ESSENTIAL OILS AS AN ALTERNATIVE TO SYNTHETIC PESTICIDE FOR CONTROL OF PATHOGENIC FUNGI AND NEMATODE

by

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Aromatic plants - Natural pesticides

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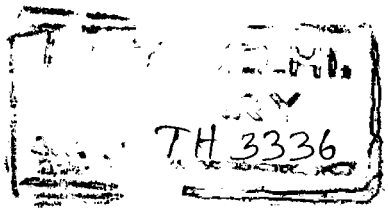

Dedicated

To

My

Beloved Family

CERTIFICATE

This is to certify that the thesis entitled "**ESSENTIAL OILS AS AN ALTERNATIVE TO SYNTHETIC PESTICIDE FOR CONTROL OF PATHOGENIC FUNGI AND NEMATODE**" being submitted by **Ms. Archana Sinha** to the Indian Institute of Technology, Delhi for the award of Doctor of Philosophy is a record of bonafide research work carried out by her under our guidance and supervision in conformity with the rules and regulations of Indian Institute of Technology, Delhi.

The research report and results presented in this thesis have not been submitted, in part or in full, to any other university or institute for the award of any degree or diploma.

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Archana Sinha

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ABSTRACT

Natural pesticides based on essential oils of aromatic plants have been in use since decades for the control of plant diseases and insect pests. These may prove alternative crop protectants to hazardous and non-eco friendly synthetic pesticides which suffer from several drawbacks like pest resistance and resurgence, contamination of food and environment, undesirable effects on the non-target biota and the like. In view of this, the present study on chemical composition and biological activity of essential oils and their constituents was undertaken to evaluate their potential as fungicide and nematicide under laboratory, green house and microplot conditions.

The essential oil of *Acorus calamus* (Sweet Flag) extracted from the rhizomes by Clevenger method showed *cis* and *trans*-asarone as its major constituents when analysed by GC-MS. Commercially available oils used in the study namely lemongrass, jamrosa, basil, Japanese mint, bergamot mint and spearmint essential oils were analysed for their composition and component profile by GC-MS. Citral and geranyl acetate were found to be the major components of lemongrass oil, whereas geraniol, piperitone, geranyl acetate and linalool were the most prevalent components of jamrosa oil and menthol and menthone were the major constituents of Japanese mint oil. Spearmint and bergamot mint, which also belong to the genus *Mentha* contained *l*-carvone, limonene and linalyl acetate, linalool, respectively as their major components. Methyl chavicol and linalool were identified as the major chemical constituents of basil oil.

Essential oils and their pure constituents were evaluated for their antifungal activity against soil borne pathogenic fungi namely, *Sclerotium rolfsii*, *Rhizoctonia solani*, *Rhizoctonia bataticola* and *Macrophomina phaseolina*. Lemongrass oil and *trans*-asarone were found to be most effective against all the test fungi and basil oil, linalool and menthone were least active. All these essential oils and their major components exhibited maximum antifungal activity against *S. rolfsii*, which is a devastating fungi that causes diseases like damping-off of seedlings, stem canker, crown blight, root, crown, bulb and tuber rot, and fruit rots.

All the essential oils and their major components when assayed for nematicidal activity exhibited dose and time dependent activity against the second stage juveniles (J_2) of root knot nematode *Meloidogyne incognita*. Basil oil and *trans*-asarone were found to be the most active and bergamot mint oil and linalool were the least effective after 12, 24 and 48 h of exposure. Effect of the essential oils against J_2 of *M. incognita* was irreversible, as they did not revive after fresh water treatment.

Drenching the soil with different concentrations of essential oils (whole) in plastic cups showed significant reduction in the penetration and development of *M. incognita* in green gram (*Vigna radiata* cv. Pusa Baisakhi). All the test oils except for bergamot mint oil considerably reduced the gall formation, nematode population inside the root, female formation and egg masses formation.

In the *in vitro* studies, maximum antifungal and nematicidal activity was exhibited by lemongrass and basil oils, respectively therefore their microemulsion and granular formulations were prepared to further evaluate their bioefficacy in *in vivo*

studies. Microemulsion formulation of both the oils was prepared by using non-ionic surfactants (Triton X-100 + Tween 80) and co-surfactant (butanol). Whereas, sodium alginate based granular formulation was prepared by interfacial insolubilization reaction using kaolin as inert ingredient. Microemulsion formulation qualified the required physico-chemical properties such as emulsion stability, flash point and acidity / alkalinity as prescribed by Bureau of Indian Standards (BIS). The microemulsion formulation of lemongrass oil when stored at room temperature showed half-life of 188.1 days. Release of lemongrass oil in water from alginate based granular formulation (on the basis of citral content) showed a half-life of 9.21 days.

Microemulsion and granular formulations of lemongrass oil effectively inhibited the growth of *S. rolfsii* in laboratory studies and hence their efficacy was evaluated *in vivo*. Both the formulations significantly prevented tomato damping-off in pot culture studies. Plant stand with microemulsion formulation treatment was at par with the non- infested control and was superior over granular formulation. Moreover, plants treated with microemulsion formulation were found to be healthier as compared to the granular formulation.

The bioefficacy of basil and lemongrass oils based microemulsion and granular formulations was also assessed against *M. incognita* in tomato plants. Microemulsion formulation of both the oils was more effective in controlling nematode infection as compared to the granular formulation.

The microemulsion formulation of basil and lemongrass oils were further tested under microplot conditions by drenching the soil with formulations 10 days before

sowing green gram (*Vigna radiata* cv. Pusa Baisakhi) seeds. The formulations significantly reduced the gall formation as compared to untreated microplot plants. Maximum root gall reduction was observed with basil oil. Significant increase in the number of bacterial nodules, plant height and yield was also observed with basil oil. The population of *M. incognita* in soil was considerably reduced with all the treatments. An increase in the population of non-parasitic nematodes was also recorded.

In view of their significant antifungal and nematicidal activity, essential oils hold good promise for possible use as pest control agents.

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