Striga Research

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An effective Striga research programme should consist of a field research component supported by more fundamental studies. These latter can be done at institutions in a number of countries both in the developed and third worlds, the only limitation being imposed by the possible risk of introducing Striga in to areas where it might have the potential to develop noxious weed.

The field component should preferably have several locations covering a range of ecological situations and soil types. One of these locations would serve as a centre where all Striga control systems that appear to be within reach of the small farmer would be examined. Those which appeared to be most practicable and effective would then be evaluated at each of the remaining centres, being duly modified as might be necessary to suit local conditions and cropping systems. The obvious main centre would be at Kamboinse - preferably under ICRISAT.

Programme and Staffing at the Main Centre

The thrust of the work on Striga control must be directed towards improved farming systems involving resistant cultivars. There is much detailed evaluation required of management systems, crop rotations, herbicide and germination stimulant applications, and the influence of fertility and other factors on the expression of Striga resistance. These are only some of the matter requiring investigation. It is therefore essential that there be a full-time agronamist at the main centre. A range of possible control measures must be evaluated for their effectiveness against Striga, and then those chosen ~~must be~~ integrated into the farming system.

Three plant breeders will be needed. One for millet, one for sorghum, and one senior breeder to hold together the programme at all sites - a co-ordinator, so long as that term does not imply a chair-borne paper-pusher.

Separate plant-breeders are needed for sorghum and millet, because the selection and testing locations will be miles apart, although both could live in Ouagadougou and have some of their material growing on Kamboinse, or at locations near-by.

The question may be raised on why there have to be breeders specifically for Striga - should it not just be one component of the sorghum or millet breeding programmes? All breeding programmes have to set priorities: and the fundamental nature of the Striga resistance requirement, together with the need for good seedling establishment, has been overlooked. Ramaiah's results illustrate the situation admirably. Order the priorities as (1) Good Striga resistance; (2) Good seedling establishment under difficult farmers' conditions (and Ramaiah would add, "selecting for tough survivors under difficult growing conditions"); (3) Good response to nitrogen, and other inputs. To these, add the requisite grain, panicle and plant type, growth duration/photosensitivity, and consistency of yield across locations/ seasons. That is what the "Striga" breeders will be aiming to produce, and they will supply much good material to the national programme plant breeders. The same will be true for millet. These Scientists will not be breeding for Striga resistance alone, but they will ensure that everything they produce is Striga resistant, establishes well, can stand tough growing conditions, and is responsive to inputs.

The senior breeder would have three main tasks: (1) Screening both sorghums and millets to identify yet better sources of resistance, testing the promising entries across locations; (2) Acting as network adviser and co-ordinator for the projects in national programmes; (3) General supervisions of the whole programme.

The other two plant breeders could well be nationals of Burkina Faso, working on a project with the national government, but under the guidance of a senior plant breeder/co-ordinator. They could be relatively junior scientists with a training component included.

Back-up Projects

(a) The selection for Striga resistance of host plants developed from somacloning or anther-culture. This could be done by the senior breeder with the aid of a good technician, once the techiques had been established. These procedures generate new source of variability, and some unexpected resistances have arisen in this way.

(b) There are no other projects of sufficient urgency to include in the breeding back-up programme at present. Parker (B, p188) emphasises the need for studies of resistance mechanisms. In my judgement, this does not have a high priority, unless money is plentiful. We know how to identify low stimulant producers, and also how to screen the best of these for field resistance. Ramaiah has been using these methodologies successfully and without undue difficulty. Let them suffice for the present.

AGRONOMY

I Fertilizers and Cattle Manure

Good field testing is required of the effects upon Striga resistance, and upon damage by Striga, of using fertilizers and cattle manure, especially those involving nitrogen. There is evidence that N in either form enhances resistance. Low fertility, usually the result of reduced resting periods through increased population pressure, is very often associated with high Striga infestation. In many parts of Africa, raising soil fertility through the use of cattle manure, probably supplemented by treated rock-phosphates, is a basic need for the agriculture as a whole. Improved fertility and good farming are Striga's main enemies.

Back-up Projects

(a) Continued Studies on Glutamine Synthetase (G.S.) Isoenzymes of Striga. Tissue nitrogen of the host root may be increased to a level at which Striga parasitism is directly inhibited. Very low nitrate concentrations in the xylem sap of Striga coupled with very low chlorlplastic GS activity suggest a very low primary assimilation of ammonia released from nitrate reduction. Glutamic acid is likely to be the major source of nitrogen transported from the millet host to the Striga parasite. (McNally et al, A, 66-72).

(b) Biochemical characterisation of Striga. Especially studies of nitrogen and carbon assimilation and the relationship between the two. Studies indicate that up to 17% of the carbon in Striga shoots could be derived from the host plant through obligate transfer of carbon during the transport of nitrogenous solutes from host to parasite. (Shah et al, A, 74-80).

(c) Any other project proposals that would help to elucidate the vulnerability of Striga to various forms of nitrogen.

II Rotations and Intercropping

Various crops germinate Striga seed, but do not act as hosts. Some of these are useful in rotations, to reduce the burden of seeds in the soil. This needs proper field evaluation. The results from both I and II need to be grafted on to Farming Systems projects.

Back-up Projects

(a) The identification of crops and crop strains which are very effective in germinating Striga. Improved pot-test techniques should make this much more effective than in the past.

(b) The use of ethrel, or synthetic strigol analogues such as GR24, in conjunction with these trap-crops, possibly in conjunction with pesticides, fungicides or herbicides that would normally be given to them as routine applications.

III Studies of the germination of Striga seed by synthetic strigol analogues, and other stimulants

Ethylene is very effective for germinating Striga seed in the soil, in the absence of a host. Methods of using ethylene developed in the USA need to be assessed for their economic applicability and effectiveness in the field.

Ethrel needs to be evaluated as a source of ethylene: could the use of ethrel ever be economic in the field in Africa?

The GR series of synthetic stimulants showed much promise for Striga seed germination, especially GR24. They appeared to be effective used in conjunction with certain herbicides.

The effect in the field of haustorial initiating compounds needs to be evaluated.

Back-up Projects

(a) Continued development of simple, small-scale equipment for injecting ethylene into the soil (Eplee, N. Carolina, B, 113-123).

(b) The development of the synthetic Strigol analogue GR24, and simple variants of it, such as one containing an unsubstituted butenolide group, which could be prepared readily and cheaply from furfuraldehyde, itself a cheap feedstock (Hassanali, B, 125-132).

(c) Further studies of the haustorial initiating activity of simple phenolic compounds. Studies of the effects of these compounds on attachment and development of Striga may lead to a practical control strategy (Macqueen, A, 118-122).

IV Herbicides

The results obtained in USA on the use of herbicides against Striga need to be evaluated in Africa under practical prevailing farming; conditions. Modifications of intercropping practices to accomodate use of certain herbicides. The diphenul esters (Goal, Flex, Fenac) may be very useful pre-emergence. More practical studies of the use of 2, 4-D derivatives and other post-emergence control chemicals are required (Eplee, B, 113-123).

Back-up Projects

To search for enzyme-directed herbicides that may block mannitol metabolism. Mannitol is of fundamental importance for the growth and reproduction of Striga. This is also true for Orobanche and probably some other obligate parasites also, and a herbicide of this type could have wide application and therefore a profitable market. (Nour et al A, 81-89).

V Possible back-up projects of less immediate applicability

(a) Biological control. The search for bioherbicides based on virulent strains of powdery mildew (*Sphaerotheca fuliginea*) or of Phoma spp. (Greathead, B, 133-160).

(b) Studies of resistance mechanisms (Parker, B, 179-189).

(c) Studies of the environmental factors influencing the host-parasite relationship, especially those influencing host resistance (Parker, B, 179-189).

(d) Identification of DNA segments associated with Striga resistance, with a view to future transfer once the technology has been well developed.

References

(A) Proceedings of the Third International Symposium on Parasitic Weeds, 1984. Sponsored by IPSPRG, ICARDA and (GTZ) GMBH: Aleppo, Syria.

(B) Striga, Biology and Control, 1984. ICSU Press and IDRC.

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Budget (all in USD)

1. The main work based on Kamboinse

A tentative budget prepared by Dr. Curtis Jackson for the on-going ICRISAT programme is available (attached).

This could be reduced by $287,000 by eliminating the following:

Item 6	Scientists tour and Workshop	51,000
Item 7	Short term consultants	60,000
Item 8	Assistance to national programmes	150,000
Item 9	10% overhead	26,000
		$ 287,000

The total then becomes $705,120: say $700,000 for three years.

The agronomist must be added, possibly as a separately funded component. This may well cost an additional $600,000 over three years, derived as follows from the same tentative ICRISAT budget.

Item 1	(for 1985)	Salaries etc.	125,000
Item 2	do.	Research expenses	43,000
Item 3	do.	Local travel	5,000
Item 4	do.	International travel	9,000
Item 9	do.	10% overheads	18,000
			$ 200,000

Total for Agronomist for 3 years: $ 600,000

An addition may be required for farm management, but the tentative total for both senior breeder and agronomist is: $1,300,000 USD over three years

2. Supporting National Projects

It is suggested that the sorghum breeder and millet breeder should be put in to the national programme, with the clear understanding that the priority in the breeding should go to:-

(a) Striga resistance

(b) Stand establishment under difficult local conditions

(c) Response to inputs, especially manure/fertilizer

The more complicated of these is the millet programme. Resistance has to be isolated and then crossed in to improved material. The national breeders would need to be in constant touch with the ICRISAT Striga breeder, since they will be developing the basic materials. They must therefore be near at hand.

It is suggested that a project at $300,000 per year over a three year period should be established.

Sorghum and millet breeding, national project (Burkina Faso) $900,000

3. Networks Projects

The network projects in national programmes would test, modify and use the experience and technology generated by the Kamboinse project and its associated National Programme project. They would be visited regularly by the ICRISAT Striga breeder. Suggested sites are Nigeria, Sudan, Ethiopia, Western Kenya or Western Tanzania, and Zimbabwe. These might be costed at $350,000 over three years each. The budget for a proposal from Nigeria is attached. This is in Naira, and given a more realistic contingency of 10%, the conversion at $1.6 = 1N. is equivalent to $350,000 USD. The cost of the present IDRC Striga project in the Sudan is approximately $100,000 USD per year, but it would be wise to round up to $350,000 USD for the three year period.

Projects in 5 national programmes $350,000 USD each = $1,750,000 USD

4. Back-up Projects

Ten back-up projects have been listed. The funding of these could probably be done at very reasonable cost in several institutions. A ball-park figure of $50,000 USD p.a. or $150,000 USD for a 3 year project is suggested.

Ten back-up projects at $150,000 USD each, total $1,500,000 USD

5. Less immediate back-up Projects

Four such projects have been suggested. Funded on the same basis as (4) above, the cost would be:

Four less urgent back-up projects @ $150,000 USD each over 3 years, total $600,000 USD.

Budget Summary for Whole Scheme

(Three year periods) in US Dollars

1. With ICRISAT at Kamboinse. Plant breeding Component, and Agronomy component	$1,300,000 USD	
2. Linked supporting national project @ 450,000	900,000 USD	
3. Five network projects	1,750,000 USD	
Grand Total	$3,950,000 USD	= 5,135,000 CAD
4. Ten Back-up projects	1,500,00 USD	
5. Four less immediate Back-up projects	600,000 USD	

Back-up projects may best be financed by the appropriate agency in the country concerned if done in the developed World.

Associated projects in Burkina Faso

It is suggested that a project on sorghum and millet should be supported with the government of Burkina Faso, should they so wish. The junior breeders in that project should be subject to the guidance of the Senior Breeder in the ICRISAT Striga project. Four junior breeders might be selected for training out of a group of 6-8 students employed during the projects first year. Two would be allotted to Sorghum, and two to Millet. They would work in the project for 18 months or so, then one from each pair would be sent to Canada for Masters Degree Training. The second member of each pair would go Canada for an MSC on the return of the first pair of qualified trainees. The running of the project would be arranged to suit this. At the end there would be two trained plant breeders with 2 years work experience with MSC: and two more who had completed their MSC