SURVEY OF GINGER RHIZOME FLY AND ASSOCIATED RHIZOME ROT IN MAJOR GINGER PRODUCING DISTRICT OF NEPAL

Janarjan Gautam[1]*, Resham Bahadur Thapa[1], Sundar Tiwari[1], Min Raj Pokhrel[1]

[1]Faculty of Agriculture, Agriculture and Forestry University, Rampur, Chitwan, Nepal

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***Corresponding author:**
gjanarjan@gmail.com
Contact no. +977-9847104070

ABSTRACT

Ginger rhizome fly, Mimegralla coeruleifrons (Macquart,1884) is one of the major insect pest of ginger. This study was conducted to identify the major ginger pest problems across seven major ginger-growing districts of Nepal: Ilam, Dhankuta, Sindhuli, Syangja, Palpa, Gulmi, and Salyan. The study employed a dual-approach survey involving 70 randomly selected households in coordination with Agriculture Knowledge Centers and Agriculture Development Sections of the local government of Koshi, Bagmati, Gandaki, Lumbini and Karnali provinces. The survey focused on farmer-reported pest problems, including collection and analysis of five sample plants per farm to record M. coeruleifrons incidence, rhizome rot and their association. The average cultivated land of the study household was 1.03 hectare of which 0.16 hectare was allocated for ginger production. Descriptive statistical analysis revealed that insect pests and diseases were the major production barriers as reported by 68.57% of farmers. Rhizome fly, rhizome rot and their combined infestation recorded 15.17%, 30.68% and 54.13%, respectively. The findings indicate pest and disease pressure reducing the potential healthy yield from 28.62 t/ha to 14.59 t/ha and underscores a significant economic gap requiring integrated management strategy for both rhizome fly and rot complex to stabilize ginger production in the mid-hills of Nepal.

1. INTRODUCTION

Ginger (*Zingiber officinale* Roscoe) is a high value spice in the global market (FAO, 2023). It is a commercially valuable and exportable commodity and extensively grown in mid-hills of Nepal (GRP, 2023). In Nepal, ginger is grown in an area of 22,430 ha with an annual production of 2,89,330 metric tonnes (MoALD, 2025). Ilam is a leading district followed by Salyan , Palpa, Udayapur, Doti, Panchthar, Morang, Nawalparasi, Sindhuli and Rolpa, respectively, which cover about 50% of the total ginger cultivated area and production in the country (MoALD, 2025). Nepal (with 287.81 million metric tonnes of ginger shares 5.93% of global ginger production) and stands in the fourth position in global ginger production after India (45.73%), Nigeria (15.32%) and China (13.51%) (FAO, 2023). In Nepal, average productivity of ginger (12.83 t/ha) is very low. The ratio of rhizome seed to rhizome production is only 1: 3.21 but has potentiality to 1:7.5 (GRP, 2023). Ginger rhizome fly, white grub, red ant, ginger shoot borer, leaf roller and termites are the important insect pests responsible for reducing the quality and quantity of rhizome production (Sah et al., 2001; Sharma et al., 1998; Gautam & Acharya, 2014).

Among the insect pests, ginger rhizome fly, *Mimegralla coeruleifrons* (Macquart,1884) (Micropezidae: Diptera) is a dominant oligophagous pest of plant species under family Zingiberaceae (Ghorpade et al., 2008).) The fly is endemic, which resulted in 31.00% reduction in ginger yield in India (Ghorpade et al., 1983). Surveys conducted in Kerala revealed *M. coeruleifrons* as the most common pest occurring in ginger rhizomes and 26.4% of the diseased rhizome samples examined contained maggots

(Koya, 1988). Sonatakke (2000) reported that 41.00% of the unprotected crop in Orissa, India was damaged *by M. coeruleifrons*. In Nepal, the fly is reported as a serious pest causing 25.00 to 31.12% infestation in the standing ginger crop and also causes rotting of the rhizome (Sharma et al., 1998; Gautam & Acharya, 2014). The occurrence and severity of the pest keeps changing across year and agroclimatic condition (Baral et al., 2021). The environmental conditions remain different across the districts and accordingly the pest occurrence and infestation. This survey was conducted across seven ginger growing districts to know the major pests and reducing ginger production in Nepal.

2. MATERIALS AND METHODS

The study was carried out following dual-appraoch household survey with ginger growers and ginger field sampling in seven major ginger growing districts (Ilam, Dhankuta, Sindhuli, Syangja, Palpa, Guilmi and Salyan) of Nepal during August-September in 2024. These seven districts cover about 33% of the area under ginger cultivation in Nepal (MoALD, 2025). A total of 70 ginger growers (10 from each district) were surveyed. Simple random sampling technique was employed for the household survey in which the list of farmers was obtained from the Agriculture Knowledge Center (AKC) in the district level and Agriculture Development Sections of the local government. For household survey, a set of semi-structured questions were asked to farmers regarding socio-economic variables and the problems of ginger rhizome fly and associated rot. The infested rhizome of the five plants from each farmer were collected randomly from the farmer' field and the ginger rhizome fly and their damage was identified in laboratory based on the symptoms, morphology, nature of damage and other distinguishing characters. Number of infected plant either by rhizome rot or by rhizome fly or by both were recorded. Field incidence was calculated from crop-cut data by using the formula number of clumps infected by total number of clumps per unit area expressed as percentage. Data on rhizome fly maggot and pupae number/plant were recorded. Descriptive statistics such as mean, range and inferential statistics; Pearson's chi-square test were calculated and the synthesis of results were presented in both graphs and tables. Finally, ginger farmers' problems, rhizome fly incidence and associated rhizome rot, and ginger rhizome loss in the field were discussed.

3. RESULTS AND DISCUSSION

3.1 Farm and household characteristics of the ginger producing farmers

The socio-economic characteristics of ginger farmers in study districts of Nepal during the year of 2024 showed diverse household, livelihood and farming characteristics (Table 1). On an average, a family had 5.61 members with 2.66 members as economically active for providing labor force in agriculture. The number can be seen as moderate level for supplying working manpower for farming. Education level averaged 7.14 years of schooling, while few farmers were also illiterate. Overall, the result of socio economic and farming characteristic suggests that moderately sized (approximately 6 family members per household) ginger farming households are involved in agriculture, and increasingly diversified their income sources. The moderate household size and heavy reliance on agriculture align with recent findings by Ghimire & Shah (2023), who noted agriculture as the economic pillar of farmers in the mid-hills and adopting "risk-spreading" strategies. Agriculture existed as the primary source of livelihood with 57.21% contribution to household income. Other sources were remittance and livestock rearing as the second and third most contributing to family income. The average landholding revealed that farmers used 1.03 hectare (range 0.10 to 0.40) of their land for cultivation, of which, ginger farming occupied almost 0.16 hectare on an average and some farmers allocating their land more than one hectare for ginger growing (Table 1). The remittance and livestock sector income are major contributors to household income after agriculture. Only small proportion of land allocated to ginger cultivation compared to total land area suggests that farmers are still limiting their crop land for ginger as a supplementary enterprise rather than the sole farming activity.

Similar land-use patterns were observed in Sindhuli and Surkhet, where farmers limited their ginger acreage to mitigate the risks associated with high input costs particularly seed rhizomes and market volatility (Ghimire & Shah, 2023). The variation in term of education and income source highlights socio-economic heterogeneity among households, which may influence adoption of improved technologies and marketing of ginger. Households with higher education and diversified income are generally more likely to participate in market-oriented production and adopt Integrated Pest Management (IPM) practices. Mainly training and literacy were significantly associated with a farmer's ability to identify disease symptoms and implement mediation interventions (Adhikari et al., 2025; Shrestha & Joshi, 2024).

Table 1: Socio economic characteristics of ginger growing farmers (n=70)

SN	Variable	Mean±SD	Range
1	Family size (No.)	5.61±2.24	2.00-15.00
2	Active member in agriculture (No.)	2.66±1.13	1.00-7.00
3	Education level (Schooling year)	7.14±3.83	0.00-12.00
4	Income from agriculture (%)	57.21±27.12	15.00-100.00
5	Income from livestock (%)	14.50±16.18	0.00-65.00
6	Income from non-agriculture sector (%)	0.93±3.83	0.00-25.00
7	Income from Job (%)	6.00±13.90	0.00-50.00
8	Income from business (%)	2.00±9.26	0.00-70.00
9	Income from remittance (%)	19.36±24.97	0.00-80.00
10	Total landholding (Hectare)	1.03 ± 0.89	0.10-4.00
11	Ginger cultivation (Hectare)	0.16 ± 0.19	0.03-1.30

Source: Household survey and ginger field sampling (2024); SD=Standard deviation

3.2 Farmers' perceptions on ginger production and marketing problems

The statistical analysis using Pearson's Chi-square test ensured that the ginger problems across districts was highly significant ($p \leq 0.001$), indicating strong variation in problem occurrence among districts (Table 2). The findings revealed that the problem caused by insect pests and diseases were the top most challenges in all study districts (Figure 1). Rhizome rot (*Pythium*) was a widespread problem in all districts (11.60% in Syangja to 39.00% in Ilam), while rhizome fly was more severe in Palpa (34.70%). The findings revealed that both problems were severe as indicated by mean response of farmers for rhizome fly (20.67%) and for rhizome rot (25.34%), respectively. The result also depicted that Gulmi and Syangja districts appeared as less affected than other districts.

The problem linked to insect-pests and diseases across all districts underscores their critical role in limiting ginger productivity in Nepal. Similarly, the ginger farmers are compelled to have considerable yield losses primarily due to rhizome fly and associated rot, which together affect more than half of the total production (Table 2). Yield reduction from 28.62 t/ha in healthy plants to nearly half in infected plants indicates the economic significance of pest and disease control, which is consistent with the yield gap analysis reported by Gautam (2025). While the national average yield remains stagnant at approximately 12.83 t/ha, which demonstrates that the economic loss is not merely theoretical but a direct result of "rhizome rot-complex" where fly infestation often facilitates fungal entry (GRP, 2023). The widespread presence of this problem suggests critical economic loss and highlights the urgent need for integrated pest and disease management strategies. The findings highlighted that Ilam, Palpa and Sindhuli emerging as most affected districts, showing high levels of infestation under farmer's field. Palpa and Sindhuli recorded the highest rhizome fly infestation, indicating that pest management interventions should prioritize these areas. On the other hand, Ilam showed the highest incidence of rhizome rot, pointing to urgent needs for disease management practices such as improved soil health, crop rotation, and resistant varieties. Districts like Gulmi and Syangja reported relatively lower levels of both problems, which may reflect either better management practices or agro-ecological conditions less favorable to pest and disease development. Geographically, the high incidence of rhizome rot in Ilam and rhizome fly in Palpa and Sindhuli underscores the need for region/district-specific management practices. Ilam's vulnerability to rhizome rot may be attributed to its high rainfall and soil moisture levels, which favor *Pythium* species (Gautam & Acharya, 2014).

Table 2: Perceptions of farmers on production and marketing problems of ginger (n=70)

Problem	District								χ^2
	Dhankuta	**Gulmi**	**Ilam**	**Palpa**	**Salyan**	**Sindhuli**	**Syangja**	**Total**	
Insect-pests and diseases	7.00	3.00	10.00	10.00	4.00	10.00	4.00	48 (68.57)	Pearson $\chi^2(24)$=76. 611 Prob = 0.000
Storage	1.00	0.00	0.00	0.00	4.00	0.00	0.00	5.0 (7.14)	
Markets	0.00	7.00	0.00	0.00	2.00	0.00	6.00	15 (21.43)	
Mulching	2.00	0.00	0.00	0.00	0.00	0.00	0.00	2 (2.86)	

Source: Household survey and ginger field sampling (2024)

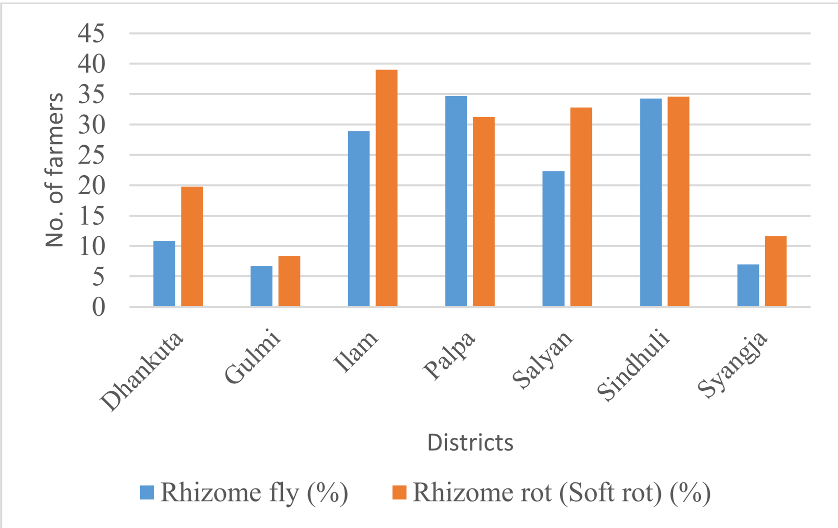

Figure1: Farmers facing pest problems (n=70) in major ginger growing districts

3.3 Incidence of ginger rhizome fly and associated rhizome rot

The ginger cultivation in different district varied considerably in term of area, disease pest infestation, crop damage and ultimately yield loss. Table 3 shows the plant density of ginger 130,000 plants per hectare, though it varied widely across farms. The infestation caused by rhizome fly alone was at 15.17%, while rhizome rot infestation alone was also more severe averaging 30.68%. The rhizome flies and rot combined affected over half (54.13%) of the plants, indicating a major ginger production challenge. The maximum field infestation of 25.00-31.12% caused by rhizome fly was reported in Nepal (Gautam & Acharya, 2014). Rhizome rot (*Pythium* spp.) was found wide spread and devastating disease of ginger with the average yield loss of 20% (Sharma et al., 1998). According to ANSAB (2011) rhizome production could be reduced up to 70% due to rhizome rot infestation in Nepal. On an average, 3.89 maggots and 1.81 pupae per rhizome were observed in ginger-cut in the laboratory, which shows significant pest pressure. Healthy plants yielded 28.62 t/ha of fresh rhizome, whereas fly-damaged edible yield was reduced to 14.03 t/ha, with an additional 4.94 t/ha classified of rhizome as non-edible. Overall, yield loss due to rhizome fly infestation averaged 14.59 t/ha, showing the substantial impact of pest and disease on productivity. Peak period of *M. coeruleifrons* incidence was in the first week of September and damaged was 20-25% and 40-42% in protected and unprotected ginger crops, respectively (Sonatakke, 2000). The occurrence of multiple maggots and pupae per rhizome reflects the key challenges hampering both quality and marketability of ginger. Baral et al. (2021) reported that variation on climate change in the mid-hills are responsible for shifting the epidemiology of soil-borne pathogens, striking a transition toward Climate Smart Agriculture (CSA). Unpredictable monsoon patterns and increasing average temperatures have shown to create "hotspots" for the development of *Pythium* responsible for rhizome fly infestation (Baral et al., 2021). These environmental shifts underscore the importance of recent findings which demonstrate that agronomic adjustments such as increasing seed rhizome size to 80g can significantly increase plant vigor and provide a physical barrier against both rhizome fly and rhizome rot infestation (Gautam, 2025). Integrating these resilient planting materials with better drainage and soil health management is no longer just a recommendation but a necessity for maintaining the stability of the mid-hill livelihood strategy in an increasingly unpredictable climate (NACCFL, 2025). These findings emphasize the urgent need for integrated disease and pest management strategies in ginger growing districts. Some strategies, like cultural practices, development of resistant varieties, and timely interventions could be improved over time. Also, strengthening farmer awareness and extension support could help mitigate yield losses and enhance ginger productivity.

Table 3: Field incidence of rhizome fly and rhizome rot (n=70)

Variable	Mean±SD	Range
Ginger plant (No/ha) (,000)	130.00±38.45	80.00-300.00
Rhizome fly infested (%)	15.17±16.57	0.00-60.00
Rhizome rot infested (%)	30.68±27.83	0.00-100.00
Rhizome fly + rot infected plant (%)	54.13±26.94	0.00-100.00
Rhizome fly maggot (No./rhizome)	3.89±8.03	0.00-48.00
Rhizome fly pupa (No./rhizome)	1.81±2.99	0.00-14.00
Fresh rhizome yield of healthy plant (t/ha)	28.62±6.14	17.20-40.40
Fly damaged edible yield (t/ha)	14.03±10.21	0.00-40.40
Fly damaged nonedible yield (t/ha)	4.94±4.35	0.00-16.00
Yield loss after rhizome fly infestation (t/ha)	14.59±9.10	0.00-36.60

Source: Household survey and ginger field sampling (2024); SD=Standard deviation

4. CONCLUSION:

Ginger farming remains as a supplementary enterprise, largely due to high risks and small landholding, which suggests that this sector is functioning far below than its commercial potential. This study revealed that ginger production was vulnerable in the mid-hills of Nepal due to the infestation of insect pests and diseases. Among them, rhizome fly and rhizome rot are limiting factors in harnessing the benefits of ginger. The problems vary across geographical locations such as in Ilam rhizome rot is the main threat whereas rhizome fly is the major constraint in and Palpa/Sindhuli districts. Ginger rhizome fly, *Mimegralla coeruleifrons* (Macquart,1884) was found emerging and destructive insect pest of ginger in Nepal. The maggot of fly is a damaging stage, which is responsible for either initiating or hastening the *Pythium* rot diseases (rhizome rot). The damage of ginger rhizome by fly alone caused about 15.17%, rot alone 30.68% and their association 54.13%. This indicates that ginger production in Nepal is not a monolith. The current "one-size-fits-all" approach to agricultural extension is insufficient to address the nuanced needs of ginger producing districts. To overcome ginger rhizome fly problem, further researches are needed to identify resistant/tolerant genotypes, evaluation of different botanical and chemical pesticides and different management practices. Finally, ginger sector illustrates resilience through household diversification, its long-term sustainability depends on integrated insect pest and disease management in the context of climate change.

DECLARATION

The authors declare no conflict of interests.

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AUTHOR CONTRIBUTIONS

Author A: Investigation, conceptualization, software, data curation, formal analysis, investigating resource, writing original draft, writing review & editing.
Author B: Conceptualization, methodology design, supervision, writing review & editing, and validation.
Author C: Methodology design, supervision, validation, writing review & editing.
Author D: Investigation, supervision, visualization, writing review & editing, and validation.

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