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SURVEY ON MAJOR INSECT PESTS OF GINGER AND SURVEY-BASED STUDY ON FARMERS KNOWLEDGE AND PATTERN OF USING INSECTICIDE ON GINGER CROP IN SHIVAMOGGA DISTRICT OF KARNATAKA INDIA

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ABSTRACT

Ginger (*Zingiber officinale* Rosc.), an herbaceous perennial belonging to the family Zingiberaceae, possesses distichous leaves with overlapping basal sheaths that form a pseudostem. Ginger widely used as a spice and valued for their medicinal properties. A roving survey was carried out in major ginger-growing regions of Shivamogga district, Karnataka, encompassing 10 villages across five taluks namely, Shivamogga, Shikaripura, Sagara, Hosanagara, Soraba to document the incidence of major insect pests and evaluate farmers' knowledge and practices related to insecticide usage. The study documented total seven insect pest species infesting ginger, including shoot borer (*Conogethes punctiferalis*), rhizome fly (*Mimegralla coeruleifrons*), leaf roller (*Udaspes* sp.), thrips (*Panchaetothrips* sp.), leaf beetles and weevils (*Altica cyanea*, *Monolepta signata*, *Myllocerus* sp.) and leaf-eating caterpillars (*Spilarctia obliqua*, *Spodoptera litura*). The shoot borer, *C. punctiferalis*, was identified as the predominant and most destructive pest, with the highest mean incidence (5.70 ± 0.16 %) recorded in Taralaghatta (Shikaripura taluk). The survey revealed extensive use of insecticides (21 products), predominantly chlorpyrifos 20 EC, lambda-cyhalothrin 5 EC and emamectin benzoate 1.9 EC, with limited adoption of biopesticides such as azadirachtin (36 %). A majority of farmers relied on pesticide dealers for information (66 %), exhibited poor adherence to safety measures (80 %) and followed routine blanket spraying (80 %) with low awareness of Integrated Pest Management (34 %) and improper disposal of pesticide containers, highlighting the need for sustainable pest management education.
Keywords: *Conogethes punctiferalis*, ginger, insect pests, insecticide use, Shivamogga.

Introduction

Ginger (*Z. officinale*) which belongs to the family Zingiberaceae, is an herbaceous perennial attributed with distichous leaves with basal sheaths that overlap to form a pseudostem. It is an important cash crop grown for its underground rhizome which is used as a spice and for its medicinal value. Ginger grows well in warm and humid climate and is cultivated from sea level to an altitude of 1500 m above sea level. The crop can be grown both under rainfed and irrigated conditions, but thrives best in well drained soils like sandy loam, clay loam, red loam or lateritic loam. A friable loam with a pH of 6.0 to 6.5 rich in humus is ideal. The crop performs well in a temperature range of 19-28°C and a humidity of 70-90 per cent (Jayashree *et al.*, 2015). India is a leading producer of ginger in the world, with an average yield of 10.72 tonnes per ha with an area of 1, 75, 764 ha and production of about 1,780,000 MT. In Karnataka, during 2023–24, ginger

was cultivated in an area of 21.34 thousand ha, with a production of 232.84 thousand MT and a productivity of 10.91 MT per ha (Indiastat, 2023-24).

Survey reports across India have reported pests such as the rhizome fly (*Mimegralla coeruleifrons* Macquart,1843), shoot borer (*C. punctiferalis* Guenee,1854), leaf roller (*Udaspes folus* Cramer, 1775), thrips (*Panchaetothrips indicus* Bagnall,1912), lacewing bug (*Stephanitis typicus* Distant, 1909) and scale insects (*Aspidiotus curcumae, Aspidiella hartii*), in addition to minor pests like leaf beetles, caterpillars (Koya, 1998; Kotikal and Kulkarni, 2000). Among them, shoot borer, *C. punctiferalis* Guenee (Lepidoptera: Crambidae) is the most serious constraint (Devasahayam and Koya, 2004). It is widely distributed throughout the Asia and Australia continent and mainly occurs in tropical and subtropical countries (Pena *et al.*, 2002). *Conogethes sahyadriensis*, commonly known as the ginger shoot borer, is a major pest responsible for significant damage to ginger crops. Studies have reported that, overall yield losses reaching up to 25 per cent (Devasahayam,2000).

Farmers primarily rely on chemical insecticides to manage these pests, with frequent use of compounds such as chlorpyrifos, lambda-cyhalothrin and emamectin benzoate. However, surveys across India and in ginger-growing regions of Karnataka have indicated that farmers often follow routine blanket spraying schedules with limited awareness of safe handling practices, environmental implications or integration with alternative pest management strategies. Improper disposal of pesticide containers and reliance on dealers for guidance further exacerbate the risks associated with pesticide use. These practices underscore the need for a comprehensive understanding of farmers knowledge, attitudes and practices regarding pest management, alongside documentation of pest incidence and distribution in ginger ecosystems. Therefore, a detailed survey assessing the occurrence of major insect pests and evaluating farmers insecticide use patterns is essential for developing sustainable and environmentally sound pest management strategies in ginger cultivation.

Materials and Methods

Study area and survey design

A roving survey was conducted in major ginger-growing villages of Shivamogga district, Karnataka, covering ten villages across five taluks of Shivamogga district. Beeranakere and Ayanuru (Shivamogga), Taralagatta and Saluru (Shikaripura), Baluru and Arasalu (Hosanagara), Kolgunisi and Anavatti (Soraba) and Iruvakki and Hosakoppa (Sagara). Observations were made during three crop growth stages, early vegetative phase (45–60 days after planting), grand growth stage (100-120 days) and maturity (210–230 days). Incidence of different insect pests were recorded using suitable recommended techniques for the observed pests respectively, to quantify the infestation (Kotikal and Kulkarni, 2000) (Table 1) (Fig. 1).

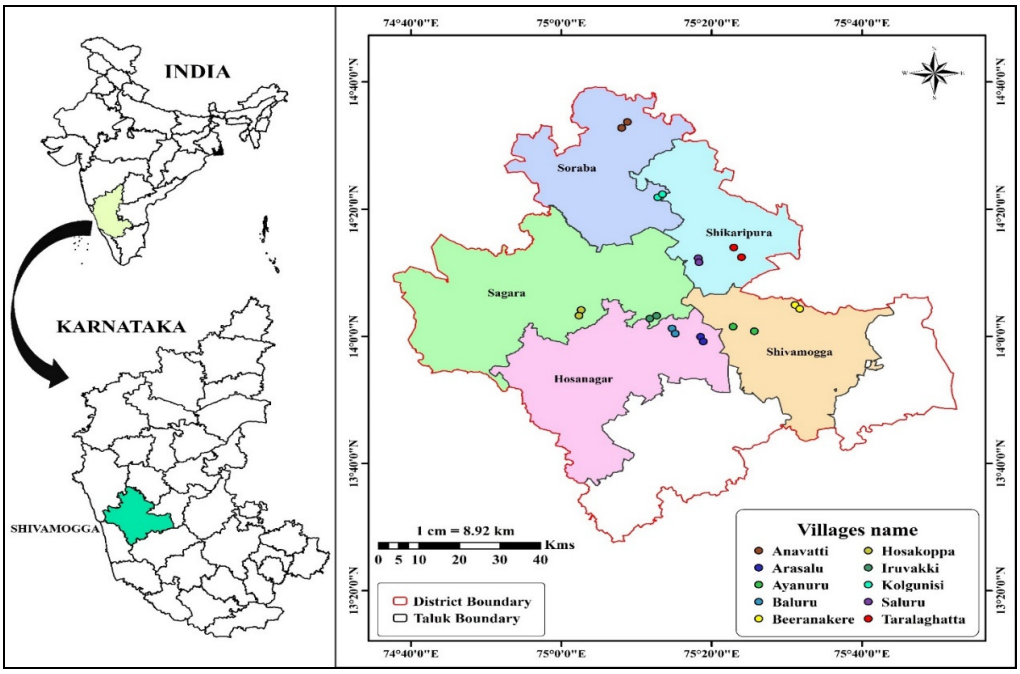

Fig. 1 : Location survey map of Shivamogga district, Karnataka

Table 1: Survey on incidence of insect pests of ginger in Shivamogga district, Karnataka

Taluks	**2 villages** from each taluk	**Varieties**	**Shoot borer** (Plants showing row of hole or dead heart /m^2)	**Rhizome fly** (No. of flies /m^2)	**Leaf roller** (No. of leaf rolls/ plant)	**Thrips** (No. of thrips /top 3 leaves)	**Leaf beetles and weevils** (No. of adults/ plant)	**Leaf eating caterpillars** (No. of live larvae/ plant)
Shivamogga, Shikaripura, Sagara, Hosanagara, Soraba	I	(Himachal, Rio De Janeiro)	5 spots	5 spots	10 plants	10 plants	10 plants	10 plants
	II	(Himachal, Rio De Janeiro)	5 spots	5 spots	10 plants	10 plants	10 plants	10 plants

(Kotikal and Kulkarni, 2000)

Survey on insect pests of ginger

Incidence of insect pests recorded using standard techniques

Shoot borer (*C. punctiferalis*): Plants showing row of holes or "dead hearts" were counted in five randomly selected one m² plots per site; Rhizome fly (*Mimegralla coeruleifrons*): Adults were counted on plants in five one m² plots per site; Leaf roller (*Udaspes* sp.): Leaf rolls per plant were counted on ten randomly selected plants in each ten gunta plot ; Thrips (*Panchaetothrips* sp.): Nymphs and adults were counted from the top three leaves of ten randomly selected plants in each ten gunta plot ; Leaf beetles and weevils (*Altica cyanea, Monolepta signata, Myllocerus* sp.): Adult beetles and weevils were counted from ten randomly selected plants in each ten gunta plot ; Leaf-eating caterpillars (*Spilarctia obliqua, Spodoptera litura*): Live larvae were counted from ten randomly selected plants in each ten gunta plot (Kotikal and Kulkarni, 2000).

Farmers' knowledge and pesticide usage survey

A roving survey was conducted to record the information on various aspects of pesticides usage like knowledge of farmers about pest management, sources of information and safety measures followed during pesticide application. The study was performed across the ten villages of Shivamogga *viz.*, Beeranakere and Ayanuru (Shivamogga taluk), Taralagatta and Saluru (Shikaripura taluk), Baluru and Arasalu (Hosanagara taluk), Kolgunisi and Anavatti (Soraba taluk) and Iruvakki and Hosakoppa (Sagara taluk), 50 farmers (five farmers from each village) were randomly selected for the survey through a questionnaire in each village. The questionnaire included, trade name or common name of the insecticide and active ingredients (a.i.), dosage, time and frequency of spraying in a growing season, type of sprayer used, spraying intervals, safety precautions adopted (Table 2).

Table 2: Questionnaire used during insecticides usage pattern survey against insect pests of ginger.

Sl.No	**Particulars**
1	Farmer name:
2	Insects observed:
3	Insecticides used (Trade name/common name and dosage):
4	Active ingredients:
5	No. of sprays/crop season:
6	Type of sprayer used: Hand / Power
7	Source of information on usage of insecticides: Dealers / Fellow farmers / Govt. officials / Company persons
8	Attention towards label information: Yes / No
9	Measurement of insecticide: Bottle cap / Approximate
10	Safety measures taken at the time of spray: No measures / Hand gloves only / Mask alone
11	Dosage: Recommended / Higher dose
12	Disposal of pesticide container: Buried in soil / Thrown in neglected area / Left in the field
13	Time of application: Morning / Noon / Evening
14	Pesticide used: Sole / Tank mix
15	Decision of spraying: Blanket spraying / Initial symptom / Looking into ETL
16	Control methods followed: Insecticides alone / Cultural control / IPM
17	Have knowledge about the pests: Yes / No
18	Have known about insecticide hazards: Yes / No
19	Have heard about IPM: Yes / No

Statistical analysis

The recorded observations on insect pest incidence and individual farmer responses were averaged and expressed as the pooled mean.

Results and Discussion

Survey on major insect pests of ginger in Shivamogga district

Ginger shoot borer, *Conogethes punctiferalis*

Taralaghatta village of Shikaripura taluk, recorded the highest average shoot borer (%) incidence of 9.28 ± 0.12 per cent during grand growth stage and lowest (0.66 ± 0.31 %) was during maturity stage. In contrast, the lowest incidence was reported from Arasalu village of Hosanagara taluk, at 3.19 ± 0.14 per cent (Table 3) (Fig. 2). The current findings aligns with the observations of Kotikal and Kulkarni (2000), who recorded a peak per cent incidence of 9.33 ± 3.50 and 9.33 ± 2.50 during grand growth stage in turmeric in Hukkeri of Belgaum district and Mudhol of Bijapur district of Karnataka, respectively. A minimum incidence of 0.67 ± 0.17 per cent was also observed in Aland, Gulbarga district, during the maturity stage of the crop. Variation in pest incidence of current research is likely influenced by geographical, agronomic and ecological factors.

Fig. 2 : Damage symptoms of shoot borer (*Conogethes punctiferalis*) in ginger field

Leaf folder, *Udaspes* sp.

A peak mean incidence of leaf roller (0.50 ± 0.31) was documented in Taralaghatta village of Shikaripura taluk. On the other hand, the lowest incidence (0.18 ± 0.14) was noted in Iruvakki village of Sagara taluk (Table 4). The present findings on leaf roller incidence are aligned with the results of Chandramani *et al.* (2015), who documented a maximum incidence of 0.64 and a minimum of 0.03, respectively.

Table 3: Incidence of shoot borer (*Conogethes punctiferalis*) on ginger in different taluks of Shivamogga district

Location	Variety	Per cent shoot borer infestation/m$^{2\#}$			
		Vegetative stage (Jun-Aug) Mean±SD	Grand growth stage (Sept-Nov) Mean±SD	Maturity stage (Dec-Feb) Mean±SD	Total Mean±SD
Shivamogga					
Beeranakere	Himachal	5.51± 0.12^{b}	7.35±0.21^{a}	1.06±0.30^{c}	4.64±0.07
Ayanuru	Rio-de-Janeiro	5.55±2.02^{a}	6.10±0.55^{a}	1.71±0.62^{b}	4.45±1.06
Shikaripura					
Taralaghatta	Rio-de-Janeiro	6.47±0.38^{b}	9.28±0.12^{a}	1.36±0.02^{c}	5.70±0.16
Saluru	Himachal	5.80±0.06^{b}	7.83±0.61^{a}	1.15±0.32^{c}	4.92±0.33
Sagara					
Iruvakki	Himachal	6.14±0.12^{b}	8.19±0.17^{a}	1.11±0.33^{c}	5.14±0.09
Hosakoppa	Rio-de-Janeiro	6.17±0.68^{b}	8.00±0.62^{a}	1.13±0.33^{c}	5.10±0.09
Hosanagara					
Baluru	Himachal	4.91±0.28^{b}	6.04±0.26^{a}	0.67±0.33^{c}	3.87±0.07
Arasalu	Himachal	3.83±0.28^{b}	5.10±0.40^{a}	0.66±0.31^{c}	3.19±0.14
Soraba					
Kolgunisi	Himachal	5.60±0.28^{b}	7.35±0.30^{a}	0.84±0.02^{c}	4.43±0.21
Anavatti	Himachal	5.55±0.59^{b}	6.78±0.21^{a}	0.87±0.02^{c}	4.40±0.25

$^{\#}$ Average of 10 observations per village

Note: Mean ± SD in a row with different alphabets are statistically significant (Tukey's test $p \leq 0.05$)

Table 4: Incidence of thrips (*Panchaetothrips* sp.) and leaf roller (*Udaspus* sp.) on ginger in different taluks of Shivamogga district

Location	Variety	No. of thrips per top 3 leaves (per plant)[#]		No. of leaf rolls / plant[#]	
Shivamogga (Taluka)		**Range**	**Mean±SD**	**Range**	**Mean±SD**
Beeranakere	Himachal	0.70–1.60	1.21±0.37	0.00–0.60	0.28±0.26
Ayanuru	Rio-de-Janeiro	0.40–1.80	0.96±0.60	0.10–0.60	0.30±0.18
Shikaripura					
Taralaghatta	Rio-de-Janeiro	0.50–1.70	1.20±0.45	0.10–1.00	0.50±0.31
Saluru	Himachal	0.50–1.80	1.08±0.62	0.20–0.70	0.45±0.20
Sagara					
Iruvakki	Himachal	0.10–0.90	0.46±0.30	0.00–0.40	0.18±0.14
Hosakoppa	Rio-de-Janeiro	0.20–0.90	0.60±0.30	0.10–0.30	0.21±0.07
Hosanagara					
Baluru	Himachal	0.20–1.60	0.91±0.63	0.10–0.40	0.25±0.12
Arasalu	Himachal	0.30–1.70	0.91±0.54	0.00–0.30	0.20±0.12
Soraba					
Kolgunisi	Himachal	0.40–1.50	1.06±0.52	0.20–0.80	0.43±0.27
Anavatti	Himachal	0.40–1.80	1.00±0.61	0.10–0.60	0.38±0.20

[#] Average of 60 plants per village

Thrips*, Panchaetothrips* sp.

The highest average thrips population (1.21 ± 0.37), was recorded in Beeranakere village of Shivamogga taluk, where lowest average population (0.46 ± 0.30) observed in Iruvakki village of Sagara taluk (Table 4). The average thrips population recorded in this study are consistent with the observations of Kotikal and Kulkarni (2000), who reported a highest incidence of 1.59 ± 0.65 in Aland and a lowest of 0.19 ± 0.21 in Gokak of Belagavi district.

Rhizome fly*, Mimegralla coeruleifrons*

Hosakoppa village of Sagara taluk, recorded the highest average rhizome fly population (2.93 ± 2.10). In contrast, the lowest average population was found in Ayanuru village of Shivamogga taluk, with a mean of 1.96 ± 1.11(Table 5). The results of the current study are found contradictory to the findings of Kotikal and Kulkarni (2000), who reported a maximum mean population of 0.46 ± 0.19 in Athani, Chincholi and Basavakalyan and a minimum of 0.07 ± 0.04. Differences in mean adult population may be influenced by location, climate.

Table 5: Incidence of rhizome fly (*Mimegralla coeruleifrons*) on ginger in different taluks of Shivamogga district

Location	Variety	No. of rhizome fly (adults / m^2) [#]	
Shivamogga (Taluka)		**Range**	**Mean ± SD**
Beeranakere	Himachal	0.40–3.40	2.10±1.17
Ayanuru	Rio-de-Janeiro	0.40–3.00	1.96±1.11
Shikaripura			
Taralaghatta	Rio-de-Janeiro	0.20–5.00	2.56±2.01
Saluru	Himachal	0.20–4.20	2.30±1.76
Sagara			
Iruvakki	Himachal	0.20–5.40	2.90±2.08
Hosakoppa	Rio-de-Janeiro	0.40–5.20	2.93±2.10
Hosanagara			
Baluru	Himachal	0.20–3.90	2.05±1.49
Arasalu	Himachal	0.40–3.80	2.13±1.39
Soraba			
Kolgunisi	Himachal	0.40–3.60	2.00±1.28
Anavatti	Himachal	0.20–4.40	2.03±1.58

[#]Average of 30 observations per village

Leaf beetles *(Altica cyanea, Monolepta signata)*

The highest average leaf beetle population (1.21 ± 0.34), was recorded in Beeranakere village (Shivamogga taluk) and Anavatti village (Soraba taluk). Conversely, the lowest average population was observed in Hosakoppa village (Sagara taluk), with a

mean of 0.80 ± 0.46 (Table 6). The findings of current study on leaf beetle incidence are in agreement with the observations of Kotikal and Kulkarni (2000), who reported a incidence of 1.20 ± 0.23 in Aland of Gulbarga district and 0.80 ± 0.l5 in Hukkeri of Belagum district. The minor discrepancies in infestation levels might be due to differences in environmental conditions and agricultural practices. Factors such as temperature, humidity and pest management techniques could have influenced the variation observed.

Weevils (*Myllocerus* sp.)

The highest average population of weevils, recorded at 0.38 ± 0.14, in Baluru village of Hosanagara taluk. Conversely, the minimum average population (0.20 ± 0.10) was noted in Beeranakere village of Shivamogga taluk (Table 6).

Leaf eating caterpillars, (*S. obliqua, S. litura*)

The highest average population of leaf-eating caterpillars was recorded in Iruvakki village of Sagara taluk, with a mean of 0.43 ± 0.34. The lowest average population (0.10 ± 0.06) was found in Anavatti village of Soraba taluk (Table 6). Incidence of caterpillars documented in this study are consistent with the findings of Kotikal and Kulkarni (2000), who reported an incidence of 0.44 ± 0.12 in Humanabad (Bidar district) and 0.10 ± 0.05 in Gokak (Belgaum district). The slight variation in caterpillar incidence may be due to similar agro-climatic conditions across the regions studied. Uniformity in ginger cultivation practices, such as planting time and crop stage, could have minimized population differences. Additionally, the availability of suitable host foliage during the observation period may have supported consistent pest presence.

Survey-based study on farmers' knowledge and pattern of using insecticide on ginger crop in Shivamogga district

Different insecticides used by farmers against insect pests of ginger

Survey results showed that insecticide usage for controlling *Conogethes punctiferalis* among farmers in Shivamogga district varied between 28 and 78 per cent. A total of twenty-one insecticidal formulations were recorded as being used by ginger farmers in Shivamogga district for pest management. Chlorpyrifos 20 EC (78 %) emerged as the most frequently applied insecticide, followed by lambda-cyhalothrin 5 EC (72 %), chlorantraniliprole 0.4 G (68 %), emamectin benzoate 1.9 EC (64 %) and chlorpyrifos + cypermethrin 50/5 EC (62 %). Combination products such as beta-cyfluthrin + imidacloprid and novaluron + emamectin benzoate were also commonly used, indicating farmers' preference for broad-spectrum formulations. The use of biopesticides such as azadirachtin (36 %) was relatively limited (Table 7). Application rates and product choices varied across villages, primarily influenced by pest pressure, crop growth stage, and perceived efficacy. Overall, the findings reflect a strong dependence on synthetic insecticides with minimal adoption of eco-friendly pest management alternatives. The current results are in contrast with those of Kariyanna *et al.* (2020), who reported the insecticide usage pattern in eggplant-growing regions of India, with emamectin benzoate 5 % EC being the most commonly used (12 %) across all locations, followed by chlorantraniliprole 18.5% SC (10 %).

Table 6: Incidence of different insect pests on ginger in Shivamogga district

Location	Variety	No. of Leaf beetles /plant[#] (*A. cyanea*, *M. signata*)		No. of Weevils / plant[#] (*Myllocerus* sp.)		No. of leaf eating caterpillars/ plant[#] (*S. obliqua*, *S. litura*)	
Shivamogga (Taluka)		**Range**	**Mean±SD**	**Range**	**Mean±SD**	**Range**	**Mean±SD**
Beeranakere	Rio-de-Janeiro	0.80–1.70	1.21±0.34	0.10–0.30	0.20±0.10	0.10–0.40	0.23±0.10
Ayanuru	Rio-de-Janeiro, Himachal	0.50–1.80	1.06±0.51	0.10–0.40	0.20±0.15	0.10–0.30	0.16±0.08
Shikaripura							
Taralaghatta	Rio-de-Janeiro	0.70–1.50	1.11±0.31	0.20–0.40	0.30±0.06	0.10–0.40	0.21±0.11
Saluru	Rio-de-Janeiro	0.40–1.60	0.96±0.45	0.10–0.40	0.25±0.10	0.10–0.40	0.25±0.13
Sagara							
Iruvakki	Himachal	0.20–1.30	0.88±0.46	0.20–0.50	0.28±0.11	0.10–1.00	0.43±0.34
Hosakoppa	Himachal	0.20–1.40	0.80±0.46	0.20–0.40	0.35±0.08	0.10–0.40	0.20±0.12
Hosanagara							
Baluru	Himachal	0.60–1.30	1.03±0.34	0.20–0.60	0.38±0.14	0.10–0.30	0.21±0.07
Arasalu	Himachal	0.50–1.60	0.93±0.39	0.10–0.50	0.31±0.16	0.10–0.70	0.33±0.24
Soraba							
Kolgunisi	Himachal	0.60–1.40	1.11±0.33	0.20–0.40	0.30±0.06	0.10–0.50	0.21±0.16
Anavatti	Himachal	0.40–1.60	1.21±0.34	0.20–0.40	0.35±0.08	0.00–0.20	0.10±0.06

[#] Average of 60 plants per village

Table 7: Commonly used insecticides by ginger growing farmers in different taluks of Shivamogga district

Common name	Trade name	Toxicity symbol	Dosage (per barrel) [#]	Percentage of farmers using[##]
Chlorpyrifos 20 EC	Lethal	Yellow	500 ml	78
Emamectin benzoate 1.9 EC	Sixer	Blue	80-100 ml	64
Chlorantraniliprole 18.5 SC	Coragen, Coranto	Green	60 ml	60
Lamda cyhalothrin 5 EC	Edge, Karate	Yellow	100-120 ml	72
Chlorantraniliprole 0.4 G	Ferterra	Green	4-5 kg/acre	68
Acephate 85 SG	Hunk	Yellow	250-400 g	40
Beta-cyfluthrin + Imidacloprid 300 OD	Solomon	Yellow	100-120 ml	50
Azadirachtin 10000 ppm	Agro Neem	Green	40-60 ml	36
Fipronil 0.3 G	Regent	Blue	5 kg/acre	44
Thiomethoxam 25 WG	Tagxone	Green	50-60 g	58
Flubendiamide 480 SC	Fame	Green	40-60 ml	42
Spiromesifen 240 SC	Oberon	Green	40-60 ml	38
Fipronil 80 WG	Jump	Blue	50-60 g	32
Ethion 50 EC	Elite	Red	200 ml	40
Emamectin benzoate 5 SG	Proclaim	Blue	50-60 g	48
Novaluron 5.25 % + Emamectin benzoate 0.9 % SC	Barazide	Red	100-120 ml	52
Quinalphos 25 EC	Ekalux	Red	200-250ml	54
Imidacloprid 17.8 SL	Confider	Green	40-60 ml	56
Chlorpyrifos 50 EC + Cypermethrin 5 EC	Koranda	Yellow	80-100 ml	62
Imidacloprid 70 WG	Ad Fyre	Green	30-40g	30
Monocrotophos 36 SL	Nuvacron	Red	200-250 ml	28

[#] 1 barrel = 200 litre of water, [##]= Average of 50 observations

Knowledge level of farmers on pesticide handling and safety measures taken against pests of ginger in different taluks of Shivamogga district

The study assessed the knowledge and practices of farmers regarding insecticide handling and safety measures in ginger cultivation across different taluks of Shivamogga district, including Shivamogga, Shikaripura, Sagara, Hosanagara and Soraba (Table 8).

Source of information on insecticide usage

Farmers predominantly rely on pesticide dealers for information, with 66 per cent of them seeking their advice. Fellow farmers and company personnel were also found as notable sources, consulted by 16 and 22 per cent of farmers, respectively. In contrast, government officials were the least consulted, with only 2 per cent of farmers using them as a resource (Table 8). The dependence on dealers was consistent across all surveyed taluks, with reliance rates ranging from 60 to 80 per cent. Studies by Mahantesh and Singh (2009), Jamali *et al.* (2014), Ranjith *et al.* (2020) supports the current findings. Rubesh *et al.* (2023) found that a majority of farmers (76.66 %) followed dealer recommendations, while a much smaller percentage contact the Department of Agriculture (13.33 %) or scientists (3 %). Similarly, Sachin and Suchithrakumari (2016) reported that roughly 29 per cent of farmers got information from private pesticide dealers, another 29 per cent make their own decisions and 32 per cent either decide on their own or consult with dealers. Just 12 per cent of farmers either take decisions independently or consult other farmers for guidance.

Attention towards label information

A notable 68 per cent of farmers reported paying attention to the information on insecticide labels. It was more common among farmers in Sagara and Soraba, where the percentages were 80 and 70 per cent respectively. In contrast, 60 per cent of farmers in Hosanagara and Shikaripura read the labels (Table 8). These findings are in contradictory with other research, conducted by Ranjith *et al.* (2020), which found that nearly 90.50 per cent of farmers failed to understand the information on pesticide labels. Similarly, Devi (2009) reported an even higher percentage, with 99.50 per cent of farmers unable to comprehend the toxicity levels based on the colour codes.

Measurement of insecticides and their dosage

Across all taluks, every farmer (100 %) uniformly used bottle caps to measure insecticides, with no other method of measurement being reported. Additionally, it was observed that each farmer (100 %) consistently followed the recommended insecticide dosage rather

than using approximate amounts (Table 8). The present findings are contrasted with Gangaraju *et al.* (2020), who reported that only 20 per cent of farmers used recommended insecticide rates, while the majority (76.62 %) applied dosages exceeding the recommended amounts, which is further supported by Rubesh *et al.* (2023), who found that 63.33 per cent of farmers used bottle caps for measurement and 30 per cent used approximate amounts. He also noted that 63.33 per cent of farmers believed that higher pesticide use, leads to higher yields.

Table 8: Knowledge level of farmers on insecticide handling and safety measures taken against pests of ginger in different taluks of Shivamogga district

Sl. No.	Particulars	Farmers respondents (%)[#]					
		Shivamogga	**Shikaripura**	**Sagara**	**Hosanagara**	**Soraba**	**Mean**
Source of information on insecticide usage							
1	Govt. officials	0	10	0	0	0	2
2	Pesticide dealers	60	60	70	60	80	66
3	Fellow farmers	30	10	10	20	10	16
4	Company persons	30	30	20	20	10	22
Attention towards label information							
1	Yes	70	60	80	60	70	68
2	No	30	40	20	40	30	32
Measurement of insecticides							
1	Bottle cap	100	100	100	100	100	100
2	Approximate	0	0	0	0	0	0
Dosage							
1	Recommended	100	100	100	100	100	100
2	Approximate	0	0	0	0	0	0
Safety measures taken at the time of spray							
1	No measures taken	80	70	80	90	80	80
2	Hand gloves only	0	0	0	0	0	0
3	Mask only	20	30	20	10	20	20
Time of application							
1	Morning	100	100	90	80	90	92
2	Evening	0	0	10	20	10	8
Decision of spraying							
1	Based on ETL	0	0	0	0	0	0
2	Blanket spraying	80	80	90	80	70	80
3	Observing initial symptoms	20	20	10	20	30	20
Insecticide used							
1	Sole	0	0	0	0	0	0
2	Tank mix	100	100	100	100	100	100
Disposal of insecticidal containers							
1	Leaving them in field	0	0	10	10	10	6
2	Throw in neglected area	20	20	10	10	10	14
3	Hand over to waste collectors	50	50	60	20	40	44
4	Burning them	30	30	20	60	40	36
Type of sprayer used							
1	Hand operated	0	0	10	10	0	4
2	Power operated	100	100	90	90	100	96
Control methods adopted							
1	IPM	0	0	0	0	0	0
2	Insecticide alone	70	100	100	100	100	94
3	Cultural control	30	0	0	0	0	6

[#] Average of 10 farmers in each taluk

Safety measures taken at the time of spray and time of application

During pesticide application, 80 per cent of farmers did not use any safety measures, with only 20 per cent wearing face masks. Shikaripura taluk had the highest rate of mask usage at 30 per cent (Table 8). These results are aligned with Devi (2009), who found that no applicators used the full range of suggested protective gear, such as face masks with filters, goggles and rubber gloves. Instead, 71 per cent of respondents adopted some form of body covering, often a full-sleeved shirt (21 % of cases) or a cloth tied around the nose (48 %). Only a small fraction (1 %) used eye protection. Studies in Sri Lanka (Sivayoganathan *et al.*, 1995) and Palestine (Yassin *et al*., 2002) reported similar lack of safety measures. In contrast, Amoako *et al*. (2012) reported a more positive trend, with a majority of farmers (67 %) adopting safety measures like protective clothing and respirators during spraying. In terms of the timing of pesticide application, most farmers (92 %) reported carrying out spraying operations during the morning hours, while only a small proportion (8 %) did so in the evening. Similar observations were made by Ranjith *et al.* (2020), who noted that approximately 90.50 per cent of farmers preferred morning spraying sessions.

Decision of spraying and insecticides used

Farmers primarily decided to spray pesticides based on blanket spraying (80 %) or by observing initial symptoms (20 %). Farmers notably didn't follow the scientific Economic Threshold Level (ETL) when making decisions, indicating a gap in the adoption of advanced pest management strategies. The practice of blanket spraying was most prevalent in the Sagara taluk, with a 90 per cent adoption rate (Table 8). The present findings are differed with the Ranjith *et al.* (2020), who reported that 70 to 82 per cent of farmers chose to spray their brinjal crops only after observing damage symptoms. However, other studies show different trends. Gangaraju *et al.* (2020) found that 83.11 per cent of farmers applied pesticides on a fixed, calendar-based schedule, regardless of whether pests were present. Similarly, Amoako *et al.* (2012) noted that 49 per cent of farmers sprayed their cabbage farms after simply noticing pests, without considering any specific threshold levels. Across all taluks, each farmer (100 %) used a complete tank-mix application, combining multiple insecticides instead of applying a single one. The present findings are in co-ordinance with a study, conducted by Sachin and Suchithrakumari (2016), who found that a majority of farmers (97 %) applied agrochemicals in combination, with only 3 per cent using a single chemical. Farmers believed that mixing multiple insecticides would increase their potency and lead to better pest control. It suggests, this behaviour is linked to farmers' limited education and lack of knowledge regarding proper insecticide use.

Types of sprayers and control methods adopted

The vast majority of farmers (96 %) used power-operated sprayers, indicating a clear trend towards mechanization in spraying. In contrast, only 4 per cent of them used hand-operated equipment. Regarding pest control strategies, a mere 6 per cent of farmers practiced cultural control methods. An overwhelming 94 per cent relied solely on insecticides to manage ginger pests, with no farmers adopting Integrated Pest Management (IPM) strategies. This dependence on chemical control was particularly pronounced outside of the Shivamogga taluk, where farmers in all other areas relied 100 per cent on insecticides (Table 8). These findings highlighted a significant lack of awareness and adoption of holistic pest control methods in the region. These results are consistent with previous studies. The present study findings indicate a strong shift toward mechanization in pesticide application. However, Gandhi and Patil (2017) reported that many farmers still face challenges such as difficulty reading labels, identifying pests and lack of knowledge about IPM and proper equipment use. This suggests that while mechanization is increasing, gaps in technical knowledge may limit the effective and safe use of pesticides.

Disposal of insecticidal containers

Farmers employed various methods for disposing of pesticide containers, many of which pose environmental risks. Specifically, 44 per cent of farmers gave containers to waste collectors, while 36 per cent burned them. Other, less common methods included leaving containers in the field (6 %) and throwing them in neglected areas (14 %) (Table 8). The prevalence of handing containers to waste collectors and burning them suggests a widespread use of potentially hazardous disposal practices. The present findings are in contrast with earlier studies on pesticide container disposal. For instance, Reddy *et al.* (2011) found that roughly 50 per cent of farmers buried empty containers directly in their fields. More recently, Ranjith *et al.* (2020) reported that a large majority of farmers (86.5 %) simply threw used containers into neglected areas, with only 3.5 per cent properly burying them. Similarly, Rubesh *et al.* (2023) found

that most farmers (73.33 %) threw away containers, while others either sold the bottles (20 %) or buried them in the ground (6.66 %).

Farmers' knowledge about pest management practices

An assessment of farmers' awareness regarding pest-related issues across various taluks of Shivamogga district revealed the following outcomes. Farmers from all five taluks (100 %) had knowledge about the pests affecting ginger, indicating a good level of awareness. Awareness of pesticide hazards among farmers varied across taluks, with the highest in Shivamogga (80 %), followed by Shikaripura (70 %), Sagara and Hosanagara (60 % each), and the lowest in Soraba (50 %). The overall mean awareness of pesticide hazards was 64 per cent.

Awareness about IPM (Integrated Pest Management) practices was notably low. In Shivamogga, 50 per cent of the farmers were aware of IPM. Awareness among farmers in the other taluks were comparatively lower, with only 40 per cent of farmers in Shikaripura, 30 per cent each in Sagara and Hosanagara and 20 per cent in Soraba reporting awareness. The overall mean awareness of IPM was 34 per cent, highlighting a significant need for education and training on sustainable pest management practices (Table 9).

Table 9: Farmers' knowledge about pest management practices

Particulars	Having knowledge about the pests (%)[#]	Have knowledge about pesticide hazards (%)[#]	Have Heard about IPM practice (%)[#]
Shivamogga	100	80	50
Shikaripura	100	70	40
Sagara	100	60	30
Hosanagara	100	60	30
Soraba	100	50	20
Mean	100	64	34

[#] Average of 10 farmers' response in each location

Conclusion

The study conducted at the College of Agriculture, Navile, Shivamogga (2024–2025) revealed that ginger in Shivamogga harbours a diverse insect pest complex, with *Conogethes punctiferalis* (shoot borer) being the most destructive. Other pests included rhizome fly, leaf roller, thrips, leaf beetles, weevils and leaf-eating caterpillars. Farmers showed heavy reliance on 21 insecticides, often following dealer advice, poor safety practices and blanket spraying. Despite high pest awareness, knowledge and adoption of IPM were low (34%). The findings emphasize the need for farmer education, IPM promotion and safer, need-based pesticide use for sustainable ginger cultivation.

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