‘‘BIOEFFICACY AND COMPATIBILITY OF NEW INSECTICIDE MOLECULE WITH FUNGICIDES AND WATER SOLUBLE FERTILIZER AGAINST PEST OF POMEGRANATE.’’

by

Mr. Lad Rahul Harishchandra

(Reg. No. 15/153)

A Thesis submitted to the

MAHATMA PHULE KRISHI VIDYAPEETH
RAHURI - 413 722, DIST. AHMEDNAGAR
MAHARASHTRA, INDIA

In partial fulfilment of the requirements for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRICULTURAL ENTOMOLOGY

DEPARTMENT OF AGRICULTURAL ENTOMOLOGY
POST GRADUATE INSTITUTE
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2018

CANDIDATE'S DECLARATION

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

Place: MPKV, Rahuri. **(Lad R. H.)**

Date: / / 2018

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CERTIFICATE

This is to certify that the thesis entitled, **"BIOEFFICACY AND COMPATIBILITY OF NEW INSECTICIDE MOLECULE WITH FUNGICIDES AND WATER SOLUBLE FERTILIZER AGAINST PEST OF POMEGRANATE."** submitted to the Faculty of Agriculture, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist- Ahmednagar, Maharashtra, India, in partial fulfillment of the requirement for the award of the degree of **MASTER OF SCIENCE (AGRICULTURE)** in **AGRICULTURAL ENTOMOLOGY,** is a record of bonafide research work carried out by **Mr. LAD RAHUL HARISHCHANDRA,** under my guidance and supervision and no part of the thesis has been submitted for any other degree or diploma.

Place: MPKV, Rahuri. **(A. R. WALUNJ)**

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Place : MPKV, Rahuri (R. H. Lad)
Dated : / /2017

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ABBREVIATIONS

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
et al.	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	Ralative humidity
WP	Wettable powder
WDG	Water Dispersible Granules
S.E.	Standard Error
sp./spp.	Specie (s)
T	Tonne (s)
viz.,	Uidelicet (Namely)
w/w	Weight by weight
%	Per cent
/	Per
@	at the rate of
+, -	Plus, minus

ABSTRACT

"BIOEFFICACY AND COMPATIBILITY OF NEW INSECTICIDE MOLECULE WITH FUNGICIDES AND WATER SOLUBLE FERTILIZER AGAINST PESTS OF POMEGRANATE"

by

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A candidate for the Degree
of
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Research Guide	:	**Dr. A. R. WALUNJ**
Department	:	**Agricultural Entomology**

Present research work on "Bioefficacy and compatibility of new insecticide molecule with fungicides and water soluble fertilizer against pests of pomegranate" was conducted during "*ambia*" bahar of 2016-17 at All India coordinated research Project on Arid zone Fruit, Department of Horticulture, M.P.K.V., Rahuri (M.S.). The field experiment was conducted to assess the bio-efficacy of new insecticide molecules with the fungicides and soluble fertilizers against the pest complex infesting pomegranate *viz.*, aphids, thrips and fruit borer of pomegranate with nine treatments including untreated control.

All the treatments were found significantly superior in controlling sucking pests (i.e. aphids and thrips) and fruit

borer over untreated control during the period of experimentation.

Among the different treatment, it was the evident that the combination treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (0:52:34) 5 g per lit water) was found most effective and compatible for the control of aphids and thrips and recorded least average survived aphids (i.e. 2.68 to 4.73 aphids and 1.89 to 4.10 thrips per 5 cm twigs) as against (14.80 to 16.10 and 14.73 to 18.27 per 5 cm twigs) in untreated control during the period of experimentation, respectively. Whereas, the combination treatment of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with soluble fertilizer (0:52:34) 5 g per lit water) was also found equally effective and compatible for the control of aphids, thrips and fruit borer and recorded least average survived pest population and least per cent fruit borer damage. These treatment also found safe to natural enemies.

The combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (0:52:34) 5 g per lit water) was found significantly superior for the control of fruit borer and recorded least average 1.17 per cent fruit damage as against 10.77 per cent fruit damage in untreated control at harvest, with gaining highest marketable yield 19.7 kg per plant (14.57 t/ha) of pomegranate fruit and the treatment of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50WP 1 g with water soluble fertilizer (0:52:34) 5 g per lit. of water) was found next best treatment in registering the least fruit damage i.e. 2.05 per cent damage, with gaining highest marketable yield 18.92 kg per plant (14.00 t/ha) of pomegranate fruit as against 12.00 kg per plant (8.88 t/ha) in untreated control.

As regards the compatibility tests, it was the evident that all the treatments under investigation did not show any incompatibility regarding the discoloration, foaming effect and sedimentation at 1, 24 and 48 hrs. after preparation of spray fluid. 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 (1.483 to 1.393 mmhos) at 1 to 48 hrs.

However, it was clearly noticed that the treatment of cyantraniliprole 10.26 % OD in combination of fungicide i.e. (carbendazim and propineb) with soluble fertilizers (0:52:34) showed optimum pH in the range of 7.2 to 7.5 after 1 hr, same trend was found after 24 hr and 48 hr observation and found most compatible and effective for the control of pests.

None of the treatment with combination and alone showed any phytotoxicity or adverse effects of on leaf injury on tips and leaf surface, wilting, vein clearing, necrosis yellowing, flower bud and fruit setting on pomegranate crop during experimentation.

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1. INTRODUCTION

The pomegranate, *Punica granatum* L. belonging to family: Puniceae is a native of Iran and it is an ancient favourite table fruits of tropical and sub-tropical regions of the world. It has been widely cultivated throughout India. The fruit is symbolic of plenty and very much liked for its cool, refreshing juice and valued for its medicinal properties. Consumption of pomegranate juices which is rich in tannins and possess anti-atherosclerotic properties that could be related to its potent anti-oxidative characteristics and also reduces blood pressure (Aviram and Dornfeld, 2001).

All the parts of pomegranate tree have been utilized as sources of tannin for curing leather. The fruit juice, peel and oil have also been shown to possess anticancer activities, including interference with tumor cell proliferation, cell cycle, invasion and angiogenesis. The versatile adaptability, hardy nature, low maintenance cost, steady but high yields, better keeping quality, fine table and therapeutic values as well as possibilities to sustain the plant into rest period when irrigation potential is generally low, it showed the way for increasing the area under pomegranate in India.

India ranks first in area (1,93,000 ha) and production (21.98 MT) of pomegranate and average productivity was 11.39 t/ha during 2015-16 (Anonymous, 2017). In India, Maharashtra ranks first with an area of 1,28,650 ha and production of 11,97,710 MT contributing 69.91 per cent of the total area under pomegranate, followed by Karnataka (23,230 ha) and Gujrat (14,770 ha). However, the productivity of this crop in Maharashtra is 9.31 t/ha which is significantly low as compared to other pomegranate growing states like Andhra Pradesh (14.25 t/ha), Gujarat (11.62 t/ha) and Karnataka (11.27 t/ha) (Anonymous, 2015).

Export potential of this crop is attracting the farmers towards its cultivation. Presently, India produces ample quantity fruits and exports to United Arab Emirates, Saudi Arab, The Netherland, Nepal, Bangladesh, United Kingdom and other countries. The export trade from India is 23657.13 MT (worth 22498.45 US$) during year 2012-13 (Anonymous, 2013). Future demand for export quality pomegranate may certainly show increasing trend.

Such an important fruit crop is attacked by several insect and non-insect pests as well as diseases. About 91 insects, 6 mites and a snail pest found damaging pomegranate crop in India. The major pests observed during different fruiting season in pomegranate area are thrips (*Scirtothrips dorsalis* H.) and aphids (*Aphis punicae* P.) which cause serious damage by desapping and scaring the fruit rind that has resulted into threatened export quality of fruits. Moreover, the fruit borer (*Virachola isocrates* F.) recorded throughout the year in most part of India and causes 50 per cent loss in marketable yield (Balikai *et al.*, 2011).

Several earlier workers attempted the insecticides *viz.,* imidacloprid, emamectin benzoate, fipronil, spinosad, lambda-cyhalothrin and tolfenpyrad against thrips, aphids and fruit borer on pomegranate and these were found to be effective (Kadam *et al.,* 2012; Walunj *et al.*, 2015).

Furthermore, the use of combinations of various pesticides is being practiced by the growers especially in commercial agriculture and is widely followed by most of the professional fruit, flower and vegetable producers or growers. In pomegranate cultivation, the management of pests and diseases by employing insecticides mixed with fungicides and liquid fertilizers as well as growth regulators is common practice among the crop growers. The application of such pesticides separately requires huge labours, spraying equipments and vast quantity of water.

The knowledge about compatibility of agrochemicals is very vital in selecting the compatible combination for effective management of insect pests, diseases and weeds. The combined application of pesticides is a labor saving short-cut method, but an understanding and knowledge of pesticide compatibility is essential to avoid side effects viz., phytotoxicity, flowers/ buds/ fruits scorching as well as drops which may arise from combinations of some pesticides. Pesticide combinations may show physical, chemical or phytotoxic incompatibility causing undesirable results. When two or more pesticides are mixed together, the resultant loss or reduction of effectiveness of one or all components or deactivation of active ingredient often occurs. Chemical incompatibility is affected by temperature, pH of spray fluid and length of time the mixture is held before use. Hence, it is desirable to avoid tank mix combination for strongly acid and alkaline material which may result into chemical compatibility. The information on compatibility of different agrochemicals is meager but it is essential for adoption in field.

Keeping in view, the newly synthesized molecule cyantraniliprole, which is commercialized by DuPont from amide group having a label claim on pomegranate was tested against the pests like thrips, aphids and fruit borer on pomegranate. The cyantraniliprole is a second generation anthranilic diamide which is an exceptionally active class of insect control chemistry that selectively activates insect ryanodine receptors causing mortality from uncontrolled release of calcium ion stored in muscle cells (Thomas *et al.,* 2013).

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

1. To find out the effectiveness of cyantraniliprole 10.26% OD molecule against sucking pests and fruit borer on pomegranate.
2. To study the compatibility of insecticide with fungicides and soluble fertilizer.

2. REVIEW OF LITERATURE

An overview of the literature pertaining to the topic under study has been reviewed here under different heads:

2.1 Pest management of horticultural crops:

2.1.1 Fruit crops:

Verma *et al.* (1995) studied the incidence of *Drosicha isocrates* Fab. on pomegranate and observed the peak pest population of fruit borer in the second half of March to June. Besides pomegranate, the pest also attacked guava, aonla, oranges, etc.

Sreedevi and Verghese (2007) recorded the infestation of *Aphis punicae* Fab. from December to March, with peak in January and February and then it was declined after March.

Ananda *et al.* (2009) surveyed pomegranate orchards at fortnightly interval in and around Bagalkot and reported the association of 11 sucking insects and 2 mite pests. Among these 7 belonged to Homoptera, 1 Hemiptera, 3 Thysanoptera and 2 Acarine pests.

Ananda *et al.* (2009) conducted series of experiment for management of sucking pests of pomegranate and found that new generation insecticides *viz.* thiamethoxam 25 WG @ 0.2 g/l and imidacloprid 200 SL @ 0.25 ml/l were most effective in controlling aphids by reducing the incidence upto 85.90 and 83.54 per cent over control, respectively. These two treatments also supressed the population of thrips to the extent of 84.37 and 79.38 per cent, and white flies by 78.97 and 78.50 per cent, respectively. The combination of dimethoate 30 EC @ 1.7 ml/l and fish oil rosin soap @ 20 g/l proved to be effective against mealy bugs.

Kotikal *et al.* (2009) studied the incidence of major sucking pests of pomegranate and revealed that the peak activity of pomegranate aphids observed during the second fortnight of December. The highest infestation of thrips noticed in the second fortnight of March. The population density of whiteflies was maximum during second fortnight of February and first fortnight of March.

Balikai *et al.* (2011) recorded total of 91 insects, 6 mites and a snail pest feeding on pomegranate crop in India. The most obnoxious enemy was pomegranate butterfly, *D. isocrates* reported for more than 50 per cent fruits loss.

Kadam *et al.* (2012) evaluated 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 hector can be included in the insecticide spray schedule against thrips on this crop.

Yadav *et al.* (2012) evaluated the effectiveness of cyantraniliprole in comparison with recommended insecticides against flea beetle, *Scelodonta strigicollis* L. and caterpillar, *Spodoptera litura* Fab. in table grapes. In field experiments, the leaf damage reduction was noticed significantly higher in the vines treated with cyantraniliprole as compared to untreated check indicating antifeedant effects of cyantraniliprole at the rate of 80 g a.i. per ha that resulted in highest leaf damage reduction. It was however at par with cyantraniliprole, thiamethoxam and spinosad.

Yadav *et al.* (2012) studied the effectiveness of cyantraniliprole at different doses in comparison with recommended insecticides against thrips, *Scirtothrips dorsalis* F., *Rhipiphorothrips cruentatus* F. and red spider mite, *Tetranychus urticae* in table grapes. In field experiments, cyantraniliprole @ 70 g a.i. ha^{-1} found most effective and at par with higher dose of 80 g a.i. ha^{-1} as well as standard checks of spinosad and thiamethoxam. None of the tested doses of the cyantraniliprole were phytotoxic.

Tiwari *et al.* (2012) suggested that cyantraniliprole should be a valuable new tool for rotation into *D. citri* management programmes. It was much less toxic to *T. radiate* than to *D. citri* and thus may have less impact on biological control than other currently used broad spectrum insecticides, such as organophosphates and pyrethroid.

Kambrekar *et al.* (2013) evaluated new insecticides for the management of pomegranate aphid, *A. punicae*. The study revealed that thiamethoxam 25 WG @ 0.2 g/l recorded highest reduction in population followed by imidacloprid 70 WG @ 0.3 g/l. The trees sprayed with thiamethoxam (9105 kg/ha) and imidacloprid (9038 kg/ha) recorded highest quantity of marketable fruits. Thus, thiamethoxam and imidacloprid recorded highest gross returns, net returns and maximum B:C ratio.

Walunj *et al.* (2015) studied the efficacy of new insecticide cyantraniliprole 10.26 OD @ 60 g a.i. ha^{-1} in comparison with neonicotinoids and synthetic pyrethroids against thrips (*S. dorsalis*) infesting pomegranate variety Bhagwa during two consecutive years of the ambe bahar. The treatment of new chemistry molecule cyantraniliprole @ 60 g a.i. ha^{-1} showed significantly least survival of thrips and per cent fruit borer damage as against the untreated control.

Walunj *et al.* (2015) studied the efficacy of new insecticide tolfenpyrad 15 % EC in comparison with neonicotinoids and synthetic pyretrhroids against thrips (*S. dorsalis*) infesting pomegranate variety Bhagwa during the ambe bahar of 2011-12 and 2012-13. All the treatments were significantly superior over untreated control. The treatment of new chemistry molecule tolfenpyrad 15% EC at 150 g a.i. ha^{-1} showed significantly least survival of thrips on 5^{th} , 7^{th} and 10^{th} days after spray and resulting in least fruit scaring damage over rest of the treatment at the time harvest.

Kambrekar *et al.* (2015) evaluated emamectin benzoate 5 SG @ 0.25 g/l and spinosad 45 SC @ 0.20 ml/l have recorded highest reduction in the fruit damage, highest marketable fruit yield, gross and net returns with maximum B:C ratio, these can be effectively employed for the management of fruit borer in pomegranate.

Kambrekar and Biradar (2015) revealed that, among the different insecticide molecules, thiamethoxam 25 WG at 0.2 g/l recorded highest reduction 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 first and second spay, whereas during the second year, the reduction was to the extent of 91.19 and 93.42 %, respectively. Similarly, imidacloprid recorded 87.92 and 90.39 % reduction in aphid population after first and second sprays whereas during the second year it was 89.73 and 93.42 %. The trees sprayed with thiamethoxam (9105 kg/ha) and imidacloprid (9038 kg/ha) have recorded highest quantity of marketable pomegranate fruits. Thiamethoxam and imidacloprid recorded highest gross returns, net returns and maximum B:C ratio during both the years of investigation.

Abd-Ella (2015) studied the efficacy of emamectin benzoate and methoxyfenozide against pomegranate butterfly, *Virachola livia* Klug (Lepidoptera: Lycaenidae) in cultivated and reclaimed lands. He stated that the pomegranate trees under the treated field showed a significant control over the butterfly.

2.1.2 Vegetables:

Burt and Karr (2008) stated that cyantraniliprole (HGW86) 10% OD was found to be active against a broader spectrum of insects like lepidopterans and sucking insects.

Alana and George (2011) stated that, cyantraniliprole (cyazypyr) is an anthranilic diamide insecticide currently under development that exhibits anti-feedant properties. Transmission of TSWV by *Frankliniella fusca* Hinds. to *Capsicum annuum* L. seedlings was reduced in plants treated with cyazypyr applied to the soil at the rates of 1.45, 2.90 and 4.41 mg a.i./plant. Mortality of *F. fusca* H. at 3 days post treatment did not differ significantly on excised foliage of cyazypyr treated and control plants, but feeding injury was significantly less on treated foliage.

Mandal (2012) reported that cyazypyr 10% OD @ 90 and 100g a.i./ha was found highly effective in controlling the fruit borer, *H. armigera* in tomato.

Alana and George (2013) evaluated the effect of cyantraniliprole on feeding behaviour and virus transmission of *F.*

Fusca and *F. occidentalis* (Thysanoptera: Thripidae). Further, his study examines the effects of cyantraniliprole and imidacloprid on thrips feeding using electrical penetration graphing (EPG), and on TSWV transmission in field cage studies. Some anti-feedant responses were observed in the EPG studies, when thrips fed on cyantraniliprole and imidacloprid treated plants.

Misra (2015) evaluated the bioefficacy of a new anthranilicdiamide, cyantraniliprole (cyazypyr) against major sucking pest and *Helicoverpa armigera* Hubner infesting tomato, and its safety to the coccinellid predator.

Misra (2015) evaluated the bioefficacy of a new anthranilicdiamide insecticide, cyantraniliprole (cyazypyr) (HGW 86) 10% OD for its efficacy against the invasive serpentine leafminer, *Liriomyza trifolii* (Burgess) (Diptera: Agromyzidae) infesting gherkin (cucumber).

Rafael *et al.* (2015) evaluated the efficacy of cyantraniliprole for managing *Bemisia tabaci* (Gennadius) biotype B and in interfering with transmission of tomato yellow leaf curl virus (TYLCV) by this whitefly. Cyantraniliprole applied as soil treatments (200 SC) or foliar sprays (100 OD) provided excellent adult whitefly control.

Kodandaram *et al.* (2015) revealed the efficacy of cyantraniliprole a new anthranilic diamide insecticide against *Leucinodes orbonalis* (Lepidoptera: Crambidae) of brinjal and stated that the cyantraniliprole @ 105 g a.i. ha^{-1} was significantly most effective and recorded lowest per cent fruit damage of 8.92 and 8.25 with highest marketable fruit yield of 18.46 and 22.40 t ha^{-1}. The present findings indicate that among different diamide insecticides, cyantraniliprole @ 90-105 g a.i. ha^{-1} proved to be highly effective against brinjal shoot and fruit borer.

Yaligar *et al.* (2016) evaluated the efficacy of new anthranilic diamide, cyantraniliprole (cyazypyr) 10.26 % OD at different dosages for the management of insect pests of brinjal (*Solanum melongena* L.). The standard insecticides *viz.*, chlorantranilprole 18.5% SC, spinosad 45% SC and imidacloprid 17.8% SL were used for comparison. Overall, the field trial studies revealed that, cyantraniliprole 10.26 % w/w OD @ 90 g a.i/ha provided cross-spectrum control of insect pests as it registered lowest number of hoppers (0.26/leaf), whitefly (0.40/leaf), thrips (5.16/leaf) at 10 days after application and also recorded lowest percent fruit damage by shoot and fruit borer (1.09 %) and highest yield of 49.70 t/ha. Thus, studies indicated that cyantraniliprole 10.26 % w/w OD @ 90 g a.i./ha can be recommended in an integrated pest management programme (IPM) of brinjal for the management of insect pests and harnessing higher yield.

2.2 Pest management of other than horticultural crops:

Lahm *et al.* (2009) stated that diamide insecticides have emerged as one of the most promising new classes of insecticide chemistry owing to their excellent insecticidal efficacy specifically lepidopterans and high margins of mammalian safety. This chemistry has been confirmed to control insects via activation of ryanodine receptors which leads to uncontrolled calcium release in muscle. The high levels of mammalian safety are attributed to a strong selectivity for insect over mammalian receptors.

Stephen *et al.* (2012) revealed that cyantraniliprole is currently the only anthranilic diamide (IRAC MoA 28) insecticide targeting aphid species such as *Myzus persicae* and *Aphis gossypii* G. There is no evidence to suggest that the performance of this compound is affected by commonly occurring mechanisms that confer resistance to other insecticide chemistries. Cyantraniliprole is therefore a valuable tool for managing insecticide resistance in these globally important pests.

Rafael *et al.* (2013) revealed that susceptibility of field populations of *B. tabaci* to cyantraniliprole is more as compared to other insecticides and so is an essential component of a resistance management programme to ensure the continued viability of cyantraniliprole for *Bemesia tabaci* management.

Cameron *et al.* (2013) evaluated effect of three insecticides with different modes of action, cyantraniliprole (Benevia), imidacloprid, and spirotetramat on *B. Tabaci* was and compared to determine reduction in feeding. Results indicate that *B. Tabaci* nymphs feeding on a plant treated with benevia have a significant reduction of feeding when compared with nymphs feeding on plants treated with imidacloprid or spirotetramat. Both benevia and spirotetramat caused significant nymphal mortality by 48 h after exposure. This novel technique will be useful to demonstrate the feeding cessation or reduction in feeding produced by different insecticides in several sucking insect groups.

Luis and John (2013) confirmed that the diamides have a favourable ecotoxicological profile and are relatively safe to insect natural enemies. The spectrum of activity of the diamides is wide, chlorantraniliprole controls whitefly, leafminer, beetle and termite species in addition to Lepidopterans, while cyantraniliprole is effective in controlling a large number of lepidoptera, homoptera, coleoptera, diptera and thysanoptera species.

Rath *et al.* (2013) conducted field trials for the evaluation of the efficacy of a new molecule cyazypyr (HGW 86 10 % OD) against yellow stem borer and gall midge infesting rice and revealed that the test compound at 100 and 120 g a.i. ha^{-1} was highly effective in reducing stem borer incidence (71.01 to 88.80 % reduction over control during the period of study), whereas the compound exercised a moderate effect on gall midge (57.70 to 58.01 % reduction over control). The check insecticides like monocrotophos and triazophos were observed to be less effective than the test compound.

Thomas *et al.* (2013) stated that the anthranilic diamides are an exceptionally active class of insect control chemistry selectively that activates insect ryanodine receptors causing mortality from uncontrolled release of calcium ion stores in muscle cells. Work in this area led to the successful commercialization of chlorantriniliprole for control of Lepidoptera and other insect pests at very low application rates. In search of lower log p analogs with improved plant systemic properties, exploration of cyano-substituted anthranilic diamides culminated in the discovery of a second product candidate cyantraniliprole having excellent activity against a wide range of pests from multiple insect orders.

Cameron *et al.* (2014) showed a reduction due to treatment of cyantraniliprole in the amount of honeydew produced by *B. tabaci* adults were equivalent to imidacloprid. The reduction in the amount of honeydew produced indicates reduced insect feeding and the possibility for a reduction in virus transmission. Plant treatments with two formulations of cyantraniliprole also resulted in higher mortality of pests than imidacloprid.

Patel *et al.* (2014) evaluated 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 @ 75 g a.i. ha^{-1}) and endosulfan 35 EC (thiodan @ 350 g a.i. ha^{-1}) as standard checks against the cotton aphid, thrips and whitefly. The two higher doses of cyantraniliprole 10% OD *i.e.* 90 and 105 g a.i. ha^{-1} was found highly effective in managing the population of aphid, thrips and whitefly compared to endosulfan and indoxacarb. The seed cotton yield 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) studied the response of natural enemies to cyantraniliprole 10 % OD applied against insect pest of cotton. The population of coccinellids, green lacewings and spiders 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^{-1}) to these predators. Among the insecticides, the higher population of natural enemies was observed in plots treated with cyantraniliprole 10 OD.

Rafael *et al.* (2015) showed that cyantraniliprole (cyazypy) is the second insecticide in the new anthranilic diamide class with xylem systemic properties and a novel mode of action. Thiamethoxam is a neonicotinoid insecticide that is used to manage the pepper weevil (*Anthonomus eugenii* Cano). Results demonstrated that cyantraniliprole and thiamethoxam inhibited daily feeding. Both products appeared to suppress feeding damage of pepper weevils.

Bird (2016) determined baseline susceptibility of *H. armigera* to cyantraniliprole as its susceptibility among field strains was 9.3-fold in topical bioassays and 2.6-fold in ingestion bioassays. The median lethal concentration in field strains was 28 mg/litre in topical bioassays and 0.065 mg/litre in ingestion bioassays, demonstrating that cyantraniliprole was >400-fold more toxic when administered orally than by contact.

Xianyi Zeng *et al.* (2016) showed that the feeding data obtained from EPG analysis of the countprobes and number of short probes (<3 min) were significantly increased when aphids were exposed to LC30 of imidacloprid treated plants. In addition, the phloem-feeding behavior of *M. persicae* was significantly impaired on fed tobacco plants treated with cyantraniliprole and imidacloprid at LC30.

Ran Wang *et al.* (2017) studied the lethal effects of six neonicotinoid and two anthranilic diamide insecticides including the novel compound cyantraniliprole on *B. tabaci* MED were examined. The sublethal effects of cyantraniliprole on the physiology and behaviour of *B. tabaci* MED were also assessed. Among eight insecticides tested, cyantraniliprole was the most toxic to *B. tabaci* MED with a LC50 of 2.05 mg/L. The sublethal effects of cyantraniliprole to adult *B. tabaci* MED were observed at LC10 (0.22 mg/l) and LC25 (0.63 mg/l) concentrations. At these concentrations, cyantraniliprole prolonged the developmental duration and decreased the survival rate of nymph stages, pseudo pupae and adults. The oviposition duration and fecundity of females were also reduced significantly.

2.3 Compatibility of insecticides with fungicides and fertilizers:

Schenck and Adlerz (1963) studied 72 combinations of insecticides, fungicides, and foliar fertilizers were compared for their compatibility on watermelon. In these tests, disease control was best with zineb-maneb and maneb alone. Disease control with mixtures containing thiodan was significantly less than with mixtures not containing them. Rindworm control was best with guthion and mixtures containing foliar fertilizers. Insecticidal control was reduced by mixtures containing dithiocarbamate fungicides without fertilizers.

Finlaysonn (1969) studied the insecticides alone or with combined with fungicides and acidic or basic starter solutions were applied to cauliflower in the transplant water to determine their compatibility for control of *Hylemya brassicae* B., *Plasmodiophora brassicae* W. and *Rhizoctonia solani* K. Effects were assessed by periodic counts to determine phytotoxicity, by 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 by club-root. Maggot damage was severe in plots without insecticides. Mercuric chloride gave some protection from maggot damage but retarded early growth and was compatible with the organophosphate insecticides like birlanem, dasanirdizinon and zinophos.

Prakash Reddy (1984) reported that, the emulsion stability of fenvalerate was effected due to more sedimentation when mixed with mancozeb, but unaffected with carbendazim. However, decamethrin was physically compatible with carbendazim and mancozeb.

Ilango and Uthansamy (1991) evaluated the pesticides for the control of bollworms and boll rot caused by combination of nine species of fungal pathogens in cotton and suggested that application of fenvalerate (0.07 %) in combination with mancozeb (0.1 %) and carbendazim (0.2 %) effectively controlled the infection in cotton plants.

Muthiati *et al.* (1991) reported that, a mixture of 0.67 per cent fenvalerate with 0.5 per cent carbendazim was effective against groundnut pest *Spodoptera litura* and late leaf spot (*Mycosphaerella berkeleyi*) and resulted in maximum pod yield. While 0.15 per cent dichlorvos in mixture with 0.2 per cent mancozeb produced minimum incidence of *Aproaerema modicella* and *M. berkeleyi*.

Nagia *et al.* (1993) evaluated the compatibility of fenvalerate 20 EC and monocrotophos 36 EC with carbendazim 50 WP and mancozeb 75 WP against leaf hopper, *Amrasca biguttula biguttula* (Ishida) and leaf blight, *Alternaria solani* (Ellis & mart) on brinjal crop. They reported that, monocrotophos in combination with mancozeb or carbendazim can be used together for the control of leafhopper (30.2 %) and leaf blight (18.81 %) compared to 55.9 per cent disease incidence in control, but fenvalerate was incompatible with either of the fungicides.

Dodan *et al.* (1997) revealed that, the neck blast (*Pyricularia oryzae*) and stem borer (*Scirpophaga incertulum*) in rice cultivar Taraosi basmati can be minimized by application of ediphenphos alone and in combination with phosphomidon was significantly better than carbendazim alone and with other combination treatments against rice blast while monocrotophos alone and in combination with carbendazim was most effective against stem borer damage.

Lakshminarayana (2000) reported that, the wettability of mancozeb and carbendazim was improved in the presence of insecticides monocrotophos, methamidophos and acephate showing physical compatibility. However, the fungicides mancozeb and carbendazim took less time for submergence in standard hard water with the combination of insecticides, compared to the time taken by the fungicides when used alone. The emulsion stability or solution stability of monocrotophos and methamidophos were affected.

Smith *et al.* (2002) studied the effect of raw water differed in quality by high pH, hardness, content of NO_2, Fe^{+2}, Fe^{+3},Ca^{+2}, organic materials compared to tap water when used for tank mix application of fungicides with insecticides and reported that the stability of mixtures decreased in tank mix of Pyrinex 48 EC (chloropyriphos) with Mankogal-80 (mancozeb) or Folpan WP-50 (folpet) due to decreased surface tension when raw water was used. When mixed with wettable formulation of fungicides like mancozeb and carbendazim due to more sediment formation (more than 2 cm) than the limit specified by Indian Standards Institution (ISI), showing physical incompatibility.

Jagginavar and Naik (2005) evaluated twelve insecticide and evaluated them by drenching and swabbing methods on pomegranate for the management of shot hole borer, *Xyleborus perforans* (wall) and a fungus, *Verticillum* sp. drenching with chlorpyriphos + carbendazim and monocrotophos + carbendazim during ambe bahar, and drenching with chlorpyriphos + carbendazim, imidachlorprid + carbendazim and monocrotophos + carbendazim during mrig bahar season emerged as best treatments by recording higher reduction in per cent shot-holes. The individual fruit weight and yield were also noted to be significant in these treatments.

Bhuvaneswari and Raj (2013) reported that, chlorantraniliprole @ 0.3 ml/l in combination with hexaconazole @ 2 ml/l (6.3 % WE) gave less incidence (8.3 %) and severity of sheath blight (12.8 %) and also less stem borer and lesser leaf folder damaged leaves per hill.

Anonymus (2013) reported that, DuPont™ Benevia® insecticide is compatible with many commonly used fungicides, liquid fertilisers, herbicides, insecticides, and biological control products. The mixing sequence recommended 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, soluble fertilisers.

Siddartha *et al.* (2014) studied compatibility of seven insecticides in combination with fungicide Saaf® tested for efficacy, five insecticides (chlorantraniliprole, flubendiamide, novaluron, Proton® and profenophos) showed synergistic effect, whereas two insecticides (indoxcarb and Hamla®) were antagonistic against *P. xylostella* larvae. In this line a study was undertaken to evaluate the insecticidal properties of selected fungicide against third instar larvae of *P. xylostella* in the laboratory at five concentrations. The results revealed that fungicide possess insecticidal properties and the mortality was significantly more at higher concentration. Among the fungicide, Saaf® (mancozeb + carbendazim) at 1875 ppm caused the highest mortality of 28.91 per cent. Though, no similar studies have been reported in the literature. The available literature envisaged that contact fungicides namely mancoze band carbendazim, are the component of Saaf® included in the present study exhibited varying levels of toxicity to some of the insects.

Sreedhar *et al.* (2014) evaluated that, fungicides, clorothalonil at 200 ppm concentration showed highest mortality of 18.51 per cent while, mancozeb and quintal caused 12.59 and 10.37 per cent mortality against *Plutella xylostella* at the same concentration. The insecticides *viz.,* endasulfan, fipronil, profenophos, indoxacarb and spinosad were found compatible with the fungicide clorothalonil, where its efficacy was increased considerably with co-toxicity co-efficient (CC) values of 1.32, 1.31, 1.26, 1.17 and 1.14, respectively. However, novaluron and thiodicarb were incompatible with clorothalonil with CC values of 0.81 and 0.97, respectively. Regarding the compatibility of insecticides with mancozeb; endosulfan, spinosad, porofenophos, novaluronand fipronil were clearly compatible with mancozeb with CC values of 1.39, 1.14, 1.12, and 1.10, respectively

Vasundara *et al.* (2015) studied the compatibility of two insecticides, three fungicides and their combinations on *Trichoderma viridae.* It shows variable responses against the tested pesticides (insecticides and fungicides) and their combinations at recommended concentrations for field studies. The treatments of mancozeb (3000 ppm), imidacloprid (2000 ppm) and combination of mancozeb (3000 ppm) + imidacloprid (2000 ppm) showed high compatibility with *T. Viridae* by showing 7,11 and 11 per cent growth inhibition, respectively. The treatments *viz.* Carbendzim (1000 ppm) + chloropyriphos (6000 ppm), tebuconazole (1000 ppm) + imidacloprid (2000 ppm) and tebuconazole (1000 ppm) + chloropyriphos (6000 ppm) showed high compatibility with 100 per cent growth inhibition.

Suneel kumar *et al.* (2016) evaluated the compatibility and bioefficacy of newly released insecticide and fungicide alone and in combination against defoliator pest, *Aproaerema modicella* D.; *S. Litura* F. and late leaf spot of groundnut during *Rabi* 2012-2013. Slight phytotoxic symptoms were seen in combination treatment of thiodicarb 75 WP + hexaconazole 5 EC, flubendiamide 20 WG + hexaconazole 5 EC and chlorfenapyr 10 SC + hexaconazole 5 EC with phytotoxic score of 1 (0 to 10 %) only at 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 combinations at recommended dose were found to be superior to the rest of combinations with a mean per cent *A. modicella* larval population reduction of 87.5 and comparable to that of insecticide alone.

Suneel kumar *et al.* (2016) studied physical compatibility of test insecticide and fungicide combinations under laboratory conditions and revealed that, when mancozeb 75 WP was mixed with spinosad 45 SC, thiodicarb 75 WP and chlorfenapyr 10 SC, pale yellow colour was observed, while it was dark yellow with flubendiamide 20 WG. The fungicide was smoothly mixed with spinosad 45 SC and flubendiamide 20 WG after stirring and no clumps were observed with a moderate pH of 7.41 and 7.80, respectively. Whereas with thiodicarb 75 WP and chlorfenapyr 10 SC, slight precipitation was observed with an alkaline pH of 8.64 and 8.70, respectively. In case of hexaconazole 5 EC, the colour was milky white with all insecticides except thiodicarb 75 WP where pearl colour was noticed. The fungicide was readily soluble with all the insecticides except thiodicarb 75 WP, where precipitation was observed. pH was moderate ranges from 7.82 to 8.32.

3. MATERIALS AND METHODS

The investigations on bioefficacy and compatibility studies of new insecticide molecules with fungicides and soluble fertilizer against pest complex of pomegranate was carried out at experimental farm of AICRP on Arid Zone Fruits, Department of Horticulture, MPKV, Rahuri, Dist.- Ahmednagar (MS). Besides this the laboratory experiment on compatibility of different insectide combinations with fungicides and soluble fertilizer (00:52:34) for their physical properties in well equipped laboratory were undertaken at AICRP on Arid Zone Fruits, 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

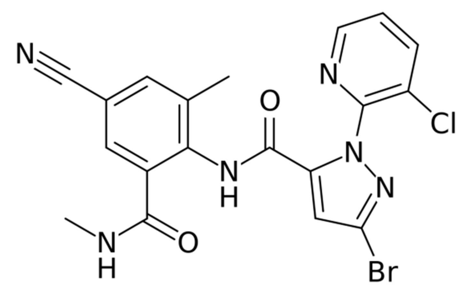
The study on bioefficacy and compatibility of new insecticide molecule with fungicides and water soluble fertilizers against major pest of pomegranate (3 year old) orchard at AICRP on Arid Zone Fruits MPKV, Rahuri was conducted. Three separate blocks each consisting of nine plants of pomegranate variety 'Bhagwa' was maintained for fruits production in the *ambe bahar* season. The spacing of plantation was 4.5 X 3.0 m. All the experimental plants in the block were kept free from application of insecticides before reaching sufficient pest population. All other agronomical practices were followed as per the recommendation made by MPKV, Rahuri.

3.1.2 Details of evaluated treatments

The details of insecticide used for the experiment with their common name, formulation and source given as below:

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]-1*H*-pyrazole-5-carboxamide	M/s. Dupont Pvt. Ltd., Mumbai
2	Emamectin benzoate	Missle	4′′-Deoxy-4′′-epi-methyl amino avermectinB1;Epimethylamino-4′′-deoxyavermectin	M/s. Crstal Pvt. Ltd.
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-tetradeoxy-β-Derythropyranosyloxy)-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	Carbendazim 50 WP	Bavistin	Methyl *1H*-benzimidazol-2-ylcarbamate	M/s. BASF, 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

Cyantraniliprole is a second-generation anthranilic diamide insecticide discovered by Du-Pont Crop Protection. Anthranilic diamides have a unique mode of action that involves activating ryanodine receptors (RyR), which play a critical role in muscle function. Cyantraniliprole binds to the RyR, causing uncontrolled release and depletion of calcium from muscle cells, thus preventing further muscle contraction and ultimately leading to death. Cyantraniliprole is a reduced-risk insecticide, with a very low toxicity to vertebrates and non-target organisms. It has root systemic and translaminar activity against a broad spectrum of sucking and chewing insects.



3-Bromo-1-(3-chloro-2-pyridinyl)-*N*-[4-cyano-2-methyl-6-(methylcarbamoyl)phenyl]-1*H*-pyrazole-5-carboxamid

3.1.3 Preparation of spray fluid

For each treatment 10 L spray fluid was prepared by taking into account spray fluid rate of 500 L ha^{-1}.

3.1.4 Application of insecticide

Hand operated knapsack sprayer equipped with hollow cone nozzle was used to carry out spraying operation. Each treatment plant was thoroughly sprayed at each spray.

Each treatment consisting of four sprays, two applied at an interval of about 15 days in March. Third and fourth spray applied at an 20 days interval in June and July. First spray was taken at the flowering and fruit setting stage. Last spray was taken at the fruit development stage.

3.1.5 Care in treatments

Care was taken to cover the entire target plants thoroughly while spraying were carried out in the morning hours and care was taken to wash the spray pump twice with the clean water to avoid the contamination of one treatment product with other.

3.2 Methods

The methods adopted to study the bioefficacy and compatibility of insecticides with fungicides and soluble fertilizer (00:52:34) were described as below:

3.2.1 Details of Experiments

A randomized block designed experiment for bioefficacy and compatibility study against pest of pomegranate was conducted during the year 2016-2017 on 3 year old orchard (cv. Bhagwa) of pomegranate at research field of AICRP on Arid Zone Fruits, Department of Horticulture, MPKV, Rahuri.

a. Location	AICRP 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	9
h. Replication	3
i. Date of bahar	*Ambe bahar*
j. Date of treatments k. Date of Harvest	First spray-1st March,IInd 17th March,2016 IIIrd 12th June & Last spray 2nd July,2016 31st Aug, 2016.
l. Fertilizers dose	625 :250:250 kg (NPK)/ha

3.2.2 Treatment details

Tr. No.	**Treatment details**	**Dose** (per lit.)
T1	Cyantraniliprole 10.26 % OD	0.2 ml
T2	Cyantraniliprole 10.26 %OD + Carbendazim 50 WP	0.2 ml + 1.0 g
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + Soluble fertilizer 0:52:34	0.2 ml + 1.0 g + 5.0 g
T4	Cyantraniliprole 10.26 % OD	0.3 ml
T5	Cyantraniliprole 10.26 %OD + Propineb 50 WP	0.3 ml + 1.0 g
T6	Cyantraniliprole 10.26 % OD + Propineb 50WP + Soluble fertilizer 0:52:34	0.3 ml + 1.0 g + 5.0 g
T7	Emamectin benzoate 5 SG	0.5 g
T8	Spinosad 45 SC	0.2 ml
T9	Untreated control	-

3.2.3 Methods of recording observations

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

a. Sucking pest complex

The observations on sucking pest's *viz.,* aphids (*A. punicae* P.) and thrips (*S. dorsalis*) were recorded from newly emerged 5 cm apical twigs of each pomegranate plant under observation. On each plant, five twigs were observed to record the number of aphids and thrips on five cm portion of each of twig. Average of 5 twigs was represented the count of average survived aphids and thrips per twig for the assessment of pest infestation.

b. Fruit borer (*D. isocrates* Fab.)

Fruit damage due to borer was recorded on the basis of infested fruits over healthy fruits at the time of harvest and per cent damage was worked out.

c. Natural enemies

Recorded the natural enemies LBB (coccinellids) at 7 days interval after last spray on 3 plants per treatments and presented data per 5 twigs per plant basis.

d. Observation on flowers, bud and fruit setting

Observation on flower, bud and fruit setting was recorded weekly after each spray treatment and per cent fruit setting in respective treatment were worked out.

3.2.4 Recording Yield

The pomegranate fruit yield obtained from the individual plant of each treatment in the field at each picking made at 15 days interval commencing from 150 days after "bahar" treatment up to termination was recorded in kg per plant and expressed in tonnes per hectare. From these observations data was subjected to statistical analysis.

3.2.5 Statistical analysis of the data

The experimental data were subjected to statistical analysis as per the method of statistical analysis of randomized block design. The values of survival populations were converted to angular transformed values (T) using formula, T= $\sqrt{n+0.5}$, where n = natural count of survived population of aphids and thrips and then subjected to statistical analysis.

As regards, the data on fruit yield of marketable fruit of pomegranate from the treatments were taken in kg/plant and expressed into t/ha and subjected to statistical analysis.

R-I	R-II	R-III
T8	T3	T6
T4	T1	T5
T6	T8	T7
T2	T4	T3
T5	T9	T1
T9	T6	T8
T7	T2	T4
T3	T5	T9
T1	T7	T5

Design:- Randomized Block Design

Fig.1 Layout of the experiment

3.3 Compatibility of insecticides with fungicides and water soluble fertilizer

3.3.1 Material

The facilities like glasshouse Electronic weighing balance, Morter and Pestal, and glassware's beakers, jars, measuring cylinders, conical flask, pH metre, EC metre, glass rod, bulb sucker and pipettes were required and also provided by the AICRP on AZF, Department of Horticulture, M.P.K.V., Rahuri.

3.3.2 Details of the experiment

Treatment details

Tr. No.	**Treatment details**	**Dose** (per lit.)
T1	Cyantraniliprole 10.26 % OD	0.2 ml
T2	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP	0.2 ml + 1.0 g
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + Soluble fertilizer 00:52:34	0.2 ml + 1.0 g + 5.0 g
T4	Cyantraniliprole 10.26 % OD	0.3 ml
T5	Cyantraniliprole 10.26 % OD + Propineb 50 WP	0.3 ml + 1.0 g
T6	Cyantraniliprole 10.26 % OD + Propineb 50 WP + Soluble fertilizer 00:52:34	0.3 ml + 1.0 g + 5.0 g
T7	Emamectin benzoate 5 SG	0.5 g
T8	Spinosad 45 SC	0.2 ml
T9	Untreated control	-

3.4 Methods

Effect of insecticide mixed with fungicide and soluble fertilizers were assessed with their physical and chemical parameters in laboratory by using glass jar. Three insecticides *viz.*, cyantraniliprole 10.26 % OD spinosad 45 SC, emamectin benzoate and two fungicides viz., carbendazim 50 WP and propineb 50 WP and liquid fertilizer 00:52:34 were used to test physical compatibility *viz.*, colour, and sedimentations also foaming of the solution etc. and tests chemical compatibility *viz.*, pH, EC, were taken under laboratory conditions and phytotoxicity observations on plants after spraying on the crop.

3.4.1 Jar Test:

Observations compatibility of new insecticide with fungicides and liquid fertilizer were recorded and compatibility tests were assessed 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 for tank mixing the products, always go from dilute to concentrate, not vice versa.

1. Add 1 pint of carrier (water, liquid fertilizer) to each of 2 one-quart jars.
2. To one of the jars add 1/4 teaspoon or 1.2 milliliters of a compatibility agent 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-S sequence when tank-mixing herbicides:

    Wettable powders or water dispersible granules

    Agitate then add adjuvants such as anti-foaming compounds, buffers

    Liquids (flowable liquids)

    Emulsifiable concentrates

    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 herbicide and fertilizer are compatible. If the components are not dispersed in the 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:

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. Foaming also recorded.

2. Chemical Compatibility:

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: Damage severity of fruit and leaf spot disease were recorded based on standard description and disease scoring was done using modified 9 point scale . Phytotoxicity symptoms on plants were recorded one week after application of chemicals. Observations for specific parameters like chlorosis, necrosis, wilting, vein clearing, hyponasty and epinasty were taken using the 0-9 scale as 0 - No phytotoxicity; 1 – 0 to 10 %, 2 – 11 to 20 %, 3 – 21 to 30 %, 4 – 31 to 40 %, 5 – 41 to 50 %, 6 – 51 to 60 %, 7 – 61 to 70 %, 8 – 71 to 80 %, 9 – 81 to 90 %, 10 – 91 to 100 % phytotoxicity. The recorded data corresponding to each treatment were subjected for statistical analysis after suitable transformation.

4. RESULTS AND DISCUSSION

The results of current studies on the bioefficacy of new insecticide molecule with fungicides and soluble fertilizer against pest complex infesting pomegranate *viz.*, aphids, thrips and fruit borer of pomegranate are presented in this chapter. The aspects of compatibility of the new molecule cyantraniliprole 10.26 % OD with the fungicides (carbendazim, propineb) and soluble fertilizer (00:52:34) in spray fluid under field and laboratory conditions which has been reported for physical and chemical parameters like sedimentation colour, pH and EC in final spray solution.

4.1 Bioefficacy and compatibility of new molecule insecticide with fungicide and soluble fertilizers against pest complex of pomegranate

It is revealed from the pooled data presented in Table 1 to 6 and depiction in figures 2 to 7 that, all the treatments found significantly superior over untreated control in suppressing the aphids and thrips infestation during the period of experimentation.

It is seen that, there were no significant differences in pre-counts of aphids and thrips, the corresponding pest population was in the range of 13.67 to 14.93 and 10.47 to 12.47 per 5 cm apical twigs, respectively.

4.1.1 Efficacy of different insecticide treatment against aphids after first spray on pomegranate

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

On first day after spray it is revealed that, the combat treatments of cyantraniliprole 10.26 % OD each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g and cyantraniliprole 10.26 % OD each at 0.2 ml + carbendazim 50 WP 1 g with soluble fertilizer (0:52:34) 5 g per lit. of spray water were found to be effective in suppressing the aphid population by 5.8 and 6.73 per 5 cm twig, respectively. Whereas, the rest of the treatment were found less effective.

On 3rd and 7th days after spray, the combat treatment of cyantraniliprole 10.26 % OD each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g was found most effective in registering least survived population of aphids in the range of 4.40 to 3.43 per 5 cm apical twigs. However, this treatment was also found on par with cyantraniliprole 10.26 % OD each at 0.3 ml + propineb 50 WP 1 g and lowest treatment of cyantraniliprole 10.26 % OD each at 0.2 ml + carbendazim 50 WP 1 g + soluble fertilizer 0:52:34 5 g per lit of water and cyantraniliprole 10.26 % OD + carbendazim 50 WP @ (0.2 ml + 1 g /lit), respectively in supressing aphid population per twig. Whereas, the rest of the treatment were not found effective as compared with the untreated control.

On 10th days after spray, it is revealed from the data that similar trend was noticed and showed the combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. of water) was found most effective in registering least survived population of aphids i.e. 5.33 per 5 cm twigs. However, this treatment was also found on par with all the combination treatment doses. Whereas the treatment of cyantraniliprole 10.26 % OD at 0.2 ml, emametin benzoate 5 SG at 0.5 g and spinosad 0.2 ml per lit. of water were found non-significant.

On 15th days after spray, it is revealed from the data that, similar trend was noticed and showed the combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. of water) was found most effective in registering least survived population of aphids i.e. 5.60 as against 15.80 per 5 cm twigs in untreated control. However, this treatment was also found on par with the treatment dose of cyantraniliprole 10.26 % OD + propineb 50 WP @ (0.3 ml + 1 g / lit) and lowest treatment of cyantraniliprole 10.26 % OD + carbendazim 50 WP + soluble fertilizer (00:52:34) @ (0.2 ml + 1 + 5 g /lit), respectively in registering the least survived aphid population in the range of 6.27 to 6.60 per 5 cm twigs, respectively. 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 % OD (each at 0.3 ml + propineb 50 WP 1 g + soluble fertilizer (00:52:34) 5 g per lit. of water) and cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with soluble fertilizer (00:52:34) at 5 g per lit. of water), respectively and recorded least number of aphids 4.91 and 5.32 as against 14.90 per 5 cm apical twig in untreated control, respectively.

4.1.2 Efficacy of different insecticide treatment against aphids after second spray on pomegranate

On first day after spray, it is revealed from the Table 2 and depicted in fig. 3 that, the combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. of water) and cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with soluble fertilizer (00:52:34) 5 g/lit. of spray water) were found to be effective in registering least population i.e. 3.67 and 3.80 per 5 cm twig, respectively. The treatments cyantraniliprole 10.26 % OD + propineb 50 WP @ (0.3 ml + 1 g/lit) was found best next effective treatment in reducing the pest population. Whereas, the rest of the treatment were found non significant.

The combat treatment of cyantraniliprole 10.26 % OD each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g was found most effective in supressing population of aphids in the range of i.e. 2.40 to 1.93 per 5 cm apical twigs on 3rd and 7th days after spray, respectively. However, this treatment was also found on par with all combat treatment *viz.*, cyantraniliprole 10.26 % OD each at 0.3 ml + propineb 50 WP 1 g and lowest treatment with dose of cyantraniliprole 10.26 % OD each at 0.2 ml + carbendazim 50 WP 1g + soluble fertilizer (00:52:34) 5 g per lit of water and cyantraniliprole 10.26 % OD at 0.2 ml + carbendazim 50 WP 1 g per lit. of water, respectively in registering the least survived aphid population i.e. 2.27 to 3.40 per twig as against 15.67 to 14.73 per twig in untreated control. Whereas, the rest of the treatment were not found effective as compared with the untreated control.

On 10th days after spray, it is seen that, similar trend was noticed and showed the combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. of water) was found to be effective in registering least survived population of aphids i.e. 3.20 per 5 cm twigs. However, this treatment was also found on par with all the combination treatment doses. Whereas, the treatment cyantraniliprole 10.26 % OD at 0.2 ml and 0.3 ml, emametin benzoate at 0.5 g and spinosad 0.2 ml per lit. of water were found non significant.

On 15th days after spray, it revealed from the data that, the similar trend was noticed and showed the combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. of water) was found most effective in registering least survived population of aphids i.e. 3.67 as against 14.73 per 5 cm twigs in untreated control and found on par with the treatment dose of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendanzim 50 WP 1 g + soluble fertilizer (00:52:34) 5 g per lit. of water) and cyantraniliprole 10.26 % OD + propineb 50 WP at (0.3 ml + 1 g / lit. of water), respectively in registering the least survived aphid population in the range of 4.00 to 5.00 per 5 cm twigs, respectively. Whereas, the rest of the treatment were found non-significant as compared with the untreated control.

The average cumulative mean population of aphids after second spray indicated that the treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g + soluble fertilizer (00:52:34) 5 g per lit. of water) and cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g + soluble

fertilizer (0:52:34) at 5 g per lit. of water), respectively and recorded least number of aphids i.e. 2.97 and 3.32 as against 15.73 per 5 cm apical twig in untreated control, respectively.

4.1.3 Efficacy and compatibility of different treatments from pooled data against aphids per twigs after two spray on pomegranate

It is revealed from the pooled data presented in Table 3. and depicted in fig. 4 that, all the treatments were found significantly superior in supressing aphid population over untreated control during the period of experimentation.

Among the different treatment, the combination treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit water) was found most effective and compatible for the control of aphids and recorded least average survived aphid populations i.e. 2.68 to 4.73 as against 14.47 to 16.10 per twigs in untreated control on first to 15th days after spray observation throughout the period of experimentation.

However, the combination treatment of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendanzim 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. water) was found most effective and compatible for the control of aphids and recorded least average survived aphids i.e. 2.92 to 5.27 with overall average mean of 4.32 as against 15.31 per twigs in untreated control followed by the combination treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml with propineb 50 WP 1 g per lit. water) was found effective and compatible for the control of aphids and recorded least average survived aphids i.e. 5.30 during the period of experimentation.

Whereas, the rest of treatment *viz.*, cyantraniliprole 10.26 % OD each at 0.2 & 0.3 ml, emamectin benzoate 5 SG 0.5 g and spinosad 45 SC 0.2 ml were found least effective for the control of aphids.

Keeping in view to above results, both the combination treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit water) and cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. water) was found most effective and compatible for the control of aphids. As the evidence from the compatibility studies on physical, chemical and phytotoxic effect, it is clearly indicated that the role of acidic and alkaline pH with EC of spray tank solution was slightly lowered and maintain at normal pH i.e. 6.5 to 7.5 and EC at 1 mmhos without showing any adverse effect on discolouration, foaming, sedimentation and phytotoxic effect on foliage , flower bud, fruit setting and natural enemies survival (Table 12 & 13).

Whereas, the ineffectiveness of new molecule cyantraniliprole 10.26 % OD (each at 0.2 & 0.3 ml per lit. water) alone without the combination with fungicides and soluble liquid fertilizer clearly indicates that, the pH & EC of water source used for spraying has played vital role and showed incompatibility as the pH & EC of spray fluid was slightly alkaline i.e. nearly 8.0.

As the new molecule is recently registered and label claim against pomegranate pest complex, the literature on horticulture fruit crops are scanty. Our findings are supported by the findings of Patel *et al.* (2014) evaluated the field bio-efficacy of a newer molecule cyantraniliprole 10 % OD *i.e.* 90 and 105 g a.i. ha^{-1} was found highly effective in managing the population of aphid, thrips and whitefly compared to endosulfan and indoxacarb.

Our findings are also similar with the findings of Anonymous (2013) stated that DuPont™ Benevia® insecticide is compatible with many commonly used fungicides, liquid fertilisers, herbicides and insecticides.

Burt and Karr (2008) showed that cyantraniliprole (HGW86) 10 % OD is to be active against a broader spectrum of insects like sucking insects and lepidopteran which is also found confirmative with present findings.

4.2 Efficacy of different insecticide treatment against thrips after first spray against pomegranate

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

It is revealed from the data presented in Table 4 and depicted in figure 5 that, the combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. of water) was found to be effective in registering least thrips population i.e. 2.73 to 5.13 per 5 cm twig from first day to the period of 15th days after first spray. Which was also found on par with the combat treatment of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with soluble fertilizer (00:52:34) 5 g/lit. of spray water) were found to be effective in registering least population of thrips i.e. in the range of 3.07 to 5.40 per 5 cm twig after first spray.

On 7th and 10th days after spray, similar trend was noticed that, the both combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g) and cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with soluble fertilizer (00:52:34) 5 g) was found most effective in registering least survived population of thrips (in the range of i.e. 2.73 to 5.13 per 5 cm apical twigs). However, this treatment was also found on par with cyantraniliprole 10.26 % OD (at 0.3 ml + propineb 50 WP at 1 g lit. water) and spinosad 45 SC, respectively in registering the least survived aphid population (i.e. 3.40 and 4.53 per 5 cm twig). Whereas, the rest of the treatment were not found effective as compared with the untreated control.

On 15th days after spray, it is revealed from the data that, similar trend was noticed and showed that the combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. of water) was found most effective in registering least survived population of thrips i.e. 4.73 as against 16.00 per 5 cm twigs in untreated control. However, this treatment was also found on par with the treatment dose of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP at 1 g with soluble fertilizer (00:52:34) 5 g per lit of water) in registering the least survived thrips population i.e. 4.93 per 5 cm twigs, respectively. Whereas, the rest of the treatment were found non-significant as compared with the untreated control.

The average cumulative mean population of thrips after first spray indicated that the treatment cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g + soluble fertilizer (00:52:34) 5 g per lit. of water) and cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with water soluble fertilizer (00:52:34) at 5 g per lit. of water), respectively were found effective and recorded least number of thrips (3.85 and 4.09) as against (13.65 per 5 cm apical twig) in untreated control, respectively.

4.2.1 Efficacy of different insecticide treatment against thrips per twigs after second spray on pomegranate

It is revealed from the data presented in Table 5 and depicted in figure 6 that, the combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. of water) was found to be effective in registering least thrips population i.e. 1.05 to 3.47 per 5 cm twig, which was also found on par with the combat treatment of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with soluble fertilizer (00:52:34) 5 g/lit. of spray water), which were found to be effective in suppressing thrips population in the range (i.e. 1.42 to 3.73 5 cm per twig) from first day to the period of 15th days after second spray during the period of experimentation.

However, the treatment of cyantraniliprole 10.26 % OD (at 0.2 ml + propineb 50 WP at 1 g lit. water) was also found effective followed by cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP at 1 g per lit. of water) and spinosad 45 SC in suppressing the least survived thrips population (i.e. 2.13 to 1.60 per twig) on 7th and 10th days after second spray. Whereas, the rest of the treatment were not found effective as compared with the untreated control.

On 15th days after spray it is revealed from the data that similar trend was noticed and showed the combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. of water) was found most effective in suppressing population of thrips i.e. 3.47 as against 20.53 per 5 cm twigs in untreated control. However, this treatment was also found on par with the treatment dose of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP at 1 g with soluble fertilizer (00:52:34) 5 g per lit. of water) in suppressing thrips population i.e. 3.73 per 5 cm twigs followed by combat treatment of cyantraniliprole 10.26 % OD each at 0.3 ml + propineb 50 WP 1 g per lit. of water, respectively. Whereas, the rest of the treatment were found non-significant as compared with the untreated control.

As regards, from average cumulative mean population of thrips after second spray, it was indicated that both the treatment cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g + soluble fertilizer (00:52:34) 5 g per lit. of water) and cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with soluble fertilizer (00:52:34) at 5 g per lit. of water), respectively were found effective and recorded least number of thrips (2.29 and 2.55) as against 18.67 per 5 cm apical twig in untreated control.

4.2.2 Efficacy and compatibility of different treatments from pooled data against thrips after two spray on pomegranate

It is revealed from the pooled data presented in Table 3 and depicted in figures 7 that, all the treatments were found significantly superior in suppressing thrips population over untreated control during the period of experimentation.

Among the different treatment, the combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. water) was found most effective and compatible for the control of thrips and recorded least average survived thrips i.e. 1.89 to 4.10 as against 14.73 to 18.27 per twigs in untreated control from the 1st to 15th days after spray observation of experimentation.

However, the combination treatment of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit water) was found most effective and compatible for the control of thrips and recorded least average survived thrips (i.e. 2.24 to 4.33) with overall average mean (3.32) as against (16.16 per twigs) untreated control followed by combination treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml with propineb 50 WP 1 g per lit. water) was found effective and compatible for the control of thrips and recorded least average survived thrips (i.e. 3.55) during the period of experimentation.

Whereas, the rest of treatments viz. cyantraniliprole 10.26 % OD (each at 0.2 & 0.3 ml), emamectin benzoate 5 SG 5 g and spinosad 45 SC 0.2 ml were found least effective for the control of thrips.

Keeping in view to above results, the combination treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. water) and cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. water) was found most effective and compatible for the control of thrips. As the evidence from the compatibility studies on physical, chemical and phytotoxic effect (Table 12 & 13), it is clearly indicated that the role of acidic and alkaline pH with EC of spray tank solution was slightly lowered and maintain at normal pH i.e. 7.0 to 7.5 and EC at 1 mmhos without showing any adverse effect on discolouration, foaming, sedimentation and phytotoxic effect on foliage, flower bud, fruit setting and natural enemies survival.

Whereas, the ineffectiveness of new molecule cyantraniliprole 10.26 % OD each at 0.2 & 0.3 ml per lit. water alone without the combination with fungicides and soluble liquid fertilizers clearly indicate that the pH & EC of water source used for spraying has played vital role in chemical compatibility as the pH & EC of spray fluid was slightly alkaline i.e. nearly 8.0

As the new molecule is recently registered and label claim against pomegranate pest complex, the literature on horticulture fruit crops specially pomegranate are scanty. Our findings are supported by the findings of Patel *et al.* (2014) who evaluated the field bio-efficacy of a newer molecule cyantraniliprole 10 % OD i.e. 90 and 105 g a.i. ha^{-1} was found highly effective in managing the population of aphid, thrips and whitefly in cotton as compared to endosulfan and indoxacarb. Siddartha *et al.* (2014) studied compatibility of seven insecticides in combination with fungicide Saaf® tested for efficacy, five insecticides (chlorantraniliprole, flubendiamide, novaluron, Proton® and profenophos) and showed synergistic effect, whereas the two insecticides (indoxcarb and Hamla®) were antagonistic against *P. xylostella* larvae. The results revealed that fungicide possess insecticidal properties and the mortality was significantly more at higher concentrations. Among the fungicide, Saaf® (mancozeb + carbendazim) at 1875 ppm caused the highest mortality of 28.91 per cent. The available literature envisaged

that contact fungicides namely mancozeb and carbendazim, are the component of Saaf® included in the present study exhibited varying levels of toxicity to some of the insects. This might be the confirmative with chemical compatibility during present investigation.

Our findings are also confirmed the findings of Anonymous (2013) who stated that DuPont™ Benevia® insecticide is compatible with many commonly used fungicides, liquid fertilisers, herbicides and insecticides. Patel *et al.* (2014) proved cyantraniliprole @ 90-100 g a.i. / ha. for control of sucking pests on cotton, Walunj *et al.* (2015) reported that the treatments of cyantraniliprole 10.2% OD at 60.9 a.i. / ha. was found most effective for the control of thrips infesting pomegranate. Several workers reported the cyantraniliprole as most effective for the control of sucking pests as well as lepidopteran borers of the horticultural crops, which might be confirmative as the internal borers are difficult to control with conventional insecticides by Lephen *et al.* (2012), Raital *et al.* (2012), Caveron *et al.* (2013) and Rath *et al.* (2013). Burt and Karr (2008) showed that cyantraniliprole (HGW86) 10 % OD is to be active against a broader spectrum of insects like sucking insects and lepidopteron.

4.3 Effect of treatment on natural enemies on pomegranate

The bioefficacy of different insecticides 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 of *Coccinella* spp. Initial count of coccinellid predators before and after both sprays was non-significant which was in the range of 1.00 to 1.40 per 5 twigs on pomegranate.

It is revealed from the data, presented 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 lady bird beetle population and showed non-significant difference among the treatment.

The present findings are also in agreement with Patel *et al.* (2015) who studied the response of a natural enemies to cyantraniliprole 10 % OD applied against insect pest of cotton and reported that, the population of coccinellids, green lacewings and spiders 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^{-1}) to these predators. Among the insecticides, the higher population of natural enemies was observed in plots treated with cyantraniliprole 10 % OD. The present studies are also found confirmative with Luis and John (2013) who confirmed that diamide have favourable eco-toxicological profile and are relatively safe to insect natural enimies. Mishra (2015) evaluated cyantraniliprole against sucking pest infesting tomato and reported its safety to the coccinellid predator, which is found confirmative with our findings.

4.4. Effect of different treatment in combination of insecticide with fungicide, soluble fertilizer and alone on fruit borer damage on pomegranate

It is revealed from the data presented in Table 8 and depicted in figure 9 that, the combat treatment of cyantraniliprole

cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. water) was found significantly superior for the control of fruit borer and recorded least average at 1.17 per cent fruit damage as against 10.77 per cent fruit damage due to pomegranate butterfly in untreated control at harvest and the treatment of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with water soluble fertilizer (00:52:34) 5 g per lit. of water) was found next best treatment in registering the least fruit damage i.e. 2.05 per cent damage due to the fruit borer on pomegranate followed by the treatment emamectin benzoate 5 SG at 0.5 g per lit. of water in recording least damage i.e. 2.19 per cent. However, the rest of the treatment in combination of new molecule cyantraniliprole with fungicide and alone were not found much effective in reducing the fruit damage.

Several workers earlier reported on different conventional insecticide for the control of fruit borer. Our findings are collaborated with the findings of Schenck and Adlerz (1963) who studied 72 combinations of insecticides, fungicides, and foliar fertilizers were compared for their compatibility on watermelon. Insecticidal control was reduced by mixtures containing dithiocarbamate fungicides without fertilizers. Hence, for better results of insecticide it was imperative to mix them with compatible fertilizer.

The incidence and damage of *D. isocarates* on pomegranate was reported by Verma *et al.* (1995). Present findings are in agreement with the efficacy of cyantraniliprole 10.26 % OD @ 60 g a.i./ha in comparison with neonicontinoids and synthetic pyrethriods against pest complex of pomegranate and proved their effectiveness against thrips and fruit borer damage as reported by Abd-Ella (2015) and Walunj *et al.* (2015). Whereas, the emamectin benzoate 5 SG @ 0.25 g per lit. of water to be effective for the reduction of fruit damage and highest marketable yield as reported by Kambrekar *et al.* (2015). However, this molecule of cyantraniliprole 10.26 % OD is found effective and confirmative with our findings, Burt and Karr (2015) who reported to be effective against broader spectrum of insect like lepidopteran. The cyazypyr 10.26 OD @ 90 and 100 g a.i./ha was found effective in controlling fruit borer in tomato, *Leuicinodes orbonalis* on brinjal as proven by Mandal (2012), Mishra (2015) and Kodandaram *et al.* (2015). Yaligar *et al.*(2016) who reported that cyazypyr 10.26 OD @ 90 and 100 g a.i./ha was found effective for the control of fruit borer and recommended for integrated pest management in brinjal in controlling fruit borer and maximum marketable yield.

4.4.1 Effect of treatment on per cent fruit setting on pomegranate

It is revealed from the data presented in table 9 and depicted in fig. 10 that, the treatment of cyantraniliprole 10.26 % OD + propineb 50 WP + soluble fertilizer (00:52:34) + @ (0.3 ml + 1 + 5 g per lit), respectively was found most effective in registering the highest fruit setting (i.e. 70.83 %) and also found on par with the treatment of cyantraniliprole 10.26 % OD at carbendazim 50 WP + soluble fertilizer (00:52:34) @ (0.2 ml + 1 g + 5 g per lit. of water), respectively in registering the maximum fruit setting. However, the rest of the treatment in combination of new molecule cyantraniliprole with fungicide and alone like cyantraniliprole @ 0.2, emamectin benzoate 0.5 g, spinosad 0.25

ml/lit. of water were found non-significant in recording the fruit setting. Due to want of literature this findings could not be compared.

4.4.2 Effect of different treatment in combination of insecticide with fungicide, soluble ferilizer and alone on fruit yield (kg/plant) on pomegranate

It is revealed from the data presented in Table 10 and depicted in figure 11 that, the treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1g with soluble fertilizer (00:52:34) 5 g per lit. of water) was found most effective in registering the highest marketable fruit yield i.e. 19.7 kg per plant (i.e. 14.57 t/ha) as against 12.0 kg per plant (i.e. 8.89 t/ha) in untreated control and also found on par with the treatment of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1g with soluble fertilizer (00:52:34) 5 g per lit. of water) in registering the maximum fruit yield i.e. 18.92 kg per plant. (i.e. 14.00 t/ha) and the treatment emamectin benzoate 5 SG at 0.5 g was also found optimum yield i.e. 18.66 kg per plant (i.e.13.80 t/ha). However, the rest of the treatment in combination of new molecule cyantraniliprole with fungicide and alone like cyantraniliprole @ 0.2, spinosad 0.25 ml/lit. of water were found non-significant in recording the fruit yield.

As regards, the cyantraniliprole newly registered molecule for pomegranate, literature is scanty. Therefore, the same has been compared with other crop, which is confirmative with the present this findings with the Kondaram *et al.* (2013 and 2015). Yaligar *et al.* (2016) who reported cyantraniliprole 10.26 % OD @ 90 g a.i/ha for gaining highest marketable yield of brinjal and tomato.

4.5 Compatibility of new insecticide molecule with fungicide and soluble fertilizers

Compatibility of pesticide is the behaviour of combination with reference to active compound that is whether maintain or reduced 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 foaming, sedimentation, colour, pH, EC was studied under laboratory condition and bioefficacy and phytotoxicity studied under field conditions before and after spraying.

4.5.1 Effect of insecticide treatment in spraying solution

4.5.1.1 Colour

It is revealed from the data presented in Table 11 that, the different treatment of cyantraniliprole 10.26 % OD (0.2 ml per lit. of water) and cyantraniliprole 10.26 OD (0.3 ml per lit. of water) with combination with fungicides *viz.* carbendazim, propineb and water soluble fertilizers and alone showed different colours in spray fluid solution. As regards, cyantraniliprole 10.26 % OD alone showed pale white colour. However, in combination with carbendazim 50 WP and soluble fertilizer showed pearl 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 % OD in combination with propineb 50 WP and soluble fertilizer (00:52:34) showed creamy white and pale yellow colour at 1, 24 and 48 hrs after preparation of spray solution, respectively. The treatment spinosad 45 SC showed pearl white colour at 1, 24 and 48 hrs respectively. The treatment emamectin benzoate and blank (water) showed no colour (colourless) after 1hr, 24 hr and 48 hr, respectively.

4.5.1.2 Foaming

It is revealed from the data presented in Table 11 that the new insecticide molecule cyntraniliprole 10.26 OD combination with fungicides (carbendazim and propineb) and soluble fertilizer (00:52:34) revealed that among the different treatments, none of the treatment with combination or alone showed foaming after1hr, 24 hr and 48 hr in spray fluid solution.

4.5.1.3 Sedimentation

It is revealed from the data presented in Table 11, that all the treatments showed no sedimentation after 1 hr. Whereas it was evident that the combination treatment of cyantraniliprole 10.26 OD with carbendazim and 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

It is revealed from the data presented in Table 12 that the new insecticide molecule cyntraniliprole 10.26 % OD combination with fungicides (carbendazim and propineb) and soluble fertilizer

(0:52:34) and revealed that none of the treatment with combination or alone showed any phytotoxicity effects of on leaf injury on tips and leaf surface, wilting, vein clearing, necrosis and yellowing on pomegranate crop during experimentation

4.6 The effect of insecticide treatment in spraying solution mixture on pH and EC with fungicides and soluble fertilizers

It is revealed from the data presented in Table13 and depicted in fig. 12 that, the treatment cyantraniliprole 10.26 OD in combination with fungicide (i.e. carbendazim and propineb) and soluble fertilizers (00:52:34) showed optimum pH in the range of 7.2 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 cyantraniliprole 10.26 OD in combination with fungicide i.e. (carbendazim and propineb) and soluble fertilizer (00:52:34) showed minimum in the range of 1.00 mmhos 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 (1.483 to 1.393 mmhos), respectively.

The test insecticides spinosad 45 SC, chlorfenpyre 10 SC with mancozeb showed physical compatibility with change in color into pale yellow without clumps with moderate pH of 7.4 to 7.8 while the thiodicarb 50 WP, chlofenapyr mixture with mancozeb showed precipitation with alkaline pH of 8.64 and 8.70 which is collaborative as reported by Suneel kumar *et al.* (2016). However, the combination of chlorantraniliprole with hexaconazole gave better efficacy (Bhuvaneshwari *et al.*, 2013). Siddartha *et al.* (2014) showed the synergetic effect of chlorantraniliprole with fungicide mancozeb + carbendazim, which is also corroborative with present investigation. Similar results were found in agreement with us as reported by Schenck and Aldlerz (1963), Itango and Uttanasamy (1991), Multaih *et al.* (1991), Nagia *et al.* (1993), Dodan *et al.* (1997) and Lakshminarayan (2000) who reported well the attributes of mancozeb and carbendazim with monocrotophos and acephate and showed physical compatibility.

Our findings are in agreement with Suneel kumar *et al.* (2016) who studied physical compatibility of test insecticide and fungicide combinations under laboratory conditions showed that when mancozeb 75 WP was mixed with spinosad 45 SC, thiodicarb 75 WP and chlorfenapyr 10 SC, and the spray fluid showed pale yellow colour, while it was dark yellow with flubendiamide 20 WG. The fungicide was smoothly mixed with spinosad 45 SC and flubendiamide 20 WG after stirring and no clumps were observed with a moderate pH of 7.41 and 7.80, respectively. Whereas with thiodicarb 75 WP and chlorfenapyr 10 SC, slight precipitation was observed with an alkaline pH of 8.64 and 8.70, respectively. In case of hexaconazole 5 EC, the colour was milky white with all insecticides except thiodicarb 75 WP where pearl colour was noticed. The fungicide was readily soluble with all the insecticides except thiodicarb 75 WP, where precipitation was observed. pH was moderate ranges from 7.82 to 8.32. (It was evident that, the little phytotoxic symptoms were not seen in combination treatments of thiodicarb 75 WP + hexaconazole 5 EC and chlorfenapyr 10 SC + hexaconazole 5 EC with phytotoxicity score of 1 (0 – 10%) only at recommended dose). No phytotoxic symptoms were observed in any of the rest insecticide and fungicide combinations at recommended dose.

Our findings are also similar with the findings of Anonymus (2013) who stated that DuPont™ Benevia® insecticide is compatible with many commonly used fungicides, liquid fertilisers, herbicides, insecticides, and biological control products with the recommended mixing sequence.

Present findings are in accordance with the findings of Prakash Reddy (1984) reported that, the emulsion stability of fenvalerate was effected due to more sedimentation when mixed with mancozeb, but unaffected with carbendazim. However, decamethrin was physically compatible with carbendazim and mancozeb.

Table 1. Bioefficacy and compatibility of new insecticide molecule against aphids on pomegranate during first spray

Tr. No.	Treatments	Dose (per lit.)	Pre Count	Av. number of survived aphids / 5 cm twig after first spray					
				1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	Mean
T1	Cyantraniliprole 10.26 % OD	0.2 ml	13.67 (3.76)	8.73 (3.03)	5.87 (2.52)	4.78 (2.30)	6.73 (2.68)	7.80 (2.88)	6.78 (2.68)
T2	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP	0.2 ml +1.0 gm	14.20 (3.83)	7.73 (2.87)	5.00 (2.34)	4.03 (2.13)	5.87 (2.52)	7.70 (2.86)	6.06 (2.54)
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + 00:52:34(Ferti.)	0.2 ml +1 gm +5 gm	13.80 (3.78)	6.73 (2.69)	4.60 (2.26)	3.57 (2.01)	5.47 (2.44)	6.27 (2.60)	5.32 (2.40)
T4	Cyantraniliprole 10.26 % OD	0.3 ml	13.93 (3.80)	8.13 (2.94)	5.53 (2.46)	4.37 (2.21)	6.60 (2.66)	7.80 (2.87)	6.48 (2.62)
T5	Cyantraniliprole 10.26 % OD + Propineb 50 WP	0.3 ml +1.0 gm	14.47 (3.86)	7.33 (2.80)	4.93 (2.33)	3.83 (2.08)	6.00 (2.55)	6.60 (2.66)	5.73 (2.48)
T6	Cyantraniliprole 10.26 % OD + Propineb 50 WP + 00:52:34(Ferti.)	0.3 ml +1 gm +5 gm	14.33 (3.85)	5.80 (2.51)	4.40 (2.21)	3.43 (1.98)	5.33 (2.41)	5.60 (2.47)	4.91 (2.31)
T7	Emamectin benzoate 5 SG	0.5 gm	14.07 (3.82)	10.07 (3.24)	6.33 (2.61)	5.13 (2.37)	6.93 (2.72)	8.00 (2.91)	7.29 (2.77)
T8	Spinosad 45 SC	0.2 ml	14.93 (3.93)	9.80 (3.21)	6 (2.54)	4.97 (2.33)	6.87 (2.71)	7.87 (2.89)	7.10 (2.73)
T9	Untreated Control	-	14.80 (3.91)	15.13 (3.95)	14.40 (3.86)	14.20 (3.83)	15.00 (3.94)	15.80 (4.04)	14.90 (3.92)
	S.E.±	-	0.11	0.10	0.07	0.07	0.089	0.092	-
	CD at 5 %	-	NS	0.31	0.23	0.21	0.26	0.27	-

*Figures in parenthesis are (√x+0.5) transformed values. DAS- Day after spray

Table 2. Bioefficacy and compatibility of new insecticide molecule against aphids on pomegranate during 2nd spray

Tr. No.	Treatments	Dose (per lit.)	Av. number of survived aphids / 5 cm twig after second spray					
			1 DAS	**3 DAS**	**7 DAS**	**10 DAS**	**15 DAS**	**Mean**
T1	Cyantraniliprole 10.26 % OD	0.2 ml	5.00 (2.34)	3.67 (2.04)	3.20 (1.92)	4.93 (2.33)	5.60 (2.47)	4.48 (2.22)
T2	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP	0.2 ml +1.0 gm	4.33 (2.20)	3.20 (1.92)	2.62 (1.76)	4.20 (2.16)	5.13 (2.37)	3.89 (2.08)
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + 00:52:34(Ferti.)	0.2 ml +1 gm +5 gm	3.80 (2.07)	3.00 (1.87)	2.27 (1.66)	3.53 (2.01)	4.00 (2.12)	3.32 (1.94)
T4	Cyantraniliprole 10.26 % OD	0.3 ml	4.67 (2.27)	3.40 (1.97)	3.00 (1.87)	4.67 (2.27)	5.40 (2.42)	4.22 (2.16)
T5	Cyantraniliprole 10.26 % OD + Propineb 50 WP	0.3 ml +1.0 gm	4.13 (2.15)	3.13 (1.90)	2.47 (1.72)	3.80 (2.07)	5.00 (2.34)	3.70 (2.03)
T6	Cyantraniliprole 10.26 % OD + Propineb 50 WP + 00:52:34(Ferti.)	0.3 ml +1 gm +5 gm	3.67 (2.04)	2.40 (1.70)	1.93 (1.56)	3.20 (1.92)	3.67 (2.04)	2.97 (1.85)
T7	Emamectin benzoate 5 SG	0.5 gm	5.67 (2.48)	4.73 (2.28)	4.20 (2.16)	5.73 (2.49)	6.67 (2.67)	5.40 (2.41)
T8	Spinosad 45 SC	0.2 ml	5.33 (2.41)	4.20 (2.16)	3.87 (2.09)	5.27 (2.40)	6.20 (2.58)	4.97 (2.32)
T9	Untreated Control	-	17.07 (4.19)	15.67 (4.02)	14.73 (3.90)	16.47 (4.12)	14.73 (3.90)	15.73 (4.02)
	S.E.±	-	0.073	0.076	0.072	0.075	0.087	-
	CD at 5 %	-	0.21	0.23	0.21	0.22	0.26	-

*Figures in parenthesis are ($\sqrt{x+0.5}$) transformed values. DAS- Day after spray

Table 3. Pooled data on bioefficacy and compatibility of new insecticide molecule against aphids on pomegranate

Tr. No.	Treatments	Dose (per lit.)	Pre-count	Average number of survived aphids /5 cm apical twig pooled data of two sprays					
				1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	Pooled mean
				Mean	Mean	Mean	Mean	Mean	
T1	Cyantraniliprole 10.26 % OD	0.2 ml	13.67 (3.76)	6.87 2.69)	4.77 (2.28)	3.99 (2.11)	5.83 (2.50)	6.70 (2.67)	5.63 (2.45)
T2	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP	0.2 ml +1.0 gm	14.20 (3.83)	6.03 (2.53)	4.10 (2.13)	3.33 (1.95)	5.03 (2.34)	6.41 (2.61)	4.97 (2.31)
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + 00:52:34(Ferti.)	0.2 ml +1 gm +5 gm	13.80 (3.78)	5.27 (2.38)	3.80 (2.06)	2.92* (1.84)	4.50 (2.22)	5.13 (2.36)	4.32 (2.17)
T4	Cyantraniliprole 10.26 % OD	0.3 ml	13.93 (3.80)	6.40 (2.60)	4.47 (2.22)	3.68 (2.04)	5.63 (2.46)	6.60 (2.64)	5.30 (2.39)
T5	Cyantraniliprole 10.26 % OD + Propineb 50 WP	0.3 ml +1.0 gm	14.47 (3.86)	5.73 (2.47)	4.03 (2.12)	3.15 (1.90)	4.90 (2.31)	5.8 (2.50)	4.71 (2.25)
T6	Cyantraniliprole 10.26 % OD + Propineb 50 WP + 00:52:34(Ferti.)	0.3 ml +1 gm +5 gm	14.33 (3.85)	4.73 (2.28)	3.40 (1.96)	2.68* (1.77)	4.27 (2.17)	4.63 (2.25)	3.94 (2.08)
T7	Emamectin Benzoate 5 SG	0.5 gm	14.07 (3.82)	7.87 (2.86)	5.53 (2.44)	4.67 (2.26)	6.33 (2.61)	7.33 (2.79)	6.34 (2.59)
T8	Spinosad 45 SC	0.2 ml	14.93 (3.93)	7.57 (2.81)	5.10 (2.35)	4.42 (2.21)	6.07 (2.56)	7.03 (2.74)	6.03 (2.52)
T9	Untreated Control	-	14.80 (3.91)	16.10 (4.07)	15.03 (3.94)	14.47 (3.87)	15.73 (4.03)	15.27 (3.97)	15.31 (3.97)
	S.E.±	-	0.11	0.086	0.07	0.07	0.082	0.089	-
	CD at 5 %	-	NS	0.26	0.23	0.21	0.24	0.26	-

*Figures in parenthesis are (√x+0.5) transformed values. DAS- Day after spray

Table 4. Bioefficacy and compatibility of new insecticide molecule against thrips on pomegranate during first spray

Tr. No.	Treatments	Dose (per lit.)	Pre count	Av. number of survived thrips / 5 cm twig after first spray					
				1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	Mean
T1	Cyantraniliprole 10.26 % OD	0.2 ml	10.87 (3.36)	6.53 (2.65)	4.80 (2.30)	4.13 (2.15)	5.08 (2.36)	6.73 (2.69)	5.45 (2.43)
T2	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP	0.2 ml +1.0 gm	11.47 (3.44)	6.20 (2.59)	3.80 (2.07)	3.53 (2.01)	4.00 (2.12)	6.13 (2.57)	4.73 (2.27)
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + 00:52:34(Ferti.)	0.2 ml +1 gm +5 gm	11.33 (3.44)	5.40 (2.43)	3.47 (1.99)	3.07 (1.89)	3.60 (2.02)	4.93 (2.33)	4.09 (2.13)
T4	Cyantraniliprole 10.26 % OD	0.3 ml	12.47 (3.60)	6.33 (2.61)	4.60 (2.25)	3.73 (2.06)	5.13 (2.37)	6.40 (2.62)	5.23 (2.38)
T5	Cyantraniliprole 10.26 % OD + Propineb 50 WP	0.3 ml +1.0 gm	10.47 (3.31)	6.07 (2.56)	3.67 (2.04)	3.33 (1.96)	3.80 (2.07)	5.07 (2.36)	4.38 (2.19)
T6	Cyantraniliprole 10.26 % OD + Propineb 50 WP + 00:52:34(Ferti.)	0.3 ml +1 gm +5 gm	10.73 (3.35)	5.13 (2.37)	3.27 (1.94)	2.73 (1.79)	3.40 (1.95)	4.73 (2.29)	3.85 (2.06)
T7	Emamectin benzoate 5 SG	0.5 gm	11.73 (3.50)	7.53 (3.83)	5.53 (2.45)	5.47 (2.44)	6.07 (2.56)	7.60 (2.83)	6.44 (2.82)
T8	Spinosad 45 SC	0.2 ml	11.87 (3.50)	6.93 (3.72)	5.27 (2.40)	3.40 (1.97)	4.53 (2.24)	7.07 (2.75)	5.44 (2.61)
T9	Untreated Control	-	11.07 (3.39)	12.33 (3.58)	13.27 (3.71)	12.27 (3.57)	14.40 (3.86)	16.00 (4.06)	13.65 (3.75)
	S.E.±	-	0.14	0.07	0.07	0.06	0.099	0.085	-
	CD at 5 %	-	NS	0.23	0.23	0.20	0.29	0.25	-

*Figures in parenthesis are (√x+0.5) transformed values. DAS- Day after spray

Table 5. Bioefficacy and compatibility of new insecticide molecule against thrips on pomegranate during 2nd spray

Tr. No.	Treatments	Dose (per lit.)	Av. number of survived thrips / 5 cm twig after second spray					
			1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	Mean
T1	Cyantraniliprole 10.26 % OD	0.2 ml	3.93 (2.10)	2.87 (1.83)	2.37 (1.69)	3.60 (2.02)	4.53 (2.24)	3.46 (1.97)
T2	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP	0.2 ml +1.0 gm	3.40 (1.97)	2.33 (1.68)	1.73 (1.48)	3.00 (1.87)	4.07 (2.14)	2.90 (1.82)
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + 00:52:34(Ferti.)	0.2 ml +1 gm +5 gm	3.07 (1.89)	1.93 (1.55)	1.42 (1.38)	2.60 (1.76)	3.73 (2.06)	2.55 (1.72)
T4	Cyantraniliprole 10.26 % OD	0.3 ml	3.73 (2.06)	2.67 (1.78)	2.17 (1.63)	3.33 (1.96)	4.47 (2.23)	3.27 (1.93)
T5	Cyantraniliprole 10.26 % OD + Propineb 50 WP	0.3 ml +1.0 gm	3.20 (1.92)	2.13 (1.62)	1.60 (1.44)	2.80 (1.82)	3.87 (2.09)	2.72 (1.77)
T6	Cyantraniliprole 10.26 % OD + Propineb 50 WP + 00:52:34(Ferti.)	0.3 ml +1 gm +5 gm	2.87 (1.83)	1.60 (1.45)	1.05 (1.24)	2.47 (1.72)	3.47 (1.99)	2.29 (1.64)
T7	Emamectin Benzoate 5 SG	0.5 gm	4.73 (2.28)	3.20 (1.92)	2.67 (1.77)	4.40 (2.20)	5.93 (2.53)	4.18 (2.14)
T8	Spinosad 45 SC	0.2 ml	4.33 (2.20)	2.07 (1.60)	1.60 (1.45)	4.20 (2.17)	5.20 (2.38)	3.48 (1.96)
T9	Untreated Control	-	17.13 (4.20)	18.53 (4.36)	18.00 (4.30)	19.20 (4.44)	20.53 (4.59)	18.67 (4.37)
	S.E.±	-	0.06	0.06	0.08	0.07	0.07	-
	CD at 5 %	-	0.20	0.18	0.24	0.21	0.21	-

*Figures in parenthesis are ($\sqrt{x+0.5}$) transformed values. DAS- Day after spray

Table 6. Pooled data on bioefficacy and compatibility of new insecticide molecule against thrips

Tr. No.	Treatments	Dose (per lit.)	Pre-count	Average number of survived thrips /5 cm apical twig pooled data of two sprays					
				1 DAS	3 DAS	7 DAS	10 DAS	15 DAS	Pooled mean
				Mean	Mean	Mean	Mean	Mean	
T1	Cyantraniliprole 10.26 % OD	0.2 ml	10.87 (3.36)	5.23 (2.38)	3.83 (2.06)	3.25 (1.92)	4.34 (2.19)	5.60 (2.45)	4.44 (2.2)
T2	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP	0.2 ml +1.0 gm	11.47 (3.44)	4.80 (2.28)	3.06 (1.87)	2.63 (1.74)	3.50 (2.00)	5.10 (2.35)	3.81 (2.04)
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + 00:52:34(Ferti.)	0.2 ml +1 gm +5 gm	11.33 (3.44)	4.23 (2.16)	2.70 (1.76)	2.24 (1.63)	3.10 (1.89)	4.33 (2.20)	3.32 (1.92)
T4	Cyantraniliprole 10.26 % OD	0.3 ml	12.47 (3.60)	5.03 (2.33)	3.63 (2.01)	2.95 (1.84)	4.23 (2.17)	5.34 (2.40)	4.23 (2.15)
T5	Cyantraniliprole 10.26 % OD + Propineb 50 WP	0.3 ml +1.0 gm	10.47 (3.31)	4.63 (2.24)	2.90 (1.83)	2.47 (1.70)	3.30 (1.94)	4.47 (2.23)	3.55 (1.98)
T6	Cyantraniliprole 10.26 % OD + Propineb 50 WP + 00:52:34(Ferti.)	0.3 ml +1 gm +5 gm	10.73 (3.35)	4.00 (2.10)	2.43 (1.69)	1.89 (1.52)	2.93 (1.84)	4.10 (2.14)	3.07 (1.85)
T7	Emamectin Benzoate 5 SG	0.5 gm	11.73 (3.50)	6.13 (2.55)	4.36 (2.18)	4.07 (2.10)	5.23 (2.38)	6.77 (2.08)	5.31 (2.48)
T8	Spinosad 45 SC	0.2 ml	11.87 (3.50)	5.63 (2.46)	4.13 (2.13)	3.72 (2.03)	4.80 (2.30)	6.13 (2.56)	4.46 (2.28)
T9	Untreated Control	-	11.07 (3.39)	14.73 (3.89)	15.90 (3.53)	15.13 (3.94)	16.80 (4.15)	18.27 (4.33)	16.16 (4.37)
	S.E.±	-	0.14	0.065	0.065	0.07	0.08	0.07	-
	CD at 5 %	-	NS	0.215	0.20	0.22	0.25	0.23	-

*Figures in parenthesis are (√x+0.5) transformed values. DAS- Day after spray

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

Tr. No.	Treatments	Dose (per lit.)	Precount	Av. number of Ladybird beetles / 5 twigs			
				First spray		Second spray	
				First week after spraying	Second week after spraying	First week after spraying	Second week after spraying
T1	Cyantraniliprole 10.26 % OD	0.2 ml	1.23 (1.31)	0.98 (1.22)	0.87 (1.17)	0.71 (1.10)	0.55 (1.02)
T2	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP	0.2 ml +1.0 gm	1.37 (1.36)	1.02 (1.23)	0.91 (1.19)	0.76 (1.12)	0.60 (1.04)
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + 00:52:34(Ferti.)	0.2 ml +1 gm +5gm	1.27 (1.33)	1.10 (1.26)	0.95 (1.20)	0.78 (1.13)	0.63 (1.06)
T4	Cyantraniliprole 10.26 % OD	0.3 ml	1.40 (1.37)	0.92 (1.19)	0.82 (1.15)	0.67 (1.08)	0.48 (0.99)
T5	Cyantraniliprole 10.26 % OD + Propineb 50 WP	0.3 ml +1.0 gm	1.30 (1.34)	0.94 (1.19)	0.87 (1.17)	0.69 (1.08)	0.51 (1.0)
T6	Cyantraniliprole 10.26 % OD + Propineb 50 WP + 00:52:34(Ferti.)	0.3 ml +1 gm +5gm	1.00 (1.22)	0.87 (1.22)	0.90 (1.18)	0.73 (1.11)	0.53 (1.01)
T7	Emamectin Benzoate 5 SG	0.5 gm	1.33 (1.35)	0.88 (1.17)	0.78 (1.13)	0.65 (1.07)	0.45 (0.96)
T8	Spinosad 45 SC	0.2 ml	1.00 (1.22)	0.93 (1.20)	0.88 (1.17)	0.73 (1.11)	0.53 (1.01)
T9	Untreated control	-	1.38 (1.37)	1.43 (1.39)	1.50 (1.41)	1.32 (1.34)	1.25 (1.32)
	S.E.±	-	0.050	0.052	0.053	0.066	0.068
	CD at 5 %	-	NS	NS	NS	NS	NS

*Figures in parenthesis are (√x+0.5) transformed values.

Table 8. Effect of different treatments on per cent fruit borer damage on pomegranate

Tr. No.	Treatment	Dose (per lit.)	Av. percent fruit borer damage at harvest			Av. percent fruit damage
			RI	RII	RIII	
T1	Cyantraniliprole 10.26 % OD	0.2 ml	4.42 (12.14)	3.37 (10.58)	2.80 (9.63)	3.53 (10.78)
T2	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP	0.2 ml +1.0 gm	3.63 (10.98)	3.06 (10.07)	2.66 (9.39)	3.12 (10.15)
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + 00:52:34(Ferti.)	0.2 ml +1 gm +5gm	1.69 (7.47)	2.36 (8.84)	2.10 (8.33)	2.05 (8.21)
T4	Cyantraniliprole 10.26 % OD	0.3 ml	2.42 (9.01)	3.80 (11.24)	4.16 (11.77)	3.47 (10.67)
T5	Cyantraniliprole 10.26 % OD + Propineb 50 WP	0.3 ml +1.0 gm	3.77 (11.20)	2.56 (9.21)	2.75 (9.55)	3.03 (9.98)
T6	Cyantraniliprole 10.26 % OD + Propineb 50 WP + 00:52:34(Ferti.)	0.3 ml +1 gm +5gm	1.69 (7.47)	0.78 (5.07)	1.05 (5.88)	1.17 (6.14)
T7	Emamectin Benzoate 5 SG	0.5 gm	2.22 (8.57)	1.81 (7.73)	2.54 (9.17)	2.19 (8.49)
T8	Spinosad 45 SC	0.2 ml	4.12 (10.71)	3.44 (10.69)	4.95 (12.86)	4.17 (11.75)
T9	Untreated Control	-	10.22 (18.64)	9.70 (18.15)	12.38 (20.60)	10.77 (19.13)
	S.E±					0.63
	C.D. at 5%					1.91

*Figures in parenthesis are arc sin transformed values

Table 9. Effect of different treatments on flower buds and percent fruit setting of pomegranate

Tr. No.	Treatments	Dose (per lit.)	Total number of buds and flowers			Total number of fruits			Av. No. of buds	Av. No. of fruits	Av. % fruit setting
			RI	RII	RIII	RI	RII	RIII			
T1	Cyantraniliprole 10.26 % OD	0.2 ml	169	139	128	110	98	75	145.3	94.33	64.90
T2	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP	0.2 ml +1.0 gm	154	173	166	106	117	109	164.3	110.6	67.34
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + 00:52:34(Ferti.)	0.2 ml +1 gm +5gm	187	152	167	122	105	120	168.6	115.6	68.58
T4	Cyantraniliprole 10.26 % OD	0.3 ml	181	179	156	118	127	95	172	113.3	65.88
T5	Cyantraniliprole 10.26 % OD + Propineb 50 WP	0.3 ml +1.0 gm	165	132	157	113	89	107	151.3	103	68.06
T6	Cyantraniliprole 10.26 % OD + Propineb 50 WP + 00:52:34(Ferti.)	0.3 ml +1 gm +5gm	160	184	136	118	127	95	160	113.3	70.83
T7	Emamectin benzoate 5 SG	0.5 gm	135	161	179	90	110	118	158	106	67.08
T8	Spinosad 45 SC	0.2 ml	145	176	149	97	116	101	156	104.6	67.09
T9	Untreated control		137	155	152	88	103	105	148	98.67	66.66
S.E.±									0.42	0.37	-
CD at 5 %									NS	NS	-

*Figures in parenthesis are arc sin transformed values

Table 10. Effect of different treatment on yield in pomegranate

Tr. No.	Treatment	Dose (per lit.)	Yield in kg / plant			Av. yield in kg / plant	Av. yield in t. /ha.
			RI	RII	RIII		
T1	Cyantraniliprole 10.26 % OD	0.2 ml	16.25	15.25	16.75	16.08	11.89
T2	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP	0.2 ml +1.0 gm	16.75	15.75	17.50	16.67	12.33
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + 00:52:34(Ferti.)	0.2 ml +1 gm +5 gm	19.00	18.50	19.25	18.92	14.00
T4	Cyantraniliprole 10.26 % OD	0.3 ml	17.00	16.70	17.50	17.07	12.63
T5	Cyantraniliprole 10.26 % OD + Propineb 50 WP	0.3 ml +1.0 gm	16.75	17.00	17.50	17.10	12.65
T6	Cyantraniliprole 10.26 % OD + Propineb 50 WP + 00:52:34(Ferti.)	0.3 ml +1 gm +5 gm	20.50	19.50	19.00	19.7	14.57
T7	Emamectin Benzoate 5 SG	0.5 gm	17.75	18.75	19.50	18.66	13.80
T8	Spinosad 45 SC	0.2 ml	14.75	15.50	16.75	15.67	11.59
T9	Untreated Control	-	11.50	12.50	12.00	12.00	8.88
	S.E±					0.40	-
	C.D. at 5%					1.20	-

Table 11. Effect of insecticide treatments in spray solution mixture on colour, foaming and sedimentation

Tr. No.	Treatments	Dose (per lit.)	Colour			Foaming			Sedimentation		
			1 Hr	24 Hr	48 Hr	1 Hr	24 Hr	48 Hr	1 Hr	24 Hr	48 Hr
T1	Cyantraniliprole 10.26 % OD	0.2 ml	Pale white	Pale white	Pale white	-	-	-	-	-	-
T2	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP	0.2 ml +1.0 gm	Pearl white	Pearl white	Pearl white	-	-	-	-	√	√
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + 00:52:34(Ferti.)	0.2 ml +1 gm +5 gm	Milky white	Milky white	Milky white	-	-	-	-	√	√
T4	Cyantraniliprole 10.26 % OD	0.3 ml	Pale white	Pale white	Pale white	-	-	-	-	-	-
T5	Cyantraniliprole 10.26 % OD + Propineb 50 WP	0.3 ml +1.0 gm	Creamy white	Creamy white	Creamy white	-	-	-	-	√	√
T6	Cyantraniliprole 10.26 % OD + Propineb 50 WP + 00:52:34(Ferti.)	0.3 ml +1 gm +5 gm	Pale yellow	Pale yellow	Pale yellow	-	-	-	-	√	√
T7	Emamectin benzoate 5 SG	0.5 gm	Colourless	Colourless	Colour less	-	-	-	-	-	-
T8	Spinosad 45 SC	0.2 ml	Pearl white	Pearl white	Pearl white	-	-	-	-	-	-
T9	Blank	-	Colourless	Colourless	Colourless	-	-	-	-	-	-

Table 12. Studies on phytotoxicity effects of insecticides with fungicides and soluble fertilizers on pomegranate

Tr. No.	Treatments	Dose (per lit.)	Observation Timing Score value				
			1 DAS	3 DAS	5 DAS	7 DAS	10 DAS
T1	Cyantraniliprole 10.26% OD	0.2 ml	0	0	0	0	0
T2	Cyantraniliprole 10.26% OD + Carbendazim 50 WP	0.2 ml + 1.0 gm	0	0	0	0	0
T3	Cyantraniliprole 10.26% OD + Carbendazim 50 WP + 00:52:34	0.2 ml + 1 g + 5 gm	0	0	0	0	0
T4	Cyantraniliprole 10.26% OD	0.3 ml	0	0	0	0	0
T5	Cyantraniliprole 10.26% OD + Propineb 50 WP	0.3 ml + 1.0 gm	0	0	0	0	0
T6	Cyantraniliprole 10.26% OD + Propineb 50 WP + 00:52:34	0.3 ml + 1 gm + 5 gm	0	0	0	0	0
T7	Emamectin benzoate	0.5 gm	0	0	0	0	0
T8	Spinosad 45 SC	0.2 ml	0	0	0	0	0
T9	Untreated Check	-	0	0	0	0	0

Table 13. Effect of insecticide treatments in spray solution mixture on pH and EC with fungicide and soluble fertilizer

Tr. No.	Treatment	Dose (per lit.)	Av. values of pH			Av. values of EC (mmhos) at		
			1 Hr	24 Hr	48 Hr	1 Hr	24 Hr	48 Hr
T1	Cyantraniliprole 10.26 % OD	0.2 ml	7.9	7.7	7.8	1.427	1.417	1.407
T2	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP	0.2 ml + 1.0 gm	7.9	7.8	7.3	1.426	1.462	1.466
T3	Cyantraniliprole 10.26 % OD + Carbendazim 50 WP + 00:52:34(Ferti.)	0.2 ml + 1 gm + 5 gm	7.2	7.4	7.1	1.00	1.00	1.00
T4	Cyantraniliprole 10.26 % OD	0.3 ml	7.8	7.8	7.8	1.421	1.414	1.405
T5	Cyantraniliprole 10.26 % OD + Propineb 50 WP	0.3 ml +1.0 gm	7.6	7.7	7.7	1.483	1.471	1.457
T6	Cyantraniliprole 10.26 % OD + Propineb 50 WP + 00:52:34(Ferti.)	0.3 ml +1 gm + 5 gm	7.3	7.5	7.4	1.00	1.00	1.00
T7	Emamectin benzoate 5 SG	0.5 gm	7.8	7.7	7.9	1.397	1.393	1.389
T8	Spinosad 45 SC	0.2 ml	7.6	8.1	8.1	1.408	1.401	1.395
T9	Blank	-	7.9	7.8	8.0	1.409	1.401	1.400

5. SUMMARY AND CONCLUSIONS

Cultivation of high yielding cultivars of pomegranate and management in the recent past under irrigated condition with early stage exploitation of plants has led to certain severe pest problems. Among them infestation of sucking pest like aphids, thrips, whiteflies, mealy bugs, scale insects, mites and fruit borer which results in low marketable yield of pomegranate. The major constraint in increasing export potential is the quality of fruits in terms of size, colour and attractiveness along with residue proof in fruit production of pomegranate.

The knowledge about compatibility of agrochemicals is very vital in selecting the compatible combination for effective management of insect pests, diseases and weeds. In pomegranate cultivation, the management of pests and disease, use of insecticides with fungicides and liquid fertilizers as well as growth regulators is common practice among the crop growers. Combined application of pesticides is a labour saving short cut method, but an understanding and knowledge of pesticide compatibility is essential in order to avoid problems. Therefore, pesticides (insecticides, fungicides) and soluble fertilizers are important inputs of pomegranate. Pesticide combinations may show physical, chemical or phytotoxic incompatibility causing undesirable results.

Therefore, it was felt necessary to study the efficacy and compatibility of insecticides, fungicides and fertilizers for the effective control of pest of pomegranate.

The nine insecticidal treatments comprising of application of cyantraniliprole 10.26 % OD, cyantraniliprole 10.26 % OD +

carbendazim 50 WP, cyantraniliprole 10.26 % OD + carbendazim 50 WP + soluble fertilizer 00:52:34, cyantraniliprole 10.26 % OD + propineb 50 WP, cyantraniliprole 10.26 % OD + propineb 50 WP + soluble fertilizer 00:52:34, emamectin benzoate 5 SG, spinosad 45 SC 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 on bioefficacy of various treatments against pomegranate aphids indicated that the different treatment, the combination treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1g with soluble fertilizer (00:52:34) 5 g per lit water) was found most effective and compatible for the control of aphids and recorded least average survived aphids i.e. 2.68 to 4.73 as against 14.47 to 16.10 per twigs in untreated control on first to 15th days after spray observation.

However, the combination treatment of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendanzim 50 WP 1 g with soluble fertilizer (0:52:34) 5 g per lit water) was found most effective and compatible for the control of aphids.

5.1.2 Efficacy of insecticide against thrips (*S. dorsalis*) on pomegranate

The combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1g with soluble fertilizer (00:52:34) 5 g per lit water) was found most effective and compatible for the control of thrips (i.e. 1.89 to 4.10) as against (14.73 to 18.27 per twigs) untreated control. However, the combination treatment of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendanzim 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit water) was found most effective and compatible for the control of thrips.

5.1.3 Effect of treatment on natural enemies and fruit borer (*D. isocrates*) on pomegranate

Among the combination treatments of insecticides with fungicides and fertilizer and alone insecticide treatment- it was evidently noticed that, the effect of all treatments on lady bird beetle population were non-significant.

However, the combat treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit water) was found significantly superior for the control of fruit borer and recorded least average (1.17 per cent fruit damage) as against (10.77 per cent fruit damage) untreated control at harvest followed by the treatment of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with water soluble fertilizer (0:52:34) 5 g per lit. of water) was found next best treatment in registering the least fruit damage followed by the treatment emamectin benzoate 5 SG at 0.5 g per lit. of water.

5.1.4 Effect of treatment on per cent fruit setting on pomegranate

It is revealed from the data, that the treatment of cyantraniliprole 10.26 % OD + propineb 50 WP + soluble fertilizer (00:52:34) + @ (0.3 ml + 1 + 5 g / lit.), respectively was found most effective in registering the highest fruit setting (i.e. 70.83 %) and also found on par with the treatment of cyantraniliprole 10.26 % OD + carbendazim 50 WP + soluble fertilizer (00:52:34) @ (0.2 ml + 1 g + 5 g /lit of water respectively) in registering the maximum fruit setting.

5.1.5 Effect of treatment on fruit yield of pomegranate

The treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1g with soluble fertilizer (00:52:34) 5 g per lit. of water) was found most effective in registering the highest marketable fruit yield i.e. (19.7 kg per plant i.e. 14.57 t/ha) as against 12.0 kg per plant i.e. (8.89 t/ha) in untreated control and also found on par with the treatment of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1g with soluble fertilizer (00:52:34) 5 g per lit. of water) in registering the maximum fruit yield.

5.2 Compatibility of new insecticide molecule with fungicide and soluble fertilizers.

As regards the compatibility test, all the treatments under investigation did not show any incompatability regarding the discoloration, foaming effect and sedimentation at 1, 24 and 48 hrs after observation. Whereas, the treatment cyantraniliprole 10.26 % OD in combination with fungicide (i.e. carbendazim and propineb) and soluble fertilizers (00:52:34) showed optimum pH in the range of 7.2 to 7.5 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 treatment cyantraniliprole 10.26 % OD in combination with fungicide i.e. (carbendazim and propineb) and soluble fertilizer (0:52:34) showed minimum in the range of 1.00 mmhos after 1 hr, same trend was found after 24 hr and 48 hr.

5.3 Conclusion

- Among the different treatments, the combination treatment of cyantraniliprole 10.26 % OD (each at 0.3 ml + propineb 50 WP 1g with soluble fertilizer (00:52:34) 5 g per lit water) was found most effective and compatible for the control of sucking pests and fruit borer with highest marketable yield 18.92 kg per plant (14.00 t/ha) of pomegranate fruit.
- The combination treatment of cyantraniliprole 10.26 % OD (each at 0.2 ml + carbendazim 50 WP 1 g with soluble fertilizer (00:52:34) 5 g per lit. water) was also found equally effective and compatible for the control of aphids, thrips and fruit borer on pomegranate.
- Both the effective combination treatments also found safe to natural enemies.
- As regards compatibility tests, it was observed that all the treatments under investigation were at 1, 24 and 48 hr after observation.
- The treatment with insecticide and combination with fungicides and alone showed slightly change in pH towards alkalinity.
- It is clearly noticed that, the treatment of cyantraniliprole 10.26 % OD in combination with fungicide i.e. (carbendazim and propineb) and soluble fertilizers (00:52:34) showed optimum pH in the range of 7.2 to 7.5 after 1 hr, same trend was found after 24 hr and 48 hr.

observation and found most compatible and effective for the control of pests.

- None of the treatment with combination and alone showed any phytotoxicity or adverse effects on pomegranate.

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7. VITA

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A candidate for the degree

of

MASTER OF SCIENCE (AGRICULTURE)

in

AGRICULTURAL ENTOMOLOGY

2017

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

Plate: 2. Thrips infestation and its symptoms

Plate: 1. General view of experimental field

Plate: 3. Aphids infestation and its symptoms

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

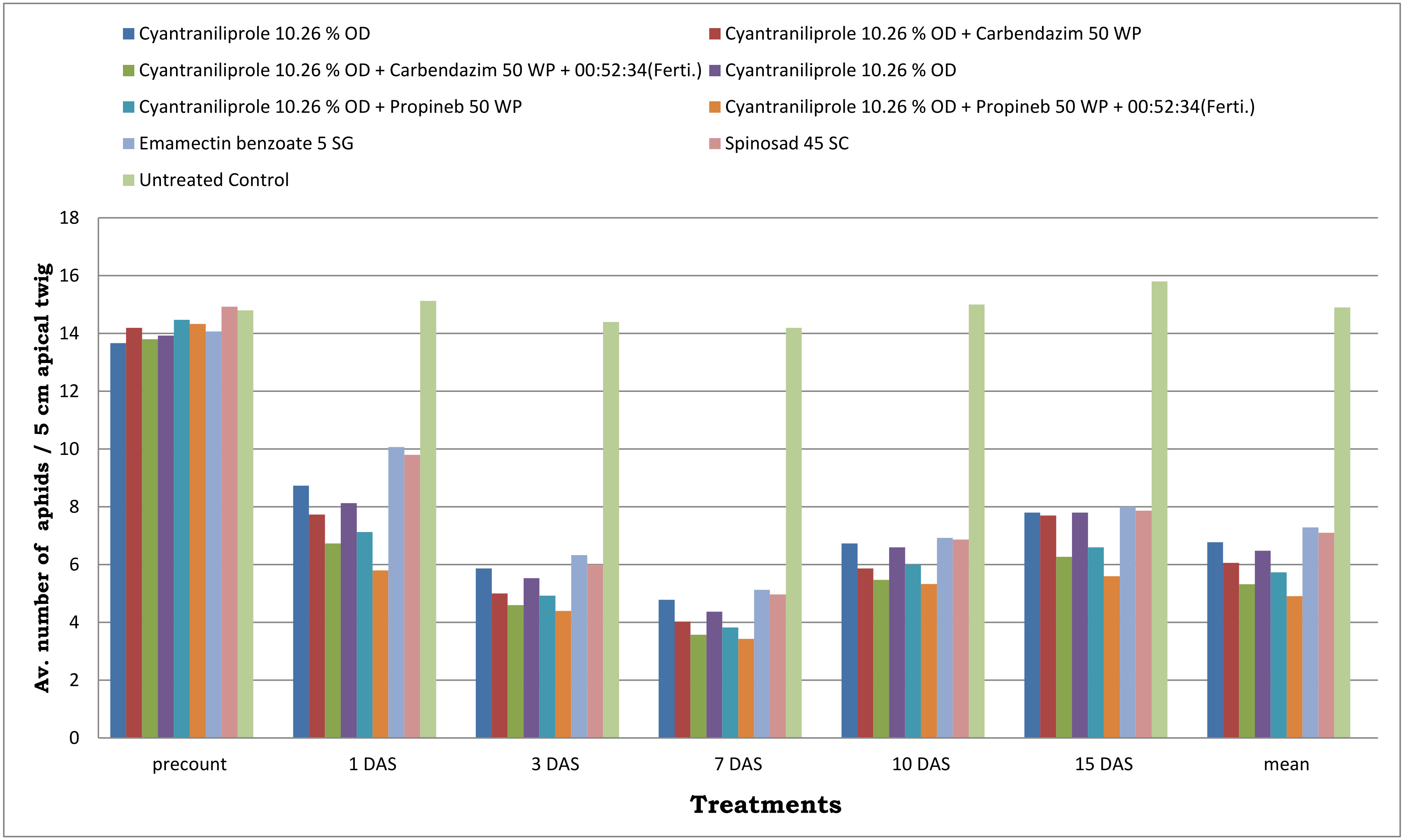

Fig. 2. Bioefficacy and compatibility of new insecticide molecule against aphids after 1st spray on pomegranate

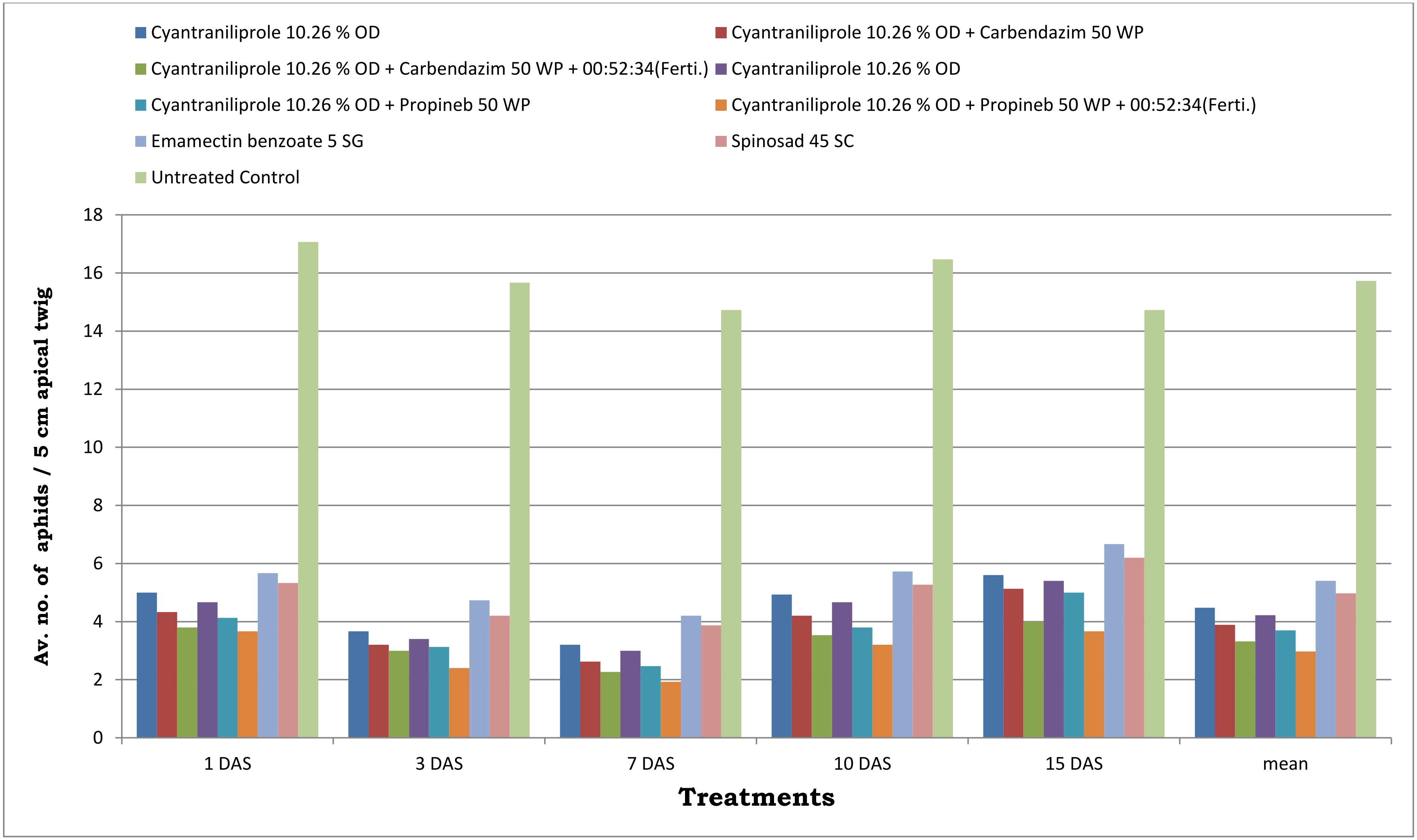

Fig. 3. Bioefficacy and compatibility of new insecticide molecule against aphids after 2nd spray on pomegranate

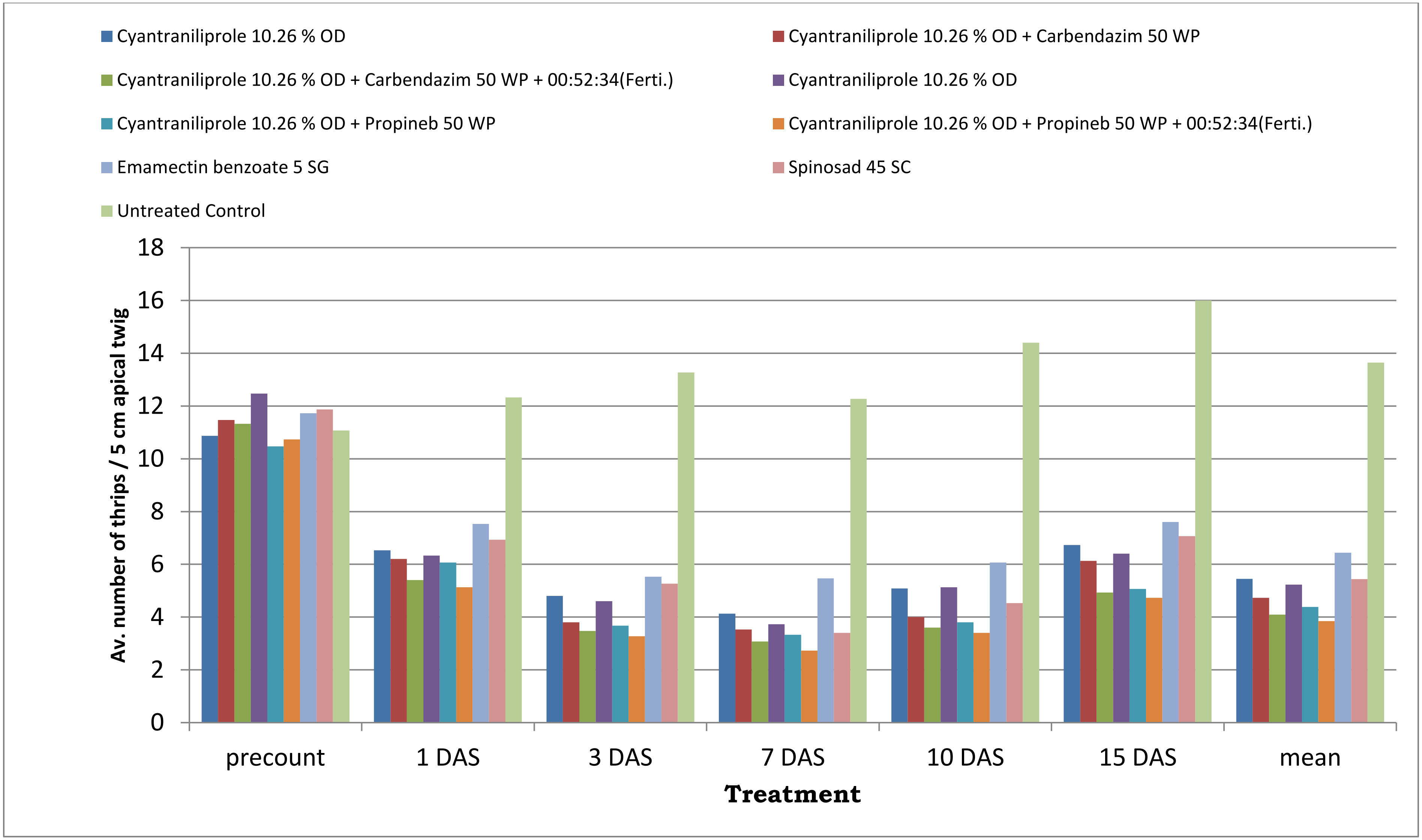

Fig. 5. Bioefficacy and compatibility of new insecticide molecule against thrips after 1st spray on pomegranate

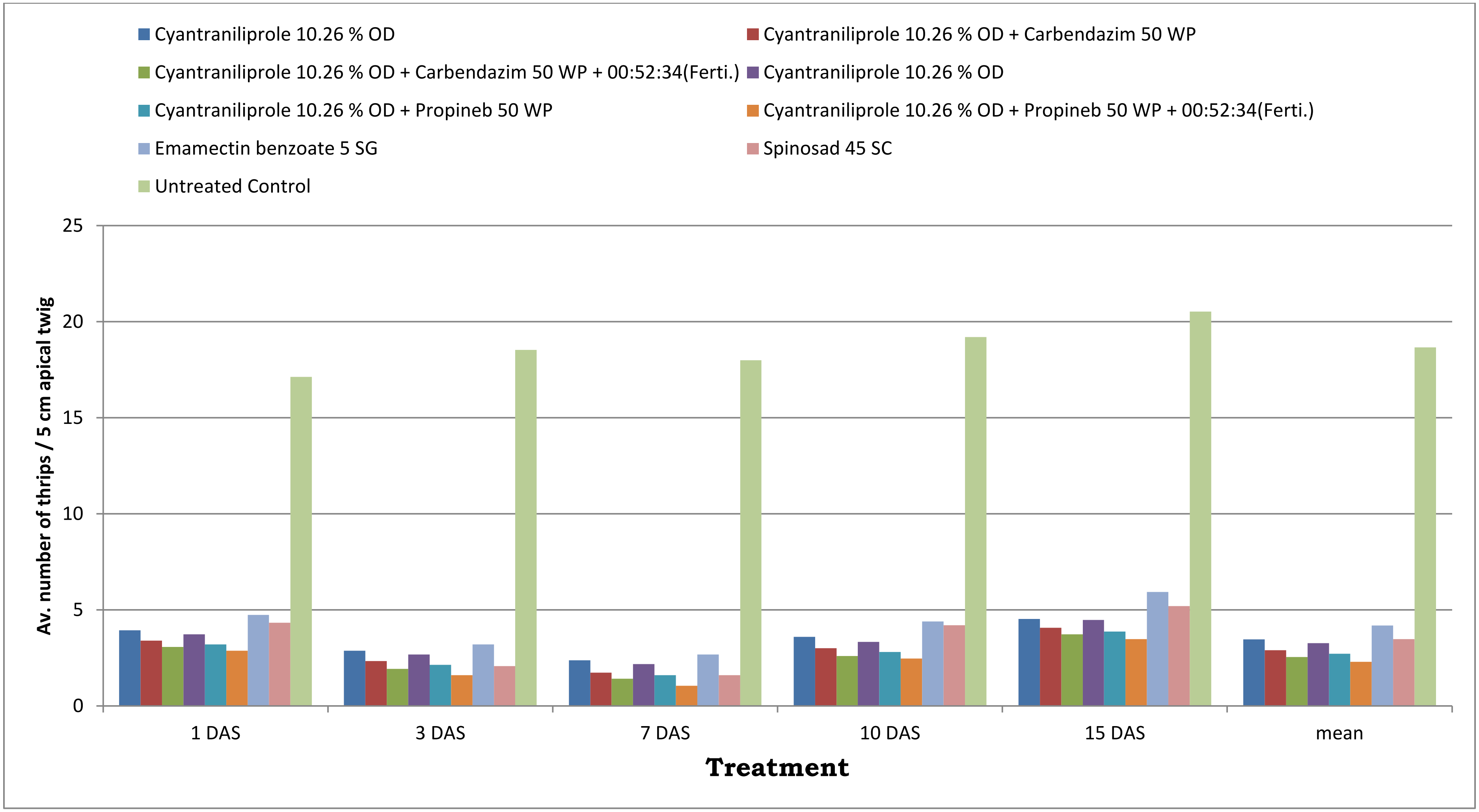

Fig. 6. Bioefficacy and compatibility of new insecticide molecule against thrips after 2nd spray on pomegranate

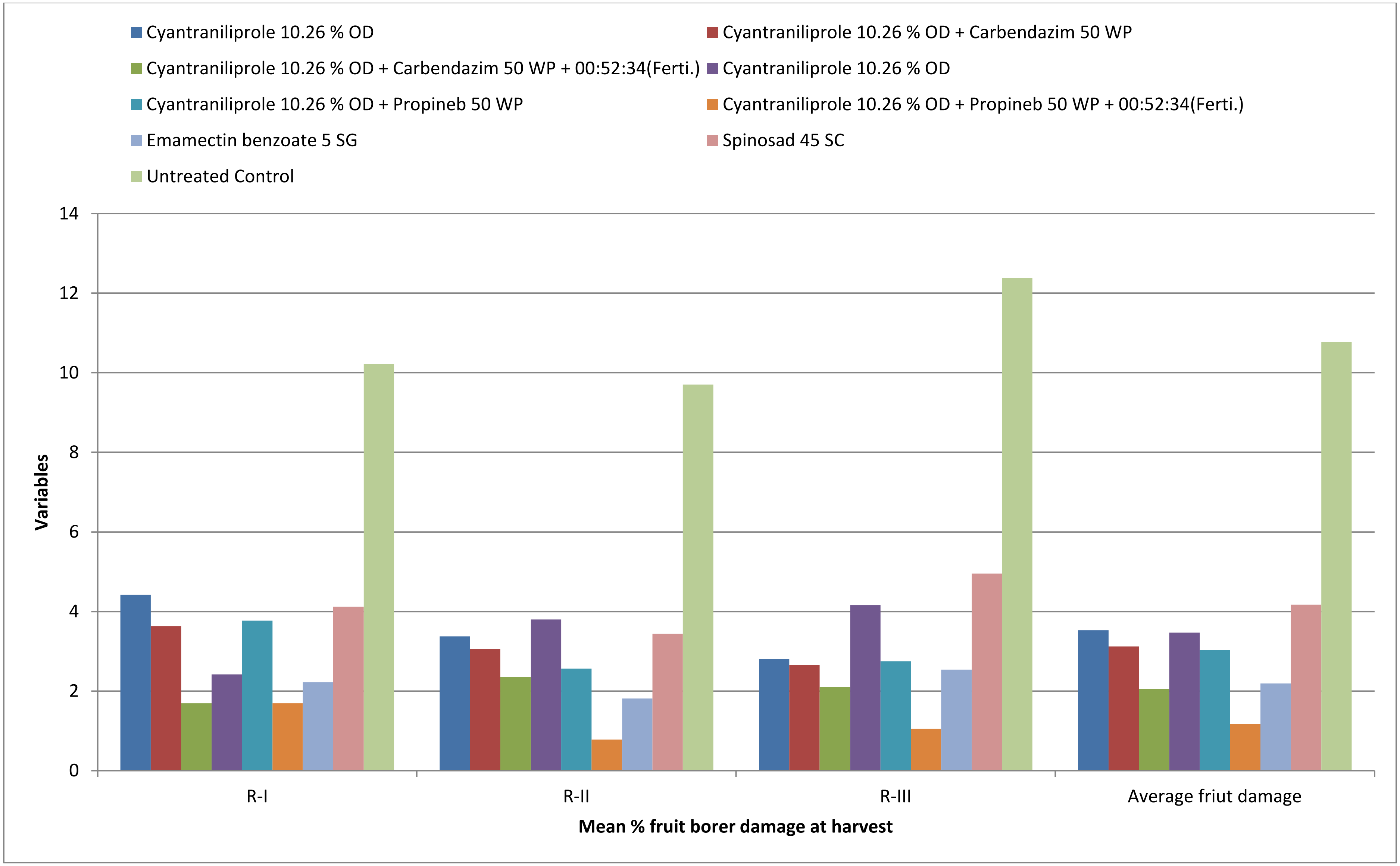

Fig. 9. Effect of treatments on per cent fruit borer damage on pomegranate

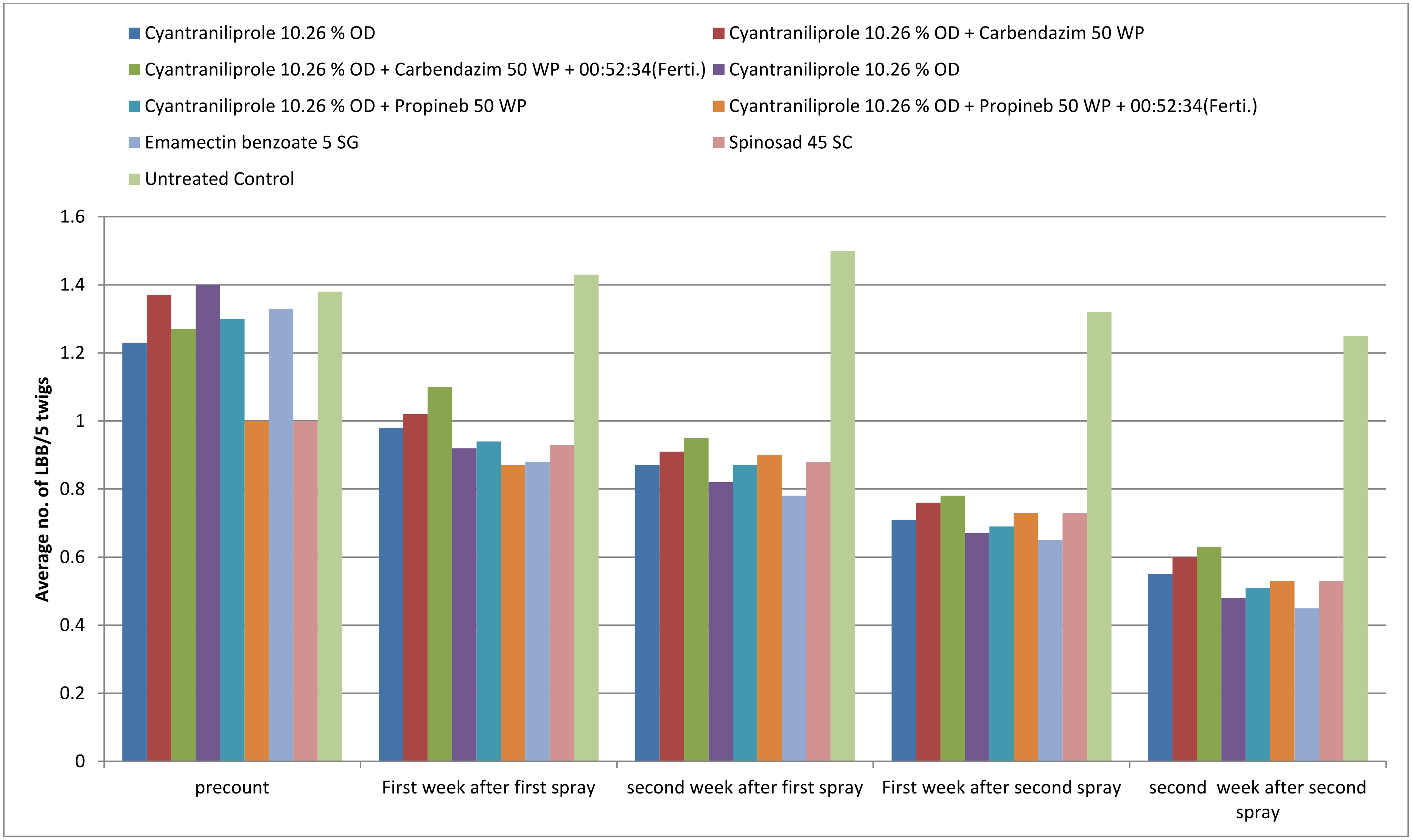

Fig. 8. Effect of different treatments on lady bird beetle on pomegranate

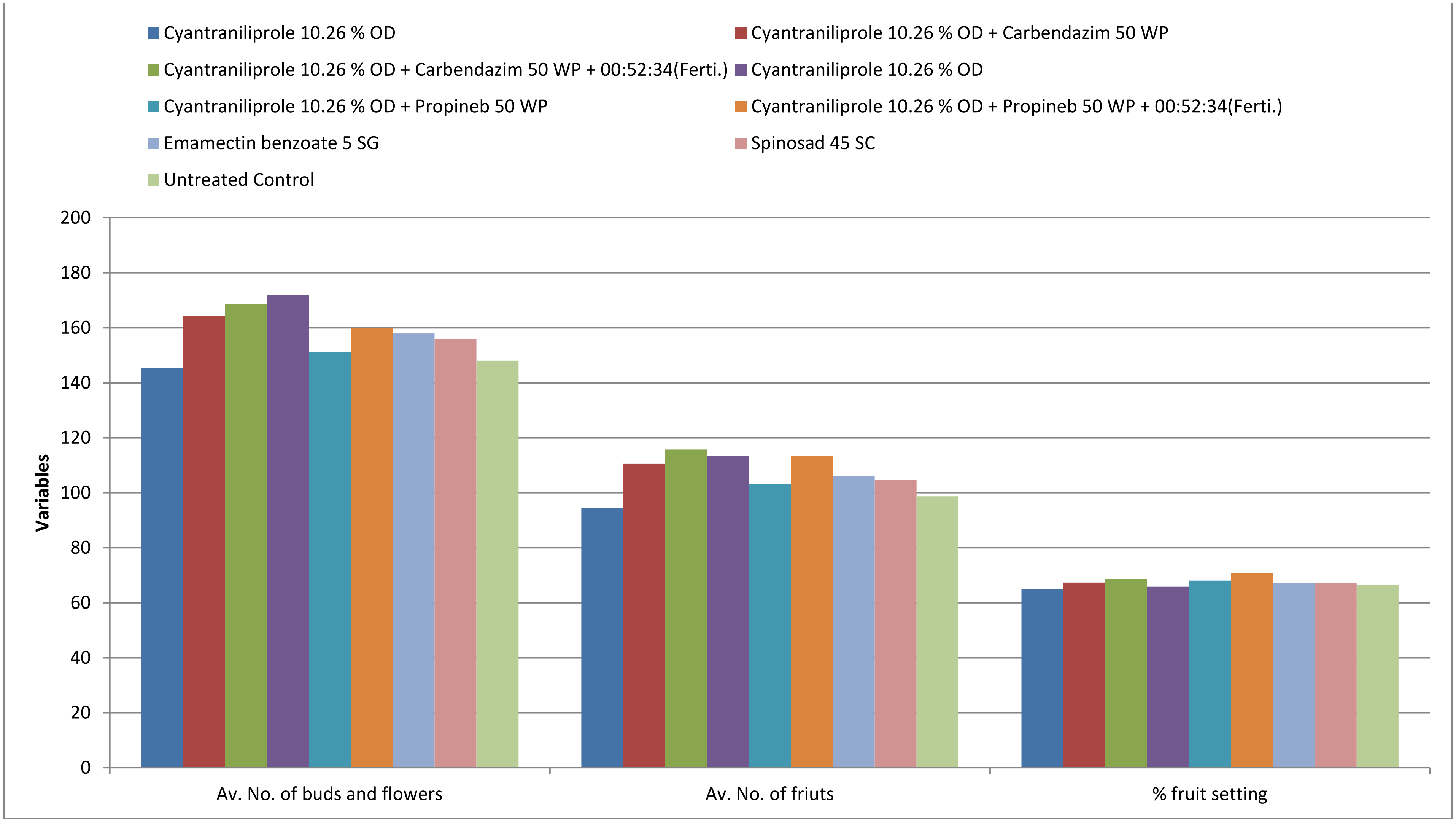

Fig. 10. Effect of treatment on flower bud and percent fruit setting in pomegranate

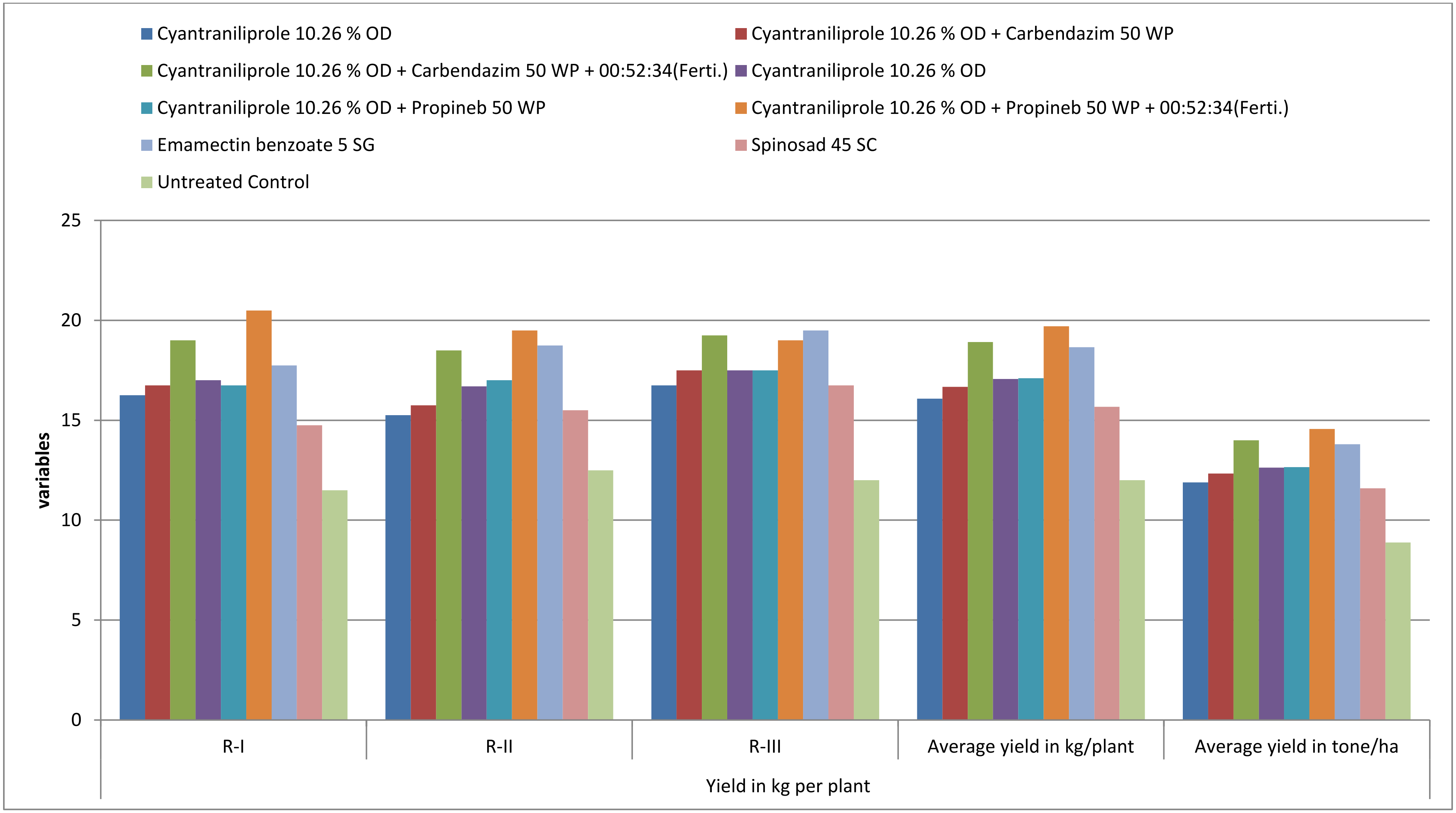

Fig. 11. Effect of treatment on yield in pomegranate

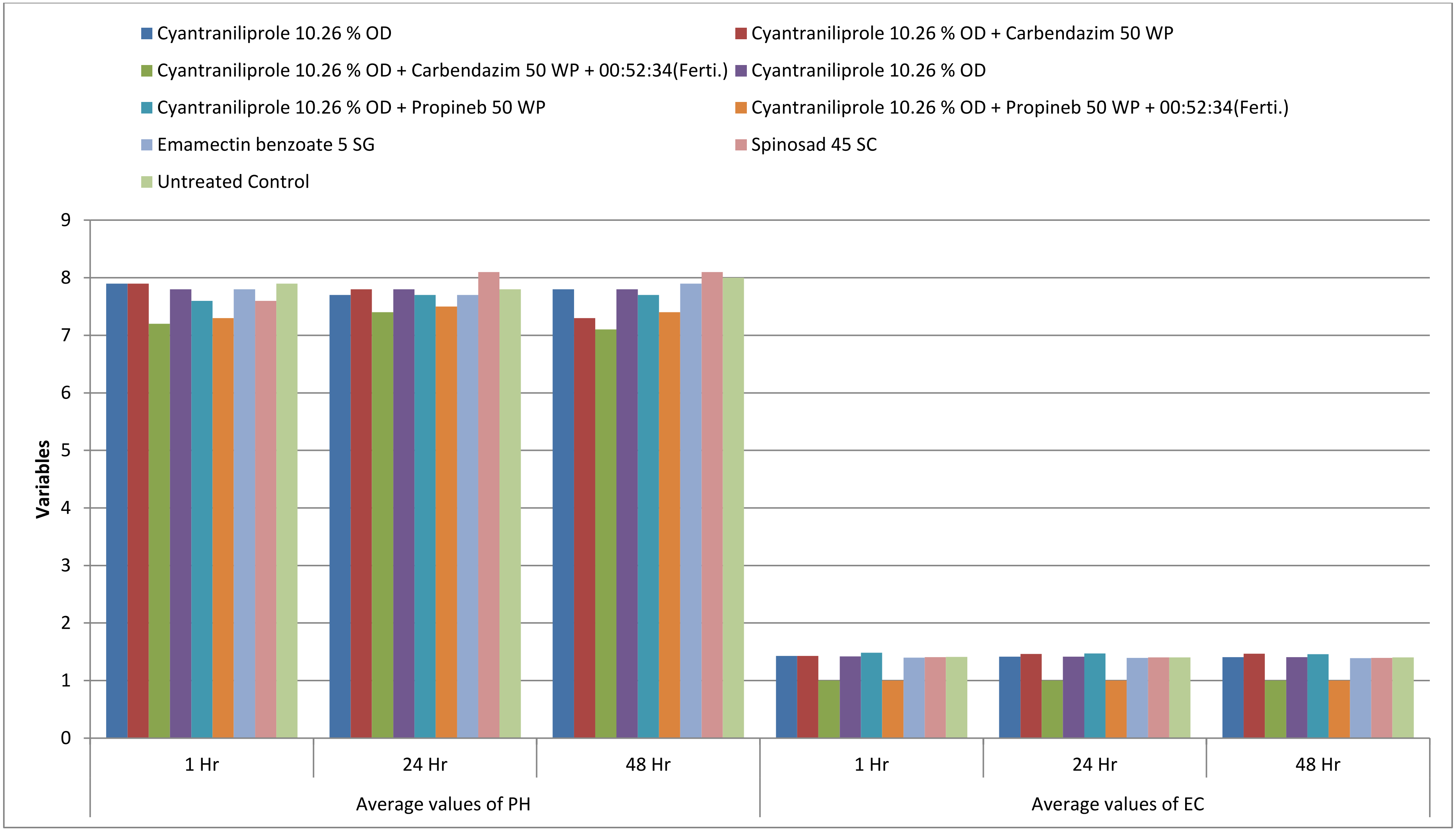

Fig 12. Effect of insecticide treatments in spray solution mixture on pH and EC with fungicide and soluble fertilizer

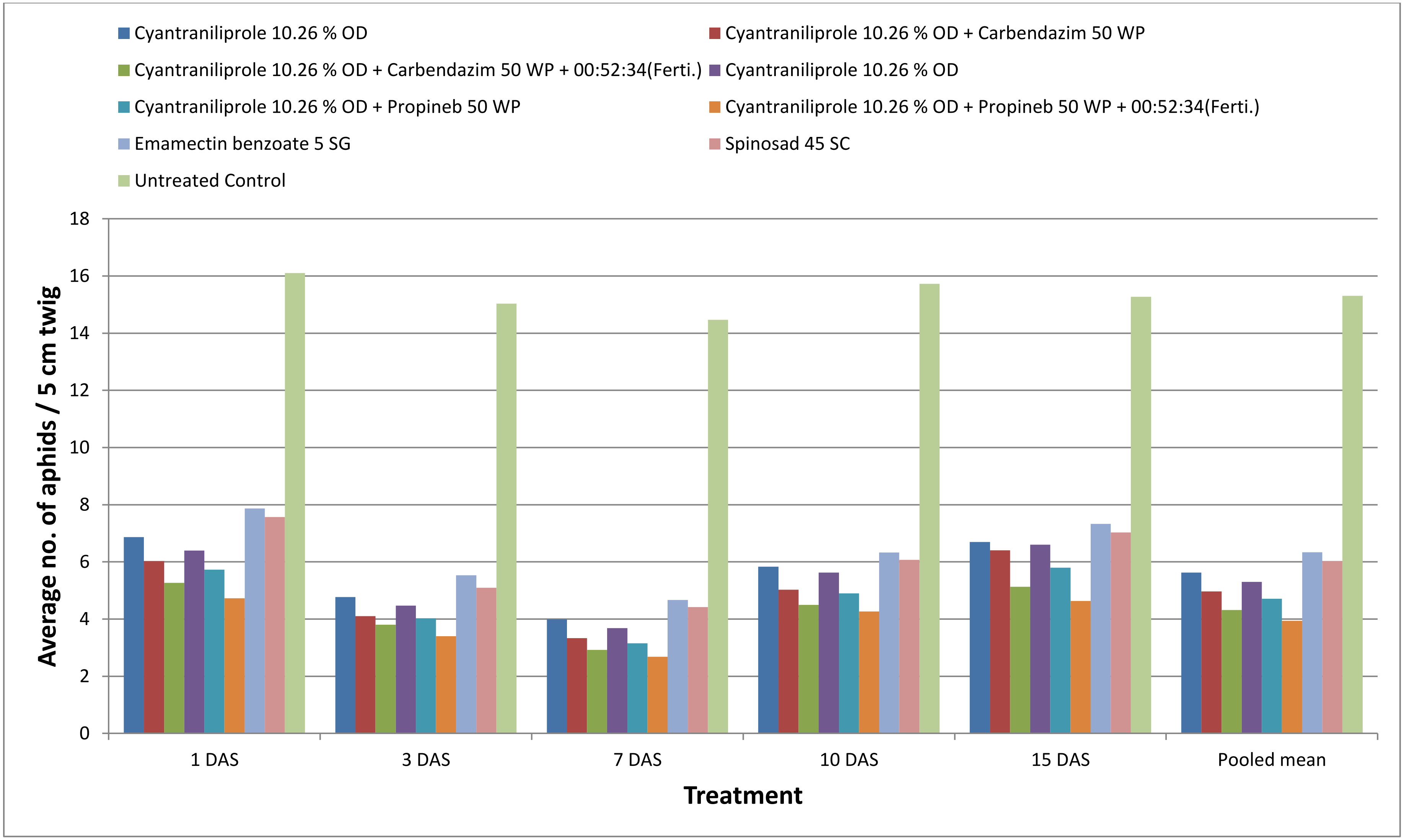

Fig. 4. Pooled data on bioefficacy and compatibility of new insecticide molecule against aphids on pomegranate

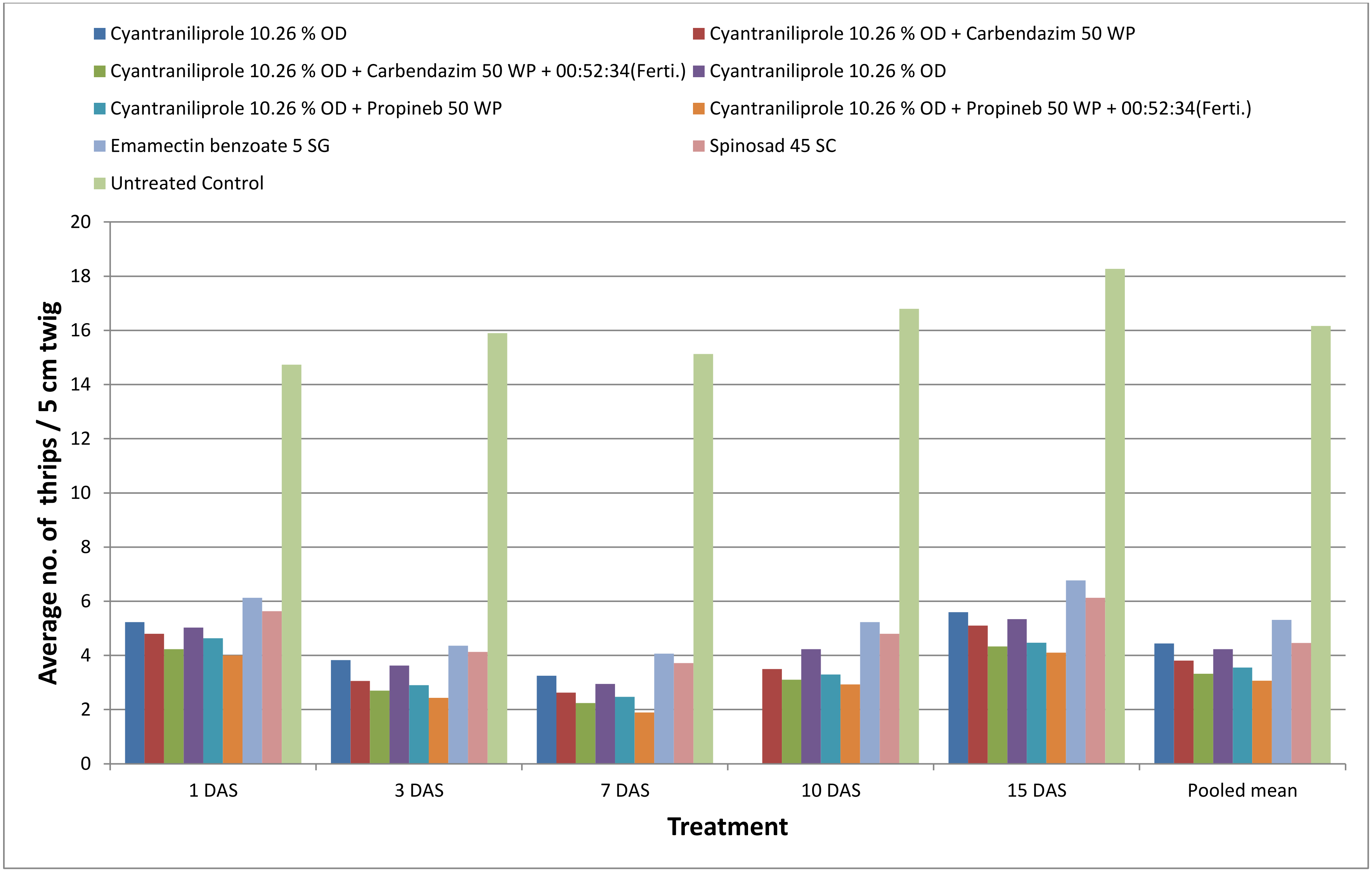

Fig. 7. Pooled data on bioefficacy and compatibility of new insecticide molecule against thrips on pomegranate