamide 19.92 per cent + Thiacloprid 19.92 SC @ 0.4 ml respectively in registering the least survived aphid population in the range of 22.0 to 22.7 per 5 cm twigs, respectively. Whereas, the rest of the treatments were found non-significant as compared to the untreated control.

The average cumulative mean population of aphids after second spray indicated that, the treatment of cyantraniliprole 10.26 percent OD @ 0.9 ml, the combination treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g per lit. of water) and Flubendiamide 19.92 per cent + Thiacloprid 19.92 SC at 0.4 ml respectively and registered least number of aphids i.e., 13.2, 14.4 and 15.8, as against 28.3 per 5 cm apical twig in untreated control, respectively.

4.1.3 Efficacy of the Different Treatments against Aphids Per Twigs after Two Spray on Pomegranate (Pooled)

It is observed from the pooled data presented in Table 3 and depicted in Fig. 4 that, all of the treatments were found to be significantly more efficient than the untreated control in suppressing the aphid population.

Among the different treatment, the treatment of cyantraniliprole 10.26 percent OD @ 0.9 ml/lit of water was found most effective for the control of aphids and recorded least average survived aphid populations i.e., 10.0 to 22.8 as against 25.0 to 35.34 per twigs in untreated control on 1st to 15th days after spray observation throughout the period of experimentation.

However, the combined treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 gm + water soluble fertilizer (00:52:34) 5 g/lit. of water) was found most effective for the control of aphids and recorded least average survived aphids i.e.12.0 to 22.8 with overall average mean of 16.4 as against 29.8 per twigs in untreated control followed by the treatment of Flubendiamide19.92 percent + Thiacloprid 19.92 SC@ 0.4 ml was found effective for the control of aphids and recorded least average survived aphids i.e.17.6 during the period of experimentation.

Table 3. Bioefficacy of the new insecticide molecules against aphids on pomegranate (Pooled)

Tr. No.	Treatments	Dose ml/g (/ lit.)	Precount	Average number of survived aphids / 5 cm apical twig pooled data of two sprays					
				1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	Mean
T ₁	Lambda-Cyhalothrin 4.9 CS	0.3	34.54 (5.91)	27.3 (5.27)	18.2 (4.32)	22.7 (4.81)	26.7 (5.21)	29.8 (5.51)	24.9 (5.02)
T ₂	Lambda-Cyhalothrin 4.9 CS	0.4	34.10 (5.88)	23.7 (4.91)	15.8 (4.04)	15.8 (4.04)	25.3 (5.08)	28.8 (5.42)	21.9 (4.70)
T ₃	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 + 1.0 g	32.66 (5.76)	26.2 (5.16)	17.5 (4.24)	14.8 (3.91)	28.0 (5.34)	29.3 (5.46)	23.2 (4.82)
T ₄	Lambda-Cyhalothrin 4.9 CS + Propineb 50 WP + Soluble fertilizer 00:52:34	0.3 + 1.0 g + 5.0 g	35.73 (6.02)	19.8 (4.49)	13.7 (3.76)	12.0 (3.54)	13.9 (3.79)	22.8 (4.88)	16.4 (4.09)
T ₅	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.3	34.67 (5.93)	23.7 (4.91)	16.2 (4.02)	14.5 (3.87)	18.8 (4.40)	27.5 (5.29)	20.1 (4.50)
T ₆	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.4	36.67 (6.09)	20.3 (4.51)	14.3 (3.81)	13.8 (3.79)	15.3 (3.86)	24.3 (4.78)	17.6 (4.15)
T ₇	Cyantranilprole 10.26 % OD	0.75	37.67 (6.18)	22.5 (4.80)	16.5 (4.12)	11.8 (3.51)	15.7 (4.02)	27.5 (5.24)	18.8 (4.35)
T ₈	Cyantranilprole 10.26 % OD	0.9	36.00 (6.04)	19.5 (4.62)	13.2 (3.78)	10.0 (3.24)	11.1 (3.54)	22.8 (4.83)	15.3 (4.0)
T ₉	Fipronil 5 SC	1.0	34.29 (5.89)	25.7 (5.14)	17.5 (4.04)	20.0 (4.52)	18.2 (4.32)	25.7 (5.11)	21.2 (4.63)
T ₁₀	Spinosad 45 SC	0.25	36.30 (6.06)	26.5 (5.19)	20.5 (4.58)	22.2 (4.50)	15.2 (3.87)	28.0 (5.34)	22.5 (4.70)
T ₁₁	Imidacloprid 17.80 SL	0.3	35.67 (6.01)	22.0 (4.98)	17.0 (4.18)	15.5 (4.0)	18.0 (4.30)	29.7 (5.49)	20.9 (4.59)
T ₁₂	Untreated control	-	35.34 (5.99)	33.5 (5.83)	33.2 (5.80)	25.0 (5.05)	27.5 (5.29)	32.5 (5.74)	29.8 (5.54)
	S.E.±		0.12	0.10	0.08	0.10	0.10	0.09	-
	CD at 5 %		NS	0.30	0.23	0.29	0.27	0.26	-

*Figures in the parenthesis are ($\sqrt{X+0.5}$) transformed values.

DAS – Day After Spray

Whereas, the rest of treatment viz., lambda-cyhalothrin 4.9 CS @ 0.3 ml, Spinosad 45 SC, Imidacloprid 17.80 SL were found statistically less effective for the aphid control.

Keeping in view to above results, it was evident that, the treatment with cyantraniliprole 10.26 per cent OD @ 0.9 ml and the combination treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g per lit. of water) was found most effective and proved compatibility for the control of aphids. The role of acidic and alkaline pH with EC of spray tank solution was slightly lowered, according to evidence from compatibility experiments on physical, chemical and phytotoxic effect and maintain at normal pH i.e., 7.2 to 7.8 and EC at 1.55 to 1.99 dSm⁻¹ without showing any adverse effect on discolouration, foaming, sedimentation and no any phytotoxic effect on foliage, flower bud, fruit setting and survival of natural enemies. The non-effectiveness of the new molecule lambda-cyhalothrin 4.9 CS (each at 0.3 and 0.4 ml per lit. of water) alone, without combination of fungicides and soluble liquid fertilizer, clearly shows that, the pH and EC of the water source used for spraying played an important role and showed incompatibility as the pH and EC of the spray fluid were slightly alkaline. i.e., nearly 8.0 (Table. 8, 9 and 10).

Several workers earlier reported the organophosphate, synthetic pyrethroids and neonicotinoids as most effective for the control of sucking pests as well as lepidopteran borers of the pomegranate, (Ananda *et al.*, 2009 and Walunj *et al.*, 2015) reported effective control with the tolfenpyrad against thrips on pomegranate.

As the new molecule which is recently registered and label claim against pomegranate pest complex, the literature on fruit crops especially pomegranate is scanty. The effectiveness of lambda-cyhalothrin 4.9 CS against thrips on chilli crop are found most confirmative as reported by Patra *et al.* (2015).

The performance of newer pesticide molecules against pomegranate aphids, showed that, the Spirotetramat + Imidacloprid 240 SC was the most effective treatment in keeping aphid populations at a minimum (3.99 aphids/shoot) followed by next effective treatments in the increasing order of superiority were fipronil 5 SC (4.30), Cyantraniliprole 10.26 per cent OD (4.40), Tolfenpyrad 15 EC (6.27), Thiocloprid 240 SC (6.29), Imidacloprid 200 SL (7.26) and Acetamiprid 20 SP (7.58). Among these

cyantraniliprole is confirmative with our findings as reported by Appala Raju *et al.* (2021)

Similarly, two sprays of the cyantraniliprole 10.26 per cent OD at 90 g a.i. /ha i.e.(0.9 ml per litre) was found most effective and recommended for the control of aphids and thrips infesting pomegranate as when incidence of pest is noticed on pomegranate, which is found confirmative with present findings as reported by (Anonymous, 2020). However, it was the evident that, the combination treatment of cyantraniliprole 10.26 per cent OD with fungicide (carbendazim, propineb and soluble fertilizer 0:52:34) found effective for the control of aphids and thrips in pomegranate as reported by Lad *et al.* (2018). The efficacy of cyantraniliprole (cyazipyr) for effective control of pest complex on brinjal, which is also confirmative with the present findings as reported by Yaligar *et al.* (2016). The cyantraniliprole (HGW86) 10 per cent OD is effective against a wide range of insects, including sucking insects and lepidopterans reported by Burt and Karr, 2008

Our findings are found inconfirmative with findings with the insecticide lambda-cyhalothrin 5 EC against pomegranate aphids reported by Jadhao *et al.* (2019), Kambrekar *et al.* (2013), Ananda *et al.* (2009).

4.2.1 Efficacy of Different Insecticide Treatments Against Thrips After First Spray on Pomegranate

Among the different treatment doses with the combination of insecticide, fungicide and water-soluble fertilizer and alone, it was evident that, significant difference was noticed among the combat treatment doses during the experimentation period i.e., 1, 3, 7, 10 and 15th days after spray observations during period of experimentation.

The precount data was found non-significant and recorded average survived thrips population in the range of 10.37-12.23 per twig /shoot.

It is observed from the data presented in Table 4 and depicted in Fig.5 that, the treatment of cyantraniliprole 10.26 per cent OD @ 0.9 ml was found to be effective in registering least thrips population i.e., 2.13 to 5.11 per 5 cm twig from first day to the period of 15th days after first spray. Which was also found on par with the combined treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water

Table 4. Bioefficacy of the new insecticide molecules against thrips on pomegranate after 1st spray

Tr. No.	Treatments	Dose ml/g (/ lit.)	Precount	Average number of survived thrips / 5 cm twig after first spray.					
				1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	Mean
T ₁	Lambda-Cyhalothrin 4.9 CS	0.3	12.1 (3.55)	6.33 (2.61)	4.39 (2.21)	4.01 (2.12)	4.08 (2.14)	6.06 (2.56)	4.97 (2.33)
T ₂	Lambda-Cyhalothrin 4.9 CS	0.4	12.23 (3.57)	5.46 (2.44)	3.69 (2.04)	4.05 (2.13)	4.26 (2.18)	6.3 (2.61)	4.75 (2.28)
T ₃	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 +1.0 g	11.25 (3.43)	7.06 (2.75)	5.12 (2.37)	4.13 (2.15)	5.16 (2.38)	7.2 (2.77)	5.73 (2.48)
T ₄	Lambda-Cyhalothrin 4.9 CS + Propineb 50 WP + Soluble fertilizer 00:52:34	0.3 +1.0 g + 5.0 g	11.9 (3.52)	5.31 (2.41)	3.17 (1.91)	2.16 (1.66)	3.66 (2.03)	4.91 (2.32)	3.86 (2.07)
T ₅	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.3	11.07 (3.40)	7.9 (2.79)	4.3 (2.19)	4.05 (2.13)	5.74 (2.50)	6.84 (2.71)	5.76 (2.46)
T ₆	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.4	11.15 (3.41)	5.74 (2.50)	5.12 (2.37)	3.3 (1.95)	4.08 (2.14)	5.18 (2.38)	4.68 (2.27)
T ₇	Cyantranilprole 10.26 % OD	0.75	11.07 (3.40)	6.06 (2.56)	3.47 (1.99)	3.17 (1.92)	3.75 (2.06)	5.13 (2.37)	4.32 (2.18)
T ₈	Cyantranilprole 10.26 % OD	0.9	12.17 (3.56)	5.11 (2.37)	3.18 (1.92)	2.13 (1.62)	3.43 (1.98)	4.67 (2.27)	3.70 (2.03)
T ₉	Fipronil 5 SC	1.0	11.14 (3.41)	7.14 (2.76)	6.09 (2.57)	3.94 (2.11)	4.7 (2.28)	6.14 (2.58)	5.60 (2.46)
T ₁₀	Spinosad 45 SC	0.25	10.37 (3.30)	6.13 (2.57)	5.24 (2.40)	3.6 (2.04)	5.08 (2.36)	7.23 (2.78)	5.46 (2.43)
T ₁₁	Imidacloprid 17.80 SL	0.3	11.7 (3.49)	8.2 (2.95)	5.3 (2.41)	4.14 (2.15)	5.67 (2.48)	7.23 (2.78)	6.11 (2.56)
T ₁₂	Untreated control	-	11.8 (3.51)	13.26 (3.71)	12.24 (3.57)	12.3 (3.58)	13.6 (3.75)	14.67 (3.89)	13.21 (3.70)
	S.E.±	-	0.07	0.05	0.05	0.06	0.04	0.04	-
	CD at 5 %	-	NS	0.16	0.15	0.17	0.13	0.11	-

*Figures in the parenthesis are ($\sqrt{X+0.5}$) transformed values.

DAS – Day After Spray

soluble fertilizer (00:52:34) 5 g per lit. of water) were found to be effective in registering least population of thrips i.e., in the range of 2.16 to 5.31 per 5 cm twig after first spray.

On 7th and 10th days after spray, similar trend was noticed that, the treatment of cyantraniliprole 10.26 per cent OD @ 0.9 ml was found most effective in recording least survived population of thrips i.e. in the range of 2.13 to 3.43 per 5 cm apical twigs. However, this treatment was also found on par with the combat treatment dose of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g/lit. of water) and the treatment of Flubendiamide 19.92 per cent + Thiacloprid 19.92 SC @ 0.4 ml, respectively in recording the thrips population in the range of 2.16 and 5.74 per 5 cm twig. Whereas, the rest of the treatments were found less effective as compared with the untreated control.

On 15th days after spray, it is observed from the data that, similar trend was noticed the treatment of cyantraniliprole 10.26 per cent OD @ 0.9 ml was found most effective in recording least survived population of thrips i.e. 4.67 as against 14.67 per 5 cm twigs in untreated control. However, this treatment was also found on par with combined treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g/lit. of water), cyantraniliprole 10.26 per cent OD @ 0.75 ml, Flubendiamide 19.92 per cent + Thiacloprid 19.92 SC @ 0.4 ml i.e. (4.91, 5.13 and 5.18) per 5 cm twigs, respectively. Whereas, the rest of the treatments were found non-effective as against 14.67 per 5 cm twigs in the untreated control.

The average cumulative mean population of thrips after first spray indicated that, the cyantraniliprole 10.26 per cent OD @ 0.9 ml and lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g/lit. of water), respectively were found effective and recorded least number of thrips (3.7 and 3.86) as against (13.21 per 5 cm apical twig) in untreated control, respectively.

4.2.2 Efficacy of Different Insecticide Treatments against Thrips after Second Spray on Pomegranate

It is observed from the data presented in Table. 5 and depicted in Fig. 6 that, the treatment of cyantraniliprole 10.26 per cent OD @ 0.9 ml was found to be effective in registering least population of thrips i.e. 1.57 to 3.11 per 5 cm twig, which was also found on par with the combat treatment of lambda-cyhalothrin 4.9 CS (each at

0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g/lit. of water), which were found to be effective in suppressing thrips population in the range (i.e. 1.74 to 3.27 per 5 cm twig) from 1st day to the period of 15th days after 2nd spray during the experimentation period.

The data on 7th day observation presented in Table. 5, showed that, all the treatments of insecticide were found effective against thrips as compared with untreated control. The treatment of cyantraniliprole 10.26 per cent OD @ 0.9 ml was found most effective against thrips in recording average survival of aphids i.e. 1.57 per twig and on par with the combat treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g per lit. of water), cyantraniliprole 10.26 per cent OD @ 0.75 ml per lit. of water and recorded least survived population of thrips i.e. 1.74 to 2.33 per twigs as against 19.52 in untreated control.

On the 10th day after spray, the combination treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g per lit. of water), was found effective suppressing the thrips population (i.e., 2.74 per twig) which is on par with the treatment of cyantraniliprole 10.26 per cent OD @ 0.9 ml recorded least thrips population of 2.6 per twig. Whereas, the rest of the treatment were found less effective as compared with the untreated control.

On 15th days after spray, it is observed from the data that, the similar trend was noticed and showed the cyantraniliprole 10.26 per cent OD @ 0.9 ml was found most effective against thrips in registering average survival of aphids i.e. 3.11 per twig. However, this treatment was also found on par with the combat treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g/lit. of water), was found effective in suppressing population of thrips i.e. 3.27 as against 19.52 per 5 cm twigs in untreated control. Whereas, the Cyantraniliprole 10.26 per cent OD @ 0.75 ml which also found next best effective treatment in suppressing thrips population up to 3.42 per 5 cm twig. Whereas, the rest of the treatment were found non-significant as compared with the untreated control.

Table 5. Bioefficacy of the new insecticide molecules against thrips on pomegranate after 2nd spray

Tr. No.	Treatments	Dose ml/g (/ lit.)	Average number of survived thrips / 5 cm twig after second spray					
			1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	Mean
T ₁	Lambda-Cyhalothrin 4.9 CS	0.3	4.25 (2.18)	3.25 (1.93)	2.42 (1.71)	3.66 (2.04)	4.14 (2.15)	3.54 (2.0)
T ₂	Lambda-Cyhalothrin 4.9 CS	0.4	4.06 (2.14)	3.03 (1.88)	2.07 (1.61)	3.34 (1.96)	5.27 (2.40)	3.55 (2.0)
T ₃	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 +1.0 g	3.85 (2.08)	3.52 (2.01)	3.24 (1.93)	4.14 (2.15)	4.41 (2.22)	3.83 (2.08)
T ₄	Lambda-Cyhalothrin 4.9 CS + Propineb 50 WP + Soluble fertilizer 00:52:34	0.3 +1.0 g + 5.0 g	3.21 (1.93)	2.25 (1.66)	1.74 (1.50)	2.74 (1.80)	3.27 (1.94)	2.64 (1.76)
T ₅	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.3	3.65 (2.03)	2.43 (1.71)	2.24 (1.65)	3.42 (1.98)	4.56 (2.25)	3.26 (1.93)
T ₆	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.4	3.65 (2.03)	2.26 (1.66)	2.28 (1.68)	2.82 (1.82)	3.96 (2.11)	2.92 (1.84)
T ₇	Cyantraniliprole 10.26 % OD	0.75	3.3 (1.95)	2.61 (1.76)	2.33 (1.69)	3.29 (1.95)	3.42 (1.98)	2.99 (1.86)
T ₈	Cyantraniliprole 10.26 % OD	0.9	3.06 (1.89)	2.18 (1.64)	1.57 (1.44)	2.6 (1.76)	3.11 (1.90)	2.50 (1.72)
T ₉	Fipronil 5 SC	1.0	3.73 (2.06)	2.51 (1.74)	2.39 (1.70)	3.96 (2.11)	4.05 (2.13)	3.33 (1.95)
T ₁₀	Spinosad 45 SC	0.25	4.29 (2.19)	3.39 (1.97)	2.45 (1.72)	4.43 (2.20)	5.18 (2.38)	3.93 (2.09)
T ₁₁	Imidacloprid 17.80 SL	0.3	3.9 (2.10)	2.6 (1.76)	3.06 (1.89)	3.88 (2.09)	4.54 (2.25)	3.60 (2.02)
T ₁₂	Untreated control	-	17.58 (4.25)	18.74 (4.39)	19.52 (4.47)	20.54 (4.59)	19.52 (4.47)	19.18 (4.43)
	S.E.±	-	0.04	0.03	0.04	0.04	0.03	-
	CD at 5 %	-	0.12	0.10	0.12	0.13	0.10	-

*Figures in the parenthesis are ($\sqrt{X+0.5}$) transformed values.

DAS – Day After Spray.

As regards, from average cumulative mean population of thrips after second spray, it was indicated that both the treatment the cyantraniliprole 10.26 per cent OD @ 0.9 ml, the combination treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g/lit. of water) and Flubendiamide 19.92 per cent + Thiacloprid 19.92 SC @ 0.4 ml respectively were found effective and recorded least number of thrips (2.50, 2.64 and 2.92) as against 19.18 per 5 cm apical twig in untreated control.

4.2.3 Efficacy of Different Treatments against Thrips after Two Sprays on Pomegranate (Pooled)

It is seen from the pooled data presented in Table 6 and depicted in fig. 7 that, during the experiments all of the treatments were found to be significantly more effective than the untreated control in reducing the thrips population.

Among the different treatment, the treatment of cyantraniliprole 10.26 per cent OD @ 0.9 ml was found most effective for the control of thrips and recorded least average survived thrips i.e., 1.85 to 4.09 as against 15.42 to 17.09 per twigs in untreated control from the 1st to 15th days after spray observation of experimentation.

However, the combined treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g/lit. of water) was found most effective for the control of thrips and recorded least average survived thrips i.e. 2.0 to 4.8 per twig) with overall average mean (3.47) as against (16.19 per twigs) untreated control followed by the treatment of Flubendiamide 19.92 per cent + Thiacloprid 19.92 SC @ 0.4 ml reduced the population of thrips i.e. 3.55 per twig during the period of experimentation.

Whereas, the rest of treatments viz., lambda-cyhalothrin 4.9 CS (each at 0.3 and 0.4 ml), Imidacloprid 17.80 SL@ 0.3 ml and Spinosad 45 SC @ 0.25 ml were found less effective for the control of thrips.

Keeping in view to above results, the treatment of cyantraniliprole 10.26 percent OD @ 0.9 ml and the combination treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g per lit. of water) was found most effective and compatible for the control of thrips. The role of acidic and alkaline pH with EC of spray tank solution was slightly lowered and maintained at

Table 6. Bioefficacy of the new insecticide molecules against thrips on pomegranate (Pooled)

Tr. No.	Treatments	Dose ml/g (/ lit.)	Precount	Average number of survived thrips / 5 cm twig pooled data of two sprays					
				1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	Pooled Mean
T ₁	Lambda-Cyhalothrin 4.9 CS	0.3	12.1 (3.55)	5.29 (2.40)	3.82 (2.08)	3.21 (1.93)	3.87 (2.09)	5.1 (2.37)	4.26 (2.17)
T ₂	Lambda-Cyhalothrin 4.9 CS	0.4	12.23 (3.57)	4.76 (2.29)	3.36 (1.96)	3.06 (1.89)	3.8 (2.07)	5.78 (2.51)	4.15 (2.15)
T ₃	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 +1.0 g	11.25 (3.43)	5.45 (2.44)	4.3 (2.20)	3.68 (2.05)	4.65 (2.27)	5.81 (2.51)	4.78 (2.29)
T ₄	Lambda-Cyhalothrin 4.9 CS + Propineb 50 WP + Soluble fertilizer 00:52:34	0.3 +1.0 g + 5.0 g	11.9 (3.52)	4.6 (2.18)	2.71 (1.79)	2.0 (1.58)	3.20 (1.92)	4.8 (2.31)	3.47 (1.96)
T ₅	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.3	11.07 (3.40)	5.31 (2.41)	3.34 (1.96)	3.15 (1.91)	4.58 (2.25)	5.7 (2.49)	4.42 (2.21)
T ₆	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.4	11.15 (3.41)	4.7 (2.28)	3.69 (2.05)	2.77 (1.81)	3.45 (1.99)	4.64 (2.25)	3.83 (2.07)
T ₇	Cyantranilprole 10.26 % OD	0.75	11.07 (3.40)	4.68 (2.28)	2.88 (1.82)	2.45 (1.72)	3.52 (2.01)	4.28 (2.19)	3.55 (2.00)
T ₈	Cyantranilprole 10.26 % OD	0.9	12.17 (3.56)	4.09 (2.14)	2.69 (1.80)	1.85 (1.53)	3.01 (1.87)	3.89 (2.10)	3.11 (1.89)
T ₉	Fipronil 5 SC	1.0	11.14 (3.41)	5.43 (2.44)	4.3 (2.19)	3.16 (1.92)	4.83 (2.08)	5.09 (2.37)	4.36 (2.20)
T ₁₀	Spinosad 45 SC	0.25	10.37 (3.30)	5.21 (2.39)	4.31 (2.19)	3.06 (1.89)	4.75 (2.28)	6.21 (2.59)	4.7 (2.27)
T ₁₁	Imidacloprid 17.80 SL	0.3	11.7 (3.49)	6.05 (2.56)	3.95 (2.11)	3.6 (2.02)	4.77 (2.30)	5.89 (2.53)	4.85 (2.30)
T ₁₂	Untreated control	-	11.8 (3.51)	15.42 (3.99)	15.495 (4.00)	15.91 (4.05)	17.07 (4.19)	17.09 (4.19)	16.19 (4.08)
	S.E.±	-	0.07	0.04	0.02	0.03	0.03	0.02	-
	CD at 5 %	-	NS	0.11	0.08	0.09	0.09	0.08	-

*Figures in the parenthesis are ($\sqrt{X+0.5}$) transformed values.

DAS – Day After Spray

normal pH i.e. 7.2 to 7.9 and EC at 1.55 to 1.9 dSm⁻¹ without showing any adverse effect on discoloration, foaming, or sedimentation, as indicated by compatibility studies on physical, chemical, and phytotoxic effect (Table 9 and 10) and phytotoxic effect on foliage, flower bud, fruit setting and survival of natural enemies.

Whereas, suitability of new molecule lambda-cyhalothrin 4.9 CS each at 0.3 and 0.4 ml per lit. water alone without the combination with fungicides and soluble liquid fertilizers clearly shows that, the pH and EC of water source used for spraying has played most important role in chemical compatibility as the pH and EC of spray solution was slightly alkaline i.e. nearly 8.0.

As the new molecule which is recently registered and label claim against pomegranate pest complex, the literature on fruit crops especially pomegranate is scanty. Several workers reported the organophosphate, synthetic pyrethroids and neonicotinoids as most effective for the control of sucking pests as well as lepidopteran borers of the pomegranate. (Ananda *et al.*, 2009., Kadam *et al.*, 2012 and Walunj *et al.* (2015) reported effective control with the tolfenpyrad against thrips on pomegranate.

The cyantraniliprole (HGW86) 10 per cent OD is effective against a wide range of insects, including sucking insects and lepidopterans reported by Burt and Karr (2008). Similarly, two sprays of the cyantraniliprole 10.26 per cent OD at 90 g a.i. /ha i.e. (0.9 ml per litre) was found most effective and recommended for the control of aphids and thrips infesting pomegranate as and when incidence of pest is noticed on pomegranate, which is found confirmative with present findings as reported by (Anonymous, 2020). However, it was the evident that, the combination treatment of cyantraniliprole 10.26 per cent OD with fungicide (carbendazim and propineb and soluble fertilizer 0:52:34) found effective for the control of aphids and thrips in pomegranate as reported by Lad *et al.* (2018) are also agreement with present investigation. As regards the effectiveness of lambda-cyhalothrin 4.9 CS against thrips on chilli crop and Lowest average score of thrips 0.75 and 1.19 in two years were recorded in lambda-cyhalothrin treatment, which is found most confirmative as reported by Patra *et al.* (2015).

Our findings are also found confirmative with the new molecule cyanraniliprole and confirmative with spinosad, cyantraniliprole and fipronil against

pomegranate thrips as reported by Khandare *et al.* (2020). Similarly, the Thiacloprid 240 SC (1.25 ml/l) and Cyantraniliprole 10.26 per cent OD @ 0.75 ml/l and lambda-cyhalothrin 5 EC treatments were found effective with each other in reducing thrips populations in pomegranate are also confirmative with these findings as reported by Vinodkumar *et al.* (2019), Jagginavar *et al.* (2018), Kadam *et al.* (2012). The efficacy of cyantraniliprole (cyazipyre) for effective control pest complex on brinjal, which is also confirmative with the present findings reported by Yaligar *et al.* (2016).

4.3 Effect of Treatments on Natural Enemies in Pomegranate

The bioefficacy of different insecticides treatment in combination and alone against sucking pest complex with effect on natural enemies was studied during experimentation after 1st and 2nd spray by recording grubs and adults of coccinellids spp. Initial count coccinellid of predators before and after both sprays was non-significant which was in the range of 1.00 to 1.38 per 5 twigs on pomegranate.

It is understood from the data, represented in Table 7 and depicted in Fig. 8 that, among the combination treatments with fungicides and with fertilizer and alone. It was the evident that, non-significant survived population was noticed. None of the treatment showed any effect on lady bird beetle population and showed non-significant difference among the different treatments.

The new molecule cyantraniliprole 10.26 percent OD found safe for coccinellids in pomegranate as reported by (Anonymous 2020). Similarly, its safety to the coccinellid predator on brinjal as reported by Mishra (2015). The population of coccinellids, spiders and green lace wings did not vary significantly from that of control after application of cyantraniliprole 10 OD in cotton field indicating its safety to natural enemies, as reported by Patel *et al.* (2015) which is found confirmative with our findings.

The present findings are also in agreement with Elanchezhian *et al.* (2008) reported that the Lambda-cyhalothrin at 50 and 25 g a.i. ha-1 were slightly harmful to the green mirid bugs in the rice ecosystem. Lambda cyhalothrin at 12.5 g a.i. ha-1 exhibited significant pest control and also not harmful to the natural enemies.

Table 7. Effect of different treatments on lady bird beetle after spraying on pomegranate

Tr. No.	Treatments	Dose ml/g (/ lit.)	Precount	Average number of survived lady bird beetle / 5 twigs				Average mean
				First spray		Second spray		
				1 st week after spray	2 nd week After spray	1 st week after spray	2 nd week After spray	
T ₁	Lambda-Cyhalothrin 4.9 CS	0.3	1.30 (1.34)	0.97 (1.21)	0.89 (1.18)	0.73 (1.11)	0.52 (1.01)	0.77 (1.12)
T ₂	Lambda-Cyhalothrin 4.9 CS	0.4	1.36 (1.36)	1.06 (1.25)	0.99 (1.22)	0.74 (1.11)	0.60 (1.05)	0.84 (1.16)
T ₃	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 +1.0 g	1.35 (1.36)	0.95 (1.20)	0.85 (1.16)	0.80 (1.14)	0.66 (1.08)	0.81 (1.14)
T ₄	Lambda-Cyhalothrin 4.9 CS + Propineb 50 WP + Soluble fertilizer 00:52:34	0.3 +1.0 g + 5.0 g	1.34 (1.36)	0.92 (1.19)	0.89 (1.18)	0.86 (1.17)	0.46 (0.98)	0.78 (1.15)
T ₅	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.3	1.36 (1.36)	0.91 (1.19)	0.88 (1.17)	0.82 (1.15)	0.73 (1.11)	0.83 (1.15)
T ₆	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.4	1.30 (1.34)	0.95 (1.20)	0.91 (1.19)	0.90 (1.18)	0.85 (1.16)	0.90 (1.18)
T ₇	Cyantraniliprole 10.26 % OD	0.75	1.38 (1.37)	0.89 (1.18)	0.87 (1.17)	0.87 (1.17)	0.75 (1.12)	0.84 (1.16)
T ₈	Cyantraniliprole 10.26 % OD	0.9	1.30 (1.34)	0.93 (1.20)	0.91 (1.19)	0.88 (1.17)	0.77 (1.12)	0.87 (1.17)
T ₉	Fipronil 5 SC	1.0	1.37 (1.37)	0.95 (1.20)	0.92 (1.19)	0.85 (1.16)	0.73 (1.13)	0.86 (1.17)
T ₁₀	Spinosad 45 SC	0.25	1.30 (1.34)	1.12 (1.27)	1.09 (1.26)	1.04 (1.24)	0.97 (1.21)	1.05 (1.24)
T ₁₁	Imidacloprid 17.80 SL	0.3	1.34 (1.36)	0.92 (1.19)	0.88 (1.18)	0.84 (1.16)	0.82 (1.15)	0.86 (1.17)
T ₁₂	Untreated control	-	1.33 (1.35)	1.42 (1.39)	1.46 (1.40)	1.31 (1.35)	1.25 (1.32)	1.36 (1.35)
	S.E.±	-	0.06	0.07	0.03	0.04	0.08	-
	CD at 5 %	-	NS	NS	NS	NS	NS	-

*Figures in the parenthesis are ($\sqrt{X+0.5}$) transformed values.

DAS – Day After Spray

The combination of lambda-cyhalothrin (LCH) (Karate Zeon® 5 CS), with foliar nutrients urea and magnesium sulphate and fungicide carbendazim (Bavistin®) was evaluated by assessing the emulsion stability and phytotoxicity. None of the treatment showed any adverse effect on natural enemies population as reported by Kalaiselvi *et al.* (2007), which is also found confirmative with our findings. Flubendiamide 24 per cent + thiacloprid 24 per cent also found safe for coccinellids and spiders as reported by Sanghamitra *et al.* (2018) also found corroborative with present findings.

4.4 Compatibility of New Insecticide Molecule with Fungicide and Soluble Fertilizers

Compatibility of pesticide is the behaviour of combination with reference to active ingredient that is whether reduced, maintained or potentiated its insecticidal activity. Pesticide which are recently label claim for pomegranate pest has been tried for their behaviour studying in presence of other chemical and soluble fertilizers to exploit the utilization of more than one chemical at a time in combination with their adverse incompatibility of spray solution compatibility study was carried out in laboratory after preparing spray solution for spraying against pest complex of pomegranate.

In this context the physical and chemical parameter like colour, foaming, sedimentation, pH, EC was studied under laboratory condition and bioefficacy and phytotoxicity studied under field conditions before and after spraying.

4.5 Effect of insecticide treatment in spraying solution

4.5.1.1 Colour

It is revealed from the data presented in Table 9 that, the different treatment of lambda-cyhalothrin 4.9 CS (0.3 ml per lit. of water) and lambda-cyhalothrin 4.9 CS (0.4 ml per lit. of water) with combination with fungicides viz. propineb and water-soluble fertilizers and alone showed different colours in spray fluid solution. As regards, lambda-cyhalothrin 4.9 CS alone showed faint white colour. However, in combination with propineb 50 WP and soluble fertilizer showed milky white and milky white colour which was also found without change in colour at 1, 24 and 48 hr. after preparation of spray solution, respectively.

Whereas, the treatment of cyantraniliprole 10.26 per cent OD shows pale white colour at 1, 24 and 48 hrs after preparation of spray solution, respectively. The treatment of flubendiamide 24 per cent + Thiacloprid 24.480 SC showed creamy white

colour at 1, 24 and 48 hrs respectively. The treatment of fipronil and blank (water) showed white and no colour (colourless) after 1hr, 24 hr and 48 hr, respectively.

4.5.1.2 Foaming

It is seen from the data presented in Table 9 that the new insecticide molecule lambda-cyhalothrin 4.9 CS combination with fungicide (propineb) and soluble fertilizer (00:52:34) revealed that among the different treatments, none of the treatment with combination or alone showed foaming after 1hr, 24 hr and 48 hr in spray fluid solution.

4.5.1.3 Sedimentation

It is revealed from the data presented in Table 8 that, all the treatments showed no sedimentation after 1 hr. Whereas, it was evident that lambda-cyhalothrin 4.9 CS alone and the combination treatment of lambda-cyhalothrin 4.9 CS with propineb and soluble fertilizer (00:52:34) at 24 hrs observation showed sedimentation at the bottom of conical flask and rest of the treatments found free from sedimentation effect, similar trend was noticed after 48 hrs prepared spray solution kept in conical flask.

4.5.1.4 Phytotoxicity

Table 9 shows that, the newer insecticide molecule lambda-cyhalothrin 4.9 CS in combination with fungicides (propineb) and soluble fertilizers (0:52:34) had no phytotoxicity effects on pomegranate leaf injury, vein clearing, necrosis, wilting, and yellowing on pomegranate crop during period of experimentation.

4.6 Effect of Insecticide Treatments in Spraying Solution Mixture on pH and EC

It is revealed from the data presented in Table 10 and depicted in Fig.10, that, the treatment lambda-cyhalothrin 4.9 CS in combination with fungicide (propineb) and soluble fertilizers (00:52:34) showed optimum pH in the range of 5.2 to 7.5 after 1 hr, same trend was found after 24 hr and 48 hr. observation.

As regards, the EC of spray solution of the treatment lambda-cyhalothrin 4.9 CS in combination with fungicide i.e. (propineb) and soluble fertilizer (00:52:34) showed the range of 1.55 dSm^{-1} after 1 hr, same trend was found after 24 hr and 48 hr. However, rest of the treatment showed pH in the range of (7.8 to 8.0) and EC in the range of (0.5 to 1.5 dSm^{-1}), respectively.

Table 8. Effect of different insecticide treatments in spray solution mixture on colour, foaming and sedimentation

Tr. No.	Treatments	Dose ml/g (per lit.)	Colour			Foaming			Sedimentation		
			1 hr	24 hr	48 hr	1 hr	24 hr	48 hr	1 hr	24 hr	48 hr
T ₁	Lambda-Cyhalothrin 4.9 CS	0.3	Faint white	Faint white	Faint white	-	-	-	-	√	√
T ₂	Lambda-Cyhalothrin 4.9 CS	0.4	Faint white	Faint white	Faint white	-	-	-	-	√	√
T ₃	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 +1.0 g	Milky white	Milky white	Milky white	-	-	-	-	√	√
T ₄	Lambda-Cyhalothrin 4.9 CS + Propineb 50 WP + Soluble fertilizer 00:52:34	0.3 +1.0 g + 5.0 g	Milky white	Milky white	Milky white	-	-	-	-	√	√
T ₅	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.3	Creamy white	Creamy white	Creamy white	-	-	-	-	-	-
T ₆	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.4	Creamy white	Creamy white	Creamy white	-	-	-	-	-	-
T ₇	Cyantranilprole 10.26 % OD	0.75	Pale white	Pale white	Pale white	-	-	-	-	-	-
T ₈	Cyantranilprole 10.26 % OD	0.9	Pale white	Pale white	Pale white	-	-	-	-	-	-
T ₉	Fipronil 5 SC	1.0	White	white	white	-	-	-	-	-	-
T ₁₀	Spinosad 45 SC	0.25	Pearl white	Pearl white	Pearl white	-	-	-	-	-	-
T ₁₁	Imidacloprid 17.80 SL	0.3	White	White	White	-	-	-	-	-	-
T ₁₂	Untreated control	-	Colourless	Colourless	Colourless	-	-	-	-	-	-

Table 9. Studies on phytotoxicity effects of different insecticide treatments on pomegranate

Tr. No.	Treatments	Dose ml/g (per lit.)	Observation timing score value				
			1 DAS	3 DAS	5 DAS	7 DAS	10 DAS
T ₁	Lambda-Cyhalothrin 4.9 CS	0.3	0	0	0	0	0
T ₂	Lambda-Cyhalothrin 4.9 CS	0.4	0	0	0	0	0
T ₃	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 +1.0 g	0	0	0	0	0
T ₄	Lambda-Cyhalothrin 4.9 CS + Propineb 50 WP + Soluble fertilizer 00:52:34	0.3 +1.0 g + 5.0 g	0	0	0	0	0
T ₅	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.3	0	0	0	0	0
T ₆	Flubendiamide 19.92 % + Thiacloprid 19.92 SC	0.4	0	0	0	0	0
T ₇	Cyantranilprole 10.26 % OD	0.75	0	0	0	0	0
T ₈	Cyantranilprole 10.26 % OD	0.9	0	0	0	0	0
T ₉	Fipronil 5 SC	1.0	0	0	0	0	0
T ₁₀	Spinosad 45 SC	0.25	0	0	0	0	0
T ₁₁	Imidacloprid 17.80 SL	0.3	0	0	0	0	0
T ₁₂	Untreated control	-	0	0	0	0	0

Table 10. Effect of different insecticide treatments in spray solution mixture on pH and EC

Tr. No.	Treatments	Dose ml/g (per lit.)	Average values of pH at			Average values of EC (dSm ⁻¹) at		
			1 hr	24 hr	48 hr	1 hr	24 hr	48 hr
T ₁	Lambda-Cyhalothrin 4.9 CS	0.3	7.2	7.56	7.7	0.55	0.5	0.48
T ₂	Lambda-Cyhalothrin 4.9 CS	0.4	7.3	7.33	7.8	0.5	0.48	0.48
T ₃	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP	0.3 +1.0 g	6.9	7.2	7.3	0.62	0.59	0.47
T ₄	Lambda-Cyhalothrin 4.9 CS + Propineb 50WP + Soluble fertilizer 0:52:34	0.3 +1.0 g + 5.0 g	5.2	5.4	5.5	1.9	1.75	1.55
T ₅	Flubendiamide 19.92 %+ Thiachloprid 19.92 SC	0.3	7.66	7.73	7.7	1.53	1.51	1.47
T ₆	Flubendiamide 19.92 %+ Thiachloprid 19.92 SC	0.4	7.66	7.73	7.7	1.53	1.53	1.51
T ₇	Cyantraniliprole 10.26 % OD	0.75	7.8	7.85	7.9	1.41	1.41	1.39
T ₈	Cyantraniliprole 10.26 % OD	0.9	7.76	7.83	7.87	1.5	1.49	1.47
T ₉	Fipronil 5 % SC	1.0	7.6	7.75	7.86	1.53	1.48	1.48
T ₁₀	Spinosad 45 SC	0.25	7.5	7.9	8	1.4	1.39	1.38
T ₁₁	Imidacloprid 17.80 SL	0.3	7.3	7.5	7.66	1.4	1.39	1.37
T ₁₂	Blank	-	7.9	7.8	8.0	0.52	0.52	0.52

The insecticides tend to be most susceptible to alkaline hydrolysis than fungicides or plant growth regulators. Insecticides in the chemical classes organophosphate (acephate, chlorpyrifos, and malathion), carbamate (carbaryl and methiocarb), and pyrethroid (bifenthrin, cyfluthrin, fluvalinate, and lambda-cyhalothrin) are most sensitive to alkaline hydrolysis or “high” pH solutions. Also declared that to maximize pesticide effectiveness, for most of insecticides the ideal pH is in between 5 and 7 which is also agreement with our present investigation as reported by Raymond A. Cloyd (2015). Our findings are also in agreement with Lad *et al.* (2018) reported the treatment cyantraniliprole 10.26 percent OD in combination with fungicide (i.e. carbendazim and propineb) and soluble fertilizer (00:52:34) showed optimum pH in the range of 7.2 to 7.5 after 1 hr, EC of spray solution showed minimum in the range of 1.00 mmhos after 1 hr.

The most pesticides are most stable when pH of solution is at about 5. In general, insecticides (particularly organophosphates and carbamates) are more susceptible to alkaline hydrolysis than are fungicides, herbicides or growth regulators and stated that the compound lambda-cyhalothrin 4.9 CS i.e. Matador has optimum pH 6.5 and this compound stable at pH range between 5 to 9 are agreement with our findings as reported by Annemiek Schielder (2008). Similarly, the compatibility of tank mix of lambda-cyhalothrin (LCH) (Karate Zeon® 5 CS), with foliar nutrients urea and magnesium sulphate and fungicide carbendazim (Bavistin®) by assessing the emulsion stability, phytotoxicity, No creaming matter and sediment formation at bottom was observed in any of the combinations of lambda-cyhalothrin at different doses with urea 2 per cent, magnesium sulphate 5 per cent and carbendazim 50 WP 0.1 per cent, which is also corroborative with present findings as reported by Kalaiselvi *et al.* (2007).

5. SUMMARY AND CONCLUSIONS

The recent cultivation of high yielding pomegranate cultivars and management under irrigated conditions with early stage plant exploitation has resulted in a number of severe pest problems. Aphids, thrips, whiteflies, scale insects, mites, mealy bugs and fruit borer are among the sucking pests that adversely affect pomegranate marketable yields. The quality of the fruits in terms of size, colour, and attractiveness, as well as residue proof in fruits of pomegranate, are the two most significant constraints to enhancing export potential.

The ability to select compatible agrochemical combinations for effective management of insect pests, diseases and weeds requires a thorough understanding of agrochemical compatibility with sequence of mixing different formulations. In the management of pests and diseases in pomegranate production, crop growers commonly use insecticides, fungicides, liquid fertilizer, and growth regulators. Combining pesticides is a labour-saving shortcut, but it requires an understanding and knowledge of pesticide compatibility to avoid problems. Pesticides (insecticides, fungicides) and soluble fertilizer are therefore significant pomegranate inputs. Physical, chemical or phytotoxic incompatibility in pesticide combinations may result in undesirable results.

As a result, it was felt to evaluate the efficacy and compatibility of insecticides, fungicides, and fertilizer for the effective control of pomegranate pests.

The twelve insecticidal treatments comprising of application of lambda-cyhalothrin 4.9 CS, lambda-cyhalothrin 4.9 CS + propineb 50 WP, lambda-cyhalothrin 4.9 CS + propineb 50 WP + soluble fertilizer 00:52:34, flubendiamide 19.92 per cent + thiacloprid 19.92 SC, cyantraniliprole 10.26 per cent OD, fipronil 5 SC, spinosad 45 SC, imidacloprid 17.80 SL and untreated control were evaluated. The summary and conclusion of the research findings are given in this chapter.

5.1 Summary

5.1.1 Efficacy of Insecticide against Aphid (*A. Punicae*) on Pomegranate

The field experiment carried on bioefficacy of various treatments against pomegranate aphids indicated that, the different treatment, the cyantraniliprole 10.26 per cent OD at 0.9 ml was found most effective in registering least survived population of aphids 15.3 per 5 cm twigs as against 29.8 per twig in untreated control. Whereas, this

treatment was also found on par with lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g with water soluble fertilizer (00:52:34) 5 g) and registered least population of aphid 16.4 per twig from 1st to 15th days after spray observations against mean population of 29.8 per twig in untreated control.

However, the treatment of Flubendiamide 19.92 per cent + Thiacloprid 19.92 SC at the rate of 0.4 ml per litre of water suppressed the aphid population up to 17.6 per 5 cm twig was found next effective treatment for the control of aphids.

5.1.2 Efficacy of Insecticide against Thrips (*S. dorsalis*) on Pomegranate

The treatment of cyantraniliprole 10.26 per cent OD @ 0.9 ml per litre was found most effective for control of thrips and reduced thrips population in the range of 1.85 to 4.09 as compared to 15.42 to 17.09 in untreated control. Whereas, this treatment was also found on par with lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g with water soluble fertilizer (00:52:34) 5 g) and registered least population of thrips i.e. 2.0 to 4.8 per twig as against mean population of thrips 16.19 in untreated control. However, the treatment of cyantraniliprole 10.26 per cent OD @ 0.75 ml per litre was found next effective treatment for control of thrips i.e. 3.55 mean population per 5 cm twig.

5.1.3 Effect of Treatment on Natural Enemies on Pomegranate

The effect of all treatments on the population of lady bird beetles was evidently non-significant among the combination treatments of insecticides with fungicides and fertilizers, and among the sole insecticide treatment.

From the cumulative data it was revealed that, the spray treatment with the treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g with water soluble fertilizer (00:52:34) 5 g) shows (0.78) and the treatment of cyantraniliprole 10.26 per cent OD @ 0.9 ml (0.87) coccinellids were observed as compared to (1.36) in untreated control. The maximum population was recorded in control (1.36) and minimum population of coccinellids was recorded in sole treatment of lambda-cyhalothrin 4.9 CS @ 0.3 ml per litre (0.77). All treatments were observed non-significant.

5.2 Compatibility of New Insecticide Molecule with Fungicide and Soluble Fertilizers

As regards the compatibility tests performed, the treatments under investigation did not show any incompatibility symptoms regarding foaming effect, discoloration and sedimentation at 1, 24 and 48 hrs after observation. Whereas, the combined treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g with water soluble fertilizer (00:52:34) 5 g) shows pH range of 5.2 to 5.5 after 1 hr and same trend was found after 24 hr and 48 hr. after preparation of spray fluid and the treatment cyantraniliprole 10.26 per cent OD @ 0.9 ml per litre showed optimum pH in the range of 7.5 to 7.9 after 1 hr, same trend was found after 24 hr and 48 hr. observation after the preparation of spray fluid.

However, the EC of spray solution of the combined treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g with water soluble fertilizer (00:52:34) 5 g) showed range of 1.55 to 1.9 dSm⁻¹ after 1 hr, same trend was found after 24 hr and 48 hr.

5.3 Conclusion

On the basis of results and discussion of the present investigation the following conclusions can be drawn.

1. Among the different treatments, the treatment of cyantraniliprole 10.26 per cent OD @ 0.9 ml and combination treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g) were found equally effective for the control of sucking pests viz.aphids and thrips on pomegranate.
2. The combination treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g) recorded least population of aphids i.e.16.4 as against 29.8 per 5 cm twig in untreated control and least population of thrips i.e. 3.47 as against 16.19 per 5 cm twig in untreated control.
3. The effective treatments i.e. cyantraniliprole 10.26 per cent OD @ 0.9 ml and combination treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb

50 WP 1 g + water soluble fertilizer (00:52:34) 5 g) are found safe to natural enemies.

4. The combination treatment of lambda-cyhalothrin 4.9 CS (each at 0.3 ml + propineb 50 WP 1 g + water soluble fertilizer (00:52:34) 5 g) was found compatible showed optimum pH in the range of 5.2 to 5.5 after 1 hr, same trend was found after 24 hr and 48 hr. observations and which increases pesticidal activity of solution found most compatible and effective for the control of sucking pests of pomegranate.
5. None of the treatment with combination and alone showed any phytotoxicity or adverse effects on pomegranate crop during period of experimentation.
6. Thus, insecticides combined with fungicides and soluble fertilizers are the better option with understanding its compatibility and sequence of formulation mixing before spraying (i.e. W-A-L-E-S) to manage the sucking pests of pomegranate as need base use which could benefit in formulating IPM strategy.

6. LITERATURE CITED

- Abd Ella, A.A.E. 2015. Effect of several insecticides on pomegranate aphid, *Aphis punicae* Passerini (Homoptera: Aphididae) and its predator under field conditions. *EPPO Bulletin*, **2**(3) : 32-42.
- Ananda, N., Kotikal, Y.K. and Balikai, R.A. 2009a. Management practices for major sucking pests of pomegranate. *Karnataka J. Agric. Sci.*, **22**(4) : 790-795.
- Ananda, N., Kotikal, Y.K. and Balikai, R.A. 2009b. Sucking insect and mite pests of pomegranate and their natural enemies. *Karnataka J. Agric. Sci.*, **22**(4) : 781-783.
- Annemiek Schielder. 2008. Effect of water pH on the stability of pesticides. Michigan state Univ. Extn. Dept. of plant pathology-March 18, 2008, <https://extension.msu.edu>.
- Anonymous, 2019. NHB 2nd advance estimate of area and production of horticultural crops.ppl.
- Anonymous, 2020. Proceeding of Joint Agresco Research and Development committee-2020 held online at Dr.P.D.K.V. Akola held on 27-31 Oct 2020 approved recommendation on proposal on Bioefficacy of Cyantraniliprole against pest complex on pomegranate.Technical session -VI Gr.No. 2 pp. 46-49.
- Anonymus, 2013. DuPont™ Benevia® insecticide. *The Miracles Sci*.
- Appala Raju, K., Patil, C.S., Kulkarni, S.R., Kulkarni, S.S., Walunj, A.R. and Deore, B.V. 2021. Bio-efficacy of newer insecticides against pomegranate aphid, *Aphis punicae*. *J. Pharma. Phytochem*, **10**(1): 2685-2688.
- Aviram Michael and Dornfeld Leslie. 2001. Pomegranate juice consumption inhibits serum angiotensin converting enzyme activity and reduces systolic blood pressure. *Atherosclerosis*. **158** : 195-198.
- Balikai, R.A., Kotikal, Y.K. and Prasanna, P.M. 2011. Status of pomegranate pests and their management strategies in India. *Acta Horti.*, **890** : 569-583.
- Bhuvanewari, V. and Krishnam Raj, S. 2013. Compatibility of fungicides and insecticides targeting sheath blight and major rice pests. *J. Rice Res. Dev.*, **6**(2) : 15-18.

- Bo Cui, Lei Feng¹ and Zhenzhong Pan. 2015. Evaluation of Stability and Biological Activity of Solid Nanodispersion of Lambda-Cyhalothrin. *PLoS One* **10**(8) : journal. pone.0135953.
- Burt, A. and Karr, D. 2008. DuPont and Syngenta enter into crop protection technology exchange, <http://News080624.en.pdf>.
- Dongarjal, R.P., Ilyas, M.D. and Shendge, S.A. 2018. Bioefficacy of newer insecticides on aphids of pomegranate. *J. Entomol. Zool. Stud.*, **6**(3): 1729-1732
- Elanchezhian, J., Regupathy, A. and Krishnamoorthy, S.V. 2008. Bio-efficacy of Lambda Cyhalothrin against *Nliaparvata lugens* (Stal.) and Safety to Green Mirid Bug. *Ann. Plant Prot. Sci.*, **16**(2) : 325-328.
- Farag Malhat and Nagla M. Loutfly. 2016. Dissipation pattern and risk assessment of the synthetic pyrethroid Lambda-cyhalothrin applied on tomatoes under dryland conditions, a case study. *Int. J. Food Contam.*, **3** : 8.
- Finlayson, D.G. 1969. Effectiveness and compatibility of fungicides, insecticides and starter solutions applied jointly to cauliflower. *Can. J. Plant Sci.*, **49** : 39-47.
- Jadhao, P.B., Kadam, D.R., Kangale, G.K. and Jadhav, R.D. 2019. Pomegranate aphid management with insecticides. *J. Entomol. Zool. Stud.*, **7**(1) : 750-753.
- Jagginavar, S., Krishna Naik and Karabantanal, G. 2018. Bioefficacy and phytotoxicity of alanto 240 SC against thrips and natural enemies in pomegranate. *Int. J. Curr. Microbiol. Appl. Sci.*, **7**(8) : 1598-1602.
- Joshi, M., Gaur, N. and Pandey, R. 2018. Compatibility of entomopathogenic fungi *Beauveria bassiana* and *Metarhizium anisopliae* with selective pesticides. *J. Entomol. Zool. Stud.*, **6**(4) : 867-872
- Kadam, D.R., Kale, V.D. and Deore, V.D. 2012. Bioefficacy of insecticides against thrips infesting pomegranate fruits. *Int. J. Plant Prot.* **40**(2): 146-147.
- Kalaiselvi, R., Ayyappan Regupathy and Krishnamoorthy, S.V. 2007. Compatibility of Lambda-Cyhalothrin 5 CS with Nutrients and Biocontrol Agents in Cotton. *The World Cotton Research Conference-4* (September 10-14, 2007).

- Kambrekar, D.N. and Biradar, A.P. 2015. Field efficacy of insecticides in the management of pomegranate aphid, *Aphis punicae* (Passerini). *Acta Hort.*, 1089.
- Kambrekar, D.N., Biradar, A.P. and Kalaghatagi, S.B. 2013. Management of pomegranate aphid, *Aphis punicae* (Passerini) with new insecticides. *Indian J. Entmol.*, **75**(1) : 57-61.
- Khan, I., Khan, S.A., Hussain, S., Maula, F., Shah, H.A., Iqbal, T. and Khan, A. 2017. To study the infestation level and effective chemical control of pomegranate fruit borer (*Virachola isocrates*). *J. Entomol. Zool. Stud.*, **5**(1) : 282-284.
- Khandare, R.Y., Kadam, D.R. and Jayewar, N.E. 2020. Bio-efficacy of newer insecticides against pomegranate thrips, *Scirtothrips dorsalis* Hood in Hasta bahar. *J. Entomol. Zool. Stud.*, **8**(5) : 1571-1573.
- Kotikal, Y.K., Ananda, N. and Balikai, R.A. 2009. Seasonal incidence of major sucking pests of pomegranate and their relation with weather parameters in India. In 2nd International Conference on Pomegranate and Minor Including Mediterranean Fruits, 23-27 June 2009, UAS, Dharwad-Karnataka (India). pp.151.
- Lad, R.H., Walunj, A.R., Pokharkar, D.S. and Patil, C.S. 2018. Bioefficacy of new insecticide molecule cyantranilprole 10.26 % OD against pests of pomegranate. *AGRES- Int. e. Journal.* **7**(2) : 180-186.
- Lakshminarayana, M. and Subbaratnam, G.V. 2000. Laboratory studies on compatibility of certain organo-phosphorous insecticides with mancozeb. *J. Res. ANGRAU.* **28**(1-2) : 78-81.
- Lanskya, E.P. and Newman, R.A. 2006. *Punica granatum* (pomegranate) and its potential for prevention and treatment of inflammation and cancer. *J. Ethnopharmacol.* **109**(2) : 177-206.
- Leila Lucia Fritz and Elvis Arden Heinrichs. 2013. Impact of lambda-cyhalothrin on arthropod natural enemy populations in irrigated rice fields in southern Brazil. *Int. J. Trop. Insect Sci.*, **33**(3) : 178-187.

- Misra, H.P. 2015. Cyantraniliprole (cyazypyr) – a new anthranilic diamide insecticide against tomato fruit borer, *Helicoverpa armigera*. *Indian J. Pl. Prot.*, **43**(1) : 1-5.
- Muthiati, C., Valluvaparidesan, V. and Hussain, H.S.J. 1991. Combined effect of insecticides and fungicides on groundnut pests. *Groundnut News*. **3**(1) : 7-8.
- Nicresse, L., Guedegba Ibrahim., Imorou Toko and Prudencio T. Agbohessi, 2019. Comparative acute toxicity of two phytosanitary molecules, lambda-cyhalothrin and acetamiprid, on Nile Tilapia (*Oreochromis niloticus*) juveniles. *J. Environ. Sci. Health B.*, **54**(7) : 580-589.
- Patel, R.D., Bharpoda, T.M., Patel, N.B. and Borad, P.K. 2014. Bio-efficacy of cyantraniliprole 10 % OD - ananthranilic diamide insecticide against sucking pests of cotton. *The Bioscan*. **9**(1) : 89-92.
- Patel, R.D., Bharpoda, T.M., Patel, N.B. and Borad, P.K. 2015. Cyantraniliprole 10 OD : a second generation anthranilic diamide insecticide and its safety to natural enemies in cotton ecosystem. *Indian J. Pl. Prot.*, **43**(3) : 290-293.
- Patra, Biswajit, Alam, S.K., Samanta, A. and Chatterji Moulita. 2015. Bioefficacy of Lambda Cyhalothrin 4.9 CS against chilli thrips and fruit borers. *The Bioscan.*, **10**(3) : 1367-1370.
- Prakash Reddy, K. 1984. Studies on the compatibility of synthetic pyrethroids with some common fungicides. M.Sc. (Agri.) thesis, ANGRAU, Hyderabad.
- Rabee Ali, 2018. Compatibility and Synergism of Certain Insecticides for Control of Thrips (*Thrips tabacia*) on Onion (*Allium cepa* L.) Plants in the Field. *J. Plant Prot. Path., Mansoura Univ.*, **9**(10) : 663-666.
- Raymond A. Cloyd. 2015. Effect of water and spray solution pH on pesticide activity. *Kansas State Univ.*, MF 3272 December 2015, www.ksre.ksu.edu.
- Sain, S.K., Monga, D., Kumar, R., Nagrale, D.T., Hiremani, N.S. and Kranthi, S. 2019. Compatibility of entomopathogenic fungi with insecticides and their efficacy for IPM of *Bemisia tabaci* in cotton. *J. Pestic. Sci.*, **44**(2) : 97-105.

- Sanghamithra, S., Vinothkumar, B., Muthukrishnan, N. and Manoharan, T. 2018. Evaluation of bioefficacy of flubendiamide 24 % W/V + thiacloprid 24 % SC W/V against shoot and fruit borer and its sucking pest and its safety to non-target organisms in brinjal. *J. Entomol. Zool. Stud.*, **6**(1) : 245-249.
- Schenck, N.C. and Adlerz, W.C. 1963. Compatibility of insecticides, fungicides and foliar fertilizers on watermelon. Florida Agricultural Experiment Stations J. Sr. No., 1579.
- Siddartha, D., Revanna Revannavar and Sanjeev Duradundi, 2014. Compatibility of selected insecticides with fungicide Saaf (mancozeb + carbendazim) against Diamondback moth, *Plutella xylostella*. *IJAPBC*. **3**(1): 2277 – 4688.
- Singh Beant and Kaur Jaspal. 2017. Compatibility of different pesticides used for aphid and stripe rust control in wheat. *J. Wheat Res.*, **9**(1): 54-59.
- Sreedevi, K. and Abraham Verghese. 2007. Seasonal incidence of aphid, *Aphis punicae* Passerini (homoptera: aphididae) and its relationship with abiotic factors. *Pest Manag. Hort. Ecosyst.*, **13**(2) : 165-171.
- Stephen P. Foster, Ian Deholm, JeanLuc Rison, Hector E. Portillo, John Margaritopoulos and Russell Slater. 2012. Susceptibility of standard clones and European field population of the green peach aphid, *Myzus persicae* and the cotton aphid, *Aphis gossypii* (Hemiptera: Aphididae) to the novel anthranilic diamide insecticide cyantraniliprole. *Pest Manag. Sci.*, **68**(4) : 629-633.
- Suneel Kumar, G.V. 2018. Evaluation of compatibility of insecticides with fungicides on lepidopterous pests and tikka leaf spot of groundnut. *Indian J. Entomol.*, **80**(4) : 1436-1441.
- Suneel Kumar, G.V., Satish, Y. and Sarada, O. 2016. Evaluation of new insecticide and fungicide for compatibility and management of defoliators and late leaf spot of groundnut. *Int. J. Plant Animal Env. Sci.* **6**(1) : 58-65.
- Thangavel, K., Murali Baskaran, R.K. and Suresh, K. 2018. Field Efficacy of Ready Mix Formulation, Alike 247 ZC (Thiamethoxam 12.6 % + Lambda Cyhalothrin 9.5%) against Major Pests on Onion. *Ann. Plant Prot. Sci.*, **26**(1) : 16-20.

- Vasundara, P., Rangaswamy, V. and Johnson, M. 2015. Compatibility studies with fungicides, insecticides and their combinations on *Trichoderma viridae* in vitro conditions. *Int. J. Res. Sci. Eng.* **6**(2) : 229-234.
- Vinothkumar, B., Sangamitra., S. Shanmugapriya, R., Muthukrishnan, N. and Kuttalam, S. 2019. Field evaluation of thiacloprid 240 SC against thrips, *Scirtothrips dorsalis* in pomegranate. *Madras Agric. J.*, **106**(7-9) : 528-532.
- Vinothkumar, B.N., Boomathi, N. Kumaran and Kuttulam, S. 2010. Combination of Flubendiamide + Thiacloprid 480 SC (RM) against bollworms and sucking pest of cotton. *Madras Agric. J.*, **97**(4-6) : 157-160.
- Visalakshmi, V., Raju, M.R.B., Upendra Rao, A., Madhu Kumar, K., Hari Satyanarayana, N. 2016. Compatibility and Efficacy of Insecticide and Fungicide Combinations on Major Pests and Sheath Blight of Paddy. *Inter. Quart. Sci. J.*, **15**(1) : 233-235.
- Walunj, A.R., Supe, V.S. and Joshi, V.R. 2015. A new molecule, Cyazypyr 10 % OD against thrips and whitefly in pomegranate. *AGRES-Int. e-J.*, **4**(1): 84-86.
- Walunj, A.R., Supe, V.S. and Joshi, V.R. 2015. Efficacy of tolfenpyrad 15 % EC against thrips (*Scirtothrips dorsalis*) on pomegranate. *AGRES-Int. e-J.*, **4**(1): 19-24.
- Yadav, D.S., Kamte, A.S. and Jadhav, R.S. 2012. Evaluation of cyantraniliprole for thrips and red spider mite management in table grapes. *Pesti. Res. J.*, **24**(2) : 217-222.
- Yaligar Raghavendra, Kapasi Mahantesh and Baskar Kathirvelu. 2016. Bio-Efficacy of Cyantraniliprole against insect pests of brinjal. *Int. J. Agric. Sci.*, **8**(15) : 1275-1280.

6. VITAE

Mr. Solankar Rahul Dajiram

Candidate for the degree
of

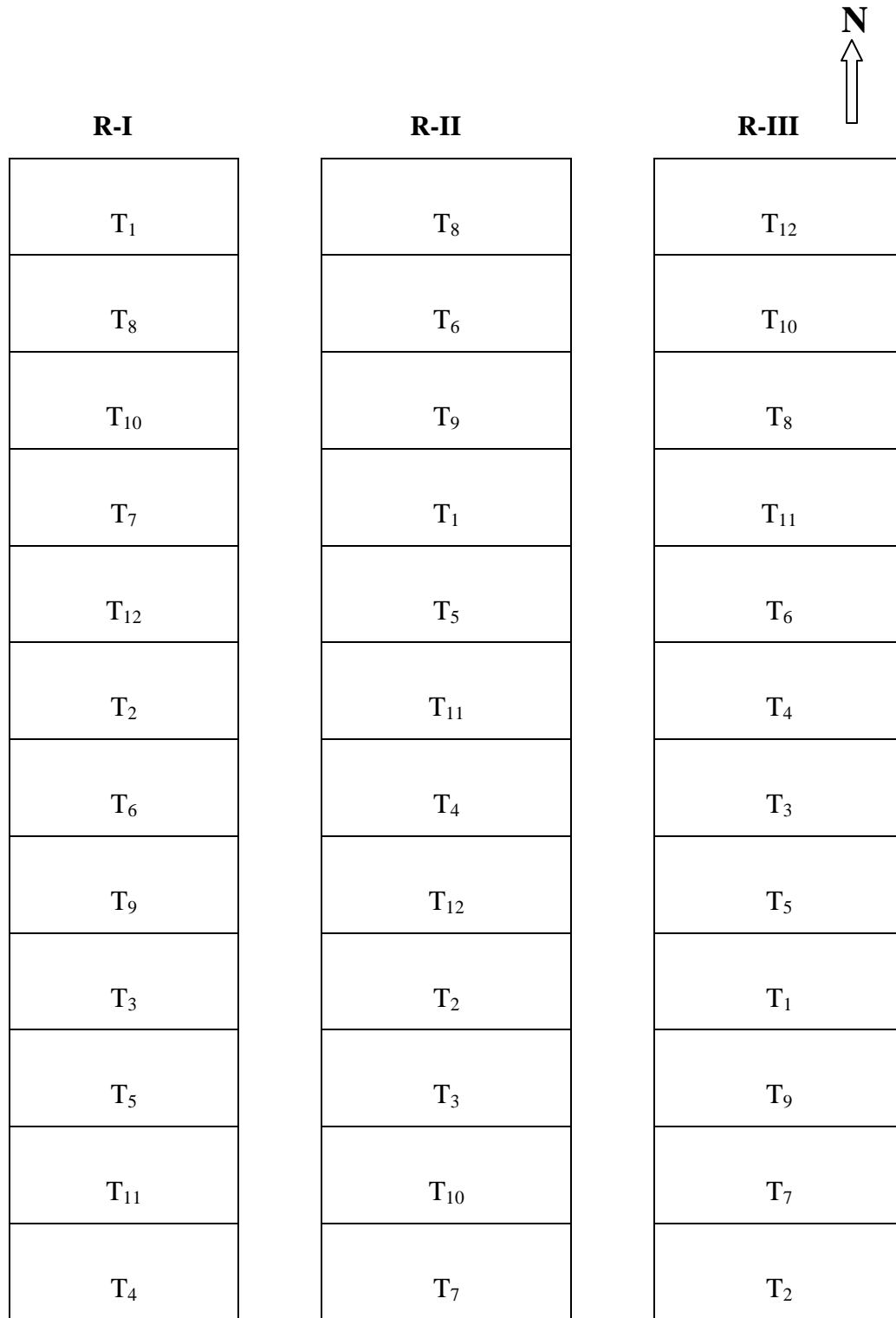
MASTER OF SCIENCE (AGRICULTURE)

in

AGRICULTURAL ENTOMOLOGY

2021

Title of Thesis		:	“Bioefficacy of Different Insecticides Against Sucking Pests of Pomegranate”
Major field		:	Agricultural Entomology
Biographical information		:	
Personal	Date of Birth	:	13 April, 1997
	Place of Birth	:	At. Sulewadi Post. Piliv, Tal. Malshiras, Dist. Solapur.
	Father's Name	:	Mr. Dajiram Sambha Solankar.
	Mother's Name	:	Mrs. Uma Dajiram Solankar.
Educational	Bachelor Degree Obtained	:	Received B.Sc. (Agri.) degree from College of Agriculture, Pune. in 2019.
	Class	:	First class with 8.29 CGPA.
	Name of University	:	Mahatma Phule Krishi Vidyapeeth, Rahuri
Address		:	At. Sulewadi, Post. Piliv, Tal. Malshiras, Dist. Solapur, Pin : 413 310 (M.S.)
	Email-id	:	rahuldsolankar@gmail.com
	Contact Number	:	9545740517



Design : Randomized Block Design

Fig. 1. Layout of the experiment



Plate: 1. General view of experimental field.



Plate: 2. Thrips infestation and its symptoms



Plate: 3. Aphid infestation and its symptoms.



Plate: 4. Preparation of treatment solution and its spraying in field



Plate. 5. Study of compatibility of insecticide of insecticide with fungicide and water soluble fertilizer in laboratory

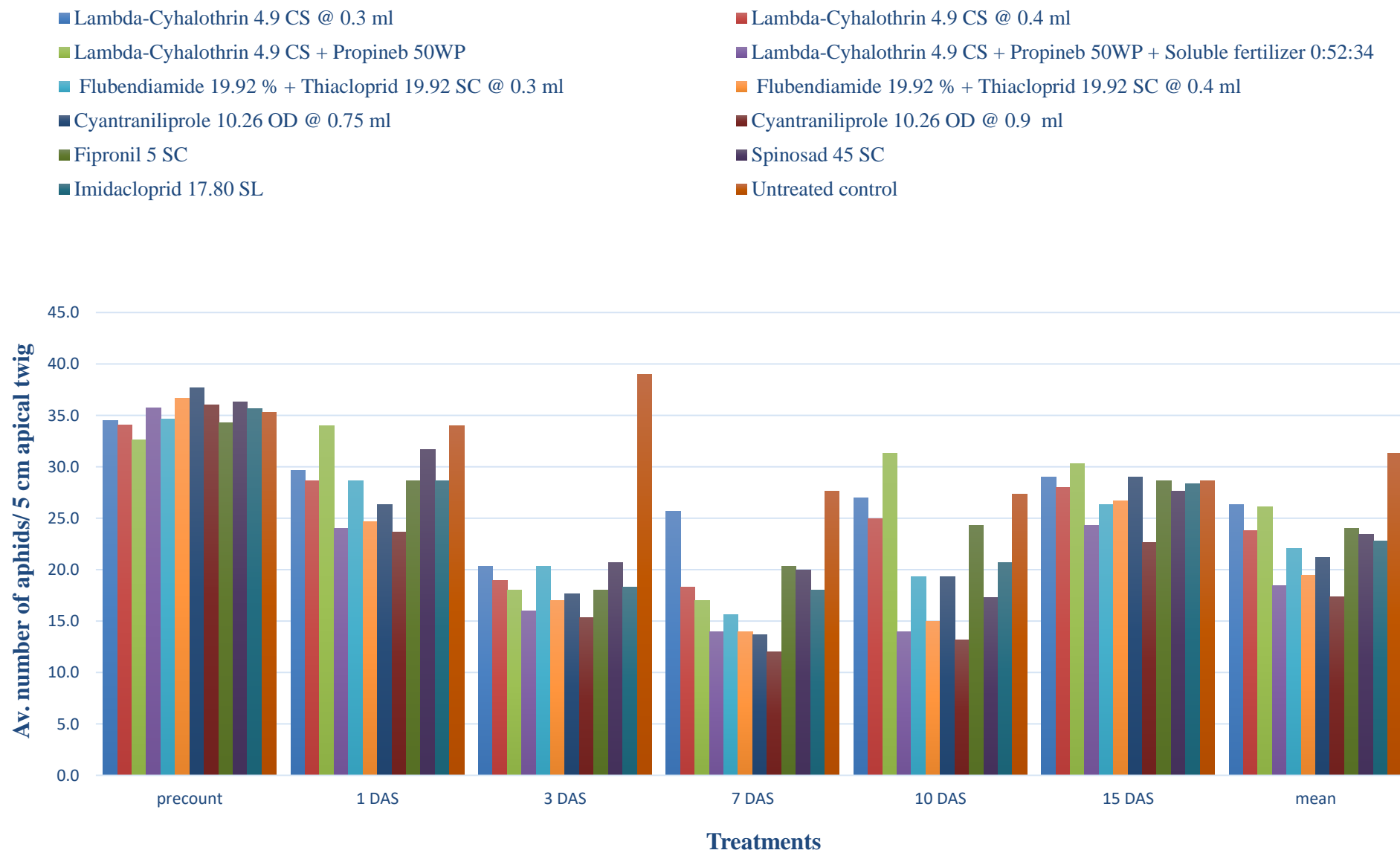


Fig. 2. Bioefficacy of new insecticide molecules against aphids on pomegranate after 1st spray.

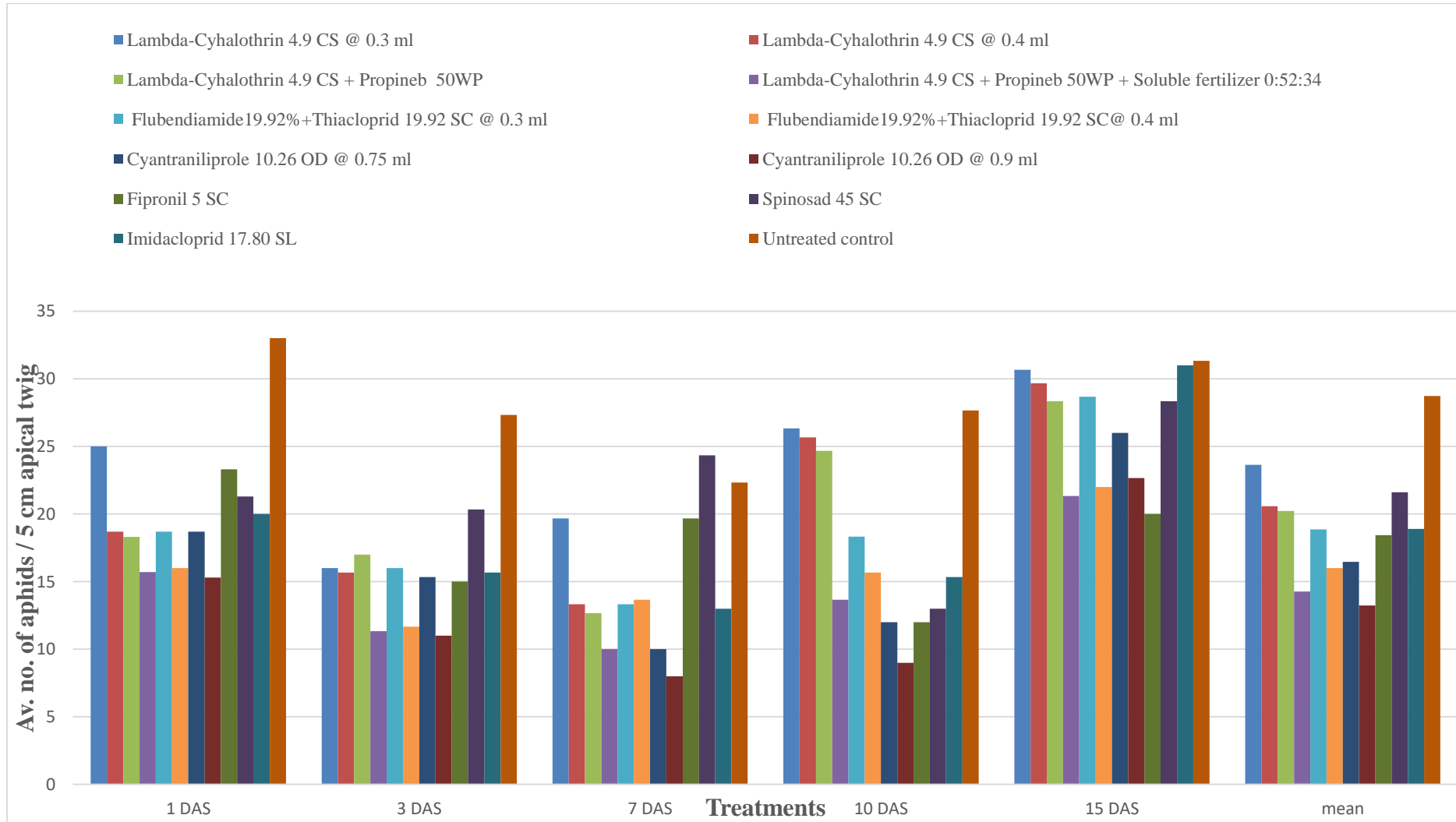


Fig. 3. Bioefficacy of new insecticide molecules against aphids on pomegranate after 2nd spray.

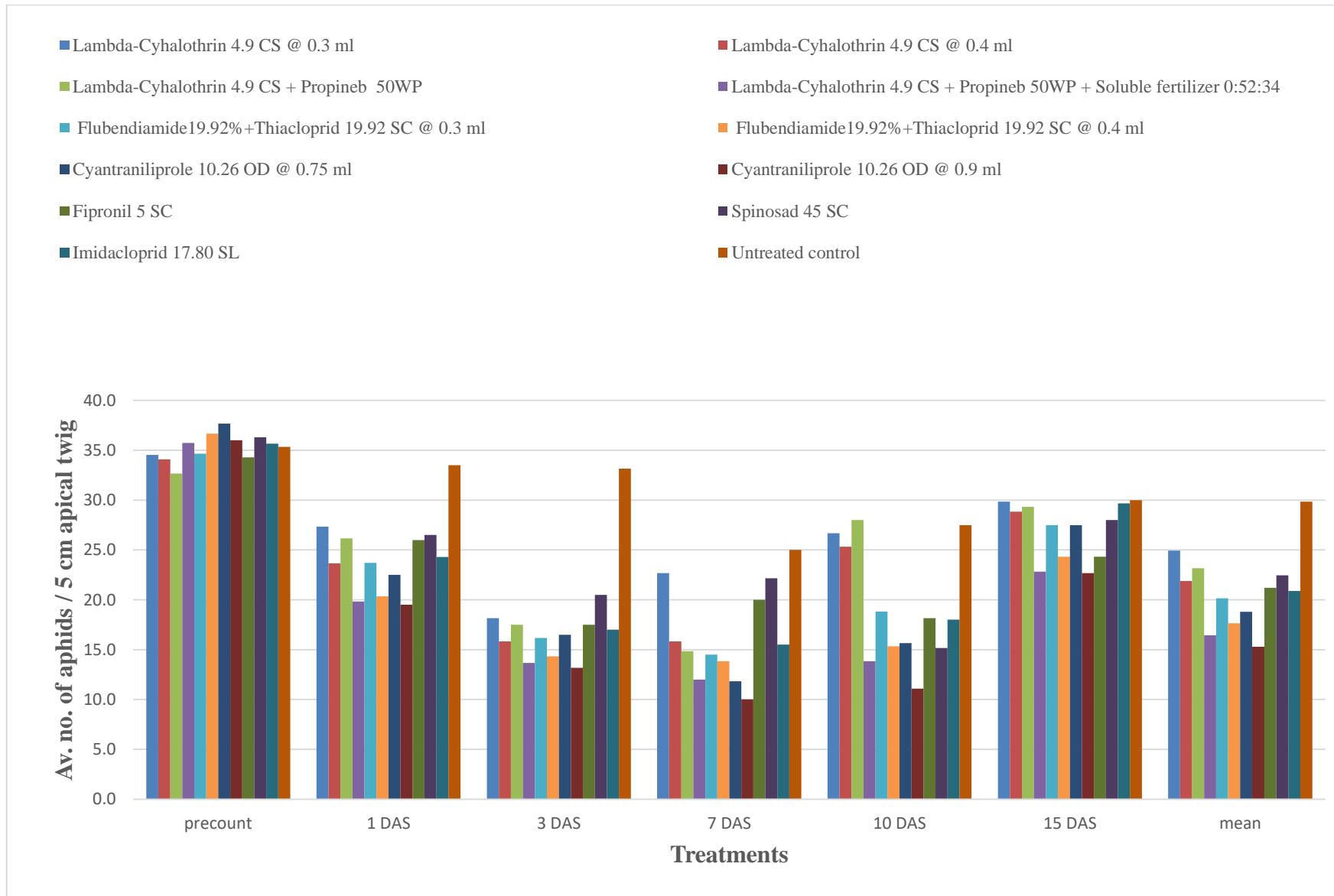


Fig. 4. Bioefficacy of new insecticide molecules against aphids on pomegranate (Pooled)

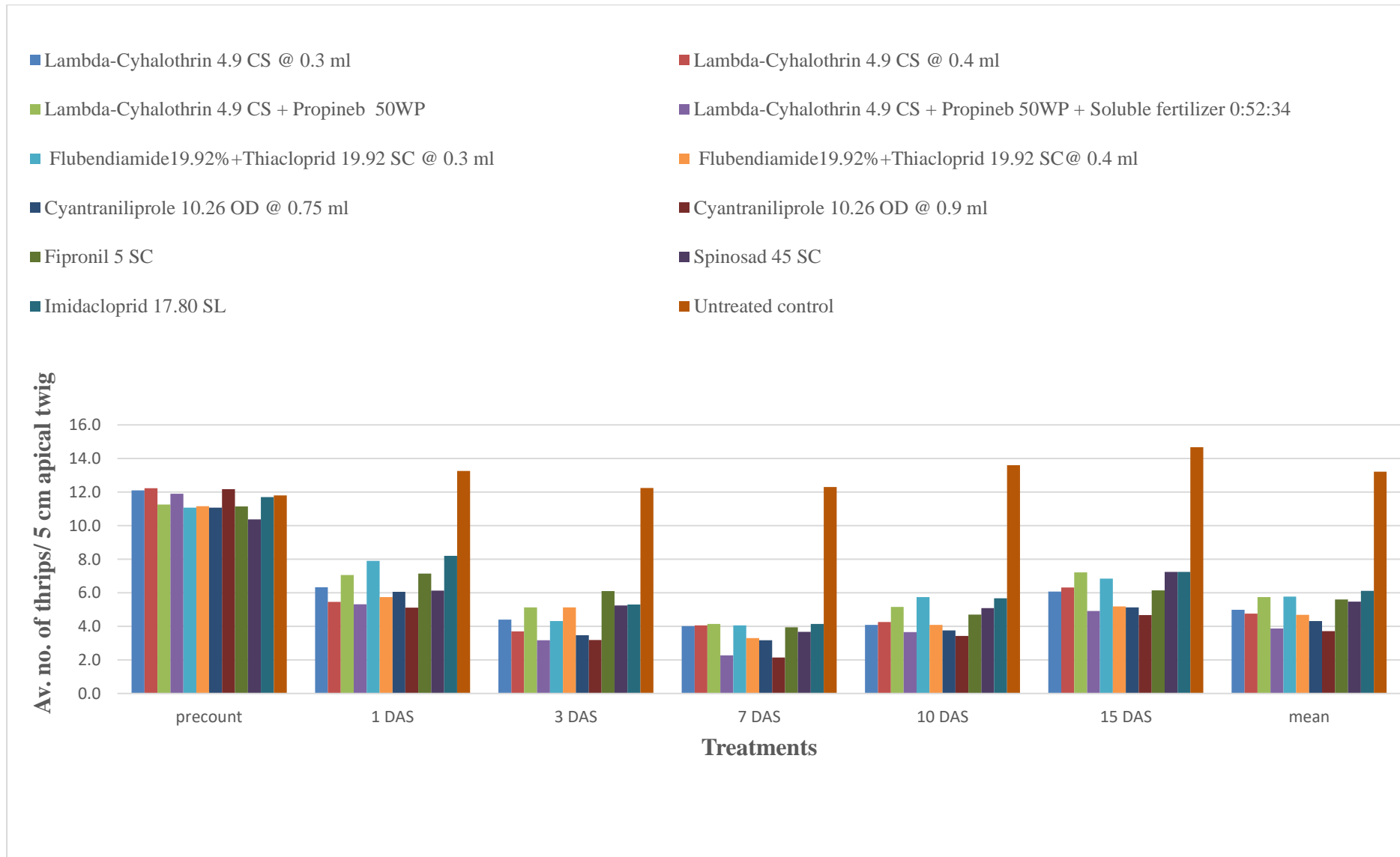


Fig. 5 Bioefficacy of new insecticide molecules against thrips on pomegranate after 1st spray.

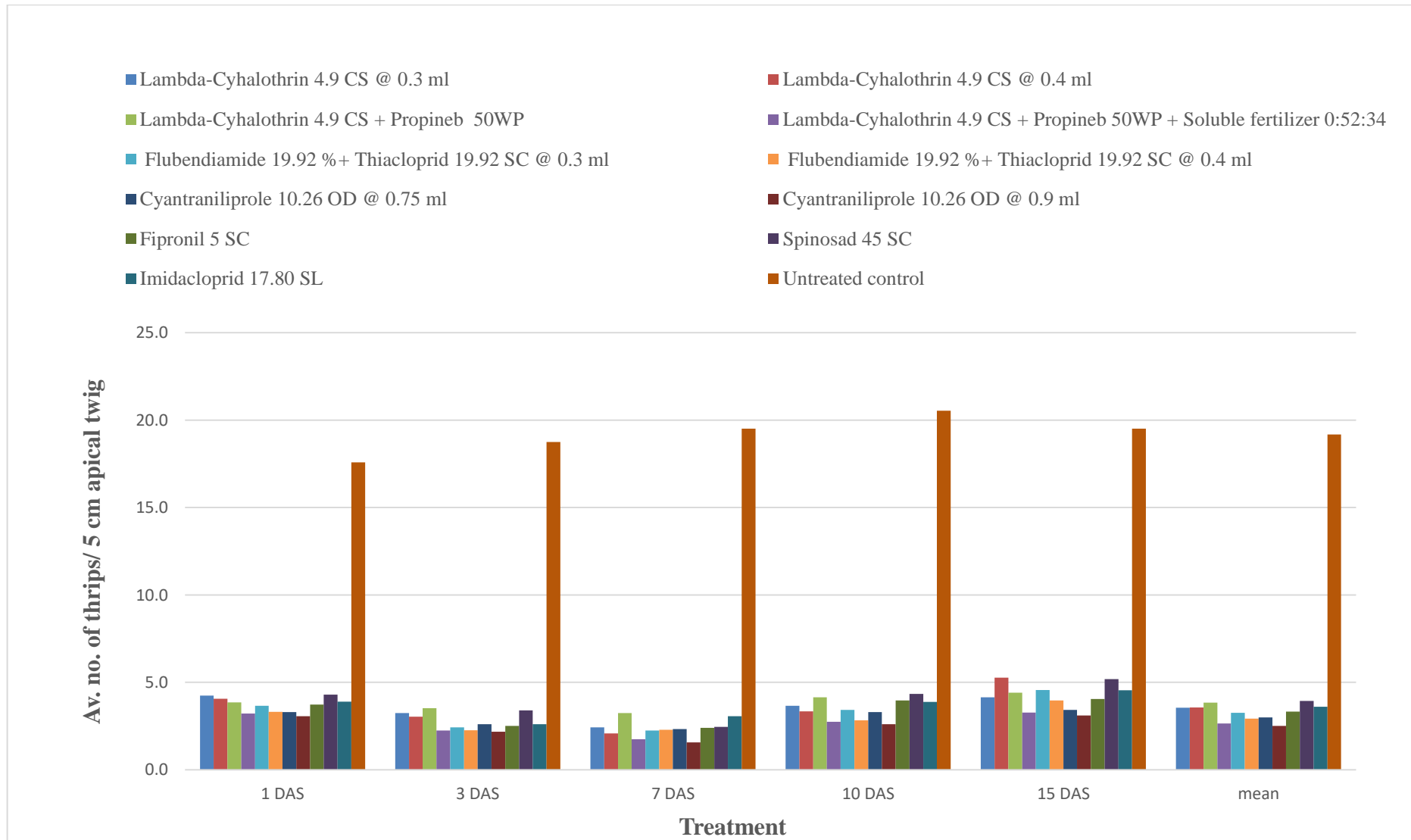


Fig. 6. Bioefficacy of new insecticide molecules against thrips on pomegranate after 2nd spray.

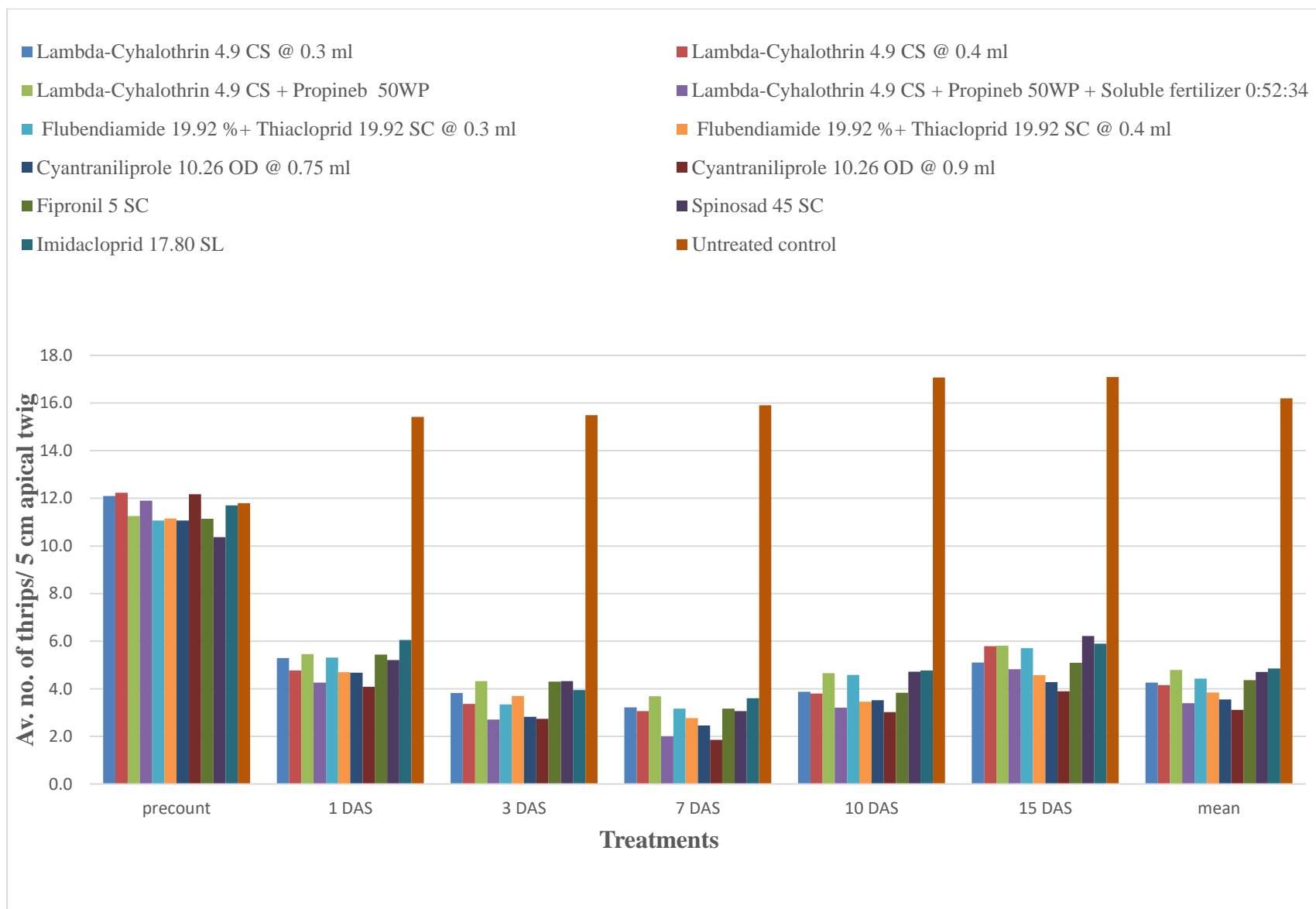


Fig. 7. Bioefficacy of new insecticide molecules against thrips on pomegranate (Pooled)

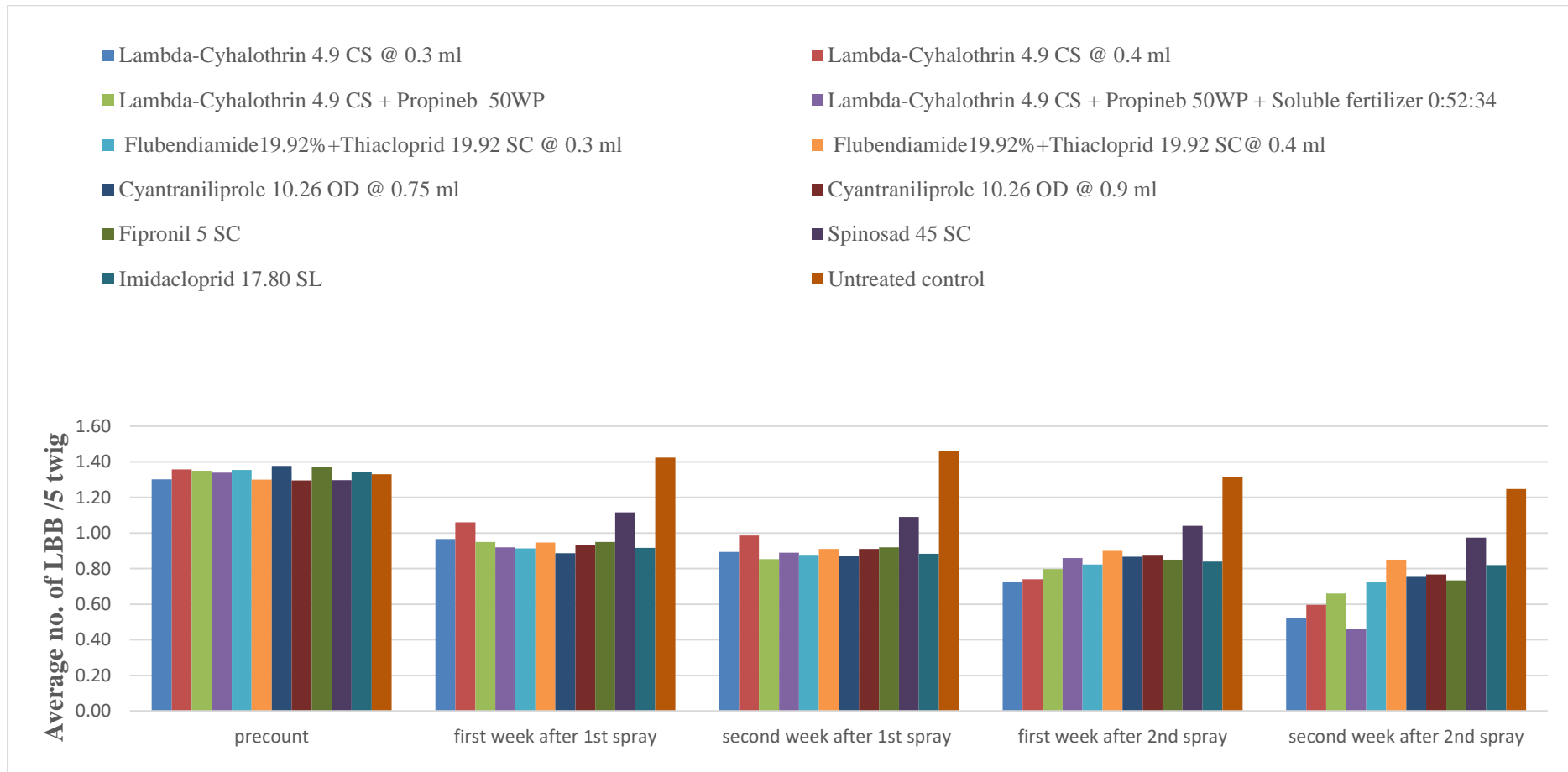


Fig. 8. Effect of different treatments on lady bird beetle after spraying on pomegranate.

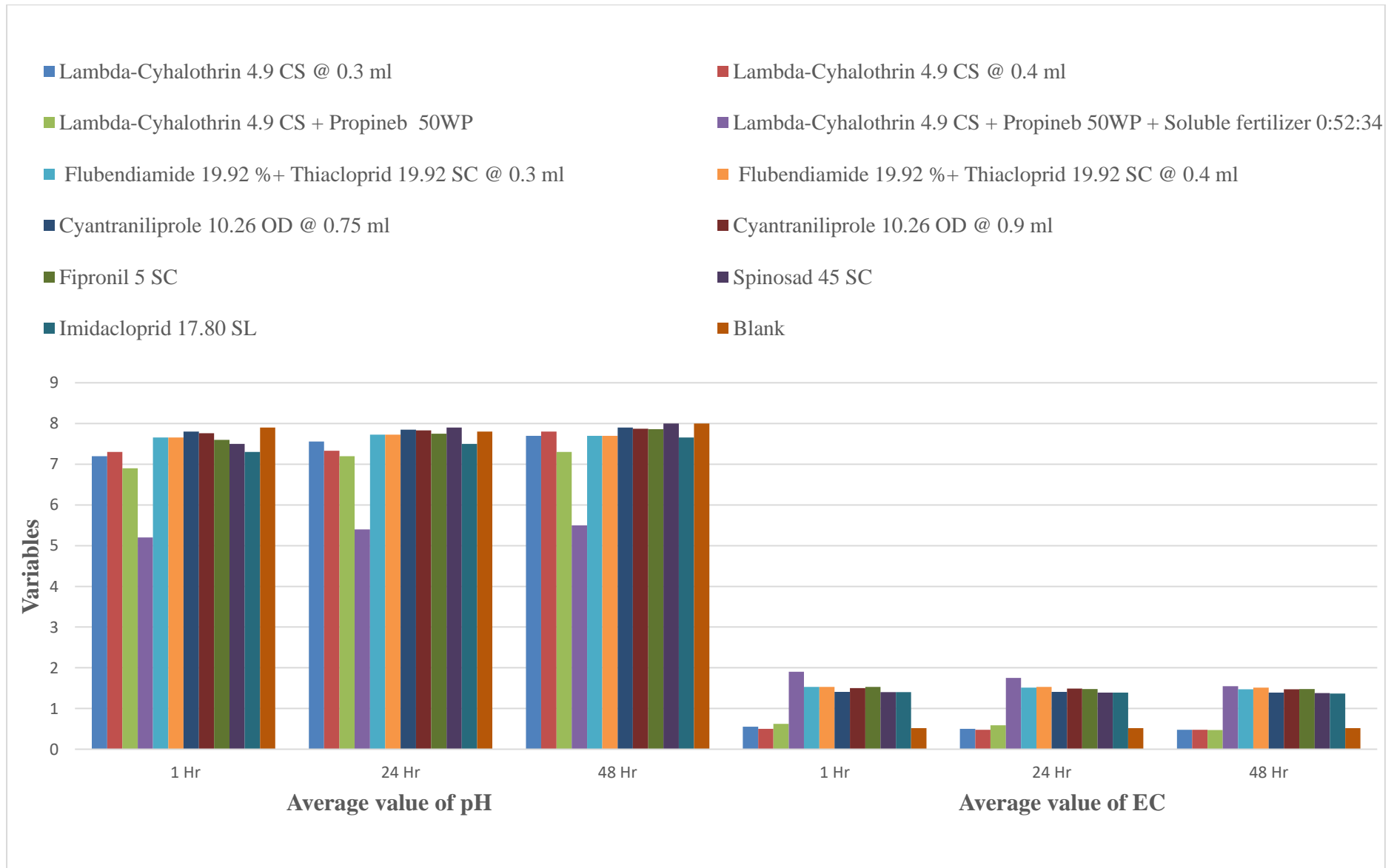


Fig. 9 Effect of different in secticide treatments in spray solution mixture on pH and EC.