

## A SURVEY OF INFESTATION OF CROPS BY STRIGA SPP. IN BENIN, NIGERIA AND TOGO

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The incidence of *Striga* spp. on agricultural crops in Benin, Nigeria and Togo between latitudes 4° N and 13° 30' N was surveyed in 1984 and 1985. The survey covered 463 fields in Nigeria, 112 in Benin and 55 in Togo. It was found that the *Striga* spp. responsible for significant commercial losses were *S. hermonthica*, *S. asiatica*, and *S. aspera*. In Nigeria *S. hermonthica* and *S. aspera* were frequently responsible for 100% loss of the crop. In the maize growing areas of Southern Benin and Togo the crop was mainly infested with *S. asiatica*. *S. aspera* is recorded on lowland *Oryza sativa* for the first time. Evidence is presented for the growth of *S. hermonthica* on *Arachis hypogea*.

Au Benin, au Nigeria et au Togo la présence du *Striga*, mauvaise herbe parasitaire se situe entre latitude 4° N et 13° 30' N. En 1984 et 1985 une prospection de 463 champs au Nigeria, 112 au Benin et 55 au Togo a montré que les espèces de parasite provoquant les dégâts significatifs sont les *S. hermonthica*, *S. asiatica* et *S. aspera*. Les pertes de récolte s'élevant fréquemment au 100% au Nigeria sont dues à *S. hermonthica* et *S. aspera*. Dans les champs de maïs au sud du Benin et Togo l'espèce la plus importante est les *S. asiatica*. Pour la première fois, on observe l'infestation du riz irrigué par une espèce de *Striga*, le *S. aspera*. On note également pour la première fois que l'arachide (*Arachis hypogea*) est attaquée par *S. hermonthica*.

### Introduction

*Striga* species are root parasitic weeds that cause major losses to cereal crops in Africa. The biology and taxonomy of the species have been reviewed (Musselman, 1980). The parasite causes extensive losses on maize (*Zea mays*) through growth reduction, poor pollen production, barrenness, weakening of the stem and mortality. They are equally harmful on other cereal crops such as sorghum (*Sorghum vulgare*), millet (*Pennisetum glaucum*), rice (*Oryza sativa*), hungry rice (*Digitaria exilis*) and sugar cane (*Saccharum officinarum*). *Striga gesneroides* is parasitic on *Vigna unguiculata* (cowpea). Maize is one of the most important cereal crops in Western and Eastern Africa and is replacing sorghum in areas where the rainfall is greater than 600 mm  $y^{-1}$ . In the savanna of Northern Nigeria, maize production has increased by 46% in the period 1980 to 1985 (or from 7% to 10.6% of the total cereal crop; United Nations, 1985). In the South, maize farming has also increased by about 40% in the derived savanna zone of the rainforest (Fajamisin, 1985). In Benin and Togo where maize is relatively more important (80% of the cereal crop in Benin and 48% in Togo) production has also increased by 24% and 36% in the period 1980 to 1985 (United Nations, 1985).

Maize, however, is a relatively new crop in the sorghum and millet growing areas and it is more vulnerable to infestation by *Striga* spp. but the distribution and relative importance of the weed is not well documented. Thus the object of this survey was to determine the distribution and severity of *Striga* spp. on maize in particular and other crops in general. Hopefully this will enable the Maize Improvement Program at the International Institute of Tropical Agriculture implement its mandate which is centered on the development of high yielding, pest and disease resistant varieties for Africa.

### Methods

Surveys were conducted over a two year period (1984 & 1985) from June to October in each year, with at least 2 visits to each area (Cochran, 1977). This was necessary because planting dates varied and even though symptoms of *Striga* infestation were evident on the crop, it was important for identification purposes to visit when the parasite was in flower.

The area surveyed extended from latitude 4° 30' N to 13° 30' N in Nigeria; 5° 30' N to 12° N in Benin and 6° N to 11° N in Togo. Villages to be visited were selected at random before the trip was undertaken. Seventeen out of 19 States in Nigeria were surveyed, at least 10 farms were visited in each administrative zone. In Benin and Togo, the survey was conducted in all provinces. Administrative zones in these countries are much smaller than in Nigeria and therefore, all farms were visited in

**Table I** Distribution (%) of *Striga* on *Zea mays*.

States	No. of fields sampled	<i>S. hermonthica</i>	<i>S. aspera</i>	<i>S. asiatica</i>	Other Spp.
<b>NIGERIA</b>					
Anambra	27	0	0	19	0
Bauchi	34	12	68	0	0
Bendel	10	0	0	0	0
Benue	43	40	74	23	0
Borno	24	29	25	0	29*
Cross River	10	0	0	0	0
Gongola	43	21	61	0	0
Imo	10	0	0	0	0
Kaduna	39	64	31	0	5'
Kano	19	100	0	0	5'
Kwara	49	33	45	22	8''
Niger	57	86	19	11	0
Ondo	10	0	0	0	0
Oyo	20	0	0	25	0
Plateau	39	69	65	15	5 <sup>+</sup>
Rivers	10	0	0	0	0
Sokoto	19	58	0	0	0
<b>BENIN REPUBLIC</b>					
Atakora	30	57	23	47	
Atlantique	5	0	0	0	
Borgou	34	59	15	50	
Mono	10	0	0	50	
Oueme	6	0	0	0	
Zou	27	0	41	48	
<b>TOGO</b>					
Centrale	10	30	50	70	
Maritime	12	0	0	83	
Plateau	9	0	0	78	
Kara & Savannes	24	88	46	38	

\* *Striga parssargei*; ' *S. brachycalyx*; '' *S. forbesii*; + *Buchnera hispida*.

areas with less than 10 maize farmers. On farms of less than 10 ha, the entire field was surveyed; on those over 10 ha, 10 plots with a basal area of 10 m<sup>2</sup> were established at intervals of 50 m, starting from the corners and working towards the center of the field. Interviews with farmers were always conducted at the farm and occasionally farmers in small villages requested a group discussion.

Surveys of the weed and its hosts were based on the presence or absence of the parasite. A field was considered infested if at least one *Striga* plant was found. Visual estimation of the percentage of crop plants infested was made and rated as follows: 0 = no visible sign of infection; 1 = less than one-third of the field affected; 2 = two-thirds infested; 3 = more than 2/3 infested. The *Striga* population was also visually estimated and was rated 1 for low; 2 = moderate and 3 = heavy infestation. In Table II these ratings were given under the headings "Effect on crop" and "Parasite density" respectively.

## Results

### NIGERIA

*Infestation of Zea mays by Striga spp.* In a country with a diversified ecology ranging from the rain forest to the arid sahel, *Striga* was present in varying degrees from slight to heavy infestation in all but the high rainforest zone (Table I). A total of 6 species were found on maize, 3 of which were of economic importance.

*Striga hermonthica* is characterized by large bright pink flowers with a five-ribbed calyx tube. The plant is erect, highly branched and can reach a height of 80 cm. It occurred in 10 out of 12 States where the weed was present (Fig 1, Table I) and was predominant in the drier northern-most zones causing serious loss in yield in the following States: Niger, Kaduna, Kano, Sokoto, Plateau and upper Benue. All the farms with a heavy *Striga* rating (3) in these areas were abandoned (Table II).



Fig 1 Map of area surveyed. Distribution of species indicated as follows: o = *Striga hermonthica*; ● = *S. asiatica*; △ = *S. aspera*; ■ = *S. gesneroides*; □ = *S. forbesii*; \* = *S. brachycalyx*; ▲ = *S. passargei*.

*Striga aspera* is similar to *Striga hermonthica* except that the width of the corolla is smaller; the corolla tube is 0.5-1 times longer than the five ribbed calyx tube, and the seed capsules are bigger. The plant is less branched with much narrower leaves and less foliage. Usually a high proportion of plants have purple pigmentation throughout the entire plant. This species was more important in the wetter areas of the Guinea and woodland savannahs where the mean annual precipitation is greater than 100 cm. *Striga aspera* appeared to be virulent on maize resulting in stunting and death of the crop before tasseling. Many farms with moderate to heavy infestation were abandoned in the Guinea savannah zone of Bauchi, lower Benue, upper Plateau and in Kwara States (Table II). Niger State was an exception where *Striga hermonthica* was predominant in a woodland savannah ecology.

*Striga asiatica* is a much smaller plant which grows up to a height of about 30 cm. The flowers are small and the corolla measured 5-10 cm in diameter with a ten ribbed

**Table II** Mean *Striga hermonthica*, *S. aspera* and *S. asiatica* ratings for densities of parasites and effects on crops in the States of Nigeria, Benin and Togo.

States	<i>S. hermonthica</i>		<i>S. aspera</i>		<i>S. asiatica</i>	
	Parasite density	Effect on crop	Parasite density	Effect on crop	Parasite density	Effect on crop
<b>NIGERIA</b>						
Anambra	0	0	0	0	1	1
Bauchi	2	2	3	3	0	0
Bendel	0	0	0	0	0	0
Benue	2	3	3	2	2	2
Borno	3	3	2	2	0	0
Cross River	0	0	0	0	0	0
Gongola	3	2	3	2	1	1
Imo	0	0	0	0	0	0
Kaduna	3	2	1	2	0	0
Kano	3	2	0	0	0	0
Kawara	3	2	3	3	2	2
Niger	3	3	3	3	2	2
Ondo	0	0	0	0	0	0
Oyo	0	0	0	0	1	1
Plateau	3	3	2	3	2	2
Rivers	0	0	0	0	0	0
Sokoto	3	2	0	0	0	0
<b>BENIN REPUBLIC</b>						
Atakora	3	3	2	2	2	2
Atlantique	0	0	0	0	0	0
Borgou	3	3	2	2	2	2
Mono	0	0	0	0	2	3
Oueme	0	0	0	0	0	0
Zou	0	0	2	2	1	1
<b>TOGO</b>						
Centrale	2	2	2	2	2	2
Maritime	0	0	0	0	3	3
Plateau	0	0	0	0	2	1
Kara & Savannes	3	2	2	2	2	2

calyx tube. The yellow flowered variety was the only species found in a few farms in Anambra and Oyo States. It was also present in Kwara State where, in some cases, it was the only species on maize. The occurrence of this morphotype was the only record of *Striga* in the rain forest ecology at Erin Ile at latitude 8° 1' N, northeast of Ibadan on the border of Kwara and Oyo States. In Niger and Benue States, it was usually in association with *Striga aspera* and *Striga hermonthica*. The red flowered variant occurred in Plateau State and the white flowered morphotype was found in Gongola State; its effects on the crops were less serious at both locations.

The intensity and severity of these 3 species across the country ranged from 50-100% of all fields sampled (Table II), except in Anambra and Oyo States.

*Striga brachycalyx* was present mostly in the northern parts of Kwara State and caused slight damage to maize on the few farms where it occurred. The plants attained a height of about 30cm, sparsely branched with leaves much more narrowly lanceolate than those of *Striga aspera*; flowers were light pink with a five ribbed calyx tube.

*Striga passargei* was found on maize growing in the bed of Lake Chad in Borno State. The plant was highly branched and grew to a height of ca. 30 cm with lanceolate to broad leaves, white flowers with a corolla diameter of 7 mm and a five ribbed calyx tube. Its severity on the crop was low to moderate. It was also present in a few farms in Kwara State.

*Buchnera hispida* a close relative of *Striga*, with blue flowers, occurred in Kaduna and Kano States. The sparsely branched plant grew to a height of 30-80cm, five petals measured 4-7 mm in diameter with a ten ribbed calyx tube. Although it was found parasitizing maize, sorghum and millet, it was not of economic significance.

Infestation of other Agricultural Crops by *Striga* spp. Sorghum and millet were seriously attacked in the Sahel and Sudan savannah zones by *Striga hermonthica* which was the predominant species in areas whose annual rainfall was less than 80 cm. These crops were also seriously attacked by this species and by *S. aspera*, and *S. asiatica* in Bauchi, Niger and Gongola States. In general sorghum was more infested than millet.

Upland rice was infested by *Striga hermonthica* in Gongola State whereas lowland rice was heavily infested by *S. aspera* in this State and in Plateau State, reducing the potential yield by over 70% in some cases. These observations were made at a few rice farms during the survey and do not indicate the effect of the weed on the rice crop in general. *Digitaria exilis* (hungry rice), a small grain crop was attacked by *S. aspera* and the red flowered variety of *S. asiatica* in Plateau State. Sesame (*Sesamum indicum*) was infested by *S. asiatica* in Benue and by *S. gesneroides* in Kano State.

Groundnut crops (*Arachis hypogea*) in Bauchi State were heavily parasitized by *S. aspera* and moderately infested by *S. hermonthica* in Niger State (cf. Andrews, 1947). Almost all incidence of *Striga* on this crop were on farms where maize or sorghum was intercropped with it and the cereal crop had been killed by the parasite. One incidence of infestation was observed on groundnuts where this was the only crop, but no apparent damage to the host was seen (Fig 2). Infestation of cowpea by *S. gesneroides* occurred only in the Sudano-sahelian savannah region where the mean annual rainfall was < 80 cm. The pink flowered variant of this species occurred in Niger State but not on the crop — it was found as a parasite on the wild legume *Arachis repens*.

## BENIN REPUBLIC

*Incidence of Striga spp. on Zea mays.* *Striga* spp. were present in all Provinces. However, there was little incidence of *Striga* on maize in the southern provinces of Oueme and Atlantique; farmers reported sporadic infestation in some years.

*Striga hermonthica* was predominant in the two northern provinces of Atakora and Borgou and was practically the only species further north near the borders with Niger and Burkina Faso (Fig 1, Table I).

*Striga aspera* was more serious in the Central Province of Zou where many farms were abandoned. The crop in an entire village in the Djonta Kpassagon region was severely infested.

*Striga asiatica*: the yellow flowered variant was commonplace in Northern Zou and Southern Borgou Provinces. It also occurred in the North-western part of Atakora but was of lesser importance than *S. hermonthica*. The red flowered variant was present in the province of Mono and the white flowered variant was found on a few farms in Atakora.

*Infestation of other crops by Striga spp.* Other crop hosts were sorghum and millet in the northern parts of Atakora and Borgou Provinces where they were heavily infested by *S. hermonthica*. Cowpea served as the host of *S. gesneroides* in the provinces of Oueme, Atlantique and Zou. Farmers claimed that most of the cowpea consumed in Benin used to be produced in Zou Province but in the last 5 years, this is no longer true because of *Striga* infestation.

## TOGO

In Togo *Striga* spp. were present in all regions of the country. In the savanna regions of the north 87.5% of the maize farms visited were infested with *Striga hermonthica*. It was also present in the central region of the country but was not the most important species, where *S. aspera* was most important (Table I). The latter species also occurred frequently in the savanna region.

*S. asiatica* the red flowered variant on maize was only observed in the maritime region. It occurred in 83% of all the fields sampled and caused such severe damage to the crop that fields were abandoned. Beyond this region, the yellow flowered variant was the representative of the species generally found. Sorghum and millet were the other food crops attacked by this species in northern Togo. No incidence of infestation of cowpea was found but the pink and white flowered *S. gesneroides* were seen on *Arachis repens*.

## Discussion

The survey showed that the most widely distributed species was *Striga hermonthica* (Fig 1), found ubiquitously on sorghum and millet in the Sahel. There is evidence (King and Zummo, 1977) for physiological specialization of this species and these crops. *S. hermonthica* is widely distributed in Africa (Doggett, 1965; Musselman, 1980; Musselman and Riley, 1984; Parker, 1984) and even at low infestation rates, dwarfing of the crop suggests toxic systemic effects. *S. aspera* appeared to be more virulent on maize, also causing damage at low frequencies of infestation (Table II). This species seemed to be better adapted to areas with higher humidity (Fig 1) epitomized by its infestation of rice in water-logged conditions. *S. asiatica* was at the least important of the 3 major species in Nigeria but was the only species found on maize in southern Togo, and in general appeared to be more common than *S. aspera* in most of that country.

The seed of *Striga* is dispersed by wind and water, particularly by dust storms during the harmattan, but also by the practice of grazing cattle in infested fields and their migration across borders in search of feed. Thus the imposition of quarantine regulations is neither feasible nor practical. The distribution map (Fig 1) suggests that the weed tolerates wide variations in soil type, but during the survey it was noticed that *S. aspera* in Togo was usually found in highly weathered soils with a high gravel component. It is therefore possible that detailed ecological studies might establish



Fig 2 Photograph of roots of *Arachis hypogea* infested with *Striga hermonthica*.

a relationship between the distribution of *S. aspera* and soil type.

Some indication of possible methods of control of *Striga* were observed during the survey. For example, in areas where the mean annual rainfall was  $> 80$  cm millet appeared to be resistant to *S. aspera*. It is possible that the root system of a crop adapted to high soil temperatures and drought does not secrete germination stimulants for *S. aspera*. Cotton is an important crop in Benin and Togo and is known to produce the germination stimulant strigol (Cook, 1972). Cotton is resistant to infestation by the weed but induces its suicidal germination. In practise good yields of maize were often seen when it was grown after cotton, but this effect only persisted for one cropping season. Hand weeding, hoeing and ploughing the soil were also found as attempts to control the growth of *Striga* on farms. Of these methods hand weeding was the most effective because the scale buds on the underground stem were uprooted. Hoeing and ploughing were ineffective because they destroyed only the aerial parts of the plant and, in fact, stimulated the scale buds to grow.

During the survey many discussions with farmers were held. In general, farmers were aware of the scale of the problem and the local names for the weed e.g. killer weed, fireweed, indicate their apprehension as the symptoms on the host made their appearance. Their general practice is to abandon infested fields and there were cases of relocation of families from Atakora to Borgou Province in Benin. Farmers are unaware of the life-cycle of *Striga*. For example bush fallow is often practiced and farmers are surprised that even after 5 years fallow maize becomes infested as they do not know that *Striga* seeds can remain viable in the soil for 20 years (Doggett, 1965). Even large farm operators do not appreciate the consequences of their actions. For example during the survey a large crop (1000 ha) of dwarf millet was examined. It was heavily infested with *S. hermonthica* but appeared to be resistant to the parasite which grew as tall as the crop — which was ultimately harvested by a combine.

The problem of *Striga* infestation is complex and much information needs to be disseminated to farmers, in particular details of agronomic practices designated to curtail the growth of the weed. In the meantime breeding varieties for resistance to *Striga* seems to be the most promising approach to improve crop production.

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