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Association of *Striga densiflora* with Sugarcane

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ABSTRACT

An experiment was carried out at Sugarcane Research & Training Institute farm to study morphological and some selected plant characters of *Striga densiflora* as well as its parasitic association with sugarcane. Striga plants grown in association with sugarcane were closely observed and described some plant characters such as leaf, stem, root, flower, fruit and seed. Striga required 33±1.40 d from seeding to emergence and produced flowers after 32±1.75 d following emergence. This parasitic weed completed its life cycle within 96±4.5 d from seeding to release of first formed seeds. The mean seed production per plant recorded was 19,090±1,189. Root-shoot ratio on dry weight basis was found to be 1:14, indicating lower root volumes due to its parasitic habit. Haustonum, a peg like structure developed from the tip of striga root penetrated into sugarcane root and formed a common bridge. This haustorium maintained connection between host and parasite possibly to absorb minerals and water from the latter.

INTRODUCTION

Striga *(Striga densiflora)* a dicotyledonous plant belongs to family scrophulariaceae which is locally known as "Bijlee ghash" is a serious root parasitic weed of sugarcane. In Bangladesh, it grows in an area of more than 1036 square kilometres, the distribution of which has been shown in the Appendix 1. Striga occurs in the sugarcane fields of Rajshahi, Pabna, Nator and Kushtia districts of which Muladuli, Malunchi, Nandangachi and Arani areas are observed to be seriously infested ones (SRTI, Annual Report, 1979). Depending on the severity of infestation, a significant yield reduction in sugarcane upto 84 percentage is reported (Kabir *et al.,* 1989). The exact first occurence of this weed in Bangaldesh is not known, however it was first noticed in sugarcane field about 77 years back (Ahmed and Mian, 1977). The available reports indicate that this parasite contaminated sugarcane of the oldest sugar mills areas where a major portion of seed canes were imported from India (Ahmed and Mian, 1977). Now a days Striga is becoming number one enemy of sugarcane in the areas mentioned earlier and creating hazzards to the cane growers causing great economic losses every year. Many species of Striga have been found to occur all over the world but species prevailing in Bangladesh has been identified as *Striga densiflora* (Ahmed and Mian, 1977).

Striga is dominant in lighter soil with areas of drier climate, receiving low annual rainfall. However, it is also found to grow on heavy soils provided other conditions reamin favourable but does not thrive well in wet and high rainfall areas Striga seeds remain dormant in soil for a long time and germinate only when come in close Contract with suitable hosts. It establishes its contact directly with vascular system of host plant through haustorium and sucks water and nutrients from host resulting in huge crop yield losses.

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This parasitic weed has been studied in aboard in relation to host specification (Doggett, 1984), respones to fertilizer inputs applied to crops (Parker, 1985) and on the physiological basis of growth and development (Ramaiah, 1984). A delay in seed germination was also explained due to secretion of chemical stimulant by host roots (Rao, 1987). In Bangladesh, a reasonably large sugarcane areas are infested by striga each year but no due attention has been given to this potential hazzard, and no systematic research work was carried out in past regarding growth, morphology and plant characteristics of striga as well as its parasitic association with host plant.

A basic understanding on the above mentioned areas is essential for developing an effective control measure of striga. Therefore, the present investigation has been carried out to study the striga's growth, morphology, important plant characteristices and host–parasite relationship.

MATERIALS AND METHODS

The research work was carried out at Sugarcane Research and Training Institute farm during 1987-88 crop season. Experiment was conducted in earthen pots of 26×30 cm size. Striga seeds were collected from striga infested areas of Pabna district and kept in a refrigerator till its use. The entire study has been clasified under following headings :

A. Study on general morphological characters of striga,
B. Study on some selected plant characters of striga,
C. Study on host - parasite relationship.

Striga plants were grown at earthen pots in association with sugarcane (host) plants to accomplish the studies. Each pot was filled up with mixtures of soil and cowdung @ 10 kg in ratio 2:1. Soils were collected from striga free areas and sterilized by heat to kill pathogens and weed seeds. Four-week aged settling of sugarcane, variety L. Jaba-c was raised in polythene bags (12.5 cm × 10 cm) and transplanted in each pot along with 15 striga seeds placed around the seettling so that roots of sugarcane plant and striga seeds remain closer for promoting germination of the latter.

Pots were watered as and when required to maintain adequate moisture level for germination of striga seeds as well as for normal growth of canes. Weeds other than striga were removed from all pots, and only striga plants were allowed to grow with sugarcane. Necessary other cultural operations were done as per recommendations.

A. Study on the general morphological characters of striga

Striga plants were collected from earthen pots on which they were grown in association with sugarcane, and they were seperated from sugarcane roots by careful washing under tap water. Morphological characters of different plant parts, such as habit, root, stem, leaf, inflorescence, flowers, fruits and seeds etc were studied by visual and microscopic observations. Description of plant parts was made as per Dutta (1973). Magnifying glass, scissors, foreceps, needle, Knife, brush, petridish, coverslip, microscope etc were used while studying plant parts of striga.

B. Study on some selected plant characters

The following plant characters were studied :

1. Number of days required for emergence.
2. Seasonal plant height (cm).
3. Stem growth pattern of striga.
4. Number of days required for flowering.
5. Number of days required for fruiting.
6. Number of effective fruits/plant.
7. Number of seeds/fruit.
8. Number of seeds/plant.
9. Plant dry weight (gm).
10. Root-shoot ratio.

The mean of each plant character was obtained from a total of 50 representative sample plants. Plant height was measured in each week and stem growth rate was determined from the plant height. Flowering date was recorded when 50 percentage of the plants produced flowers. Fruiting time, however, was considered with plant completed 50 percentage fruit production. Plant dry weight was taken after drying samples at 80° C for 24 hrs in an oven, and root-shoot ratio also determined on oven dry basis.

C. Study on host - parasite relationship

a) External morphology of striga - sugarcane root connection :

External morphology of host - parasite relationship was investigated by means of visual observation and photography Striga plants as grown with sugarcane at earthen pots were taken away with roots of its own and of sugarcane, and washed carefully to remove soils for exposing host - parasite establishment. Haustorium developed by striga parasite, and penetrated into host root formed a common bridge between parasite and host. This structure was observed and photographed.

b) Internal morphology of striga-sugarcane root structure :

Additional striga plants were depotted and washed free of soils so that host-parasite structures within roots were not destroyed or disconnected. Later on, transverse sections of haustorium penetration zone between host and parasitic roots were made by hand with the help of a sharp blade. The fine sections were selected and stained in Methylene Blue and mounted in 50 percentage glycerine. Slides were prepared by using fine sections of host-parasite root structures and observed under a light microscope. Finally figures of these tissue structures were drawn by free hand.

RESULTS AND DISCUSSION

A. 1. General morphological characters of striga

The different general morphological cheracters of striga plants studied and described with photographes and diagrams presented in Figures 1-6.

Vegetative characters :

Habit : Herbaceous, annual, root parasitic plant and sometimes branching in habit (Figure 1).

Root : Tap root system (Figure 2), the mean length of principal root was found 6.0±0.60 cm. Number of primary branches were 9.0±0.70 and roots become swollen at the point of attachment to the sugarcane roots. Root is devoid of root hairs. This observation is in agreement with the findings of King (1974). Striga root cannot absorb water and minerals from the soil possibly due to the absence of root hair of its own.

Figure 1. A Striga plant.

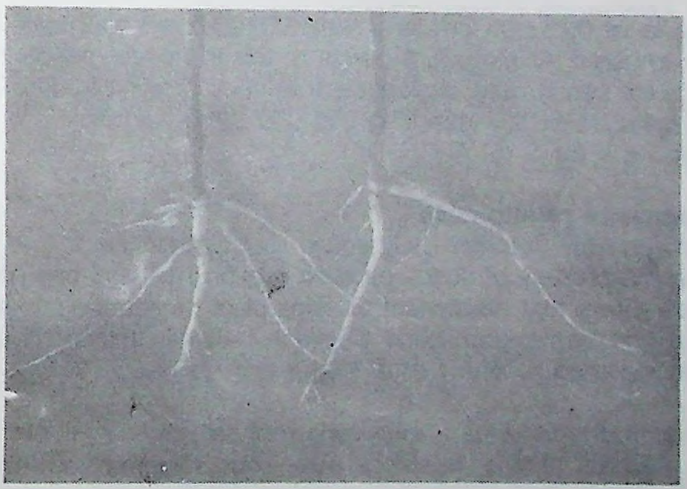


Figure 2. Root of Striga.

Stem : Stem is erect, rounded close to the ground (below and above) and often becoming square on the upper part of the plant. It is green but sometimes light pink nearer to the ground and provided with shallow groove on all sides along the length, being covered with rough minute hairs. Stem is often branched and branches are produced laterally. These observations are in agreement with the findings of Shaw *et al.* (1962) and Rao (1987) who worked with the species *S. asiatica* and *S. lutea*, respectively.

Leaf : Simple, sessile, opposite (decusate) on the mainstem below the branching zone but alternate on the branches. Minute hairs are present on the dorsal side of leaves. Leaf is green but sometimes light pinkish. Leaf apex is acute, and shape is linear. Mean leaf size was found to be 4.5±0.30 cm in length and 3.25±0.25 mm in width.

Floral Characters :

Inflorescence : Spike, flowers are sessile. A similar flower type and inflorescence have also been reported by Rao (1987).

Flowers : Complete, Irregular, bisexual, hypogynous and bracteate. Flowers are white coloured (Figures 3A and 3B).

Calyx : Sepals five, gamosepalous, pappus, green and companulate.

Corolla : Petals five, gamopetalous, zygomorphic and tubular.

Androecium : Stamens four, epipetalous, stamens are of unequal length, outer two short and inner two long i.e. didynamous. Anthers are adnate, over-lying with the fillament.

Gynoecium : Bicarpellary syncarpases, overy superior, bilocular with bilobed stigma.

Fruit : A capsule of 0.75±.05 cm long with 3.0±0.20 mm diameter and is partially two chambered. At maturity it bursts at top to release seeds.

Seeds : Seeds are very minute, angled, black to deep brown coloured. Individual seed measured 0.68±0.03 mm long and 0.27± mm width.

Floral fourmala : ± k (5) C (5) A_2+_2 G (2)

A. 2. Host-parasite relationship

a) External morphology of striga - sugarcane root connection.

The external morphology of host - parasitic relationship has been presented in the Figure 4 which shows that haustorium of striga plant penetrated into sugarcane root and formed a common bridge. Such a linkage between the striga and host roots has also been identified by Shaw *et al.* (1962) and Ba (1983).

b) Internal morphology of striga - sugarcane root structure.

Transverse section of the host- parasite root structure as observed under microscope confirmed that a tube like structure (haustorium) extending from striga root entered into sugarcane root (Figure 5). The host - parasitic root structure showed

that the haustorium, a peg like structure developed from tip of striga root penetrated into epiblema of host root and reached to vascular tissues of the latter passing through cortex and endodermis of the same. Shaw *et al.* (1962) and Rao (1987) reported that striga root penetration appeared to be accomplished through chemical or enzymatic means rather than mechanical pressure. This tube like haustorium maintains connection between host and parasite and possibly absorbs minerals and water from host. A phenomenon of transportation of minerals and water from host to parasite is also reported elsewhere (Shaw *el al.*, 1962; Egley, 1971; Singh, 1983).

C. Study on some selected plant characters

Selected plant characters of striga studied are presented in the Table 1. Data show that striga plant emerges after 33±1.40 d of seeding. This delay in emergence of parasitic weed has been explained by many workers (Shaw *et al.*, 1962; Singh, 1983; Rao, 1987). According to those workers, seeds do not germinate until and unless they come close to host roots and are stimulated by host root exudates. It has also been reported that adequate soil moisture is required for germination, and emergence of striga (Shaw *et al.*, 1962). The present experiment revealed that number of days required for flowering after emergence is 32±1.75 d, and plant requires another 31±1.72 d for fruiting. These observations are similar to the findings of Shaw *et al.* (1962) who reported that striga produced flowers in about one month following emergence and took another one month for maturing fruits.

It was also observed that striga plant bears indeterminate flowers and fruits. However, most of the late flowers do not mature into effective fruits/seeds. The whole life cycle of striga isthus completed within 96± d. 4.87 takinginto account of seeding time to the release of first formed seeds. Shaw *et al.* (1962) stated that striga plants take 90-120 d for completing life cycle.

Data presented in the Table further show that number of fruits/plant were 38.40±2.25 whereas the number of seeds/fruit were found to be 502 + 2.25. However as high as 19,090±189 seeds were recorded from a single plant. Quite a higher number of seeds plant (10-100 thousands) has been reported by Shaw *et al.* (1962). It is important to note that striga seeds are very minute and even smaller than tobacco seeds. Dry matter accumulations as experessed by plant dry weight was 0.72±0.07 gm/plant, and root - shoot ratio was 1:14 on oven dry bais. Result on root - shoot ratio implies that higher shoot dry weight of striga compared to root was mainly due to its parasitic nature. On the other hand, this ratio in crop plant should evidently be narrower. For instance, Miah *et al.* (1987) studied 45 d old settlings of sugarcane and found that root: shoot was 1 : 4 only.

Seasonal plant height

Seasonal plant height shown in the Figure 6 A represent that stem height of striga is increasing progressively upto 56 d after emergence. Later on, stem height increases very little as the plant approaches to maturity. Further, the graph shows that striga plant attains one-third of its final height within 21 d after emergence and more than two-thirds of the final height after 35 d of emergence which is actually during the early flowering stage. Final plant height is attained at 63 d after emergence beyond

which there occurs practically no growth of plants, and the mean plant height of 25.60±1.29 cm was recorded at maturity.

Figure 3A. Flowers of Striga

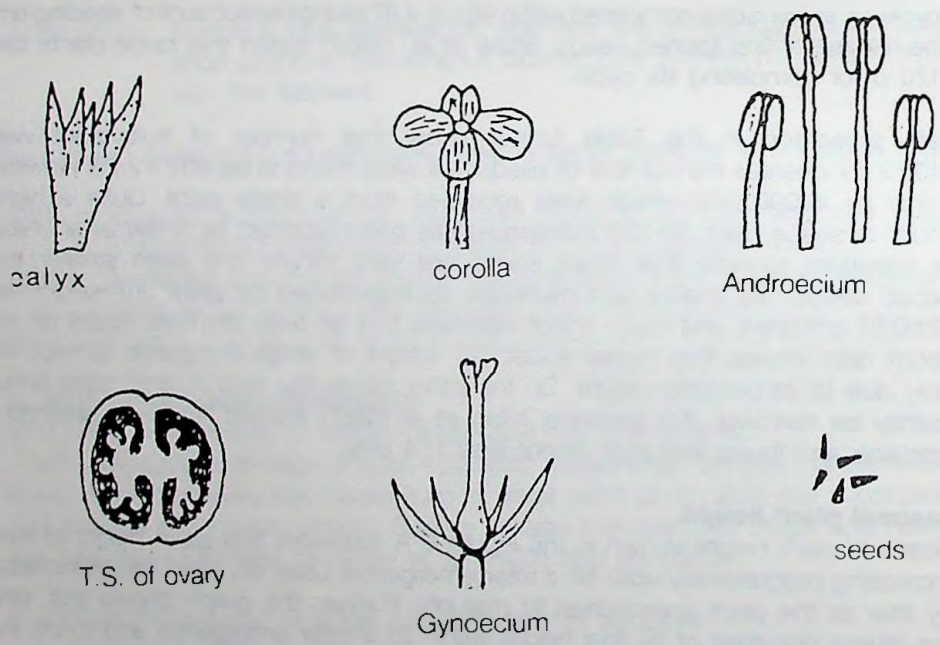


Figure 3B. Floral parts.

Figure 4. External morphology of Striga-Sugarcane root connection.

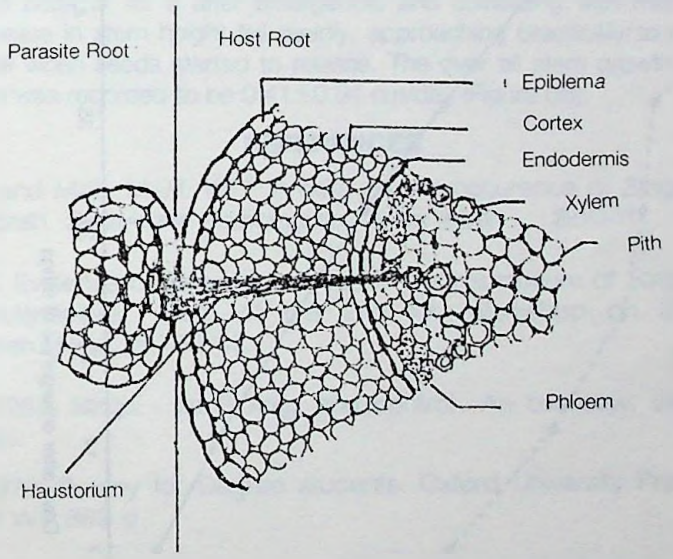
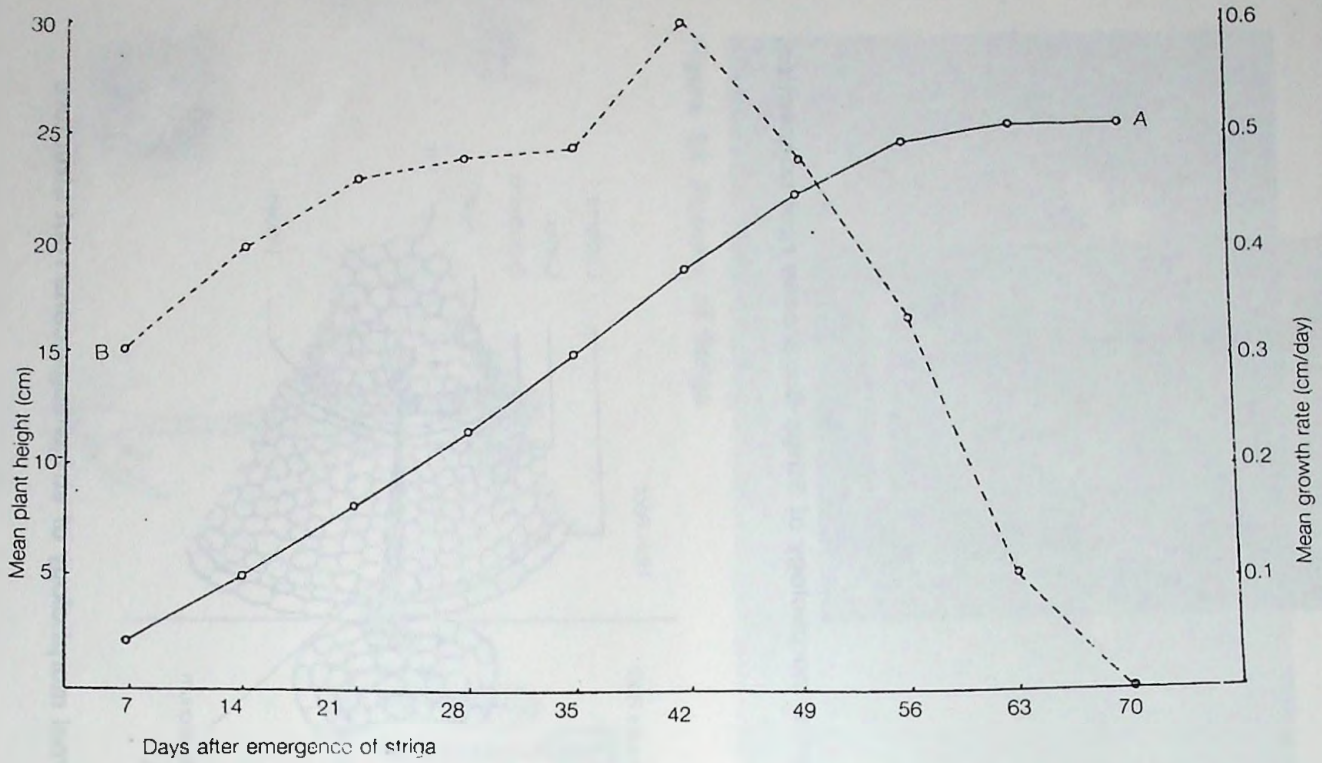


Figure 5. Internal morphology of striga-sugarcane root structure



Figue 6. Graphical representation of striga growth and development : A. seasonal plant height B. Stem growth pattern.

Table 1. Observation on some selected plant characters of Striga.

Sl. No	Selected plant characters	Mean*	SE (±)
1.	Number of days required for emergence of striga.	33.00	1.40
2.	Number of days required for flowering after emergence.	32.00	1.75
3.	Number of days required for first fruiting after flowering	31.00	1.72
4.	Number of effective fruits/plant	38.40	2.25
5.	Number of seeds/fruit	502.00	2.25
6.	Number of seeds/plant	19,090.00	1,189.00
7.	Plant dry wt. (gm).	0.72	0.07
8.	Root-shoot ratio (dry wt. basis)	1.14	—

*Mean values of 50 plants
SE - Standard error of mean

Stem growth pattern of striga

The growth pattern recorded as stem growth/day of striga was faster upto 21 days after emergence and after which it increased slowly during early stage of flowering. Stem growth rate attained its peak at 42 d after emergence, and coinciding with mid flowering time. Thereafter, increase in stem height fell rapidly, approaching practically to nil beyond 63 d after emergence when seeds started to release. The over all stem growth throughout the growing season was recorded to be 0.41±0.04 cm/day (Figure 6B).

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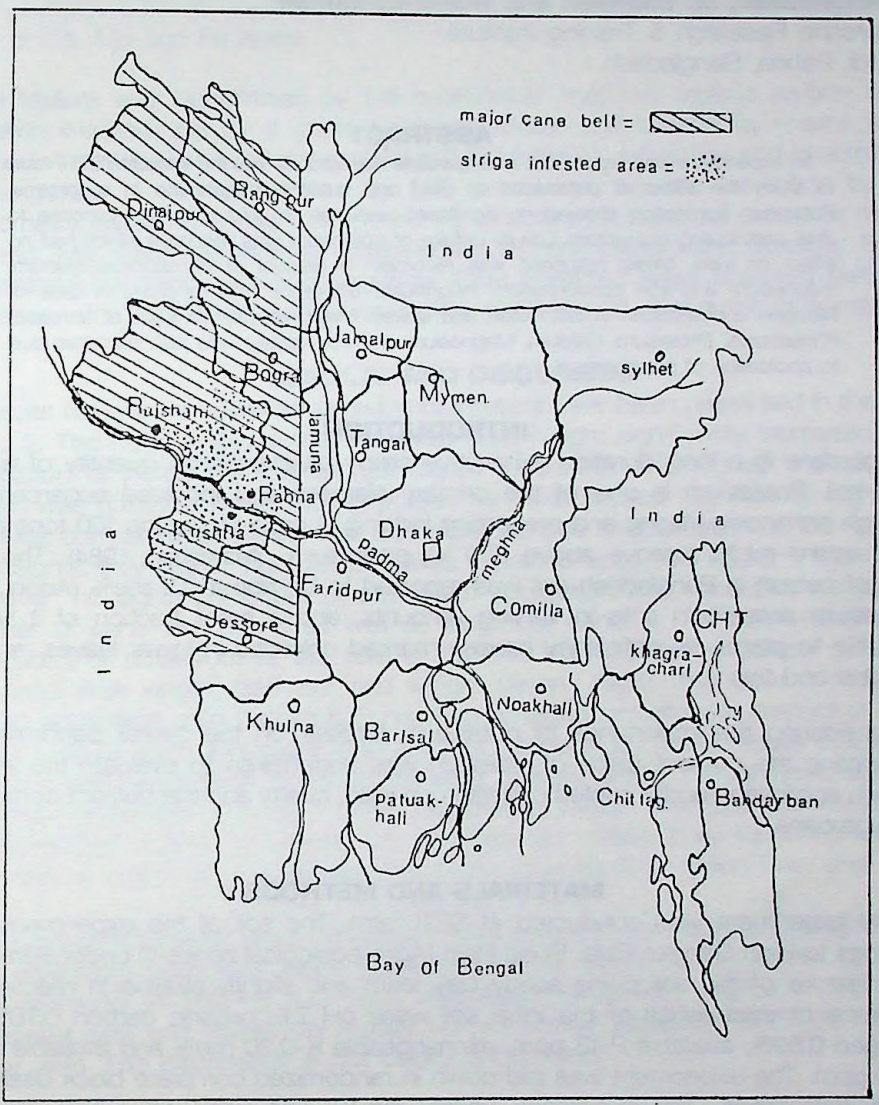
Appendix I.



Striga infested areas of Bangladesh (greater districts).