

## REDUCED ATTACK OF KEORA (*SONNERATIA APETALA*) BY STEM BORER IN MIXED-SPECIES PLANTATIONS IN COASTAL BANGLADESH

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**WAZIHULLAH, A.K.M., ISLAM, S.S., RAHMAN, F. & DAS, S. 1996. Reduced attack of keora (*Sonneratia apetala*) by stem borer in mixed-species plantations in coastal Bangladesh.** A survey was conducted in 1990-1992 on attack by the stem borer, *Zeuzera conferta*, in mixed-species and monoculture plantations of keora (*Sonneratia apetala*) in four Coastal Afforestation Divisions and natural stands in the Sundarbans, Bangladesh. In monoculture stands, 51% of the keora trees were attacked by stem borers, whereas 32% sustained attack in mixed-species stands. In the latter stands, infested trees comprised only 10.6% of the total stems. Infestation levels were similar in plantations and natural stands. Infestation frequency increased from the West coast to the East, with the least infestation in the Sundarbans. There was a significant negative relationship ( $r = -0.98$ ) between the numbers of kankra (*Bruguiera conjugata*) trees and the intensity of infestation in the mixed-species stands in all the coastal divisions. Soil salinity levels in the Sundarbans did not show any correlation ( $r = 0.12$ ) with infestation. We recommend that in the future keora should be planted with kankra in mixed culture in coastal areas of Bangladesh.

Key words: Keora (*Sonneratia apetala*) - stem borer (*Zeuzera conferta*) - mixed-species plantation - monoculture plantation - coastal afforestation - mangrove forest

**WAZIHULLAH, A.K.M., ISLAM, S.S., RAHMAN, F. & DAS, S. 1996. Pengurangan serangan ke atas keora (*Sonneratia apetala*) oleh pengorek batang di ladang-ladang spesies-campur di pesisiran pantai Bangladesh.** Satu kajian telah dijalankan dalam tahun 1990-1992 ke atas serangan pengorek batang, *Zeuzera conferta*, ke atas ladang-ladang spesies-campur dan monokultur keora (*Sonneratia apetala*) di empat Bahagian Penghutanan Pesisiran Pantai dan dirian asli di Sundarbans, Bangladesh. Di dalam dirian-dirian monokultur, 51% daripada pokok-pokok keora telah diserang oleh pengorek batang, manakala 32% diserang di dalam dirian spesies-campur. Di dalam dirian spesies-campur, pokok-pokok yang dijangkiti hanya meliputi 10.6% daripada jumlah pokok. Tahap jangkitan adalah sama di dalam ladang dan dirian asli. Kekerapan jangkitan meningkat daripada pesisiran pantai Barat hingga ke Timur, dengan jangkitan yang paling kurang di Sundarbans. Terdapat perkaitan negatif yang ketara ( $r = -0.98$ ) di antara bilangan pokok kankra (*Bruguiera conjugata*) dan keamatan jangkitan di dalam dirian-dirian spesies-campur di semua bahagian pesisiran pantai. Tahap kemasinan tanah di Sundarbans tidak menunjukkan sebarang korelasi ( $r = 0.12$ ) dengan jangkitan. Kami mengesyorkan supaya di masa hadapan keora ditanam dengan kankra di dalam pertanian campur di pesisiran pantai Bangladesh.

## Introduction

Keora, *Sonneratia apetala*, one of the major natural mangrove species in Bangladesh, has recently gained importance in coastal plantations because of its fast growth and adaptability in newly formed muddy land. The coastal afforestation programme, started in the country in the early 1960s, was aimed at creating shelter-belts against natural disasters in coastal areas as well as introducing a natural land management system. The other species planted with keora included baen (*Avicennia* sp.), kankra (*Bruguiera sexangula*), gewa (*Excoecaria agallocha*) and sundri (*Heritiera fomes*). More than 100 000 hectares of land have been planted with these species by the Forest Department in Chittagong, Noakhali, Barisal and Patuakhali Coastal Afforestation Divisions. In the Sundarbans there are many keora stands in the world's largest natural mangrove forest.

Keora has generally been planted at 1.2 × 1.2 m spacing throughout the coastal belt (about 6900 seedlings per hectare). In Barisal and Patuakhali, plantations were purely monoculture, while in Chittagong and Noakhali mixed-species plantations were also raised. Natural regeneration of other species in the monoculture plantations occurred subsequently in Barisal and Patuakhali.

A severe stem borer attack was reported in these plantations in 1983 in Patuakhali and later in Noakhali in 1984, particularly in the 1977-78 keora plantations of Char Quasem. The larvae of the moth bored into the wood of living trees resulting in numerous perforations and tunnels of pencil-size diameter (Baksha 1983). The insect was identified by Chowdhury (1988) as *Zeuzera conferta* (Lepidoptera: Cossidae), a species not previously known to attack keora in Bangladesh (Mathur & Singh 1961). Siddiqui and Khan (1989) reported that about 68% keora trees were attacked in Barisal. Dalmacio and Bajracharya (1989) mentioned an infestation of about 20-100% in the older plantations of keora in Noakhali.

In a country-wide survey for stem borer attack covering the four Coastal Divisions, Islam *et al.* (1988) revealed that 52% of all keora trees were infested. Studies of the relationships of plantation age, duration of rainfall, canopy density and plantation composition indicated that rainfall duration was negatively correlated with infestation level. The survey also showed that the mixed plantations of keora were significantly less attacked by stem-borer than monoculture stands in the Noakhali Coastal Division. Our study was then undertaken during 1990-1992 to determine the effect of mixed-species plantations of keora on stem-borer attack throughout the coastal belt.

## Materials and method

The survey covered the four Coastal Afforestation Divisions, constituting the man-made forests of Bangladesh as well as the natural forest of the Sundarbans. At least 12 sample plots for each mixed-species and monoculture stands were laid out in each location (forest range or beat), providing 36 and 34 plots in Chittagong, 31 and 24 in Noakhali, 26 in Barisal, 24 in Patuakhali, and 20 and 29 in the Sundarbans (total 112 plots for each type of stand). The locations of

the sample plots were Chittagong Division (eight locations): Uttar Kattali, Bagachattar, Dhumkhali, Maghadia, Teknaf, Damdamia, Zadimura and Urirchar; Noakhali (four locations): Hatia, Char Osman, D.C. Clerk and Head Quarters range; Barisal (four locations): Char Kukri Mukri, Dhal Char, Kalkinirchar and Char Patila; Patuakhali (three locations): Khajuria, Mohipur and Char Quashem; and the Sundarbans (five locations): Chandpai, Charkhali, Katka, Hiranpoint and Kobodak ranges. Sample plots were 0.02 ha in size and were placed in the locations where mixed-species and monoculture plantations were side by side.

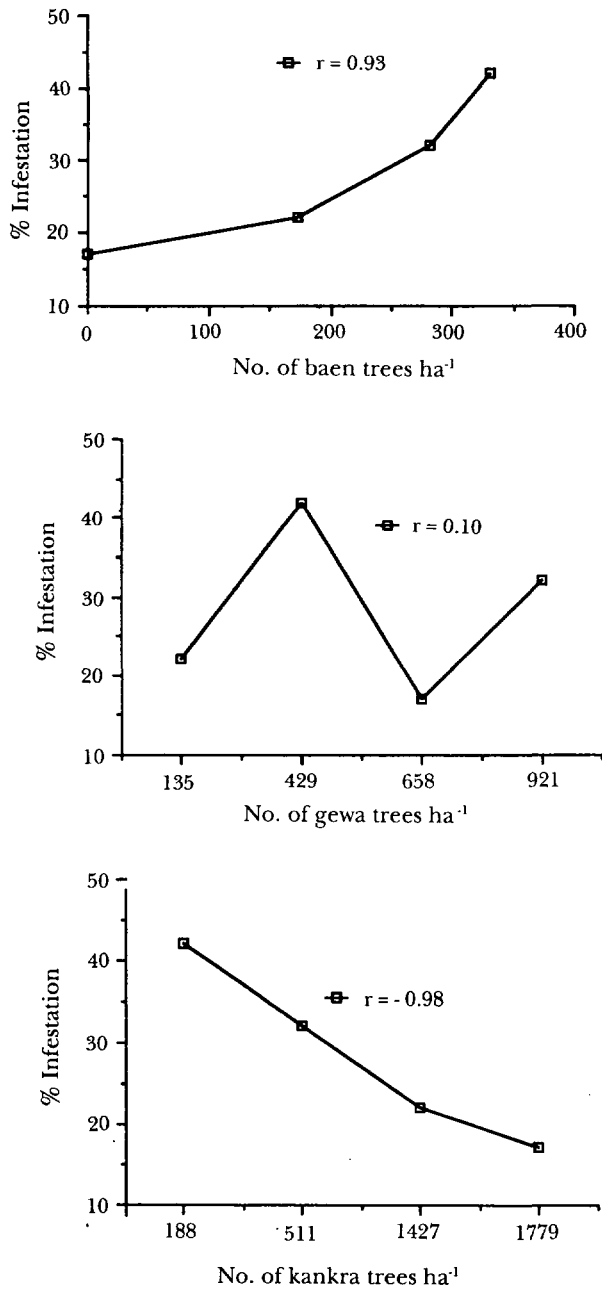
The numbers of borer holes in stems of keora trees up to two metres from ground level were recorded (Bakshi 1977). Numbers of other species infected were recorded in the mixed plots. Soil samples were collected from five locations of the Sundarbans to investigate any relationship between soil pH and infestation level.

Percentages of infested keora trees by division in both types of stand, as well as density of other species in the mixed-species stands, were calculated. Student's *t*-tests compared the percentage of keora stems infested in mixed-species and mono-culture stands in each division. Correlation coefficients (*r*) were calculated for infestation level in relation to frequency of baen, gewa and kankra in the mixed-species stands, and for the relationship between soil pH and percentage infestation in the Sundarbans.

## Results and discussion

An average of 32% and 51% keora trees were attacked by stem borers in the mixed-species and monoculture plantations respectively (Table 1). The significant difference indicates that the monoculture plantations are highly susceptible to stem borer attack. The infested keora trees represented only 10.6% of the trees in the mixed stands strikingly showing the impact of the stem borers. Similarly, the natural forests of the Sundarbans showed a 15% infestation in the mixed-species stands and a 27% infestation in the single-species stands, also a significant difference (Table 1). There was no relationship ( $r = 0.10$ ) between infestation level and number of gewa trees (Figure 1). However, there was a significant negative relationship between the number of kankra trees and percentage infestation ( $r = -0.98$ ) in all the divisions. On the contrary, for baen trees, percentage infestation rose to 42% with increasing density up to 331 trees per ha, and declined sharply to 17% with no baen trees ( $r = 0.93$ ). Therefore, optimal reduction of infestation level could probably be achieved by interplanting of keora with kankra at any density exceeding 188 trees per ha, and no baen or gewa trees anywhere. Soil salinity in five locations in the Sundarbans showed no correlation ( $r = 0.12$ ) with infestation. Such a result would probably be expected for other parts of the coastal belt.

The trend of borer attack (Table 1) indicates an increasing rate of infestation from Patuakhali in the West coast to Chittagong in the East. The lowest infestation level was in the Sundarbans, probably because of stabilized soil and a natural ecosystem.



**Figure 1.** Relationship between infestation by *Zeuzera conferta* on keora and the occurrence of other species in mixed-species plantation

**Table 1.** Stem borer infestation in the mixed-species and monoculture plots of keora in Chittagong, Noakhali, Barisal and Patuakhali Coastal Afforestation Divisions and in the natural forest of the Sundarbans, Bangladesh. Mixed-species plantations include primarily baen, gewa, kankra and garan in addition to keora.

Type of stand and division	Species composition	No. of sample plots	No. of trees per plot ( $x \pm SE$ )	No. of keora trees per plot ( $x \pm SE$ )	Percentage keora trees infested ( $x \pm SE$ )	t-value for infested trees ( $p < 0.05$ )
<b>Plantations</b>						
Chittagong	Mixed-species	36	35.9 $\pm$ 5.2	15.9 $\pm$ 1.3	42 $\pm$ 4.9	2.29*
	Monoculture	34	21.2 $\pm$ 1.2	21.2 $\pm$ 1.5	54 $\pm$ 5.1	
Noakhali	Mixed-species	31	52.2 $\pm$ 7.1	15.9 $\pm$ 1.2	32 $\pm$ 4.3	3.31**
	Monoculture	24	19.8 $\pm$ 1.4	19.8 $\pm$ 1.4	51 $\pm$ 5.1	
Barisal	Mixed-species	13	53.0 $\pm$ 7.9	12.3 $\pm$ 0.6	22 $\pm$ 3.5	6.68**
	Monoculture	13	24.5 $\pm$ 1.6	24.5 $\pm$ 1.6	56 $\pm$ 5.2	
Patuakhali	Mixed-species	12	74.0 $\pm$ 9.5	18.8 $\pm$ 1.9	17 $\pm$ 3.9	2.42*
	Monoculture	12	19.2 $\pm$ 1.3	19.2 $\pm$ 1.3	13 $\pm$ 6.8	
Plantations in all divisions combined	Mixed-species	92	47.9 $\pm$ 5.7	15.8 $\pm$ 1.5	32 $\pm$ 4.5	2.97*
	Monoculture	83	21.1 $\pm$ 1.5	21.1 $\pm$ 1.4	51 $\pm$ 5.4	
<b>Natural stands</b>						
Sundarbans	Mixed-species	20	45.8 $\pm$ 5.1	16.7 $\pm$ 1.4	15 $\pm$ 3.3	2.56*
	Monoculture	29	17.6 $\pm$ 1.2	17.6 $\pm$ 1.3	27 $\pm$ 3.6	

\* significant at 5% level ; \*\* significant at 1% level.

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