AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D. C. 20523
BIBLIOGRAPHIC INPUT SHEET

FOR AID USE ONLY
Batch 58

1. SUBJECT CLASSIFICATION
A. PRIMARY: Food production and nutrition — AH20-0230-G236
B. SECONDARY: Plant diseases--Sugar and starch crops--Sugarcane--Morocco

2. TITLE AND SUBTITLE
Observations on sugarcane diseases in Morocco

3. AUTHOR(S)
Benda,G.T.A.

4. DOCUMENT DATE	5. NUMBER OF PAGES	6. ARC NUMBER
1977	12p.	ARC

7. REFERENCE ORGANIZATION NAME AND ADDRESS
USDA/ERS

8. SUPPLEMENTARY NOTES *(Sponsoring Organization, Publishers, Availability)*

9. ABSTRACT

Since Morocco is in a program of major expansion of the sugar cane industry, it is important to know whether phytosanitary problems exist which could lead to serious epiphytotics. Sugar cane cultivation is an excellent crop for this area because: it will grow on heavy soils; it survives winter flooding; it grows as a monoculture; the crop can be left standing two or three years; it is tolerant to slightly increased salt control; it suffers from few leaf diseases; it shades out competing weeds; and sugarcane begasse can be utilized to provide energy for the production of sugar. Sugarcane mosaic is the only major sugarcane disease definitely identified in Morocco. This report describes the symptoms and treatments for the following sugarcane diseases and disorders: ratoon stunting disease, stubble-piece and root diseases, diseases of the stalk, leaf spots, physiological disorders of leaves, stunting, and Johnsongrass. The suarcane experiments studied were in the Gharb, Loukkos, and the Moulouya. The report concludes with the following recommendations for maintaining the excellent health of sugarcane in Morocco: index the cane to determine more definitely if ratoon stunting disease is present; continue rigorous quarantine of all cane brought into Morocco; and make every effort to prevent the establishment of Johnsongrass in the sugarcane.

10. CONTROL NUMBER
PN-AAD-712

11. PRICE OF DOCUMENT

12. DESCRIPTORS
Morocco
Sugarcane

13. PROJECT NUMBER

14. CONTRACT NUMBER
PASA 276-04-72 GTS

15. TYPE OF DOCUMENT

AID 590-1 (4-74)

Observations on Sugarcane Diseases in Morocco

May 29-June 22, 1977

G.T.A. Benda, Plant Physiologist
U.S. Sugarcane Field Laboratory, P. O. Box 470
Houma, Louisiana 70361

During my stay in Morocco on temporary assignment to U.S.A.I.D., I worked with the sugarcane project of the "Station Centrale des Plantes Sucrières" of the "Direction de Recherche Agronomique" (D.R.A.) of the Ministry of Agriculture, Rabat. I was asked to pay particular attention to three diseases of sugarcane, sugarcane mosaic, ratoon stunting disease, and leaf scald.

I should like to acknowledge the unfailing courtesy and cooperation shown me by the personnel of the D.R.A. and of O.R.M.V.A.G, O.R.M.V.A.M., and O.R.M.V.A.L. Dr. Schmidt, project leader of sugarcane investigations, devoted much time and effort to accompany me to the numerous experiments, and I very much appreciate his many kindnesses.

Introduction

The exploitation of sugarcane in Morocco as a commercial crop has begun only recently after a lapse of over two centuries. Sugar was produced from sugarcane in a factory for the first time in 1974. The 1977 level of production is more than 175,000 tons of cane ground from about 3,600 hectares harvested. The projection is that within 5 to 10 years, the area devoted to sugarcane will be about 135,000 hectares of which 110,000 hectares will be in the Gharb, 19,000 hectares in the Loukkos Valley, and 5,000 hectares in the Moulouya.

This expansion in sugarcane cultivation is dependent on the completion of several large irrigation projects incorporating land suitable for sugarcane culture in areas that are relatively frost-free. There are various reasons that sugarcane in these areas with plentiful water is the crop of choice: A) it will grow on heavy soils difficult to work, (with several ratoon crops, the land need only be plowed once every few years); B) it will survive winter flooding which other crops, such as sugarbeet, will not; C) it will grow as a monoculture, with transportation to the factory over shorter distances than if the cane crop were rotated and greater land areas would be required; D) if the crop appears poor one year, it can be left standing a second or third year for increased profitability; E) sugarcane is relatively tolerant to slightly increased salt content; F) it does not suffer from many leaf diseases; G) given a head start, it will shade out competing weeds; and H) in the mill, sugarcane bagasse can be utilized to provide the energy required for the production of sugar. (Schmidt, G. 1975. Einige Aspekte des Anbaus von Zuckerrohr oder Zuckerrueben in Marokko. Z. Zuckerind. 25(6):348-350.

The usefulness of cane as the only possible crop on alkaline clay soils liable to flooding has been emphasized by Spanish workers who harvest 12-month cane in the Spring. (Anon. 1970. Resumen de Experiencias sobre Caña de Azúcar en el ultimo Decenio. Centro de Cultivos Subtropicales, Instituto National de Investigationes Agronomicas, Malaga, Spain). With 93.7% of the area in NCo 310, the average yield per hectare in Spain was 9 tons of sugar in 1969.

The Moroccan research has also shown that for CP 44-101 and NCo 310, if both quality of the harvested cane and ratooning ability of the cane after harvest are taken into consideration, the optimum time of harvest is in the "spring" (February to June in the Gharb and Loukkos; December to May in the Moulouya). Poor ratooning results from harvest in the summer or autumn, and is also affected by excessive wetness in the winter. (Schmidt, G., F. W. Hesse, and A. N'ciri. 1973. Influence de l'époque de récolte et de la durée de végétation sur le rendement et la qualité de la canne à sucre dans la vallée du Loukkos. Al-Awamia 46:59-85). See also The Annual Reports of the Station Centrale des Plantes Sucrières for 1971, 1972, and 1973-75.

The two commercial Moroccan varieties, CP 44-101 and NCo 310, were introduced from Spain, along with several other varieties which have since been discarded. According to Dr. Schmidt, the field-grown cane was neither heat-treated nor closely examined for diseases before or after shipment. Subsequent importations of varieties has been in small quantities from organizations that take extensive phytosanitary precautions before shipment, and these canes have been received and grown initially in isolated areas under observation, either at the greenhouse in Kenitra or at experimental plots of the D.R.A. in Rabat. Presently a greenhouse for sugarcane quarantine is under construction in Rabat.

Although there is no resident pathologist specifically assigned to specialize in sugarcane diseases, the Section of "Phytiatrie" of the D.R.A. is responsible for the study of diseases of crops and maintains a professional cadre of phytopathologists. Besides these scientists, sugarcane pathologists from the French "Institut des Recherches Agronomiques Tropicales" (I.R.A.T.) have visited Morocco repeatedly as part of the contract between O.R.M.V.A.G. and I.R.A.T. I have not had a chance to read Dr. Barat's reports of 1969 and 1971, but I have seen a copy of Dr. Baudin's report "État sanitaire des cultures de canne à sucre dans la plaine du Gharb" discussing the observations of a visit from August 27 to September 4, 1976.

The only one of the major diseases of sugarcane definitely identified in Morocco is sugarcane mosaic which was first noted on NCo 310 some years after its importation from Spain. Mosaic may have been introduced from Spain, or the plantings may have become infected in Morocco from a local source of the virus which has not yet been identified. The virus has been isolated and identified as strain D. (Fisher, H. U., and B. E. L. Lockhart. 1974. Identity of a strain of sugarcane mosaic virus occurring in Morocco. Plant Disease Reporter 58:1121-1123).

According to Baudin's paper cited above, leaf scald was suspected by Barat in some clumps of CP 52-68 at Sidi Allal Tazi Experiment Station (Gharb) in 1969. These clumps were destroyed. Baudin considers it likely that the variegation that he observed at this same Experiment Station in 1976 is due to leaf scald, although he notes that no stalk symptoms typical of the disease had been observed. He cites reports that the causal bacterial agent had not been isolated by Mr. Janati nor by A. S. Bennani (1972. Al-Awamia 42:35-46).

Because of the manner in which the initial shipment of cane was imported, it has seemed very probable that the most widely distributed diseases, such as pineapple disease and ratoon stunting disease, would be present. However, these diseases as well as such major diseases of sugarcane as Fiji disease, gummosis, leaf scald, smut, red rot, downy mildew, and chlorotic streak have not been demostrated to occur in Morocco.

As Morocco enters a program of major expansion of the industry, it becomes urgent to know whether phytosanitary problems exist which, given the large-scale multiplication projected, could lead to serious epiphytotics.

Observations

Sugarcane culture is primarily situated in the coastal region of three irrigation projects, namely, the Moulouya (Mediterranean coast), and the Gharb and the Loukkos (Atlantic coast). In the course of my stay, we visited Experimental Stations at Bou-Areg, Zebra, Boughriba and Slimania in the Moulouya, at Sidi Allal Tazi, Mechra bel Ksiri, El Menzeh and Moghrane in the Gharb, and at Guedira, R'Mel and Merouane in the Loukkos area. Besides these plantings, observations were made in the fields of several growers.

The sugarcane observed fell into three age groups. The ratoon crops harvested this spring had excellent stands with the plants at a stage suitable for observing sugarcane mosaic. The ratoon crops which had not yet been harvested had standing cane about 15 months old, and this was a size favorable for observation on ratoon stunting disease. The cane planted in the spring of 1977 was generally too small to make observations either on population or stand. Because of a severe freeze in the winter of 1975-76, only a few fields had been planted in the spring of 1976.

The observations may be summarized as follows:

1) Sugarcane mosaic: No sugarcane mosaic was found in any variety at any experimental station. Where mosaic was suspected (one plant each of CP 44-101 and L 65-69) the plants were also variegated. In a grower's field (the farm of M. M'Chiche) near Sidi Allal Tazi in the Gharb, planted in 1971 or 1972, mosaic was frequent in NCo 310. The infected plants were yellowed and stunted; according to Dr. Fisher, they appeared to have symptoms like the plants that were found to have strain D.

2) Ratoon stunting disease: No mature-node symptoms of RSD were found at any of the experiment stations where 15-month old cane was available (Bou-areg, Guedira, Merouane, Sidi Allal Tazi, Mechra bel Ksiri, El Menzeh) nor were symptoms seen in any of the growers' fields that we checked. The mature stalks examined were of varieties CP 44-101, L 62-96, L 65-69, Cl 47-83, and Co 421. Under Louisiana conditions, these varieties would be expected to show symptoms.

3) Stubble-piece and root diseases: The stand generally was uniform and the population excellent in the ratoon crops at all the experiment stations visited. As the planting rate is equivalent to only one running stalk with some lap, seed piece, stubble piece or root diseases do not appear to be a problem in cane planted or cut in the spring.

4) Diseases of the stalk: The stalks were generally free of internal discoloration. An internode damaged by borer feeding usually showed a reddish discoloration, but there seemed to be little or no spread of the reddening beyond either nodal plate. The growth cracks of L 62-96 were frequently associated with a reddish discoloration which was restricted to the affected internodes. The rind, but not the interior, of internodes formed during the winter or spring often were partially discolored or showed necrotic areas and the associated leaf sheaths showed reddening. There were some cases where the top part of the stalk seemed to have been damaged by Pokkah Boeng, but no knife-cut symptoms were observed.

5) Leaf spots: With the exception of symptoms resembling brown spot (Cercospora longipes) on leaves of L 62-96 in the Loukkos area (Guedira), the leaves appeared to be free of the common pathological spotting.

6) Physiological disorders of leaves: a) White-striped plants: The most spectacular disorder noted on the leaves of young ratoon plants was variegation which seemed to occur on most if not all varieties. The incidence of variegation varied widely; it was most frequent in L 61-67 in all areas visited; the variety could be identified from a distance by its variegation.

Characteristically, the variegation consisted of white stripes running the length of the leaf blade and often extending into the sheath. The stripes varied in width and number per leaf, and varied in width and frequency from leaf to leaf on one shoot. The variegation was most intense on the first leaves of young ratoon shoots; by the middle of June, many of the newly formed leaves appeared to be mostly green. The white stripes on the oldest variegated leaves had not become necrotic by the middle of June, nor had the oldest variegated leaves died. No dead shoots were noted among the variegated shoots unless there was borer damage (dead-hearts).

In the 15-month old cane of L 61-67 (at the Experiment Station Sidi Allal Tazi) the tops of L 61-67 generally were green, although variegated leaves were noted occasionally. Stalks showing whitish stripes running the length of an internode (ribboning) were noted occasionally. In some cases, the stripes of the internode could be followed into the sheath and leaf blade. Shoots that showed variegation, as well as the shoots that were green, had no excessive or unusual development of axillary buds; where tillers occurred, they came from belowground, or, if the top was damaged, from the axillary buds close to the injured apical meristem. The only internal discoloration of the stalk noted was associated with borer damage or growth cracks. There were no "scalded" shoots.

The variegation observed in Morocco appears like that observed each spring in Louisiana. In Louisiana, the incidence of variegation varies widely from year to year and varies among varieties. No pathological agent has been associated with this variegation in Louisiana. The botanical basis for the expression of variegation in sugarcane has been described by Thielke (1970. Principles of chimeral variegation in grasses. Sugarcane Pathologists Newsletter 5:49).

In August and September, 1976, Baudin examined the plants of the same experiment that I examined as standing cane in Sidi Allal Tazi. He had considered the variegation suggestive of leaf scald. Because of the freeze the previous winter, Baudin did not have older cane to examine. He did mention that there was no evidence of stalk discoloration. In the absence of internal stalk discoloration, and without excessive axillary shoot development, without scalded shoots, and without premature death of the white stripe tissue, I see no reason to consider this variegation pathological in origin.

b) Marbled leaves: A second form of variegation was noted on some plants of several varieties (NCo 310, CP 44-101, L 65-69). Instead of apparently parallel lines of white the length of the leaf blade, the pattern consists of lines of irregular length, with some lines very short, and of several shades of green (from normal to very light) and of white and yellow. The pattern observed is reminiscent of the variegation in *Nicotiana glutinosa* elicited by heat. (Benda, G. 1962. Heat-induced abnormalities--a model disease. Phytopathology 52:1307.)

c) Yellow leaves with green veins: A severe yellowing was observed in NCo 376 at Boughriba, in CP 44-101 in a grower's field near the Zebra Experimental Station, and less severe and more incidental yellowing was noted in other varieties in all the experimental stations of the Moulouya region. The symptoms resemble those associated with iron deficiency. The symptoms apparently are transitory for they are said to recur each year when stubble cane resumes growth after harvesting. The later growth is a normal, green color, and yields are good. A similar yellowing in the regrowth shortly after harvest is often observed in the tropics.

d) Yellowing: A second yellowing, where the entire leaf blade is yellow, was noticed at the Guedira Experimental Station in the Loukkos area in plant cane. To what extent this yellowing is related to insufficient water, an imposed experimental condition, has not been determined.

e) Mild sunburn: At the El Menzeh Experiment Station, the young stubble shoots of CP 65-357 showed a purple coloration in the bend of the leaf blade where the leaf is most directly exposed to the sun. As far as I have observed, this response does not occur under Louisiana conditions.

7) Stunting: Both in the Gharb and in the Moulouya, there were a number of fields of cane, one-year old or older, which had not been harvested in 1977 and in which the cane was very stunted. In some of the larger areas, there was a sawtooth effect with cane nearest the irrigation pipes taller, the cane farther away shorter, in a repeating pattern. Faulty irrigation, in the quantity or frequency of application, is considered to be the prime cause of this stunting. Very severe stunting was observed in year-old cane planted on deep sands in the Loukkos area (Guedira Experiment Station). The plants were not only stunted but there was also a severe leaf spotting on some varieties reminiscent of deficiency or toxicity. Insufficient irrigation is considered to be one factor in the poor growth of this cane. No symptoms of ratoon stunting disease were noted in stunted cane sampled in the three regions.

8) Johnsongrass: Johnsongrass, the most pernicious sugarcane weed in Louisiana, was seen in each irrigation area, but it was not noted as a weed in sugarcane. The fields were usually clean of weeds.

Johnsongrass was identified by appearance and/or the presence of rhizomes. Johnsongrass was seen near the Slimania Experiment Station along an irrigation canal (Moulouya), at Merouane in weeds adjacent to a sugarcane field (Loukkos), and at El Menzeh Experiment Station in the experimental citrus orchard (Gharb). Mr. Bourge of O.R.M.V.A.G. indicated that johnsongrass was a serious weed in some citrus orchards in the Gharb.

Dr. J. P. Peltier of the Institut des Sciences, Mohammed V University, Rabat, kindly referred me to two references which list johnsongrass as present in Morocco. (Maire, R. 1952. Flore de l'Afrique du Nord. v. I, p. 265 of the Encyclopédie Biologique 33, Paul Lechevalier, Editeur, Paris. Also in Jahandiez, E. and R. Maire. 1931. Catalogue des Plantes du Maroc. v. I, p. 25. Minerva, Algiers). In the latter work, johnsongrass [as Andropogon halepense (L.) Brot.)] is listed as occurring in irrigated fields and in cool sandy places of the plains and lower mountains, up to 1500 meters, in April to October.

Discussion

1) Ratoon stunting disease: In view of the proposed expansion of sugarcane culture in Morocco, it is urgent to establish whether ratoon stunting disease is actually present. If it should be found to be present, a system of heat treatment of propagating material should be promptly instituted; if the disease is not present, the heat treatment should be omitted.

The symptoms of ratoon stunting disease are fairly definite, and the presence of the disease when symptoms are present can be readily established. In the absence of symptoms, however, it is not possible to conclude that the disease is absent because the expression of symptoms may be masked by environmental conditions or the physiological state of the plant.

Besides the characteristic sugarcane symptoms there are several other methods to test for the presence of the disease. These methods may be listed as follows:

a) Some methods depend on infectivity and use the juice from suspected sugarcane stalks to inoculate diagnostic test plants. The best known and fastest of these methods is the use of special clones of elephant grass prepared as uprights (Matsuoka, S. 1971. Elephant-grass, an indicator plant for ratoon stunting virus of sugarcane. FAO Plant Prot. Bull. 19:110); the positive response of elephant grass, a discoloration of nodal tissue within 2-3 weeks after inoculation, has recently been shown not to be specific. (Betti, J. A., A. S. Costa, C. Paradela F., and S. Matsuoka. 1976. Vascular discoloration in the knot region of elephant grass caused by different species of bacteria. Fitopatologia 11(1):4).

The uprights of the sorghum-sudangrass hybrid NB 280 S respond much more slowly than elephant grass, but the symptom is very distinctive and is visible without cutting into the plant. The syndrome consists of a differential dying of all shoots of the upright, with the main shoot usually wilting first during the day and recovering from wilting last in the evening, then wilting without recovering, and then dying. The characteristic symptoms is best seen early in the morning when the contrast between the wilted, dying main shoot and one or more normal, turgid axillary shoots is greatest. The symptom requires 2 to 3 months to develop. (Benda, G. 1971. Wilting and death in the ratoon stunting disease of sudangrass hybrid uprights. Amer. Soc. Sugar Cane Technol., Proc. 1(NS):39-44; Chen, C. T. and S. M. Lee. 1976. Wilting and death of sudangrass hybrid infected with RSD of sugarcane. Taiwan Sugar Res. Inst., Ann. Rept. 1975-6:30).

Some sugarcane varieties or sugarcane-related hosts show mature-node symptoms relatively quickly when grown as uprights. (Benda, G. 1969. The upright: An experimental form of sugarcane. Sugarcane Pathologists Newsletter 2:34-37). Particularly good varieties are CP 45-184, Co 453, and Saccharum spontaneum, var. Coimbatore. These may have well-developed mature node symptoms within 4 or 5 months.

b) Methods have been developed to identify the ratoon stunting disease by the presence of an RSD-associated bacterium either by means of phase-contrast microscopy or by electron microscopy. In recent years, a bacterium has been found to be associated with ratoon stunting disease infection in many parts of the world (Gillaspie, A. G., R. E. Davis, and J. F. Worley. 1976. Diagnosis of the ratoon stunting disease based on the presence of a specific microorganism. Plant Disease Reptr. 57:987-990; Teakle, D. S. 1975. Diagnosis of RSD by electron microscopy of sugar-cane tissue diffusates. Qld. Soc. Sugar Cane Technol., Proc. 42:115-116). Because the bacterium has not been shown to be capable of causing the disease, it would be premature to identify the presence of a disease entirely in this manner. As the associated bacterium has been found to be highly concentrated in a localized area of the sorghum-sudangrass hybrid upright (Worley, J. F. and A. G. Gillaspie, Jr. 1975. Electron microscopy in situ of the bacterium associated with ratoon stunting disease in sudangrass. Phytopathology 65:287-295), the two methods could obviously be used together.

c) The presence of the ratoon stunting disease should be demonstratable through a reduction in yield. The effect of the disease, especially marked in some varieties, is a significant reduction in the tonnage of cane harvested when the yields from the progeny of untreated (diseased) cane are compared with the yields from heat-treated (cured) cane. In practice, this reduction in yield, which is usually more evident in stubble crops and which is affected by irrigation, is too non-specific to allow a disease diganosis based solely on yield data.

d) Suspected canes may be compared with known diseased canes: If foreign cooperators with large quarantine facilities are willing, it would be feasible and desirable to send samples of cane from different areas of Morocco to be grown alongside known diseased plants of the same variety. The conditions under which the known diseased plants express symptoms can then be used to establish whether the lack of symptoms in Morocco is due to masking of the expression of symptoms or to the absence of the disease. If the samples are collected with care, both from a phytosanitary and a geographical standpoint, probably 50 samples of CP 44-101 from commercial fields should be adequate to determine whether the disease is present in this variety in Morocco. Such a small sample should be adequate because of the highly infectious nature of the disease and the ease with which it is spread by mechanical means.

The converse experiment, that known RSD-infected canes are introduced into quarantine in Morocco, is dangerous, and any proposal for such an experiment should be rejected.

Dr. Fischer of the Section of "Phytiatrie", D.R.A., has indicated that he will index suspected plants of sugarcane on uprights of the sorghum-sudangrass hybrid.

2) Sugarcane mosaic and NCo 310: The variety NCo 310 has repeatedly shown symptoms of sugarcane mosaic. Diseased material has been eliminated from the experiment stations, but some mosaic persists in commercial plantings. The incidence of mosaic in NCo 310 has generally been low, and it would seem to present no actual economic problem. From a phytosanitary standpoint, however, the presence of such diseased stools is very undesirable as they present a potential danger as a source of mosaic inoculum.

If NCo 310 were dropped, the variety CP 44-101 would become the only commercial variety. The risk of depending on one variety is obvious, but other promising varieties should soon become available from the testing program.

3) Ratooning and time of harvest: Several of the conditions which are believed to contribute to poor ratooning in Louisiana appear to be absent in Morocco. These factors would include damage by heavy farm equipment, such as harvesters moving through wet fields, the deleterious effects of weeds, especially johnsongrass, and the herbicides used to combat them, and the presence of diseases such as ratoon stunting disease and red rot.

The experimental results suggest that the primary factors identified with poor ratooning in Morocco are the time of harvest and the degree of wetness in the winter. It is not clear to me from a physiological standpoint why the time of harvest should play such an important role if the age of the cane at harvest is held constant. It would appear possible that there exists a pathological problem which affects the stubble piece of cane harvested in summer or autumn.

4) Quarantine: Morocco is in the fortunate position that it may be free of most of the serious sugarcane diseases. The vital importance of quarantine is to keep it that way. The responsibility for importation of cane has been assigned to the D.R.A., and no exceptions to this centralized authority should be considered. Every effort should be made to discourage the illegal importation of cane by travelers returning from foreign countries.

Quarantine in the past has been handled primarily by isolation, by growing the newly imported canes far away from canes in commercial culture. Within the next year, the completion of a greenhouse facility especially built for sugarcane quarantine should improve the ease with which the quarantine system can be administered.

The new facility will consist of an insect-proof greenhouse with three fully isolated chambers, one larger chamber and two smaller ones. The greenhouse will be part of a complex that has facilities for sterilization of plant material, pots, and soil.

The utilization of the new facility should follow the usual quarantine porcedure.

a) The imported canes should be unwrapped in an isolated area and carefully examined so that canes with obvious disorders may be discarded. If the canes have not been treated before shipment, they should be given a short hot-water treatment (52°C for 30 minutes) in order to destroy insects and mites. Cuttings should then be potted and placed in one of the small chambers.

b) The shoots from the imported cane should be observed regularly for about 6 months or until they are large enough for the preparation of cuttings. After the cuttings have been taken, the tillers in the original pots should be allowed to grow out. It is advisable to water the plants sparingly as symptoms of some of the latent diseases appear to be expressed better under these conditions. After another 6 months of observation, and if the cuttings taken earlier have prospered, the cane in the original container, the soil, and the pot, should all be sterilized. No soil, containers, or plants should ever be moved directly from this first chamber to other chambers or to the field.

c) The cuttings, from b above, should be given the long hot-water treatment for the control of the ratoon stunting disease. If the cuttings are small, it may be advisable to treat them for 10 minutes at 50°C on the first day, and for 2 hours at 50°C the second day; survival of tender shoots tends to be much better than after a single 2-hr. treatment.

After the treatment is completed, the treated cuttings should be potted and placed in the larger chamber. There they should be observed regularly until the shoots are large enough for making cuttings. These cuttings should then be planted in observation plots outside. The pots in the large chamber should be allowed to tiller, and, if the cuttings outside fail, fresh cuttings should be prepared from these pots. When the cane is established outside, and further cuttings are not needed, the plants, soil, and containers from the larger chamber should be sterilized.

The plants in the observation plots should be encouraged to grow as rapidly as possible to provide planting material for further propagation and for variety trials.

Whenever, during this long period of observation, any of the progeny of the imported cane show abnormal growth or symptoms of disease, they should be discarded. To reduce the chance of importing diseases, it is desirable, whenever possible, to import cane from experiment stations that are actively involved in quarantine.

5) Johnsongrass: The presence of johnsongrass in Morocco appears to me to pose a very direct threat to sugarcane cultivation. Seeds could be carried easily in irrigation water, and during the several ratoons of each crop, the rhizomes could thoroughly invade the cane.

It may be that johnsongrass of Morocco differs from Louisiana johnsongrass in agressiveness. It seems more likely, however, that the absence of johnsongrass from sugarcane is that crop and weed have not yet met.

Johnsongrass appears to be fairly uncommon and is as yet little known among sugarcane personnel. In a training session for sugarcane personnel, most of those present seemed not to know the plant. It is very important that through appropriate extension work everyone concerned with sugarcane becomes aware of this plant. Only then can adequate precautions be taken to prevent its entry into the sugarcane crop.

Summary of Observations

During June, 1977, I visited sugarcane experiments in three irrigation project areas, the Gharb, the Loukkos, and the Moulouya. The sugarcane observed was either regrowth from cane harvested earlier this year or standing cane (12 to 15 months old). Cane planted this spring was still too small for evaluation.

Sugarcane mosaic was observed in one commercial field of NCo 310 but was not found elsewhere. No definite symptoms of the ratoon stunting disease (the so-called mature node symptom) were noted on any of the standing cane examined. The stand and tillering in all the ratoons were generally excellent, and this suggests that there are no serious stubble-piece or root diseases when cane is harvested in the spring. I observed no symptoms which suggest that other major diseases, such as smut, leaf scald, or gummosis, are present.

The disorders noted seemed to be induced by climatic conditions or by deficiencies. Among the regrowth of cane cut in 1977, variegation was frequent in the three irrigation projects. Variegation was most frequent in L 61-67. Where the cane had been harvested early this year, it was already evident that the variegation in the regrowth was restricted to the oldest leaves and that the new leaves generally were green. Observations on 15-month old cane indicated few variegated leaves and stalks, even in L 61-67.

In the region of the Moulouya project, the regrowth from cane harvested in the spring of 1977 showed yellowing of the interveinal area of the leaf blades, particularly in NCo 376. This transitory yellowing, which in appearance is like iron deficiency, is said to occur each year. A similar transitory yellowing is common in sugarcane in the tropics.

Faulty irrigation, in the quantity or frequency of application, is considered to be the prime cause of severe stunting observed in commercial fields in the Gharb and the Moulouya project areas. This stunting is also evident on the deep sands at the Guedira Station in the Loukkos Valley project. No symptoms of ratoon stunting disease were noted in stunted canes sampled in the three regions.

Infection of sugarcane following injury by the moth borer seems to be restricted in all the varieties sampled to the internodes actually wounded. The infection from "growth cracks", very frequent in L 62-96, also appears to be restricted to affected internodes.

Johnsongrass, the most pernicious sugarcane weed in Louisiana, was seen in each irrigation region, but it was not noted as a weed in sugarcane. The fields were usually clean.

Recommendations

1) In view of the proposed expansion of sugarcane in Morocco, it would seem urgent to index cane to determine more definitely if the ratoon stunting disease is present; such work has been planned. If the disease is found, a system of heat treatment of propagating material should be promptly instituted.

2) In view of the apparent excellent health of sugarcane, the quarantine procedures have been adequate, and continued rigorous quarantine of all cane introduced into Morocco is essential.

3) In view of the presence of johnsongrass, every effort should be made to prevent its establishment in sugarcane. This effort will require informed growers and continuous vigilance.