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PROCEEDINGS OF ONION PRODUCTION AND RESEARCH FOR THE EIGHTIES WORKSHOP

Ministry of Agriculture, Food and Consumer Affairs (MAFCA)
and
Inter-American Institute for Cooperation on Agriculture (IICA)

BRIDGETOWN, BARBADOS MARCH 2-3, 1983

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GRAEME HALL, CHRIST CHURCH, 2-3 MARCH, 1983

INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE
MINISTRY OF AGRICULTURE, FOOD AND CONSUMER AFFAIRS
BARBADOS

EDITED BY

Victor Ojeda and Winston Small

IICA OFFICE IN BARBADOS

PROJECT SUPPORT OF THE TRANSFER OF TECHNOLOGY FOR
THE PRODUCTION OF FOOD CROPS

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INTRODUCTION AND OBJECTIVES OF THE WORKSHOP

The Ministry of Agriculture requested the cooperation of IICA for the preparation of an Onion Breeding Programme to be implemented during the next five years.

After consulting with several technicians, inside and outside IICA, it was decided to make a plan for the future not only in a breeding programme but a programme where all the aspects of onion research and development can be put in a manner that they can inter-correlate, avoiding repetitions and waste of energy and resources. In this way, it was proposed to Ministry of Agriculture to hold a workshop where qualified researchers, farmers and planners in Barbados meet to discuss the problems affecting this important crop and present recommendations to the Ministry.

Seven papers and sixteen participants and observers were invited and a programme has been elaborated to cover most of the areas of agronomic, economic and social aspects in the production of onions.

In the past, there were many works in research, but there was no following of a national programme, in this context, it is important to collect the experience that has been gained in the programme and develop a new path for the future.

The main objectives of this workshop were:

- To identify onion research needs in the country;
- To make recommendations to the Ministry of Agriculture in relation to an Onion Breeding Programme; and
- To cooperate in outlining a policy to be followed by the Ministry of Agriculture in Onion Production and Development in the next five years.

Therefore this document summarize the major findings and recommendations to improve onion research and development in Barbados as well as the papers presented in the workshop.

Victor Ojeda, IICA
Workshop Coordinator

OPENING REMARKS BY J.P. JEFFERS, DEPUTY CHIEF AGRICULTURAL OFFICER FOR RESEARCH, MAFCA, BARBADOS

Ladies and Gentlemen, may I welcome you to this meeting today when for the next two days we shall be looking at all possible ways on improving our onion industry.

If I may look back to the start of the industry for a moment, you will recall that with the advent of precision planters in the late 60's, direct planting of onion and other small seeded crops became a viable agronomic proposition.

Lots of work was done in this period mainly on the preparation of an "agronomic package" which would enable farmers to produce the crop. Here I must pay tribute to Mr. W. DeC. Jeffers, Dr. B. Eavis, Dr. W. Small, Mrs. F. Chandler, Messrs R. Hoad and H. Williams who with others both in and out of the Ministry pioneered this industry.

Like most things it had a small beginning and grew rapidly. And with growth came problems. Some of those problems are with us still, hence this"think tank". We are all familiar with the thrips and leaf miner damage which we can take care of; but our main concerns for some years have been the "Blast Syndrome" and the poor storage properties of our main variety.

Even now after a decade of variety trials we have not solved these problems. We have had some assistance from extra regional areas, we have looked at varieties, pathogenic organisms, soils factors and must now conclude that the Blast may possibly have to be looked upon as being caused by physiological factors and hence may have to be dealt with in a breeding programme. If this is indeed so, then the storage aspect of the problem may be tackled at the same time.

These Ladies and Gentlemen are my thoughts on the subject. You have all been involved in one way or other with onions and I hope that this first organised meeting of minds will result in a fresh and original look at the problems that beset this industry.

I would like to wish you every success in your deliberations, and once again welcome you to this Workshop.

WELCOME ADDRESS BY HECTOR BARREYRO, DIRECTOR, IICA, BARBADOS

I welcome you to the initiation of this workshop on Onion Production.

This workshop is part of a project of Technical Cooperation with the Ministry of Agriculture. The main purpose of this technical cooperation is to facilitate and support Transfer of Technology for crops other than sugar; to support the diversification of agriculture; to substitute imports and promote non-traditional export crops.

The project which has run now for one year will go into 1985 with an approximate total cost of US$270,000 in four years.

This workshop will run as you know for two (2) days, and has the purpose of analysing together the state of the arts in onion production in Barbados for them to produce recommendation which can be used in defining a research and extension policy for the country. In doing this, we should look at both the short and long run of the onion industry from the point of view of fully utilizing the present potential for onion production but also looking at the long run to ensure and increase the productivity of the crop.

In order to estimate what is the size of the industry, I went along with some of the existing figures which indicates:

a. that the size of the Barbados Domestic Market is of 2300 Tons per year. This 2300 Tons could be produced in approximately 200ha.

b. An estimation done of the CARICOM Market is set at 2000 Tons (I think this may be a very low estimate which should be revised). Two thousand Tons could be produced in about 180 ha.

Therefore, according to this we are taking a potential production area of a minimum of 380 ha (940 ac). Of course account should be made of the limitations imposed by the personnel production.

Anyway, the production of 380 ha implies a short term investment of the farm sector of about $3,3M and in terms of $8,8M which may generate some $5.6M on gross returns of which $2,6M will be of foreign exchange.

This figure indicates to me that the onion industry for Barbados has probably a definite cooling in the short run which should be carefully monitored by the industry, but also stresses the importance of the crop as a source of import distribution and foreign exchange earner.

I therefore conclude my welcoming remarks by encouraging all of you to fully explore the subject. The project through Victor Ojeda will publish the findings provided by this workshop to ensure the wide distribution of it and the Government representatives here will ensure its input in the policy making process of the Ministry.

ONION RESEARCH AND PRODUCTION IN BARBADOS WITH PARTICULAR REFERENCE TO VARIETY PERFORMANCE BY FRANCES CHANDLER, CARDI, BARBADOS

Onions represent the largest portion of the total imports of vegetables into Barbados. Over 3.5 million lbs. are imported into the island annually at a cost of approximately BDS $1.5 million.

The development of a local onion industry therefore, has the potential for generating considerable foreign exchange savings through import substitution, and possibly, may even contribute to export earnings.

Production from 275 acres would be necessary to satisfy the domestic requirement of 320,000 lbs. per month. However, the seasonality of production of the crop is such that up to now, onions have been commercially produced only between February and April with under 60 acres being enough to satisfy the domestic market during this period. In the absence of long term storage therefore, this seasonal production means that the local industry produces only about 23% of annual domestic requirements.

Onion has been seen as an important crop in the diversification of agriculture in Barbados and consequently, considerable research research has gone into the development of the industry. However, there are a number of problems which remain unsolved after 13 years of production and which will limit the expansion of the industry.

Consumer preference in Barbados and the Caribbean region is for the hard, brown-skinned yellow fleshed onions of the type traditionally imported from extra-regional sources such as Holland and Canada. However, these are long-day onions and cannot be produced under local short-day conditions. The aim therefore, of initial variety trials was to select a variety which would bulb within the local daylight range of 11 hours 22 minutes to 12 hours 55 minutes, but which would have similar characteristics to the imported onions and would thus be acceptable to the consumer.

The early onion variety trials carried out by the Ministry of Agriculture in 1966 resulted in the selection of the yellow fleshed varieties Granex F_1 Hybrid and Texas Early Grano. These varieties produced high yields of good sized bulbs, the characteristics of which were acceptable to the consumer, but unlike the imported onions, did not keep well in storage. The variety Red Creole stored better than the yellow variety but was not readily accepted by the Barbadian housewife.

Granex F_1 Hybrid was adopted as the standard onion variety and in 1968 commercial production was attempted with the introduction of direct seeding with precision seed drills. During the 1968-1969 season, thirty acres were planted by the Ministry of Agriculture on 10 private farms throughout the island with a total production of 200 tons (Eavis & Jeffers 1969).

At this stage, trials were conducted by Jeffers, Williams and Alleyne to examine the effect of date of planting on yield during the period October to March. Bulbing occurred at a progressively earlier stage of growth throughout this period and yields decreased five fold (Eavis & Jeffers 1970). In the earlier plantings bulbing took place after the plant had reached a large size and therefore large bulbs were produced while onions which were sown later had a shorter growing period before bulbing initiation and thus these small plants produced only small sized bulbs.

Prior to 1970, no experimentation had been done with planting dates outside the period October to March. During 1970, under the OAS Vegetable Variety Selection Programme, over 70 varieties were tested with plantings being made both in the normal season (september to November) and out-of-season in January, February, May and June. The following five major variety trials were carried out:

TABLE NO 1: ONION VARIETY TRIALS IN BARBADOS

	Site	Planting Date	Harvest Date	# of Varieties
Trial # 1	Graeme Hall	June 1970	August-September '70	48
Trial # 2	Sayes Court	Jan. 1971	May 1971	54
Trial # 3	Sayes Court	Nov. 1971	March-May 1972	45
Trial # 4	Sayes Court	Nov. 1971	March-May 1972	24
Trial # 5	Graeme Hall	Feb. 1972	June 1972	15

Granex performed well when planted in May and early June. However, this late planting date resulted in harvesting in the wet season which presented problems and necessitated artificial drying.

In addition, the weather conditions at this time of year were conducive to 'Blast' and thus constrained further commercial production at this time. However, it is possible that more research in this area could be beneficial.

A number ot varieties have yielded well in trials over the years, e.g. Ring Gold, Henry's Special, Early Top and San Joaquin, but none of these varieties stores well. An African variety - "Violet de Gaimi" was found to be promising from a storage point of view but consumer reaction to this red variety was not favourable.

Hybrid R-10 and Beth Alpha Autumn from Israel also produced well during the normal growing season. Rio has a better skin and is harder than Granex, but supply of commercial quantities of this seed was not reliable.

Beth Alpha Autumn produces a lower yield than Granex but storage life is longer. In one storage trial carried out at Graeme Hall, 84% of the Beth Alpha Autumn sample was marketable after one month in storage as compared to 38% for Granex. After 2 months, 63% of the Beth Alpha Autumn were marketable as compared to only 0.70% for Granex. However, Beth Alpha Autumn appeared susceptible to Blast.

The variety Yellow Creole was found to be much firmer and more pungent than Granex, and in 1977 was recommended for September to November plantings particularly for export. However, yields tend to be low, with bulb size small - medium, and planting of this variety was discontinued by growers.

It was recommended at this time that a price incentive be offered to growers planting this variety, particularly for export, to compensate for the lower yield expected from the variety.

A white fleshed variety El Toro has been recommended in the past for late planting with irrigation in December to January to be harvested in May and June when onions are in short supply on the world market. El Toro was planted commercially by a few farmers for two seasons but planting was not continued, possibly, because of competition for management during the sugar cane season.

It was soon realised that a number of problems existed in the industry some of which posed a great danger to its survival. These problems could be divided into:

(a) Agronomic; and
(b) Market problems.

The agronomic problems include the "Blast" disease, inadequate weed control especially in fields which had not come out of sugar cane and the poor keeping quality of the standard variety "Granex" on which the industry was based. Although this variety yields extremely well (yields as high as 23 tons/acre have been obtained commercially), it has an extremely short storage life, poor skin retention and a tendency to suffer from Blast and neck-rot.

From the marketing point of view, a problem is created by the fact that the poor keeping quality of the variety used is coupled with the very seasonal production of the crop, the majority of which matures in March. The table below shows the percentage intake of onions by the Barbados Marketing Corporation over the period January to June.

TABLE NO. 2: ONION PERCENTAGE INTAKE BY

BARBADOS MARKETING CORPORATION (JAN-JUNE)

TIME PERIOD	1980 lbs	% INTAKE 1980	1981 lbs	% INTAKE 1981
January	450	0.01	16,500	2.01
February	44,750	11	49,650	6.05
March	215,000	53	407,205	49.66
April	119,500	29	239,750	29.24
May	25,100	6	78,010	9.51
June	-	-	28,800	3.51
Total	404,800	100.00	820,360	100.00

Some farmers without irrigation plant their crops in September, but because of the risk of "washing out" which may come about as a result of heavy rains sometimes experienced in September, the majority of these farmers plant during October. Farmers with irrigation, although they could theoretically plant during November and as late as January 15th, tend to plant during October as well. There are a number of reasons for this. With late planting, yields tend to be lower, cost of production is higher and planting during this late period would mean that the early growth period of the onion crop which requires an especially high level of management would coincide with the sugar cane harvest season when the work load of the grower is high.

As was mentioned before, this situation leads to the bulk of the onion crop being put on the market in March. In addition, the export of onions at this time is complicated by the fact that the local onion must compete on the overseas market with the good supply of better keeping, lower priced onions from extra regional sources.

These problems have caused fluctuations in production over th years as can be seen from the table below:

TABLE NO. 3: ONION. ACREAGE AND PRODUCTION IN BARBADOS.

1974-1981

YEAR	ACREAGE HARVESTED	PRODUCTION (tons)
1974	216	810
1975	163	848
1976	114	682
1977	165	693
1978	140	742
1979	175	539
1980	109	520
1981	76	435

In view of these problems during the period 1973-1977, an extensive research programme involving over 50 varieties was conducted with the following objectives:

(1) To extend the production season.

(2) To select varieties with good storage qualities.

(3) To select varieties tolerant to 'Blast' disease.

(4) To find an effective weed control system using both pre and post emergent herbicides which would prevent weed development

while having no adverse effect on the onion crop.

It was felt that the onion production season could be extended in three (3) ways:

The first alternative would be to spread the production over a wider period. It has been suggested that farmers <u>without</u> irrigation should continue to plant early while those <u>with</u> irrigation should be encouraged to extend the production season by planting their crop in December or early January to mature in late April and May when world market prices are higher. Although this could possible be done by offering a price incentive for their later plantings, it is not known whether farmers would in fact be willing to plant later in spite of an increased price for the reasons mentioned earlier.

Another possibility for the extension of the onion season would be the use of varieties with different periods of maturity. This could extend the season in both directions from the normal harvest period of late February to early April.

The third alternative would be storage which would involve two (2) factors:

(1) adequate storage facilities;

(2) a variety which will keep well in storage.

During 1979, the variety Hybrid F_1 Golden was found to give a yield comparable to that of Granex when planted in September to mid-November appeared to be more tolerant to Blast than Granex and compared favourably with Granex in a storage trial at Graeme Hall. After one month the percentage of marketable onions was 62% for Golden and 38% for Granex with both varieties yielding 8.57 tons/acre. Golden has since replaced Granex as the standard variety with 100% of the 1982-83 crop being planted in this variety.

However, although Golden is an improvement on Granex as far as storage is concerned, it does not provide a complete solution to the problem.

In 1981 during a BMC/BAS visit to Dessert Seed Company in California, a number of varieties was offered by the company, some of which were described as having good storage characteristics. In addition, a new daylight neutral variety was introduced. These varieties, along with a number of other U.S., Israeli and Japanese varieties are being tested in small plots under commercial conditions at two sites and with three planting dates. Trials are incomplete, but at least six (6) varieties appear promising from the production point of view and at least three (3) have matured much earlier than Golden. The varieties will be tested for their ability to store.

It was interesting to note that Dessert Seed Company were showing an increased interest in the production of varieties for the tropics and appeared willing to inject some of the "Creole" characteristics which are related to good keeping quality into the Golden variety.

In the long term, if it is possible to breed a variety specifically for our conditions, cooperation with a seed company could possible be beneficial.

DISCUSSION

The major points made during the discussion on this paper were that further research was necessary into:

a) Agronomic practices for late plantings, since in the past the practices used in and late early plantings were similar.
b) Fertilizer regimes with particular reference to phosphorous.
c) The effect of mycorrhizae on yield.
d) The influence of environmental factors, particularly temperature on bulbing.
e) The use of onion setts for late plantings
f) Physiological factors associated with bulbing.
g) Determining storage parametres for onions.

DEVELOPMENT PROPOSALS FOR THE BARBADIAN ONION.

GERMPLASM DEVELOPMENT, SHORT AND MEDIUM TERM

Ian W. Julien, MAFCA

INTRODUCTION

The objectives of this paper are not to propose detailed plans for a breeding project but rather to emphasise certain key strategies.

The objectives of any development project would broadly be:

(a) The production of a cultivar satisfying certain requirements for successful, utilization in Barbados.

(b) The collection of a substantial amount of scientific information on the growth and adaptational requirements of tropical onion production.

A system to produce such a cultivar and generate the necessary information would embrace the following:

(a) The identification of the biological requirements of an agronomically and economically viable cultivar and the development from these of a plant and crop ideotype or model.

(b) The identification and validation of a method or methods of obtaining such a cultivar in the minimum time period.

(c) The provision of adequate facilities for the collection and utilization of information.

(d) The provision of the infrastructure for the continuous improvement of the biological side of the onion industry.

At present the production of onions is based on seasonal plantings with a peak of harvesting around March (Orshan, 1982). One obvious improvement in the system would be the extension of the harvesting period back to late December or early January and forward to June or July, but the use of the present cultivars in this modification may not be feasible because of photoperiodic requirements. Cultivars which have an optimum photoperiod falling around December or January would bulb too early when planted in January or February and produce an unsatisfactory yield.

TABLE 1: DESIRABLE BULB CHARACTERS IN THE BARBADIAN ONION

1) High keeping quality. Should be able to be stored up to six months, which would mean possessing the following:

a) High dry-matter content, i.e. around 16%.
b) Multiple, firmly adhering scales.
c) Low incidence of sprouting and rooting in storage.
d) Low incidence of 'soft rot' and Aspergillus sp. in storage.

2. Good bulb appearance.

a) Preference (selection) should be given to large bulbs as in a crop situation bulb size is easily modified by planting density.
b) Preference given to globe shaped bulbs. Not a character of vital importance.
c) Firmness. Bulbs should be as firm as possible. A hard bulb stores better as firmness and dry matter content tend to be positively correlated. Moreover, when mechanical harvesting or deleafing machines come into use in Barbados, firm bulbs will suffer a lot less mechanical injury.
d) Colour. Brown to gold, for fresh market.

e) Doubling and other characters which increase the spoilt yield should be selected against.

3. Good resistance or tolerance to field and storage disorders and diseases.

a) 'Blast'. Symptoms on onions very similar to 'blast' have been reported (Brewster, 1977) and are thought to be caused by periods of wet weather followed by periods of dry. Wet weather leads to a shallow root system being produced by the plants and during dry weather it is unable to supply the transpiration losses from the leaves and the typical narcotic lesions develop. If this is the case, then selection against 'blast' may lead to improved root systems in plants.

b) 'Soft rot' or 'neck rot'. Casual organism - Erwinia cartovora. There is some evidence that cultivars higher in dry matter content tend to be less susceptible, but infection may also be related to the physiological maturity of the plant at harvest and how well the sealing of the neck has taken place.

TABLE 2: DESIRABLE CROP CHARACTERS IN THE BARBADIAN ONION

Good yield::

a) Maximum yields in excess of 20 tonnes per hectare.
b) Good phenotypic plasticity leading to high yield stability over location, and nutrient and moisture variations.

To this end the concept of having two seasons which will refer to in the remainder of this paper as the in-season (September to April and off-season (December to July), has been introduced in Barbados (Chandler, 1982). Early cultivars are those defined, in the Barbadian context, as ones which could mature in the environmental conditions of December to April and produce a good yield. Late cultivars, on the other hand, would mature in June or July, the major differences in environmental conditions here being longer day lengths and higher night temperatures.

The largest imports of onions into Barbados are in the months July to December (Orshan, 1982), and the replacement of these by local onions would be beneficial to the industry and the Island.

Within each of the major agronomic groups, early and late, at certain type of crop and plant is desired and to this end, I have prepared a list of features of crop and plants that I think necessary to a successful crop. The list is by no means inflexible (Tables 1 and 2).

Once the biological and agronomic requirements of the crop have been identified the next step is the consideration of the methodology to be used in achieving the desired goals. Traditionally, in Barbados, the method of importation and evaluation of germplasm has been followed as the only means of achieving the desired goals. This has resulted in the identification of three usable cultivars. This method, however, is most efficient in the early development stages of an industry but suffers from a number of drawbacks. Some of these are listed below:

(a) A low rate of success in identifying suitable cultivars, which stems from the high adaptational requirement made on cultivars.

(b) The lack of a progressive development of germplasm which would provide a constant improvement in the adaptation and thus merit of the biological material.

The system gains enormous practical importance, however, when linked to a progressive cultivar development programme as a means of supplying not only finished, directly usable, biological material for the industry, but also as sources of breeding material for the progressive programme. Proposals for the short and medium term improvement of the quality of Barbadian onions should, therefore, include both importation and screening methods and progressive developmental methods.

Importation and Screening Methodology

This scheme may be divided into two sections as follows:

(a) the germplasm search;
(b) the evaluation of imported germplasm.

Materials must be sought from both traditional and non-traditional sources and should include the following:

(a) Commercial seed companies. Specific cultivar requirements should be made to increase the probability of obtaining useful material. Asgrow Seed Company, for example, has an on-going onion breeding programme headed by Dr. John Call who stated that he would be willing to cooperate with other serious plant breeders specifically in the area of germplasm exchanges. (Northeast Regional Plant Introduction Station publication, 1981).

(b) U.S. Plant Introduction Stations. These stations import and evaluate material from all over the world and will undoubtedly be an important source of germplasm. The New York station has already supplied me with germplasm for research purposes and the Director of the station indicated that he would be willing to cooperate further.

Material introduced to these stations is evaluated on a wide range of criteria, which include: Uniformity, vigor, plant height, leaves per plant, amount of bloom on leaves, earliness of bulbing, neck length, neck diameter,bulb depth, bulb diameter, bulb shape, bulb colour, number of loose scales, keeping quality and date of harvest.

One important point about these stations is that they concentrate on the evaluation of improved material and thus would be an extremely valuable source of germplasm.

(c) Germplasm collections outside of the U.S.A. Other countries in the tropical world are involved in onion development projects of their own and would be important sources of material if their cooperation could be obtained. The Sudan, a country that grows in excess of ten thousand hectares of onions annually and exports to the Middle East and Europe, has recently released a number of improved tropical cultivars which were developed from local cultivars (FAO, Plant Genetic Resources - Newsletter 42, 1980). They seem willing to supply serious projects with material.

Other possible sources of material include:

(a) French Caribbean territorial possessions.

(b) India. Improved cultivars have recently been released.

(c) West African and Latin American Countries.

Dr. S. Sinnadurai of the University of Legon, Ghana, for example, published several papers on the potential of local Ghanaian cultivars in tropical onion development. (Sinnadurai 1970; Sinnadurai, 1980).

The process of obtaining genetic material whether it be imported or not constitutes a vital part of the whole scheme and must be approached in a scientific manner. Success of the whole project depends to a large extent on the ability to thoroughly search for material in the correct areas using the correct criteria for selection or rejection. This principle becomes even more important when the limitations of the evaluation process are understood.

Evaluation Methodology

In any project of this type it is not enough to uncover superior cultivars. The reasons for their superiority in the field or storage must be understood. To this end, as much scientific information as possible about all aspects of development in the vegetative and generative phases of growth must be obtained, and data on a package of plant characters such as those suggested earlier on in the paper and also those used by major planting introduction stations must also be collected and analysed. Moreover, in order that the effects of the environment (biological or physical) be fully accounted for, the evaluation process must include the following factors:

a) Years - a minimum of two years

b) Locations - a minimum of two locations

c) Planting dates - four (4) dates are suggested -

- early September
- early November
- early January
- early March

The project should aim at evaluating a minimum of thirty introductions and preferably in the region of fifty, in the first year. Introductions of obvious limited usefulness may be eliminated the second year and the others studied more comprehensively. At the end of this period, promising introductions may be released to chosen growers for further evaluation under commercial conditions.

Superior material identified in this part of the programme may also be incorporated into the progressive developmental scheme as a source of germplasm.

System for the progressive development of superior cultivars

The breeding programmes suggested are modifications of one proposed by Jones and Emsweller, 1933. The modifications are ones that would utilise recent developments in the genetic modification of open pollinated populations. The backbone of the two programmes consists of cyclical or recurrent selection methods, which would lead to continuous improvement of the two populations (in-season and off-season), and the ability to extract improved inbred lines at regular intervals which in turn may then be directed into the secondary programmes. These lines may be used in the production of open-pollinated, synthetic or hybrid cultivars, although the latter would require further extensive work. Recurrent selection methods, although only developed some twenty to thirty years ago, have already been successfully utilised in the development of out-breeding vegetable crop species. (Hallauer, 1981).

As already mentioned the programme will utilise two separate schemes for in-season and off-season cultivar development. It must be understood, however, that there are no shortcuts to the successful breeding of these cultivars. The scope for the production of in-season cultivars seem, for example, limited in the context of a four-year programme as this time period would allow only one complete cycle of selection (Table 3), but with care, a cultivar may be substantially improved in this time, using the secondary non-cyclical methods which are part of the whole programme. The two schemes are outlined in Tables 3 and 4.

TABLE 3: SCHEME FOR CYCLICAL AND NON-CYCLICAL PRODUCTION OF AN IN-SEASON CULTIVAR

Year 1. - September to April. Planting ot general population of parent cultivar. Selection of mother bulbs, using criteria outlined before. Retain at least five (600) hundred bulbs for storage and seed production.

Year 2. - September to April. Plant mother bulbs. Retain one hundred (100) bulbs that flower well and satisfy the selection requirements. Self pollinate all selected plants. Keep separately all S_1 seed.

Year 3. - September to April. Plant out S_1 lines and select between lines within lines.

Year 4. - September to April. Seed production.

Year 4.	4a) Allow complete cross pollination of selected bulbs to complete cycle one.	4b) Self secondary and tertiary umbels of selected bulbs to produce S_2 seed.
Year 5.	5a) Restore the cycle	5b) Seed production. Allow for complete cross pollenation to form open-pollenated cultivar.

Plant a sample of seed to obtain setts for seed increase the following year.

6b) a) Seed increase

b) Release of small amounts of seed to growers cooperating in the project for evaluation in conditions.commercial

TABLE 4: SCHEME FOR THE CYCLICAL AND NON-CYCLICAL PRODUCTION OF OFF-SEASON CULTIVARS

Year 1 (Jan-June). Evaluation of material and selection of parent bulbs. (This may be made from the introduced germplasm in cycle 1)

Year 1 June-Jan). Production of S_1 seed from parent bulbs.

Year 2 (Jan-June). Evaluation of S_1 material on the basis of families (progeny testing). Best bulbs selected from best families.

(2)

Year 2 (June-Jan). Induction of flowering and the complete recombination of all selected bulbs.

Production of S_2 material by selfing secondary or tertiary flowering stems on selected bulbs. Some selection for ease of flowering carried out. Seed of each bulb retained.

Synthetic (3)

(1)

Year 3 (Jan-June). Evaluation of material and comparison to original cultivar(s). Production of mother bulbs for seed increase.

Evaluation of S_2 material C_1 i.e. bulbs within lines within families.

Year 3 (June-Jan). Seed increase of C_1 if material compared favourably with test cultivars.

Formulation of O.P. cultivar by complete intercrossing of component bulbs.

Year 4 (Jan-June). Possible release ot C_1 as O.P. cultivar.

Evaluation of O.P. cultivar using original cultivar(s) as standard or in commercial cultivation.

Synthetic Cultivar

Year 3 (June-Jan)	Production of bulbs for seed production and crossing to tester cultivar (top-cross).
Year 3 (June-Jan)	Crossing of lines to tester cultivar.
Year 4 (Jan-June)	Evaluation of top-cross progeny. Calculation of General Combining Ability (GCA) of lines. Calculation, using prediction of mother bulbs of all lines using original S_2 seed retained in year 2. Selection of best bulbs in selected lines for cool storage and seed production.
Year 4 (June-Jan)	Formulation of synthetic by complete inter-crossing of selected bulbs.
Year 5 (Jan-June)	Release of syn-1 seed on a limited scale into commercial production. Retain syn-1 seed for the formulation of syn-2.

CONCLUSION

The programme outlined provides for the following:

(a) The importation and evaluation of a wide range of improved and semi-improved onion cultivars, and the release of superior material as cultivars and/or their inclusion in the progressive developmental programme.

(b) Two cyclical schemes for the development of in-season and off-season cultivars and continuous improvement of the two base populations.

(c) The improvement of the ability of cultivars to flower in the tropics and thus in the ease of handling. A side industry consisting of the contracting of chosen growers for large scale seed production will be a spin-off from the main programme.

(d) The generation of a considerable amount of scientific information on the growth and adaptational requirements of tropical onions.

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DISCUSSION

The major aspects of the discussion on this paper gave rise to the general consensus that the research programme outlined by Mr. Julien was indeed of high priority. It was felt that the programme was likely to be costly and a collaborative programme with a US university should be looked into. The type of programme envisaged was a model where US university students, with funding from an international agency (eg. USAID) would carry out higher degree studies on various aspects of the onion breeding project in Barbados along with Barbadian counterpart scientists, who could also be working toward higher degrees. Some aspects of the work, such as seed production, could be carried out in the USA but all selection work would be done in Barbados. The Barbados authority would retain control of the project and the project would be designed by the collaborating agencies but with major input coming from the Barbados Ministry of Agriculture. It was emphasized that quarantining requirements for movement of onion planting material both into and out of Barbados would have to be rationalized.

ONION BLAST IN BARBADOS - A RESEARCH OUTLINE FOR THE EIGHTIES

BY WINSTON SMALL, SENIOR CONSULTANT, SYSTEMS, BARBADOS

BACKGROUND

Onion blast, a debilitating disease of onions, and arguably the major constraint to the large scale culture of that crop in Barbados, was first recorded in Barbados in early 1971. It is not known if earlier large scale plantings of onions in Barbados at the turn of the century suffered from the same or a similar disease. Blast fluctuated in severity from year to year since 1971 causing losses in bad years which have tended to cause farmers to significantly reduce their acreage of onions.

There is some confusion in the literature with respect to the causation of 'Blast' disease. As early as 1904 in the USA, Whetzel described a disease of onions with essentially the same symptoms as blast in Barbados as being caused by physiogenic meteorological conditions. Later workers, for example, Lorbeer in New York State, USA, concluded that blast was caused by various species of the fungal genus *Botrytis,* notably *B. allii* and *B. cinerea*. It is now thought that there are 2 separate diseases, 'Blast' caused by physiogenic factors and 'Blight' caused by various fungi and having essentially the same gross symptomatology. (See MSc Thesis - L.W. Small).

The disease, in Barbados, is evidenced in most cases by the appearance of pale spots on the leaves. The leaves then gradually die back from the tips. Older leaves are more severely affected than younger ones and blast usually occurs after a period of rainy weather.

In Barbados initial research on the problem was carried out by D. Norse and L.W. Small of the Ministry of Agriculture. These workers identified a number of possible causal agents, e.g. Alternaria sp, Stemphylium sp, etc., but after further work, concluded that none of these agents was the primary pathogen. Later work by Lorbeer may be construed as essentially coming to the same conclusion. Christen and Phelps later, separately, carried out preliminary studies which indicated that bacterial species might have been involved in the causation of blast but these studies were not followed up. Small later attempted to isolate bacteria from disease lesions but with no success. Botrytis sp were never isolated from diseased onions in Barbados. It therefore appears that "Onion Blast" in Barbados is not caused by otrytis sp or any other fungus and that more work is needed to investigate the possible bacterial causation of the disease.

From early on in the research programme it was recognised that onion blast might be caused by a non-pathogenic agent, acting alone, or as a predisposing factor to subsequent attack by a secondary factor. Thus such causes as inadequate drainage, air pollutants, e.g. ozone and aircraft tumes, phytotoxic chemicals,wind dessication, constant overcast conditions, high solar radiation, abrasion by small soil particles and soil nutrient deficiency or excesses were considered and tested. The most detailed work in this area was carried out by Eavis, who, in a series of experiments, provided some evidence that blast was associated with nutritional factors. Further work, however, is necessary to fine tune the extent of the relationship between onion blast and nutrition. Small carried out a series of experiments using windbreaks which indicated that wind was associated with blast. Other experiments of a preliminary nature were carried out by Small, L. Smith and others with respect to air pollutants, wind abrasions, etc. These experiments were in the main inconclusive. In general, the investigations on a non-pathogenic causation of blast were, to some extent, disjointed and un-coordinated. The findings indicate that wind and soil nutrient imbalances may be associated with blast but do not completely eliminate the other factors mentioned above.

Blast of onions has been a major problem in Barbados for over 12 years. During that time, a number of separate, short, part-time, investigations have been made into the disease and the causal agent is still not known. During that time also, in stark contrast, Internal Brown Spotting disease of yams was subjected to an indepth investigation by a full-time researcher. That disease has now been identified, control measures worked out and improved systems used by the farmer. The onion blast studies have suffered from the fact that an interdisciplinary, full-time research project has never been mounted. All the work detailed above, has been carried out on a part-time basis with relatively poor funding. The author has, on a number of occasions, made recommendations for a coordinated multi-disciplinary full-time approach, but with little success. The economic and agricultural climate now appears favourable for policy makers to take a new look at exportable non-sugar crops such as onions and onion farmers appear to be interested in assisting in the funding of a rational research programme for onions. Such a research programme must include an in-depth study of onion blast.

THE PROPOSED ONION BLAST PROGRAMME

It is proposed that in inter-disciplinary programme be set up as soon as possible to start research for the 1983/84 crop. The major areas of investigation would be:-

1) A full study of the possible pathogenic agents that may cause blast including the possible association of insect vectors with the disease.

2) A disease measurement study of blast to characterise the effect of disease incidence on yield.

3) A study of the possible non-pathogenic agro-meteorological factors that may be associated with blast.

4) A study of the soil factors that may be involved in blast.

5) The determination of control measures for blast.

6) The identification of tolerant/resistant varieties.

7) A study of the effect of mycorrhizae on the disease.

The studies above would build on the data and conclusions provided by earlier studies, however some repetition of experiments will be necessary.

It is essential that a full-time plant pathologist or plant pathology student be engaged to devote his/her full attention to carrying out the pathological aspects of the study and to liaise with other part-time professional staff of pathology inputs into non-pathological aspects of the study.

The total programme is likely to run for about 3 years before significant results become available.

Resources Required (per year)

Professional Staff

1 Plant Pathologist	12 man months
1 Soil Scientist	4 " "
1 Agro Meteorologist	4 " "
1 Emtomologist	3 " "

Support Staff

2 Technicians (A.A. Level)	12 man months
Casual labour	12 " "

Materials

Biological Laboratory Infrastructure (Plant Pathology, Soil Chemistry, Soil Physics)

Mobile Lab for Field Studies (Agromet)

Sundry Chemicals

Sundry Equipment.

Detailed costings for the onion blast studies are not provided in this paper since it is assumed that there may be major modifications made following discussion at the 'Onion Production and Research for the 80's workshop'.

CONCLUSION

There has been over a decade of research on onion blast in Barbados. This research has not been carried out on a full-time interdisciplinary basis. It is not surprising, therefore, that results are not definitive to date. It is suggested that the onion blast problem requires no less than a well-planned, interdisciplinary research effort, carried out by committed full-time scientists on an on-going basis. It is preferable that such research should be under the aegis of a non-governmental institution where workers are unlikely to be delegated to other duties during the course of the study.

An agency such as CARDI, IICA, or BAS, should be invited to assist in the project by providing for the attachment of the full-time technical 'onion blast' project personnel to their staff for the duration of the project. Funding for the project should come from Government and other funding agencies such as Barclays International, CIDA, USAID, FAO etc. These agencies could be requested to provide specific portions of the various resources required for the various sections of the onion blast programme. Such an approach is not a novelty in Barbados. For the Barbados Sugar Producers Association, Barclays International and CARDI, have collaborated for some years now, in funding an entomological project at Edgehill, St. Thomas on the Biological Control of Sugar Cane Pests.

With such an approach, I am confident that within a relatively short period of time, the causal agent(s) of onion blast in Barbados will be characterised and rational control measures developed.

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DISCUSSION

It was generally agreed that 'Blast' was a major constraint to the production of onions. It was felt that the research programme should follow the lines suggested by the author and that the following research areas might offer a chance of rapid benefits:

a) The influence of mycorrhizal inoculation on blast susceptibility/resistance.

b) The use of antitranspirants.

c) Agro-meteorological investigations leading to disease forecasting and determination of optimal time of spraying.

d) Relational use of irrigation.

e) Parallel selection of varieties resistant or tolerant to 'Blast'.

PESTS AND DISEASES OF ONION BY CHELSTON W.D. BRATHWAITE, REGIONAL PLANT PROTECTION SPECIALIST, INTER-AMERICAN INSTITUTE FOR COOPERATION ON AGRICULTURE (IICA), IICA OFFICE IN TRINIDAD AND TOBAGO

Onion (*Allium cepa*) has been grown on an experimental basis in several islands in the Caribbean but only in Barbados has the crop been produced commercially. The crop is grown widely in the temperate region but less widely in the tropics. Like all crops, onion is subject to attack by a variety of pests and diseases which limit the productivity of the crop in many areas.

This paper attempts to briefly review the major pests and diseases of the crop.

I. PESTS OF ONION

The main pests of onion are:

Spodoptera littoralis	- (Egyptian) Cotton leafworm
Spodoptera litura	- Tobacco caterpillar'
Spodoptera exigua	- Lesser cotton leaf worm
Lipaphis erysimi	- False cabbage aphid
Agrostis ipsilon	- Greasy cutworm
Thrips tabaci	- Onion thrips
	- Leaf miners
	- Cutworms

A. Leaf eating caterpillars

These were reported to appear about seven days after germination and fed on the tips of the onion leaves. New generations of insects appear throughout the growth of the crop and they later enter the hollow leaves and feed on the inner tissues. As the crop nears maturity, the caterpillars sometimes feed within the crown of the bulb and this damage can lead to premature rotting. The species of insects involved was not identified.

B. Leaf miners

Hollow tunnels appear in the middle tissues of the leaf and these take on a distorted and translucent appearance. Severe infestations can result in death of the plants.

C. Onion thrips

Onion thrips are among the most common pests of onion and occur in almost all areas in which onion is grown.

Below is a review on onion thrips taken from Diseases, Pests and Weeds of tropical crops (1979).

1) Geographical distribution: This small insect is found in most countries of the world although it is particularly abundant in areas with rather hot, dry climates. The Commonwealth Institute of Entomology

Distribution Map 20 (revised 1969) suggests that the species is not found in the larger areas of tropical rainforests. It is likely that the pest came originally from the eastern Mediterranean together with its most favoured host plant Allium cepa.

2) Host plants: The onion thrips has been recorded from more than three hundred species of plants, although when given a choice it appears to prefer onions (Allium cepa). In temperate regions it is common on various Compositae (eg. Achillea, Senecio) and Cruciferae (eg. Brassica), whilst in warmer climates it is particularly abundant on cotton (Gossypium), tomatoes (Solanum), tobacco (Nicotiana), cucurbits (Cucurbita, Cucumis), and various weed Compositae (eg. Emilia sonchifolia). This wide range of host plants, together with the ease with which the insects are dispersed by wind and the rapidity with which they breed, makes Thrips tabaci an unpredictable pest which can be difficult to control.

3) Symptoms: Thrips usually feed on the lower surface of leaves. The cell contents are removed from the lower mesophyll, and as a result air spaces develop and the leaf becomes distorted. Attacked leaves frequently have a silvery sheen and they may bear small spots of faecal matter. Feeding damage on cabbages leads to russeting or bronzing of leaves, and young plants are particularly susceptible. Heavy thrips attack can cause sufficient leaf damage to kill young onion or cotton plants.

In addition to direct feeding, Thrips tabaci also carries Tomato spotted wilt disease to several crops. On pineapple (Ananas) this disease is known as Pineapple Yellow Spot due to the small round yellowish spots produced on the upper surface of the leaves. These spots increase to irregular streaks and a lethal necrosis may set in which can affect 40% of a crop. The same virus disease on tobacco (Nicotiana) is known as Kromnek in South Africa. The apex of an infected plant bends over due to a check in growth on one side and this eventually leads to necrosis. Young tobacco plants with a severe infection usually die but older plants may recover.

4) Control: Control of alternative host plants is unlikely to be a useful method of reducing the numbers of tabaci on a crop, except under exceptional circumstances, because of the wide range of plants on which the insect breeds. However weed control can be important when the weeds are known to harbour Tomato spotted wilt and decorative garden plants in surrounding urban areas can also be a source of this virus. Ploughing and harrowing of fields after a crop has been harvested can be useful in reducing subsequent thrips populations by killing both pupae in the soil and adults sheltering in grass stems and plant debris. Overhead and surface irrigation have both been found to be effective in controlling thrips damage, partly by killing thrips that are already present on the plants or in the soil, but also by stimulating the growth of a crop and so reducing the period during which it is most susceptible to damage. Similarly a crop may be protected by bringing forward the planting date so that the maximum population of thrips does not coincide with the seedling stage. Optimum plant density varies with the crop and

the conditions under which it is being grown, but the distance between individual plants can be varied to reduce the number of thrips present or the damage which they cause. Crop loss has similarly been reduced, particularly in tomatoes, by growing varieties which are least susceptible to thrips damage.

The range of cultural practices by which losses to thrips may be contained in such that the use of insecticides may be avoidable or even uneconomic. Moreover attempts at chemical control of the spread of Tomato spotted wilt are usually unsatisfactory. In tobacco fields in Bulgaria a control of tabaci and the virus disease was obtained by ploughing into the soil 50kg/ha of 12% gamma BHC dust both just after one crop and just sowing the next, followed by monthly dustings with DDT. However such concentractions of insecticide would not be acceptable on a food crop. Both carbaryl and DDT are effective as foliarsprays at 0.5-1.0 lbs/acre in reducing thrips populations, and DDT can be used as a 5-10% dust on bulbs in store or at about 20lbs/acre in the field as a foliar dust. In glasshouses thrips are best controlled by gamma BHC or DDT smokes, or malathion aerosols rather than by spraying.

II. DISEASES OF ONION

There are several fungi and bacteria which have been reported from onion. Among the most common are:

Alternaria porri	-	Purple blotch
Alternaria tenuis	-	Seed mold
Aspergillus niger	-	Black mold
Botrytis squamosa	-	Neck rot
Botrytis cinerea	-	Gray mold
Botrytis allii	-	Leaf blight
Collectotrichum circinans	-	Smudge
Erwinia carotovora	-	Soft rot
Fusarium solani	-	Pink root
Perenospora destructor	-	Downy mildew
Pythium spp.	-	Damping off
Rhizoctonia solani	-	Damping off
Sclerotinia sclerotiorum	-	Watery soft rot
Sclerotium cepivorum	-	White rot
Sclerotium rolfsii	-	Southern blight
Stemphylium botryosum	-	Black stalk
Pyrenochaeta terrestris	-	Pink root
Urocystis cepulae	-	Onion smut
	-	Physiological disorders
	-	Chlorosis
	-	Blast

I shall deal with a few of the most common diseases in detail. Most of the information presented is from J.C. Walker's book "Diseases of Vegetable Crops".

A. Bacterial Soft Rots

Bacterial decay of onion is one of the most widespread and destructive causes of loss in storage. Several organisms have been described in connection with this type of rot. Three distinct species are considered here.

1) Symptoms. Bacterial soft rot begins in the field as plants are approaching maturity. It may escape notice until after harvest. The bacteria enter the neck tissue through dead or senescent leaves and progress down one or more scales without passing from one scale to another. Thus one or two scales may become completely rotted, the remainder being sound. When the rot has progressed in that way for some time, the diseased bulbs can be detected by gently pressing them, whereupon the watery fluid is extruded through the neck. When onions are subjected to sunscald or harvest bruises and kept in, warm humid storage, soft rot may be confined largely to outer fleshy scales. The slimy decay is usually accompanied by a foul sulfurous odor. Sour skin is a decay that affects only certain of the outer fleshy scales. The rot is slimy and yellow and gives off a vinegar-like odor. The scales outside the rotting ones slip off readily in handling.

2) The causal organisms: The bacterial-soft-rot organism, Erwinia cartovora (L.R. Jones) Holland, described under carrot, is the incitant usually cited. Although it has been shown to be pathogenic on onion,it appears to be relatively uncommon as an onion pathogen in nature. Another organism which incites a rot that is not as soft as typical

bacterial soft rot was described in 1942 by Burkholder as *Pseudonomas alliicola* Burk. The incitant of the sour skin is P. *cepacia* Burk.

3) Disease Cycle and Control. The organism exist as saprohytes in soil and refuse. Penetration is through wounds and senescent tissue. The cutting of tops at harvest while the necks are still succulent facilitates infection. The onion maggot puparia were shown by Johnson to contain soft-rot bacteria, and adult flies arising from the puparia were shown to be contaminated. This insect may therefore be a source of inoculum and a means of dissemination. Penetration through bruises and following sunscald is common. Humid conditions are essential for penetration and disease development.

Control measures consist of permitting the crop to mature well before harvesting. The tops should be allowed to dessicate as much as possible after lifting and before topping. Mechanical toppers should be designed to permit a minimum of bruising, and care in handling generally should be pointed toward the same objectives. Bulbs need thorough curing before storage, and the latter should be provided with sufficient ventilation to avoid accumulation of moisture on the surface of the bulbs. Rigid sorting at harvesting and at packing is necessary.

B. Damping-off and root rot

Damping-off of onion seedlings is incited by *Pythium* spp. and *Solani*. Seed rotting, pre-emergence damping-off, and post-emergence damping-off occur in young seedlings. The disease may appear in the field in roughly circular areas in which all plants are killed. Later in the season, stunting and root rot may occur. _Fusarium_ spp. and the pink-rot organism _Pyrenochaeta terrestris_ (Hansen) Gorenz et al., may also be associated with the disease in midseason and later. The disease is controlled in part by treatment of seed with Arasan (see control of onion smut).

C. _Downy mildew_

This is a disease of moist conditions. It is caused by the fungus, _Peronospora destructor_.

1) Symptoms. The disease first appears either on systematically infected leaves of perennial onions and on plants growing from infected bulbs or as local lesions from air-borne inoculum. Systematically infected plants are dwarfed, becoming distorted and pale green, and in humid weather the fungus produces a violet downy mildew over the entire surface of the leaves. In dry climate or in a dry greenhouse only white spots appear on systematically infected leaves. Local lesions, resulting from secondary infection, are oval to cylindric in shape, variable in size, and often paler than the normal yellow green of the leaf or stem. They may consist of alternating chlorotic and green layers of tissue. In humid atmosphere the fungus fruits on the surface. In drier atmosphere the lesion may become necrotic in the centre without fructification. When leaves are infected between the centre and the tip, the leaf droops at the point of the lesion and the tip dies. The plant produces new leaves as growth continues. The severity of the

disease depends on the environment. Advance may be checked for a time in dry weather and then be renewed with the return of favourable conditions. Plants are seldom killed, but bulb growth is reduced, and the bulb tissue is inclined to be spongy and of poor keeping quality.

When expanding seed stems are infected, uneven, stunted growth follows. When growth is checked by infection on one side of the stem, the latter bends in the direction of the lesion. As the seed umbel grows heavier, weakened stems break over, and either seed maturation is prevented or mature seed is shrivelled.

The leaf-mold organism commonly develops in onion-mildew lesions as a saprophyte or a very mild facultative parasite. The fructifaciton of this organism consists of dark-colored spores produced in abundance on the surface of the lesion. The conspicuous appearance of this black mold is commonly such as to obscure the sporangiophores and sporangia which make up the mildew of the downy-mildew disease.

2) Disease Cycle. The fungus overwinters as systematic mycelium in bulbs, in infected overwintering plants in mild-winter areas, and as oospores in the soil. In New York, for instance, perennial onions in home gardens are regarded as the most important source of primary inoculum. Since infection of flower parts has been found and since oospores have been reported on the surface of seeds, some workers have regarded seed transmission as important. Yarwood, however, found no evidence of such transmission of the pathogen. The germ tube usually forms an appressorium over the stomatal opening, penetrates through the

stoma, and forms a substomatal vesicle from which the intercellular mycelium arises and sends filamentous haustoria into the host cells. Sporangia are produced in high humidity over a range of 4 to 25°C., with an optimum at about 13°C. Yarwood found sporangia to develop during the night, maturing early in the morning, and being disseminated during the day. Relative humidity and alternation of light and darkness both influence sporulation. The sporangia remain viable, when attached for about 3 days, or even longer in the dark, but for a shorter period when detached. Air currents make up the chief agent of dissemination. Germination occurs in water from 1 to 28° with little difference in percentage of spores germinating from 7 to 16°. Relatively cool and rather humid weather is required to build up an epidemic. Rain is not necessary if heavy dews occur repeatedly.

3) Control. Although many control experiments with inorganic and organic fungicides show a reduction in the amount of disease, control by these means has often been disappointing. Factors which seem to have reduced the effectiveness of this type of control measure are the spasmodic nature of the disease, the difficulty of getting fungicides to stick on the glossy surface of onion leaves, and the rapid exposure of new leaf tissue during the growing period. Failure to secure good chemotherapeutic control in Louisiana was reported in 1950 by Tims. On the other hand Nelson in 1951 reported encouraging results in Michigan with a mixture of Dithane Z78 and sulfur.

Avoidance of poor drainage has a beneficial effect. Eradication of perrenial onions as a source of inoculum is important in some sections. Seed growing has shifted to some extent to simiarid irrigated areas to reduce the mildew hazard.

While differences between varieties in their susceptibility to mildew have been observed by numerous workers, little use of resistance as a control measure has been made until recently. Calred is a variety introduced by the California Experiment Station and the U.S. Department of Agriculture in 1947. It is derived from a cross between resistant Italian Red and Lord Howe Island. The seed stalks are highly resistant and the leaves moderately so.

D. Neck Rot

The first description of neck rot of onion was published by Sorauer in Germany in 1876. The disease was reported in the United States in 1890 and in England in 1894. It is now known in many countries and is one of the major bulb-destroying diseases of this crop. In 1926, Walker distinguished three species of Botrytis, each of which may incite a neck rot of onion bulbs, the respective diseases differing somewhat in symptoms. They were given distinctive names as follows: gray-mold neck rot (B. allii Munn); mycelial neck rot (B.byssoidea J.C. Walker); Small sclerotial neck rot (B squamosa J.C. Walker). The first of the three is the most common. The organisms of gray-mold neck rot and mycelial neck rot are pathogenic on shallot and garlic.

1) Symptoms: Gray-mold neck rot is found most commonly upon the bulbs after harvest, infection usually taking place through the neck

tissue but occassionally through the stem end or through wounds elsewhere. The first sign is the softening of the affected scale tissue, which takes on a sunken cooked appearance. This remains characteristic of the advancing region of Decay, which is separated from healthy tissue by a definite margin. Since the effect upon host cells is produced somewhat in advance of the hyphae of the pathogen, there is usually little evidence of mycellium in the outer zone of decaying tissue. As the mycellium increase in the older diseased area, the tissue becomes grayish in color, and later a dense, grayish mycelial mat often develops upon the surface of the scales. Under moderately humid conditions conidial production is prompt. A dense layer of gray mold appears which consists of comparatively short conidiphores and myriads of conidia.

The disease progresses most rapidly down the scales which have been originally infected at the neck. The spread from scale to scale proceeds somewhat more slowly. In a cross section of a partially rotted bulb, at the advance margin of the disease, the parenchyma tissue has a distinctly water-soaked appearance. A few millimeters back from this point a grayish tinge and a slight shrinkage in the decaying tissue becomes evident, and still farther back shrinkage and mycelial development increase. In connection with the older decayed tissue, sclerotia appear, first as whitish compacted masses of mycelium, which become darker with age until they assume the appearance of hard, black, kernel-like bodies, spherical, oblong, or irregular, and varying from 1 to 5 mm in length. They form usually on the outer surface of the scale or slightly embedded in the deseased host tissue. Will the host tissue in the beginning of its decay is somewhat watery, it dessicates rather promptly. The moisture which is released is often sufficient to stimulate premature sprouting. The older decayed bulb presents the appearance of a "mummy". While the pathogens of gray-mold and mycelial neck rots are primarily parasitic on dormant fleshy scales, they may cause small, white, necrotic lesions on leaves and seed stalks. They may induce sufficient damage to cause blasting or reduce the quality of the seed. Mycelial neck rot differs from gray-mold neck rot in a greater quantity of extramatrical mycelium and sparseness of sporulation.

Small-sclerotial neck rot is found almost entirely on white-bulb varieties. The fungus usually appears near the neck of the bulb several weeks after harvest. The first evidence is the appearance of thin, scale-like, roughly circular sclerotia, ½ to 1½ mm, which adhere closely to the dry scales. They are at first light colored, but most of them turn completely black with age. In many instances their development is arrested prematurely, and bodies which are light gray in the centre and black only at the margin result.

E. Purple Blotch

This is a disease which affects leaves, seed stems, and bulbs. While the fungus is a widespread one, it is most serious in southern locations and in irrigated areas. Leek and probably other cultivated species of Allium are affected.

1) Symptoms. Small, white, sunken lesions with purple centres rapidly enlarge and eventually girdle leaf or seed stem. About 2 or 3 weeks after first appearance of the disease, darkened zones consisting of superficial masses of fungus spores appear on the lesion. If the environment is favourable, most affected leaves and stems fall over within 3 or 4 weeks after lesions appear. At harvest time and later, bulb decay is noticeable as a semiwatery rot, beginning at the neck and being especially conspicuous because of the deep yellow to wine-red color. As the dark-colored fungus threads become conspicuous, the diseased tissue dessicates to a dark, papery texture. Affected leaf and stem tissue is commonly overrun by the leaf-mold fungus.

2) The causal organism. Alternaria porri (Ell.) Cif. The mycelium, conidiophores, and conidia are indistinguishable from those of the potato-early-blight fungus. For that reason the latter has been reduced to a variety of A. porri by Neergaard. The onion fungus does not affect potota and vice versa. The pathogen subsists between crop seasons as mycelium in infected plant refuse and as spores. Penetration is through stomata and wounds. The climatic environment most favourable for the disease is not entirely worked out. Purple blotch is commonly associated with downy mildew, but the former develops over a much wider geographical range and has less exacting climatic requirements for development.

3) Control. No control for the field phase of the disease has been worked out. The handling and storage measures recommended for neck rot apply to purple blotch.

F. Pink root

The pink-root disease of onion first came into prominence in the Rio Grande Valley of Texas, where it was described in 1921 by Taubenhaus and Mally. It is now widespread throughout the United States and has been reported in other parts of the world. It occurs on Welsh onion, leek, shallot, garlic and chive. The pathogen is a rather common soil inhabitant and affects the roots of many, plants, particularly among the monocots, including corn, cereals, grasses, sorghum, and sugar cane. It is also reported on cucumber, carrot, spinach, pea, Hubbard squash, muskmelon, tomato, pepper, eggplant and cauliflower.

1) Symptoms. The disease becomes manifest in young seedlings and at any subsequent time in the growth period of the host. Abnormal yellowing of the roots is commonly associated with pink root, but it is not necessarily at stage of this disease. Affected roots turn pink, shrivel and die. As the plants send out new roots, they in turn eventually become diseased and functionless. If this procedure continues throughout the growing season, the affected plants are commonly not killed, but the reduced food supply results in the formation of mere scallions or small bulbs. During the growing season there may be a few above-ground signs of the disease. It becomes more apparent at harvest, when the size of the bulb is roughly in inverse proportion to the severity of attack. The disease can be controlled by seed treatment.

G. Smut

Onion smut was first reported in 1869 in the Connecticut River Valley, where by 1888 it was of great economic importance on old onion soils. It has become an important disease in a majority of the onion-growing areas throughout the northern states as far west as Oregon. The pathogen was undoubtedly introduced from Europe, where its occurrence was not recorded until some time later than the American record. A specimen of the fungus in the Persoon herbarium in France, collected about 1834, leaves no doubt as to its European origin. The disease has become important in numerous European countries and has been recorded from the Capsian Sea region, which is not far removed from the original habitat of the onion. It also occurs in New Zealand and Canada. In the United States the disease has remained strictly a northern one, not being reported south of Kentucky, although there is good reason to believe that the fungus has been transported frequently to southern growing regions. It was reported in central California in 1949. There is a similar concentration of the fungus in northern Europe, in contrast to its very rare occurrence of its absence in Spain, southern France and Italy.

The fungus is restricted to the genus Allium, within which there is a considerable number of susceptible species. Common economic hosts, aside from onion, are leek and Welsh onion.

1) Symptoms. The disease appears first on the cotyledon of the young plant soon after it emerges from the soil. The lesion consists of a dark, slightly thickened area involving leaf or cotyledon for one to several millimeters. Sometimes the major part of a leaf is taken up by

a single lesion, and in such a case the leaf tends to curve downward abnormally. On older plants numerous raised blisters occur near the base of the scales. The lesions in plants at all stages often rift to expose black powdery masses of spores.

The fungus progresses inward from leaf to leaf at the base of the plant. The majority of infected plants die within 3 to 4 weeks after emergence. Some plants survive in a weakly condition until midseason or later, and occasional plants produce bulbs, which bear the lesions on the outer fleshy scales and in one or more underlying scales. The fungus does not produce a rot in storage, but affected bulbs may be more subject than healthy ones to invasion by other pathogens. Very rarely, infected leaves may arise from a bulb which became infected during the previous season.

2) Disease cycle. The fungus remains viable for an indefinite number of years in infested soil. Anderson claims that it persisted in the soil as a saprophyte. There is no convincing experimental evidence of this, however. Since the fungus is known to remain viable in air-dry soil for many years, it is possible that many of the spores remain dormant for a long time. Spores have been reported rarely on onion seed, and distribution by this means is not regarded as important. Onion sets and onion transplants are important means of widespread distribution of the fungus. Wind-borne soil and surface drainage water are means of local dissemination.

The onion is susceptible to initial penetration in the seedling stage. Infection ordinarily occurs in the cotyledon before it emerges above ground. When the cotyledon approaches full size, it is usually no longer susceptible. If by chance it has escaped infection during this early period, the entire plant continues to remain healthy. The leaves of the onion are produced successively in the embryonic transition region between root and leaf and remain enclosed within the preceding leaf until they emerge at the "neck" above ground. Each leaf goes through a susceptible period, but if the previous leaf has remained free from infection, the former is protected from infection until it passes into the resistant stage. If the cotyledon is removed before the first leaf has become resistant, direct infection of the latter from the soil may occur, but ordinarily infection occurs first in the cotyledon, and the fungus penetrates each successive inner leaf. Often the infection of a cotyledon takes place only near the tip or "knee" while it is below ground but the lesion matures above ground. The base of the cotyledon then remains healthy and protects the first leaf from infection. Many originally infected plants escape systemic infection in this manner.

The optimum temperatures for chlamydospore germination, hyphal-fragment germination, and vegetative growth of the thallus lies between 13 and 22^{o}C. Above 25^{o} there is a decided reduction in the amount of germination which occurs, and growth of the thallus becomes meager as the temperature rises. Such hyphae as do appear above 28^{o} not only grow very slowly but also lose their viability upon continued exposure to these temperatures. On the contrary, protracted exposure to near-minimum temperatures does not so affect the slowly growing thallus.

Abundant infection occurs at soil temperatures as low as 10 to 12^{0}, which is nearly as low as germination and growth of the onion occurs. Infection occurs equally well up to 25^{0}, but above that a rapid reduction in infection is noted, while at 29^{0} the onion seedling grows free from the disease in infested soil. At slightly lower soil temperatures the seedling grows more rapidly than at lower temperatures, and the susceptible period is correspondingly shortened. The onion seed in southern states is usually sown in autumn when the soil temperature is high. This is considered to be a major factor in restricting the disease in those areas.

3) Host resistance. Evans has studied the host-parasite relations of this disease in onion and in the relatively resistant Welsh onion. No resistant individuals have been found in the former, but it and Welsh onion cross fairly readily, although the hybrid is usually sterile. The hybrid may be backcrossed to each parent but least readily to common onion. Walke et al. studied the inheritance of resistance in this hybrid and in a fertile amphidiploid from the hybrid. The F_1 hybrid was considerably more resistant than the susceptible parent but less so than the resistant parent. Backcrosses to Welsh onion were highly resistant, but backcrosses to common onion were very susceptible. The amphidiploid, which is a nonbulbing type like Welsh onion, is quite highly resistant, though less so than the Welsh onion. It is also resistant to pink root. It has value as a bunching onion and is known by the name Beltsville Bunching.

4) Control. Thaxter was the first to show the short susceptible period of the seedling onion. He also was the first to try various materials placed in the furrow with the seed as protectants. A mixture of sulfur and lime showed promise, and this treatment was placed on a commercial basis in New York by Sirrine and Stewart in 1900. Shortly after this, Selby developed the formaldehyde-drip control in Ohio which has been improved and applied widely since that time. The latter method consists in applying a stream of dilute formaldehyde in the soil with the seed. Apparently the material volatilizes sufficiently to inhibit the fungus in the soil through which the seedlings emerges for the period of susceptibility. The standard treatment consists of 1 pint of 37 to 40 per cent formaldehyde solution in 16 gal of water applied at the rate of 1 gal to 150 ft of row or 1 pint in 8 gal of water at the rate of 1 gal to 300 ft of row. The treatment is cumbersome, formaldehyde injury may occur in very dry soil, and heavy rains immediately after application may reduce its effectiveness.

Arasan was shown by Newhall in New York to be effective when pelleted with Methocel sticker on seed sown at the usual rate for bulb onions of about 5 lb per acre. In Wisconsin on upland soil good control was secured by Gorenz and Walker with 1 lb of Arasan to 10 lb of seed applied without sticker when seed was sown thickly for sets (about 80 lb of seed and 8 lb of dust per acre). Nelson secured erratic results with this method on muck in Michigan when seed was sown at about 5 lb of seed and thus a much smaller amount of dust per acre. Newhall has devised a means of applying Arasan dust by a separate mechanism in the furrow with the seed. Arasan applied in much smaller amounts

(0.5 per cent of the weight of seed) is effective against Pythium damping-off.

Onion sets and onion transplants may be planted in smut-infested soil without any danger of infection.

III. DISEASES OF ONION IN THE CARIBBEAN

The disease that has caused most concern in the Caribbean is often referred to as Onion 'Blast'. As this is the subject of a paper by Dr. Small, I shall not discuss the disease at this stage. Other diseases of concern are:

1. Purple blotch reported from Jamaica.
2. Bacterial rot from Montserrat
3. Stubby root from Trinidad and Tobago
4. Storage rot in Barbados
5. Pythium damping off in Montserrat.

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DISCUSSION

The major point of discussion was on the Plant Quarantine aspect of any serious expansion in production of onions in Barbados. viz: The fact that introduction of sets from overseas may bring in diseases or pests not yet present in Barbados. The fact that increased plantings if not properly controlled, could introduce various seed borne diseases into the island. It was emphasized that for plant quarantine services would have to be very vigilant. It was emphasized also that the breeding and selection studies should be designed to improve the genetic base for combatting diseases and pests other than blast and thrips. It was brought to the notice of the workshop that the Ministry of Agriculture had plans to set up a seed testing facility at Graeme Hall in the near future.

INSECT CONTROL IN ONIONS BY E.H. ALLEYNE, ENTOMOLOGIST

No truly quantitative assessment has been made of the effect of insect damage on overall yields of onions in Barbados, but it is obvious when one considers the types and frequency of damage, that it must be quite substantial.

There are three types of insects which are commonly associated with onions locally, which could qualify as pests of this crop. These are:

i) Spodoptera sp. (Lepidoptera:Noctuiidae)
ii) Leaf-miners - Liriomyza munda (Diptera:Agromyzidae); and
iii) Onion thrips - Thrips tabacci (Thysanoptera:Thripidae).

These three insect pests may be found together on the plant, but because of their feeding activity and behavior do not compete directly. Although each of the above three insects is separately capable of completely destroying the crop, T. tabacci is generally regarded as the most consistent offender.

Before embarking on any control program it is essential that some knowledge of the insect to be controlled be provided. This is necessary if the chemicals to be used in the program are to produce the desired effect.

Also, such prior knowledge could provide clues on the weakest points in the life cycle of the insects, which could then be exploited in the control program. It further allows for the more effective integration of other factors, both biotic and abiotic, particularly weather, parasites and predators.

INSECT PESTS

1. *Spodoptera sunia*

Caterpillars of the moth when fully grown, may measure more than an inch in length. Eggs resemble small white beads and are often laid at night in masses either on blades or under the sheaths of onion leaves. Larvae feed ravenously on onion leaves and produce irregular holes and greenish yellow pellets of excrement which is often present inside the hollow onion blades or in between the leaf sheaths. When severely damaged, onion leaves may droop and fall on the ground. Once such holes are present, the leaf blades can be separated to locate the larva within the cavity. When fully grown the larva falls to the ground and buries itself. Pupation occurs in the soil. The adult moth has dull grey forewings mottled with light and dark spots.

Control

Although this insect is a serious pest of other crops, mainly cotton and sweet potatoes, it does not cause comparable damage to onions. This may in part be attributed to the large number of natural enemies to which *Spodoptera* sp. are subjected in Barbados. Egg parasites e.g.*Trichogramma* sp., Braconid wasps and Tachinid flies are the most important. Birds also feed on the larger caterpillars. Chemical control when required can be achieved with many of the common contact insecticides, e.g. Folithion and the synthetic pyrethroid insecticides. Kill is mainly by contact action.

2. Leaf-miner (*Liriomyza munda*)

This tiny fly, unlike onion thrips, attacks onions quite early and can seriously stunt growth. Its presence is more recogniseable than that of thrips. The adult female fly lays its eggs in the green leaf tissue. The larva hatches from the egg and feeds on the parenchymatous tissue between the epidermal layers. As a result of this feeding activity mines are created. Each mine is produced by a single larva and entire areas of the leaf may be affected, when populations are large. The resultant effect is a drastic reduction of photosynthetic area of the leaf with consequential reduction in yields.

Leaves that are severely attacked may also wither and plants may die prematurely. After the larvae have completed their feeding activity, they emerge from their mines and pupate on the leaf. It is also believed that pupation occurs within the soil.

L. munda feeds on a wide range of cultivated and wild plants in Barbados.

Control

As attacks by this insect can occur quite early in the life of the plant, systemic insecticides applied at planting can produce good control during the initial critical growth period. Granular systemic insecticides like Furadan or Disyston release their active ingredients slowly over an extended period of 6-8 weeks. Later attacks when the plant is more advanced, have to be treated with foliage application of insecticides. In such instances any one of a wide range of contact insecticides e.g. Orthene and the synthetic pyrethroids, will be effective.

Very late attack of leaf miners are not as damaging to bulb yields as similar attacks of thrips.

3. Onion thrips - Thrips tabacci

This insect is the major insect pest of onions not only in Barbados but in most onion growing areas of the world.

The adult is very small (barely visible to the naked eye), brownish or black in colour with two pairs of frilly wings. The female punctures the onion leaf and deposits a single egg at a time. In a couple of days this egg hatches, the nymph emerges and begins to feed on the plant. Both adult and young thrips feed by the same method (rasping and sucking). This differs from the feeding activities of both Spodoptera sp. and Liriomyza sp. where only the larval stage is responsible for damage. Because of this factor, it will be apparent that T. tabacci presents a great threat. Both nymphal and adult thrips feed on the leaf blade, and populations are usually quite large as the life cycle takes aoout 2 weeks to complete. The typical symptoms of feeding activity is a silvery leaf appearance of leaf, as the green tissue is removed and cells are killed because of the sucking activity. This combined rasping and sucking feeding activityi allowed to go unchecked, can kill the plant in a very short time . The adult insect also moves from seriously weakened or drying plants to more healthy ones and in the space of a week or so the entire area will be affected.

Control

Thrips are very susceptible to dessication and therefore avoid direct sunlight. As a result they are rarely seen on exposed leaves during the daytime, but remain hidden and well protected between the leaf sheaths in the base of the plant. They, however, come out and feed on the exposed leaves during the late afternoon, evening and early morning when conditions are cool. This behavioral pattern makes the conventional spraying programs presently used, very inadequate, as sprays are often applied during the daytime. If sprays have to be applied at this period, then high pressure will be required to force the insecticide into the leaf sheaths in the base of the plant where the thrips are located. This is a rather difficult operation. A far easier method would be to spray when the thrips are feeding openly. This would entail spraying at dusk or during the early evening. Spraying at dawn is less successful since droplets of water formed as a result of condensation of dew will cause run off of insecticides.

A wide range of contact insecticides are available for control.

DISCUSSION

The major concensus reached was that the envisaged breeding and selection program should select for resistance/tolerance to onion thrips leaf miners and Spodoptera as well as to onion blast. It was suggested that short term research projects should be mounted in the use of ultra low volume spray applications to control the major insect pests. The recent introduction of spraying of insecticides and fungicides at night was considered and it was agreed that the practice appeared to the scientifically sound and should be encouraged.

CLIMATIC CONDITIONS IN THE INCIDENCE OF BLAST ON ONIONS

BY W. deCOURCEY JEFFERS, AGROMETEOROLOGIST,
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INTRODUCTION

Whereas small scale production of onions was started in Barbados during 1966, commercial production was first attempted during 1968/69. During this period some thirty acres were planted at ten different sites. Production was most encouraging and since no serious problems were encountered, expansion could be described as rapid.

Onion Blast was first noticed in 1970 when five fields out of thirty-two planted, developed symptoms of 'Blast' on the onion leaves. In 1971 there were eleven cases in a total of thirty-three fields; in 1972 there were twenty-eight cases in forty fields, and in the spring crop of 1973 there were seventeen cases in thirty-two fields. (Eavis).

It is reasonable to say that the incidence of Onion Blast was noticed throughout the Island with the exception of the Scotland District where the crop was not planted. All of the major Coralline Soil types with the exception of the Red Sands of St. Peter and the 64/65 soils of the St. John's Valley were involved. It was estimated that during 1973 no less than a quarter of a million EC dollars was lost as revenue to onion growers as a result of Onion 'Blast'. It can therefore be appreciated that Onion 'Blast' is of considerable importance particularly if an expanded industry is envisaged. Farmers will hardly invest substantially or expand acreages until, and when, solutions are found for the problem of Onion 'Blast'.

A substantial amount of preliminary work has been undertaken in the past and in my view has served to eliminate some possibilities. Without intending to be in any way critical of previous investigators, some areas need reinvestigation in order to obtain far more precise information.

Before proceeding further let us have a look at the Symptoms of Onion Blast as described by Brian Eavis.

THE SYMPTOMS OF BLAST

Eavis in his "Investigations into the nature and causes of Onion Blast Disease in Barbados" describes the Symptoms of Blast as follows:

"Lesions develop on the windward side of the leaf blades. The leaf collapses, shrivels and turns brown. Only the leaf blades are affected. The oldest leaves are first affected followed by the other leaves in order of age.

"The earliest visible symptom is a poorly defined whitish fleck. Microscopic examination of individual flecks show that they are the result of the disappearance of palisade and mesophyll cells between the intact upper and lower epidermal tissue. The vascular tissue is not damaged at this stage. These early symptoms generally go unnoticed in the field. The fleck often remains quiescent and series of photographs for example have shown little change over periods up to one week.

"The first onset of flecks on healthy plants is generally preceded by spells of hot weather, but subsequently new flecks appear on the younger leaves in all types of weather.

"The disease is usually first noticed when the flecks suddenly enlarge into necrotic lesions giving rise to obvious patches in the field where the older leaves collapse and die. The enlargement of the lesion is again due to further loss of palisade and mesophyll tissues and is sometimes accompanied by a longitudinal splitting of the epidermis. The tubular leaf blade opens up and where there are several lesions on one leaf, the leaf can be split from top to base.

"Sometimes the epidermis stays intact in which case the leaf blade remains standing with the dried up tissue always facing the wind. The green parts of these leaves later become brittle and small longitudinal cracks appear around the stomates.

"In the field the flecks cover a much wider area initially than the area affected by leaf die-back. There is often a sharp dividing line between apparently healthy plants (with flecks) and the plants with severe leaf collapse. The position of this line moves slowly outward for several days. Sometimes the plants recover and new healthy leaves take over from those which have withered away. In mild cases there may be no further outbreak, In more severe cases the plants never recover from the first outbreak, new leaves being affected within a few days of their emergence. After one outbreak of the disease it is common after a recovery period for there to be second and third outbreaks usually affecting a progressively larger part of the field.

"The disease has occurred at all times of year. It is common for the leaf die-back symptoms to develop in several fields at the same time even though the fieldsare widely separated in the Island.

"The yield losses vary from negligible to total loss, depending on the severity of the lesions, the stage of growth and the size of the affected patches in fields".

CLIMATIC FACTORS

In his investigations into the nature and causes of onion 'Blast' Disease in Barbados, Eavis looked at weather damage as a possible contributing factor. He stated "That wind may be a contributory factor is also suggested by the 'blast' lesions always occurring on the windward side of the leaf blade. It is possible that the lesions could result from excessive transpiration from this side of the leaf".

In my view it would be particularly difficult to establish an increased transpiration rate on one side of an onion leaf vis a vis the other side. I am inclined to the view that as a result of 'eddying' very fine dust particles, and other debris could be dislodged in isolated areas in a field and transported by the wind. This wind-borne material probably functions as an abrasive agent bruising epidermal leaf cells thereby permitting invasion by other pathogens.

I therefore see the need to scientifically determine the behaviour of wind in various horizons both within and outside of protected areas. Trapping should also be undertaken to determine what is transported by the wind.

Temperature was also looked at in relation to sun scorch. In my view, temperature, along with other environmental factors, should be investigated with a view to determining linkages with the 'Blast' condition. Soil temperatures, atmospheric temperatures, precipitation, humidity, evaporation, soil moisture and radiation should also be thoroughly investigated. All these climatic or weather factors tend to interact or influence each other and in the final analysis the end product 'weather' will, or can have a significant effect upon the development of pathogens. Eavis mentioned that "Both the increased incidence and severity of outbreaks since 1969 and the apparent spread in the field strongly suggest that a pathogen is involved either as a primary or secondary factor".

Having seen wind as a problem in onion growing in the Muck Crop areas in Ohio, U.S.A., I am inclined to believe that wind plays a far more significant role in 'Onion Blast' than presently envisaged. I believe that in order to get to the roots of the problem it will be necessary for an interdisciplinary approach to be undertaken.

I believe that there is sufficient evidence to support the view that the several factors which ultimately determine climate, be thoroughly investigated after which firm conclusions may be drawn and remedial action taken.

Much of what I have said may be considered as conjecture, but in the absence of detailed and accurate information on the climatic variables the problem is left wide open for even further speculation.

DISCUSSION

It was generally agreed that a thorough investigation into the influence of agro-meteorological factors on 'Blast' should be undertaken. A number of inconsistencies in Eavis' model of the development of 'Blast' as a result of primary or secondary pathogen causation, were discussed. The wind/abrasive particle hypothesis was explored and it was agreed that further investigation was needed in this area.

Mr. Jeffers informed the workshop of initiatives he is currently taking in developing a joint collaborative project on onion 'Blast' and other agricultural problem areas with workers at Penn State University. The workshop generally felt that such a joint project, if it came to fruition, should be beneficial to both sides, and that every effort should be made to ensure that it got off the ground.

A REVIEW OF ONION PRODUCTION IN BARBADOS

BY VICTOR OJEDA, IICA, BARBADOS

1. INTRODUCTION

It was my intention to prepare a paper on "Economic Losses caused by onion blast in Barbados", but after reviewing the literature, I found only a few references on the quantification of the incidence of 'blast' disease. Eavis in 1974 recorded the incidence of blast in onion between 1969-1973. After that, most of the reports state there have been attacks of 'Blast' but there is no quantification of the incidence nor of the economic losses caused by the disease.

2. ONION BLAST IN BARBADOS

Up to date, there is no clear definition about the cause or causes of the onion 'blast'. Among the possible causes of this disease are mentioned the weather, physiological factors, pathogens, etc. TABLE 1 shows that between 1969-1973, 148 onion fields were planted in Barbados, and the disease occurred in 61 fields, representing 41.2% of the total. In the same period the same author also reports 11 onion fields with "Crop was a total loss" in relation with the severity of the disease. This figure represents about 7.5% of the total number of fields. TABLE No. 2 shows that in 1972, 27 fields out of 40 were attacked by blast and four of the fields were completely destroyed. Although no records have been kept recently on the incidence of the disease, more attention should be paid to monitoring it. A possible attack of the disease has probably been the cause of discouraging farmers from planting. Hence the ups and downs in acreage and production. (See TABLE 3).

3. ONION PRODUCTION

Onion production in Barbados is characterised by few producers. Onion has been grown in the country since 1969 with some success. Production, imports, exports, consumption and degree of self-sufficiency are shown in TABLE 3. Onion represents a substantial amount of the total imports of entering Barbados and increased production and expanding the season will result in saving foreign exchange. Between 1970-80 the country has produced an average of 742.5 t/year reaching a peak of production in 1972 of 1,113 t. Since then production has been declining. Domestic production has accounted for a relatively stable share of 23% of domestic self-sufficiency between 1970-80. The monthly consumption of onions is approximately 160 t with little fluctuation from this figure.

When production is over 440 t/year, the remainder is exported. Onions exported have been reported with losses of above 50%.

TABLE NO. 1. OCCURENCE AND SEVERITY OF ONION BLAST IN BARBADOS 1969-1973

YEAR	NO. OF FIELDS	FIELD WITH	%	NO. CASES WITH TOTAL LOSS OF CROPS
1969	10	0	0	0
1970	32	5	15.6	0
1971	33	11	33.3	2
1972	41	28	70.0	4
1973	32	17	53.1	5
TOTAL	148	61	41%	11

SOURCE: EAVIS, B.W.., Investigation into nature and causes of onion blast disease in Barbados. MAFCA, Barbados, 1974.

TABLE: 2 SEVERITY OF ONION BLAST IN 1972 IN BARBADOS

Rating for severity of disease	0	1	2	3	4	5	Total
No. of fields	14	6	5	7	5	4	41

0 = No symptoms appeared
5 = Crop was a total loss
SOURCE: EAVIS, B.W., Investigation into nature and causes of onion blast diseases in Barbados. MAFCA, Barbados, 1974.

TABLE 4 shows the area in production since 1974. It seems that there is no relation between the area and the yield produced (t/ha).

The number of producers is declining. However the industry shows a slight recovery in 1983.

Barbados faces several difficulties and constraints in expanding its onion production:

1) the local production covers only 12 weeks during the year - a limited production period;

2) in relation to the expansion and rational development of an

export market the following constraints have to be taken into account:

a) the onion varieties grown in Barbados are typically of higher moisture content and are extremely perishable and subject to rapid weight loss at all stages of the marketing chain;
b) there is no adequate drying and storage facilities for onions;
c) due to short shelf storage of onion, delays in loading and unloading of ships, variable sailing schedules and lack of environmental control, Barbados produced onions are unsuited for the available inter-island transportation,
d) Barbados produced onions have not been able to compete effectively with extra-regional importation of onions in terms of price and quality in both the domestic and export markets.

3) There is a marked resistance to change of varieties by the farmer. This is reportedly due to the fact that existing varieties are high yielding and have characteristics wanted by the consumer.

4) No economic incentives exist for growers to produce onions during periods of higher production costs. Growers produce during the least risk period (February-April).

4. CONCLUSION

The main objective to develop an onion programme in the country is not only to increase production, because according to the present situation, any increase in production will go for export. The existing export facilities are not adequate to handle the needs. So any further investigation should take into account these factors.

TABLE: 3 ONION PRODUCTION, EXPORTS, CONSUMPTION AND SELF SUFFICIENCY: 1970-1980

YEAR	PRODUCTION	IMPORTS	EXPORTS	CONSUMPTION	SELF SUFFICIENCY (%)	
	..................TONNES....................				DOMESTIC	TOTAL
1970	543.3	1,500.6	81.2	1,962.8	23.5	27.6
1971	907.0	1,412.6	53.9	1,812.1	20.3	50.0
1972	1,133.8	1,292.3	734.0	1,692.1	23.6	67.0
1973	816.3	1,304.4	498.5	1,622.1	19.6	50.3
1974	822.7	1,163.3	182.8	1,803.0	35.5	45.6
1975	816.3	1,244.3	465.3	1,595.4	22.0	51.2
1976	680.3	1,648.5	296.8	2,032.0	18.9	33.5
1977	693.0	1,312.5	293.4	1,712.0	23.3	40.5
1978	742.9	1,711.0	195.0	2,258.8	24.2	32.9
1979	539.7	1,510.6	70.6	1,979.7	23.6	27.3
1980	472.0	1,831.4	29.9	2,273.1	20.7	19.4
Average/ year	742.5			1,885.7	23.2	40.5
S.D	189.1			236.5	4.5	13.9

SOURCE: Ministry of Agriculture

TABLE: 4 ONION, AREA, PRODUCTION, YIELD AND NUMBER OF GROWERS

YEAR	AREA (ha) 1/	PRODUCTION 2/ tonnes	YIELD t/ha	NO PRODUCERS 1/
1974	87.4	822.6	9.41	
1975	66.0	816.3	12.36	
1976	46.1	680.3	14.75	
1977	66.7	693.0	10.39	
1978	56.6	742.9	13.12	28
1979	70.8	539.7	7.62	30
1980	44.1	472.9	10.72	20
1981	30.8	396.2	12.86	15
1982	23.4	432.9	18.50	10
Yield/year (1974-82)			12.19	

SOURCES: 1/ F. Chandler - Personal Communication

2/ IICA. An Assessment of Production and Marketing of Onion in Barbados, SBF Barbados 1981.

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1. Eavis, B.W. Investigation into Nature and Causes of Onion Blast Disease in Barbados. Report to the Division of Sectoral Studies, OAS. Ministry of Agriculture, Science and Technology, Barbados, 1971, 30p.

2. IICA. An Assessment of the Production of Onions in Barbados. IICA Simon Bolivar Fund, Barbados, 1981, 25p.

3. Orshan, J. Onion and Yam Development. Project mission progress report. OAS and BECP, Barbados, 1982.

DISCUSSION

It was agreed that more precise measurements need to be taken on the incidence and severity of blast and its effect on yield in Barbados. Current figures do not show this. Indeed, it was pointed out that in the year in which Barbados produced its highest crop of onions (1972) blast had its highest degree of incidence. Thus underscoring the need for severity figures being taken in addition to data on incidence.

The participant farmers in the workshop, Mr. A. Gale and Mr. R. Kirton gave the workshop some idea of the problems which they considered as serious ones in their production of onions. Thrips and blast were seen as very important problems needing some in-depth research work. They did not consider praedial larceny of onions as of a high priority as the above-mentioned problems. They intimated that, while not speaking for all onion farmers, they were prepared to collaborate in the projected onion programme and expected that the majority of onion growers would support it.

THE GENERAL WORKSHOP SESSION REPORT

The points of concensus agreed on were:

1) An Onion Production Development Programme (OPDP) should be instituted in Barbados.

2) The OPDP would be designed to provide both short and long term solutions to the following problem areas affecting onion production in Barbados:

   a) The relatively poor storage capabilities of current onion varieties.
   b) The narrow genetic bases of the current varieties which increases the probability of crop failures due to various causes.
   c) The depredation of onion blast disease.
   d) The narrow production season which necessitates importation of onions for the majority of the year and does not allow producers to benefit from production in high-price periods of the year.
   e) A possible sub-optimal level of production technology.

3) Research priorities were identified for each of the problem areas mentioned above under the broad heading of research areas.

4) Technical resources were identified in terms of the minimal technical resources necessary to adequately carry out the programme.

5) Various organizational structures for the OPDP were discussed and concensus was reached on the following points:

a) Full time staff in the programme, should not be directly attached to a Government Department or Ministry. It was felt that remuneration, bottlenecks in decision making and delay in obtaining essential supplies could hamper the programme. The other constraint was the likelihood of the project staff being arbitrarily taken off the onion project to work on ad hoc schemes and situations. For these reasons, it was recommended that the project should be a "Special Project".

b) Part-time resource persons should be drawn from any agricultural institution operating in Barbados or in the wider region. Indeed competent qualified scientists could be co-opted into the project on an individual consultant basis.

c) Funds for the project may come from Government and OAS but should also be sought from the various funding agencies operating in Barbados as well as from the newly suggested Onion Growers Fund.

d) The direction and initial planning of the project should reside with the Ministry of Agriculture who should also have some degree of control of the programme.

e) The major institutional models suggested for the OPDP was -

   i) A programme under the aegis of the Special Projects Division of the Ministry of Agriculture; and/or
   ii) A Special Project of the Barbados Agricultural Development Corporation.

f) Details of the proposed structure would be worked out prior to the submission of IICA's report to MAFCA.

6) The following research areas were suggested:

a) Storage
-Use of respiratory inhibitors to advance dormancy
-Development of drying/storage facilities
-Genetic development of good storing cultivars
-Post harvest handling education
-Determination of parameters involved in near ambient storage.

b) Broadening of genetic base
-Screening, importing and evaluation of germplasm
-Breeding off-season cultivars
-Breeding in-season cultivars.

c) Onion Blast
-Mycorrhizae
-Agro-meteorological studies
-Disease measurements
-Koch's postulates, especially on bacteria
-Anti-transfirants
-Anatomical studies
-Disease forecasting

d) Pests
-Control measures, e.g. Ultra Low (ULV) spray frequency of application, etc.
-Biology of pests
-Assessment of insect/pest attack on onion yields.

e) Out of season production
-Importation of disease free onion setts
-Production and use of setts, e.g. planting density,

selection, etc.

-Varietal selection of seeds

-Irrigation costing and needs study.

f) Agronomic studies - production technology

-Time of planting studies

-Agronomic practices for late planting

-fully costed production trials on farmers fields

-Improved technology trials
- Mycorrhizae
- Herbicide trials
- Fertilizer trials/especially phosphate utilization
- Irrigation trials
- Disease control trials
- Pest control trials.

-Compatibility trials

g) The problems of marketing onions were discussed. It understood that marketing will form a separate portion of the overall Onion Development Programme.

7) The human resources identified for the programme were:

Full-time

1 Plant breeder	1 technician
1 Production Agronomist)	
1 Agronomist/physiologist)	2 technicans
2 technicians	

Part-time

1 Plant pathologist

1 Entomologist

These will share one of the technicians above.

1 Agro-meteorologist who will direct the work of one of the technicians above who will be working solely

in agro-meteorology.

8) The programme was envisaged as being a four-year one in the first instance.

CLOSING REMARKS BY DR. LIONEL SMITH

Well Mr. Chairman, I would like to thank IICA and all the other corporations for taking part in this workshop. My only regret is that I had to miss part of yesterday morning and certain parts of this morning sessions. I think that we have been stimulated in many respects and I am sure that the results of the discussions will provide IICA with the type of information which the Ministry of Agriculture, Food and Consumer Affairs will be able to support. I can make one further recommendation, and as I said to Chelston either yesterday or earlier today, that if this workshop approach is successful, it provides a mechanism whereby we might have to use it again in trying to tackle other agricultural problems. I am sure that all of us who have participated in the workshop would have found it stimulating and somewhat challenging in that it allowed you to do things that you haven't been doing recently. The workshop has tested your academic soundness in certain respects and has given you certain information that you have read about and never had a chance to hear and deliberated upon.

I must thank all of you for taking part and giving your time and more so, the consultants who are highly paid persons. I am glad to see that they could come in to the Ministry and as they say in common parlance "rap with your colleagues". Your presence at this workshop at least provides the act of support which all professionals require if they are to grow personally and if the institutions in which they work are to grow. I would again like to thank IICA for providing this opportunity and look forward to the recommendations that will come forward. I am sure that IICA will provide another opportunity for all of us to get together and further discuss in more detail some of these recommendations or the structures etc. to see if there is any further recommendation that can lead to improvements in the original recommendations.

As I said I'd like to see if this procedure can work and it might be one way of getting around the inherent problems of the Caribbean Research Institution. The institutions themselves are not always able to put together the broad spectrum of professionals that are required, therefore what you would find in the Caribbean is that we have very sound and good professionals working with several of our institutions. No single institution has in one place all the specialisations and this mechanism should provide us with the positive and right kind of research policy that is required, I would like to thank all of you.