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MANAGEMENT OF THE ELM BARK BEETLE, *SCOLYTUS KASHMIRENSIS* SCHEDL INFESTING ELM TREES (*ULMUS* SPP.) IN KASHMIR

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ABSTRACT

Experiments were conducted to determine the influence of cultural and chemical control measures of elm bark beetle, *Scolytus kashmirensis* Schedl on elm trees (*Ulmus* spp.) in Kashmir. Seasonal pruning reduced infestation of the pest significantly; spring and autumn pruning reduced it by 1.17% and 65.77% respectively. However, sanitation reduced the infestation rate only by 15.91% and 27.61% in two treated elm plots. The efficacy of the screened chemicals at different concentrations against the pest varied significantly among each other. 1.0% concentrates of all the screened chemicals were effective with Dichlorvos ranking first in efficacy against the pest. Dichlorvos was efficient followed by a mixture of Monocrotophos and Carbendazim. However, Imidacloprid was least effective followed by Endosulfan. Technically 0.05% concentrate of these chemicals was ineffective whereas 0.1% solution controlled the pest population considerably. The results showed that 1.0% solution of Dichlorvos (causing a mortality of 92.70%) or a mixture of Monocrotophos and Carbendazim (mortality 86.33%) could be used to control the infestation rate of *S. kashmirensis* effectively.

Key words: *Scolytus kashmirensis*, *Ulmus* spp., dutch elm disease, pruning, sanitation, chemical control

INTRODUCTION

Bark beetles are of great economic importance to forestry and horticulture in the temperate climatic zones including the valley of Kashmir. Elm trees (*Ulmus wallichiana* Planch and *U. villosa* Brandis ex Gamble) in poor physiological condition are often attacked by species of the genus *Scolytus* which, although they are secondary pests, are a major cause of tree's decay (Felt, 1934; Rudinsky, 1962). Dutch elm disease caused by the fungus *Ophiostoma ulmi* (*Ceratocystis ulmi*) is one of the most destructive plant diseases to affect elm trees (Gibbs and Brasier, 1973; Brasier, 1991). Although the disease may be transmitted in several ways (Schwarz, 1922; Smucker, 1935), insects are the best fungal vectors (Collins *et al.*, 1936). In particular, the elm bark beetles (*Scolytus* spp.) have been demonstrated to be the most efficient vector of the fungal spores (Gibbs, 1974; Webber and Brasier, 1984; Neumann and Minko, 1985; Webber, 1990; Favaro and Battisti, 1993). In spring, fresh beetle adults emerging from dead elms fly towards the top of healthy elms for maturation feeding on the crotches of young twigs (Gibbs, 1974; Webber and Brasier, 1984). The feeding activity carried by the infected beetles may cause the contamination of the host tissues and the consequent development and diffusion of the fungus within the xylem and vessels. Later beetles attack the trunk of elms whose twig crotches got damaged during the previous year. Here the inner bark provides ideal breeding material on which larvae can develop

(Parker *et al.*, 1941). The bark also becomes contaminated with the spores of *O. ulmi* carried by infected beetles when breeding galleries are excavated. The maternal galleries are an ideal micro-environment both for the growth and sporulation of the fungus (Webber and Brassier, 1984). Losses caused by the beetles are not confined to feeding activities alone but also intensify by disseminating disease pathogens. Their population increases rapidly when there is abundance of decadent tree, wind fall and weakened tree due to water, diseases, nutrients or salt stresses (Wood, 1982). The trees infested by the bark beetles may be recognized at a distance by fading foliage of the tree, initially a light green then changing to a light straw color in a few weeks, and eventually to yellowish-brown. Close inspection may show a fine reddish-brown boring dust in bark cervices and at the base of the tree (Webber, 1990).

In order to prevent infection, different methods like chemical control (Maksimovic and Motal, 1972; Schreiber and Peacock, 1974), sanitary measures (Neely, 1975; Maksimovic and Motal, 1983), and trapping with synthetic pheromones (Peacock and Cuthbert, 1975) have been tried against bark beetles. Natural enemies, especially the bark beetle parasitoids, have also been used (Kennedy, 1970, 1981; Hajek and Dahlsten, 1984). However, biological control programmes against *Scolytus* larvae by pathogenic bacteria, (e.g. *Bacillus thuringiensis*,) have yet found no practical application (Jassim *et al.*, 1990a, 1990b). The complete chemical protection of the trees against both insects and fungus can be achieved by a combined treatment of compatible insecticides and fungicides, without danger for man or other organisms (Zechini d' Aulerio *et al.*, 1986; 1990).

The objective of the present study was to assess the effectiveness of the cultural and chemical control methods against *S. kashmirensis* in order to devise an efficient management system of elm trees in the Himalayan region.

MATERIALS AND METHODS

The investigations on the management of the pest were carried out from the study areas at four districts of Kashmir viz., Anantnag, Shopian, Baramulla and Ganderbal during 2008-2010.

1. Cultural control

Cultural control is a preventive method which is inexpensive and may prove effective and efficient, if employed after a thorough knowledge of the life-history and habitat of a pest. It was executed by the following methods:

Pruning

Spring and Autumn pruning were made to investigate its impact on the infestation rate of the shot-hole borer among elm plants.

Sanitation

It involved the prompt removal and disposal of dead and dying elms to reduce bark beetle breeding sites. The barked elm wood, leaves, twigs were completely disposed off along with their harboring beetles at two sites/locations during the present study in Autumn, 2009. The infestation rate was compared with the control site in the following season.

2. Chemical control

Following synthetic chemicals/ insecticides were screened against *S. kashmirensis*:

i) Dichlorvos
ii) Endosulfan
iii) Imidacloprid
iv) Benzene hexachloride (BHC)
v) Monocrotophos
vi) Monocrotophos + Carbendazim

Three different concentrations (0.05%, 0.1% and 1.0%) of the above chemicals were used against the pest and Pearson's square method was adapted for dilution of chemicals.

For field evaluation a big elm plot was selected. Here alternative rows were selected and within each row, plants were selected alternatively and then tagged. This was done to avoid multiple spraying. The concentrations of all the treatments were sprayed with a hand-operated sprayer and five replications were maintained for every treatment level. A control was also maintained in each case. Data regarding pest population were recorded a day before spray (Pre-treatment population) and 24 hours, 48 hours, 72 hours and 96 hours after treatment (Post-treatment population).

3. Data analysis

The observations made during the current study were summarized and tabulated. The data were statistically analyzed by different methods. Arithmetic mean± SE (Standard error of mean) and Chi square (X^2) test were used to analyze the data. The means were compared by Student's t-test and the values were considered significant at $P \leq 0.05$.

RESULTS

1. Seasonal Pruning

Table 1 showed that spring pruning reduced the infestation rate of elm shot-hole borer in the next generation by 1.17% as compared to the control plots, whereas autumn pruning reduced it by 65.77%. The autumn pruning reduced the infestation rate significantly ($P<0.05$) while as spring pruning gave insignificant results ($P>0.05$).

2. Sanitation

Sanitation in elm plots/nurseries reduced the borer infestation rate by 15.91% in plot I and 27.61% in plot II as compared to control plot/nursery (Table 2). Reduction in the borer infestation rate over control showed significant results ($P<0.05$) in both the treatments.

Table 1. Effect of seasonal pruning on infestation rate of *S. kashmirensis*

Pruning season	No. of sampled trees	Percent infestation in following spring (mean ± SE)	Percent reduction over control	t- value
Spring	50	19.43±1.00	1.17	0.40
Autumn	50	6.73±0.67	65.77	15.00
Control	50	19.66±0.76	-	-

Table 2. Effect of sanitation on elm plots/nurseries

Treatment in elm plots	No. of trees ascribed to sanitation	Percent infestation rate in following spring (mean ± SE)	Percent reduction over control	t-value
I	100	8.77±0.68	15.91	15.33
II	100	7.55±0.57	27.61	16.00
Control	100	10.43±0.58	-	-

3. Chemical Control

The data concerning the treatment of chemicals against *S. kashmirensis* are provided in Table 3. Each of the chemicals viz., Dichlorvos, Imidacloprid, Monocrotophos, Carbendazim, Endosulfan and Benzene hexachloride (BHC) screened against the pest were effective at 0.1% and 1.0% concentrations, however, 0.05% of each of them were significantly (P<0.05) ineffective to control the borer population. Dichlorvos 1.0% was the most effective to rest of the chemicals tested against the pest, controlled 92.70% population followed by Monocrotophos and Carbendazim mixture which controlled 86.33%. The rest of the chemicals though controlled a good proportion of the pest population, but were significantly less effective (P>0.05) than Dichlorvos and the mixture of Monocrotophos and Carbendazim.

Table 3. Efficacy of synthetic chemicals against the *S. kashmirensis*

Insecticide	Percent mortality (mean±SE) at concentrations 0.05%	0.1%	1.0%
Dichlorvos	20.33±4.3	69.00±4.3	92.70±3.3
Imidacloprid	13.67±3.1	56.33±3.3	70.00±4.0
Endosulfan	12.70±4.2	57.33±3.3	72.33±3.0
BHC	13.33±4.0	60.0±5.6	80.33±3.1
Monocrotophos	15.67±4.0	61.70±2.6	78.00±2.0
Monocrotophos+ Carbendazim	14.00±2.0	62.67±4.6	86.33±3.1
Control (Water)	8.00±3.3	8.00±3.3	8.00±3.3

DISCUSSION

Elm trees (*Ulmus* spp.) stressed by unfavorable environmental conditions, disease, defoliation, age, or poor tree care are most susceptible to bark beetle attack (Hagen, 1995). Pruning of trees is a cultural operation, an economical tool employed in integrated pest management of perennial plants. However, wounding trees by pruning will attract the bark beetle vectors of Dutch elm disease (Byers *et al.*, 1980). The findings of the current study are at par with Lanier (1978) who suggested that ideally, routine pruning should be done in the dormant season or are restricted to the periods of beetle inactivity; Sanborn (1996) recommended that elm trees should not be pruned from March to September. In the present study, spring and autumn pruning reduced infestation rate of the elm borer by 1.17% and 65.77% respectively. Autumn pruning prevented the elm trees from the borer infestation by destroying the harboring grounds of overwintering larvae along with the pruned branches, thus restricting the infestation in the next season. Spring pruning could not prevent the elm plants from the borer infestation as the twigs sprouted from the spring pruned plants are the preferred oviposition sites for elm shot-hole borer. Pruning in the management of elm bark beetle is appealing for several reasons viz., reduced the borer infestation rate significantly; no environmental hazard encountered; did not interfere in the economics of silviculture ecosystem.

Sanitation is the most important element of management program for existing elms because it removes the elm bark beetles' breeding habitat from the system. It consists of the immediate removal of any dead or wounded branches, and the debarking of branches stored for use as timber and fuel. The present study is at par with Schreiber and Peacock (1974); van Sickle and Sterner (1976) who suggested that the most effective control measures against the elm bark beetles to date have been based on sanitation programs consisting of prompt removal of recently dead or dying trees, as well as the speedy destruction of all elm material infested by beetles. Lanier (1978) suggested that no borer infestation and thereof Dutch elm disease management program will be successful without good sanitation. Sanitation prevented elm trees from borer infestation as it destroyed the overwintering harboring grounds of the borer. It reduced the borer infestation rate by 15.91% in elm plot I and 27.61% in elm plot II as compared to control plot in the present investigations.

Chemicals for elm bark beetle control have been researched since the 1940's (Dimond *et al.*, 1949). Synthetic chemical treatments have been potentially useful for suppression of infestation of elm bark beetles (Beckman, 1959; Smalley, 1962). Faccoli (2001) used Carbendazim (8%), Monocrotophos (52%), Ometoato (50%), Methomil (35%), Acephate (42%) against the elm bark beetle, *Scolytus multistriatus*. Nishijima (1977) showed that Carbendazim is temporary very mobile within the tree, quickly distributed to the foliage and is lost as the leaves drop. Malik (1966) used 50% DDT and 10% BHC against the *Scolytus* spp. in Kashmir orchards. Pajars and Lanier (1989) used pyrethoid insecticides against the *Scolytus multistriatus*. However, Lanier (1978) suggested that pruning combined with fungicide gives better Dutch elm disease management than pruning or fungicide alone when dealing with a residual infection. Nielsen (1981) pointed out the limited vulnerability of borers to insecticides. This is partially true of species such as *S. kashmirensis* that attack elm trees in Kashmir and spend much of their life cycle under the bark.

The present observations revealed that the efficacy of the screened insecticides at different concentrations against *S. kashmirensis* varied significantly among each other. 1.0% concentrates of all the screened chemicals were effective with Dichlorvos ranking first in efficacy against the borer under study. Dichlorvos was 92.70% efficient followed by a mixture of Monocrotophos and Carbendazim, BHC and Monocrotophos which killed 86.33%, 80.33% and 78.00% grubs respectively. However, Imidacloprid was least effective followed by Endosulfan. Technically 0.05% concentrate of these chemicals was ineffective whereas 0.1% solution controlled the pest population considerably.

It can be concluded that management practices by cultural operations including pruning and sanitation reduced the infestation rate of the pest considerably. These techniques could be used to control the elm bark beetle if we are to manage this beetle pest and the Dutch elm disease more effectively and see a healthy return of the mature elm to our landscape. The cultural methods coupled with selective fungicide application could be employed for better bark beetle and Dutch elm disease management of elm trees in Kashmir.

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