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EVALUATION OF DISEASE AND OTHER PROBLEMS IN THE SINDH BANANA INDUSTRY

Final Consultancy Report

by

R. H. Stover

July 1991

PARC • USAID • MART • WINROCK

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A

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EVALUATION OF DISEASE AND OTHER PROBLEMS IN THE SIND BANANA INDUSTRY

R. H. Stover

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EVALUATION OF DISEASE AND OTHER PROBLEMS IN THE SIND BANANA INDUSTRY

R. H. STOVER[1]

SUMMARY

PRODUCTION IN THE SIND BANANA INDUSTRY HAS DECLINED ABOUT 70% SINCE 1988. APPROXIMATELY 50% OF THE BANANA FIELDS HAVE BEEN ABANDONED OR CONVERTED TO OTHER CROPS. TWO SERIOUS DISEASES AND SOIL SALINITY IN THATTA DISTRICT ARE INVOLVED. BUNCHY TOP VIRUS IS WIDESPREAD AND STILL SPREADING. IT IS TRANSMITTED BY THE BANANA APHID PENTALONIA NIGRONERVOSA WHICH IS PRESENT. IN MANY AREAS THERE IS A DISEASE CONSISTING OF HEART LEAF ROT AND THE PRODUCTION OF STUNTED SUCKERS WITH NUMEROUS SWORD-SHAPED LEAVES. MANY OF THE PLANTS WITH HEART LEAF ROT DIE. LIMITED FOLIAR ANALYSES INDICATE EXCESS LEVELS OF IRON AND BORON. ONE OR BOTH OF THESE ELEMENTS ARE LIKELY CAUSING TOXICITY RESULTING IN HEART LEAF ROT AND STUNTED SUCKERS WITH LEAF PROLIFERATION. MORE RESEARCH INCLUDING EXTENSIVE SOIL AND FOLIAR ANALYSES IS URGENTLY REQUIRED TO RESOLVE THIS PROBLEM. MANY PLANTS IN THATTA DISTRICT SHOW SYMPTOMS OF SODIUM TOXICITY AND SALINITY LEVELS EXCEED THE 1.5 MMHOS CONSIDERED THE THRESHOLD FOR BANANAS. SALINITY LEVELS ABOVE THIS THRESHOLD SERIOUSLY REDUCE YIELDS.

FOR A SUCCESSFUL REHABILITATION OF THE BANANA INDUSTRY A FULL TIME RESEARCH AND EXTENSION SERVICE MUST BE ESTABLISHED. THIS SERVICE WOULD MONITOR SOIL AND LEAF MACRO AND MICRO-NUTRIENTS TO PREVENT EXCESSES AND DEFICIENCIES THAT PRECLUDE A SUCCESSFUL LEVEL OF BANANA PRODUCTION.

1 CONSULTANT TO WINROCK INTERNATIONAL IN SIND, PAKISTAN, JULY 4-18, 1991. ADDRESS: LA LIMA, HONDURAS, C. A. A PRELIMINARY ABRIDGED FORM OF THIS REPORT WAS ISSUED IN PAKISTAN JULY 12, 1991.

INTRODUCTION

A "NEW DISEASE" HAS DESTROYED OR MADE UNPRODUCTIVE ABOUT 70% OF THE SIND BANANA INDUSTRY. THE DISEASE WAS FIRST BROUGHT TO THE ATTENTION OF SIND EXTENSION WORKERS BY A FARMER IN THATTA DISTRICT IN MAY 1989. THE PAKISTAN AGRICULTURAL RESEARCH COUNCIL ISSUED THE FIRST REPORT ON POSSIBLE CAUSES IN DECEMBER 1990. THIS REPORT WAS REISSUED JULY 13, 1991 AT THE BANANA DISEASE SEMINAR. THEY ATTRIBUTED THE DISEASE TO NEMATODES AND FUSARIUM FUNGI IN THE ROOTS. IN THE REPORT ISSUED JULY 13, 1991, IT WAS STATED "THE BANANA CRISIS IS MAINLY DUE TO PROLONGED BANANA RATOONING" AS WELL AS NEMATODES AND ROOT FUNGI. SUBSEQUENT REPORTS WERE ISSUED BY THE SIND AGRICULTURAL INSTITUTE AND THE AGRICULTURAL UNIVERSITY. THE LAST REPORT WAS PREPARED BY THE SIND HORTICULTURAL RESEARCH INSTITUTE, MIRPURKHAS, FOR THE BANANA DISEASE SEMINAR HELD IN HYDERABAD IN JULY 1991. AGAIN, NEMATODES AND ROOT INVADING FUNGI WERE CITED AS THE CAUSE.

ON JANUARY 2, 1991, MR. M. H. PANHWAR, A SIND BANANA GROWER, SENT 50 PHOTOGRAPHS OF THE DISEASE TO DR. H. E. OSTMARK IN LA LIMA, HONDURAS. THESE PHOTOGRAPHS WERE TAKEN BY THE SIND DEPT. OF AGRICULTURAL EXTENSION. LA LIMA HAS BEEN A CENTER OF BANANA RESEARCH IN CENTRAL AMERICA SINCE 1940. IN A REPORT ACCOMPANYING THE PHOTOGRAPHS, MR. PANHWAR CORRECTLY DIAGNOSED ONE OF THE PROBLEMS AS BUNCHY TOP VIRUS TRANSMITTED BY APHIDS. MR. PANHWAR HAD VISITED AUSTRALIA WHERE THE DISEASE HAS BEEN PRESENT SINCE 1919 AND HAD OBTAINED RECENT LITERATURE DESCRIBING BUNCHY TOP AND ITS CONTROL. THE PHOTOGRAPHS ALSO SHOWED SYMPTOMS OF A HEART LEAF ROT AND ABNORMAL SUCKERS THAT ARE NOT CAUSED BY BUNCHY TOP.

IN APRIL 1991, I WAS REQUESTED BY WINROCK INTERNATIONAL AND THE DIRECTOR OF THE MANAGEMENT OF AGRICULTURE RESEARCH AND TECHNOLOGY PROJECT IN PAKISTAN TO COME TO PAKISTAN AND EVALUATE THE DISEASE SITUATION [SEE TERMS OF REFERENCE APPENDIX 1].

THE PRESENT BANANA INDUSTRY BASED ON THE DWARF CAVENDISH VARIETY BEGAN ABOUT 1958 AND CONTINUED TO EXPAND INTO THE 1980S. WILLIAMS WAS INTRODUCED FROM AUSTRALIA IN 1978 BUT COMPRISES LESS THAN TWO PERCENT OF THE AREA. SMALL VOLUMES WERE EXPORTED TO AFGHANISTAN AND IRAN AND THESE MARKETS COULD BE GREATLY EXPANDED.

BANANA AREA AND PRODUCTION IN SIND

YEAR	HA	METRIC TONS
1958	831	-
1967	5,898	47,987
1979	12,827	114,228
1989	20,103	182,856

SOURCE: BANANA CULTIVATION IN SIND. NATIONAL SEMINAR ON BANANA DISEASES. HYDERABAD, JULY, 1991.

RAINFALL IS LOW (250 MM OR LESS) AND LOW TEMPERATURES (5º - 10ºC) INCLUDING THE OCCASSIONAL FROST BETWEEN DECEMBER AND FEBRUARY AND HIGH TEMPERATURES (45º - 50ºC) BETWEEN APRIL AND JUNE CAN CAUSE DAMAGE AND STOP GROWTH (SEE APPENDIX 2).

CULTURAL PRACTICES ARE PRIMITIVE AND AVERAGE YIELDS FOR THIS VARIETY ARE THE LOWEST IN THE WORLD (9 - 10 TONS/HA). THE POTENTIAL IS HIGH FOR INCREASING YIELD ONCE BUNCHY TOP DISEASE IS BROUGHT UNDER CONTROL AND CERTAIN SOIL PROBLEMS RELATED TO SALINITY AND EXCESS IRON AND BORON ARE CORRECTED.

DISEASE EVALUATION IN SIND - BUNCHY TOP

ACCORDING TO GROWERS THE DISEASE BEGAN IN THE MOST SOUTHERN PORTION OF THE DISTRICT OF THATTA IN 1988 AND THEN MOVED NORTH APPEARING IN THE HYDERABAD AREA IN MID 1990 AND AROUND THE TOWN OF SAKRAND IN 1991. THIS TOWN IS ABOUT 120 KM NORTH OF WHERE THE DISEASE STARTED. THE BANANA GROWING AREA ALONG THE INDUS RIVER IS ABOUT 30 KM WIDE. THUS, BUNCHY TOP HAS SPREAD OVER AN AREA OF ABOUT 5,000 KM^2 IN LESS THAN THREE YEARS. THE FIELDS AROUND SAKRAND HAVE ONLY A FEW CASES (A DETAILED INSPECTION WAS NOT MADE) AND THIS APPEARS TO BE THE MOVING "FRONT" OF APHID TRANSMISSION. THE BANANA ZONE EXTENDS FOR 50 KM NORTH OF SAKRAND.

FIELDS WERE EXAMINED IN THATTA, BADIN AND HYDERABAD DISTRICTS AND INFECTION WAS COMMON. A DETAILED SURVEY WAS NOT MADE. ALL THE CLASSICAL SYMPTOMS WERE PRESENT. THERE WAS SHORTENING OF THE LEAVES AND INTERNODES LEADING TO SEVERE ROSETTING (BUNCHY TOP). THE DOT-DASH DARK GREEN STREAKING IN THE EPIDERMIS WAS NOT PROMINENT ON THE LEAF LAMINA IN SOME AREAS BUT WAS PROMINENT ON THE LEAF PETIOLE WHERE IT JOINED THE PSEUDOSTEM. THERE WAS EXCESSIVE BRITTLENESS OF THE FOLIAGE. MOST OF THE ROOT SYSTEM DECAYS IN ADVANCED

STAGES OF DISEASE.

A SEARCH FOR BANANA APHIDS IN THE FIELDS WAS NEGATIVE. THIS MAY HAVE RESULTED FROM A SEVERE HEAT WAVE IN JUNE WITH TEMPERATURES REACHING 50ºC. ONE DISEASED SUCKER WAS BROUGHT TO A MEETING IN KARACHI AND I FOUND THREE PENTALONIA APHIDS UNDER A LEAF SHEATH. MR. H. A. SIDDIQUI, OF THE HORTICULTURAL INSTITUTE HAD FOUND APHIDS EARLIER IN THE YEAR IN MAY. ONE OF THE FIRST RESEARCH PRIORITIES SHOULD BE TO DETERMINE FLUCTUATIONS IN APHID POPULATIONS THROUGHOUT THE YEAR AND THE LIFE HISTORY OF THE APHID UNDER SIND CLIMATIC CONDITIONS.

PROGNOSIS

IT IS ESTIMATED, SINCE THERE ARE NO ACCURATE MEASUREMENTS, THAT 70% OF THE BANANA AREA IS INFECTED AND 50% IS NO LONGER PRODUCTIVE. I PREDICT ALL OF THE BANANA AREA WILL BE INFECTED BY MID 1992 AND 80% WILL BE UNPRODUCTIVE BY THE END OF 1992. THIS IS BECAUSE THERE IS NO GENERAL ERADICATION PROGRAM IN PLACE IN AREAS HEAVILY DISEASED AND THERE IS NO INSPECTION AND ERADICATION PROGRAM IN PLACE IN AREAS WITH LIGHT OR NO INFECTION. AS WITH OTHER APHID VECTORED DISEASES, THE FIRST CASES APPEAR ON THE EDGES OF THE FIELD ON THE SIDE OF THE PREVAILING WINDS. THE DISEASE IS THEN VECTORED INWARD TOWARDS THE CENTER. IT IS NOT POSSIBLE TO INSPECT INSIDE MANY OF THE FIELDS BECAUSE OF THE PRIMITIVE METHODS USED FOR GROWING BANANAS IN MOST AREAS OF SIND. THERE IS LITTLE OR NO CONTROL OF POPULATIONS. THERE IS LITTLE OR NO DESUCKERING AND NO REMOVAL OF SENESCENT AND DYING LEAVES. THUS, IN MANY CASES, THE INNER PORTION OF A FIELD IS A MASS OF VEGETATION PREVENTING ANY EFFECTIVE INSPECTION.

CONTROL MEASURES

SINCE BUNCHY TOP IS NOT PRESENT IN THE WESTERN HERMISPHERE, I HAVE NOT OBSERVED CONTROL MEASURES IN SITU. THE FOLLOWING IS TAKEN FROM NEW SOUTH WALES AND QUEENSLAND PUBLICATIONS WHERE BUNCHY TOP DESTROYED THE BANANA INDUSTRY IN THE 1920S. A THRIVING INDUSTRY HAS EXISTED SINCE THE 1930S AS A RESULT OF GOOD MANAGEMENT, GOVERNMENT ASSISTANCE AND GROWERS COOPERATION IN CONTROLLING BUNCHY TOP. INDUSTRY SUPPORTED INSPECTORS ARE CONTINUOUSLY SURVEYING AND RAPIDLY ERADICATING THE OCCASSIONAL BUNCHY TOP INFECTED PLANT THAT IS INFECTED. THE DISEASE CANNOT BE ERADICATED PERMANENTLY.

SET UP A BANANA BUNCHY TOP CONTROL ORGANIZATION HEADED BY THE BANANA BUNCHY TOP CONTROL BOARD AS A PART OF THE SIND DEPT. OF AGRICULTURE. THERE SHOULD BE AN OFFICE IN EACH BANANA GROWING DISTRICT. INTRODUCE IN THE STATE LEGISLATURE: "LEGISLATION FOR THE CONTROL OF BANANA BUNCHY TOP":

1) BANANA PLANTS SHOWING SYMPTOMS OF BUNCHY TOP MUST BE ERADICATED PROMPTLY (WITHIN 48 HR) BY THE GROWER OR THE GROWER WILL ADVISE BUNCHY TOP CONTROL INSPECTORS WHO WILL DESTROY THE PLANTS.

2) BLOCKS OF ONE-ACRE OR MORE IN A BANANA FIELD SHOWING AN INCIDENCE OF BUNCHY TOP EXCEEDING 10% MUST BE ERADICATED ENTIRELY WITHIN 10 DAYS.

3) BANANA BUNCHY TOP CONTROL INSPECTORS ARE AUTHORIZED TO ENTER AND SURVEY A BANANA FIELD AT ANY TIME AND TO ERADICATE ANY PLANT SHOWING SYMPTOMS OF BUNCHY TOP AND HEALTHY-APPEARING PLANTS AROUND THE DISEASED PLANT UP TO A RADIUS OF 5.0 M.

4) ABANDONED BANANA FIELDS MUST BE DESTROYED BY THE OWNER OR BY THE BANANA BUNCHY TOP CONTROL INSPECTORS. IF BY THE LATTER, EXPENSES CAN BE CHARGED TO THE OWNER OF THE LAND.

5) MUSA OF ANY KIND ARE PROHIBITED ENTRY INTO SIND UNLESS IN THE FORM OF TISSUE-CULTURED PLANTS AND WITH A PRIOR-TO-ENTRY IMPORT CERTIFICATE FROM QUARANTINE AUTHORITIES. THIS INCLUDE IMPORTATION FROM OTHER AREAS OF PAKISTAN.

6) A TAX WILL BE ASSESED EACH ACRE OF BANANAS ONCE A YEAR TO PAY FOR THE BANANA BUNCHY TOP CONTROL PROGRAM. IN LIEU OF THE TAX, THE CONTROL PROGRAM WILL BE PAID FOR PARTIALLY OR ENTIRELY BY THE PROVINCIAL GOVERNMENT.

THE BANANA GROWING DISTRICTS SHOULD BE DIVIDED INTO BANANA BUNCHY TOP CONTROL ZONES OF ABOUT 1,000 ACRES [400 HA] FOR SURVEY, ERADICATION, AND ADMINISTRATIVE PURPOSES. TRAINING SHOULD BEGIN <u>NOW</u> OF SURVEY CREWS IN HOW TO DETECT BUNCHY TOP IN THE EARLY SYMPTOM STAGE. TRAINED CREWS SHOULD BE ESTABLISHED <u>NOW</u> BEFORE MASSIVE ERADICATION BEGINS.

A CAMPAIGN SHOULD BE STARTED TO ERADICATE ALL BANANAS IN THATTA DISTRICT AND THEN MOVE PROGRESSIVELY NORTHWARD.

A BUFFER ZONE OF HEALTHY APPEARING PLANTS 5.0 M AROUND THE DISEASED PLANT IS ALSO ERADICATED. ONCE THESE PLANTS HAVE DIED, THE TREATED AREA CAN BE REPLANTED, USUALLY WITHIN 2-3 WEEKS OF ERADICATION.

THE SUCCESS OF THE CONTINUOUS CONTROL PROGRAM WILL DEPEND ON THE EARLY DETECTION AND THE RAPID ERADICATION OF INFECTED PLANTS. IF THIS IS NOT DONE, THE DISEASE WILL SPREAD LIKE WILDFIRE, CONTROL WILL BE LOST AND THE ENTIRE FIELD WILL HAVE TO BE ERADICATED.

IT IS RECOMMENDED THAT AS SOON AS POSSIBLE A DELEGATION OF PROGRESSIVE FARMERS OR FARMER ASSOCIATION PRESIDENTS AND ONE OR TWO PLANT PATHOLOGISTS ACTIVE IN FIELD WORK [NOT ADMINISTRATIVE] FLY TO BRISBANE, QUEENSLAND, TO OBSERVE BUNCHY TOP CONTROL MEASURES. TWO EXTENSION WORKERS SHOULD STAY IN QUEENSLAND FOR ABOUT 2 WEEKS TO WORK WITH THE QUARANTINE AND ERADICATION PROGRAM.

AFTER ALL BANANAS HAVE BEEN ERADICATED, REHABILITATION CAN BEGIN WITH PLANTING OF RHIZOMES FREE OF DISEASE ("CLEAN SEED"). SOURCE OF CLEAN SEED IS DESCRIBED IN THE NEXT SECTION. IT SHOULD BE EMPHASIZED THAT BANANAS ARE NOT EASY TO ERADICATE. UNDER EACH LEAF SHEATH IS A BUD THAT CAN GERMINATE. THUS, A LARGE RHIZOME CAN HAVE 30 BUDS CAPABLE OF PRODUCING A SMALL PLANT AFTER THE RHIZOME IS CUT UP. DESTRUCTION CAN BE BY DEEP PLOWING, FOLLOWED BY CUTTING THE RHIZOME INTO 5.0 CM PIECES AND THEN ELIMINATION OF BUDS WITH A SHOVEL THAT CONTINUE TO GERMINATE OVER A PERIOD OF SEVERAL MONTHS. FOR DIGGING UP RHIZOMES, A CHISEL-LIKE TOOL IS USED IN CENTRAL AMERICA. ALTERNATIVELY, AFTER PLOWING AND CUTTING INTO PIECES RHIZOME TISSUE CAN BE SPRAYED WITH A 0.2% SOLUTION OF 2,4-D. ACCORDING TO ONE GROWER, THE CHEAPEST METHOD WAS TO CUT THE PLANTS DOWN LOW TO THE GROUND AND FLOOD FOR 30 DAYS. SURVIVING BUDS ARE REMOVED BY SHOVEL. THE LACK OF RAIN WILL GREATLY ASSIST IN BANANA ERADICATION.

ONCE CLEAN SEED HAS GERMINATED, <u>WEEKLY</u> SURVEYS MUST BE MADE BY TRAINED INSPECTORS LOOKING FOR BUNCHY TOP. IF AN INFECTED PLANT IS ENCOUNTERED, IT IS IMMEDIATELY SPRAYED WITH KEROSENE OR A SYSTEMIC APHID INSECTICIDE AND ERADICATED WITHIN 48 HOURS.

Tissue Culture - A Source of Clean Seed

Once infected bananas have been eradicated and problems associated with soil salinity and excess iron and boron have been corrected, a rehabilitation program can begin. This will necessitate a disease-free supply of planting material [called "clean seed" in the trade]. For this purpose it is recommended that a commercial tissue culture laboratory be established in Sind. Any residential house can be used with 5 rooms available for: 1] office and materials storage; 2] media preparation and sterilization room; 3] meristem extraction and transfer room with one or two laminar flow cabinets; 4] a growth room with temperature and light controls; 5] a glassware wash room which can also serve for storage. There are international agencies that can assist in this project.

The Atomic Energy Agriculture Research Center of Tandojam has a tissue culture laboratory in operation for sugar cane research. It has also a small collection of banana varieties in tissue culture and could provide assistance.

A permanent grow-out nursery will be needed for the tissue culture plants. This should be located at least 30 km from the nearest banana farm. Tissue culture plants must be grown at first under serran cloth providing about 60% shade. They can be grown in 7 x 14 cm black plastic bags. A 0.75 acre serran cloth shade house will hold 40,000 plants. They can be grown in a mixture of 50% rice hulls and 50% river sand (not sterilized). Nutrients are provided in the irrigation water. The more sophisticated nurseries have one plastic emitter per bag. Plants should be ready for the field in 4 - 6 months depending on temperatures in Sind. The time interval may be longer in cool winter months. Plants should be hardened off by moving to 20% shade for a few weeks. This shade could be made with palm leaves. Commercial laboratories are now providing millions of plants to growers in Central and South America who have been rapidly expanding production. Plants delivered overseas cost about $1.00 each.

Cultural Practices

To control bunchy top it is necessary that periodic surveys be made by inspectors who must examine all plants and suckers. This cannot be done in overpopulated plantings full of unpruned suckers and fallen and dead leaves.

BANANAS MUST BE GROWN BY INTERNATIONALLY RECOGNIZED STANDARDS SUCH AS: POPULATIONS MUST NOT EXCEED 1,000 PRODUCTION UNITS PER ACRE AT TIME OF PLANTING [2,470 PRODUCTION UNITS/HA]. A PRODUCTION UNIT IS A MOTHER PLANT PLUS ONE SUCKER, TWO SUCKERS COUNT AS TWO PRODUCTION UNITS AND SO FORTH. IN AREAS OF POOR GROWTH A MAXIMUM OF TWO SUCKERS CAN BE LEFT PER MOTHER PLANT TO ENSURE A CLOSED CANOPY. EXCESS SUCKERS MUST BE REMOVED AT INTERVALS NO LONGER THAN SIX WEEKS. FALLEN AND SENESCENT LEAVES MUST BE REMOVED MONTHLY. THESE STANDARDS WILL PERMIT INSPECTORS TO MOVE THROUGH THE FIELDS FREELY WITH SUFFICIENT LIGHT TO SEARCH FOR BUNCHY TOP SYMPTOMS.

TO BECOME ACQUAINTED WITH HOW DWARF CAVENDISH BANANAS SHOULD BE GROWN, IT IS RECOMMENDED THAT A DELEGATION OF ABOUT FOUR PROGRESSIVE GROWERS AND ONE OR TWO UNIVERSITY HORTICULTURE PROFESSORS WITH TENURE VISIT THE CANARY ISLANDS FOR ONE WEEK. THE HORTICULTURE PROFESSORS SHOULD TEACH BANANA GROWING IN A COURSE ON TROPICAL AND SUBTROPICAL FRUIT PRODUCTION.

THE CANARY ISLANDS HAVE BEEN GROWING DWARF CAVENDISH FOR EXPORT FOR MORE THAN 100 YEARS IN A DESERT CLIMATE WITH ALMOST NO RAIN. WATER FROM SNOWFALL IN HIGH MOUNTAINS IS PIPED TO THE LOWLAND DESERT PLAIN. THEY HAVE THREE MONTHS OF COLD, POOR GROWTH WEATHER BUT NO FROST AND NO EXTREMES OF HEAT ABOVE 42ºC. THEY PRODUCE ABOUT 440,000 TONS/YEAR FOR THE SPANISH MAINLAND MARKET. THEIR AVERAGE YIELDS ARE AMONG THE HIGHEST IN THE WORLD ON THE BETTER-MANAGED FARMS. THE FARMS ARE MOSTLY FAMILY OWNED AND OPERATED AND RANGE FROM 3 - 10 HA. MANY OTHER CROPS, ESPECIALLY VEGETABLES, ARE GROWN FOR EXPORT. THEREFORE, A VISIT DURING THE FIRST FIVE MONTHS OF THE YEAR WOULD BE MOST INFORMATIVE.

IN GUJERAT, DWARF CAVENDISH BANANAS ARE PLANTED EACH YEAR AS PART OF A ROTATION CROP. THIS SYSTEM WOULD PROVIDE AN OPPORTUNITY TO ERADICATE BUNCHY TOP PLANTS WHEN PLANTS ARE BEING SELECTED FOR THE ANNUAL PLANTING. IF THERE IS NO RATOONING, POPULATIONS OF 1,200 PLANTS/ACRE COULD BE PLANTED FOR A SINGLE HARVEST. THIS SHOULD BE TESTED IN SIND.

DISEASE EVALUATION IN SIND - HEART LEAF ROT

THE PHOTOGRAPHS SENT TO HONDURAS IN JANUARY 1991 SHOWED A VARIETY OF SYMPTOMS AMONG WHICH WAS A HEART LEAF ROT EXTENDING FOR 20 - 50 CM DOWN INTO THE PSEUDOSTEM. THERE WAS NO CONNECTION WITH THE RHIZOME. HEART LEAF ROT

SYMPTOMS ARE NOT CAUSED BY THE BUNCHY TOP VIRUS. DURING THE FIRST DAY IN THE FIELD IN THATTA DISTRICT SIMILAR SYMPTOMS WERE OBSERVED OF HEART LEAF ROT WITH DEATH OF THE PLANT AND THE EMERGENCE OF NUMEROUS STUNTED, ROSETTED SUCKERS AROUND THE BASE OF THE DEAD PLANT. ROSETTED SUCKERS WITH A PROLIFERATION OF LEAVES ARE VERY COMMON WHERE HEART LEAF ROT IS FOUND. SUPERFICIALLY THEY RESEMBLE BUNCHY TOP SUCKERS BUT THE LEAF LAMINA IS NOT BRITTLE AS IN BUNCHY TOP. EVENTUALLY, WE SORTED OUT THE PRESENCE OF TWO PROBLEMS BY VISITING A LOCATION WITH TYPICAL BUNCHY TOP SYMPTOMS AND NO HEART LEAF ROT AND VISITING AN AREA OF A FIELD WITH NO BUNCHY TOP SYMPTOMS BUT NUMEROUS PLANTS WITH HEART LEAF ROT AND ROSETTED SUCKERS.

PHOTOGRAPHS OF THE HEART LEAF ROT SYMPTOMS AND SUCKER ROSETTING WITH A PROLIFERATION OF LEAVES ARE SHOWN IN APPENDIX 3. THE HEART LEAF OF MEDIUM-SIZED MATURE PLANTS BECOMES CHLOROTIC, THEN NECROTIC FOLLOWED BY AN ODOROUS WET ROT. THE PLANT USUALLY DIES, BUT IN SOME CASES THE MERISTEMATIC TISSUE IS NOT DESTROYED AND A MASS OF STUNTED, ROSETTED CHLOROTIC LEAVES EMERGE. AFTER A PLANT DIES, NUMEROUS STUNTED SUCKERS EMERGE SUPERFICIALLY RESEMBLING BUNCHY TOP SUCKERS.

RESULTS OF SOIL AND FOLIAR ANALYSES ARE DISCUSSED IN THE NEXT SECTION - SOIL PROBLEMS. THESE DATA INDICATE THE HEART LEAF ROT AND SUCKER STUNTING ARE THE RESULT OF TOXICITY PROBABLY FROM AN EXCESS OF IRON OR BORON OR A COMBINATION OF BOTH.

SOIL PROBLEMS

EIGHT SOIL SAMPLES WERE TAKEN AT 10 AND 40 CM DEPTHS AND THREE LEAF SAMPLES FROM LEAF THREE OF PLANTS WITH FRUIT 2 - 4 WEEKS OLD. EACH LEAF SAMPLE WAS FROM FIVE PLANTS ONLY IN AN AREA OF LESS THAN 0.25 HA. THE SOIL SAMPLES WERE NOT COMPOSITE BUT REPRESENTATIVE OF ONLY ONE LOCATION. THUS, THESE SAMPLES ARE VERY RESTRICTED IN REPRESENTATION AND ONLY INDICATIVE OF THE PROBLEMS TO BE INVESTIGATED BY MUCH MORE STATISTICALLY SOUND SAMPLING. AT THE WRITING OF THIS REPORT, ANALYSES OF A SOIL SATURATION EXTRACT FOR SALINITY, SODIUM, BORON AND OTHER ELEMENTS HAS NOT BEEN DONE. SATURATION EXTRACT DATA ARE USED BY THE USDA SALINITY LABORATORY AND ARE THE STANDARD FOR EVALUATING SALINITY AND EXCESS ELEMENT PROBLEMS. FUTURE ANALYSES SHOULD FOLLOW THE USDA METHODS USING A SATURATION EXTRACT.

For a successful rehabilitation of the banana industry a full time research and extension service must be established. This service would monitor soil and leaf macro and micro-nutrients to prevent excesses and deficiencies that preclude a successful level of banana production. To ensure accurate data the foliar analyses laboratory should be affiliated with the International Plant Analytical Exchange in Wageningen [Dr. V. Houba, P.O.Box 8005, 6700 EC Wageningen, The Netherlands].

Salinity and Sodium

Leaf symptoms of sodium toxicity (chlorosis of the edges of the leaf lamina) were widespread in Thatta District. Electrical conductivity data for two of the three farms sampled in Thatta District show salinity levels of 2.6 and 4.6 mmhos (Appendix 4). The critical level for reduced banana yields is around 1.5 mmhos. Thus, salinity is a major limiting factor in banana production in Thatta District. Salinity levels can be reduced by installing a good drainage system and flushing the soil with good quality irrigation water. One grower stated that paddy rice cultivation reduced salinity levels.

Iron

Foliar analyses (Appendix 5) show leaf three has 2.6 to 3.5 times the average level of iron in Cavendish varieties (Appendices 5 and 6). Iron levels were 400, 416 and 528 ppm. The only published report of iron toxicity is from the Canary Islands where growers applied iron sulphate [J. Ben Meir. 1979. A case of iron excess in Canary Islands bananas. Int. Banana Nutrition Newsletter № 1, 11-14]. Affected plants had black margins and a proliferation of sword sucker leaves in individual suckers with up to 16 leaves. Affected leaves had 400 to 800 ppm of iron in the dry matter. Proliferation of stunted sword sucker leaves was a common symptom associated with heart leaf rot (see Appendix 3) but black leaf margins as seen in the Canary Islands were rare.

The role of excessive iron uptake in the heart leaf rot and sword sucker leaf proliferation disorders requires much more study. Iron should be measured in affected sucker leaves and heart leaves with the initial stages of necrosis and compared with foliage from healthy, normal plants.

Boron

Boron levels in leaf three (Appendix 5) were 1.5 to 2.5 times normal [27 - 45 ppm in comparison with a normal mean of 17 ppm]. Boron levels should be measured in heart leaves with early stages of necrosis and compared with healthy, normal plants. Soil boron levels were above 1 ppm in three of the eight soil samples (Appendix 4).

Drainage

Bananas require at least a 60 cm soil profile and preferably one meter free of a fluctuating water table. In general, I saw few or no drains in the banana fields to remove excess irrigation water quickly. Poor drainage causes a yield decline following the plant and ratoon crops and results in small bunches. It is also a major contribution to the gradual build up of salts and the salinity problems in Thatta District.

OTHER DISEASES AND PESTS

Of the 18 important banana diseases and at least eight destructive banana insects world-wide Sind has only two diseases and no major insect pests. Efforts should be made to exclude these diseases and insects by importing plants only from tissue culture-laboratories.

Nematodes

Root knot species and Helicotylenchus are widespread on bananas in Sind. Rotylenchus is sometimes found but not the destructive P.* coffeae and P. goodeyi. Root knot and Helicotylenchus are common on bananas wherever grown. Radopholus similis was recently discovered according to the Institute of Nematology in Karachi. This species does not prosper in alkaline soils. There are no serious root rot symptoms although spiral nematode lesions are common. No uproots were observed. An occassional plant falls as a result of high-mat. Until nematicide trials have been carried out to demonstrate a yield increase as a result of nematode reduction, the nematologists should not claim that nematodes are involved in the present disease situation in Sind and are causing important yield losses.

* *Pratylenchus*

Yellow Sigatoka

Considerable spotting caused by *Mycosphaerella musicola* was observed in more humid areas close to the sea in Thatta District. The disease is not important in a desert climate.

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APPENDIX 1

TERMS OF REFERENCE
BANANA DISEASE EXPERT
R. H. STOVER

A new banana disease has appeared in Sindh province and is causing serious losses. The disease was first diagnosed as a soil-borne fungal disease, then later as caused by nematodes, but apparently it does not respond to treatment with nematicides.

The purpose of this consultancy will be to travel to Sindh province, in company with plant pathologists from PARC and Sindh, to study the disease, identifying it positively if possible, and recommending measures to alleviate the problem.

After completing the study tour, the consultant will write a report describing his observations, studies, and conclusions. The report will also give detailed recommendations for preventing, avoiding, or curing the disease. The recommendations should be applicable to growers and the extension service. Also recommendations should be made for the research system indicating lines of research that should be pursued regarding the disease. The consultant should also include in his report any recommendations he may wish to give regarding the general subject of banana production in Pakistan.

This consultancy will begin about 20 February 1991* and will require up to four weeks. The consultant should arrive in Islamabad for discussions with PARC scientists and to plan his travel in Sindh in detail. He will then travel to Sindh for the study tour, returning to Islamabad to complete his report and to brief PARC and USAID officials regarding his findings and recommendations.

* Changed to July 1, 1991

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APPENDIX 2. AVERAGE MAXIMUM AND MINIMUM TEMPERATURES AND RAINFALL AT HYDERABAD [18 YEAR AVERAGE].

	AVERAGES		
	°C		MM
MONTH	MAXIMUM	MINIMUM	RAINFALL
JANUARY	24.4	10.0	5.08
FEBRUARY	27.8	11.7	5.08
MARCH	33.3	17.2	5.08
APRIL	38.9	22.2	2.54
MAY	42.2	25.6	5.08
JUNE	40.0	27.8	10.16
JULY	36.7	26.7	76.20
AUGUST	35.8	25.8	50.80
SEPTEMBER	36.4	25.0	15.24
OCTOBER	36.7	20.8	0
NOVEMBER	31.1	15.2	2.54
DECEMBER	25.6	11.1	2.54
AVERAGE/YEAR	34.1	19.8	TOTAL = 180.34

HEART LEAF ROT DISORDER

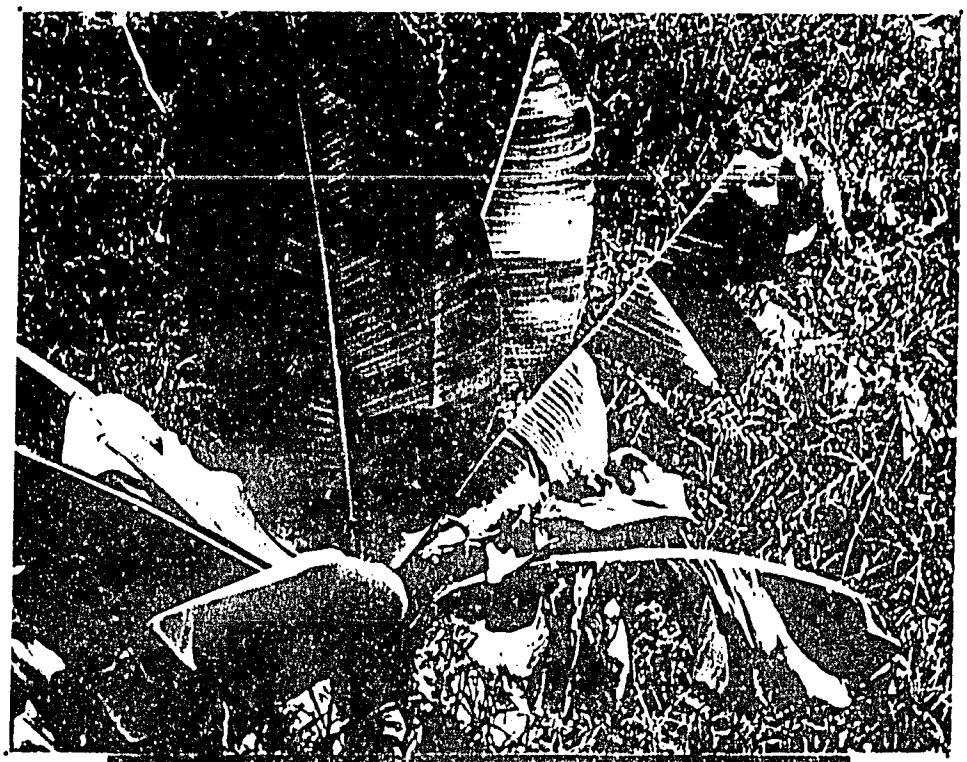

FIGURE 1. DEATH OF CENTER LEAVES INCLUDING HEART LEAF OF DWARF CAVENDISH.

FIGURE 2. LEAF SHEATHS PEELED BACK TO SHOW NECROSIS ON FURLED HEART LEAF OF DWARF CAVENDISH.

FIGURE 3. ADVANCED STAGE OF HEART LEAF ROT - PLANT DIES.

FIGURE 4. ABNORMAL AND NORMAL SUCKERS IN AREAS OF HEART LEAF ROT.

FIGURE 5. CLUSTERS OF ABNORMAL SUCKERS THAT GROW AT THE BASE OF PLANT THAT HAS DIED FROM HEART ROT. NOTICE NORMAL SUCKERS IN BACKGROUND.

Appendix 4. Soil analyses from banana fields in Sind.

Location	Depth [cm]	PPM					C.E.	PPM	Me/100g
		Fe	Mn	Cu	Zn	B	umhos	Na*	Na+
Saeed Farm, Thatta District	10	13.0	4.0	3.0	0.66	1.0	2620	114	1.24
Saeed Farm Thatta District	40	4.1	4.2	1.46	2.6	1.8	760	92	0.87
Ibrahim Farm Thatta District	10	11.0	3.8	3.0	0.38	0.6	560	128	1.31
Ibrahim Farm Thatta District	40	9.0	2.8	1.62	0.20	0.4	440	108	2.14
Akhsar Shah Farm Thatta District	10	5.1	3.8	3.0	0.50	2.2	4600	672	0.95
Akhsar Shah Farm Thatta District	40	8.0	2.2	1.34	0.18	1.2	840	176	1.96
Quamar Shah Farm Badin District	-	10.0	6.0	2.4	0.42	0.4	560	92	1.71
East Karachi Field	-	9.0	3.6	1.22	1.58	0.5	320	25	0.61

Notes: Fe, Mn, Cu, Zn = DTPA; Boron = Calcium Phosphate; Electrical Conductivity = 1:2 soil-water; Na* = 1:2 soil-water; Interchangeable Na = Ammonium Acetate Extractant pH 7.0

APPENDIX 5. CONCENTRATIONS OF NUTRIENTS IN THE LAMINA OF LEAF № 3 OF CAVENDISH VARIETIES.

	MEAN CONC.	CRITICAL CONC.	PAKISTAN SAMPLES 1	2	3
P	0.21%	0.2	0.21	0.21	0.15
K	3.27%	3.0	4.39	4.48	4.35
CA	0.79%	0.5	1.13	1.13	1.43
MG	0.36%	0.3	0.44	0.45	0.37
CL	0.76%	0.6	1.3	-	1.1
FE	150.0 PPM	80	528	400	416
MN	1476.0 PPM	25	153	150	174
CU	12.1 PPM	9	12	12	12
ZN	17.6 PPM	18	20	19	20
B	16.8 PPM	11	27	45	31

NOTES: MEAN AND CRITICAL CONCENTRATION TAKEN FROM E. LAHAV AND D. W. TURNER. BANANA NUTRITION. INT. POTASH INSTIT. 1983. SAMPLE 1) EAST KARACHI FARM IRRIGATED FROM WELLS; SAMPLE 2) SAEED FARM, THATTA DISTRICT; SAMPLE 3) SIND AGRICULTURE UNIVERSITY, TANDOJAM. SAMPLES WERE FROM THE THIRD LEAF FROM PLANTS WITH 2-4 WEEK-OLD FRUIT. FIGURES UNDERLINED ARE MUCH ABOVE NORMAL.

APPENDIX 6

Table 40.13 Leaf composition (% or ppm of the DM) in 30 banana cultivars at Alstonville, Australia. Whole transverse strip of leaf III, mean of two samplings: 1st cycle 12 months after planting and 2nd cycle 24 months after planting (from TURNER and BARKUS, 42).

Species or cultivar		N %	P %	S %	K %	Ca %	Mg %	Cl % (1)	Al ppm	Fe ppm	Mn ppm	Cu ppm	Zn ppm	B ppm	Mo ppm
Wild bananas	(*M velutina*	3.71	0.22	0.29	3.47	0.57	0.40	1.24	93	158	1101	13	34	12	0.08
	(*M ornata*	3.71	0.23	0.28	2.22	0.82	0.31	0.62	64	140	1485	10	23	15	0.06
	(*M acuminata subsp.* (AA)(2)	3.95	0.23	0.28	2.76	0.96	0.45	1.02	57	129	1107	11	24	15	0.06
	(*M balbisiana* (BB)	2.99	0.18	0.20	2.79	0.66	0.41	0.50	53	130	540	5	13	19	0.15
Cavendish (AAA)	(Dwarf Parfitt	4.14	0.23	0.33	3.50	1.20	0.40	0.79	68	253	1795	13	21	15	0.15
	(Dwarf Cavendish	3.78	0.22	0.30	3.46	1.09	0.38	0.81	56	183	1257	12	18	17	0.17
	(New Guinea Cavendish	3.76	0.22	0.30	3.26	1.05	0.37	0.77	53	180	1240	12	16	16	0.28
	(Chinese Cavendish	3.77	0.21	0.30	3.29	0.90	0.36	0.80	48	141	957	12	16	16	0.21
	(Cavendish C	3.71	0.21	0.28	3.20	0.99	0.36	0.77	51	138	1454	12	17	16	0.20
	(Cavendish S	3.56	0.20	0.27	3.31	0.82	0.33	0.73	31	131	972	12	27	16	0.22
	(Cavendish N	3.62	0.21	0.28	3.24	0.77	0.35	0.70	49	147	1394	12	17	16	0.16
	(Hochuchu	3.84	0.21	0.28	3.14	0.71	0.35	0.77	37	180	1917	12	17	19	0.16
	(Vienana	3.66	0.21	0.27	3.15	0.73	0.37	0.85	40	149	2068	12	17	17	0.14
	(Mons Mari	3.72	0.20	0.29	3.25	0.66	0.37	0.75	22	131	1471	12	16	17	0.13
	(Williams	3.62	0.21	0.28	3.33	0.65	0.37	0.67	28	138	1221	12	17	17	0.13
	(Williams (pub)	3.59	0.22	0.27	3.25	0.74	0.38	0.74	37	138	1703	13	18	18	0.07
	(Pisang Masak Hijau	3.66	0.20	0.28	3.26	0.60	0.34	0.71	32	142	1812	12	16	16	0.07
	(Robusta	3.73	0.20	0.28	3.31	0.65	0.39	0.77	53	153	1728	12	17	18	0.07
Gros Michel (AAA)	(Highgate	3.63	0.19	0.26	3.59	0.54	0.35	0.88	40	118	1082	12	18	14	0.13
	(Bodles Altafort	3.99	0.22	0.32	3.36	0.66	0.34	0.72	39	170	1178	14	21	12	0.16
	(2390	3.77	0.20	0.28	3.15	0.84	0.38	0.69	39	170	2221	12	16	16	0.15
Figures Roses (AAA)	(Red	2.92	0.17	0.22	3.25	0.68	0.29	0.55	41	95	910	10	14	15	0.09
	(Green Red	2.97	0.18	0.22	3.38	0.63	0.29	0.55	39	97	842	9	15	14	0.12
Various	(Figue Pomme (AAB)	3.54	0.21	0.25	3.00	0.73	0.37	0.73	44	147	1277	10	15	20	0.10
	(Silk (AAB)	3.53	0.20	0.27	2.72	0.64	0.34	0.54	37	114	1020	10	16	16	0.16
	(Pisang Awak (ABB)	2.94	0.17	0.21	2.95	0.46	0.35	0.55	42	112	626	9	17	12	0.04
	(Silver Bluggoe (ABB)	3.09	0.19	0.23	2.79	0.62	0.31	0.61	36	104	734	8	14	17	0.05
	(Bluggoe (ABB)	3.05	0.20	0.23	2.67	0.62	0.32	0.63	50	108	828	7	15	17	0.04
	(Blue Lubin (AAB)	3.22	0.19	0.24	2.69	0.61	0.35	0.58	51	107	1102	7	15	18	0.08
	(Corne Plantain (AAB)	3.32	0.20	0.25	3.35	0.52	0.40	0.87	57	103	910	9	21	14	0.14

1) Cl was determined at the second sampling only
2) A - half genome from *Musa acuminata*. B - half genome from *Musa balbisiana*
Most cultivated bananas are triploids; dessert bananas are AAA while plantains (culinary bananas) are AAB.

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