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SCIENTIFIC FOUNDATIONS OF BIOLOGICAL PROTECTION OF MEDICINAL CHAMOMILE AGAINST PESTS IN FORESTRY ENTERPRISES

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Abstract. This thesis examines the scientific principles of biological protection of medicinal chamomile (Matricaria chamomilla L., also treated in botanical literature as Matricaria recutita L.) cultivated in forestry-managed plantations. It synthesizes published knowledge on the crop's arthropod pest complex, pest–natural enemy interactions, biological control options, and phytosanitary surveillance. Particular attention is paid to conservation biological control, habitat management, evidence-based use of microbial or botanical products, and the protection of medicinal raw-material quality. A stage-specific monitoring and decision framework is proposed for forestry enterprises in Uzbekistan. The analysis emphasizes that pest species, economic thresholds, and product efficacy must be verified under local field conditions before recommendations are implemented.

Keywords; Medicinal chamomile; Matricaria chamomilla; forestry enterprises; biological control; natural enemies; phytosanitary monitoring; integrated pest management; medicinal plant quality.

INTRODUCTION

Medicinal chamomile is a commercially valuable aromatic and medicinal plant whose flower heads are harvested for pharmaceutical, cosmetic and herbal products. Its cultivation within forestry enterprises can diversify production, but plantation expansion requires careful attention to arthropod pests and the quality of harvested flowers. The medicinal use of the crop creates a strong incentive to reduce unnecessary pesticide exposure and adopt preventive, biologically based plant-protection methods.

Uzbekistan has adopted national measures supporting the cultivation, processing and rational use of medicinal plants, including presidential initiatives announced in April 2020 and May 2022. The Forestry Agency also reported on the implementation of medicinal-plant development tasks in 2026. These policy developments make the design of environmentally responsible pest management relevant to forestry enterprises. However, official support for medicinal plants does not itself establish the pest composition or effectiveness of biological control in a particular chamomile plantation.

The objective of this thesis is to substantiate a scientifically grounded biological protection system for medicinal chamomile in forestry enterprises by integrating pest bioecology, conservation of natural enemies, crop-stage monitoring and locally validated intervention criteria.

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Bioecological foundations of biological protection. The biological protection of chamomile begins with accurate identification of the organisms present in the plantation. Published work on chamomile-associated insects indicates that multiple arthropod groups may occur on the crop. Potentially damaging guilds include sap-feeding insects, flower-associated feeders and foliage-feeding larvae; however, their relative importance differs among regions and seasons. Not every insect collected from chamomile is a pest, and an organism recorded in another country should not automatically be classified as a major pest in Uzbekistan.

Population development is affected by temperature, moisture, crop phenology, weed hosts, surrounding vegetation and the presence of predators or parasitoids. Flowering is a particularly important observation period because injury to flower heads can reduce the marketable medicinal harvest even when total plant biomass appears satisfactory. In forestry-managed fields, forest margins, shelterbelts and nearby semi-natural habitats may supply both herbivores and natural enemies. Their effects must be measured rather than presumed beneficial or harmful.

Principal biological protection mechanisms. Conservation biological control aims to preserve naturally occurring predators and parasitoids by avoiding unnecessary broad-spectrum pesticide treatments and maintaining suitable refuge and food resources. Ladybird beetles, lacewings, hoverfly larvae and parasitoid wasps may contribute to suppression of susceptible pest stages, but their presence and effectiveness should be established through repeated local observations. Beneficial flowering strips can support some natural enemies; nevertheless, plant species must be selected carefully to avoid providing reservoirs for crop pests or invasive weeds.

Microbial control agents, including products based on Bacillus thuringiensis for susceptible lepidopteran larvae or entomopathogenic fungi for suitable target pests, are potential components of an integrated programme. Their performance depends on correct pest identification, life stage, temperature, humidity, formulation and application timing. Botanical products may also have insecticidal or repellent activity, but “natural” does not mean automatically safe for beneficial insects, pollinators or medicinal raw material. No named preparation should be recommended without checking its current legal authorization and label restrictions in Uzbekistan.

Table 1. Scientific basis and limitations of biological protection methods

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Approach	Biological mechanism	Monitoring indicator	Key limitation
Conservation of predators	Natural predation on vulnerable pest stages	Predator:pest counts; pest trend	Species-specific effectiveness varies
Parasitoid conservation	Parasitism of eggs or immature stages	Parasitism rate; emergence records	Requires accurate identification
Microbial products	Infection or toxicity to susceptible targets	Live pest density before/after	Target specificity; weather and registration
Habitat management	Refuges and alternative resources for enemies	Edge/interior counts; enemy diversity	May also favor herbivores
Sanitation and agronomy	Reduced carry-over and plant stress	Infestation incidence; flower damage	Must avoid removing beneficial habitat indiscriminately

Monitoring-based implementation in forestry enterprises. A reliable protection programme should use permanent sampling routes and repeated observations from seedling establishment through flowering and harvest. A practical starting protocol is to inspect representative plants in several field zones, including forest-edge and interior plots, at approximately weekly intervals during active growth, with additional checks when pest populations increase. Sampling intensity should be adapted to plantation size and statistical variability. For each survey, record the date, crop stage, pest identity, pest abundance per standardized unit, natural enemy abundance, visible injury and weather conditions.

Infestation incidence can be expressed as I (%) = 100 × number of infested plants / number of examined plants. Flower-head injury is F (%) = 100 × number of damaged flower heads / number of inspected flower heads. Pest density should be reported per a fixed plant, shoot, leaf or flower-head unit. These indicators are descriptive: they do not constitute an economic action threshold until linked with harvested dry-flower yield, medicinal quality and intervention cost.

For scientifically defensible assessment, candidate biological measures should be tested in replicated plots with untreated or standard-practice comparisons, pre-treatment pest counts, post-treatment observations, marketable dry-flower yield and, where feasible, quality indicators. Trials should also record non-target impacts on pollinators and beneficial arthropods. A treatment that reduces pest counts but lowers flower quality or is uneconomic cannot be considered successful.

Proposed integrated biological protection sequence. Before sowing, select healthy planting material, inspect previous-season pest records and plan balanced irrigation, appropriate plant density and weed management. During vegetative growth, identify pest guilds and beneficial species and establish baseline population trends. At budding and flowering, increase attention to flower-associated damage and preserve natural enemies whenever possible. If a locally established action criterion is exceeded, select only a legally permitted, target-appropriate intervention and verify its field performance. After harvest, evaluate pest pressure, biological control outcomes,

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dry-flower yield and quality, and use the records to refine the following season's management plan.

The proposed sequence is a research-based management framework rather than a validated local control package. In particular, no universal numerical treatment threshold for medicinal chamomile in Uzbekistan is asserted here.

CONCLUSION

Biological protection of medicinal chamomile in forestry enterprises should be based on the ecology of the crop–pest–natural enemy system rather than routine chemical treatments. Conservation of beneficial arthropods, sound agronomic practices, and carefully selected biological agents can form a complementary protection strategy. The priority for Uzbekistan is to identify locally important pests, quantify their seasonal dynamics and flower-head damage, and determine whether biological interventions improve marketable yield and medicinal quality under replicated field conditions. Standardized monitoring, edge-to-interior comparisons and legally compliant product selection will provide the evidence needed for effective, environmentally responsible protection of chamomile plantations.

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