EVALUATION OF CORIANDER GENOTYPES FOR RESISTANCE TO *Hyadaphis coriandri* Das AND ITS MANAGEMENT THROUGH PLANT OILS

BY

Dinesh Choudhary

(2007A27M)

Thesis submitted to the Chaudhary Charan Singh Haryana Agricultural University in partial fulfillment of the requirements for the degree of

MASTER OF SCIENCE

IN

ENTOMOLOGY

COLLEGE OF AGRICULTURE

CCS HARYANA AGRICULTURAL UNIVERSITY

HISAR - 125 004

2010

CERTIFICATE – I

This is to certify that this thesis entitled, **"Evaluation of coriander genotypes for resistance to *Hyadaphis coriandri* Das and its management through plant oils"**, submitted for the degree of **Master of Science** in the subject of **Entomology** to the CCS Haryana Agricultural University, Hisar is a bonafide research work carried out by **Mr. Dinesh Choudhary** under my supervision and that no part of this thesis has been submitted for any other degree.

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

(Dr. V.K. Kalra)
Major Advisor
Professor
Department of Entomology
CCS HAU, Hisar-125 004, India

CERTIFICATE – II

This is to certify that this thesis entitled, **"Evaluation of coriander genotypes for resistance to *Hyadaphis coriandri* Das and its management through plant oils"**, submitted by **Mr. Dinesh Choudhary** to the CCS Haryana Agricultural University, Hisar in partial fulfillment of the requirements for the degree of **Master of Science** in the subject of **Entomology** has been approved by the Student's Advisory Committee after an oral examination on the same.

MAJOR ADVISOR

HEAD OF THE DEPARTMENT

DEAN, POST-GRADUATE STUDIES

Acknowledgements

Foremostly, I bow before “Almighty god” for vesting wisdom to all my wishes and without the blessing this effort would have remained a far fetched dream.

No burden remains heavy if there are so many hands to lift it. These aphorisms have been amply substantiated in this present work. It has been my great privilege to work under the inspiring and encouraging guidance of my major advisor, Dr. V.K. Kalra, Professor, Department of Entomology, CCS HAU, Hisar. I owe to him my profound thanks for his sincere involvement, constructive suggestions and insightful criticism during my academic career. He is the one who inoculated in me the insurmountable enthusiasm, the constant help and the spirited inspiration not only limited to this work but will take me a long in my life.

The supreme guidance, close supervision, constant encouragement and ever willing help exhibited to my Co-advisor, Dr. Ram Singh, Professor, Department of Entomology in the pursuit of present study which boosted my moral in the successful completion of the present research is acknowledged. It is my pleasure to express my sincere gratitude to members of advisory committee, Dr. Naresh Mehta, Professor, Department of Plant Pathology, Dr. Lajpat Rai, Professor and Head, Department of Maths and Statistics, Dr. S.K. Tehlan, Professor, Department of Vegetable Science and Dr. D.P.S. Nandal, Professor, Department of Agro-Forestry, for their sustained guidance and critical appraisal during all phases of the present study.

I owe my sincere thanks and gratitude to Dr. Sucheta Khokhar, Head Department of Entomology and DEAN, College of Agriculture for providing all necessary help required for the completion of the degree programme.

To embellish my gratitude to all my teachers and staff members, Department of Entomology who have extended their liberal help in binging this work to fruition. I wish to use one of the most graceful sentence “I thank you.

No choice of words will suffice to adequately register thanks to Sh. Balwan Singh, Lab. Assistant and farm staff for their ever willing support during the course of research.

I fail in my duty if I do not thank my friends and to all my seniors and juniors who helped me in my work.

Feeling from the core of my heart, moulded into words would not convey what I wish to express to my parents during the years of my learning. I owe a lot to my beloved parents, my sisters and brother for bringing me up in the best of ways, for rendering me the best of education, for nurturing in me the best of ideals and for helping me to see the best of times.

Date: **(Dinesh Choudhary)**
Place : Hisar

CONTENTS

LIST OF TABLES

LIST OF PLATES

CHAPTER - I

INTRODUCTION

Coriander (*Coriandrum sativum* L.), commonly known as 'Dhania', is an important seed spice crop. India is the largest producer of coriander in the world (Meena *et al*., 2006). The seeds and leaves contain essential oil, which accounts for aromatic character of plant (Sankaracharya and Sankaranarayana, 1989). In Haryana, it is grown both for green vegetable and seed purpose. The powdered seeds of coriander are used as condiments for flavoring curries, soups and also used in pickles and spices. Coriander seeds are also known for their medicinal properties and are considered carminative and diuretic. It has been reported to be attacked by a number of insect-pests including coriander aphid, chalcid fly, cotton white fly, semi-looper, pentatomid bugs and tobacco caterpillar (Mittal and Butani, 1994). Among various insect pests infesting coriander crop, coriander aphid (*Hyadaphis coriandri* Das) affects the seed yield as well as quality the most. The nymphs and adults of *H. coriandri* suck the sap from tender leaves, shoots, flowers and fruits resulting in wilting of these plant parts and shriveling of fruits. The honeydew secreted by this pest leads to formation of sooty moulds (Dress and Jackman, 1998). The aphid collected from coriander at Lahore was first described as *Brevicoryne coriandri* by Das in 1918. Later on this aphid was included in the genus *Hyadaphis* by Bodenheimer and Swirski (1957). Coriander aphid is yellow-green in color, dusted with greyish wax. As per studies conducted in Florida, United States by Remaudiere and Halbert, (2000) it was revealed that coriander aphid is short, dusky, slightly swollen and siphunculi (cornicles) that are about twice as long as wide. In its native land of Central Asia, the life cycle of the coriander aphid is similar to that of other host-alternating aphids. Overwintering eggs occur on *Lonicera nummulariifolia* and other *Lonicera* spp. The life cycle of *H.coriandri* was studied by Halbert, (2003) in Florida, United States and observed that a fundatrix (stem mother) hatches from the egg in the spring. Her offspring are parthenogenetic, winged-female spring migrants. They colonize summer host plants in the family Umbelliferae. During the summer, there are many generations of aphids. All individuals are parthenogenetic females; they can be either winged or wingless, depending on host plant quality and crowding in the colony. If host plant quality declines, the colony becomes crowded, winged individuals form that can establish colonies on new plants. In the autumn, parthenogenetic females migrate to cooler temperatures and/or short days. These return to the winter hosts, where they give birth to egg-laying females. Similarly, the summer colonies produce winged males in the fall. The males also return to the winter host plants, where they mate with the egg-laying females to produce the overwintering eggs. They form

dense and often damaging colonies on leaves, heads and stems of their host plants. Coriander aphids probably are native to Central Asia, where they have been found on their primary host plants. Current worldwide distribution includes Central Asia, the Mediterranean area, the Indian Subcontinent, Africa, California and Florida in the United States. In northern India, the life cycle of coriander aphid (*H. coriandri*) was studied by Kumar and Sagar, (1994) from October, 1991 to September, 1992 and they observed that it remained active from last week of December to first week of April on coriander and from second week of March to first week of April on fennel, dilseed, psyllium and celery. The coriander aphid is considered a key pest of coriander in India from mid March to first week of April (Jain and Yadav 1988a; Mittal and Butani, 1989; Sagar, 1986). Kumari and Yadav (2002) conducted an experiment to investigate sources of coriander aphid (*H. coriandri*) resistance among 73 *Coriandrum sativum* genotypes and observed that seven genotypes (JCO-115, UD-686, JCO-18, JCO-130, GC-43, RD-23 and UD-255) showed antixenotic activities and three genotypes (UD-159, JCO-227 and JCO-22) showed insecticidal effects on the aphids and seven genotypes (RD-63, JCO-123, JCO-70, ATP-02, UD-28, UD-303 and DH-53) showed better tolerance to pest. Studies conducted by Kalra *et al*. (2006) showed that out of 10 coriander cultivars, *H. coriandri* caused minimum (30.2%) seed yield losses on var. Hisar Anand and maximum (111.3%) on cultivar UD-774. Jain and Yadav (1989) concluded that a population of 55-70 aphids/5 plants during flowering stage of coriander could reduce yield by 50% and in case of usage of chemical insecticide (aldicarb) to control *H. coriandri*, coriander leaves, whole plants or grains can be safely consumed only 30 days after application. Moreover, being a low-input crop and fresh leaves being used as vegetables, the farmers are generally not interested nor it is being desirable to use chemical insecticides on this crop (Upadhyay *et al*., 1996). The available literature reveal that only scattered information is available pertaining to the population dynamics and management of *H. coriandri* especially using edible and non edible oils. Therefore, it was considered imperative to conduct studies on the coriander aphid with the following objectives in view:

1. To study the response of coriander aphid (*Hyadaphis coriandri* Das*)* on different genotypes of coriander.
2. To study the biology of coriander aphid (*Hyadaphis coriandri* Das*)* on eight genotypes of coriander.
3. To evaluate the efficacy of some edible and non edible oils of plant origin against *H. coriandri in vivo* and *in vitro.*

CHAPTER - II

REVIEW OF LITERATURE

Coriander (*Coriandrum sativum* L.) is one of the important seed spice crop. Though, this crop is regularly attacked by many insect pests, *viz*. aphids, seed midges, etc., yet studies related to insect pest attacking it have been conducted only to a limited extent. The available literature on these aspects has been reviewed here under:

2.1 Varietal screening and biology

Detailed studies related to the occurance of coriander aphid revealed that *Hyadaphis coriandri* is a key pest of coriander and remain active from mid March to Ist week of April in northern India (Mittal and Butani, 1989). Jain and Yadav (1986) observed that the time of sowing also play an important role in the infestation by coriander aphid. They concluded that 15 days delay in the sowing of coriander crop after 25th October, resulted in increased aphid population and reduced crop yield under Rajasthan conditions.

Studies conducted by Kumari and Yadav (2005) in Bihar showed that out of 73 coriander genotypes only seven genotypes (JCO-115, GC-43, GC-46, JCO-18, M-1, UB-190 and JCO-13) had low susceptibility to the coriander aphid and attractiveness to aphidophagous coccinellids. Similar studies of Kalra *et al*. (2006) showed that average aphid population for the season during 2002-03 ranged from 4.6 to 8.35 per umbel, the minimum being on cv. DH-246 and maximum on var. Hisar Anand.

In similar studies, Mathur *et al*. (1971) screened 70 coriander varieties against *H. coriandri* and revealed that population build up was lesser on six varieties namely EC 69 , RC 15, RC 5, EC 10, RC 17 and RC 2 as compared to other varieties.

Studies on the population dynamics of *H. coriandri* on 10 coriander (*Coriandrum sativum* L.) cultivars (Hisar Anand, JCO -283, JCO-387, LCC-128, LCC-133, UD-743, UD-744, DH-208, DH-246 and Narnaul selection) were carried out by Kalra *et al*. (2006) in Hisar, Haryana, India during 2001-02 and 2002-03. They revealed that the aphid incidence on the crop started in first week of March and increased with advance of season and peak incidence of the pest was recorded during the end of February and 1st week of March (average of 31.5 aphids/umbel). On the basis of season's average JCO-283 with 10.7 and 9.25 aphids/umbel in 2001-02 and 2002-03, respectively was found to be most susceptible and DH-246 with 4.0 and 4.18 aphids/umbel, the least susceptible. Similarly, on the basis of two season's average, Hisar Anand afforded the minimum (30.02 %) seed yield losses and UD-744, the highest (111.3%).

Experiment was conducted by Singh *et al.* (1998) in Madhya Pardesh on 20 coriander cultivars to evaluate resistance to *H. coriandri*. They observed that cultivars Panipat Local and CS-193 showed a good level of resistance to this pest and these were high yielders (1110 and 812 kg/ha, respectively) in comparison to cultivar CS-362 which was highly susceptible to this pest and was the lowest yielder (250 kg/ha).

In another experiment Meena *et al*. (2002b) during 1997-98 determined the effect of date of sowing (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 the incidence of aphids (*H. coriandri*) on coriander and observed that coriander variety Rcr-41 sown at an early date (30th October) resulted in minimum aphid infestation (25.13 aphid/plant) and higher yield (9.88 q/ha), while the late sown crop (20th November) showed maximum aphid infestation (77.01 aphid/plant) and less yield (6.33 q/ha). Out of ten varieties/entries screened for relative susceptibility against aphid, three varieties (UD-684, Rcr-446 and Rcr-436) were categorized as the least susceptible; UD-686, Rcr-435, Rcr-20, UD-685 and UD-447 as moderately susceptible; and Rcr-41 and local cultivar as highly susceptible and they concluded that early sown and selection of less susceptible variety proved a suitable component of aphid management on coriander.

Among the coriander germplasm lines (ND Cor-2 , ND Cor-7, ND Cor-9, ND Cor-18, ND Cor-21, ND Cor-29, ND Cor-30, ND Cor-32, ND Cor-33, ND Cor-34, ND Cor-35, ND Cor-36, ND Cor-37, ND Cor-38 and k. selection) screened under field conditions for resistance to *H. coriandri*, Nath *et al*. (2004) observed that none was resistant, only ND Cor-35 was moderately resistant while ND Cor-18 and ND Cor-30 were highly susceptible.

In another experiment carried out by Pal and Choudhuri (2003) to determine the relative susceptibility of some selected coriander cultivars to aphid (*H. coriandri*) it was observed that none of the cultivars screened against aphid was completely free from aphid infestation. Cultivars Rajendra Swathi (RD-44), Pant Haritima and DH-205 were categorized as less susceptible (up to 10 aphids/5 umbels/plant), DH-234 and local cultivars as moderately susceptible (11-20 aphids/5 umbels/plant) and Rcr-41 as highly susceptible (above 20 aphids/5 umbels/plant) and aphid population was the least on Rajendra Swathi (RD-44).

Seventy three coriander genotypes, screened for their resistance to *H. coriandri* and attractiveness to predatory coccinellids by Kumari and Yadav (2005) revealed that seven genotypes JC-115, GC-43, GC-46, JCO-18, M-1, UD-190 and JCO-13 had low susceptibility to the aphid and attractiveness to aphidophagous coccinellids and the remaining genotypes responded differently to the pest and the predator.

Studies conducted on twenty varieties of coriander to evaluate resistance for *H. coriandri* Jain and Yadav (1988b) categorized 9 as moderately susceptible and 11 as highly susceptible and none to be resistant to *H. coriandri*. They observed that aphid incidence was generally greater on the late flowering variety than on the early flowering ones.

Studies on the biology of coriander aphid, *H. coriandri* were carried out by Singh *et al*. (2005) on different coriander cultivars (Narnaul Selection, Pant Haritma and CO-3) under laboratory conditions. They observed that there were four nymphal instars and the total nymphal duration on different cultivars ranged from 6.0±0.20 to 7.8±0.19 days. The mean pre-reproductive, reproductive and post-reproductive periods varied from 1.30±0.15 to 1.50±0.16, 7.2±0.43 to 7.4±0.38 and 3.20±0.34 to 3.90±0.41 days, respectively, in different cultivars. The number of nymphs produced per mother aphid ranged from 32.20±1.58 to 37.00±2.01 in the different cultivars. The female aphid continued nymph laying for 6-8 days and the peak period of nymph laying was observed from the 3rd to 5th day and *H. Coriandri* had a lifespan ranging from 18.0±0.45 to 20.4±0.35 days on different cultivars.

Studies conducted by Kumar and Sagar (1996), on life history of *Hyadaphis coriandri*, revealed that there were three nymphal instars and nymphal duration varied from 1.35±0.08 to 2.35±0.12, 1.55±0.11 to 3.69±0.13 and 1.71±0.11 to 6.00±0.21 and pre reproductive and post reproductive periods varied from 1.48±0.10 to 2.89±0.21, 5.05±0.37 to 24.40±0.40 and 1.53 ±0.11 to 11.71±0.53 days, respectively in each month from mid January to mid June. The number of nymphs produced per mother ranged from 10.68±1.21 to 57.27±2.04 and the reproductive rate ranged from 1.93 to 3.84 nymphs/aphid per day from the last week of January to the second week of June. The pest passed through 19 overlapping generations from January to June and the longest duration (13.43 ±0.22) of a generation was in January- February and the shortest (5.40±0.22 days) in June.

The correlation coefficients worked out between coriander aphid population and various weather parameters revealed that no clearcut relationship existed among these. However, the population of coriander aphid is negatively related with relative humidity (Singh, V. 2002). In another experiment Jain and Yadav, (1988a) observed that the activities of both pest and predator are highly affected by weather parameter and they concluded that aphid multiplication was highest when temperature was 18.5 to 22.6°C.

2.2 Evaluation of plant extracts

Studies on the evaluation of plant extracts against *H. coriandri in vivo* revealed that plant extracts (seed extracts) of neem (*Azadirachta indica)*, karanj (*Pongamia* sp.*),* bakain (*Melia azedarach*) and pride of India (*Lagerstroemia indica)* reduced its population by more than 50 per cent within seven days (Singh and Nath, 2003). Matter *et al*. (1993) tested the

effects of oils (*Azadirachta indica, Melia azedarach, Cymbopogon citrates* and *Geranium* sp.) on *Coccinella undecimpunctata* in the laboratory and found that none of the oil affected survival or behavior of *C. undecimpunctata* and consumption of aphids (*Aphis gossypii*).

Nath and Singh (2003) examined the safety of 4 plant extracts, one neem formulation and a synthetic insecticide (dimethoate) to the ladybird beetle (*Coccinella septumpunctata)* and syrphid flies predating on *H. coriandri* infesting coriander *in vivo*. They observed that pride of India (*Lagerstroemia indica)* seed kernel extract (PSKE 1%) was the safest to both predators, followed by karanj (*Pongamia* sp.*)* seed kernel extract(1%), Neem (*Azadirachta indica)* seed kernel extract (1%), bakain (*Melia azedarach*) seed kernel extract (1%) and Neemarin (1%). However dimethoate (0.03%) was highly toxic to the ladybird beetle and syrphid larvae. They could conclude that botanical extracts were safer and more environment-friendly insecticides when used on coriander crop for aphid control.

Experiment conducted by Bahar *et al*. (2007) against bean aphid with botanical extracts of tobacco, neem, garlic and eucalyptus revealed that the mortality caused by tobacco leaf extract was maximum (74.90%) and neem leaf extract and garlic extract showed similar performance. In another experiment Mishra, H.P. (1993) evaluated some synthetic insecticides and oils against mustard aphid *Lipaphis erysimi* and observed that all the treatments except neem oil (1%+0.1% teepol) decreased the aphid population significantly.

According to Swaminathan *et al.* (1999) neem oil (2%) was better than neem kernel extract in reducing Safflower aphid population. In an experiment conducted by Vekaria and Patel (2005) on the effect of botanical insecticides against mustard aphid, it was observed that Nicotine sulphate (0.05%), Amritguard and Nimbecidine (0.05%), caused more than 70% aphid mortality within 48 h of application on mustard leaves.

CHAPTER - III

MATERIALS AND METHODS

Coriander crop (*Coriandrum sativum* L.) was raised in the research area, Department of Vegetable Science, CCS Haryana Agricultural University, Hisar during the '*rabi*' season of 2008-09. Two experiments were conducted, first for the studies on the response of coriander aphid (*Hyadaphis coriandri* Das) on different genotypes of coriander and the second to evaluate efficacy of some edible and non edible oils of plant origin against *H. coriandri in vivo.* The biology of the coriander aphid and efficacy of some edible and non edible oils of plant origin against *H. coriandri in vitro* was studied in the Laboratory, Department of Entomology, CCS Haryana Agricultural University, Hisar. The experimental details have been given here under.

3.1 The response of coriander aphid on different genotypes of coriander

The experiment for the studies on the response of coriander aphid, *H.coriandri* was conducted on 20 genotypes (Gujarat Coriander-1, Gujarat Coriander-2, Rcr-20, Rcr-41, Rcr-435, Rcr-436, Rcr-446, Rcr-480, Rcr-684, Sudha, Sindhu, Swathi, Sadhana, NRCSS-Acr-1, Jawahar Dhania-1, CS-6, Hisar Anand, Hisar Sugandh, Hisar Bhoomit and Hisar Surbhi). Coriander crop was sown on November 8, 2008 following normal recommended Agronomical practices (Anonymous, 1998). The experiment was laid out in Randomized Block Design with three replications with a plot size of 1m × 4m. The crop was kept under constant vigil and as the aphids started appearing on the crop, the observations for aphid incidence were started. Numbers of aphids (nymphs and adults) were recorded from top ten cm twig including umbel. For this, ten randomly selected plants per genotype were examined. The observations were recorded daily till the maturity of crop.

3.2 Biology of coriander aphid on different genotypes of coriander

The biology of the coriander aphid was studied on eight genotypes of coriander (Gujarat Coriander-1, Gujarat Coriander-2, Rcr-41, Rcr-446, Sudha, Sindhu, NRCSS-Acr-1, and Hisar Bhoomit). The aphid culture was maintained in the laboratory and one day old nymphs laid by these aphids were reared separately on the respective genotypes in Petri plate (size 10 cm.). Fresh umbels, base of which was wrapped with water soaked cotton swabs were provided as food for the aphids. Ten replications for each of the eight promising genotypes were maintained. Separate crop of each of the above mentioned genotypes was raised in separate plots of 3m×4m size. Such plots were kept free from any insecticidal application and umbels from such crop were used as food for conducting the biology of aphid. The observations on following biological parameters were recorded.

3.2.1 Nymphal duration (days)

Studies on the duration of nymphal instars were conducted by confining one freshly laid nymph in a Petri plate. Such aphids were provided fresh umbels of respective genotypes, daily, as food. The duration of each instar was recorded by observing the presence of exuviae left at each moult. The exuviae were removed simultaneously with camel hair brush. The data, pertaining to total nymphal duration, were recorded from the date of release to the date of last moult of nymphs.

3.2.2 Pre-reproductive and reproductive period (days)

Reproductive period was considered as the total time during which the aphid continued to produce young ones. The period (days) between the last moult and production of first young one was considered as pre-reproductive period.

3.2.3 Fecundity

The number of nymphs laid by each aphid daily were counted and removed simultaneously till the aphid stopped producing young ones. The total number of young ones produced by each female per day and the total number of young ones produced by each female throughout its reproductive period were thus worked out.

3.2.4 Post-reproductive period (days)

The period between the time when female produced the last nymph until its death was considered as post-reproductive period.

3.2.5 Life span (days)

The period between the day the nymph is laid and the death of the adult aphid was considered to be the life span.

3.3 Efficacy of some edible and non edible oils of plant origin against *H. coriandri*

3.3.1 Field experiment

The experiment was carried out in the research area, Department of Vegetable Science, CCS Haryana Agricultural University, Hisar, during the '*rabi*' season of 2008-09. Coriander crop (genotype DH-228) was sown on November 8, 2008 following normal recommended agronomical practices (Anonymous, 1998). The experiment was laid out in Randomized Block Design with five replications in a plot size of 3m × 4m. There were eight treatments, including edible oils (groundnut oil 1% and sesame oil 1%), non edible oils (neem oil 1%, castor oil 1%, karanj oil 1%, garlic oil 0.25% and mahua oil 1%) and control (teepol+distilled water 1:1000). Teepol was used both as spreader and solvent for making suspension which was sprayed in the field. Pre treatment counts of aphids on five randomly selected umbels per treatment per replication were recorded on a day prior to the application

of treatments. The aphid population present on top 10 cm twig including umbel was considered for taking the counts and the post treatment observations were made one, three and five days after the spray. The spray was done when five per cent plants were observed to be infested with aphids.

3.3.2 Laboratory experiment

The experiment was carried out in the Laboratory, Department of Entomology, CCS Haryana Agricultural University, Hisar. The experiment was carried out under laboratory conditions with eight treatments, including edible oils (groundnut oil 1% and sesame oil 1%), non edible oils (neem oil 1%, castor oil 1%, karanj oil 1%, garlic oil 0.25% and mahua oil 1%) and control (teepol+distilled water 1:1000). There were ten replications for each treatment. Teepol was used to prepare oil suspensions in which the coriander umbels were dipped for 30 sec. and dried in shade. On such treated umbels, the aphids were released. Fourth instar/adult aphids from the aphid colonies, reared in laboratory, were released on the umbels of genotype DH-228 treated with different oil suspensions in the laboratory. Such umbels were kept in Petri plates after wrapping their ends with cotton swabs dipped in water to maintain turgidity. Observations on the mortality of the aphids were recorded 24, 48 and 72 h after their release.

CHAPTER - IV

EXPERIMENTAL RESULTS

4.1 Response of coriander aphid (*Hyadaphis coriandri* Das) on different genotypes of coriander

The population of aphid, *H. coriandri* differed significantly on different genotypes of coriander during '*rabi*' season of 2008-09 (Table 4.1a, 4.1b). Incidence of aphid was first recorded in the second week of February, 2009. The regular observations on the population build up of aphids were started from the last week of February when five per cent of plants were observed to be infested with aphids.

The mean aphid population on 27th February ranged between 0.60 to 13.20 aphids per umbel (umbel + peduncle up to 10 cm length) in different genotypes of coriander. The maximum number of aphids were recorded on genotype Rcr-435 (13.20 aphids/umbel) and minimum (0.60 aphid/umbel) on Rcr-41. The mean aphid incidence/umbel on coriander crop was observed 3.20 aphids/umbel.

The observation recorded on the 28th February revealed that aphid population ranged between 0.20 to 16.00 aphids/umbel among different coriander genotypes. During this period the maximum population was recorded on genotype Rcr-435 (16.00 aphids/umbel) and it differed significantly from all other genotypes. The minimum aphid population (0.20 aphid/umbel) on this date was recorded on genotype Rcr-446 followed by NRCSS-ACr-1 (0.60 aphid/umble) Jawahar Dhania and Hisar Anand (0.80 aphid/umbel) and Hisar Bhoomit and Sudha (0.90 aphid/umbel). The mean aphid incidence/umbel, irrespective of the genotype, was 3.03 aphids/umbel.

Table 4.1(a) Population dynamics of *Hyadaphis coriandri* Das on different genotypes of coriander

Genotypes	Mean aphid incidence per umbel									
	27.02.09	28.02.09	01.03.09	02.03.09	03.03.09	04.03.09	05.03.09	06.03.09	07.03.09	08.03.09
Gujarat Coriander-1	12.70 (3.70)*	9.80 (3.28)	40.60 (6.45)	26.40 (5.23)	25.10 (5.11)	60.10 (7.82)	43.30 (6.66)	38.50 (6.28)	21.00 (4.69)	45.80 (6.84)
Gujarat Coriander-2	3.00 (1.99)	1.90 (1.70)	4.10 (2.26)	3.90 (2.21)	1.40 (1.49)	12.40 (2.95)	3.30 (2.07)	1.50 (1.58)	5.70 (2.59)	3.90 (2.21)
Rcr-20	2.40 (1.84)	0.60 (1.26)	0.80 (1.34)	4.60 (2.37)	5.50 (2.52)	0.90 (1.76)	1.20 (1.48)	0.80 (1.34)	1.70 (1.64)	1.90 (1.70)
Rcr-41	0.60 (1.26)	0.50 (1.22)	0.40 (1.18)	0.70 (1.30)	2.80 (1.91)	0.60 (1.48)	0.70 (1.30)	1.20 (1.48)	3.80 (2.19)	2.20 (1.79)

Genotypes	Mean aphid incidence per umbel									
	27.02.0 0	28.02.0 0	01.03.0 0	02.03.0 0	03.03.0 0	04.03.0 0	05.03.0 0	06.03.0 0	07.03.0 0	08.03.0 9
Rcr-435	13.20 (3.77)	16.00 (4.12)	4.50 (2.34)	1.20 (1.48)	1.40 (1.49)	4.60 (2.08)	3.50 (2.12)	4.60 (2.37)	4.40 (2.32)	6.00 (2.64)
Rcr-436	3.00 (1.98)	3.20 (2.05)	9.10 (3.18)	0.50 (1.22)	0.80 (1.28)	0.50 (1.25)	0.70 (1.30)	0.80 (1.34)	1.60 (1.61)	1.70 (1.64)
Rcr-446	1.20 (1.48)	0.20 (1.09)	0.50 (1.22)	6.20 (2.68)	7.90 (2.96)	3.60 (2.42)	3.10 (2.02)	1.60 (1.61)	1.80 (1.67)	1.50 (1.58)
Rcr-480	2.60 (1.89)	4.00 (2.23)	1.30 (1.52)	3.10 (2.02)	2.00 (1.68)	0.80 (1.46)	5.80 (2.60)	11.80 (3.58)	1.90 (1.70)	1.30 (1.51)
Rcr-684	5.00 (2.44)	6.70 (2.77)	1.90 (1.70)	1.20 (1.48)	0.90 (1.38)	5.50 (2.55)	5.60 (2.56)	9.70 (3.27)	1.90 (1.70)	2.40 (1.84)
Sudha	1.90 (1.70)	0.90 (1.26)	19.80 (4.56)	4.80 (2.41)	18.50 (4.42)	8.20 (3.03)	7.70 (2.95)	11.60 (3.55)	1.20 (1.48)	15.10 (4.01)
Sindhu	1.00 (1.41)	1.50 (1.58)	0.90 (1.38)	0.80 (1.34)	0.80 (1.34)	1.20 (1.48)	1.60 (1.61)	2.20 (1.79)	0.80 (1.34)	3.40 (2.09)
Swathi	5.30 (2.51)	3.10 (2.03)	1.60 (1.61)	0.60 (1.26)	0.60 (1.26)	1.10 (1.45)	1.10 (1.45)	1.50 (1.58)	0.30 (1.14)	0.80 (1.34)
Sadhana	2.10 (1.76)	4.20 (2.28)	1.50 (1.58)	0.70 (1.30)	0.90 (1.38)	1.20 (1.48)	0.80 (1.34)	1.50 (1.58)	1.00 (1.41)	1.10 (1.45)
NRCSS-ACr-1	0.80 (1.34)	0.60 (1.26)	0.50 (1.22)	18.40 (4.41)	4.30 (2.30)	7.20 (2.86)	5.70 (2.59)	5.20 (2.49)	1.00 (1.41)	2.50 (1.87)
Jawahar Dhania-1	1.10 (1.45)	0.80 (1.34)	0.70 (1.30)	1.60 (1.61)	1.40 (1.55)	1.00 (1.41)	0.90 (1.38)	1.00 (1.41)	0.60 (1.26)	2.80 (1.95)
CS-6	1.50 (1.58)	1.00 (1.16)	0.60 (1.26)	3.00 (2.00)	2.60 (1.89)	0.50 (1.22)	0.70 (1.30)	0.50 (1.22)	0.70 (1.30)	0.80 (1.34)
Hisar Anand	0.90 (1.38)	0.80 (1.34)	1.20 (1.48)	2.40 (1.84)	2.00 (1.73)	1.50 (1.58)	1.20 (1.48)	0.60 (1.26)	1.10 (1.45)	1.30 (1.51)
Hisar Sugandh	1.60 (1.61)	1.90 (1.70)	1.10 (1.45)	1.50 (1.58)	1.20 (1.48)	0.90 (1.38)	1.20 (1.48)	3.30 (2.07)	1.00 (1.41)	0.90 (1.38)
Hisar Bhoomit	2.40 (1.84)	0.90 (1.38)	0.80 (1.34)	0.60 (1.26)	0.60 (1.26)	0.50 (1.22)	2.50 (1.87)	4.00 (2.23)	2.80 (1.95)	1.60 (1.61)
Hisar Surbhi	1.80	2.10	2.00	2.50	2.20	0.60	1.90	3.10	0.90	0.90

Genotypes	Mean aphid incidence per umbel									
	27.02.09	28.02.09	01.03.09	02.03.09	03.03.09	04.03.09	05.03.09	06.03.09	07.03.09	08.03.09
	(1.67)	(1.76)	(1.73)	(1.87)	(1.79)	(1.26)	(1.70)	(2.02)	(1.38)	(1.38)
Mean	**3.20**	**3.03**	**4.69**	**4.23**	**4.14**	**5.64**	**4.62**	**5.25**	**2.76**	**4.89**
SEm±	(0.04)	(0.05)	(0.01)	(0.01)	(0.01)	(0.22)	(0.01)	(0.01)	(0.01)	(0.01)
CD (P=0.05)	(0.12)	(0.14)	(0.03)	(0.03)	(0.03)	(0.62)	(0.03)	(0.03)	(0.03)	(0.03)

*Figures in parentheses are transformed values

The population of aphid recorded on 1st March revealed that the maximum numbers of aphids were harboured by genotype Gujarat Coriander-1 (40.60 aphids/umbel) and minimum on Rcr-41 (0.40 aphid/umbel). The mean aphid incidence/umbel among all genotypes was observed to be 4.69 aphids/umbel. There was a significant increase in infestation on genotype Sudha (19.80 aphids/umbel), too.

The population of aphid varied significantly on 2nd March from 0.50 to 26.40 aphids/umbel (umbel + peduncle up to 10 cm length) in different genotypes of the crop. The maximum number of aphids was recorded on the genotype Gujarat Coriander-1 (26.40 aphids/umbel) and the minimum on Rcr-436 (0.50 aphids/umbel). However, it was at par with all other genotypes except Gujarat Coriander-1.

Table 4.1(b) Population dynamics of *Hyadaphis coriandri* Das on different genotypes of coriander

Genotypes	Mean aphid incidence per umbel										
	09.03.09	10.03.09	11.03.09	12.03.09	13.03.09	14.03.09	15.03.09	16.03.09	17.03.09	18.03.09	Season's Avg.
Gujarat Coriander- 1	57.20 (7.63)*	46.00 (6.86)	39.10 (6.33)	24.10 (5.01)	16.80 (4.23)	29.00 (5.48)	5.50 (2.549	9.20 (3.19)	3.40 (2.09)	0.80 (1.34)	27.72
Gujarat Coriander-2	5.60 (2.57)	5.60 (2.57)	1.80 (1.67)	3.00 (2.00)	2.40 (1.84)	1.20 (1.48)	0.40 (1.18)	1.12 (1.45)	0.70 (1.30)	0.00 (1.00)	3.10
Rcr-20	1.00 (1.41)	0.60 (1.26)	11.2 (1.48)	1.30 (1.51)	0.30 (1.14)	0.20 (1.09)	0.10 (1.05)	0.20 (1.09)	0.10 (1.04)	0.10 (1.05)	1.25
Rcr-41	2.5 (1.87)	1.00 (1.41)	1.30 (1.51)	2.20 (1.79)	0.50 (1.22)	1.10 (1.45)	1.80 (1.67)	1.30 (1.52)	1.00 (1.41)	0.90 (1.38)	1.80
Rcr-435	2.80 (1.95)	3.30 (2.07)	1.40 (1.55)	0.90 (1.38)	4.90 (2.43)	7.20 (1.45)	1.40 (1.67)	2.40 (1.52)	1.30 (1.52)	0.00 (1.00)	4.25
Rcr-436	0.70 (1.30)	0.40 (1.18)	0.30 (1.14)	1.20 (1.48)	0.10 (1.05)	0.20 (2.86)	0.50 (1.55)	0.40 (1.84)	0.20 (1.09)	0.00 (1.00)	1.30
Rcr-446	1.40 (1.55)	1.20 (1.48)	1.30 (1.52)	0.80 (1.34)	0.50 (1.22)	0.50 (1.09)	0.20 (1.22)	0.30 (1.18)	0.30 (1.14)	0.10 (1.05)	1.70

Genotypes	Mean aphid incidence per umbel										
	09.03.09	**10.03.09**	**11.03.09**	**12.03.09**	**13.03.09**	**14.03.09**	**15.03.09**	**16.03.09**	**17.03.09**	**18.03.09**	**Season's Avg.**
Rcr-480	1.60 (1.61)	0.80 (1.34)	0.90 (1.38)	0.60 (1.26)	0.50 (1.22)	0.20 (1.22)	0.40 (1.23)	0.10 (1.14)	0.70 (1.30)	1.00 (1.41)	2.07
Rcr-684	2.10 (1.76)	2.20 0.78)	1.50 (1.58)	0.40 (1.18)	0.50 (1.22)	0.30 (1.09)	0.50 (1.18)	0.40 (1.05)	0.30 (1.14)	0.20 (1.09)	2.46
Sudha	18.00 (4.36)	10.50 (3.39)	8.70 (3.11)	12.70 (3.70)	3.80 (2.19)	1.80 (1.14)	1.30 (1.22)	1.20 (1.18)	1.00 (1.41)	0.10 (1.05)	7.44
Sindhu	0.80 (1.34)	0.40 (1.18)	0.40 (1.18)	1.10 (1.45)	0.30 (1.14)	0.50 (1.67)	0.20 (1.52)	0.30 (1.48)	0.20 (1.09)	0.00 (1.00)	0.92
Swathi	1.30 (1.52)	0.60 (1.26)	1.40 (1.55)	0.50 (1.22)	2.40 (1.84)	1.10 (1.22)	0.60 (1.09)	0.70 (1.14)	0.10 (1.05)	0.00 (1.00)	1.23
Sadhana	1.90 (1.70)	1.80 (1.67)	1.50 (1.58)	1.70 (1.64)	0.50 (1.22)	0.30 (1.45)	0.30 (1.26)	0.20 (1.30)	0.10 (1.05)	0.00 (1.00)	1.16
NRCSS-ACr-1	1.80 (1.67)	1.30 (1.51)	2.90 (1.98)	2.70 (1.92)	1.30 (1.51)	5.10 (1.14)	4.30 (1.14)	3.80 (1.09)	2.40 (1.84)	1.60 (1.61)	3.67
Jawahar Dhania-I	1.00 (1.41)	1.00 (1.41)	1.20 (1.48)	0.80 (1.34)	0.50 (1.22)	0.60 (2.47)	0.70 (2.30)	0.50 (2.19)	0.40 (1.18)	0.10 (1.04)	0.93
CS-6	0.70 (1.30)	0.30 (1.14)	0.30 (1.14)	0.50 (1.22)	0.40 (1.18)	0.20 (1.26)	0.10 (1.30)	0.10 (1.22)	0.10 (1.05)	0.00 (1.00)	0.73
Hisar Anand	1.10 (1.45)	1.40 (1.55)	1.10 (1.45)	0.70 (1.76)	0.80 (1.34)	0.70 (1.09)	0.60 (1.04)	0.40 (1.04)	0.30 (1.14)	0.20 (1.09)	1.02
Hisar Sugandh	1.00 (1.41)	0.60 (1.26)	0.60 (1.26)	0.50 (1.22)	0.70 (1.30)	0.40 (1.30)	0.30 (1.26)	0.20 (1.18)	0.10 (1.05)	0.10 (1.05)	0.96
Hisar Bhoomit	0.60 (1.26)	0.40 (1.18)	1.40 (1.55)	0.60 (1.26)	0.30 (1.14)	0.30 (1.18)	0.40 (1.14)	0.50 (1.09)	0.30 (1.14)	0.10 (1.05)	1.08
Hisar Surbhi	0.60 (1.26)	0.70 (1.30)	0.80 (1.34)	1.40 (1.55)	0.30 (1.14)	0.40 (1.14)	0.20 (1.18)	0.10 (1.22)	0.10 (1.05)	0.00 (1.00)	1.12
Mean	**5.18**	**4.01**	**3.45**	**2.88**	**1.89**	**2.56**	**0.99**	**1.17**	**0.65**	**0.26**	
SEm±	(0.01)	(0.01)	(0.01)	(0.11)	(0.01)	(0.01)	(0.03)	(0.01)	(0.01)	(0.01)	
CD (P=0.05)	(0.03)	(0.03)	(0.03)	(0.29)	(0.03)	(0.03)	(0.08)	(0.03)	(0.03)	(0.03)	

*Figures in parentheses are transformed values

The population of aphid recorded on 3rd March was the maximum on var. Gujarat Coriander-1 (25.10 aphids/umbel) and it was significantly higher than all genotypes and it was minimum on vars. Swathi and Hisar Bhoomit (0.60 aphid/umbel) . Irrespective of the genotype, the mean aphid infestation was observed as 4.14 aphids/umbel. The population of *H. coriandri* reached its peak during the first week of March in various genotypes.

The observations recorded on 4th march revealed that the maximum number of aphids were on Gujarat Coriander-1 (60.10 aphids per umbel) and the minimum was on

Rcr-436, CS-6 and Hisar Bhoomit (0.50 aphid/umbel). The mean aphid infestation on coriander crop, irrespective of genotype, was 5.64 aphids/umbel, the highest of the season.

The population recorded on 5th March showed the maximum number of aphids on Gujarat Coriander-1 (43.30 aphids/umbel) which differed significantly from all genotypes evaluated. The minimum number of aphids were observed on Rcr-41, Rcr-436 and Cs-6 (0.70 aphids/umbel). The mean aphid infestation was observed 4.62 aphids/umbel, slightly lower than previous day.

The population of *H. coriandri* varied greatly on 6th March and it ranged from 0.50 to 38.50 aphids/umbel in different genotypes. The maximum population was observed on Gujarat Coriander-1 (38.50 aphids/umbel) and minimum on CS-6 (0.50 aphid/umbel). The infestation on genotype Sudha also increased to a great extent from beginning of the season (1.90 aphids/umbel) to 11.60 aphids/umbel. The mean aphid infestation was observed 5.25 aphids/umbel and it was second highest in season.

The observations recorded from 7th March to 17th March revealed that Gujarat Coriander-1harboured maximum aphid population (3.40 to 57.20 per umbel) whereas vars. /cv. Swathi, CS-6, Hisar Bhoomit, Rcr-436 and Rcr-684, the lowest. On the basis of season's average genotype Gujarat Coriander-1 harboured maximum (27.72 aphids/umbel) whereas, minimum (0.73 aphid/umbel) were harboured by genotype CS-6.

4.2 Biology of *H. coriandri* on different genotypes of coriander

The biology of *H. coriandri* on some selected (eight) genotypes of coriander viz. Gujarat Coriander-1, Gujarat Coriander -2, Rcr-41, Rcr-446, Sudha, Sindhu, NRCSS-Acr-1 and Hisar Bhoomit was studied in the laboratory, Department of Entomology at room temperature.

These studies were conducted by collecting newly laid nymphs from the culture maintained in laboratory on respective coriander genotypes under study and were reared separately in Petri plates. Ten replicates for each variety were maintained.

4.2.1.1 Nymphal duration

There were four nymphal instars and data on the duration of different nymphal instars, reared on different genotypes of coriander, have been presented in Table 4.2.

Table 4.2 Duration of different nymphal instars of *Hyadaphis coriandri* Das on some selected genotypes of coriander

	Duration of Nymphal instars (days)				
Genotypes	**Instar-I**	**Instar-II**	**Instar-III**	**Instar-IV**	**Total nymphal duration**
Hisar	2.70	2.20	1.90	1.60	8.40

Bhoomit	(1.92)*	(1.77)	(1.69)	(1.61)	(3.06)
Sindhu	1.90 (1.69)	2.00 (1.71)	1.40 (1.53)	1.10 (1.45)	6.40 (2.70)
Gujarat Coriander-2	1.50 (1.56)	1.10 (1.43)	1.10 (1.45)	1.10 (1.43)	4.80 (2.36)
Rcr-41	2.10 (1.74)	1.00 (1.41)	1.00 (1.41)	1.30 (1.5)	5.40 (2.50)
Rcr-446	1.80 (1.67)	1.30 (1.49)	1.50 (1.56)	1.00 (1.41)	5.60 (2.55)
NRCSS-Acr-1	2.10 (1.74)	1.30 (1.47)	1.30 (1.48)	1.20 (1.48)	5.90 (2.59)
Sudha	1.90 (1.69)	1.60 (1.58)	1.90 (1.69)	1.40 (1.54)	6.80 (2.77)
Gujarat Coriander-1	1.70 (1.59)	1.00 (1.41)	1.00 (1.41)	1.00 (1.41)	4.70 (2.34)
Mean	**1.38**	**1.43**	**1.38**	**1.21**	**6.00**
SEm±	(0.06)	(0.09)	(0.07)	(0.05)	(0.32)
CD (P=0.05)	(0.18)	(0.27)	(0.21)	NS	(0.11)

*Figures in parentheses are transformed values

3.31.2 First instar nymph (days)

Mean duration of 1st nymphal instar, irrespective of genotype, was recorded to be 1.38 days (Table 4.2, Plate 1). It varied from 1.70 to 2.70 days on different genotypes being maximum on Hisar Bhoomit (2.70 days) followed by Rcr-41 (2.10 days), NRCSS-Acr-1 (2.10 days), Sindhu and Sudha (1.90 days), Rcr-446 (1.80 days), Gujarat coriander-1 (1.70 days) and minimum on Gujarat Coriander -2 (1.50 days).

3.31.3 Second instar nymph (days)

Duration of the second nymphal instar was maximum on Hisar Bhoomit (2.20 days) followed by Sindhu (2.00 days), Sudha (1.60 days), Rcr-446 (1.30 days), NRCSS-Acr-1 (1.30 days), Gujarat Coriander -2 (1.10 days) and minimum on Rcr-41 and Gujarat Coriander -1 (1.00 days). Irrespective of the genotype, the mean duration of second nymphal instars was 1.43 days. (Table 4.2).

Plate 1: Nymph of *Hyadaphis coriandri* Das

3.31.4 Third instar nymph (days)

The duration of third nymphal instar varied from 1.00 to 1.90 days on different genotypes and was maximum on Sudha and Hisar Bhoomit (1.90 days) followed by Rcr-446 (1.50 days), Sindhu (1.40 days), NRCSS-Acr-1 (1.30 days),Gujarat Coriander-2 (1.10 days) and minimum on Gujarat Coriander -1 (1.00 day). The mean nymphal duration, irrespective of the genotype, was 1.38 days.

3.31.5 Fourth instar nymph (days)

Mean duration of fourth instar nymph was observed to be 1.21 days (Table 4.2, Plate 2). It was maximum on Hisar Bhoomit (1.60 days) followed by Sudha (1.40 days), Rcr-41 (1.30 days), NRCSS-Acr-1 (1.20 days), Sindhu and Gujarat Coriander -2 (1.10 days) and minimum on Rcr-446 and Gujarat Coriander-1 (1.00 day).

Plate 2: Fourth instar nymph of *Hyadaphis coriandri* Das removing exuviae

3.31.6 Total nymphal duration (days)

The total nymphal duration on different genotypes varied from 4.70 to 8.40 days and it was observed maximum in Hisar Bhoomit (8.40 days) followed by Sudha (6.80 days), Sindhu (6.40 days), NRCSS-Acr-1 (5.90 days), Rcr-446 (5.60 days), Rcr-41 (5.40 days) Gujarat Coriander -2 (4.80 days) and minimum on Gujarat Coriander-1 (4.70 days). Irrespective of the genotypes, the mean nymphal duration was 6.00 days (Table 4.2, Plate 3, 4).

Plate 3: Exuviae of *Hyadaphis coriandri* Das

Plate 4. Adult of *Hyadaphis coriandri* Das

3.3.1 Pre-Reproductive period (days)

The data relating to the pre-reproductive period in Table 4.3 revealed that it varied from 1.00 to 1.50 days on different genotypes. It was maximum on Rcr-41 (1.50 days)

followed by Gujarat Coriander-1 and Hisar Bhoomit (1.40 days) and minimum on Rcr-446 (1.00 days). Irrespective of the genotypes, the mean pre-reproductive period observed was 1.26 days.

Table 4.3 Biological parameters (Pre-reproductive, reproductive, post reproductive period and life span of *Hyadaphis coriandri* Das on some selected genotypes of coriander

Genotypes	Pre-reproductive period (days)	Reproductive period (days)	Post -Reproductive period (days)	Life span (days)
Hisar Bhoomit	1.40 (1.54)*	5.90 (2.59)	2.40 (1.80)	18.10
Sindhu	1.30 (1.51)	5.50 (2.48)	1.60 (1.59)	14.80
Gujarat Coriander-2	1.10 (1.43)	6.20 (2.64)	1.60 (1.58)	13.70
Rcr-41	1.50 (1.57)	7.00 (2.67)	1.30 (1.49)	15.20
Rcr-446	1.00 (1.41)	6.40 (2.62)	1.00 (1.37)	14.00
NRCSS-Acr-I	1.10 (1.40)	6.00 (2.58)	1.90 (1.66)	14.90
Sudha	1.20 (1.48)	7.30 (2.10)	2.70 (1.92)	18.00
Gujarat Coriander-1	1.40 (1.54)	7.50 (2.86)	1.50 (1.53)	15.10
Mean	**1.26**	**6.47**	**1.75**	**15.47**
SEm±	(0.06)	(0.22)	(0.09)	N.S.
CD (P=0.05)	N.S.	N.S.	(0.26)	(1.47)

*Figures in parentheses are transformed values

3.3.2 Reproductive period (days)

The reproductive period of *H. coriandri* on different genotypes of coriander presented in Table 4.3 revealed that it was maximum on Gujarat Coriander-1 (7.50 days) followed by Sudha (7.30 days) , Rcr-41(7.00 days), Rcr-446 (6.40 days), Gujarat Coriander-2 (6.20 days), NRCSS-Acr-1 (6.00 days), Hisar Bhoomit (5.90 days) and it was minimum on Sindhu (5.50 days). However, irrespective of the genotypes, the mean reproductive period was observed to be 6.47 days.

3.3.3 Post-reproductive period (days)

The post reproductive period of *H. coriandri* was observed to be maximum on Sudha (2.70 days) followed by Hisar Bhoomit (2.40 days) , NRCSS-Acr-1 (1.90 days) and being

similar on Sindhu and Gujarat Coriander-2 (1.60 days) followed by Gujarat Coriander- 1 (1.50 days), Rcr-41 (1.30 days) and minimum on Rcr-446 (1.00 days). The mean post-reproductive period observed on different genotypes of coriander was worked out to be 1.75 days.

4.4 Fecundity and life span

The data pertaining to the number of nymphs produced per female given in Table 4.4 revealed that it was maximum on Gujarat Coriander-1 (49.00 nymphs) followed by Sudha (47.00 nymphs), Rcr-446 (45.00 nymphs), Gujarat Coriander-2 (42.00 nymphs), NRCSS-Acr-1 (31.00), Rcr-41(27.00 nymphs) and minimum on Hisar Bhoomit (21.00 nymphs). Irrespective of the genotypes, the mean number of nymphs produced per female was 37.00 nymphs. The female aphid continued nymph laying for 6-8 days on all genotypes evaluated during the studies. The mean number of nymphs laid on first day of nymph laying was maximum on Gujarat Coriander-2 (3.90 nymphs) followed by Gujarat Coriander-1(3.10 nymphs), Sindhu (2.00 nymphs) and NRCSS-Acr-1(2.80 nymphs) and minimum on Hisar Bhoomit (1.00 nymphs). The mean number of nymphs laid on second day of nymph laying was maximum on Gujarat Coriander-2 (6.10 nymphs) followed by Sindhu (5.50 nymphs), Gujarat Coriander-1 (4.90 nymphs), Rcr-446(4.70 nymphs), Sudha (4.50 nymphs), NRCSS-Acr-1 (4.30 nymphs) and it was minimum on Hisar Bhoomit (1.70 nymphs). The maximum numbers of nymphs were laid on third to fifth day of oviposition period and started declining thereafter. The maximum nymph production was observed on fourth day and it was 11.30 nymphs on Gujarat Coriander-1 followed by Sindhu (10.50 nymphs), Gujarat Coriander-2 (9.70 nymphs), Rcr-446 (9.40 nymphs), NRCSS-Acr-1(8.70 nymphs), Sudha (7.50 nymphs), Hisar Bhoomit (6.30 nymphs) and minimum on Rcr-41 (5.60 nymphs). The nymphs laid by female aphid continued up to eighth day where an average 3.00 nymphs/female were laid on Sudha and this number was 2.00 on var. Gujarat Coriander-1. Irrespective of the genotypes, the mean number of nymphs produced by female aphid was maximum on fourth day (8.62 nymphs) followed by third day (8.00 nymphs), fifth day (7.50 nymphs), second day (4.37 nymphs), sixth day (3.62 nymphs), seventh day (2.80 nymphs) and minimum on first and eighth day (2.50 nymphs) and the overall fecundity of this aphid, irrespective of its age was observed 37.00 nymphs per female.

Table 4.4 Fecundity of *H. coriandri* on different genotypes of coriander

Genotypes	1st day	2nd day	3rd day	4th day	5th day	6th day	7th day	8th day	Total
Gujarat Coriander-1	3.10 (1.99)*	4.90 (2.36)	9.60 (3.24)	11.30 (3.27)	8.10 (2.94)	6.20 (2.63)	3.80 (2.13)	2.00 (1.70)	49.00 (6.75)
Gujarat Coriander-2	3.90 (2.16)	6.10 (2.61)	9.40 (3.03)	9.70 (3.26)	5.90 (2.55)	3.8 (2.13)	3.20 (2.01)	0.00 (1.00)	42.00 (6.27)

Rcr-41	2.40 (1.83)	3.30 (2.14)	6.70 (2.66)	5.60 (2.46)	5.10 (3.94)	3.00 (1.96)	0.90 (1.37)	0.00 (1.00)	27.00 (5.07)
Rcr-446	2.60 (1.96)	4.70 (2.39)	10.30 (3.21)	9.40 (3.18)	10.90 (3.32)	5.00 (2.39)	2.10 (1.72)	0.00 (1.00)	45.00 (6.48)
Sudha	2.20 (1.77)	4.50 (2.34)	6.80 (3.15)	7.50 (2.71)	12.80 (3.61)	6.20 (2.57)	4.00 (2.19)	3.00 (1.96)	47.00 (6.61)
Sindhu	2.80 (1.96)	5.50 (2.58)	8.20 (2.81)	10.50 (3.36)	5.20 (2.45)	1.80 (1.70)	0.00 (1.00)	0.00 (1.00)	34.00 (5.66)
NRCSS-Acr-1	2.00 (1.71)	4.30 (2.28)	7.70 (2.91)	8.70 (2.97)	7.30 (2.84)	1.00 (1.40)	0.00 (1.00)	0.00 (1.00)	31.00 (5.42)
Hisar Bhoomit	1.00 (1.40)	1.70 (1.62)	5.30 (2.40)	6.30 (2.67)	4.70 (2.30)	2.00 (1.70)	0.00 (1.00)	0.00 (1.00)	21.00 (4.51)
Mean	**2.50**	**4.37**	**8.00**	**8.62**	**7.50**	**3.62**	**2.80**	**2.50**	**37.00**
SEm±	(0.11)	(0.16)	(0.24)	(0.25)	(0.23)	(0.14)	(0.09)	(0.05)	(0.59)
CD (P=0.05)	(0.31)	(0.46)	N.S.	N.S.	(0.65)	(0.41)	(0.27)	(0.15)	N.S.

*Figures in parentheses are transformed values

The data on the life span of *H. coriandri* on different genotypes of coriander revealed that it was maximum on Hisar Bhoomit (18.10 days) followed by Sudha (18.00 days), Rcr-41 (15.20 days) , Gujarat Coriander-1 (15.10 days), NRCSS-Acr-1 (14.90 days) , Sindhu (14.80 days), Rcr-446 (14.00 days) and minimum on Gujarat Coriander -2 (13.70 days) and irrespective of genotype, the mean life span of *H. coriandri* was observed to be 15.47 days (Table 4.3).

4.5 Survival (%) of different instars of *H. coriandri* on different genotypes of coriander

The data presented in table 4.5 pertain to survival (%) of different instars of *H. Coriandri* nymphs. Mean survival (%) of *H. coriandri* nymphs varied from 89.83 to 99.97, 70.00 to 99.97, 60.02 to 99.97 and 50.03 to 89.98 in 1st, 2nd, 3rd, and 4th instar, respectively, on different genotypes of coriander evaluated in the present studies.

Table 4.5 Survival (%) of different instars of *H. coriandri* nymphs on different genotypes of coriander

Genotypes	1st instar	2nd instar	3rd instar	4th instar
Hisar Bhoomit	99.97 (88.97)*	79.99 (71.54)	70.00 (62.82)	70.00 (62.82)
Sindhu	99.97 (88.97)	99.97 (88.97)	99.97 (88.97)	60.02 (54.10)
Gujarat Coriander-2	89.98 (80.25)	79.99 (71.54)	79.99 (71.54)	60.02 (54.10)

Rcr-41	89.83 (80.25)	70.09 (62.82)	60.02 (54.10)	60.02 (54.10)
Rcr-446	99.97 (88.97)	79.99 (71.54)	70.00 (62.82)	50.03 (45.39)
NRCSS-Acr-1	89.98 (80.25)	70.00 (62.82)	60.02 (54.10)	60.02 (54.10)
Sudha	99.97 (88.97)	79.99 (71.54)	79.99 (71.54)	70.00 (62.82)
Gujarat Coriander-1	99.97 (88.97)	99.97 (88.97)	99.97 (88.97)	89.98 (80.25)
SEm±	(5.33)	(10.57)	(11.34)	(13.47)
CD (P=0.05)	N.S.	N.S.	N.S.	N.S.

*Figures given in parentheses are angular transformed values

4.6 Bioefficacy of plant oils against *H. coriandri* nymphs under field conditions

The efficacy of different plant oils varied significantly after one, three and five days of treatment. Data in Table 4.6 revealed that all the plant oils evaluated in the present study significantly reduced the population of aphid (*H. Coriandri*).

Table 4.6 Bioefficacy of plant oils against *H. coriandri* under field conditions

Treatments	**Reduction (%) in aphid population (days after treatment)**		
	One	**Three**	**Five**
Neem oil 1%	32.22 (34.41)*	52.71 (46.55)	71.92 (58.49)
Castor oil 1%	41.88 (40.26)	74.18 (59.71)	91.60 (73.61)
Karanj oil 1%	41.78 (40.10)	92.60 (74.51)	98.51 (84.62)
Garlic oil 0.25 %	48.58 (44.17)	73.24 (59.35)	89.41 (71.12)
Sesame oil 1%	42.95 (40.86)	86.50 (68.62)	97.31 (83.65)
Mahua oil 1%	52. 09 (46.18)	88.57 (70.49)	97.26 (83.51)
Groundnut oil 1%	10.99 (14.57)	21.19 (21.10)	28.43 (26.21)
Untreated (Control)	9.12 (13.55)	14.84 (17.19)	23.12 (25.18)
SEm±	(3.96)	(5.37)	(5.75)
CD (P=0.05)	(11.54)	(15.65)	(16.76)

*Figures given in parentheses are angular transformed values

One day after application, all the treatments were found significantly effective over control, in reducing aphid population. Mahua oil 1% was observed to be the most effective which reduced the population of aphids up to 52.09 %. However, it was on par with castor oil

1% (41.88 %), karanj oil 1% (41.78 %), garlic oil 0.25 % (48.58 %), sesame oil 1% (42.95 %). Neem oil showed moderate efficacy and caused 32.22 % reduction in aphid population. Groundnut oil (10.99%) was on par with untreated control (9.12%).

Data pertaining to three days after treatment show that karanj oil 1% was the most effective in reducing aphid population, though all the treatments were remained significantly superior over control. The effectiveness of karanj oil 1% (92.60 %) was statistically on par with mahua oil 1% (88.57%) and sesame oil 1 % (86.50 %). Castor oil 1% (74.18 %), garlic oil 0.25% (73.24 %) and neem oil 1% (52.71%) showed moderate effectiveness in reducing aphid population. Groundnut oil 1% proved inferior among all plant oils which reduced only 21.19 % of aphid population.

Five days after treatment, karanj oil proved most effective in reducing population of *H. coriandri* up to 98.51 %. However, it was statistically on par with castor oil 1% (91.60 %), garlic oil 0.25 % (89.41 %), sesame oil 1% (97.31 %) and mahua oil (97.26 %). Neem oil 1% showed moderate efficacy as compared to other oils. Groundnut oil 1% remained poor in performance affording only 28.43 % aphid population after five days of treatment.

4.7 Bioefficacy of plant oils against *Hyadaphis coriandri* Das under laboratory conditions

In the experiment conducted to evaluate efficacy of plant oils against *H. coriandri* (Table 4.7) sesame oil 1% reduced the aphid number up to 80.00%, after 24h of treatment, this proved to be significantly higher than that afforded by karanj oil 1% (20.15%), castor oil 1%(20.15 %) , neem oil 1% (10.17 %), garlic oil 0.25 % (10.17 %), mahua oil 1% (20.15 %) and groundnut oil 1% (20.15 %).

Table 4.7 Bioefficacy of plant oils against *Hyadaphis coriandri* Das under laboratory conditions

Treatments	Reduction (%) in aphid number (hours after treatment)		
	24h.	48h.	72h.
Karanj oil 1%	20.15 (19.79)*	60.05 (54.23)	70.02 (62.85)
Sesame oil 1%	80.00 (71.46)	89.97 (80.07)	99.95 (88.68)
Castor oil 1%	20.15 (19.79)	60.05 (54.23)	89.97 (80.07)
Neem oil 1 %	10.17 (11.17)	60.05 (54.23)	70.02 (62.85)
Garlic oil 0.25 %	10.17 (11.17)	30.12 (28.39)	40.10 (37.01)
Mahua oil 1%	20.15	50.07	50.07

	(19.79)	(45.62)	(45.62)
Groundnut oil 1%	20.15 (19.79)	20.15 (19.79)	20.15 (19.78)
Untreated (Control)	10.17 (11.17)	20.15 (19.78)	20.15 (19.78)
SEm±	(10.49)	(12.79)	(11.66)
CD (P=0.05)	(29.66)	(36.15)	(32.94)

*Figures given in parentheses are angular transformed values

After 48h of treatment sesame oil at 1% remained the most effective against *H. coriandri.* It caused aphid reduction up to 89.97 %. It was found to be superior over garlic oil 0.25 % (30.12 %), mahua oil 1% (50.07 %) and groundnut oil 1% (20.15 %), though the reduction in aphid number afforded by karanj oil 1%, castor oil 1% and neem oil 1% were similar (60.05%) statistically to that of sesame oil 1%. However, karanj oil 1%, castor oil 1% and neem oil 1% were on par among each other. Garlic oil 0.25% caused 30.12 % reduction in aphid and groundnut oil caused 20.15 % and they were observed as the least effective against *H. coriandri* among all plant oils evaluated.

Observation recorded 72h after treatment also reveal that sesame oil 1 % was proved to be the best among all the plant oils evaluated and resulted in 99.95 % reductions of aphids. However it was significantly better than karanj oil 1% (70.02 %), castor oil 1% (89.97 %) and neem oil 1% (70.02 %). The effectiveness of mahua oil 1% remained (50.07%). Groundnut oil proved the least effective among all the oils evaluated.

CHAPTER - V

DISCUSSIONS

Coriander, an important spice crop, is attacked by coriander aphid, *Hyadaphis coriandri* Das which concides with the flowering stage of the crop. In the short duration of infestation, this aphid damages the crop to a great extent. In this chapter, the results obtained from the experiments conducted in the present studies, on coriander aphid, have been discussed with those obtained by various other researchers.

5.1 Response of *H. coriandri* on different genotypes of coriander

On the basis of season's average, population of *H. coriandri* ranged from 0.73 to 27.72 aphids/umbel/day on coriander crop. Earlier Jain and Yadav (1988a) observed aphid population to range from 25 to 107.25 aphids/umbel in 1980-81. The infestation of *H. coriandri*, started in 2nd week of February and increased with the advance of season and its peak was recorded during the first week of March (average of 5.64 aphids/umbel). Similar results were also obtained by Kalra *et al.* (2006), while working with this aphid.

Among twenty genotypes screened, in the present studies against the coriander aphid, none was observed completely free from infestation. Similar results also being observed by Pal and Choudhuri (2003). They observed that among six genotype screened none was completely free from infestation. In a similar experiment Jain and Yadav (1988b) examined twenty varieties of coriander for resistance to *H. coriandri* and observed that none was completely resistant to the pest and they categorized cultivars Rajendra Swathi (RD-44), Pant Haritima and DH-205 as less susceptible (up to 10 aphids/plant), DH-234 and local cultivar as moderately susceptible (11-20 aphids/plant) and RCR-41 as highly susceptible (above 20 aphids/plant). In the present investigations it was observed that Gujarat Coriander-1, Sudha, Rcr-435 and NRCSS-Acr-1 were highly susceptible to *H. coriandri* and genotypes Hisar Bhoomit, Swathi CS-6, Sindhu, Rcr-436, Jawahar Dhania-1, Hisar Sugandh and Hisar Anand as less susceptible to the pest and this was probably due to their early flowering and maturity habit. This finds support from the findings of Jain and Yadav (1988b) who screened 20 varieties of coriander and found more aphid incidence on the late flowering varieties than the early flowering varieties. Nevertheless the aphid infestation varied widely in other varieties having more or less similar flowering durations. This was probably due to the intrinsic resistance mechanism of different varieties to aphids as reported by Kumari and Yadav (2002). According to these workers resistance mechanisms like antixenosis, antibiosis and tolerance have been evident in coriander varieties. The infestation of *H. coriandri* started declining from 2nd week of March and this was probably due to the fact that crop was

attaining maturity and because of the high population of predatory beetles (*C. septumpunctata*). Similar observations were reported by Meena *et al.* (2002a) who worked out a positive correlation between the aphid infestation and coccinellid predator's population. Population of coccinellids reached a peak in 2nd week of March. In a similar study conducted by Kalra *et al.* (2006) on the population dynamics of *H. coriandri* on 10 coriander cultivars (Hisar Anand, JCO-283, JCO-387, LCC-133, UD-743, UD- 744, DH-208, DH-246 and Narnaul Selection) in Hisar, Haryana during 2001-02 and 2002-03, which revealed that the aphid incidence on the crop started in the 1st week of February in both years and increased with the advance of season. The peak incidence was recorded during the end of February and the first week of March (average of 31.5 aphids/umbel). On the basis of season's average JCO-283 with 10.7 and 9.25 aphids/umbel was found to be most susceptible and DH-246 with 4.0 and 4.18 aphids/umbel, the least susceptible and on the basis of two season's average Hisar Anand afforded the minimum (30.2%) seed yield losses and UD-744 the highest (111.3%).

5.2 Biology of coriander aphid (*H. coriandri*)

5.2.1 Nymphal duration (days)

There were four nymphal instars and the nymphal durations of the *H. coriandri* among different genotypes varied from 4.70 t0 8.40 days. In a similar study Kumar and Sagar (1996) observed that nymphal duration of *H. coriandri* varied from 4.65±0.15 to 10.90±0.25 days in the different months of year. The present investigations confirm the findings of Kumar and Sagar (1996). The results presented by Singh *et al.* (2005) are also in line with the results obtained in the present studies. According to them total nymphal duration on different cultivars ranged from 6.0±0.20 to 7.8±0.19 days.

5.2.2 Pre-reproductive, reproductive and post reproductive periods (days)

The results obtained in the present investigations revealed that the pre-reproductive, reproductive and post reproductive periods of *H. coriandri* varied from 1.00 to 1.50 days, 5.50 to 7.50 and 1.00 to 2.70 days, respectively. Kumar and Sagar (1996) reported that the pre-reproductive, reproductive and post reproductive periods ranged from 1.48±0.10 to 2.89±0.21, 5.05±0.37 to 24.40±0.40 and 1.53±0.11 to 11.71±0.53 days. The results obtained in the present studies support the findings of these workers. In a similar experiment Singh *et al.* (2005) also observed that mean pre-reproductive, reproductive and post reproductive period varied from 1.30±0.15 to 1.50±0.16, 7.20±0.43 to 7.40±0.38 and 3.20±0.34 to 3.90±0.41 days, respectively on different cultivars.

5.2.3 Reproduction

5.2.3.1 Mean number of nymphs produced per female

Studies conducted by Kumar and Sagar (1996) revealed that the number of nymphs produced per mother aphid ranged from 10.68±1.21 to 57.27±2.04 during different months of year. The present investigations confirm the findings of these workers as the mean number of nymphs produced per female on different genotypes varied from 21.00 to 49.00 nymphs. The observations recorded by Singh *et al.* (2005) also revealed that the mean number of nymphs produced per mother aphid ranged from 32.20±1.50 to 37.00±2.01 on different cultivars.

5.2.3.2 Mean number of nymphs produced on different days

The female aphid continued to produce nymphs up to 7 to 8 days and maximum number of nymphs were produced on 4^{th} and 5^{th} day. Similar observations were also recorded by Singh *et al.* (2005).

5.2.3 Total life span (days)

The present studies suggest that the life span (days) of *H. coriandri* varied from 13.70 to 18.10 days. Studies conducted by Singh *et al.* (2005) also report that *H. coriandri* has a life span ranging from 18.00±0.45 to 20.04±0.35 days on different cultivars and is in line of present studies.

5.2.4 Survival (%) of different nymphal instars

Among eight genotypes evaluated in the present studies, survival (%) of 1^{st}, 2^{nd}, 3^{rd}, and 4^{th} instar nymph was observed to range from 89.83 % to 99.97% ,70.00 % to 99.97, 60.02 % to 99.97% and 50.03 to 89.98 % respectively. There is no earlier work reported on this aspect.

5.3 Bio efficacy of plant oils against *H.coriandri*

Among the plant products neem (*Azadirachta indica*) has been in use for long time in India, for pest management and the effect was confirmed in the laboratory and field tests and now it is quite popular and has been commercialized. Besides neem, pongam, karanj, garlic, castor, sesame, groundnut and mahua possess highly odoriferous active chemical compounds reportedly used as pesticides and gaining importance in modern pest control methods Anonymous (1978). This study was made to combat this pest by using plant oils.

5.3.1 Bio efficacy of plant oils against *H.coriandri in vivo*

Application of ecofriendly chemicals has become necessary at certain stage in the pest management programme. The results presented in the present investigations revealed that reduction (%) of aphid population after one, three and five days of treatment varied from 10.99% to 52.09%, 21.19% to 92.60% and 28.43% to 98.51%, respectively. Earlier Bahar *et al.* (2007) also observed the effectiveness of tobacco, neem, garlic and eucalyptus extracts on bean aphid. The mortality caused by tobacco leaf extract was maximum (74.90%), neem leaf extract and garlic extract also showed similar performance. Katole *et al.* (1993) observed

that in the management of citrus black fly nymphs with plant oils, neem oil (1%) was observed most effective and castor oil was found to be least effective. In another study Meena *et al.* (2003) revealed that azadirachtin (0.5%) and karanj pod extract (1.0%) proved least effective in the management of coriander aphid. The present investigations confirm that neem oil (1%) was least effective against this pest (1%). Mishra, H.P. (1993) evaluated some synthetic insecticides and oils against mustard aphid, *Lipaphis erysimi*. He, too, found that all treatments except neem oil (1%+0.1% teepol) decreased the aphid population significantly. It was further proved that karanj oil (1%) and Garlic oil (0.25%) also proved effective against *H. coriandri*. Similar results were also reported by Sardana and Kumar (1989) against leafhoppers on Okra. The observations recorded by Krishnaiah and Mohan (1983) revealed that garlic oil was ineffective in controlling the aphid in the present investigations against coriander aphid under laboratory conditions. As per studies conducted by Swaminathan *et al.*(1999) neem oil (2%) proved better than neem kernel extract in reducing safflower aphid population. Seed extracts of neem (*Azadirachta indica*), karanj (pongamia spp.), bakain and pride of India reduced the aphid population by more than 50% within seven days (Nath and Singh, 2003). Further non edible oils were observed to be more effective as compared to leaf extract against mealy bug (Saminathan and Jayaraj, 2001). Similar results have been obtained in the present investigations too.

5.3.2 Bio efficacy of plant oils against *H.coriandri in vitro*

The bioefficacy of plant oils *in vitro* after 24h, 48h and 72h of exposure of *H. coriandri* to different treatments varied from 10.17 to 80.00, 20.15 to 89.97 and 20.15 to 99.95 per cent, respectively. It was revealed that the sesame oil (1%) was most effective and it caused 80.00% reduction in aphid number within 24h of exposure, which reached 99.95% within 72h. The effectiveness 70.3% mortality of neem oil at 24% against brown planthopper was observed by Mohapatra *et al. (*1991). As per investigations carried out by Natarajan and Sundramurthy (1990) it was revealed that growth and development of nymphs of *B. tabaci* were suppressed by treatment with neem oil. In an experiment conducted by Vekaria and Patel (2005), it was observed that botanicals insecticides Nicotine sulphate (0.05%), Amritguard and Nimbecidine (0.05%), caused more than 70% mortality of *L. erysimi* within 48h. Garlic oil 4.0% repelled 100% of adult aphids, as per the studies conducted by Ahmed *et al.,* 2007. Venkatetan *et al.* (1987) observed that blends of neem formulations with sesame oil were effective in reducing the aphid population in cotton 1-3 days after treatment.

CHAPTER - VI

SUMMARY AND CONCLUSION

Studies on the evaluation of coriander genotypes for resistance to *Hyadaphis coriandri* Das and its management through plant oils were undertaken during '*rabi*' season of 2008-09. Three experiments *viz.* response of coriander aphid (*H. coriandri*) on different genotypes of coriander, biology of coriander aphid (*H. coriandri*) on different genotypes of coriander and efficacy of some edible and non edible oils of plant origin against *H. coriandri in vivo* and *in vitro* were conducted at the research area, Department of Vegetable science and laboratory, Department of Entomology, CCS Haryana Agricultural University, Hisar.

Studies on the response of coriander aphid on 20 genotypes of coriander revealed that aphid (*H. coriandri*) started appearing on the crop from the third week of February and as the season progressed the insect population also increased and its peak was observed during the first week of March, 2009. On this date (4th March), the maximum numbers of aphids were recorded on genotype Gujarat Coriander-1 (60.10 aphids/umbel+ peduncle up to 10 cm length) and minimum number was recorded on genotype Hisar Bhoomit and Rcr-436 (0.50 aphid/umbel). In the second week of March too, the aphid population was observed to be very high in different genotypes. Thereafter, a declining trend in the population was noticed. On the basis of seasons average genotype Gujarat Coriander-1 harboured maximum aphids/umbel (27.72) whereas, minimum (0.73 aphid/umbel) were harbored on genotype CS-6.

The biology of the *H. coriandri* was studied in the laboratory, Department of Entomology, CCSHAU, Hisar. There were four nymphal instars. The mean duration of first, second, third and fourth nymphal instars on different genotypes varied from 1.50 to 2.70, 1.00 to 2.20, 1.00 to 1.90 and 1.00 to 1.60 days, respectively and the total nymphal duration ranged from 4.70 to 8.40 days. The mean pre-reproductive, reproductive and post-reproductive period varied from 1.00 to 1.50, 5.50 to 7.50 and 1.00 to 2.70 days, respectively in different genotypes.

The mean number of nymphs produced per mother aphid ranged from 21.00 to 49.00 in different genotypes. The female aphid continued nymph laying up to 7-8 days in all the genotypes viz. Gujarat Coriander-1, Gujarat Coriander-2, Rcr-41, Rcr-446, Sudha, Sindhu, NRCSS-Acr-1 and Hisar Bhoomit. The peak nymph production was observed from 3rd to 5th day and it declined thereafter. *H. coriandri* had the longest life span of 18.10 days on Hisar Bhoomit and shortest life span (13.70 days) on genotype Gujarat Coriander-2. Survival (%)on eight genotypes of coriander of *H. coriandri*, first, second, third and fourth instar

nymph ranged from 89.83 to 99.97, 79.99 to 99.97, 60.02 to 99.97 and 50.03 to 89.98 per cent, respectively. The efficacy of some edible and non-edible oils of plant origin against *H. coriandri in vivo* and *in vitro* was studied in the research area, Department of Vegetable science and laboratory, Department of Entomology CCS Haryana Agricultural University, Hisar. The reduction (%) in aphid population *in vivo* after one, three and five days after treatment ranged from 10.99 to 52.09, 21.19 to 92.60 and 28.43 to 98.51 per cent, respectively. The maximum reduction (%) was observed with karanj oil (1%) and minimum with groundnut oil (1%). The reduction (1%) of aphid number *in vitro* after 24h, 48h and 72h of exposure remained between 10.17 to 80.00, 20.15 to 89.97 and 20.15 to 99.95 per cent, respectively. The maximum reduction (%) was observed with sesame oil (1%) 99.95% and minimum (20.15%) observed with groundnut oil (1%).

BIBLIOGRAPHY

Ahmed, A.A.I., Salem, E.I., Hawary, E.I. 2007. Persistance and biological activity of mint and garlic oils against the cowpea aphid, *Aphis craccivora* Koch. (Homoptera: Aphididae). *Egyptian Journal of Biological Pest Control* **17**(1/2): 29-33.

Anonymous.1978. *Tree-borne Oilseeds*, *Non-edible Oils and Soap Industry*. Khadi and Village Industries Commission, Bombay, India.

Anonymous.1998. *Phal-Phool-Sabji Utpadan avam Prirakshan* (*Samarag Sifarise*). Directorate of Publication, Chaudhary Charan Singh Haryana Agricultural University, Hisar, pp.200-203.

Bahar, H., Islam, A., Mannan, A. and Uddin, J. 2007. Effectiveness of some botanical extracts on Bean aphid attacking yard-long beans. *Journal of Entomology* **4**(2): 136-142.

Bodenheimer, F.S. and Swirski, E. 1957. *The Aphidoidea of the Middle East*. The Hebrew Univ. Jerusalem and Agricultural Research Station, Rehovat, p. 373.

Dress, B.M. and Jackman, J.A. 1998. *A Field Guide to Common Texas Insects.* Gulf Publishing Company, Houston, p.359.

Halbert, S.E. 2003. *Florida Department of Agriculture and Consumer Services*, Division of Plant Industry, Florida, Publication No. EENY-296.

Jain, P.C. and Yadav, C.P.S. 1986. Effect of date of sowing on the incidence of insect pests of coriander. *Indian journal of Agricultural Sciences* **56**(1): 56-59.

Jain, P.C. and Yadav, C.P.S. 1988a. Pest complex of coriander and seasonal incidence of coriander aphid (*Hyadaphis coriandri* Das) in relation to insect predator. *Indian Journal of Applied Entomology* **3**:5-10.

Jain, P.C. and Yadav, C.P.S. 1988b. Relative susceptibility of coriander varieties to coriander aphid (*Hyadaphis coriandri* Das). *Indian Journal of Entomology* **50**(4): 535-536.

Jain, P.C. and Yadav, C.P.S. 1989.Incidence of pests and their control on coriander. *Indian-Cocoa-Arecanut and spices* **13**(2):61-62.

Kalra, V.K., Sharma, S.S. and Tehlan, S.K. 2006. Population dynamics of *Hyadaphis coriandari* on different cultivars and varieties of coriander and seed yield losses caused by it. *Journal of Medicinal and Aromatic Plant Sciences* **28** (3):377-379.

Katole, S.R., Thakare, H.S. and Mahajan, R.K. 1993. Management of citrus blackfly nymphs with some insecticides and plant oils. *Journal of Maharashtra Agricultural Universities* **18**(1): 68-71.

Krishnaiah, K. and Mohan, N.J. 1983. Control of cabbage pests by new insecticides. *Indian Journal of Entomology* **45**(3): 222-228.

Kumar, N. and Sagar, P. 1994. Seasonal history and host range of coriander aphid *Hyadaphis coriandri* Das. *Journal of Research Punjab Agricultural University* **31**(3): 283-284.

Kumar, N. and Sagar, P. 1996. Studies on the life history of the aphid, *Hyadaphis coriandri* (Das) on coriander, *Coriandrum sativum*. *Journal of Medicinal and Aromatic Plant Sciences* **18**(2): 287-289.

Kumari, S. and Yadav, R.P. 2002. Genotype variation in coriander for resistance to aphid (*Hyadaphis coriandri* Das) infestation under field condition. *Insect Environment* **8**(4): 190-191.

Kumari, S. and Yadav, R.P. 2005. Tritrophic interactions among coriander genotypes, pest-insect (*Hyadaphis coriandri* Das) and predaceous coccinellids. *Annals of Plant Sciences* **13** (1): 136-138.

Matter, M.M., Marei, S.S., Moawad, S.M. And Gengathi, S.1993. The reaction of *Aphis gossypii* and its predator, *Coccinella undecimpunctata* to some plant extracts. *Bulletin of Faculy of Agriculture, University of Cairo* **44**(2)417-432.

Mathur, S.C., Anwer, M. and Chandola, L.P. 1971. Note on screening coriander (*Coriandrum sativum* L.) varieties against aphid, *Hyadaphis coriandri* Das. *Science and Culture* **37**(3): 162-163

Meena, P.C., Sharma, J.K. and Noor, A. 2002a. Effect of abiotic factors on the occurrence of aphid, *Hyadaphis coriandri* (Das) and Coccinella predator on coriander varieties. *Annals of Agri- Bio-Research* **7**(2): 181-186.

Meena, P.C., Sharma, J.K. and Noor, A. 2002b. Varietal reaction of coriander *(Coriandrum sativum L.)* and impact of date of sowing on incidence of aphid (*Hyadaphis coriandri* Das). *Indian Journal of Entomology* **64**(1): 58-62

Meena, P.C., Sharma, J.K. and Noor, A. 2003. Evaluation of some chemical and botanical insecticides against coriander aphid, *Hyadaphis coriandri* (Das). *Annals of Biology* **19**(1): 95-97.

Mishra, H.P. 1993. Evaluation of some synthetic insecticides and oils against mustard aphid, *Lipaphis erysimi*. *Indian Journal of Entomology* **55**(1): 58-61.

Mittal, V.P. and Butani, P.G. 1989. Evaluation of some insecticides against coriander aphid (*Hyadaphis coriandri* Das). *Abstracts First National Symposium on Seed Spices*, October 24-25,1989, Jaipur, pp. 41-42.

Mittal, V.P. and Butani, P.G. 1994. Pests of seed spices, pp. 825-840. *Advances in Horticulture* Vol: **10-***Plantation and Spice Crops part II*. Eds. K.L. Chadha and P. Rethinam. Malhotra Publishing house. New Delhi (India).

Mohapatra, R.N., Patnaik, N.C., Mishra, B.K. and Patnaik, H.P. 1991. Comparative toxicity of some insecticides and neem oil against the brown planthopper, *Nilaparvata lugens* and its predators. *Orissa Journal of Agricultural Research* **4**(3-4): 239-240.

Natarajan, K. and Sundramurthy, V.T. 1990. Effect of neem oil on cotton whilefly (*Bemisia tabaci*). *Indian Journal of Agricultural Sciences* **60**(4): 290-291.

Nath, L. and Singh, A.K. 2003. Safety of some plant extracts and a neem formulation to predators of the coriander aphid, *Hyadaphis coriandri* (Das) under field conditions. *Pest Management and Economic Zoology* **11**(2):159-162.

Nath, L., Singh, A.K. and Singh, H.M. 2004. Relative resistance of coriander (*Coriandrum sativum* L.) germplasm against aphid *Hyadaphis coriandri. Shashpa* **11**(1): 87-88.

Pal, S. and Choudhuri, P. 2003. A short note on reaction of some coriander varieties to aphid, (*Hyadaphis coriandri* Das) under terai-ecological conditions of West Bengal. *Orissa Journal of Horticulture* **31**(2): 105-106.

Remaudiere, G. and Halbert, S. E. 2000. *Hyadaphis coriandri* (Das), Espece Heteroecique Distincte De *H. tataricae* (Aizenberg) (Hemiptera : Aphididae). *Annals of Entomological Society of France* **36**: 157-163.

Sagar, P. 1986. A study on the population abundance of the aphid, *Hyadaphis coriandri* (Das) on four cultivars of coriander in the Punjab. *Indian Perf.* **29**(4):461-64.

Saminathan, V.R. and Jayaraj, S. 2001. Evaluation of botanical pesticides against the mealy bug, *Ferrisia virgata* cockrell (Homoptera: Pseudococcidae) on cotton. *Madras Agricultural Journal* **88**(7-9): 535-537.

Sankaracharya, N.B. and Sankaranarayana, M.L. 1989. Processing and flavour quality of seed spices. *Proc. First National Seminar Seed Spices*, Jaipur, 24-25 October, 1989, PP. 301-328.

Sardana, H.R. and Kumar, N.K.K. 1989. Effectiveness of plant oils against leaf hopper and shoot and fruit borer on okra. *Indian Journal of Entomology* **51**(2): 167-171.

Singh, A.K. and Nath, L. 2003.Efficacy and economics of some botanical and synthetic insecticides against coriander aphid (*Hyadaphis coriandri* Das). *Pest Management and Economic Zoology* **11**(1):79-82.

Singh, U.C., Singh, R. and Jadhav, M.R. 1998. Incidence of protomyces gall and aphid on coriander. *Flora and Fauna* **2**(2): 129-130

Singh, V. 2002. Studies on insect pest of coriander, *Coriandrum sativum* L. M.Sc. Thesis, CCS Haryana Agricultural University, Hisar, p.58.

Singh, V., Bhanot, J.P. and Kalra, V.K. 2005. Biology of coriander aphid, *Hyadaphis coriandri* (Das) on some varieties of coriander. *Annals of Agri-Bio-Research* **10**(2):163-166.

Swaminathan, R., Dhaked, B.M., Husain, E.T. and Bhati, K.K. 1999. Effect of neem derivatives on the safflower aphid (*Dactynotus carthami* HRL.). *Entomon* **24**(1): 85-89.

Upadhyay, S., Mishra, R.C. and Nigam, K.B.1996. Magnitude of damage and assessment of loss in yield of coriander genotypes by *Hyadaphis coriandri* Das. *Journal of Insect Science* **9**(2):168-169.

Vekaria, M.V. and Patel, G.M. 2005. Comparative efficacy of botanical and chemical insecticides against mustard aphid, *Lipaphis erysimi* (Kaltenbach). *Indian Journal of Entomology* **67**(2): 182-184.

Venkatetan, S., Balasubramanian, G., Jayaraj, S. and Gopalan, M. 1987. Studies on the efficacy of neem products against the aphid (*Aphis gossypii*) on cotton. *Madras Agricultural Journal* **74**(4-5): 255-257.

ABSTRACT

Title of Thesis	:	**Evaluation of coriander genotypes for resistance to *Hyadaphis coriandri* Das and its management through plant oils**
Full Name of the Degree Holder	:	**DINESH CHOUDHARY**
Admission Number	:	2007A27M
Title of the Degree	:	**Master of Science**
Name of Discipline	:	Entomology
Name and Address of Major Advisor	:	**(Dr. V.K. Kalra)** Major Advisor Professor Department of Entomology CCS HAU, Hisar-125 004, India
Degree Awarding University	:	CCS Haryana Agricultural University Hisar-125 004 (Haryana), India
Year of Award of Degree	:	2010
Major Subject	:	Entomology
Total Number of Pages in Thesis	:	28 + iii
Number of Words in Abstract	:	377
Key words	:	Genotype, biology, edible oil, non-edible oil, coriander

Three experiments *viz*. response of coriander aphid (*Hyadaphis coriandri*) on different genotypes of coriander, biology of coriander aphid on some selected genotypes and the efficacy of some edible and non-edible oils of plant origin against *H. coriandri in vivo* and *in vitro* were conducted at the Research farm, Department of Vegetable Sciences and the Laboratory, Department of Entomology, CCS Haryana Agricultural University, Hisar during *'rabi'* season of 2008-09. The coriander aphid started appearing on the crop in the third week of February and reached to its peak in the second week of March and maximum population was observed on Gujarat Coriander-1. Among twenty genotypes screened, none was completely free from infestation. On the basis of season's average Gujarat Coriander-1 harboured maximum population (27.72 aphids/umbel) while Hisar Bhoomit, Swathi, CS-6, Sindhu, Rcr-436, Jawahar Dhania-1, Hisar Sugandh and Hisar Anand had relatively low infestation of *H. coriandri* (0.73 to 1.08 aphids/umbel).

Coriander aphid passed through four nymphal instars and total nymphal duration on different genotypes varied from 4.70 to 8.40 days. The mean pre-reproductive, reproductive and post reproductive period varied from 1.00 to 1.50, 5.50 to 7.50 and 1.00 to 2.70 days, respectively on different genotypes.

The number of nymphs produced per mother aphid ranged from 21.00 to 49.00 in different genotypes. The female *H. coriandri* continued to produce nymphs up to 7-8 days and the peak nymph production was observed on 3rd to 5th day. The *H. coriandri* life span ranged from 13.70 to 18.10 days on different genotypes. Among eight genotypes survival (%) of 1st, 2nd, 3rd, and 4th instar nymph was observed to ranged from 89.83 % to 99.97% ,70.00 % to 99.97, 60.02 % to 99.97% and 60.02 to 89.98 % respectively

Two edible oils (groundnut and sesame) and five non-edible oils (castor, karanj, neem, garlic and mahua) at a conc. of 1%, except garlic oil (0.25%) were evaluated for their bioefficacy against *H. coriandri* and reduction (%) in aphid population *in vivo* after one, three and five days after treatment was observed maximum with karanj oil (1%) and minimum with groundnut oil (1%). The reduction (%) of aphid population (*in vitro*) after 24h, 48h and 72 h after treatment was observed maximum with sesame oil (1%) 99.95% and minimum (20.15%) with groundnut oil (1%).

MAJOR ADVISOR **DEGREE HOLDER**

HEAD OF THE DEPARTMENT

CURRICULUM VITAE

(a)	Name	:	**Dinesh Choudhary**
(b)	Date of Birth	:	04.01.1987
(c)	Place of Birth	:	Pangala (Karnal)
(d)	Mother's Name	:	Smt. Krishna Devi
(e)	Father's Name	:	Sh. Shishpal Choudhary
(f)	Permanent Address	:	Vill. Pangala Tehsil Assand Distt. Karnal
(g)	Telephone	:	-
(h)	Mobile	:	+919813714415
(i)	E-mail	:	dinesh_13a@yahoo.co.in
(j)	Academic Qualification		

Degree	Univ./Board	Year of Passing	Percentage of marks	Subjects
B.Sc.	HAU, Hisar	2007	67.40%	Major : Agriculture Subjects
10+2	CBSE Board	2002	62.00%	Chemistry, Physic, Maths, English, Physical Education

(k)	Co-Curricular Activities	:	–
(l)	Medals/Honours received	:	–
(m)	List of Publications	:	–

UNDERTAKING OF THE COPY RIGHT

"I **Dinesh Choudhary,** Admn. No. **2007A27M** undertake that I give copy right to the CCS HAU; Hisar of my thesis entitled **"Evaluation of coriander genotypes for resistance to *Hyadaphis coriandri* Das and its management through plant oils"**

I also undertake that, patent, if any, arising out of the research work conducted during the programme shall be filed by me only with due permission of the competent authority of CCSHAU, Hisar.

Dinesh Choudhary