VITEX NEGUNDO Linn : A PLANT SOURCE FOR STORED GRAIN PROTECTION

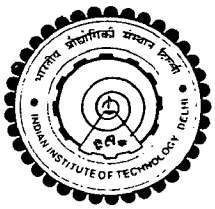
By

DHANANJAY KUMAR TEWARY
Center for Rural Development and Technology

Submitted
in fulfilment of the requirements
of the degree of

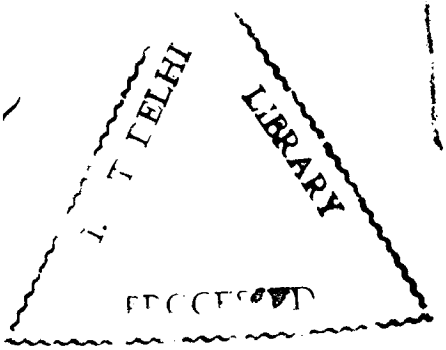
DOCTOR OF PHILOSOPHY

to the



INDIAN INSTITUTE OF TECHNOLOGY, DELHI
INDIA
SEPTEMBER, 2001

Grain storage



To
My Parents

CERTIFICATE

This is to certify that the thesis entitled "***Vitex negundo* Linn - A plant source of stored grain protectant**", submitted by **Mr. Dhananjay Kumar Tewary**, to the Indian Institute of Technology, Delhi for the award of the degree of Doctor of Philosophy is a record of bonafide research work carried out by him. Mr. Dhananjay Kumar Tewary has worked under our guidance and supervision, and has fulfilled the requirement for the submission of this thesis, which to our knowledge has reached the requisite standard. The results contained in this dissertation have not been submitted in part or full to any other university or institute for award of any degree or diploma.

Padma Vasudevan
(Prof. Padma Vasudevan)

Santosh
(Prof. Santosh)

Center for Rural Development & Technology
Indian Institute of Technology, Delhi
Hauz Khas, New Delhi - 110016
INDIA

ACKNOWLEDGEMENTS

Gratitude can seldom be expressed in words.

Beginning with the formulation of research problem, till date I have been especially privileged one to receive guidance from my teachers Prof. Padma Vasudevan and Prof. Santosh whose academic excellence and constant encouragement steered me through the work all the way and all the time. I would seize the opportunity to express my deep sense of gratitude for their motivational urge, valuable analysis, criticism and personal affection which instilled in me immense confidence to continue my research right from the beginning of my research work till the accomplishment of the goal. In addition to their constant inspiration, they also contributed a lot to develop my vision and ideas in the direction of rural development. Undoubtedly it was a fortunate experience to work under their reflective and revered guidance.

I am grateful to Prof. Rajendra Prasad and Prof. R. C. Maheshwari CRDT, IIT, Delhi for providing me lab facility and timely requirements for my research work.

I am also grateful to Prof. K.D.P. Nigam, Head Chemical Engineering Department for his expert advice throughout the course of this work.

I express my gratitude to Dr. S.C. Khanna, Dr. Prem Dureja and Dr Amarnath Jha, IARI, for providing valuable suggestions and laboratory facilities.

I wish to put on record my thanks to faculty members, laboratory and office staff of the CRDT. I am especially grateful to Dr. S.N. Naik whose constructive suggestions and help enabled me to complete this research work.

When one owes so many, it is almost impossible and even invidious to single out names. I am indebted to my friends Vivek, Rakesh and Sandeep for their help, constant encouragement and wholehearted moral support without which it would have been difficult to finish this task. I especially thank Arpita for her help and support in conducting experiments and preparing the manuscript.

I express my sincere thanks to all my friends particularly Anuja, Padma, Vidya Sagar, Anshu, Anshuman, Yadvika and Prabhat for their timely help and co-operation.

Words fail to express my gratitude to Neetu and Mohini whose love care and help kept me always aloof from any inconveniences.

I thank Uncle, Aunty, Rajneesh and Manish for their good wishes and warm affection and keeping me cheerful all through the time.

Lastly, I am ever indebted to my father, mother, brothers and sister whose blessings brought me here up to.

Dhananjay Kumar Tewary

Dhananjay Kumar Tewary

ABSTRACT

Achieving food –nutritional security for growing population demands that in addition to increasing production, food quality should be given due attention right from the crop stage to the storage level. Use of toxic chemicals at storage level is a matter of great concern as food commodities are directly subjected to these chemicals affecting their quality. Hence, world over attention is focussed on alternative strategies including botanical pesticides. Traditionally, certain plant species have been in use for stored grain protection. However, efficiency of such plant products is limiting due to changing scenario in terms of shrinking seed diversity, use of HYV seeds, pest resistance, storage structures etc. hence, there is an urgent need to carry out R&D based on a holistic approach to address this problem.

Keeping the above in view, present study was undertaken to explore the bioactive potential of Vitex negundo L. (Verbenaceae) as a source of stored grain protectant especially for traditional decentralized grain storage system. The major objectives are:

(i) To work out technological inputs needed for maximizing the biomass yield of the plant.

(ii) To evaluate the bioactive potential of oil against dominant storage insect-pests and certain fungal strains and optimization of dose for persistence actions.

(iii) To study the efficacy of oil and leaves based formulations in traditional wheat storage system.

The thesis entitled "Vitex negundo Linn: A plant source for stored grain protection" (organized in 6 chapters) starting with a brief introduction on the theme, presents literature review on relevant aspects and focuses attention on bioactive potential of V. negundo L. plant. In order to ensure sustained availability of the bioresource, research findings for enhancing the biomass and oil yield using certain growth regulators, coppicing technique etc. are presented. Results of bioassay experiments in terms of oil's toxicity (i.e. admixing oil with grain) and fumigant action against major storage insect-pests and optimization of dose for persistent action are discussed. Preliminary investigation on the bioactivity of V. negundo L. oil on some fungal strains causing damage in stored grains is also carried out. Data pertaining to preparation and evaluation of suitable formulations based on plant leaves and oils under simulated traditional storage conditions are presented. All the data are statistically analyzed and discussed.

Among all the growth regulators studied, Stik and IBA were found to be best for faster establishment of plant growth and development. Optimum coppicing frequency (i.e. 3 harvests/year) could yield 6.6 tons dried leaves per hectare land per year. The oil yield from shade dried leaves was in the range 0.4 – 0.6%. GC analysis of oil samples harvested in different seasons has shown qualitative and quantitative variations

in oil characteristics.

The bioassay experiments using this essential oil has shown broad-spectrum activity against test insect-pests and fungal strains, with an appreciably high degree of persistence. LC_{50} values clearly indicate that Sitophilus oryzae L. was the most susceptible pest against oils toxicity while Rhyzopertha dominica F. was found to be the most susceptible against the fumigant action of the oil. The oil gave considerable amount of protection even when inoculation was done 60 days after the treatment. The oil has also demonstrated reproduction retardant activity, as there was significant reduction in adult emergence in F1 generation. Thus, population build up of pests could be controlled in storage conditions.

Based on the data, dose concentration – exposure/contact period- persistence matrix was evolved. To see the practical utility of these laboratory results, performance of various simple leaf and oil-based formulations against one of the major pests, S. oryzae was evaluated for HYV and indigenous wheat cultivar under simulated rural household conditions. Very interesting observation with regard to the differential susceptibility of these two wheat cultivars was noted. The indigenous cultivar was less susceptible to insect damage as compared to HYV. Leaf pellets impregnated with oil may be considered an alternative to crushed leaves. Further R&D on physico-chemical stability of such formulation needs to be done before recommending its large-scale applications.

Finally, feasibility of using this bioresource for stored grain protection in rural habitats was looked into. Data indicate that sufficient amount of leaves and oil could be generated by propagation of V. negundo by using methods for enhancing biomass production, as a component of agro and social forestry schemes. In this context, it may be noted that pest infestation under natural storage environment would require very less amount of bioresource in terms of leaves/oil as compared to experimental condition, where ten insects pairs were used for inoculation creating a situation where infestation rate is extremely high.

In toto, research findings reveal the possibility of using plant based bioactive products for stored grain protection by integrating indigenous people's knowledge with modern scientific and technological inputs.

CONTENTS