



Incidence of Insect Pests of Carrot, *Daucus carota* L. and Their Natural Enemies with Special Reference to Carrot Fly, *Melanagromyza* sp.

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Roving survey was conducted in major carrot growing districts of Karnataka, India during rabi/summer 2021-22 to record the incidence of different insect pests and their natural enemies in carrot at the pre-rooting stage and rooting stage. Observations were made from the three randomly selected spots in each field and from each spot, five plants were observed for incidence by looking at the symptoms inflicted by the different insect pests. Data on damage by agromyzid fly was registered by adopting destructive sampling method. Among the three districts surveyed, the

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highest mean % infestation of agromyzid fly during the pre-rooting stage was recorded in Gadag (22.40%) followed by Dharwad (19.63%) and Belagavi district (15.12%). During rooting stage, the highest mean % infestation of agromyzid fly was documented in Gadag (50.56%) followed by Belagavi district (48.09%) and Dharwad (46.56%). Gadag witnessed the highest % damage of the agromyzid fly during pre-rooting and rooting stages which might be due to year-round cultivation of carrot. Further, monocropping without crop rotation might have attributed to the highest incidence of insect pest of carrot. Sucking insect pests are of minor importance as compared to agromyzid fly, as it causes damage to edible taproot which is of economic importance in carrot cultivation.

Keywords: Damage; *Melanagromyza* sp.; survey; taproot.

1. INTRODUCTION

Carrot, *Daucus carota* (L.) is an annual or biennial vegetable crop belongs to family Apiaceae [1] which constitutes over 250 genera and about 2800 species primarily herbaceous plants [2]. Carrots have been ranked 10th in nutritional value among 39 fruits and vegetables [3]. Carrot is native to the Mediterranean region [4]. The plants require cool to moderate temperatures and are not grown in summer in the warmer regions. They require deep, rich, but loosely packed soil [5]. The cultivated carrots are mainly classified into eastern carrots and western carrots based on pigmentation in the carrot roots [6]. The taproot, which is the edible part of the carrot, is a rich source of nutrients [7]. It contains significant amounts of thiamine, riboflavin, carotene, iron, vitamin A, vitamin B, vitamin C and sugar [8]. Carrot is used in preparations of pickles, preserves, sweets, carrot powder, kanji, salads, cooked vegetables and other delectable beverages [9]. The main ingredients in carrot flavour are sugars and volatile terpenoids, primarily glucose, fructose and sucrose [10]. Carrot is planted throughout India, with a total area of 0.64 million hectares with production of 4.14 million tonnes [11]. Haryana and West Bengal stand out as the top producing states of carrots in India [12]. Karnataka ranks 8th in total area and production with 4,833 hectares and 92,914 tonnes respectively [13]. In Karnataka carrot is majorly grown in Belagavi, Gadag, Dharwad, Bengaluru, Bagalkot and other districts [14].

Most serious insect pests which attack carrot are carrot weevil, *Listronotus oregonensis* LeConte; carrot rust fly, *Psila rosae* Fabricius; carrot psyllid, *Trioza apicalis* Forster; aster leaf hopper, *Macrosteles quadrilineatus* Forbes; willow carrot aphid, *Cavariella aegopodii* Scopoli; cutworm, *Agrotis segetum* Denis; and pale striped flea beetle, *Systema blanda* Melsheimer [15]. aphid, *Myzus persicae* Sulzer from United States of

America [16]. Carrot aphid, *Semiaphis heracleid* Takahashi; semilooper, *Thysanoplusia orichalcea* Fabricius and thrips, *Aeolothrips meridionalis* Bagnall from Jammu and Kashmir, India [17]. Wireworm, noctuidae caterpillars, common cockchafer larvae, *Melolontha melolontha* Fabricius and oldworld swallowtail caterpillar, *Papilio machaon* Linnaeus [18] [19-21]. According to Szwejdka and Wrzodak [22], carrot aphid, *Semiaphis dauci* Fabr; hawthorn-carrot aphid, *Dysaphis crataegi* Kalt and root aphid, *Pemphigus phenax* Born.

The pest surveillance studies, indicated that the major economic loss of carrot in main growing areas of Karnataka was due to infestation by agromyzid fly and sucking pests. The agromyzid fly maggot caused severe damage to the taproot, resulting in the production of inferior grade carrots which lowers marketable prices. To address this issue, a study was done to assess the current pest status of the agromyzid fly and sucking pests in major carrot-growing districts of Karnataka.

2. MATERIALS AND METHODS

A series of roving surveys were conducted during rabi/summer 2021-22 in major carrot growing districts of Karnataka covering Bailhongal, Belagavi and Gokak taluka of Belagavi district, Ron taluka of Gadag district and Dharwad taluka of Dharwad district to record the incidence of insect pests and their natural enemies in carrot at the pre-rooting stage and rooting stage (Fig. 1). From each taluka, three villages were selected and from each village, three fields were surveyed as mentioned in Table 1. Observations were made from the three randomly selected spots in each field and from each spot, five plants were observed for incidence by looking at the symptoms inflicted by the different insect pests. Carrots were uprooted following a zig-zag pattern of sampling, washing them thoroughly and examining them for damage symptoms and the different life stages of the pest. Pest incidence

was calculated based on the symptoms observed and expressed as a percentage of damage. Data collected were pooled and % damage, mean number of agromyzid fly, sucking pests three leaves⁻¹ and mean number of natural enemies' plant⁻¹ were calculated Fig. 2; Fig. 3).

Observation on % damage by agromyzid fly was recorded adopting destructive sampling method.

$$\% \text{ damage} = \frac{\text{Number of infested plants}}{\text{Total number of plants}} \times 100$$



Fig. 1. Farmers field visited during roving survey in different districts of Karnataka



Fig. 2a. Agromyzid fly, *Melanagromyza* sp. Fig 2b: Leaf hopper, *Blaclutha* sp. Fig 2c: Plant hopper, *Sogatella* sp.



Fig. 3. Damage symptoms of Agromyzid fly, *Melanagromyza* sp.

Table 1. Locations of roving survey conducted during rabi/summer 2021-22

District	Taluka	Villages
Belagavi	Bailhongal	Deshanur, Nesargi and Giriyal
	Gokak	Tukkanatti, Badigwad and Akkatangerhal
	Belagavi	Kakati, Kondaskoppa and Kolikopp
Gadag	Ron	Nagaral, Abbigeri and Yarebeleri
Dharwad	Dharwad	Garag, Lokur and Narendra

3. RESULTS AND DISCUSSION

3.1 Agromyzid Fly

Among the three districts surveyed, the highest mean % infestation of agromyzid fly during the pre-rooting stage of the crop was recorded in Gadag district (22.40 %) followed by Dharwad district (19.63 %) and Belagavi district (15.12 %). The lowest mean % infestation (13.21 %) was observed in Giriyal village of Bailhongal taluka in Belagavi district, while the highest mean % infestation (24.74 %) was recorded in Nagaral village of Ron taluka of Gadag district. During rooting stage, the highest mean % infestation of agromyzid fly was recorded in Gadag (50.56 %) followed by Belagavi (48.09 %) and Dharwad district (46.56 %). The lowest % infestation (42.52 %) was continued to record in Giriyal village of Bailhongal taluka in Belagavi district. The highest mean % infestation (53.43 %) was documented in Akkatangerhal village of Gokak taluka in Belagavi district.

3.2 Defoliators

Among three districts surveyed, the highest mean % defoliation during pre-rooting stage of the crop was recorded in Gadag district (4.25%) followed by Belagavi district (3.64%) and Dharwad district (3.06 %). The lowest mean % defoliation (2.78%) was observed in Garag village of Dharwad taluka in Dharwad district. While the highest mean % defoliation (5.74%) was recorded in Nagaral village of Ron taluka of Gadag district. During rooting stage, the highest mean % defoliation was recorded in Gadag district (3.16%) followed by Belagavi district (2.52%) and Dharwad district (2.40%). The lowest mean % defoliation (1.34%) was observed in Garag village of Dharwad taluka in Dharwad district. While the mean highest % defoliation (3.74 % leaves) was recorded in Nagaral village of Ron taluka of Gadag district.

3.3 Aphids

The highest mean number of aphids three leaves⁻¹ during pre-rooting stage of the crop was

recorded in Gadag district (11.26 aphids three leaves⁻¹) followed by Belagavi district (10.10 aphids three leaves⁻¹) and Dharwad district (8.70 aphids three leaves⁻¹). The lowest mean number of aphids three leaves⁻¹ (8.05 aphids three leaves⁻¹) were observed in Garag village of Dharwad taluka in Dharwad district. While the highest mean number of aphids three leaves⁻¹ (13.62 aphids three leaves⁻¹) were recorded in Nagaral village of Ron taluka of Gadag district. At rooting stage, mean number of aphids three leaves⁻¹ was recorded in Gadag district (10.00 aphids three leaves⁻¹) followed by Belagavi district (9.43 aphids three leaves⁻¹) and Dharwad district (7.90 aphids three leaves⁻¹). The lowest mean number of aphids three leaves⁻¹ (7.23 aphids three leaves⁻¹) was observed in Giriyal village of Bailhongal taluka in Belagavi district. While the highest mean number of aphids three leaves⁻¹ (11.62 aphids three leaves⁻¹) was recorded in Nagaral village of Ron taluka of Gadag district.

3.4 Leaf Hoppers

The highest mean number of leaf hoppers per three leaves during pre-rooting stage of the crop was registered in Gadag district (9.41 leaf hoppers three leaves⁻¹) followed by Belagavi district (8.02 leaf hoppers three leaves⁻¹) and Dharwad district (7.78 leaf hoppers three leaves⁻¹). The lowest mean number of leaf hoppers three leaves⁻¹ (6.12 leaf hoppers three leaves⁻¹) was observed in Giriyal village of Bailhongal taluka in Belagavi district. While the highest mean number of leaf hoppers three leaves⁻¹ (10.58 leaf hoppers three leaves⁻¹) was recorded in Nagaral village of Ron taluka of Gadag district. The highest mean number of leaf hoppers three leaves⁻¹ was recorded in Gadag district (9.34 leaf hoppers three leaves⁻¹) followed by Belagavi district (7.88 leaf hoppers three leaves⁻¹) and Dharwad district (7.03 leaf hoppers three leaves⁻¹) during rooting stage. The lowest mean number of leaf hoppers three leaves⁻¹ (6.12 leaf hoppers three leaves⁻¹) was observed in Giriyal village of Bailhongal taluka in Belagavi district. While the highest mean number of leaf hoppers three

leaves⁻¹ (10.58 leaf hoppers three leaves⁻¹) was recorded in Nagara village of Ron taluka of Gadag district [23,24].

3.5 Plant Hoppers

The population of plant hoppers recorded in Ron taluka in Gadag district at pre-rooting stage, was ranged from 7.96 to 9.78 plant hoppers three leaves⁻¹ in all villages with district mean of 8.76 plant hoppers three leaves⁻¹. The highest population of plant hoppers was documented in Nagara village with 9.78 plant hoppers three leaves⁻¹ and the lowest population was recorded in Yarebeleri village with 7.96 plant hoppers three leaves⁻¹. Further, at rooting stage, the population of plant hoppers recorded in all the villages of Ron taluk in Gadag district ranged from 6.23 plant hoppers three leaves⁻¹ (Yarebeleri) to 9.54 plant hoppers three leaves⁻¹ (Nagara) with district mean of 7.88 plant hoppers three leaves⁻¹. At pre-rooting stage, the population of plant hoppers recorded in all the villages of Dharwad taluk was ranged from 5.55 plant hoppers three leaves⁻¹ (Garag) to 4.37 plant hoppers three leaves⁻¹ (Lokur) with mean population of 4.93 plant hoppers three leaves⁻¹. During rooting stage, Lokur village recorded the

highest population (5.14 plant hoppers three leaves⁻¹) and lowest population was observed in Narendra village (4.08 plant hoppers three leaves⁻¹) with mean population of 4.49 plant hoppers three leaves⁻¹ (Table 2) [25].

3.6 Natural Enemies

The highest mean number of coccinellids plant⁻¹ was recorded in Gadag district (0.48 grubs and adults plant⁻¹) followed by Dharwad district (0.33 grubs and adults plant⁻¹) and Belagavi district (0.30 grubs and adults plant⁻¹) and the highest mean number of chrysopids plant⁻¹ was recorded in Gadag district (0.35 grubs plant⁻¹) followed by Dharwad district (0.24 grubs plant⁻¹) and Belagavi district (0.23 grubs plant⁻¹) during pre-rooting stage. Further, the highest mean number of coccinellids was recorded in Gadag district (0.40 48 grubs and adults plant⁻¹) followed by Belagavi district (0.27 48 grubs and adults plant⁻¹) and Dharwad district (0.26 48 grubs and adults plant⁻¹) and the highest mean number of chrysopids was recorded in Gadag district (0.25 grubs plant⁻¹) followed by Belagavi district (0.22 grubs plant⁻¹) and Dharwad district (0.19 grubs plant⁻¹) during rooting stage [26].

Table 2. Status of agromyzid fly and defoliators of carrot in different districts of Karnataka during rabi/summer 2021-22

District	Taluka	Village	% damage			
			Agromyzid fly		Defoliators	
			Pre-rooting stage	Rooting stage	Pre-rooting stage	Rooting stage
Belagavi	Bailhongal	Deshanur	17.05	48.89	3.64	2.64
		Nesargi	13.45	46.03	3.45	2.34
		Giriyal	13.21	42.52	2.98	1.76
		Mean	14.57	45.81	3.35	2.25
	Gokak	Tukkanatti	15.23	47.34	3.14	2.14
		Badigwad	15.67	48.15	3.52	2.53
		Akkatangerhal	16.89	53.43	4.78	3.18
		Mean	15.93	49.64	3.81	2.62
	Belagavi	Kakati	15.37	50.93	3.95	3.02
		Kondas koppa	14.81	48.12	3.92	2.65
		Kolikopp	14.43	47.45	3.43	2.43
		Mean	14.87	48.83	3.76	2.70
		Mean (district)	15.12	48.09	3.64	2.52
Gadag	Ron	Nagara	24.74	52.38	5.74	3.74
		Abbigeri	21.89	50.69	3.62	3.13
		Yarebeleri	20.56	48.63	3.41	2.62
		Mean	22.40	50.56	4.25	3.16
Dharwad	Dharwad	Lokur	24.37	48.06	3.43	3.43
		Narendra	17.57	46.34	2.98	2.43
		Garag	16.94	45.29	2.78	1.34
		Mean	19.63	46.56	3.06	2.40

Table 3. Status of sucking insect pest of carrot and their natural enemies in different districts of Karnataka during rabi/summer 2021-22

District	Taluka	Villages	Mean number three leaves ⁻¹						Mean number plant ⁻¹			
			Aphids		Leaf hoppers		Plant hoppers		Coccinellid (Grubs/adults)		Green lacewings (Grubs)	
			Pre-rooting stage	Rooting stage	Pre-rooting stage	Rooting stage	Pre-rooting stage	Rooting stage	Pre-rooting stage	Rooting stage	Pre-rooting stage	Rooting stage
Belagavi	Bailhongal	Deshanur	10.67	9.67	8.76	8.76	5.67	6.22	0.13	0.32	0.19	0.24
		Nesargi	9.18	9.08	7.94	6.54	4.89	5.44	0.21	0.21	0.18	0.21
		Giriyal	8.98	7.23	6.12	6.12	4.21	4.98	0.34	0.13	0.14	0.19
		Mean	9.61	8.86	7.6	7.14	4.92	5.55	0.23	0.22	0.17	0.21
	Gokak	Tukkanatti	9.74	9.74	7.81	7.89	7.42	5.22	0.47	0.29	0.37	0.12
		Badigwad	10.96	9.96	8.32	8.32	8.89	5.98	0.29	0.31	0.26	0.26
		Akkatangerhal	12.21	10.21	9.84	9.84	9.13	6.65	0.3	0.47	0.21	0.37
		Mean	10.97	9.97	8.66	8.68	8.48	5.95	0.35	0.36	0.28	0.25
	Belagavi	Kakati	11.85	10.85	8.69	8.69	6.23	6.21	0.43	0.43	0.24	0.23
		Kondas koppa	9.71	9.31	7.50	7.52	4.98	5.87	0.18	0.18	0.14	0.23
		Kolikopp	8.26	8.26	7.21	7.21	4.64	5.12	0.34	0.13	0.27	0.21
		Mean	9.74	9.47	7.80	7.81	5.28	5.73	0.32	0.25	0.23	0.22
		Mean (district)	10.10	9.43	8.02	7.88	6.22	5.74	0.30	0.27	0.23	0.22
	Gadag	Ron	Nagaral	13.62	11.62	10.58	10.58	9.78	9.54	0.57	0.57	0.45
Abbigeri			10.84	9.32	9.85	9.65	8.55	7.86	0.49	0.39	0.36	0.26
Yarebeleri			9.34	9.06	7.80	7.80	7.96	6.23	0.39	0.24	0.23	0.16
Mean			11.26	10	9.41	9.34	8.76	7.88	0.48	0.40	0.35	0.25
Dharwad	Dharwad	Lokur	9.72	8.58	8.74	7.79	5.55	5.14	0.17	0.39	0.33	0.23
		Narendra	8.34	8.05	7.43	6.74	4.89	4.08	0.39	0.23	0.26	0.21
		Garag	8.05	7.96	7.17	6.56	4.37	4.27	0.43	0.17	0.12	0.14
		Mean	8.70	7.90	7.78	7.03	4.93	4.49	0.33	0.26	0.24	0.19

Carrot was cultivated throughout the year and the date of cultivation plays a crucial role in recording the peak incidence of insect pests. Further, monocropping without adequate crop rotation might have attributed to the highest incidence of insect pest of carrot. Very limited studies have been conducted on the incidence of insect pests of carrot i.e., the information regarding insect pest of carrot is scant. However, available literatures indicated that carrot crop was attacked by aster leafhopper, flea beetle, aphid, carrot weevil, carrot rust fly and cut worm, which limit the production of carrot [15]. Raghunandan and Manjunatha [23] reported the feeding damage and symptoms caused on carrot by the carrot fly *Melanagromyza* sp. for the first time on carrot from India. The adult fly activity was commenced at 25-27 days after sowing (DAS) and peak activity recorded during 34 to 40 DAS. Damage commenced from 41 to 60 days old and prevailed till 70 to 90 days old crop and caused an economic loss of rupees 18.30/kg of good quality carrots. Carrot and related Apiaceous crops such as parsnip, celeriac and celery were infested by a relatively small number of damaging insect species that can reduce both quality and yield and the carrot was infested by aphids, cutworms and carrot fly [24]. Carrot is infested with aster leafhopper, flea beetle, willow carrot aphid, green peach aphid, carrot weevil, carrot rust fly and cutworm [25], these reports support present investigation [30-32].

4. CONCLUSION

Gadag had the highest % damage of the agromyzid fly during the pre-rooting and rooting stages might be due to year-round cultivation of carrot. Further, monocropping without adequate crop rotation might have attributed to the highest incidence of insect pest of carrot. Sucking insect pest are of minor importance as compared to agromyzid fly, as it causes damage to edible taproot which is of economical importance in carrot cultivation.

5. FURTHER RESEARCH

Study the population dynamics of insect pests and their natural enemies during kharif, rabi and summer seasons to establish pest status and development of IPM modules for the management of agromyzid fly, *Melanagromyza* sp. in carrot.

DISCLAIMER (ARTIFICIAL INTELLIGENCE)

Author(s) hereby declares that NO generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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