

**“Germplasm Screening and Management of Coriander
Aphid, *Hyadaphis coriandri* D.”**

BY

TUHIN DAS



**MASTER OF SCIENCE IN (AGRICULTURE)
ENTOMOLOGY**

DEPARTMENT OF ENTOMOLOGY

**DR. RAJENDRA PRASAD CENTRAL AGRICULTURAL UNIVERSITY
PUSA (SAMASTIPUR) – 848 125**

2021

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**A THESIS SUBMITTED TO
DR. RAJENDRA PRASAD CENTRAL AGRICULTURAL UNIVERSITY,
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**DR. RAJENDRA PRASAD CENTRAL AGRICULTURAL UNIVERSITY
PUSA (SAMASTIPUR) – 848 125**

2021

Regd. No. M/Ento./332/2019-20

Dedicated

To

**My respected parents
and
Family**

*“Whose faith, sacrifice and perpetual affection always
inspired me to attain higher values of life”*

✍️.....TUHIN DAS

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Certificate

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It is further certified that such help or information received during the course of this investigation and preparation of the thesis have been duly acknowledged.

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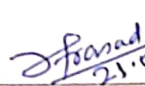
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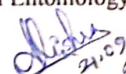

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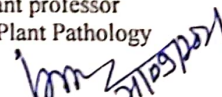
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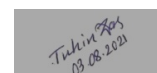
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ABSTRACT

A sets of field experiments were conducted at the Tirhut College of Agriculture research farm at Dholi, Muzaffarapur, (Bihar) from November to March, 2020-21 to study the susceptibility of coriander germplasms to aphid infestation and the effectiveness of botanical insecticides against the coriander aphid, *Hyadaphis coriandri*.

Through the seven weekly observations which were recorded during *rabi* season 2020-21, it was found that RD-416 had the lowest mean population (19.91 aphid/ plant) and RD-373 had the highest mean population (34.69 aphid/ plant). The resistance variabilities in coriander germplasms were as followed: RD-416> RD-380 > Acr-1 > RD-417

> RD-382 > RD-412 > RD-120 > RD-404 > RD-23 > RD-188 > RD-379 > RD-378 > RD-383
> RD-365 > RD-407 > RD-403 > RD-377 > RD-366 > RD-154 > RD-373.

In second objective, the combined effect of two sprayings applied at fortnightly interval against coriander aphid revealed that, thiomethoxam 25 WG @ 0.2g/l had lowest mean population of aphid (5.78 aphid/10 cm apical twig) and it was superior to all other treatments in terms of managing aphid population, followed by Neem Seed Kernel Extract @ 5 ml/l (14.02 aphid/10 cm apical twig) and Neem oil @ 3 ml/l (14.80 aphid/10 cm apical twig). However, Neem seed kernel extract @ 5 ml/l was found at par with neem oil @ 3 ml/l (14.80 aphid/10 cm apical twig), tobacco decoction @ 5ml/l (15.98 aphid/10 cm apical twig) and karanj oil @ 10 ml/l (16.68 aphid/10 cm apical twig) treatments. Remaining treatments viz. *Lecanicillium lecanii* @ 4 g/l (17.45 aphid /10 cm apical twig) and Yam Bean Seed Extract @ 5ml/l (YBSE) (18.77 aphid /10 cm apical twig) showed considerably less efficiency against coriander aphid.

The plots treated with Thiomethoxam 25 WG @ 0.2g/l recorded highest seed yield (12.95 q/ha). The seed yield obtained in the plots that were treated with Neem Seed Kernel Extract @ 5 ml/l, Neem oil @ 3 ml/l, tobacco decoction @ 5 ml/l and karanj oil @ 10 ml/l recorded 11.35 q/ha, 11.01 q/ha, 10.58 q/ha and 10.51 q/ha seed yield, respectively, and found comparable to each other and considerably superior to the other treatments. The lowest seed yield was achieved in Yam Bean Seed Extract @ 5 ml/l treatment (10.25 q/ha), followed by *Lecanicillium lecanii* @ 4 g/l (10.37 q/ha), which was statistically at par with one another.

Thiomethoxam 25 WG @ 0.2g/l had the highest benefit-cost ratio (2.61) followed by Neem Seed Kernel Extract @ 5ml/l (1.99) and Neem oil @ 3ml/l (1.86). The treatment with *Lecanicillium lecanii* @ 4 g/l resulted the lowest benefit-cost ratio (1.59), followed by Yam Bean Seed Extract @ 5ml/l, Karanj oil @ 10 ml/l and Tobacco decoction @ 5ml/l, which resulted benefit-cost ratios of 1.61, 1.66, and 1.75, respectively.

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LIST OF ABBREVIATIONS

T	:	Tonnes
@	:	At the rate of
C. D.	:	Critical difference
cm	:	Centimeter
S. Em.	:	Standard error of mean
°C	:	Degree Celsius
<i>et al.</i>	:	And others
etc.	:	Et cetera
Q	:	Quintal
Fig.	:	Figure
m ²	:	Square meter
G	:	Gram
Kg	:	Kilogram
ml	:	milliliter
max.	:	Maximum
>	:	Greater than
<	:	Less than
Ha	:	Hectare
i. e.	:	That is
NS	:	Non-significant
<i>viz.</i> ,	:	Namely
%	:	per cent
SMW	:	Standard Mean Week
Avg.	:	Average



CHAPTER - I



INTRODUCTION



INTRODUCTION

Coriander (*Coriandrum sativum* Linn.) is a popular spice in the Indian subcontinent. The family of coriander is Apiaceae. Despite its Mediterranean origins, coriander is widely produced in India, Russia, Central Europe, Asia Minor, and Morocco (Kumaresan *et al.* 1988). The crop is grown all throughout India for its green leaves and seeds.

Coriander is grown in India during the month of Rabi. Average height of this crop is 30-90 cm. Color of the flowers are either white or pinkish. The fruits have 2.0 to 3.5 mm diameter and are globular in shape. Color of the fruits are yellowish brown.

Coriander is widely known as "Dhania" and is produced for both green vegetable and seed uses. India generates a significant amount of foreign money through the spice export such as coriander, the seeds and leaves. Coriander leaves contain essential oils that contribute to the plant's fragrant flavour (Sankaracharya and Sankaranarayana, 1989). Seeds of coriander are diuretic, carminative, aphrodisiac, and alleviate intestinal discomfort problems (Panda, 1994). Coriander seed essential oils have antimicrobial properties (Lo-cantore *et al.*, 2004). Coriander seed's powder are widely used in the manufacturing of curry powder, which is used to flavour curries.

Coriander is a popular seed spice crop in Haryana. It demands a chilly temperature when it is in early stage and a warm, dry environment when it is mature. A variety of insect pests have been documented to attack it, including the coriander aphid, chalcid fly, cotton whitefly, semilooper, pentatomid bug, tobacco caterpillar, and others (Mittal and Butani, 1994). The infestation of such insect pests causes a significant drop in productivity (Singh, 2002). Among these, coriander aphid, *Hyadaphis coriandri* (Das) attacks to this crop on a regular basis and is negatively impacting seed output both in number and quality (Singh, 2002; Upadhyay *et al.*, 1996). Coriander aphid is the most common insect pest that attacks coriander crops, and it may frequently be a limiting factor in seed output (Jain, 1984). *H. coriandri* nymphs and adults eat by sucking the cell sap from leaves, flowers, and seeds.

It is widely understood that insect pest infestation is affected by climatic condition, growth stage of crop and the existence of natural enemies at a particular moment. Coccinellid

predators, *Coccinella septempunctata* (Linn.) and *Menochilus sexmaculatus* (Fab.), play an important role in aphid population decrease (Bana, 2007 and Kalra, 2011).

Economic decision levels are the cornerstone of insect management programmes and are essential because they indicate when action should be made in any particular pest problem. Appropriate pesticide application is only feasible if the insect population level that causes economic harm is understood (Patil and Lingappa, 2001). Through economic decision levels, indiscriminate application of insecticides may be prevented, reducing the number of sprays applied by farmers and, as a result, the cost of control is reduced. (Godwal, 2010, Samota *et al.*, 2014 and Naga and Kumawat, 2015).

The adoption of insect resistant cultivars reduces the need of insecticides, provides insect management at no extra expense, and works as a preventive strategy against insect population buildup. A research of the aphid population on different genotypes/varieties of coriander was conducted in order to identify the least vulnerable genotypes/varieties to coriander aphid (Seema and Yadav, 2005, Tatarwal *et al.*, 2012 and Purti *et al.*, 2017).

The use of fungal insect pathogen such as *Verticillium lecanii*, *Beauveria bassiana*, and *Metarhizium anisopliae*, as well as botanicals such as neem oil and karanj oil, were helpful in controlling aphids (Kant *et al.*, 2013, Chaudhary *et al.*, 2015 and Meena *et al.*, 2016).

A nice scented odour emanates from the stem leaves and fruits. An essential oil made composed of hydrocarbons and oxygenated molecules is responsible for the odour and flavour. Hydrocarbons make up around 20% of essential oil. Coriander is the most abundant oxygenated compound. In dried seeds, the oil content ranges from 0.4 to 1.12%.

Coriander leaves have copper 0.53 mg, sodium 4.0 mg, potassium 453.0 mg, and oxalic acid 5.0 mg per 100 g, but coriander seeds have protein 14.1 g, fat 16.1 g, phosphorus 32.6 g, iron 17.9 mg, carotene 950 µg, thiamine 0.22 mg, niacin (B3) 1.1 mg, and riboflavin 0.13 mg per 100 (B2).

Coriander is widely farmed in India on 320.8 million hectares for its seeds, yielding 233.2 million tonnes with a productivity of 727 kg/ha.

Aphid infestation on coriander begins during blossoming and continues until maturity, causing in a significant reduction in production. Green yellow in colour, this insect is a dangerous polyphagous pest. Because of the viviparous parthenogenesis reproduction, the aphid

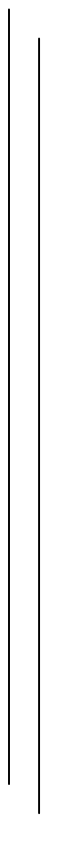
population grows quite quickly. They inflict significant harm to the plant at first by extracting plant cell sap from vulnerable shoots and umbels (sensitive portions are preferred for feeding and reproduction). They eat the sap from growing seeds, Latre. In addition to direct harm, the insect's secreted material, honey dew, promotes the growth of sooty mould, which interferes with the plant's photosynthesis.

To determine the susceptibility of coriander germplasm to aphid infestation and the effectiveness of botanical insecticides against the coriander aphid, *H. coriandri*, The current study was carried out with following objectives in mind.

1. Field screening of coriander germplasm against aphid.
2. To ascertain the field efficacy of some botanical insecticides against aphid on coriander.



CHAPTER - II



REVIEW OF LITERATURE



REVIEW OF LITERATURE

A review of the literature indicated that relatively little research has been worked onField screening of coriander germplasm against aphid and To ascertain the field efficacy of some botanical insecticides against aphid on coriander. However, the available material on the aforementioned elements has been examined under different headings.

2.1. Field screening of coriander germplasm against aphid :

Mathur *et al.* (1971) conducted the first study on coriander cultivars and their resistance to *H. coriandri*. They discovered that the aphid population on six types, EC-69, RC-15, RC-5, EC-10, RC-17, and RC-2, was lower than on other types.

Gupta(1984) screened that 50 varieties of cumin as highly suceptible,moderately suceptible and least suceptible based on population of aphid, *M. persicae* and involvement of volatile oil content.

Kanwat (1988) tested 26 coriander varieties for resistance to the coriander aphid*H.coriandri* and found none.

In a field experiment in Rajasthan, Jain and Yadav (1988) screened twenty kinds of coriander for resistance to *H. coriandri* and classified them as follows: none were resistant, 9 were moderately sensitive and 11 were very vulnerable. They also discovered that aphids were more prevalent on late flowering cultivars than on early flowering cultivars.

Sachan and Sachan (1991) evaluated the biochemical elements of several coriander cultivars and discovered that susceptible cultivars had greater protein, sugar, and oil levels than moderately susceptible cultivars, with a positive association with population of aphid. In resistant cultivars, there was a higher phenol content.

Meena (1993) examined twelve coriander cultivars for their sensitivity to the aphid *H. coriandri*, and found that cultivars UD-1 and UD-436 were the least sensitive. UD-20, UD-21, UD-110, UD-149, UD-155, UD-373, and Pusa-360 were moderately susceptible , while UD-374, UD-435, and RCr-41 were highly susceptible.

Ramdhari *et al.* (1995) looked at biochemical and anatomical components such as total sugar, reducing sugar, total phenols, protein, epidermis thickness, and vascular bundle depth and discovered a positive correlation between aphid population and high levels of total and reducing sugars and proteins, but a negative correlation with phenol. The aphid infection was not influenced by epidermal thickness or vascular bundle depth.

Singh *et al.* (1998) tested twenty coriander cultivars for resistance to *H.coriandri* in field circumstances in northern Madhya Pradesh and observed Panipat local and CS-193 to be resistant and high yield producer (1100 and 812 kg ha⁻¹ respectively), whereas cultivar CS-362 was very susceptible and lowest yield producer (250 kg ha⁻¹).

In a research on coriander aphid in Mandsaur, M.P., Upadhyay *et al.* (1996) discovered that MCS-1, 2 and 5 were the least vulnerable, however MCS-7 is vulnerable to aphid. The infestation of umbels varied from 35 to 79.17 percent. In the treated condition, they recorded an average seed production of 17.56 q/ha, while in the untreated condition, the average seed production was 12.10 q/ha. MCS-1 had the lowest yield loss of 0.37 q/ha, while MCS 11 had the highest yield loss of 8.54 q/ha.

Meena *et al.* (2002) investigated the impact of sowing dates (30th October and 6th, 13th and 20th November) and varieties (UD-685, Rcr-20, UD-686, Rcr-435, UD-447, Rcr-446, Rcr-436, Rcr-41, and UD-684) on aphid *H.coriandri* occurrence on coriander and Coriander early seeded variety Rcr-41 (30th October) had the least amount of aphid infection (25.13 aphids/plant) and the highest yield (9.88 q/ha), whereas the late seeded crop (20th November) had the most aphid infestation (77.01 aphids/plant) and the lowest yield (6.33 q/ha). Three cultivars (UD-684, Rcr-446, and Rcr-436) were characterised as the least susceptible; five cultivars (UD-686, Rcr-435, Rcr-20, UD-685, and UD-447) were rated as moderately sensitive; and two cultivars (Rcr-41 and local cultivar) were classed as extremely sensitive.

Kalra and Sharma (2001) found that out of 16 varieties/ advanced breeding lines tested in Haryana, the variety UD-686 had the lowest aphid population (31.19 aphids/umbel) compared to 139.42 aphids/umbel on variety Hisar Anand, which was the most susceptible.

Singh (2002) investigated 15 advanced coriander breeding lines/cultivars in depth. According to the season's average, the entry Hisar Anand has the lowest aphid population (0.89

aphids/umbel) compared to the cultivar DH-13, which has the maximum aphid population (4.16 aphids/ umbel). Also, The longest life span was found on the variety Narnaul Selection, the shortest time was 20.4 ± 0.35 days on CO-3 variety (180.45 days). Singh (2002) performed a recent study on the preventable seed production losses of the coriander crop . According to these research, Pant Haritma had the highest (100.3 percent) increase in seed production over the unprotected, while CO-3 and Narnaul Selection had 93.87 and 65.87 percent increases in seed production, respectively.

Pal & Choudhuri (2003) tested six coriander cultivars in the field, including one local strain, under field conditions for their reactivity to the aphid, *Hyadaphis coriandri* (Das). The varieties Rajendra Swathi (RD-44), Pant Haritma, and DH-205 were classified as less susceptible (up to 10 aphids per plant); DH-234 and local cultivar as moderately susceptible (up to 11-20 aphids per plant); and RCr-41 as highly susceptible (up to 11-20 aphids per plant) based on peak aphid population per plant (above 20 aphids per plant).

Singh *et al.* (2004) reported that none of the coriander germplasm (NDCor2, NDCor7, NDCor9, NDCor18, NDCor21, NDCor29, NDCor30, NDCor32, NDCor33, NDCor34, NDCor35, NDCor36, NDCor37, NDCor38 and K.selection) which observed for resistance to *H. coriandri* under field circumstances was resistant. The resistance of NDCor35 proved as moderate, whereas NDCor18 and NDCor30 were both highly susceptible to aphid.

Lekha (2002) tested 10 coriander cultivars for aphid susceptibility and discovered that none of them were resistant to aphid attack. RCr-436, RCr-446, and RCr-684, on the other hand, were classified as less sensitive; RCr-20, RCr-435, UD-774, UD-743, UD-480, as moderately sensitive; and RCr-41 and local cultivar, as highly sensitive.

Patel *et al.* (2005), examined 21 coriander germplasms for aphid *H. coriandri* resistance and found that UD-20, UD-374, UD-435, and Part-1 were the least susceptible, while CJ-4, CJ-6, UD-436, and Comp-1 were moderately susceptible.

73 coriander genotypes were tested against *H. coriandri* by Seema and Yadav (2005). Only seven were found as promising, namely JCO-18, JCO-115, JCO-130, GC-43, GC-46, M-1, and UD-190, with susceptibility to the aphid, *H. coriandri*, and higher attractiveness to the related aphidophagous coccinellids.

According to a recent study by Kalra *et al.* (2006), aphid incidence on coriander crop began in the first week of month of February and peaked in the last week of February and the first week of March (31.5 aphids/umbel). On the basis of the season's average, JCO-283 was determined to be the most susceptible, with 10.7 and 9.25 aphids/umbel, while DH-246 was determined to be the least susceptible, with 4.0 and 4.18 aphids/umbel. Similarly, based on average of two-season, Hisar Anand had the lowest seed production losses (30.2 percent) and UD-744 had the greatest (111.3 percent).

Bana (2007) examined 10 coriander cultivars for their relative sensitivity to the aphid, *H. coriandri*, and found that none of the varieties or entries were totally aphid-free. He classified RCr-684 as the least susceptible, RCr-20, RCr-435, RCr-446, UD-600 and UD-744 as the moderately susceptible, and UD-728 and RCr-41 as the extremely susceptible varieties/entries. He also discovered a positive relation between population of aphid and the number of days till 50% flowering.

Choudhary and Jat (2007) discovered that the number of days required for 50% blooming was positively connected with the number of aphids, *H. coriandri*, but seeds/umbel and height of plant were inversely connected with the number of aphids. They also discovered a negative connection between total phenol level and aphid population.

Lekha and Jat (2007) evaluated ten coriander cultivars for *H. coriandri* susceptibility. RCr-436, RCr-446, and RCr-684 were the least susceptible cultivars, whereas RCr-20, RCr-435, UD-480, UD-743, and UD-774 were moderately sensitive, and RCr-41 and Local cultivar were very susceptible.

Ghadage *et al.* (2009) examined coriander's twenty genotypes against the aphid, *H. coriandri* and discovered that genotypes Dhana-98, K-selection, Gcr-1, Gcr-2, and Jcr-391 were the least susceptible, while genotype EC-363974 was the most susceptible.

Pareek (2009) evaluated 10 coriander cultivars for the aphid, *H. coriandri*, and found that none of the varieties/entries were entirely aphid-free. He classified RCr-436 as the least susceptible variety, RCr-435, RCr-446, RCr-684, and UD-118 as moderately susceptible, and RCr-20, RCr-41, UD-480, and UD-728 as very susceptible. He looked at biochemical and morphological components such as days to 50% flowering and plant height, which were found to

be positively correlated with population of aphid, but umbels per plant, seeds/umbel, total amount of phenols, and volatile oil content were found to be non-significantly correlated with aphid population.

Tetarwal *et al.* (2012) evaluated eight coriander cultivars for their susceptibility to the aphid, *H. coriandri*, and found that none were resistant to the aphid attack. The varieties/entries RCr-436 and RCr-684 were identified as least susceptible, whereas UD-728 and RCr-41 were labelled as extremely susceptible, according to statistical classification.

Purti *et al.* (2017), evaluated coriander varieties for their susceptibility to the coriander aphid, *H. coriandri*, and discovered that the aphid, *H. coriandri*, varies substantially between various coriander cultivars. Hisar Anand had the highest aphid population (10.74 aphid/ umbel) based on the season's average variety. Germplasm DH-2, on the other hand, had the fewest aphids (6.35 aphid per umbel). The coriander cultivars that took the longest to mature and blossom had the largest aphid population.

2.2. To ascertain the field efficacy of some botanical insecticides against aphid on coriander

Jat (1993) evaluated the relative effectiveness of nine pesticides against *H. coriandri* and found that phosphamidon (0.03 percent) and monocrotophos (0.036 percent) were both extremely effective. Dimethoate (0.03 percent), methyl demeton (0.025 percent), phosphamidon (0.02 percent), and formathion (0.025 percent) were among the most effective treatments, while pyrethrum (0.004 percent), Jawan (0.5 percent), and neem guard (0.04 percent) were among the least effective.

Meena (1993) examined nine insecticidal effects against the coriander aphid, *H. coriandri*, and discovered that phosphamidon (0.03 percent) was the most effective, followed by methyl demeton (0.025 percent) and monocrotophos (0.036 percent). Dimethoate (0.03 percent) and formothion (0.025 percent) treatments were in the middle of the effectiveness scale, while followed by Jawan (0.05 percent), neem guard (0.4 percent) was the least effective.

At the initiation phase of flower bud, Kotwal and Gupta (1994), tested foliar treatments of formothion 25 EC (0.07 percent), endosulfan 35 EC (0.07 percent), oxy-demeton methyl 25 EC (0.03 percent), phosphomidon 100 EC (0.03 percent), fenthion 80 EC (0.03 percent), and thiometon 25 EC (0.08 percent) and discovered that oxy-demeton methyl was better to formothion and phosphamidon, with a loss decrease of 51.0, 34.7 and 46.4 percent, respectively.

Chaudhary and Singh (1996) examined several treatments and discovered that spray of azadirachtin @ 5 ml/l was the most effective strategy for controlling aphids on coriander while also enhancing seed yield.

Patel and Jhala (1998) examined the effectiveness of 11 synthetic pesticides, eight azadirachtin and two products of neem, on radish against *L. erysimi* and found that monocrotophos (0.04 percent), phosphamidon (0.03 percent), and dimethoate (0.03 percent) killed more than 90% of the aphids, whereas neem seed kernel extract (5.0 percent), nimbecidine (0.2 percent), repelin (1.0 percent), and margocide CK (0.1 percent) killed aphids by more than 80%.

Ghetiya and Butani (1996) discovered that 0.03 percent methyl-O-demeton, 0.03 percent dimethoate, 0.036 percent monocrotophos, and 0.07 percent endosulfan were effective against *H. coriandri*.

Against the mustard aphid, *L.erysimi*, the bio-efficacy of 11 insecticides was studied by Dhaka and Pareek (2001). After 50 and 71 days from seeding, insecticides were treated twice. Phosphomidon (0.03%) was shown to be the most effective, followed by dimethoate (0.03%) and methyl demeton (0.03 percent).Cypermethrin (0.004 percent) was the least effective. Plots treated with phosphamidon (0.03 percent), followed by dimethoate(0.03 percent), had the highest seed output (14 q/ha) .

Sreekanth and Bapu (2001) investigated the efficacy of several new insecticides, including imidacloprid 20 EC (0.008 and 0.02 percent), silafluofen 20 EC (0.02 percent), deltamethrin+triazophos 36 EC (0.07 percent), profenofos 50 EC (0.05 percent), diafenthiuron 50 WP (0.025 percent), dichlorovos 76 EC (0.1 percent) and monocrotophos 36WSC (0.05 percent) and Imidacloprid was shown to be the most efficient, followed by profenofos, with 99.06 and 98.31 percent aphid population suppression, respectively.

Lekha (2002) examined the relative effectiveness of ten insecticides on coriander against *H.coriandri* and found that phosphamidon (0.03 percent) was the most effective, followed by dimethoate (0.03 percent). Endosulfan (0.035%), malathion (0.05%), acephate (0.05%), endosulfan dust (20 kg ha⁻¹) and malathion dust (20 kg ha⁻¹) were all in the middle of the effectiveness. The neem-based products Margocide-CK and Neemnath @ 5 ml/litre were the least effective among insecticidal treatments.

Gami *et al.* (2002) examined the effectiveness of 11 insecticides against *L.erysimi* on mustard found that oxy-demeton methyl (0.025 percent), carbofuran (0.04 percent), monocrotophos (0.04 percent), and methyl parathion (2% dust at 25kg/ha) were all extremely successful, whereas azadirachtin (0.00075 percent) and profenofos (0.05 percent) were not.

Baloda *et al.* (2003) tested the effectiveness of six insecticides against *A.pisum* which infesting fenugreek, including neem extract (0.05 percent), monocrotophos (0.036 percent), dimethoate (0.03 percent), pyrethrum (0.004 percent), and phosphamidon (0.03 percent & 0.02 percent), and found dimethoate to be the most effective, followed by methyl demeton, phosphamidon and monocrotophos. The plots treated with dimethoate also had the highest seed production (0.03 percent).

Gour and Pareek (2003) checked nine insecticides in mustard, all with two concentrations, against the mustard aphid, *L.erysimi* and found that dimethoate(0.03 percent), dimethoate (0.015 percent), imidacloprid (0.05 percent), cypermethrin (0.002 percent), and acephate (0.05 percent) were the most effective. Neem extract (0.2 percent), neem extract (0.4 percent), ethofenprox (0.002 percent), and cartap hydrochloride were the least effective (0.04 percent) whereas, in the moderate effectiveness group, malathion (0.025 and 0.05 percent), cartap hydrochloride (0.08%), endosulfan (0.02 and 0.035 percent), ethofenprox (0.004 percent), cypermethrin (0.001 percent), and acephate (0.025 percent) were found. Dimethoate produced mustard seed's highest yield followed by acephate and imidacloprid; however, cartap hydrochloride produced the lowest yield. The therapy of dimethoate had the greatest cost-benefit ratio (20.1), whereas imidacloprid had the lowest.

According to a recent research done by Meena *et al.* (2003), monocrotophos at 0.02 and 0.036 percent revealed to be the most efficient insecticide against *H.corian dri* on coriander, followed by dimethoate at 0.02 and 0.03 percent, malathion at 0.05 percent, and endosulfan at 0.07 percent. Furthermore, pod extracts containing azadirachtin (0.5%) and 'karanj' (1.0%) (*Pongamia pinnata*) were shown to be the least efficient. In plots treated with monocrotophos at 0.036 percent, the highest seed yield (10.17 q/ha) was obtained.

Singh and Nath (2003) compared the performance of six pesticides on coriander at Kumarganj, Uttar Pradesh, and found that all of them were considerably better than the control at lowering the aphid population. After one, three, five, and seven days of spraying, dimethoate (0.03 percent) was the most effective, reducing the aphid population by 95.46, 96.25, 96.95, and 99.59 percent, respectively, whereas the botanical insecticide namely neemarin (1 percent) reduced the aphid population by 63.81 to 80.50 percent. After seven days, neem seed extract (*Azadirachta indica*), buken (*Melia agedarach*), karanj (*Pongamia sp.*), and pride of India (*Lagerstromia indica*) each at (1%) reduced aphid population by more than 50%, but did not improve crop production.

Lekha and Jat (2004) found that plots treated with phosphomidon 85 SL (13.25 q ha⁻¹) had the highest seed production, followed by dimethoate 30 EC (13.0 q ha⁻¹) and acephate 75 SP (12.0 q ha⁻¹) while neem-based products Margocide-CK (9.5 q ha⁻¹) and Neemnath 0.15 EC had the lowest seed production (9.25 q ha⁻¹). The control had the most preventable loss (6.25 q ha⁻¹),

followed by Neemnath 0.15 EC (4.0 q ha⁻¹) and Margocide-CK (3.75 q ha⁻¹), whereas the treatments of phosphomidon 85 SL, dimethoate 30 EC (0.25 q ha⁻¹) and acephate 75 SP had the lowest (1.25 q ha⁻¹). The plots treated with phosphomidon 85 SL (12.46) had the highest benefit cost ratio, followed by dimethoate 30 EC (10.25), whereas Neemnath 0.15 EC (0.33) and Margocide-CK had the lowest (0.41).

Jat *et al.* (2004) investigated the efficacy of nine insecticides (two applications) against the mustard aphid, *L.erysimi*, and found that dimethoate (0.03%) was the most effective, followed by imidacloprid (0.005%) and acephate (0.05%). Thiomethoxam (0.005%), Profenofos (0.05%), endosulfan (0.07%) and profenofos+cypermethrin (0.04%) were in the middle of the efficacy list. The least effective were neem-based products such as margocide CK (5ml/lt.) and N.S.K.E (5ml/lt.). The percentage of avoidable losses and total avoidable losses were both zero in the dimethoate treatment, but were maximum in the margocide CK and N.S.K.E treatments. Dimethoate had the greatest benefit-to-cost ratio (19.56), followed by acephate (15.81), while margocide CK had the lowest (1.76).

Sharma (2004) compared the effectiveness of 8 insecticides against *H.coriaandri* infested cumin, finding that endosulfan (0.07%) was the most effective, followed by phosphamidon (0.03 percent). Endosulfan (0.035 percent), malathion (0.05 percent), endosulfan dust @20 kg/ha, and methyl-parathion dust @20 kg/ha were the next treatments.

According to Gupta and Rai (2004) neem oil at 1.0 percent was the most effective against the aphid *H. coriaandri* in the coriander crop, followed by neem seed extract and cow urine 3 percent + methyl demeton 0.003%.

Choudhary and Sharma (2005) investigated the effectiveness of phosphamidon (25 ml/ha) and acephate (700 ml/ha), as well as four botanicals, nimbecidine (750 ml/ha), neem leaf extract (10 percent), neem seed kernel extract (5 percent), and neemark (750 ml/ha), against aphid, *L.erysimi* infesting mustard and found that phosphamidon (250 ml/ha) had the greatest reduction, followed by acephate (700 g/ha).Neem seed kernel extract (5%) and nimbecidine (0.03 percent) were the two neem-based plant products that caused maximum aphid mortality.

Including botanicals,Bana (2007) tested the performance of seven insecticides on coriander cropagainst the aphid, *H.coriaandri*in Bikaner and showed imidacloprid (0.005%), oxy-

demeton methyl (0.02%), and thiomethoxam to be the most effective (0.005 percent)and found that endosulfan (0.07%) and malathion (0.05%) were in the middle of the effectiveness scale. The nimbecidine (5ml/lt.) treatment was the least effective, followed by NSKE (5 percent).

Non-chemical methods of pest management were evaluated on cumin against *H.coriaandri* by Noor (2008) in Jodhpur. Testing of cow urine (10%) against cumin aphid revealed that chemical control with acephate 75 SP @750 g/ha was more effective than cow urine-based treatments, leading in lower aphid incidence and higher seed production. Two years of research found that a combination of 10% cow urine, 1% neem oil, and 5% garlic extract was the second best therapy, and it was on par with acephate.

Sundaria (2008) screened non-chemical and ten chemical treatments on cumin against the aphid *H.coriaandri* and discovered that plots treated with seed treatment combination with two sprays of thiomethoxam 25 WG@ 100 g/ha and imidacloprid 70WS @ 7.5g/kg had the lowest aphid population (0.86 & 0.46 aphid/umbl, respectively) and had the highest seed production and was considerably superior to all other treatments (396 and 418 kg/ha respectively). In non-chemical treatment, a combination of NSKE 5% + garlic extract 2% + cow urine 10% sprays was effective in lowering aphid population from 9.80 to 2.53 aphids/umbl and outperformed over treatments of neem cake @ 1.5 t/ha+neem oil 10 ml/lt+RDF 50 percent, cow urine 10 percent +neem oil 10 ml/lt and neem soap 1 percent spray, with aphid populations of 5.13 aphids/umbl, 4 aphids/umbl, and 8.06 aphids/umbl, respectively.

Ratnoo (2008) evaluated effectiveness ten treatments: (1) neem oil @ 3ml/lt + cow urine 10% @ 100ml/lt (2) cow urine 10% @ 100ml/lt spray (3) garlic extract 20g/lt+cow urine 10% @ 100ml/lt (4) garlic 2 percent +neem extract 2.5 percent +cow urine 10% @100ml/lt (5) garlic extract 20g/lt (6) neem(azadirachtin) 0.03% @3ml/lt(7) karanj oil 0.1 percent spray (8) panchgavya (30ml/lt) spray (9) sulphur + wood ash (3:1) dust @25 kg/ha (10)control on cumin aphid *H.coriaandri* .Treatments 3 and 4 considerably decreased the aphid population. Treatment no. 4 (344kg/ha) had the highest seed yield, followed by treatment no. 3 (322kg/ha) and treatment no. 2 (306kg/ha), with the control plots yielding 217kg/ha.

According to Gupta and Pathak (2009), the incidence of coriander aphid was reduced to the point where the crop is treated by neem oil 1percent (983 kg/ ha and Rs. 12165/ ha) yielded

the highest coriander seed yield and net profit, followed by neem seed kernel extract (in cow urine) 3 percent + methyl demeton 0.03 percent (967 kg/ ha and Rs. 11295/ ha), cartap hydrochloride 0.1% (967 kg/ha and Rs. 9660/ ha) and phenthoate 0.1% (917 kg/ ha and Rs. 9000/ha).

Jat *et al.*, (2009) examined the twelve insecticides against aphid, *H. coriandri* and discovered the most effective insecticide against the aphid, *H. coriandri*, was dimethoate 30 EC, which reduced maximum population of aphid (87.03%) with highest seed production (15.38 q ha⁻¹) and benefit cost ratio (48.91), followed by acephate 75 SP, which reduced aphid population by 84.05 percent with seed yield (14.32 q ha⁻¹) and benefit cost ratio (19.94). Margocide-CK 20 EC, neem oil (0.5 percent), and NSKE (5.0 percent) were shown to be the least effective treatments. The treatments of NSKE, neem oil, and Margocide-CK 20 EC had the lowest seed yield (10.47 q ha⁻¹) and benefit cost ratio (1.2).

Pareek (2009) examined the relative performance of thirteen insecticides, including botanicals, on the coriander crop, against the aphid, *H. coriandri* and found imidacloprid (0.005 percent) to be the most effective, followed by dimethoate (0.03 percent) and acephate (0.05 percent).

Pareek (2009) compared the relative efficiency of total thirteen insecticides, including botanicals, on coriander against aphid, *H. coriandri* and discovered that imidacloprid (0.005%) was the most efficient, followed by dimethoate (0.03%) and acephate (0.05%). He found that Calotropis extract (5%) was least efficient followed by neem leaf extract (5%) and azadirachtin (5 ml/l). He found that plots treated with dimethoate 30 EC had the highest seed production (12.22 q ha⁻¹), followed by acephate 75 SP, where seed production was 11.85 q ha⁻¹ and that plots treated with NSKE and azadirachtin 20 EC had the lowest seed output (9.10 q ha⁻¹ and 12.22 q ha⁻¹ respectively). In coriander crop against aphid, *H. coriandri*, the lowest avoidable and percent avoidable losses were recorded in plots treated with dimethoate 30 EC (0.16 q ha⁻¹; 1.29 percent), followed by acephate 75 SP (0.53 q ha⁻¹; 4.28 percent), and the highest in untreated plots (4.59 q ha⁻¹; 37.08 percent), followed by NSKE (3.28 q ha⁻¹; 26.17 percent). The treatment of dimethoate 30 EC (4.43 q ha⁻¹; 56.87 percent), followed by acephate 75 SP (4.06 q ha⁻¹; 52.12 percent), produced the highest increase in yield and yield percent over control, while the treatment of NSKE (1.31 q ha⁻¹; 16.82 percent) and azadirachtin 20 EC (1.35 q ha⁻¹; 17.33

percent) produced the lowest increase in yield and yield percent over control. The treatment with dimethoate 30 EC produced the highest net profit (Rs. 13492) followed by acephate 75 SP (Rs. 12007), while the treatments of NSKE, neem leaf extract and azadirachtin 20 EC produced the lowest net profit (Rs. 2975, Rs. 3160 and Rs. 3350 respectively).

Sachan *et al.* (2010) investigated the efficiency of chemical and botanical insecticides against the coriander aphid, *H. coriandri*, and found that all treatments were efficient in lowering the population of coriander aphid and thereby improving yield considerably when compared to control. Before the spray, the aphid population ranged from 135 to 170 aphids/10 cm apical twig per plant, which did not alter substantially. The most effective spray was oxy-demeton methyl 25 EC @ 0.05 percent (56 aphids/plant), followed by dimethoate 30 EC @ 0.03 percent (72 aphids/plant) and endosulfan 35 EC @ 0.07 percent (74 aphids/plant) one day after spraying. The treatments of 3% neem oil and 5% neem seed kernel extract were the least successful (101 and 82 aphids/plant, respectively), although they were still better than the control (186 aphids/plant).

Bana *et al.* (2011) compared the efficacy of seven insecticides, including botanicals on coriander crop against the aphid, *H. coriandri* and found imidacloprid (0.005 percent) to be the most effective, followed by oxy-demeton methyl (0.02 percent) and thiamethoxam (0.005 percent), while malathion (0.05 percent) and endosulfan (0.07 percent) were proved as medium effective. Treatment of nimbecidine (5 ml/l) was the least effective, followed by NSKE (5 percent). The treatments with azadirachtin 20 EC had the lowest benefit-to-cost ratio (1.21), followed by NSKE (1.68). The control plots had the most avoidable losses (4.35 q ha⁻¹), followed by the azadirachtin 20 EC (2.96 q ha⁻¹) and NSKE (2.69 q ha⁻¹) treated plots.

Kant *et al.* (2013) examined the effectiveness of 10 botanicals and microbial insecticides against *H. coriandri* individually and in combination. After first spray of *Metarhizium anisophila* and second spray of *Beauveria bassiana*, the reduction of aphid population was maximum 32.3 aphid/ floret and 8.1 aphid/ floret respectively. In the case of *M. anisophila*, however, the highest yield was obtained. The karanj seed extract (1%) provided the best aphid control (30.5 and 11.2 aphids/floret after the first and second sprays, respectively), as well as a yield of 12.5 qt/ha.

Chaudhary *et al.* (2015) examined six different neem-based insecticides formulations against the coriander aphid, *H. coriandri*. After each spray on the crop, the use of azadirachtin 1500 ppm @ 5 ml/ l showed most efficient in reducing aphid population and increasing coriander seed production at harvest. After the first spray, neem oil (2.0 percent) proven to be on par with it in terms of population reduction. Azadirachtin has a reduced effectiveness at 2ml/l in terms of aphid reduction and coriander production. Although all of the treatments were considerably better than the untreated control, neem oil (1.0 percent) and NSKE (2.0 percent) exhibited moderate efficacy in controlling aphid on coriander crops. The effectiveness of bio-pesticides and botanicals against the coriander aphid, *H. coriandri*, was investigated by Meena *et al.* (2016). In both years, the plots treated with organic salt (bio-product) 5ml/ l had the greatest reduction in aphid population (67.83 and 70.10 percent), followed by karanj seed extract 10ml/ l (67.0 and 68.96 percent) and tumba fruit extract 10 ml/ l (64.89 and 68.32 percent).





CHAPTER - III



MATERIALS AND METHODS



MATERIALS AND METHODS

The present study, titled “Germplasm Screening and Management of Coriander Aphid, *Hyadaphis coriandri* D.” is being carried out under Bihar's ecological conditions from November to March, 2020-21. This chapter describes the materials utilised and technique employed throughout the research on “Germplasm Screening and Management of Coriander Aphid, *Hyadaphis coriandri* D.” as outlined in the work plan.

3.1 General details of experiment

The muraul research farm of Tirhut College of Agriculture, Dholi, Muzaffarpur in North Bihar is located on the banks of the Gandak River at a latitude of 26.00° N, longitude of 85.58° E, and elevation of 54.15 m above mean sea level. The soil discovered is alkaline and sandy loam. Dholi is located in Bihar's Agro-climatic Zone-1.

3.2 Field screening of coriander germplasm against aphid

Twenty coriander germplasm samples from T.C.A. Dholi were tested for resistance to the coriander aphid *H. coriandri* D. under natural infestation conditions during November to March, 2020-21. The germplasm under research will be cultivated using standard agronomic techniques and will not be treated with insecticides.



Plate-1 General View of an experimental plot

3.2.1 List of genotypes:

Sl.No:	Treatment	Genotype
1.	V ₁	RD-23
2.	V ₂	RD-120
3.	V ₃	RD-121
4.	V ₄	RD-416
5.	V ₅	RD-365
6.	V ₆	RD-366
7.	V ₇	RD-417
8.	V ₈	RD-377
9.	V ₉	RD-378
10.	V ₁₀	RD-379
11.	V ₁₁	RD-380
12.	V ₁₂	RD-382
13.	V ₁₃	RD-373
14.	V ₁₄	RD-403
15.	V ₁₅	RD-154
16.	V ₁₆	Acr 1
17.	V ₁₇	RD-407
18.	V ₁₈	RD-412
19.	V ₁₉	RD-404
20.	V ₂₀	RD-383

3.2.2 Experimental details and Methodology:

All genotypes were subjected to a natural aphid infestation. Three plants from each germplasm have been chosen at random from four replications. The observations for aphid population in each germplasm were made shortly after the aphid appeared. The number of aphid present per plant has been counted at weekly intervals. A screening of 20 coriander germplasms has been performed to identify potential germplasms that are less susceptible to aphid attack. After

transforming the data on the aphid population into $\sqrt{(x + 1)}$ values, the data on the aphid population was subjected to analysis of variance to obtain critical difference.

Scale for classifying coriander germplasm susceptibility against coriander aphid, *H.coriandri*-

$$\text{Grade} = \bar{x} \pm \sigma$$

Where, $\bar{x}$ = Mean of peak aphid population, and

σ = standard deviation of peak aphid population.

The vulnerability of coriander germplasm to aphid population was assessed based on population. Using the following method, coriander germplasms were classified based on peak aphid population throughout the crop season.

Grade	Peak aphid population per plant
Least Susceptible	Below $\bar{x} - \sigma$
Moderately Susceptible	$\bar{x} - \sigma$ to $\bar{x} + \sigma$
Highly Susceptible	Above $\bar{x} + \sigma$

(Meena *et al.*, 2019)

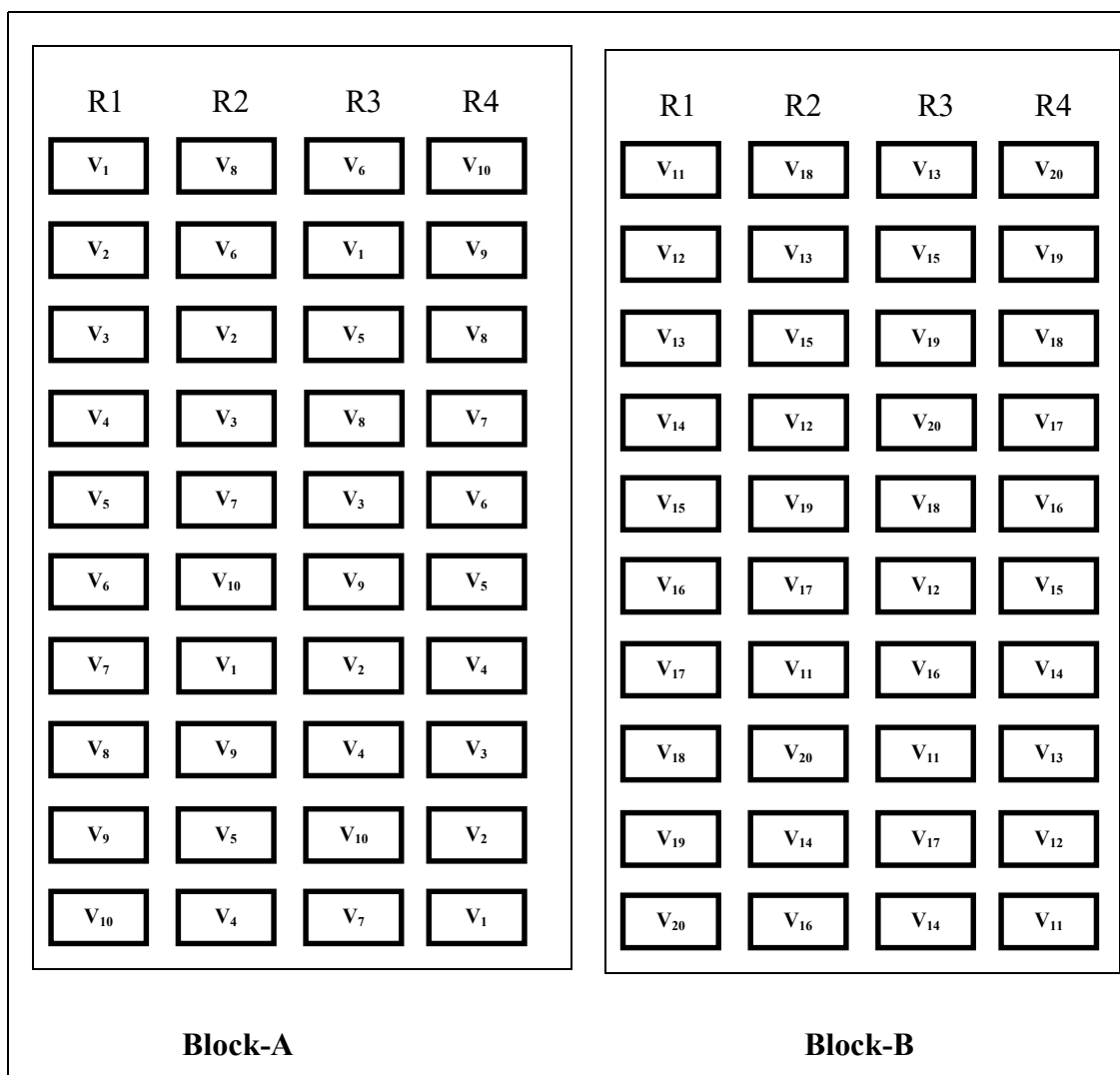


Fig 1. Layout of experimental field for screening of coriander germplasm against aphid *H. coriandri* in Randomized Block Design (RBD).

3.3 To ascertain the field efficacy of some botanical insecticides against aphid on coriander

Experimental details

1. Crop	: Coriander
2. Variety	: Rajendra swati
3. Design	: Randomized block design
4. Replications	: 3
5. Treatments	: 8
6. No of Plots	: 24
7. Plot size	: 3 x 1 (sq m)
8. Distance between Rows	: 25 cm
10. Distance between Plants	: 20 cm
11 . Seed rate	: 10 kg / ha
12. Date of sowing	: 13.11.2020
13. Date of harvesting	: 22.03.2021

Table 1: Details of treatment

S. No.	Details of Insecticides used	
	Chemical Name	Dose
1	Neem oil	3 ml/l
2	NSKE(Neem Seed Kernel Extract)	5 ml/l
3	YBSE(Yam Bean Seed Extract)	5 ml/l
4	<i>Lecanicillium lecanii</i>	4 g/l
5	Karanj oil	10 ml/l
6	Thiamethoxam 25 WG	0.2 g/l
7	Tobacco Decoction	5 ml/l
8	Control	

3.3.1 Methodology:

The aphid population was counted from 10 randomly selected apical twigs (10 cm length 5 apical twig/ plot). At the vegetative stage, infestation of aphid was not occurred in the field. At a fortnightly interval, all test insecticides were administered during the flowering period. Spraying to the crop was occurred for the first time on February 11th, using a hand sprayer, and a second

treatment was performed 15 days later. The crop was sprayed with a 500 litre/ha spray solution. One day before treatment, a pre-treatment count was performed. The post-treatment data were collected after three, five, seven and ten days after application.

At harvest, yield data for coriander seeds were collected from both protected and unprotected plots. The increased yield in treated (protected) plots over control (unprotected) plots, and the avoidable loss were calculated using Khosla's equations (1977) -

$$\text{Increase in yield (\%)} = \frac{\text{yield in treatment} - \text{yield in control}}{\text{yield in control}} \times 100$$

$$\text{Avoidable loss of yield (\%)} = \frac{\text{Treatment which gives highest yield} - \text{yield of respective treatment}}{\text{Treatment which gives highest yield}} \times 100$$

The net profit and benefit cost ratio was calculated by taking the spending on individual insecticide treatment and the associated yield into consideration in order to find the most economical and effective treatment.

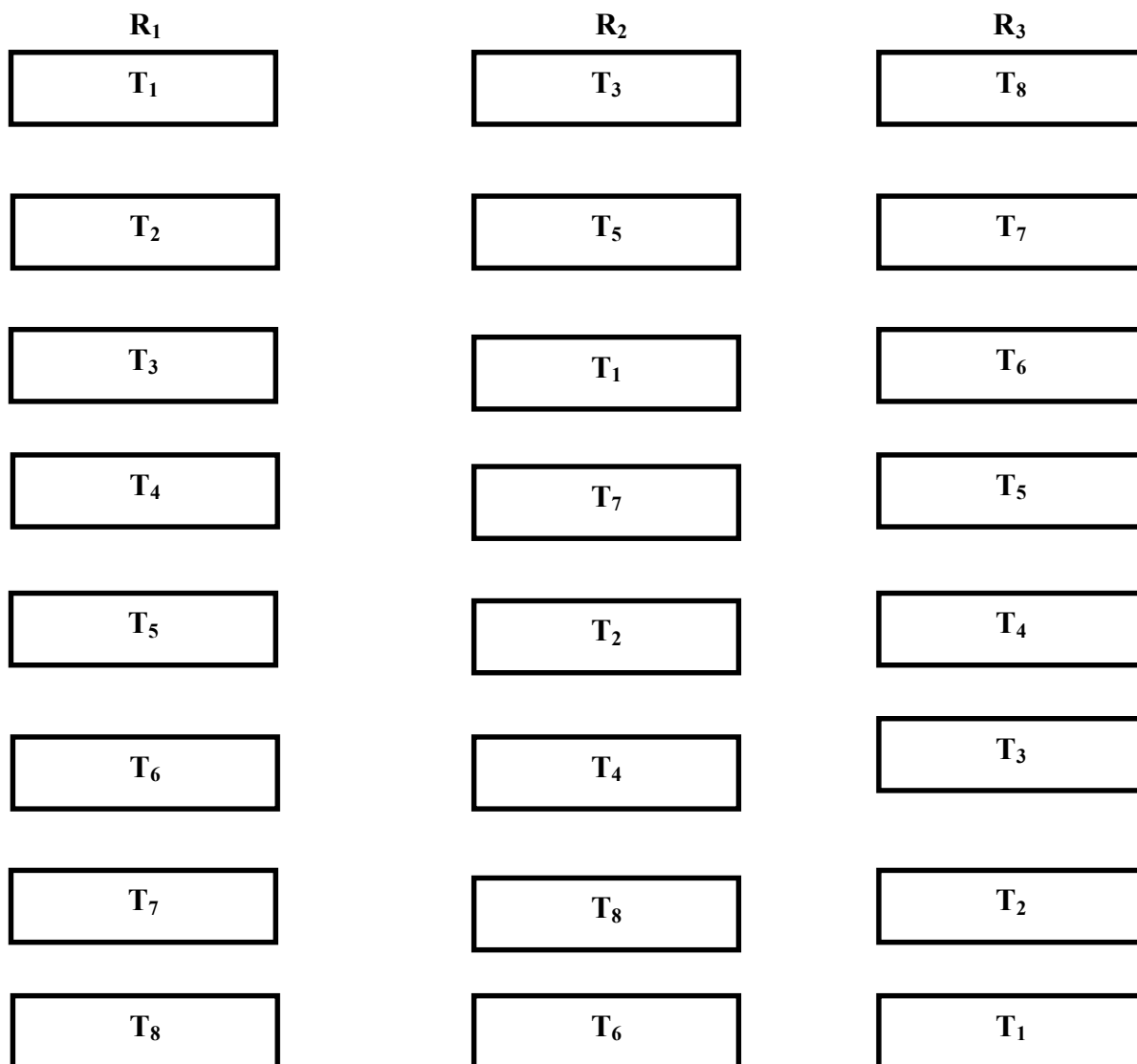


Fig 2. Layout of experimental field for application of insecticides in Randomized Block Design (RBD).

3.4 Statistical analysis

Source of variation	D.F.	Sum of square (SS)	Mean Sum of Square (MSS)	F calculated	F tabulated
Block (r)	(r - 1)	SSB	MSS(B)=SSB/(r - 1)	MSS(B)/MSS(E)	-
Treatment (t)	(t - 1)	SST	MSS(T)=SST/(t - 1)	MSS(T)/MSS(E)	-
Error	(r - 1) (t - 1)	SSE	MSS(E)= SSE/(t - 1) (r - 1)	-	-
Total	(rt - 1)	-	-	-	-

SSB = Block sum of square, SST = Treatment sum of square, SSE = Error sum of square

Standard Error of mean:

$$SEm = \pm \sqrt{\frac{MSS (E)}{r}}$$

Critical difference (CD) :

$$CD = \sqrt{2} \times SEm \times \text{value of } t \text{ at (5\%), at error df.}$$

Where,

SEm = Standard error of mean

MSS (E) = Error mean sum of square

CD = Critical Difference

r = number of replications

t = Table value at 5% level of 't' of significant at error df

Significance of treatment means were tested by 'F' test. If 'F' test expressed the significant difference between the treatments means then critical difference (CD) at 5 percent level of significance were computed.

Table 2. Weekly observation of meterological data during experimental period (November 2020 – March 2021)

Month/ Year	Standard weeks	Rainfall(mm)	Temperature(⁰ C)			Relative humidity (%)	
			Max.	Min.	Mean.	7 am	2 pm
November, 2020	45	0	29.9	15.5	22.7	85.0	55.0
	46	0	30.0	18.6	24.3	82.0	51.0
	47	0	26.6	14.4	20.5	86.0	62.0
	48	0	26.8	13.0	19.9	92.0	59.0
December, 2020	49	0	23.1	12.1	17.6	96.0	79.0
	50	0	22.6	12.0	17.3	95.0	72.0
	51	0	19.8	8.4	14.1	96.0	71.0
	52	0	22.9	8.1	15.5	94.0	65.0
January, 2021	01	0	24.4	11.2	17.8	94.7	65.7
	02	0	21.6	11	16.3	95.2	68.4
	03	0	15.6	8.2	11.9	93.6	77.4
	04	0	16.9	8.3	12.6	94.7	82.1
	05	0	19.4	7.2	13.3	94.3	74.0
February, 2021	06	0	24.6	10.6	17.6	90.3	62.9
	07	0	26.0	12.2	19.1	93.1	71.0
	08	0	28.0	14.0	21.0	90.2	58.9
	09	0	29.2	15.6	22.4	84.1	55.1
March, 2021	10	0	30.3	16.9	23.6	92.9	64.0
	11	0	30.2	17.6	23.9	88.6	56.9
	12	0	33.9	18.9	26.4	82.0	42.0
	13	0	34.2	17.2	25.7	87.0	45.0

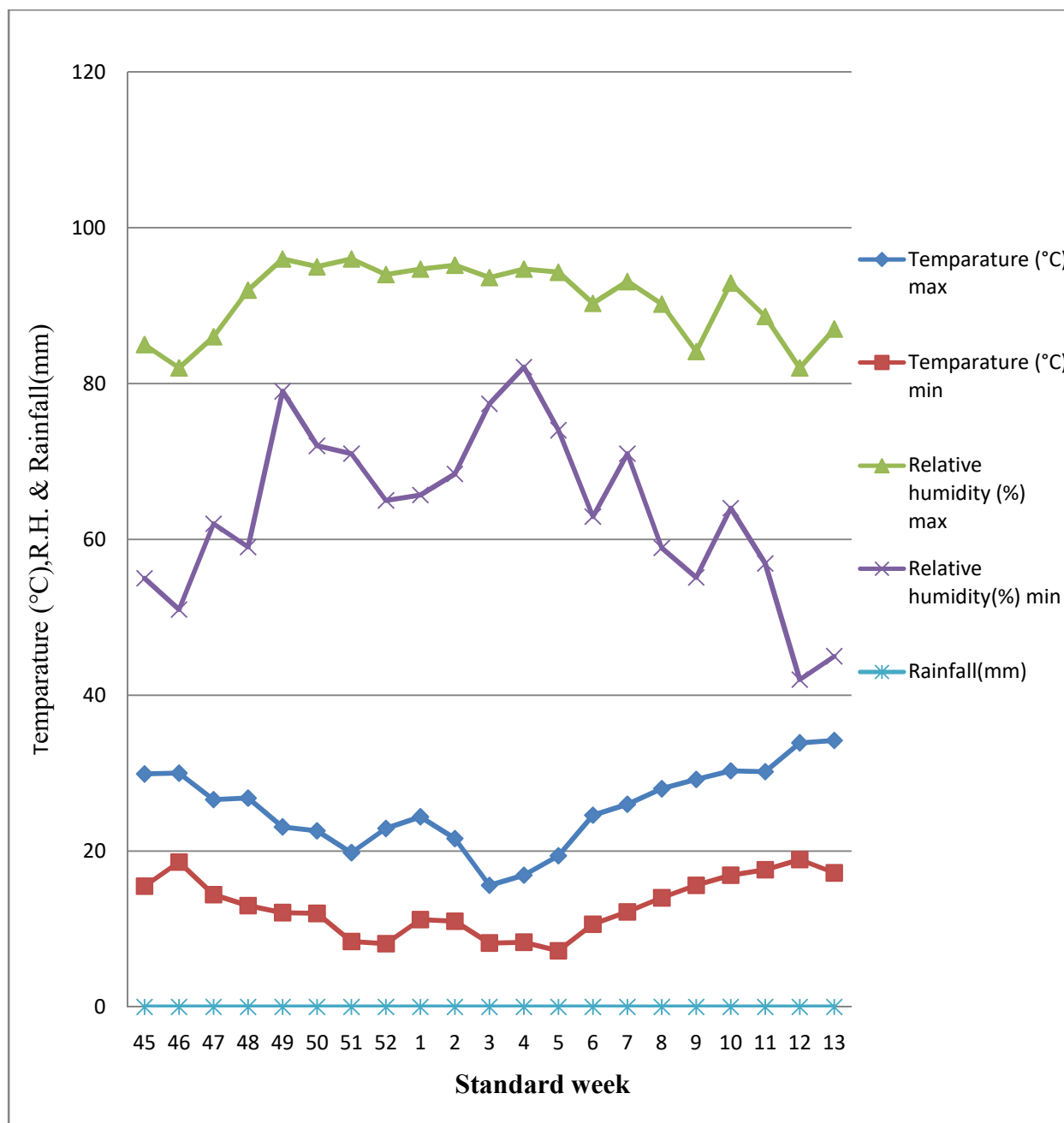


Fig 3. Weekly mean meteorological observation during the experiment period



CHAPTER - IV



RESULTS & DISCUSSION



RESULTS AND DISCUSSION

The findings of research conducted during *Rabi* season, 2020-21 on germplasm screening and management of the coriander aphid, *Hydaphis coriandri* D., are provided under the following headings:

4.1 Field screening of coriander germplasm against aphid :

In *Rabi*, 2020-21, twenty coriander germplasms were tested for resistance to the coriander aphid, *H. coriandri*. The weekly observations on the population of aphid were recorded shortly after their appearance. It is worth noting that none of the germplasms studied were totally free of aphid infestation. On January 11 th, 2021, the first observation of an aphid population was made.

On continuation table 3., the first observation (January 11th, 2021) revealed that the mean aphid population/plant ranged from 5.08 to 12.83 per plant among different germplasms. RD-412 had the lowest mean population (5.08 aphid/ plant), followed by RD-382 (5.16aphid/ plant), RD-416 (5.25 aphid/ plant), RD-378 (5.33aphid/ plant),RD-380 (5.58aphid/ plant),RD-407 (6.08aphid/ plant), RD-404 (6.16aphid/ plant) and RD-417 (6.23aphid/ plant) all of which were at par with each other. RD-121 had the highest mean population (12.83 aphid/ plant), followed by RD-379 (11.58aphid/ plant) both were at par with each other.

The second observation (January 18st, 2021) revealed that the mean aphid population/plant ranged from 18.83 to 33.25 per plant among different germplasms. RD-412 had the lowest mean population (18.83 aphid/ plant), followed by RD-416 (19.41aphid/ plant), RD-382 (19.75 aphid/ plant), RD-380 (20.25aphid/ plant) and RD-378 (20.58aphid/ plant) all of which were at par with each other. RD-121 had the highest mean population (33.25 aphid/ plant), followed by RD-373 (32.91aphid/ plant) and RD-403 (30.66aphid/ plant) all of which were at par with each other.

The third observation (January 25 th, 2021) revealed that that the mean aphid population/plant ranged from 32.08 to 58.50 per plant among different germplasms. RD-382 had the lowest mean population (32.08 aphid/ plant), followed by RD-120 (35.41aphid/ plant) and both of which were at par with each other. RD-403 had the highest mean population (58.50 aphid/ plant), followed by RD-365 (57.99aphid/ plant), RD-412 (57.83aphid/ plant),RD-379 (57.75aphid/ plant)and RD-121 (55.91aphid/ plant) all of which were at par with each other.

The fourth observation (February 1st, 2021) revealed that the mean aphid population/plant ranged from 32.91 to 75.50 per plant among different germplasms. RD-416 had the lowest mean population (32.91 aphid/ plant), followed by RD-380 (33.25aphid/ plant), Acr-1 (34.33aphid/ plant), RD-417 (35.42aphid/ plant), all of them were at par with each other. RD-373 had the highest mean population (75.50 aphid/ plant), followed by RD-366 (72.83aphid/ plant) and RD-154 (69.33aphid/ plant) all of which were at par with each other.

The fifth observation (February 8 th, 2021) revealed that the mean aphid population/plant ranged from 23.41 to 47.99 per plant among different germplasms. RD-416 had the lowest mean population (23.41 aphid/ plant), followed by RD-417 (24.16aphid/ plant), RD-380 (24.50aphid/ plant), Acr-1 (24.99aphid/ plant) and RD-121 (25.75aphid/ plant) and all of which were at par with each other. RD-154 had the highest mean population (47.99 aphid/ plant), followed by RD-366 (45.16aphid/ plant) and RD-373 (44.41aphid/ plant) and all of which were at par with each other..

The sixth observation (February 15th, 2021) revealed that the mean aphid population/plant ranged from 12.08 to 22.99 per plant among different germplasms. RD-380 had the lowest mean population (12.08 aphid/ plant), followed by RD-417 (12.33aphid/ plant), RD-416 (12.49aphid/ plant), Acr-1 (12.91aphid/ plant), RD-379 (13.41aphid/ plant), RD-383 (13.83aphid/ plant), RD-412 (14.66aphid/ plant) and RD-120 (14.91aphid/ plant) and all of which were at par with each other. RD-154 had the highest mean population (22.99 aphid/ plant), followed by RD-366 (20.58aphid/ plant) and RD-373 (20.41aphid/ plant) and all of which were at par with each other.

The seventh observation (February 22th, 2021) that the mean aphid population/plant ranged from 1.16 to 9.16 per plant among different germplasms. Acr-1 had the lowest mean population (1.16 aphid/ plant), followed by RD-417 (2.16aphid/ plant) and RD-416 (2.25aphid/ plant) and all of which were at par with each other. RD-154 had the highest mean population (9.16 aphid/ plant).

Through the seven weekly observation which is recorded during rabi season 2020-21, it is found that the mean population of aphid is ranged from 19.91 to 34.69 /plant among germplasms/varieties. RD-416 had the lowest mean population (19.91 aphid/ plant), followed by RD-380 (20.41aphid/ plant), Acr-1 (21.06aphid/ plant), Acr-1 (12.91aphid/ plant), RD-417 (21.18aphid/ plant) and RD-382 (22.82aphid/ plant) and all of which were comparable with each

other. RD-373 had the highest mean population (34.69 aphid/ plant), followed by RD-154 (34.20aphid/ plant)and RD-366 (33.87aphid/ plant) and all of which were comparable.The resistance variability in coriander germplasms was as follows: RD-416> RD-380 > Acr-1 > RD-417 > RD-382 > RD-412 > RD-120> RD- 404 >RD-23> RD-188 > RD-379 > RD-378 > RD-383 > RD-365 > RD-407> RD-403> RD-377 > RD-366 > RD-154 > RD-373. (Table 3)

For ease of interpretation, the data of peak population of aphid of different coriander germplasms were divided into separate groups (highly susceptible, moderately susceptible and least susceptible).

The genotypes/varieties were classified based on $\bar{x} \pm \sigma$, the mean of peak aphid population ($\bar{x} = 56.39$), and standard deviation of peak aphid population (S.D = 10.41).(Table 4)

Through the classification of suceptibility of coriander germplasm against coriander aphid *H.coriandri*based on peak aphid population of different germplasm(Table 4), it is found that RD-416, RD-417, RD-380, Acr 1 were least susceptible (Peak aphid population per plant < 45.98); RD-23,RD-120,RD-121,RD-365,RD-377,RD-378,RD-379,RD-382,RD-403,RD-407, RD-412,RD-404 and RD-383 were moderately susceptible (Peak aphid population per plant45.98 to 66.80) and RD-366,RD-373,RD-154 were highly susceptible (Peak aphid population per plant>66.80) against coriander aphid, *H.coriandri*. Meena *et al.* (2002) observed that coriander germplasms RCr-446 and RCr-436 were least suceptible to aphids which supports present findings.According to Pareek (2009), RCr-436 is the least susceptible variety, RCr-435, RCr-446, RCr-684, and UD-118 are moderately susceptible, while RCr-20, RCr-41, UD-480, and UD-728 are highly susceptible. The current findings are consistent with those of Tetarwal *etal.* (2012), who found substantial variations in aphid susceptibility across coriander genotypes/varieties.They discovered that RCr-436 and RCr-684 were the least susceptible, while RCr-41 was the most highly susceptible.

Table 3. Performance of coriander germplasm against coriander aphid *H. coriandrid* during November-March, 2020-21.

Germplasm	Mean aphid population/plant							
	11.01.21	18.01.21	25.01.21	01.02.21	08.02.21	15.02.21	22.02.21	Mean
V1- RD-23	7.58 (2.93)	23.49 (4.95)	37.66 (6.22)	57.16 (7.63)	37.66 (6.22)	15.66 (4.08)	4.50 (2.34)	26.25 (5.21)
V2- RD-120	7.25 (2.87)	24.75 (5.07)	35.41 (6.03)	57.83 (7.67)	33.33 (5.86)	14.91 (3.98)	3.91 (2.21)	25.63 (5.16)
V3- RD-121	12.83 (3.70)	33.25 (5.85)	55.91 (7.54)	41.75 (6.53)	25.75 (5.17)	13.83 (3.85)	3.16 (2.04)	26.64 (5.25)
V4- RD-416	5.25 (2.48)	19.41 (4.51)	43.66 (6.68)	32.91 (5.81)	23.41 (4.94)	12.49 (3.67)	2.25 (1.80)	19.91 (4.57)
V5- RD-365	7.91 (2.98)	23.50 (4.95)	57.99 (7.68)	47.33 (6.95)	32.91 (5.81)	19.16 (4.47)	7.99 (2.99)	28.12 (5.39)
V6- RD-366	7.91 (2.98)	28.91 (5.47)	53.25 (7.36)	72.83 (8.59)	45.16 (6.79)	20.58 (4.64)	6.41 (2.72)	33.87 (5.90)
V7- RD-417	6.83 (2.80)	22.16 (4.81)	45.16 (6.79)	35.42 (6.03)	24.16 (5.01)	12.33 (3.63)	2.16 (1.78)	21.18 (4.70)
V8- RD-377	8.83 (3.14)	26.83 (5.27)	45.08 (6.78)	62.99 (7.99)	42.08 (6.56)	19.83 (4.56)	6.66 (2.77)	30.33 (5.60)
V9- RD-378	5.33 (2.50)	20.58 (4.64)	39.41 (6.35)	58.25 (7.70)	38.41 (6.28)	18.33 (4.39)	7.33 (2.88)	26.81 (5.27)
V10- RD-379	11.58 (3.54)	29.16 (4.49)	57.75 (7.66)	43.33 (6.65)	28.49 (5.43)	13.41 (3.79)	2.91 (1.97)	26.66 (5.26)
V11- RD-380	5.58 (2.56)	20.25 (4.61)	44.91 (6.77)	33.25 (5.85)	24.50 (5.05)	12.08 (3.61)	2.33 (1.80)	20.41 (4.63)
V12- RD-382	5.16 (2.47)	19.75 (4.55)	32.08 (5.75)	48.75 (7.05)	33.08 (5.84)	15.08 (4.00)	5.83 (2.61)	22.82 (4.88)
V13- RD-373	12.25 (3.63)	32.91 (5.82)	50.50 (7.17)	75.50 (8.74)	44.41 (6.74)	20.41 (4.62)	6.83 (2.80)	34.69 (5.97)
V14- RD-403	10.91 (3.45)	30.66 (5.62)	58.50 (7.71)	50.41 (7.17)	33.00 (5.82)	15.83 (4.10)	5.08 (2.46)	29.20 (4.49)
	10.33	28.91	50.66	69.33	47.99	22.99	9.16	34.20

V15- RD-154	(3.36)	(5.47)	(7.19)	(8.38)	(6.99)	(4.90)	(3.18)	(5.93)
V16- Acr 1	6.91 (2.81)	22.08 (4.80)	44.50 (6.78)	34.33 (5.94)	24.99 (5.10)	12.91 (3.73)	1.16 (1.47)	21.06 (4.69)
V17- RD-407	6.08 (2.66)	24.83 (5.08)	41.83 (6.54)	61.17 (7.88)	39.25 (6.34)	17.42 (4.29)	6.16 (2.68)	28.39 (5.42)
V18- RD-412	5.08 (2.46)	18.83 (4.45)	57.83 (7.67)	45.50 (6.82)	30.66 (5.53)	14.66 (3.95)	2.83 (1.96)	25.06 (5.10)
V19- RD-404	6.16 (2.67)	21.58 (4.75)	38.66 (6.30)	54.25 (7.43)	37.66 (6.22)	17.66 (4.32)	6.99 (2.82)	26.14 (5.21)
V20- RD-383	7.75 (2.96)	23.25 (4.92)	40.58 (6.45)	60.16 (7.82)	38.58 (6.29)	18.58 (4.42)	7.66 (2.94)	28.08 (5.38)
Sem (±)	0.62	1.01	1.94	2.41	1.58	1.02	0.39	1.19
C.D. (5%)	1.75	2.86	5.51	6.85	4.48	2.89	1.10	3.38
C.V.	15.62	8.19	8.34	9.26	9.21	12.38	15.25	8.90

* Figures in parenthesis are transformed values based on square root $\sqrt{(x+1.0)}$

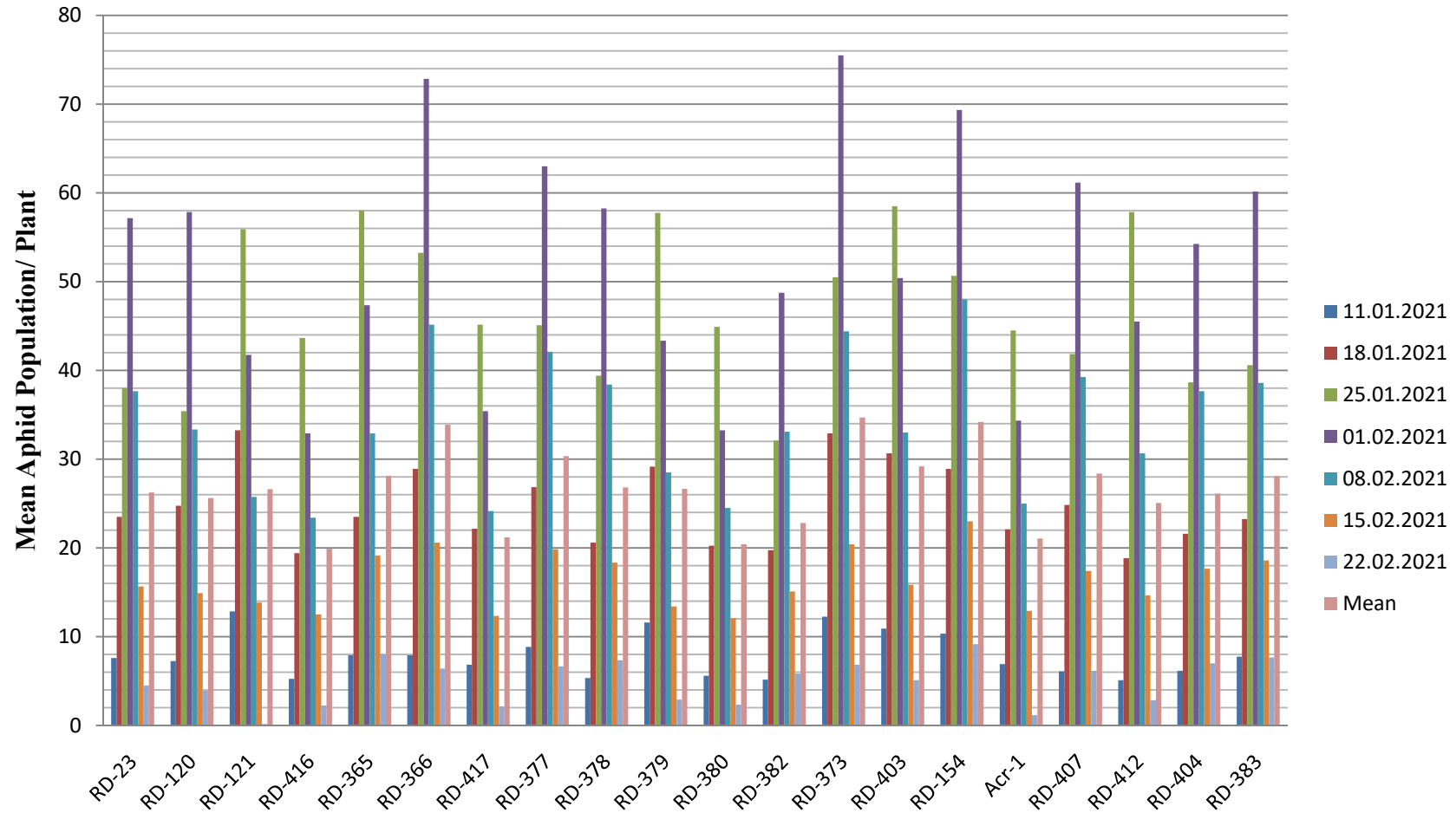


Fig 4. Performance of Coriander Germplasm against coriander aphid, *H.coriandri* during November-March 2020-21

Table 4. Classification of susceptibility of coriander germplasm against coriander aphid *H. coriandri*

SL No.	Grade	Peak aphid population per plant	Germplasm
1.	Least susceptible	<45.98	RD-416, RD-417, RD-380, Acr 1
2.	Moderately susceptible	45.98 to 66.80	RD-23, RD-120, RD-121, RD-365, RD-377, RD-378, RD-379, RD-382, RD-403, RD-407, RD-412, RD-404 and RD-383
3.	Highly susceptible	>66.80	RD-366, RD-373, RD-154

4.2 To ascertain the field efficacy of some botanical insecticides against aphid on coriander

The effectiveness of insecticides was evaluated using mean aphid populations on 10 cm terminal twigs. Two pesticide spraying schedules were followed at 15-day intervals. Observations were made 24 hours before, 3, 5, 7, and 10 days after each spray.

4.2.1. First Spraying (90 Days After Sowing):

Pre treatment-

The findings revealed no statistically significant variations in aphid population among the experimental plots. The aphid population per 10 cm twig varied from 36.33 to 37.93. (Table 5)

Post treatment-

(i) After three days-All insecticidal treatments were shown substantially better (14.40 to 33.80 aphid/10 cm apical twig) in decreasing the aphid population over the untreated control (44.93 aphid/10 cm apical twig). Thiomethoxam 25 WG treatment had the lowest population of aphid (14.40 aphid/10 cm apical twig). Neem Seed Kernel Extract (NSKE) treatment had the lowest population of aphid (28.40 aphid/10 cm apical twig) among botanicals and was at par with Neem oil, Tobacco decoction and Karanj oil (29.20, 31.40 and 32.40 aphid/10 cm apical twig, respectively). *Lecanicillium lecanii* and Yam Bean Seed Extract (YBSE) treatments were shown significantly less efficient than all other insecticides and had relatively higher population of aphid than treated plot (33.20 and 33.80 aphid/10 cm apical twig, respectively). (Table 5)

(ii) After five days-When compared to the untreated control (52.40 aphid/10 cm apical twig), all insecticidal treatments were shown considerably superior in controlling the aphid population (10.27 and 29.40 aphid/10 cm apical twig). Thiomethoxam 25 WG treatment had the lowest population of aphid (10.27 aphid/10 cm apical twig) and performed substantially better than all other insecticides. Neem Seed Kernel Extract (NSKE) treatment had the lowest mean population of aphid (23.33 aphid/10 cm apical twig) among botanicals and was at par with Neem oil, Karanj oil and Tobacco decoction (24.2, 26.80 and 27.13 aphid/10 cm apical twig, respectively). *Lecanicillium lecanii* and Yam Bean Seed Extract (YBSE) treatments were shown

to be significantly less efficient than all other insecticides and had relatively higher population of aphid than treated plot (28.33 and 29.40 aphid/10 cm apical twig, respectively).(Table 5)

(iii)After seven day-When compared to the untreated control (45.80aphid/10 cm apical twig), all insecticidal treatments were showed considerably superior in controlling the aphid population (7.67 and 25.80aphid/10 cm apical twig).Thiomethoxam 25 WG treatment had lowest population of aphid (7.67 aphid/10 cm apical twig) and performed substantially better than all other insecticides. Neem Seed Kernel Extract (NSKE) treatment had lowest population of aphid among botanicals (18.13 aphid/10 cm apical twig) and at par with Neem oil, Tobacco decoction and Karanj oil (19.47, 21.13 and 22.60aphid/10 cm apical twig).*Lecanicillium lecani*treatment had relatively higher population of aphid (23.40 aphid/10 cm apical twig) and was showed considerably less efficient in reducing aphids.*Lecanicillium lecani*treatment was at par with Yam Beam Seed Extract (YBSE) treatment (25.80 aphid /10 cm apical twig).(Table 5)

(iv)After ten day-When compared to the untreated control (40.40aphid/10 cm apical twig), all insecticidal treatments were showed considerably superior in controlling the aphid population (5.80 and 22.33 aphid/10 cm apical twig).Thiomethoxam 25 WG treatment had lowest population of aphid (5.80 aphid/10 cm apical twig) performed substantially better than all other insecticides. Among botanicals, the lowest mean population of aphid was seen on Neem Seed Kernel Extract (NSKE) treatment(16.87 aphid/10 cm apical twig) which was at par with Neem oil, tobacco decoction and karanj oil (17.88, 18.07 and 19.80 mean aphid population/10 cm apical twig) treatment . These were showed somewhat moderately efficient in controlling coriander aphid, *H.coriandri*. *Lecanicillium lecani*treatment had relatively higher population of aphid (20.53 aphid/10 cm apical twig) and was showed considerably less efficient in reducing aphids.*Lecanicillium lecani*treatment was at par with Yam Beam Seed Extract (YBSE) treatment (22.33 aphid /10 cm apical twig).(Table 5)

The mean results of different intervals revealed that thiomethoxam 25 WG treatment (9.28 aphid/10 cm apical twig) was superior to all other treatments in terms of reduction of aphid population, followed by Neem Seed Kernel Extract (21.68 aphid/10 cm apical twig) and Neem oil (422.67 aphid/10 cm apical twig) treatments.The population of aphid in Tobacco decoction (24.43 aphid/10 cm apical twig), Karanj oil (5.13 aphid/10 cm apical twig) and *Lecanicillium lecanii* (5.23 aphid/10 cm apical twig) treatments were higher than NSKE and neem

oil treatments. Yam Bean Seed Extract (YBSE) treatment (5.37 aphid/10 cm apical twig) was shown to be considerably less efficient in reducing aphids (Table 5). Gupta and Rai (2004) discovered that neem oil at 1% was the most efficient against aphids in coriander crop, providing maximal protection, followed by NSKE and cow urine at 3% + methyl demeton at 0.003%. Meena *et al.* (2003) discovered that neem and Karanj products had the least efficiency when compared to synthetic insecticides, which supports the present finding.

Table 5. Evaluation of efficacy of different treatments in management of coriander aphid during first spray 90 DAS (Days After Sowing)

Treatments	Doses	Pre-treatment	Mean aphid population/ 10cm twig				
			3 DAS	5 DAS	7 DAS	10 DAS	Mean
T ₁ :Neem oil	3 ml/l	37.93 *(6.23)	29.2 (5.49)	24.2 (5.01)	19.47 (4.51)	17.88 (4.33)	22.67 (4.87)
T ₂ :Neem Seed Kernel Extract	5 ml/l	36.67 (6.13)	28.40 (5.41)	23.33 (4.93)	18.13 (4.36)	16.87 (4.21)	21.68 (4.76)
T ₃ :Yam Bean Seed Extract	5 ml/l	37.87 (6.22)	33.80 (5.89)	29.40 (5.50)	25.80 (5.17)	22.33 (4.82)	27.83 (5.37)
T ₄ : <i>Lecanicillium lecanii</i>	4 g/l	36.33 (6.10)	33.20 (5.84)	28.33 (5.41)	23.40 (4.93)	20.53 (4.63)	26.37 (5.23)
T ₅ :Karanj Oil	10 ml/l	36.93 (6.15)	32.40 (5.76)	26.80 (5.26)	22.60 (4.84)	19.80 (4.55)	25.40 (5.13)
T ₆ :Thiomethoxam 25WG	0.2g/l	37.00 (6.16)	14.40 (3.92)	10.27 (3.34)	7.67 (2.93)	5.80 (2.59)	9.53 (3.20)
T ₇ :Tobacco Decoction	5ml/l	37.33 (6.18)	31.40 (5.68)	27.13 (5.30)	21.13 (4.68)	18.07 (4.35)	24.43 (5.04)
T ₈ :Control		37.40 (6.18)	44.93 (6.77)	52.40 (7.30)	45.80 (6.83)	40.40 (6.43)	45.88 (6.85)
SEm(±)		2.40	1.56	1.29	1.55	1.05	1.27
C.D. (5%)		NS	4.61	3.92	4.71	3.17	3.92
C.V.		11.19	8.41	8.08	11.70	8.97	8.10

* Figures in parenthesis are transformed values based on square root $\sqrt{(x+1.0)}$

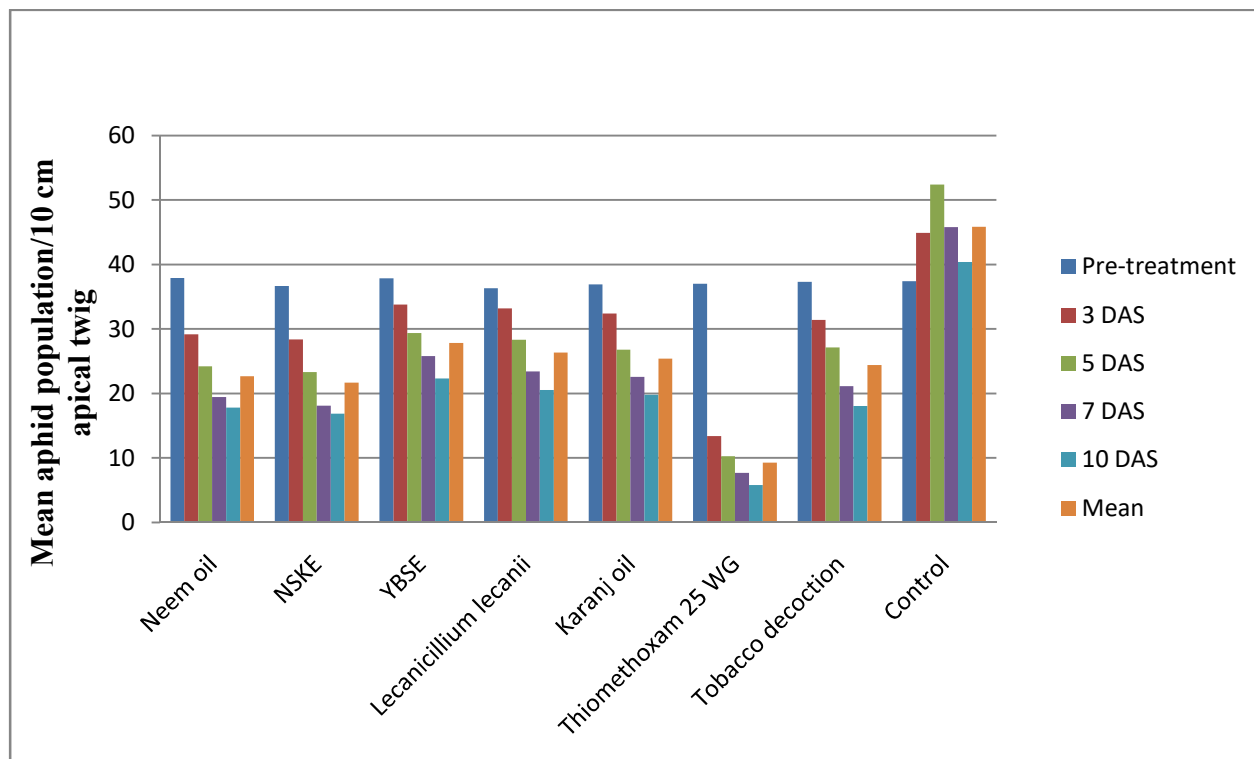


Fig 5. Representation of efficacy of different treatments in management of coriander aphid during first spraying 90 DAS (Days After Sowing)

4.2.2. Second Spraying(105 Days After Sowing):

Pre treatment-

The findings revealed no statistically significant variations in aphid population among the experimental plots. The mean population of aphid/10 cm apical twig varied from 5.33 to 31.13. (Table 6)

Post treatment-

(i)After three day-All insecticidal treatments were showed substantially better (3.80 to 13.47 aphid/10cm apical twig) in decreasing the aphid population over the untreated control (24.33 aphid/10cm apical twig).Thiomethoxam 25 WGtreatment had the lowest mean population of aphid (3.80 aphid/10 cm apical twig), followed by Neem Seed Kernel Extract (NSKE) (9.87 aphid/10 cm apical twig) treatment.Neem Seed Kernel Extract (NSKE) treatment had lowest population of aphid among botanicals and at par with Neem oil, Tobacco decoction and Karanj oil (10.67, 11.06 and 11.67 aphid/10 cm apical twig). *Lecanicillium lecanii* and Yam Bean Seed Extract (YBSE) treatments were showed significantly less efficient than all other insecticides and had higher population of aphid (12.27 and 13.47 aphid/10 cm apical twig, respectively). (Table 6)

(ii)After five day-When compared to the untreated control (17.4aphid/10 cm apical twig), all insecticidal treatments were showed considerably superior in controlling the aphid population (2.47 and 11.53aphid/10 cm apical twig).Thiomethoxam 25 WG (2.47 aphid/10 cm apical twig) treatment performed substantially better than all other insecticides. Neem Seed Kernel Extract (NSKE) treatment had lowest mean population of aphid among botanicals and at par with Neem oil, Tobacco decoction and Karanj oil (8.73, 9.27 and 9.73 aphid/10 cm apical twig) treatments. *Lecanicillium lecanii*treatment was showed considerably less efficient in reducing aphids(10.33 aphid/10 cm apical twig) and was at par with Yam Beam Seed Extract (YBSE) (11.53 aphid/10 cm apical twig) treatment. (Table 6)

(iii)After seven day-When compared to the untreated control (11.53 mean aphid population/10 cm apical twig), all insecticidal treatments were showed considerably superior in controlling the

aphid population (1.93 and 8.40aphid/10 cm apical twig).Thiomethoxam 25 WG treatment had lowest population of aphid (1.93 aphid/10 cm apical twig) and performed substantially better than all other insecticides. Neem Seed Kernel Extract (NSKE) treatment had lowest population of aphid among botanicals (5.13 aphid/10 cm apical twig) and at par with Neem oil and tobacco decoction (5.60 and 6.47 aphid/10 cm apical twig) treatment.Karanj oil, *Lecanicillium lecanii*and Yam Bean Seed Extract treatments had relatively higher population of aphid (6.80, 7.20 and 8.40 aphid/10 cm apical twig, respectively) and was showed considerably less efficient in reducing aphids.(Table 6).

(iv)After ten day-When compared to the untreated control (6.20aphid/10 cm apical twig), all insecticidal treatments were showed considerably superior in controlling the aphid population (0.93 and 5.40aphid/10 cm apical twig).Thiomethoxam 25 WG (1.39 aphid/10 cm apical twig) treatment performed substantially better than all other insecticides. Neem Seed Kernel Extract (NSKE) (2.40 aphid/10 cm apical twig) and Neem oil (2.67 mean aphid population/10 cm apical twig) treatments were showed somewhat highly efficient in controlling coriander aphid, *H.coriandri*and at par with each other.Tobacco decoction (3.27 aphid/10 cm apical twig) treatment showed somewhat moderately efficient in controlling coriander aphid, *H.coriandri*, and with Karanj oil (3.60 aphid/10 cm apical twig).Yam Beam Seed Extract (YBSE) (5.40 aphid/10 cm apical twig) treatments showed considerably less efficient in reducing aphids, followed by *Lecanicillium lecanii* (4.33 aphid/10 cm apical twig) treatment. (Table 6)

The mean results of different intervals revealed that thiomethoxam 25 WG (2.28 aphid/10 cm apical twig) had lowest mean population of aphid and was superior to all other treatments in terms of aphid population reduction, followed by Neem Seed Kernel Extract (6.35 aphid/10 cm apical twig) and Neem oil (6.92aphid/10 cm apical twig).Tobacco decoction (7.52 mean aphid population/10 cm apical twig), Karanj oil (7.95 mean aphid population/10 cm apical twig) *Lecanicillium lecanii*andYam Beam Seed Extract (YBSE) (8.53 and 9.70 aphid/10 cm apical twig, respectively) were shown to be considerably less efficient in reducing aphids (Table 6). Meena *et al.* (2016) discovered that the plots which are treated with the organic salt(bio-product) 5ml/l (67.83 and 70.10%) reduced maximum number of aphid population followed by kanel extract 10 ml/l (67.00 and 68.96 %) and tumba fruit extract 10 ml/l (67.83 and 68.32 %) in both experimental years, respectively which supports the present findings.

Table 6. Evolution of efficacy of different treatments in management of coriander aphid during Second spray 105 DAS (Days After Sowing)

Treatments	Doses	Pre-treatment	Mean aphid population/ 10cm twig				
			3 DAS	5 DAS	7 DAS	10 DAS	Mean
T ₁ :Neem oil	3 ml/l	15.73 *(4.06)	10.67 (3.40)	8.73 (3.10)	5.60 (2.55)	2.67 (1.90)	6.92 (2.80)
T ₂ :Neem Seed Kernel Extract	5 ml/l	14.73 (3.97)	9.87 (3.30)	8.00 (3.00)	5.13 (2.48)	2.40 (1.84)	6.35 (2.71)
T ₃ :Yam Bean Seed Extract	5 ml/l	20.33 (4.60)	13.47 (3.78)	11.53 (3.51)	8.40 (3.05)	5.40 (2.51)	9.70 (3.26)
T ₄ : <i>Lecanicillium lecanii</i>	4 g/l	18.53 (4.42)	12.27 (3.64)	10.33 (3.37)	7.20 (2.86)	4.33 (2.31)	8.53 (3.09)
T ₅ :Karanj Oil	10 ml/l	17.67 (4.29)	11.67 (3.54)	9.73 (3.26)	6.80 (2.77)	3.60 (2.12)	7.95 (2.99)
T ₆ :Thiomethoxam 25WG	0.2g/l	5.33 (2.51)	3.80 (2.18)	2.47 (1.85)	1.93 (1.71)	1.39 (0.93)	2.28 (1.80)
T ₇ :Tobacco Decoction	5ml/l	16.27 (4.16)	11.06 (3.47)	9.27 (3.17)	6.47 (2.72)	3.27 (2.04)	7.52 (2.90)
T ₈ :Control		31.13 (5.66)	24.33 (5.01)	17.4 (4.27)	11.53 (3.52)	6.20 (2.67)	14.87 (3.97)
SEm(±)		1.13	0.71	0.57	0.51	0.26	0.17
C.D. (5%)		3.42	2.15	1.74	1.54	0.81	0.50
C.V.		11.18	10.10	10.24	13.26	12.74	9.77

* Figures in parenthesis are transformed values based on square root $\sqrt{(x+1.0)}$

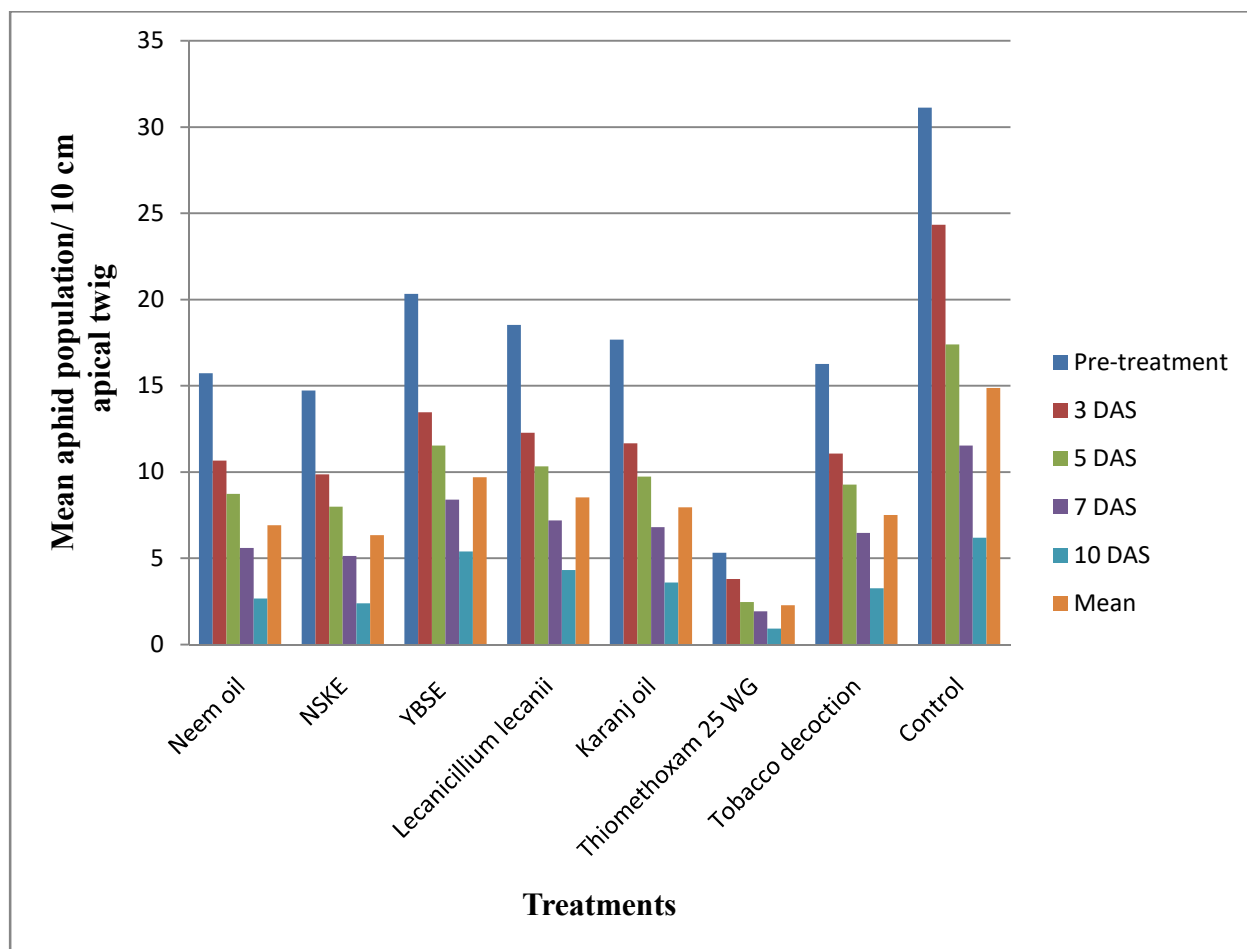


Fig 6. Representation of efficacy of different treatments in management of coriander aphid during second spraying 105 DAS (Days After Sowing)

4.2.3. Combined effect of two spraying in management of coriander aphid

The combined effect of two spraying in 15 days interval on coriander aphid revealed that thiomethoxam 25 WG had lowest mean population of aphid (5.78 aphid/10 cm apical twig) and was superior to all other treatments in terms of aphid population reduction, followed by Neem Seed Kernel Extract (14.02 aphid/10 cm apical twig) and Neem oil (14.80 aphid/10 cm apical twig). Tobacco decoction (15.98 aphid/10 cm apical twig), Karanj oil (16.68 mean aphid population/10 cm apical twig) and *Lecanicillium lecanii* (17.45 aphid/10 cm apical twig) were moderately effective and were at par in their efficiency. Yam Beam Seed Extract (YBSE) (18.77 aphid/10 cm apical twig) was shown to be considerably less efficient in reducing aphids. (Table 7)

Application of thiamethoxam also proved highly effective as reported by Jat (2004), whereas Rohilla *et al.* (2004) reported it as moderately effective against *L. erysimi* on mustard support the present findings. The present results are in conformity with the finding of Patel and Jhala (1998) who reported Margocide CK and nimbecidine less effective against, *L. erysimi* on radish. Jat (2004) and Lekha and Jat (2004) also reported neem products as least effective against, *L. erysimi* infesting mustard and *H. coriandari* on coriander, respectively as compared to synthetic chemical insecticides. Bhatnagar *et al.* (2004) reported that, imidacloprid 17.8 SL, thiamethoxam (Actara) 25 WG at 50 g a.i./ ha, oxydemeton methyl 25 EC and monocrotophos 36 EC were most effective against mustard aphid, *L. erysimi* which is relatable to present finding.

Table 7. Overall effect of two spraying in magagement of coriander aphid

Treatment	Doses	After 1 spray	After 2 spray	Pooled Mean
T1-Neem oil	3 ml/l	22.67 (4.87)	6.92 (2.80)	14.80 (3.84)
T2-Neem Seed Kernel Extract	5 ml/l	21.68 (4.76)	6.35 (2.71)	14.02 (3.74)
T3-Yam Bean Seed Extract	5 ml/l	27.83 (5.37)	9.70 (3.26)	18.77 (4.32)
T4- <i>Lecanicillium lecanii</i>	4 g/l	26.37 (5.23)	8.53 (3.09)	17.45 (4.16)
T5-Karanj oil	10 ml/l	25.40 (5.13)	7.95 (2.99)	16.68 (4.06)
T6-Thiomethoxam 25 WG	0.2 g/l	9.53 (3.20)	2.28 (1.80)	5.78 (2.50)
T7-Tobacco decoction	5 ml/l	24.43 (5.04)	7.52 (2.90)	15.98 (3.97)
T8-Control		45.88 (6.85)	14.87 (3.97)	30.38 (5.41)
SEm(±)		1.27	0.17	0.94
C. D. (5 %)		3.92	0.50	2.71
C. V.		8.10	9.77	8.97

* Figures in parenthesis are transformed values based on square root $\sqrt{(x+1.0)}$

4.2.4. Effect of insecticidal treatments on the seed yield of coriander :

The results showed that all of the insecticide-treated plots produced substantially more seed than the untreated control. The plots treated with Thiomethoxam 25 WG yielded the most seeds (12.95 q/ha). The seed yield obtained in the plots that were treated with Neem Seed Kernel Extract and Neem oil were 11.35 q/ha and 11.01 q/ha, respectively. The seed yield in the plot that treated with Neem Seed Kernel Extract were found at par with the plots yield which treated with neem oil (11.01 q/ ha), tobacco decoction (10.58 q/ ha) and karanj oil (10.51 q/ ha). Among the all insecticides treatment plots, lowest yield was achieved in the Yam Bean Seed Extract treatment (10.25 q/ha), followed by *Lecanicillium lecanii* (10.37 q/ha). (Table 8)

The results of the field studies revealed that there was a substantial difference in seed yield increase in treated plots as compared to untreated plots. The plots treated with Thiomethoxam 25WG yielded the highest yield of 12.95 q/ ha, followed by neem seed karnel extract and neem oil, which yielded 11.35 and 11.01 q/ha (Table 8), respectively. The lowest seed yield was found in untreated plot 8.15 q/ha (Table 8). Choudhary and Pal (2005) reported that the highest yield of mustard was obtained in the plots treated with acephate 0.075% (12.31 q/ha) followed by thiamethoxam 0.0125% (12.24 q/ha) and dimethoate 0.03% (11.03 q/ha). Patel (2006) observed that the treatment imidacloprid gave the highest seed yield (1531 kg/ha) followed by thiamethoxam (1344 kg/ha) and acetamiprid (1225 kg/ha). Those studies were comparable to the present study.

Table 8.Effect of different botanical insecticides on seed yield

Treatment	Doses	Seed yield (q/ha)
T ₁ :Neem oil	3 ml/l	11.01
T ₂ :Neem Seed Kernel Extract	5 ml/l	11.35
T ₃ :Yam Bean Seed Extract	5 ml/l	10.25
T ₄ : <i>Lecanicillium lecanii</i>	4 g/l	10.37
T ₅ :Karanj Oil	10 ml/l	10.51
T ₆ :Thiomethoxam 25WG	0.2 g/l	12.95
T ₇ :Tobacco Decoction	5 ml/l	10.58
T ₈ :Control		8.15
SEm(±)		0.27
C. D. (5 %)		0.86
C. V.		8.23

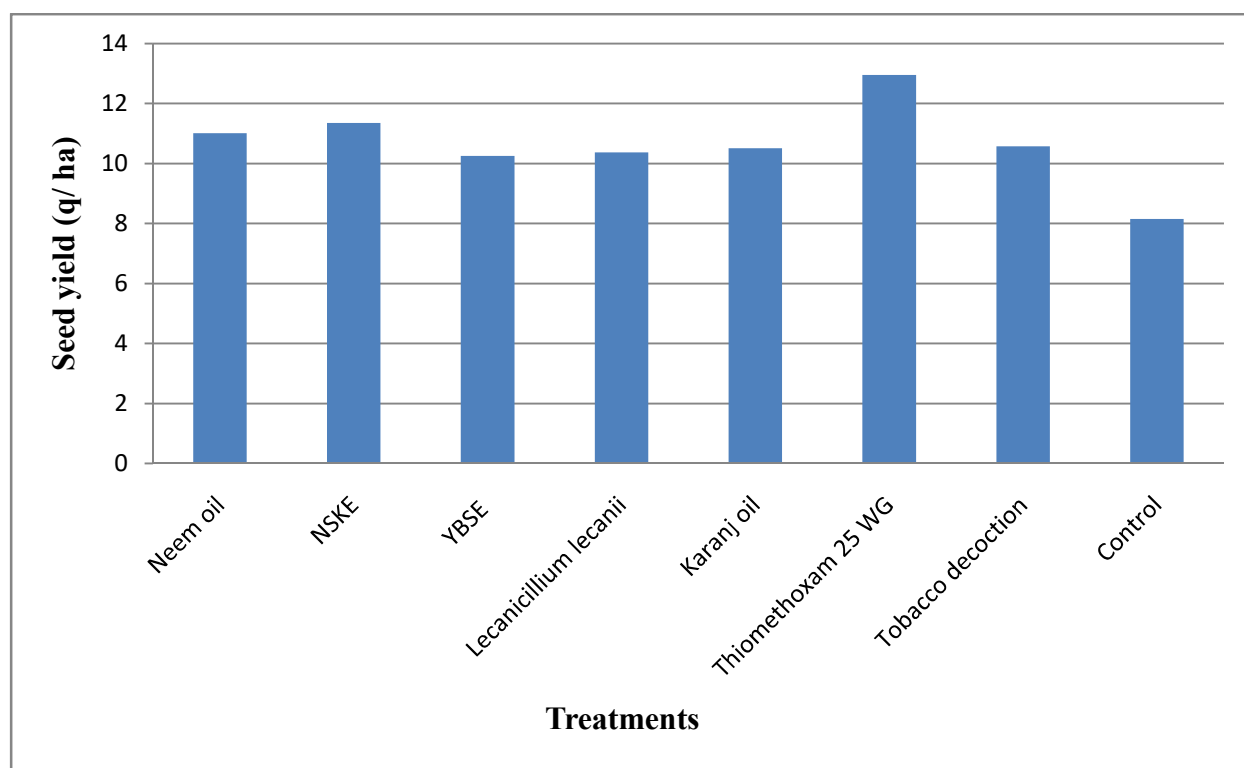


Fig 7. Representation of the effect of different treatments on grain yield

4.2.5. Assessment of avoidable loss of corinder seed yield over control in different treatments

During Rabi, 2020-21, the untreated plot had highest percent avoidable loss of 37.07, followed by yam bean seed extract and *Lecanicillium lecanii*, which had percent avoidable losses of 20.85 and 19.92, respectively. The plot treated with karanj oil, had percent avoidable loss of 18.84, followed by tobacco decoction, which had percent avoidable loss of 18.30. The plot treated with neem oil, had percent avoidable loss of 14.98, followed by NSKE, which had percent avoidable loss of 12.36. Thiomethoxam WG treated plot had lowest avoidable loss percentage. (Table 9)

The untreated plot had highest avoidable loss of 4.80 q/ha, followed by yam bean seed extract and *Lecanicillium lecanii*, which had avoidable losses of 2.7 and 2.57, respectively. The plot treated with karanj oil, had avoidable loss of 2.44, followed by tobacco decoction, which had avoidable loss of 2.37. The plot treated with neem oil, had avoidable loss of 1.94, followed by NSKE, which had avoidable loss of 1.60. Thiomethoxam 25 WG treated plot had lowest avoidable loss. (Table 9)

The current findings are consistent with those of Lekha and Jat (2004) and Bana *et al.* (2011), who found that untreated control had the highest total avoidable and percent avoidable loss, followed by neem oil, NSKE, and azadirachtin 20 EC in coriander crop against aphid, *H. coriandri*. The findings of Pareek (2009), who reported the lowest avoidable and percent avoidable losses in plots treated with dimethoate 30 EC followed by acephate 75 SP and the highest in untreated plots followed by NSKE and azadirachtin 20 EC in coriander crop against aphid, *H. coriandri*, support the current findings.

Table 9. Assessment of avoidable loss of coriander seed yield over control in different treatments

Treatment	Doses	Seed Yield (q/ha)	Avoidable loss	
			(q/ ha)	(%)
T ₁ :Neem oil	3 ml/l	11.01	1.94	14.98
T ₂ :Neem Seed Kernel Extract	5 ml/l	11.35	1.60	12.36
T ₃ :Yam Bean Seed Extract	5 ml/l	10.25	2.70	20.85
T ₄ : <i>Lecanicillium lecanii</i>	4 g/l	10.37	2.58	19.92
T ₅ :Karanj Oil	10 ml/l	10.51	2.44	18.84
T ₆ :Thiomethoxam 25WG	0.2 g/l	12.95	0	0
T ₇ :Tobacco Decoction	5 ml/l	10.58	2.37	18.30
T ₈ :Control		8.15	4.80	37.07

4.2.6. Assessment of Increase coriander seed yield over control in different treatments

During Rabi, 2020-21, the plot treated with Thiomethoxam 25 WG, had highest increase of yield over the control 58.09, followed by Neem Seed Kernel Extract and Neem oil, which had increase of yield over the control 39.50 and 35.09 %, respectively. The plot treated with Tobacco decoction, had increase of yield over the control 29.82 %, followed by Karanj oil, which had increase of yield over the control 28.96 %. The plot treated with Yam Bean Seed Extract, had lowest increase of yield over the control 25.77 %, followed by *Lecanicillium lecanii*, which had increase of yield over the control 27.24 %. (Table 10)

The findings are confirmed by the findings of Pareek (2009), who found the greatest increase and percent increase in yield over control in the treatment with dimethoate 30 EC followed by acephate 75 SP.

Table 10. Assessment of Increase coriander seed yield over control in different treatments

Treatment	Doses	Seed Yield (q/ha)	Increase yield over control	
			(q/ ha)	(%)
T ₁ :Neem oil	3 ml/l	11.01	2.86	35.09
T ₂ :Neem Seed Kernel Extract	5 ml/l	11.35	3.2	39.26
T ₃ :Yam Bean Seed Extract	5 ml/l	10.25	2.1	25.77
T ₄ : <i>Lecanicillium lecanii</i>	4 g/l	10.37	2.22	27.24
T ₅ :Karanj Oil	10 ml/l	10.51	2.36	28.96
T ₆ :Thiomethoxam 25WG	0.2 g/l	12.95	4.8	58.90
T ₇ :Tobacco Decoction	5 ml/l	10.58	2.43	29.82
T ₈ :Control		8.15	0.00	0.00

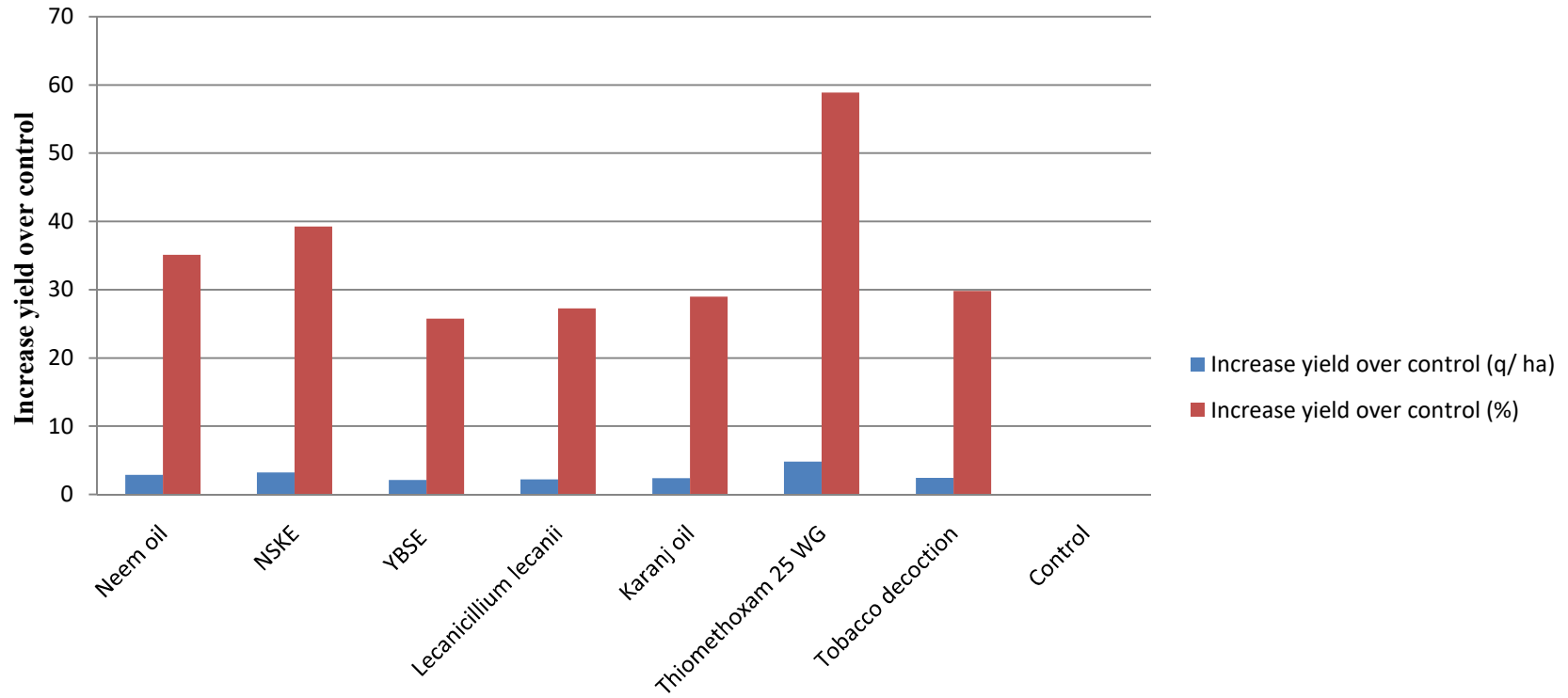


Fig 8. Representation of Increase coriander seed yield over control in different treatments

4.2.7 Economics of the insecticidal treatments

Net Profit

During *Rabi*, 2020-2021, the treatment with Thiomethoxam 25 WG yielded the highest net profit (Rs.44628), followed by Neem Seed Kernel Extract and Neem oil, which yielded net profits of Rs.33628 and Rs.31388, respectively. The plots treated with *Lecanicillium lecanii* had the lowest net profit (Rs.26828), followed by Yam Bean Kernel Extract and Karanj oil, which had net profits of Rs.27278 and Rs.28088, respectively. However, the Tobacco decoction treatments generated a net profit of Rs.29508. (Table 11)

Benefit-Cost ratio

Thiomethoxam 25 WG had the highest benefit-to-cost ratio (2.61) followed by Neem Seed Kernel Extract (1.99) and Neem oil (1.86). The treatment with *Lecanicillium lecanii* yielded the lowest benefit cost ratio (1.59), followed by Yam Bean Seed Extract, Karanj oil and Tobacco decoction, which yielded benefit cost ratios of 1.61, 1.66, and 1.75, respectively. (Table 11). Akhauri and Singh (2009) reported the cost benefit ratio of some chemical insecticides and bio-products against mustard aphid and found that highest return (1:24.6) was obtained in NSKE @ 5% followed by dimethoate 30EC (1:22.7), imidacloprid 17.8 SL (1:19.4), betacyhalothrin (1:18.1), neem oil (1:15.9), endosulfan (1:14.4) and diflubenzuron (1:9.0) and is in corroboration to the present study. Bana et al. (2011) found that the treatments with NSKE 5% had benefit-to-cost ratio (1.68) which is quite similar with this result. (Table 11).

Table 11. Economics of insecticides evaluated to test efficacy against coriander aphid *H.coriandri*

Treat-ment	Fixed cost (Rs/ha)	Variable cost(Rs/ha)		Total cost (Rs/ha)	Seed yield (q/ha)	Price (Rs/ha)	Gross return (Rs/ha)	Net Return (Rs/ha)	B:C Ratio
		Insecti-cide	Labor (spray)						
T ₁ :Neem oil	32000	1200	1472	34672	11.01	6000	66060	31388	1.86:1
T ₂ :Neem Seed Kernel Extract	32000	1000	1472	34472	11.35	6000	68100	33628	1.99:1
T ₃ :Yam Bean Seed Extract	32000	750	1472	34222	10.25	6000	61500	27278	1.61:1
T ₄ : <i>Lecanicilium lecanii</i>	32000	1920	1472	35392	10.37	6000	62220	26828	1.59:1
T ₅ :Karanj Oil	32000	1500	1472	34972	10.51	6000	63060	28088	1.66:1
T ₆ :Thiomet hoxam 25WG	32000	200	1472	33672	12.95	6000	77700	44628	2.61:1
T ₇ :Tobacco Decoction	32000	500	1472	33972	10.58	6000	63480	29508	1.75:1
T ₈ :Control	32000			32000	8.15	6000	66060	16900	

Economics and Production of Coriander in various Treatments

Number of spraying : 2

Labour charge: 368/day/person.

Requirment of labour: 2 persons/spray/hectare.

Price of seed: Rs-6000/q.



CHAPTER - V



SUMMARY & CONCLUSION



SUMMARY AND CONCLUSION

During the “*rabi*” season of 2020-21, a study on the “Germplasm Screening and Management of Coriander Aphid, *Hyadaphis coriandri* D.” was conducted. Two studies were carried out at Muraul, TCA, Dholi, Muzaffarpur, Bihar: “Field screening of coriander germplasm against aphid” and “To ascertain the field efficiency of various botanical insecticides against aphid on coriander.”

5.1. Field screening of coriander germplasm against aphid

Twenty germplasms of coriander crop were studied for their sensitivity to coriander aphid, *H. coriandri*. During November- March, 2020-21, the experiment was conducted at T.C.A, Dholi (Muzaffarpur), Bihar. According to the results, no germplasm was found to be totally free of aphid infestation. However, Different germplasm, revealed varied degrees of sensitivity to *H. coriandri*. Through the classification of susceptibility of coriander germplasm against coriander aphid *H. coriandri* based on peak aphid population of different germplasm, it is found that RD-416, RD-417, RD-380, Acr 1 were least susceptible (Peak aphid population per plant < 45.98) , RD-23, RD-120, RD-121, RD-365, RD-377, RD-378, RD-379, RD-382, RD-403, RD-407, RD-412, RD-404 and RD-383 were moderately susceptible (Peak aphid population per plant 45.98 to 66.80) and RD-366, RD-373, RD-154 were highly susceptible (Peak aphid population per plant > 66.80) against coriander aphid, *H. coriandri*.

5.2. To ascertain the field efficacy of some botanical insecticides against aphid on coriander

The field effectiveness of 20 treatments against the coriander aphid was tested. The treatments were conducted with Neem oil (3 ml/l), Neem Seed Kernel Extract (5 ml/l), Yam Bean Seed Extract (5 ml/l), *Lecanicillium lecanii* (4 g/l), Karanj oil (10 ml/l), Thiomethoxam 25 WG (0.2 g /l) and Tobacco decoction (5 ml/l) and they were evaluated between November 2020 to March 2021. Spraying is planned for 90 and 105 DAS (Days after sowing). The experimental design is a Randomized Block Design (RBD) with 8 treatments and 3 replications. “Rajendra swati” is the variety utilized in the experiment.

Overall data and insecticide efficacy data show that treatment-T6 (treatment with Thiomethoxam 25 WG @ 0.2 g/l) had the lowest coriander aphid infestation, followed by T2

(treatment with Neem Seed Kernel Extract @ 5 ml/l) while treatment-T3 (treatment with Yam Bean Seed Extract @ 5 ml/l) has the lowest efficacy.

Overall, the maximum seed yield is recorded in treatment T6 -treatment with Thiomethoxam 25 WG @ 0.2 g/l (12.95 q/ha), followed by treatment T2 -treatment with Neem Seed Kernel Extract @ 5 ml/l (11.35) whereas the lowest seed production is reported among insecticidal treatments in T3-treatment with Yam Bean Seed Extract @ 5 ml/l (10.25 q/ha). All treatments beat the control, which produced a marketable seed yield of 8.15 q/ha.

Based on the estimated benefit-cost ratio, it can be concluded that investment in treatment T6 (Thiomethoxam 25 WG @ 0.2 g/l) with a benefit-cost ratio of 2.61:1 was determined to be cost-effective when compared to other treatments. Treatment T2, with a benefit-cost ratio of 1.99:1, is the most cost-effective in botanical insecticides, followed by Neem oil, with a benefit-cost ratio of 1.86:1. Whereas the lowest benefit-cost ratio 1.59:1 is recorded among insecticidal treatments in T4-treatment with *Lecanicillium lecanii* @ 4g/l.

Conclusion:

- Germplasm-RD 416 is classified as resistant to coriander aphid infestation, whereas germplasm-RD 373 is classified as very susceptible.
- All insecticidal treatments effective over the untreated control, but T6 (Thiomethoxam 25 WG @ 0.2g/l) was found to be the most effective at reducing aphid population, followed by T2 (NSKE), which was on par with T6 (Thiomethoxam 25 WG @ 0.2g/l) and would be a better choice for coriander aphid management through eco-friendly management.
- When Benefit-cost ratio was considered, T6 (Thiomethoxam 25 WG @ 0.2g/l) gave highest B:C ratio followed by NSKE @ 5 ml/l. Therefore for eco-friendly management of coriander aphid, two spray of NSKE @ 5 ml/l at 15 days interval may be recommended without any severe loss to coriander crop due to infestation of aphid, *H.coriandri*.



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