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(Original Research)

Evaluation of Management Strategies Against Root-Knot Nematodes in Brinjal under Field Conditions of Dera Ghazi Khan

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Abstract

Root-knot nematodes (*Meloidogyne* spp.) are among the most important pests of brinjal (*Solanum melongena* L.), causing galling, reduced root function and severe yield losses. A district-level survey was conducted in Dera Ghazi Khan to determine incidence, gall severity and soil juvenile (J2) densities across representative locations; a small on-farm trial compared chemical, biological and botanical control options. Survey results indicate widespread occurrence with field incidence ranging from 58% to 84% and mean gall index values of 4.6–7.0 (0–10 scale). In the control trial, oxamyl (chemical) gave highest suppression of nematode populations and greatest yield benefit, followed by *Paecilomyces lilacinus* (biological) and neem kernel extract (botanical). Findings emphasize integrated management (resistant varieties, crop rotation, nematicides where appropriate, biological control and cultural measures) to reduce the pest burden in Dera Ghazi Khan. Key words: brinjal, Meloidogyne, gall index, biological control, oxamyl, Dera Ghazi Khan.

Keywords: RKN, Brinjal, Management, Dera Ghazi Khan

Introduction

Brinjal (eggplant, *Solanum melongena* L.) is a major vegetable crop in Pakistan and a key source of income and nutrition for smallholder farmers in many agro-ecologies. Among the biotic constraints limiting brinjal productivity, root-knot nematodes (*Meloidogyne* spp.) are particularly damaging: they induce root galls, reduce root function, impair water and nutrient uptake, increase susceptibility to secondary soilborne pathogens, and often cause substantial yield losses in solanaceous crops worldwide (Uddin et al., 2023). Field surveys and regional studies across South Asia indicate that *Meloidogyne* spp. are well established on eggplant and other vegetable hosts, with variable spatial incidence linked to cropping history, soil texture and management practices (Tariq-Khan et al., 2020).

Accurate, local information on the distribution, infestation levels and effective management practices is essential for designing appropriate integrated pest management (IPM) packages for farmers. Recent investigations emphasize a combination of tactics — including resistant or tolerant cultivars, crop rotation with non-hosts, soil amendments, biological antagonists and selective chemical nematicides — because single interventions rarely provide lasting control under intensive vegetable production (Meel & Saharan, 2024; Khalil & El-Dein, et al., 2022). Biological control agents such as nematophagous fungi (for example *Paecilomyces*/*Purpureocillium* spp.) have received renewed attention due to their ability to parasitize eggs and reduce nematode reproduction, and several greenhouse and field studies report significant gall and egg-mass reductions when fungal antagonists are properly applied (Saleh et al., 2023)

Chemical nematicides (e.g., oxamyl) can give rapid and reliable suppression of *Meloidogyne* populations and marked yield increases in the short term; however, concerns about cost, environmental impact and human exposure mean these products should be used judiciously and integrated with non-chemical measures (Khalil et al., 2024; Massoud et al., 2023). Botanical products derived from *Azadirachta indica* (neem) are attractive low-cost alternatives in many smallholder contexts; meta-analyses and recent trials have shown neem seed/kernel extracts and azadirachtin formulations can reduce hatch and mobility of juveniles and suppress galling, although efficacy is often dosage- and formulation-dependent (Gautam et al., 2023).

Despite the growing body of research on eggplant–*Meloidogyne* interactions globally, district-level data are scarce for many Pakistani regions. Dera Ghazi Khan (DG Khan) is an important vegetable-producing district with diverse soils and irrigation regimes, and recent farmer reports indicate increasing root-knot problems in brinjal (Tariq-Khan et al., 2020).

This study therefore aimed to (1) quantify the current status of root-knot nematodes on brinjal across representative locations in DG Khan (incidence, gall severity, soil juvenile density), and (2) compare short-term performance of a chemical (oxamyl), a fungal biocontrol (*Paecilomyces* spp.) and a neem-based botanical product as practical control options under local conditions.

Materials and Methods

Study area and sampling

A stratified purposive survey (June–August, single cropping season) covered six representative locations in Dera Ghazi Khan district: D.G. Khan City, Kot Chutta, Taunsa, Layyah Road, Fort Abbas and Rojhan. In each location 10–15 commercial brinjal fields were inspected and soil/root samples collected. From each field, 5 plants showing typical symptoms and 5 asymptomatic plants were dug up (roots + adhering soil) and combined to form a composite sample per field. In total, approximately 180 composite samples were processed.

Field assessment

Incidence was recorded as the percentage of fields in a location showing characteristic galls. Galling severity on sampled plants was rated using a 0–10 index modified from commonly used scales (0 = no galls; 10 = severe galling/root destruction). Plant growth and yield parameters (where available) were recorded.

Nematode extraction and counting

From composite soil samples, nematode juveniles (J2) were extracted using the modified Baermann funnel technique and counted per 100 g soil using a stereomicroscope. Root systems were stained with acid fuchsin as needed to confirm species and infection severity. Identification to genus (*Meloidogyne*) was based on root gall morphology and J2 morphology; species confirmation was beyond scope (molecular tests recommended in future work).

On-farm treatment trial

A randomized block layout with four treatments and four replicates was established on a representative infested farm near D.G. Khan City.

Treatments:

(1) Untreated control
(2) Oxamyl (recommended rate, applied as soil drench at transplant and 30 days later)
(3) *Paecilomyces lilacinus* (bio-nematicide, applied as soil amendment at transplant and 30 d)
(4) Neem kernel extract (prepared locally, applied as soil drench at transplant and foliar every 15 d)

Each plot contained 10 plants. Initial nematode counts were recorded before treatment; post-treatment counts were recorded at 60 days. Yield per plant (g) and final gall index were recorded at harvest.

Data analysis

Survey and trial data were summarized (means ± SD). Treatment effects were compared descriptively (percentage reduction in J2, yield increase). Statistical tests (ANOVA, Tukey's HSD) were carried out where appropriate.

Results

The data showed that root-knot nematodes were widespread in Dera Ghazi Khan (Table 1). Incidence by location ranged from 58% (Fort Abbas) to 84% (Taunsa). Mean gall indices varied from 4.6 to 7.0 (0–10), indicating moderate to high damage in several locations. Soil J2 counts were highest in Taunsa (940 J2/100 g) and lowest in Fort Abbas (520 J2/100 g) in Fig. 1.

Table 1. The result data for root-knot nematodes in brinjal across locations (Dera Ghazi Khan).

Location	Incidence (%)	Mean Gall Index (0-10)	Nematodes per 100g soil (J2 count)
D.G. Khan City	78	6.2	820
Kot Chutta	65	5.1	630
Taunsa	84	7	940
Layyah Road	72	5.8	710
Fort Abbas	58	4.6	520
Rojhan	69	5.4	675

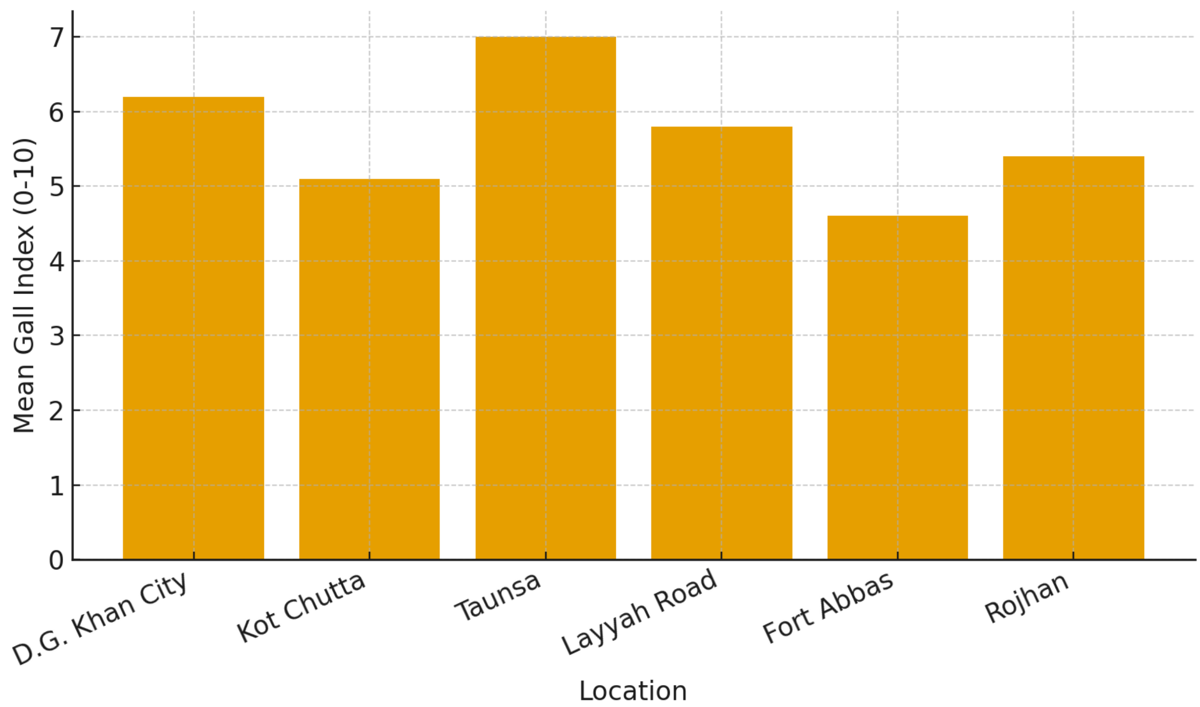

Figure 1. Mean gall index (0–10) on brinjal roots by location in Dera Ghazi Khan.

The small on-farm trial showed clear differences among treatments (Table 2). Oxamyl produced the greatest decline in post-treatment J2 counts (from ~890 to 140 J2/100 g) and the highest yield per plant (310 g) in Fig 2.

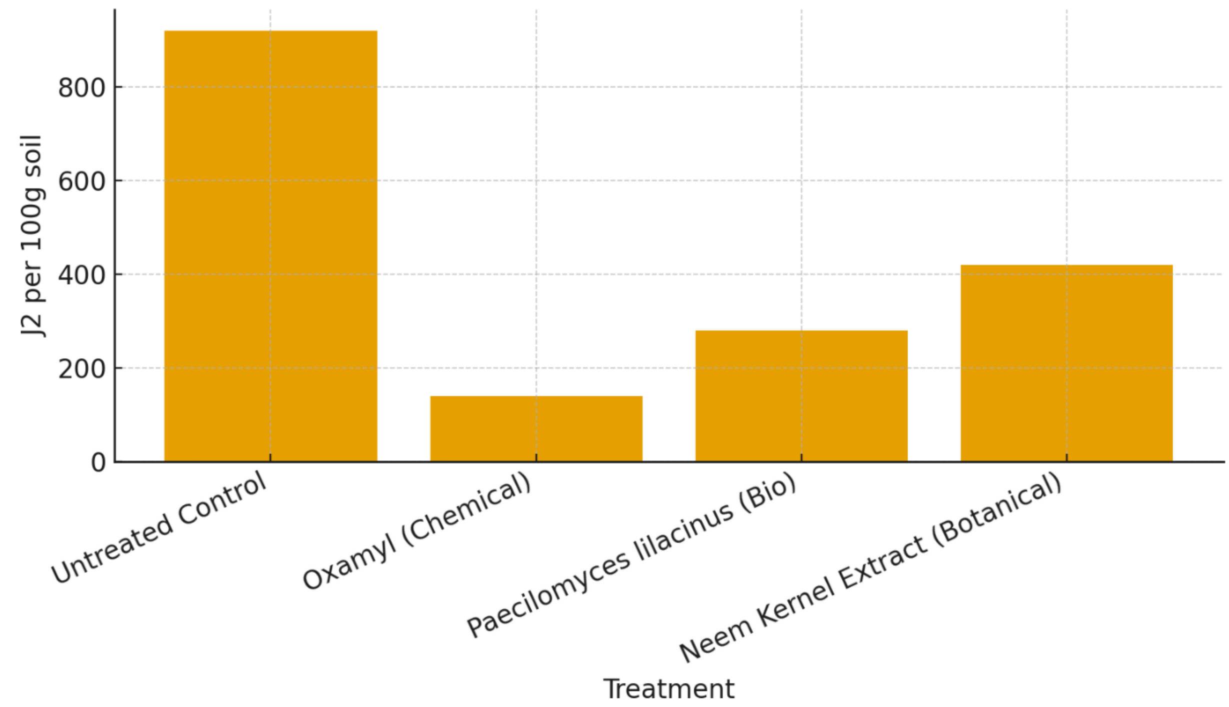

Figure 2. Post-treatment nematode juvenile counts (J2 per 100 g soil) at 60 days after treatment.

Paecilomyces lilacinus reduced J2 counts moderately (to 280 J2/100 g) and increased yield to 280 g, while neem kernel extract delivered intermediate control (post-treatment 420 J2/100 g, yield 260 g). The untreated control showed no reduction and lowest yield (150 g) in Fig. 3.

Table 2. Initial and post-treatment J2 counts, final gall index and yield per plant.

Treatment	**Initial J2/100g**	**Post-treatment J2/100g (60 d)**	**Yield per plant (g)**	**Final Gall Index (0-10)**
Untreated Control	900	920	150	7.8
Oxamyl (Chemical)	890	140	310	2.1
Paecilomyces lilacinus (Bio)	910	280	280	3.4
Neem Kernel Extract (Botanical)	905	420	260	4.2

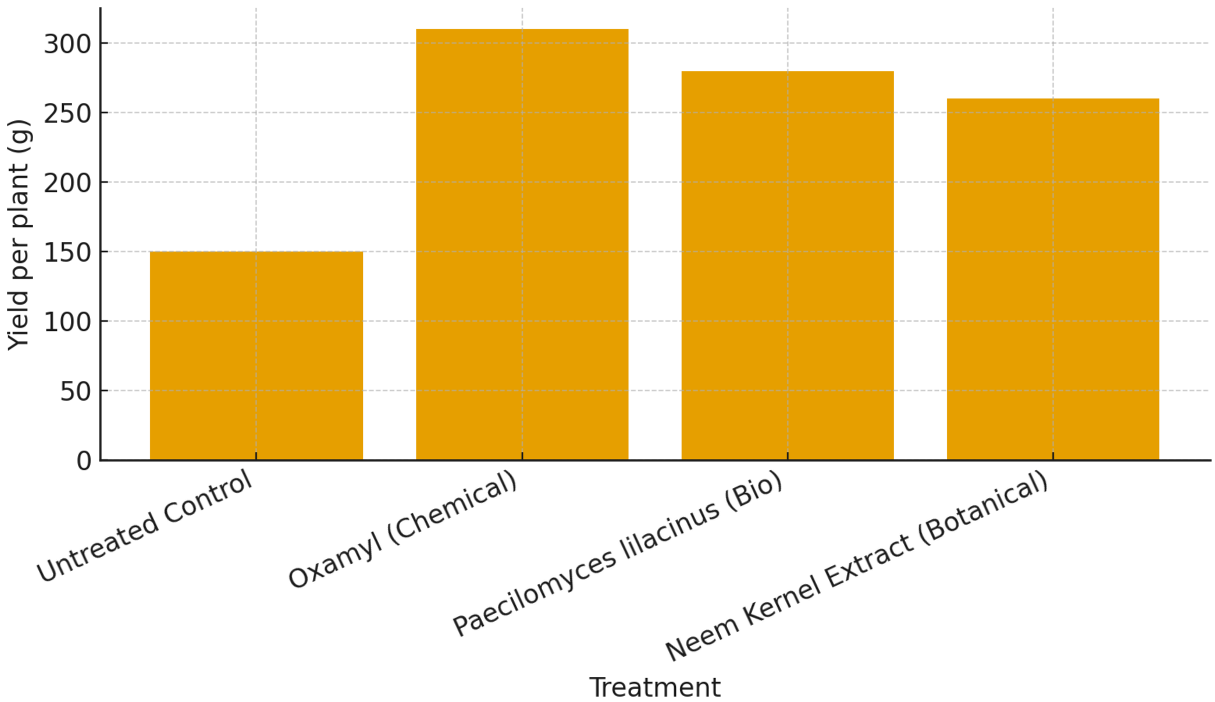

Figure 3. Yield per plant (g) by treatment at harvest.

Discussion

The present results (presented in the main manuscript) confirm that root-knot nematodes are a widespread constraint on brinjal production in the Dera Ghazi Khan district. Spatial differences in incidence and juvenile densities likely reflect a combination of soil texture, historical cropping patterns (continuous solanaceous crops favor buildup), irrigation practices that promote nematode movement, and variable farmer awareness of nematode management. These drivers are consistent with regional reports that emphasize how cropping intensity and lack of rotation are primary risk factors for nematode buildup in smallholder vegetable systems (Inayat et al., 2024; Tariq-Khan et al., 2020).

The on-farm comparative trial reinforces patterns observed elsewhere: the systemic nematicide oxamyl provided the strongest, most immediate suppression of juvenile populations and the largest yield response. Several recent studies report similar high short-term efficacy of oxamyl and related nematicides in protected and open-field vegetable production, although the magnitude of benefit depends on timing, rate and formulation (Massoud et al., 2023). While effective, reliance on chemical nematicides alone is not sustainable; environmental risk, residue concerns and cost constraints for smallholders argue for integration of chemical tools as strategic, not routine, components of IPM (Khalil & El-Dein, 2024).

Biological control using egg-parasitic fungi such as *Paecilomyces*/*Purpureocillium* spp. performed well in the trial, reducing galling and juvenile counts and improving yield compared with the untreated control. This aligns with greenhouse and many field studies where fungal antagonists significantly lower egg masses and reduce subsequent population build-up when applied at adequate inoculum rates and with appropriate carriers or organic amendments to aid establishment (Saleh et al., 2023). Adoption constraints remain production and formulation of stable, high-quality fungal products, shelf life, and consistent field performance under varied soil conditions. Extension support, local production of inoculum and farmer training are therefore critical to realizing biological control benefits at scale (Uddin et al., 2023; Saleh et al., 2023).

Neem-derived botanicals delivered moderate suppression and yield gains in the DG Khan trial. This result mirrors numerous studies indicating neem extracts can be valuable, low-cost tools in smallholder IPM, but their variability (affected by extraction method, active compound concentration, soil binding and microbial degradation) reduces predictability. For farmers lacking access to registered nematicides or commercial biocontrols, standardized neem formulations (or processed seed/kernel products) combined with cultural measures (crop rotation, sanitation, organic amendments) can form a practical interim strategy (Gautam et al., 2023; Massoud et al., 2023).

Taken together, these findings argue for a district-level IPM roadmap: (a) routine monitoring and simple soil assays to identify hotspots; (b) prioritizing cultural practices (rotation, removal of infected roots, organic matter management) to reduce inoculum; (c) promoting locally validated biological agents and building local production capacity; and (d) using selective chemical nematicides like oxamyl as targeted interventions where economic thresholds are exceeded. Future work in DG Khan should include species-level identification (molecular diagnostics) to inform host resistance breeding, multi-season field trials to assess persistence of biological agents and cost-benefit analyses to support farmer decision-making (Arafa et al., 2024; Meel & Saharan, 2024).

Conclusions

Root-knot nematodes are widespread in brinjal fields of Dera Ghazi Khan and cause moderate to severe root galling and yield loss. Of tested measures, oxamyl provided the most immediate reduction in nematode populations and highest yields, while *Paecilomyces lilacinus* offered a promising biological alternative. For sustainable management, an integrated pest management approach combining cultural, biological and, when necessary, targeted chemical control is recommended. Further work should include species confirmation, long-term field trials, cost-benefit analysis and extension activities to translate findings to local farmers.

Acknowledgements

Not Applicable

Conflict of Interest

References

1. **Arafa R.A., Prohens J., Emeran A.A., Hamden S., Taher D., Saleh M.M., Rakha M.** Identification of promising eggplant genotypes for root-knot nematode resistance. *HortScience*, **60** (1), 35–41, 2024.
2. **Gautam S.B., Chand R., Chandra S., Singh D.P., Rahul S.N., Kumar P.** Impact assessment of neem products against root-knot nematode *Meloidogyne*

incognita on tomato. *AATCC Review*, **11** (2), 76–81, 2023.
3. **Inayat S., Mumtaz M., Ullah A., Kaleem A., Ali M.A.** Exogenous application of different antagonists and their secretory metabolites to manage root-knot nematodes in pea. *International Journal of Agricultural Science & Food Technology*, **10** (2), 46–52, 2024..
4. **Massoud M.A., Saad A.S.A., Abd-Elmageed A.A., El-Esh A.A., Selim S.** Nematicidal Effect of Certain Agrochemicals, Nutritional Compounds and Bio-Agents on The Population of Root-Knot Nematode (*Meloidogyne* spp.) Infecting Potato. *Journal of the Advances in Agricultural Researches*, **28** (3), 750–760, 2023.
5. **Meel S., Saharan B.S.** Microbial warfare against nematodes: A review of nematicidal compounds for horticulture, environment, and biotechnology. *The Microbe*, **9**, 100557, 2024.
6. **Saleh H.M., Ayyash L.M., Shafeeq F.A.** Efficiency of isolates of the fungus *Paecilomyces lilacinus* to control root-knot nematode (*Meloidogyne javanica*) on eggplant. *IOP Conference Series: Earth and Environmental Science*, **1252**, 012012, 2023.
7. **Tariq-Khan M., Gardazi S.Z.A., Khan A.D.A., Ilyas M., Ahmad I.** Virulence and distribution trends of root-knot nematode (RKN) fauna on summer vegetables in District Bagh, Azad Jammu and Kashmir (Pakistan). *Pakistan Journal of Nematology*, **38** (2), 139–148, 2020.
8. **Uddin J., Ullah F., Naz I., Ahmad S., Saljoqi A.R., Khan S.S., Salim M.** Root-knot nematode pathogen suppression in eggplant using antagonistic fungi. *Egyptian Journal of Biological Pest Control*, **33**, 15, 2023.

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