Workshop Proceedings
Actes de Seminaire

CIAT

Network on Bean Research in Africa
Reseau de Recherche sur le Haricot en Afrique

35644

PROCEEDINGS OF THE BEAN FLY WORKSHOP

ARUSHA - TANZANIA

16-20 NOVEMBER 1986

edited by D J Allen and J B Smithson

Pan-African Workshop Series No 1

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PREFACE

This volume marks the start of a new publications series that will document the findings of researchers on beans (**Phaseolus vulgaris**) in Africa Most of the anticipated publications will be the proceedings of workshops held to assess the status, future needs and methodological issues of research in selected topics that constrain production or productivity of this crop across much of Africa These occasional meetings of specialists from national and international research organisations form part of the activities of the pan-African bean research network, and serve to stimulate, focus and coordinate research efforts

The network is organised by the Centro Internacional de Agricultura Tropical (CIAT) through three interdependent regional projects for the Great Lakes region of Central Africa, for Eastern Africa and for the SADCC/Southern African region Some workshop proceedings will take more of a geographical focus highlighting research progress across many disciplines within a small group of countries

Support for the regional projects and these workshops comes from the Canadian International Development Agency (CIDA), the Swiss Development Cooperation (SDC) and the United States Agency for International Development (USAID)

Further information on regional research activities on beans in Africa is available from

Regional Coordinator, SADCC/CIAT Regional Programme on Beans in Southern Africa P O Box 2704, Arusha, Tanzania

Regional Coordinator, CIAT Regional Programme on Beans, P O Box 67 Debre Zeit, Ethiopia

Coordinateur Regional CIAT, Programme Regional pour l Amelioration du Haricot dans la Region des Grands Lacs, B P 259 Butare, Rwanda

Workshop Objectives

The purpose of the workshop was for the principal bean fly workers to meet and develop a coordinated research strategy on this pest Although bean fly does not occur in Latin America, a lot of work has been done in Africa and Asia, but conclusions are conflicting probably mainly due to species differences Emphasis will be on integrated control with concentration on host plant resistance DJA stressed the small, informal nature of the workshop, to encourage free discussion and debate The workshop was separated into 10 sessions over three days, with one day devoted to a field tour Since this was possibly the largest group of bean fly specialists ever to meet it was important that a full record of the discussions be prepared from which specific recommendations may emerge

Discussion leaders were named for each session and rapporteurs were appointed

Opening Session

Participants were welcomed and introduced by D J Allen Coordinator/Pathologist, CIAT Arusha (Full addresses in the Appendix)

Cesar Cardona	(CC)	Entomologist CIAT	Colombia
N Stuart Irving	(NSI)	Entomologist, EPAD	Zambia
Epimaki Koinange	(EK)	Bean Coordinator/Breeder TARO	Tanzania
Julia Kornegay	(JK)	Bean Breeder CIAT	Colombia
Jim Moyer	(JM)	Canadian Wheat Team	Tanzania
John Nderitu	(JN)	PhD student Entomologist ICIPE, Kenya	
Ferede Negasi	(FN)	Entomologist IAR	Ethiopia
Amos Oree	(AO)	Entomologist Ministry of Agriculture and Forestry	Uganda
Axel Panse	(AP)	PhD student formerly CIAT	Colombia
J Barry Smithson	(JBS)	Bean Breeder CIAT	Ethiopia
N S Talekar	(NST)	Entomologist, AVRDC	Taiwan
Peter Trutmann	(PT)	Pathologist CIAT	Rwanda

The workshop was hosted by the Tanzania Agricultural Research Organisation (TARO), through the Tanzania-Canada wheat project at Selian Research Station Arusha and the Tanzania Bean Programme JM described the development of wheat research for northern Tanzania, and the gradual evolution of Selian as TARO s Northern Research Institute which will also work on oilseeds grain legumes and maize

Tanzania Bean Programme

In absence of EK, DJA briefly described the history and current status of bean research in Tanzania

Work was negligible before independence and concentrated mainly on canning beans for export, but expanded in the 1960s Seed production for Europe was very important, but was controlled by expatriate firms

Food bean research dates back 20 years There are now three institutions involved the largest is TARO based at Lyamungu, but with a network of stations throughout the country, Uyole in the Southern Highlands with Scandinavian support, the largest research station in Tanzania, and Sokoine University of Agriculture in Morogoro, funded by a USAID Collaborative Research Support Project in collaboration with Washington State University, which has been involved for 5 years

Recent moves aim to develop a coordinated programme among the three institutions

SADCC/CIAT Regional Bean Programme

Described by DJA From March 1987, the SADCC/CIAT Regional Bean Programme is based at Selian, with funding from the Canadian International Development Agency (CIDA) This new regional project will work very closely with two other regional bean projects the Great Lakes Regional Project initiated in 1983 with funding from the Swiss Development Corporation, and the Eastern Africa project started in 1984 with joint funding from the United States Agency for International Development and CIDA These projects work with national programmes and are integrated to share specialised resources This workshop was one such joint activity

Session 1--Literature

Lead discussant Amos Uree (AU) Rapporteur Barry Smithson (JBS)

The purpose of this session was to discuss the availability of literature, and exchange bibliographies and other sources of information

AU described the contents of an abstract of the literature on bean fly in Phaseolus vulgaris prepared by himself and Guy Hallman at CIAT during a visit in 1984 The abstract includes references up to 1984 It covers the three species of Ophiomyia (O phaseoli, O spencerella and O centrosematis) of which O spencerella is the most important in Africa Subjects include taxonomy distribution and host range (including a comprehensive table by country), and biology--mainly from work of Greathead in Africa and others in Asia and Australia It is notable that leaf punctures are mainly for feeding and not oviposition with evidence that the upper surface is preferred for oviposition but the lower surface can be used in unfavourable weather conditions Damage estimates range up to 100% Control measures studied are

- chemical (mainly seed dressing but also spraying) cultural (mainly sowing-time infestations tending to be reduced during wet periods)
- host plant resistance (mechanisms and resistant materials identified)
- biological control (parasites identified) and
- integrated management (suggestions only)

A bibliography has also been prepared by Ashok Karel

Other reviews and bibliographies include

- A CAB document covering literature from 1913 to the mid-1960s
- A book to be authored by Dr N S Talekar entitled Beanflies of Grain Legumes in the Tropics and published by AVRDC/Wileys Eastern The book covers O phaseoli, O spencerella, O centrosematis, Melanagromyza sojae, and M dolichostigma, and includes 300 references It covers identification of species and feeding habits, and contains a seven-page table listing hosts by country First draft to be finished January and second by March for publication in 6 months, but more likely by the end of 1987 Available through AVRDC

All participants were requested to list the papers that they have not been able to obtain and request them from CIAT including Annual Reports and work not formally reported Outreach staff have obviously the best chance of obtaining these documents during their travel A copy of the Zambia report for 1985-86 was supplied Recent work of Karel does not appear in the abstract prepared by Uree during his visit to CIAT, but it was agreed that it was more important to complete it than to await additional references It was noted that work in Uganda subsequent to breathead is not formally reported

Useful publications are

Anon 1981 Principau Ennemis de Cultures de la Region de Grandes Lacs d Afrique Centrale September 1981 ISABU

Bohlen E 1972 Crop Pests in Tanzania and their Control Published by Verlag Paul Parey, Federal Agency for Economic Cooperation

Ingram W R Irving N S and Groome, R E 1973 Pest Control Handbook ODA/Botswana Govt, Govt Printer Gaborone (ref to O phaseoli in cowpea)

International Conference on Tropical Entomology 31 August-5 September 1986 Nairobi Abstracts S11 P 12 C 124

Okinda A P 1979 Influence of the bean fly (Diptera Agromyzidae) on the performance of French beans (Phaseolus vulgaris L) and some aspects of its chemical control in Kenya MSc thesis, Univ Nairobi

Spencer K A 1985 East African Agromizidae (Diptera) further descriptions revisionary notes and new records Journal of Natural History 19(5) 969-1027 Dep of Biological Sciences, University of Exeter United Kingdom

Talekar, N S and Chen D S 1985 The Bean Fly Pest Complex of Tropical Soybeans In Soybeans in Tropical and Subtropical Cropping Systems AVRDC

AF noted that Bayer have a computerised data retrieval system and he will contact them on his return home

Conclusions

It was agreed that Karel and Oree should consider merging their two publications to be pursued with A van Schoonhoven at CIAT The meeting noted the urgency of completing this document as soon as possible The CAB bibliography will be photocopied and distributed A photocopy of second draft of the Talekar book would be provided Talekar will request photocopies of references he has not seen from CIAT

There was some discussion of the screening of CIAT germplasm and breeding materials in Taiwan This had been undertaken by NST in response to a request from van Schoonhoven in 1978 No resistance had been found in P vulgaris two P coccineus accessions (G 35023 and G 35035) were highly resistant None of Regional Beanfly Resistance Nursery (RBFRN) entries were resistant Segregating populations in current field trials had suffered high losses due to *Pythium* and *Rhizoctonia* Resistant *P. coccineus* had been used in crosses and populations being screened in Great Lakes

Session 2--Species Identification

Lead Discussant Stuart Irving (NSI) Rapporteur David Allen (DJA)

The purpose of this session was to discuss the relative value of larval pupal and adult characteristics in the distinction of _Ophiomyia phaseoli_, _O spencerella_ and _O centrosematis_ The following information is a synthesis of discussions held in the conference room field and laboratory over two days The session also addressed procedures for collection and despatch of specimens for identification and the need for training in identification methods

Adult characters

NSI stressed that David Greathead s classic paper (_Bull Ent Res_ 59 541-561, 1968) remains a vital reference and his drawings of genitalia are an invaluable guide to identification Adult male flies are used by Irving in preference to larvae and pupae The techniques he has developed, among much other useful information, are being written up for publication, perhaps in _Bull Ent Res_

O centrosematis is distinguishable from the other two species by the shape of the orbital triangle which is equilateral in _O centrosematis_ and more elongated in _O phaseoli_ and _O spencerella_ The sexes of all three species are readily distinguishable the male has a bulb-like structure at the tip of the abdomen whereas the female s abdomen is tapered and truncated, thus

Fig 1

The ovipositor valve of females is useful but not an easy character to distinguish species NSI prefers the use of the male aedeagus

With a fine dissecting needle a small scalpel and a x60 binocular dissecting microscope cut off the abdomen and tease away the bulb (in 70% alcohol) and the aedeagus will come away with it The aedeagus of _O spencerella_ is solidly chitinised throughout (Fig 2a) whereas that of _O phaseoli_ (which is less distinctive) is less heavily chitinised (Fig 2b) The aedeagus of _O centrosematis_ has two tiny spines at its tip with small teeth behind them (Fig 2c)

FIG 2

For identification collect many stems, place them in a cotton bag and leave for adults to emerge The sex ratio is close to 1 1 NSI with practice is able to identify 100 adults per hour

Pupal Characters

It was concluded that the pattern and position of the posterior spiracle of the 3rd instar larvae and pupae are diagnostic (see Fig 1 in Talekar and Chen 1985) Larvae are difficult to handle, so pupae are preferable

FIG 3

In both *O phaseoli* and *O spencerella* there are 8-9 spiracle openings in rather large spiracles (Fig 3a), whereas in *O centrosematis* the spiracles are smaller and three-lobed (Fig 3b)

For our field visit we collected both *O spencerella* (much the locally predominant species in northern Tanzania at the time of our visit) and *O centrosematis* (a single pupa), which we examined and confirmed this distinction We did not find *O phaseoli* (although this species is previously known from northern Tanzania)

Pupal Colour

After sceptism had been expressed (because colour changes somewhat with maturation and parasitism) it was concluded that pupal colour was indeed a useful character although it was not as reliable as genitalia JN believes that *O spencerella* is consistently black tending to be paler on its ventral surface, close to the stem Both *O phaseoli* and *O centrosematis* are a translucent yellowish brown, darker towards the tips

Oviposition and Larval Feeding Site

O phaseoli probes and oviposits in the leaves, whereas *O spencerella* and *O centrosematis* oviposit directly into the stem The presence of subepidermal larval mining in the stem is characteristic of *O phaseoli*, larval feeding of the other two species is not easily visible

Identification Key (Larval and Pupal Characters)

1	Pupae black posterior spiracles with 8-9 openings relatively large no mining canals visible subepidermally	*O spencerella*
	Pupae translucent yellowish brown	2
2	Posterior spiracles of pupae large with 8-9 openings, larval feeding mines visible subepidermally	*O phaseoli*

Three small lobes on posterior spiracles, no mining canals visible externally on stem — O. centrosematis

It was agreed that the type of identification method adopted depended on the purpose. There was a need to establish with certainty what species occurred in any given region and season, and for this genitalia preparations were necessary. Thereafter, cruder methods of identification were satisfactory.

Collections for Identification

Mark Ritchie (National Museums, Nairobi) has offered to receive and pass on collections to the Commonwealth Institute of Entomology (CIE) in London. There are two advantages to doing this: we would build-up a central repository of specimens from the region in Nairobi, and the identification services of CIE would be free via this route.

It was suggested that dead adults be sent in gelatin capsules, dead larvae and pupae in alcohol, at least until an entomologist is appointed to the CIAT team in Arusha. The entomologist should visit both AVRDC and CIE.

Training in Identification

There are plans to run a training course in Malawi in March 1987 aimed at research technicians from the SADCC region. Techniques of Ophiomyia identification could be covered by Irving and Nderitu. This was agreed noting that there remained a need for similar training in other regions of Africa.

Session 3--Biology and Importance of *Ophiomyia* spp

Lead Discussant N S Talekar (NST) Rapporteur Cesar Cardona (CC)

The group reviewed past and present knowledge of the biology and habits of *Ophiomyia* spp The consensus was that a fairly good knowledge of the basic biology of the bean fly is available More or less detailed accounts of the behaviour and damage of the known species have been published

However areas in which more studies would be needed were identified Some of these are

1 The population dynamics of the three species throughout the year

2 Species composition as affected by geographical areas and altitude Good information has been obtained in Zambia but more studies in other areas are needed

3 Determination of carry-over potential of plant debris as well as migratory capacity of the species Sources of infestation need to be identified

4 More information is needed on the effect of different crop management practices on bean fly populations Some of the factors that ought to be considered are

- 4 1 Crop associations (in particular the bean tree legume association in Rwanda)
- 4 2 Crop rotations
- 4 3 Planting dates as related to peaks of adult emergence (see recommendations Session 4)

5 The consensus was that more studies should be conducted on the effect of environmental factors on bean fly populations and damage

6 The group also recommended a study to quantify yield losses due to *O phaseoli* and *O spencerella*

7 Apart from Greathead s publication on the biology and nature of damage of *O spencerella* little has been published The group recommends further studies on these aspects

Finally it was suggested that bean fly damage be considered as a factor when on-farm trials are planned

Session 4--Sampling and Collection Methods

Lead Discussant Julia Kornegay (JK) Rapporteur Barry Smithson (JBS)

This session is an extension of Session 3 especially in relation to distribution surveys

Many sampling methods have been examined in Taiwan Screening is done only in the autumn when bean fly populations are high Evaluation is now concerned solely with larval and pupal numbers at 5-6 weeks after sowing In later stages, when pupae are difficult to count damage scores are also done These correlate well with larvae and pupae numbers Samples are taken twice at 4-6 weeks after emergence Three weeks is too soon and beyond 6 weeks is too late--in the autumn season in Taiwan flowering is not yet started at 6 weeks Punctures on unifoliolate leaves are not well correlated with larval and pupal numbers With small plots 10 plants per plot are sufficient with larger plots 30 plants are necessary

The screening system in Taiwan involves source blocks of susceptibles sown 3 weeks before test lines followed by weekly sowings of rows of test lines parallel to source blocks

1600 CIAT germplasm and breeding materials sown late in Melkassa (Ethiopia) have been evaluated by damage scores and pupal counts Pupal counts are time consuming and not correlated with damage scores For adults, keep pupae in vials with moist paper and muslin lids

In Zambia keeping stem pieces in petri dishes for adult emergence have been tried but there are problems with moulds when conditions are wet Samples are now retained in muslin bags

The relative merits of larval and pupal counts and adult emergence as indices of resistance was discussed Adult emergence may be satisfactory for small numbers of plots and provides information on parasitism For larger numbers of plots larval and pupal counts may be easier Staggering of sowing dates (as in Taiwan) allows time for evaluating large numbers of materials However the two methods are unlikely to correlate because adults are already emerged at the time of collection and failure of emergence due to larvae starvation Percent emergence may indicate antibiosis Numbers of adults emerged are important in terms of build up of infestations

Sample sizes are not based on statistical considerations and may need to be adjusted Also, since insects are not evenly distributed place of collection may be important For example, edge rows which are often used may suffer from border effects

It was agreed to design a trial to examine correlations among pupal and larval counts, adult emergence, damage scores and seed yields, and the importance of sample numbers and methods (in Zambia Ethiopia, and Arusha, Tanzania)

For screening information on temporal changes in populations is vital Trapping adults is one way of acquiring such information Numbers relate to sources of infestation Crotalaria erlangeri is an alternate host in Ethiopia At CIAT Headquarters Empoasca are being trapped using metal boxes 30 x 30 x 15 cm with sides coated with Tac-Trap or Tanglefoot, heavy resins (will need 12 litres/year)

In Syria agromyzids are most attracted to blue but yellow traps other insects also The choice of the colour yellow, and traps set at three heights (50 100 and 150 cm) both in bean crops and in fallow on research stations were suggested Resin can be coated on plastic strips for ease of removal and soaked in benzene to loosen insects, which can then be stored in 70% alcohol for examination Counts to be done weekly A problem of confusion of bean fly with other Agromyzids was noted This work has been published and copies of publications will be provided on request to LC

Bean fly is known to diapause in winter in Egypt and other species diapause in the tropics It has not been found in plant debris in the dry season in Zambia It was agreed that further studies of these aspects would not be very useful Destruction of crop residues is known to be a good husbandry practice and should be encouraged

Conclusions

1 Trial to be designed to examine sampling and data collection

2 Adult trapping to be conducted at selected locations to study temporal distribution of bean fly

3 Information on sources of infestation is important but studies of plant debris are not justified

Session 5--Chemical Control Use and Abuse of Insecticides-- Past Experience and Future Prospects

Lead Discussant N S Talekar (NST) Rapporteur Peter Trutmann (PT)

The topic was introduced noting that research on the use of insecticides had taken place in the form of seed treatments, band application, and foliar sprays

Past research experience was discussed

In Zambia, aldrin and dieldrin have been found effective and have been emphasized, however these were now being phased out in favour of organophosphorous compounds where possible A number of chemicals have been used the most effective of which were endosulfan carbofuran and pirimiphos-ethyl (ICI) Endosulfan seed treatments were as effective as aldrin but had the advantage of low toxicity, and were readily available due to the cotton industry It was used at a rate of 10 g of 50% wp per kg seed It was applied as a wet dressing dried and sown as soon as possible because the treatment depressed germination

Carbofuran was also effective but was less favoured due to its systemic nature, an unfavourable trait where bean leaves form part of the local diet Pirimiphos-ethyl produced e cellent results as a seed treatment, but was discontinued because it was unavailable in Zambia An emulsifiable concentrate was found less effective than the wettable powder The advantages of endosulfan are its low toxicity and its persistence which is long enough to control bean fly Follow-up studies on this compound were regarded as worthwhile

At AVRDC in Asia foliar applications have been used, because a soil of pH 7 renders soil treatments ineffective after as little as 1 week In contrast, in Zambia soil pH is very low (4 0-5 5) The use of foliar treatments is not feasible because farmers could not afford the equipment and because of the negative effects on parasites which are highly important in bean fly control in Africa Monocrotophos, folinet dimethoate and isodrine have been e amined Monocrotophos was the best but was very toxic Dimethoate was the only effective compound with low toxicity It was noted that because farmers in Africa do not use chemicals, this is an excellent opportunity to use biological control

In Ethiopia both seed treatments and soil banding have been investigated in the past primarily with aldrin 40% and carbofuran 35% ec The latter was tested at rates of 15-25 g/kg The highest rate was found to be phytotoxic This year seed treatment trials have started again with these treatments aldrin, carbofuran, safrotin endosulfan 50% wp and promate (Ciba-Geigy) using zilex as sticker Initial observations showed good vigour with endosulfan treatments as good as those treated with aldrin

In the Great Lakes region work using insecticides started in 1985 when a number of chemicals were evaluated for their effectiveness and for use as seed treatments Crushed pyrethrum flowers lindane 1/ wp dimethoate and aldrin were used Significant effects on infestation and vigour were observed only in the aldrin treatment High toxicity of the aldrin made it unfit for use by farmers Further research in Burundi by A Autrique using 3 g lindane 25/ wp per kg seed gave promising results by reducing infestation to nil however yield was not recorded In addition, diazinon in combination with a number of fungicides is being evaluated

Concern was voiced about the use of lindane because its use has been severely restricted in many industrialized nations due to the persistent nature of the compound and environmental hazards associated with its use There were claims that it had been found to be carcinogenic It was agreed that if this claim could be susbstantiated, work would be abandoned However the chemical has very favourable traits such as very low oral and dermal toxicity and very low cost If the carcinogenicity is not substantiated testing alongside more toxic, but less persistent chemicals such as endosulfan is warranted

The persistent nature of lindane could cause problems in subsequent seasons where root-crops are grown In Taiwan breakdown of very persistent chemicals such as DDT was more rapid than in temperate environments It could not be detected in the soil after a year

Recommendations for a standardized trial were made

1 Endosulfan 50/ wp
    - 1 0/ = 10 g/kg
    - 0 5/ = 5 g/kg
    - 0 1/ = 1 g/kg
    - 0 05/ = 0 5 g/kg
2 Compare with local practices
3 Factorial wet and dry treatments
4 Six replications
5 Randomized block design

Should other chemicals be included in trials? Suggestions were pirimiphos, neem, and BPMC

Recommendations for trial observations were

1 Phytotoxicity and stand count
2 Stem damage (cracking at third trifoliolate leaf stage)
3 Percent plants wilted after emergence and at regular intervals
4 Percent stem lodging
5 Use of 20 plants for adult pupal and larval counts
6 Use of 10 rows per plot for observations
7 Two rows for sampling and two outer rows for borders
8 Collection of yield data
9 Late planting is recommended

Agreed sites

1 Melkassa Ethiopia
2 Awassa Ethiopia
3 Rubona Rwanda
4 Kisozi Burundi
5 Msekera Zambia

Discussions on Neem

Neem appeared to be a very promising insecticide to evaluate further for bean fly control because it is a natural product Karel has shown its effectiveness as a foliar treatment The active ingredient has been isolated which opens the way for synthetic production and commercialization Dr Saxena should be contacted at IRRI Apparently they have large amounts of the extract Other merits of neem are its systemic nature non-toxicity to humans and common occurrence in Africa

Session 6--Cultural and Biological Control

Lead Discussant N S Irving (NSI) Rapporteur Peter Trutmann (PT)

The importance of cultural and biological control in an integrated pest management system together with resistance and chemical control was stressed These components may be especially important if it is confirmed that yield increases with insecticides can only be obtained with addition of nitrogen or if high levels of resistance are not found

Cultural Control Recommendations

1 Early planting time, to avoid peak infestation periods Problems with the recommendation are the physical constraints on farmers in terms of labour and priority allocated to beans directly after the first rains The need to define peaks in bean fly populations was agreed

2 Rotations with non-hosts

3 Intercropping such as maize/beans

4 Mulching especially for O spencerella and O centrosematis dominated regions, in areas where mulching materials are readily available, sufficient labour is present and if striking differences are visible in such target areas

5 Hilling or soil mounding to encourage adventitious root formation, or as a barrier to hypocotyl infestation It was regarded as beneficial to conduct a study on the effect of time of hilling on the severity of bean fly attack A study in Rwanda has shown that hilling significantly increased plant survival but had little effect on severity of infestation

Biological Control

High levels of parasitism have been found on O phaseoli, indicating that it may play an important role in regulating this species It is important not to establish a strategy heavily orientated to chemical control

The main parasite is Opius phaseoli, which was found on a high proportion of O phaseoli and on about 10% of O spencerella Eucoilidea impartus is the main parasite of O spencerella, but it is not very efficient or its effectiveness is density dependent It appears that O spencerella is not effectively controlled by parasites However it is possible that other parasites exist in other regions and even other continents such as Asia and that these could augment the efficacy of biological control However because O spencerella has only been found in Africa it is unlikely that parasites will be found elsewhere The potential of introducing exotic parasites was discussed and it was agreed that LIBC should be contacted to see what they recommend

Session 7--Host Plant Resistance Underlying Mechanisms

Lead Discussant N S Talekar (NST) Rapporteurs Amos Oree (AO)
David Allen (DJA)

It was stressed that the cheapest and environmentally most acceptable method of bean fly control is the use of resistant varieties However no good source of resistance to O phaseoli had been found in beans, although reliable resistance to this species is known in mung bean (Vigna radiata) and P coccineus

Trichome Density

In V radiata, high trichome densities on leaves and stems were found to be negatively correlated with oviposition punctures of O phaseoli and O centrosematis, respectively Resistant varieties have twice the trichome density of susceptible ones The number of larval mines and pupae were also less in resistant varieties In Taiwan leaf hairiness has been examined among bean lines from CIAT but little difference has been found It was noted that in work with Empoasca California Light Red Kidney does have a significantly greater trichome density than other bean cultivars

Pigmentation and Lignification

In O spencerella stem characters are likely to be more important than leaf characters Stem pigmentation and perhaps particularly the degree of lignification may prove important It was noted that with many insect pests purple pigmentation appears not to relate to resistance A student project might examine variation in lignification, using cross-sectioning and staining It was concluded that it was premature to consider mechanisms of resistance until we had greater confidence in sources

Tolerance

In Zambia, tolerance is measured by the number of flies that emerge from infested plants A 161 consistently yields fewer flies but there are no significant correlations between the number of flies emerging and seed yield Tolerance should be evaluated under heavy population pressure The necessity to use protected plots in tests to confirm tolerance was emphasized

Session 8--Screening for Resistance: Trial Design and Nursery Management

Lead Discussant Barry Smithson (JBS) Rapporteur David Allen (DJA)

JBS outlined the key questions

1 Can we obtain the uniformity and level of infestation required?

2 Can natural infestations be relied upon, or are they too unreliable? Can natural infestation be better manipulated in screening? What frequency of susceptible spreaders are required, and what should be their distribution throughout the nursery? Should the spreaders be pre-sown? Should the test lines be sown relatively early or late to maximize infestation ?

3 What stage of testing is under consideration? Do we opt for single rows in mass screening, and large plots later in the screening sequence?

4 If it is not possible to make natural infestation adequately uniform, is it possible to develop methods of mass rearing and infest artificially?

5 Whatever approach is taken, infestation will not be absolutely uniform But can we rectify patchy distribution by better trial design, such as augmented designs and neighbouring plot designs? In confirmatory screening, lattice designs would improve precision

6 We should aim at standard designs at this Workshop

The Use of Spreaders and Staggered Plantings

The use of a single standard susceptible variety as an indicator in trials or staggered planting is advocated in Taiwan If the test lines have a lower infestation than the spreaders it is not clear what to conclude Pre-sown spreaders may act as traps and are therefore protective rather than the reverse as is the intention The merit of pre-sown spreaders therefore remains unclear and concern was expressed at the idea of spreaders acting as a trap

Is there a need for spreaders at all? One possibility is for pre-sown spreaders being cut out after sowing the test material thus forcing the fly on to the test lines Cutting out can introduce error if using staggered planting, but beans could be sown as a green manure and ploughed-in before sowing test lines It was agreed that uniformity was more important than merely increasing infestation per se Staggered plantings also tend to be confounded by environment, because of seasonal changes, and yet it was accepted that staggered planting was normally unavoidable because of the large numbers of lines to be evaluated in mass screening

Finally, it was concluded that spreaders could be eliminated because natural infestation could be managed adequately provided both susceptible and partially resistant checks as indicators be included at regular intervals among the test material In sequential screening a good entry may be picked out and sown again in a subsequent sowing

Choice of Sites as Hot Spots for Particular _Ophiomyia_ spp

The importance of the previous history of fields on research stations was emphasized Timing of planting at a single site can strongly influence the species that predominates with obvious implications for screening

The following striking reversal in species composition in two successive plantings was observed at a single site (Msekera) in Zambia

	First	Second
O phaseoli	87%	0
O spencerella	13%	96%
O centrosematis	0	4%

It was concluded that for an initial mass screening two contrasting sites in Tanzania (Selian and Morogoro) should suffice Sites for a confirmatory nursery might be those used for the Regional Bean fly Resistance Nursery (RBFRN)

Trial Design

The problems inherent in mass screening include seasonal (because all the material may not always be evaluated at one time) and site effects (because the land area is often large) Two solutions to these problems were the use of augmented designs and nearest-neighbour analysis In augmented designs, test entries are randomized grouped into blocks (of about 20-50, depending on total number and field size) then a set of checks (2-5) are randomized within each block The checks are then analyzed as a randomized block and the SE so derived used to assess differences among unreplicated test lines This is perhaps useful in staggered plantings the performance of test lines can be adjusted by the deviation of the mean of the checks in the same plot from the mean of all the checks

If it is possible to replicate, then it is possible to use nearest- neighbour analysis in which each plot is adjusted according to the performance of neighbouring plots (their position depending on plot shape) Outlines of these designs were distributed

Session 9--Putative Sources of Resistance, and a Scheme for Evaluation

Lead Discussant Julia Kornegay (JK) Rapporteur David Allen (DJA)

Sources

Tentative data from the RBFRN and other screening suggest that the following lines do have partial resistance and/or tolerance

A 62* A 74* G 5653* (Ecuador 299)	Consistently resistant, in terms of number of emerging, lodging, and yield (Msekera) A 74 picked out at AVRDC and G 5653 also in Ethiopia Also resistant at Morogoro
A 83* BAT 85* BAT 1210* G 5660*	Evidence of tolerance (Msekera and Morogoro) BAT 85 picked out also at AVRDC
A 161* A 5711*	Variable performance A 161 perhaps resistant to O phaseoli and susceptible to O spencerella (Msekera), but was susceptible at Morogoro
G 4489* G 4485 XAN 58	Variable at Msekera XAN 58 perhaps tolerant
G 35023 G 35075	P coccineus Resistant to O phaseoli (AVRDC)

* Entries in the First RBFRN

All of the first seven in the above list had been used in crosses (and intercrossing, to raise the level of partial resistance), and it was agreed that the F2 should be subjected to bean fly pressure, selecting for yield

Evaluation Scheme

Some heated discussion revolved around what material should be evaluated Ultimately, it was agreed that there was merit in looking at unimproved germplasm accessions such as a subset (of about 1300 lines) representative of the total genetic diversity held at CIAT as well as African landraces, and advanced breeding lines emerging from CIAT headquarters An accidental screening, conducted this season in Ethiopia of genetically diverse material from which several promising lines had been identified was described

An approximate scheme for evaluation was proposed

Stage 1 Mass Screening (germplasm, landraces, advanced lines)

Aim to evaluate 2000 lines per season unreplicated Two contrasting sites e g Selian and Morogoro, desirable, but logistically difficult Perhaps two contrasting seasons at one site might be adequate to provide pressure against both chief Ophiomyia species From these trials attempt to identify groups of material with apparent resistance and then request more of same groups JF suggests improved Cariocas Mulatinos, Brazilian and Mexican highland small-seeded types

Stage 2 Confirmation Nursery

50 entries 2 replications One or two sites

Stage 3 Reconfirmation Nursery

Multilocational Artificial challenges in screened cages with the 2 spp independently at Selian

Stage 4 EBFRN (later changed to ABFRN the African Bean Fly Resistance Nursery)

Session 10--The Regional Bean Fly Resistance Nursery

Lead Discussants Stuart Irving (NSI) Rapporteur Barry Smithson
Cesar Cardona (CC) (JBS)

Purpose of RBFRN was to concentrate attention on bean fly Initial entries were not necessarily resistant, but were best available from existing information

Design

Field plan not appropriate to some situations Need to leave choice of field arrangement to cooperators

Treatments

Protected treatment should be included Four unprotected replications are essential Two replications protected Reduce to 16 entries and use a lattice design Enclose endosulfan for treatment of seed for protected treatments

Samples

Initially it was proposed to sample 10 plants, but this was reduced to 5 to reduce the work load Sample 10 plants per plot at 20-25 and 30-35 days after emergence Take every fifth plant from each of the two outer rows of each plot, including the protected replications

Records

Rate above-ground damage on scale of 1-9 to be established by individual cooperators, but scale to be described

Rate stem damage and adventitious rooting on 1-9 scale on both samples according to diagram (Fig 4) prepared by PT and Alain Autrique (ISABU, Burundi)

FIG 4

Record pupal and larval numbers on both samples At second time of planting store stem pieces in suitable container to record adult emergence

Identify species based on pupal, larval, and adult characteristics

Assess vigour by fresh weight of sampled plants

Rate incidence severity and lodging at plant growth stage R8 (mid podfill)

Do stand count at primary leaf stage

Assemble compound samples of 50 pupae and 50 adults from each location and each sampling date - retain in 70% alcohol and send to CIAT entomologist in Arusha

Entries

Omit G 5751, G 4489 IMO91 and BAT 1252

Locations

Autrique already has two nurseries one at Kisozi and one at another site in Burundi Send two for March sowing--Kisozi and Mosso

Rwanda Zaire and Uganda--none

Ethiopia--A set has been received and will be multiplied in dry season and grown at Awassa and Melkassa in 1987 Omitting four dropped

Kenya--One set on provision of a permit and address to send direct Sow in long rains at National Agricultural Labs

Tanzania--Two sets for Arusha and Morogoro

Zambia -Old set already sent To remove the excluded lines New field book to be supplied from CIAT

Zimbabwe- One set for sowing in mid-January at Gwebi

After this season, responsibility to be the CIAT regional entomologist in Arusha

Closing Session

Proceedings to be prepared and sent to attendees and absentees The structure of the workshop has been satisfactory and will result in assembly of much useful information Identification problems were resolved It is important to understand biology gaps have been highlighted--the source of infestation--and plans made to overcome them

Appendix

BEAN FLY WORKSHOP ARUSHA, 16-20 NOVEMBER 1986

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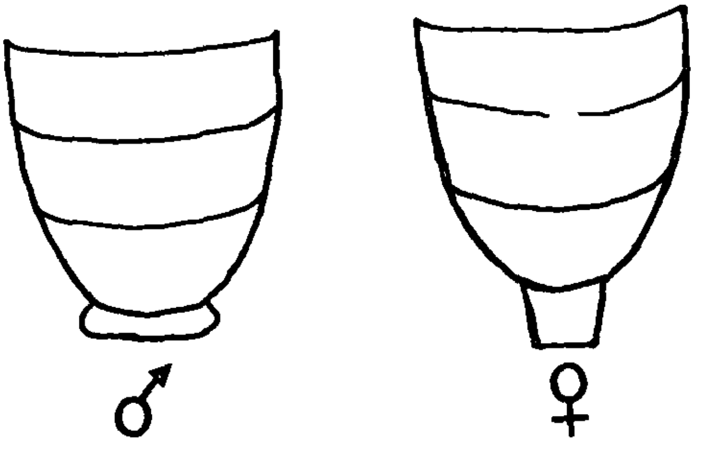
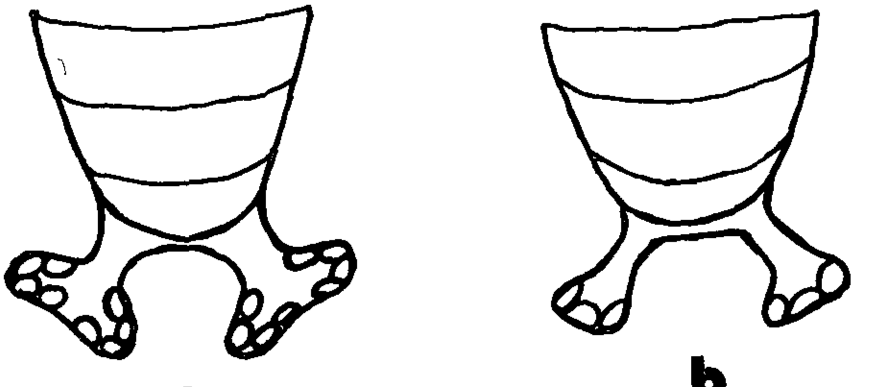


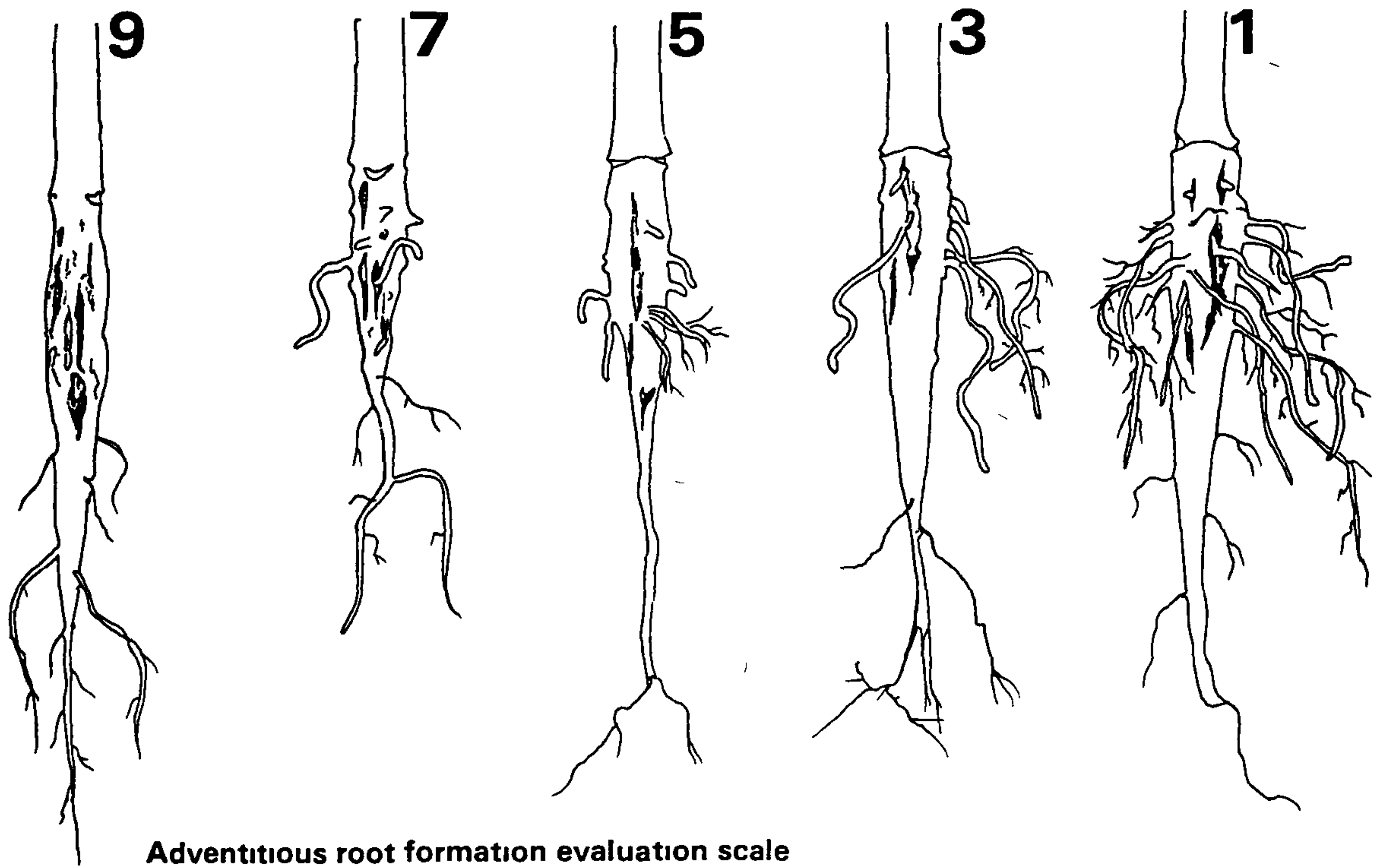
Fig 1

Fig 2



a b

Fig 3



Adventitious root formation evaluation scale

Fig 4