PHYSIOLOGICAL RESPONSES OF THE BANANA PLANT TO INTERNAL AND ENVIRONMENTAL FACTORS IN THE SUBTROPICS

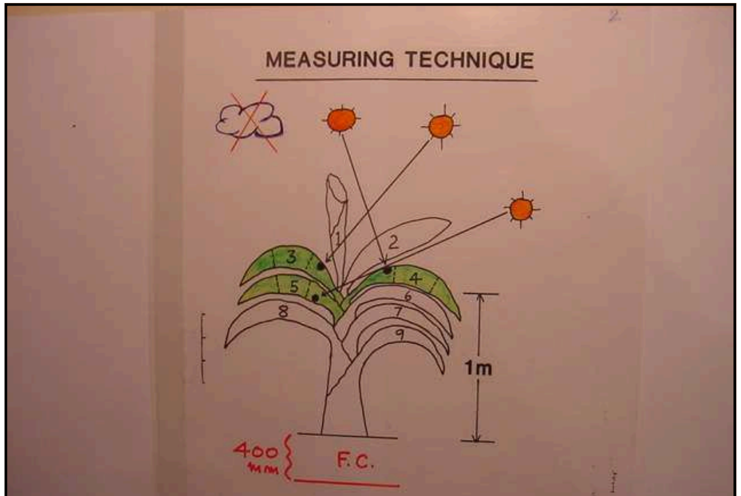
J.C. ROBINSON
DU ROI LABORATORY, SOUTH AFRICA
and K. ECKSTEIN
BAYER, SOUTH AFRICA

MATERIALS AND METHODS

- SUBTROPICAL LOCALITY – SOUTH AFRICA 27˚S; MEAN MIN 10.6˚C; MEAN MAX 28.0˚C
- MUSA AAA CAVENDISH SUBGROUP CULTIVARS GRAND NAIN, WILLIAMS, CHINESE CAV., DW.CAV
- LCA 3 PORTABLE Ps MEASURING EQUIP.(ADC)
  Ps AND Tr MEASURED SIMULTANEOUSLY.
- IRGA AND HUMIDITY SENSORS CALIBRATED- LEAF AREA 6.2 cm² - ANGLED TOWARDS SUN- EXPOSURE TIME 30s – 09h00 TO 12h00- SWP RETURNED TO FC PRIOR TO MEASURE - EACH DATA POINT = 30 READINGS OR MORE
  (5 plants x 3 leaves x 2 readings per leaf)

INTRODUCTION

- "DEVELOPMENT"- INCREASE IN PLANT SIZE OVER TIME: MORPHOLOGY AND PHENOLOGY. OPTIMUM TEMP = ±35ºC
- "GROWTH" –ASSIMILATION OF DRY MATTER OVER TIME: PHOTOSYNTHESIS AND TRANSPIRATION.
- OPTIMUM TEMP = ±28ºC.
- TO MAXIMISE CROP YIELD POTENTIAL:
  a. MEASURE ASSIMILATION LEVELS
  b. IDENTIFY ENVIRONMENTAL CONSTRAINTS
  C. APPLY REMEDIAL ACTIONS
- THIS TALK: SUMMARISES PHYSIOLOGICAL WORK IN Ps AND Tr OF BANANA IN RSA AND SUGGESTS MANAGEMENT RECOMMENDATIONS BASED ON THIS KNOWLEDGE.



MEASUREMENTS FROM 09:00 TO 12:00

PHYSIOLOGICAL INVESTIGATIONS

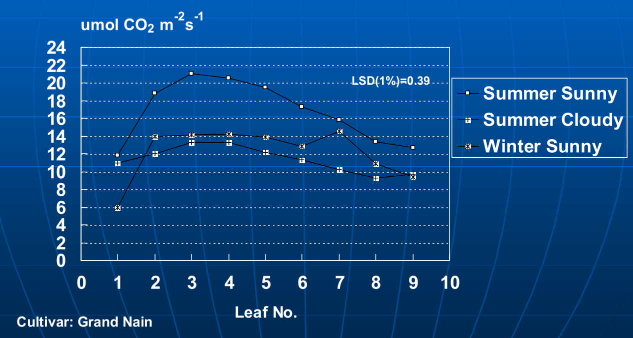
INTERNAL PLANT FACTORS CONTROLLING PHOTOSYNTHESIS:-

LEAF CHARACTERISTICS, PLANT ONTOGENETIC STAGE, CULTIVAR, TYPE OF PLANTING MATERIAL, COMPENSATORY PHOTOSYNTHESIS, PARENT/SUCKER INTERACTION, SEASONAL DISTRIB OF DM

EXTERNAL ENVIRONMENTAL FACTORS INFLUENCING Ps AND Tr

DIURNAL AND SEASONAL CLIMATE, PAR AND SHADE, SOIL WATER POTENTIAL, LEAF TEARING,

Photosynthesis Rate in relation to leaf position and seasonal conditions



INTERNAL PLANT FACTORS

1. LEAF POSITION AND LEAF SURFACE

VARIATIONS IN Ps ON LOWER AND UPPER LEAF SURFACE OF BANANA A/C TO SEASON

LEAF SURFACE (3,4 or 5)	Ps (µmol $CO_2/m^2/sec$)
LOWER / UPPER (SPRING)	24.1 / 7.7
LOWER / UPPER (SUMMER)	32.2 /21.6
LOWER / UPPER (AUTUMN)	20.6 / 7.9
LOWER / UPPER (WINTER – NORMAL)	18.8 / 6.1
LOWER / UPPER (WINTER – YELLOW)	13.4 / 2.5

MANAGEMENT - LEAVES

1. IMPORTANT THAT THE MOST EFFICIENT LEAF AREA (LEAVES 2 TO 6) REMAINS FREE OF LEAF DISEASE, LEAF TEARING, EXCESSIVE SHADING, LEAF WILTING OR FOLDING.
2. BEFORE CHOOSING A BANANA GROWING AREA, STUDY WINTER NIGHT TEMPS TO ENSURE THERE IS NO POTENTIAL FOR WINTER LEAF YELLOWING. ALSO, POOR NUTRITION, IRRIG AND DRAINAGE CAUSE LEAF YELLOWING.

YELLOW, WILTED LEAF CANOPY – WINTER !

SEVERE WINTER LEAF DAMAGE

HEALTHY VIGOROUS LEAF CANOPY

2. PLANT ONTOGENETIC PHASE

3. CAVENDISH SUBGROUP CULTIVARS

Ps OF BANANA LEAVES 3,4 OR 5 IN MID-SUMMER, ACCORDING TO PHASE OF PLANT ONTOGENY

ONTOGENETIC PHASE	Ps (umol $CO_2/m^2/sec$)
PRIOR TO FLOWER	18.4
MID-FRUIT DEVEL.	13.0
AT HARVEST	8.2

MANAGEMENT – ONTOGENY (SUBTROPICS)

Ps DECLINES WITH LEAF AGE.

IF FLOWERING OCCURS IN SUMMER OR AUTUMN THEN ACTIVE LEAVES 3,4 AND 5 ARE ONLY 1 Month OLD. PLANTS FLOWERING AT END OF WINTER HAVE LEAVES 4 months OLD AT F.E. AND 8 Mths AT HARV. – 4 mths IN TROPICS

SUMMER Ps RATE OF DIFFERENT CAVENDISH SUBGROUP CULTIVARS

CULTIVAR	Ps (µmol$CO^2/m^2/sec$)
CHINESE CAV	29.5
WILLIAMS	29.1
DWARF CAV	29.1
GRAND NAIN	28.6
VALERY	27.5

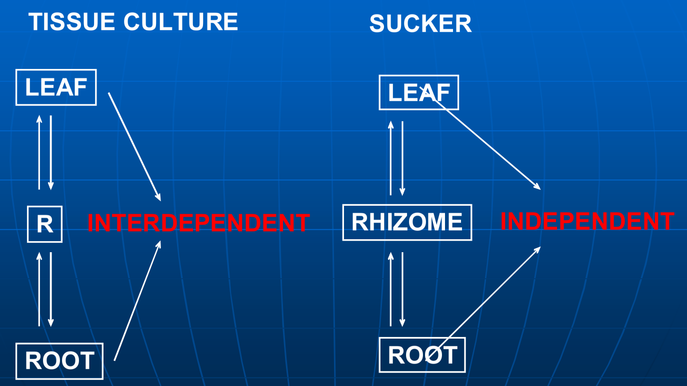
CHINESE IS THE MOST EFFICIENT WITH Ps 7% HIGHER THAN VALERY AND 3% HIGHER THAN GRAND NAIN –

IN THE FIELD, CHINESE HAD FASTER LER AND FEWER LEAVES/ PLANT DUE TO Ps EFFICIENCY. GAVE HIGH YIELDS /ANNUM IN TRIALS.

4. PLANTING MATERIALS-

TISSUE CULTURE Vs CONVENTIONAL SUCKERS

LEAF/ROOT INTERACTION



REDUCED GROWTH WHILE USING UP RESERVES

PHYSIOLOGICAL FACTORS

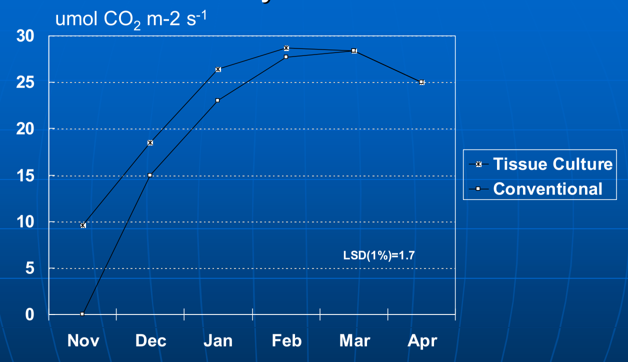
TC = JUVENILE PLANT MATERIAL
NO STORAGE RESERVES → INCREASED PHOTOSYNTHETIC DEMAND FROM LEAVES

INCREASED PHOTOSYNTHETIC EFFICIENCY
INCREASED FUNCTIONAL LEAF AREA
INCREASED PHOTOSYTHETIC CAPACITY
INCREASE ROOT VIGOUR AND DRY MASS

SUCKER = MATURE PLANT MATERIAL. STORAGE RHIZOME SO LESS Ps DEMAND FROM LEAVES

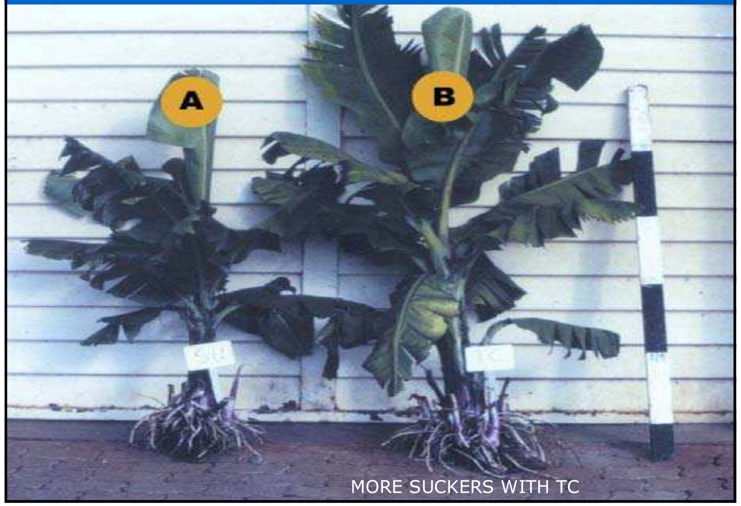
1 = CONVENTIONAL SUCKER; 2 = TC (1 month)

Photosynthesis Rate

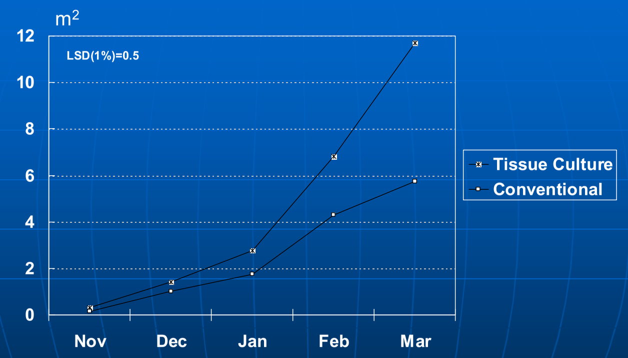


Planting Date – OCTOBER (spring)
Cultivar: Williams

A = CONVENTIONAL SUCKER; B = TC – 3 MONTHS



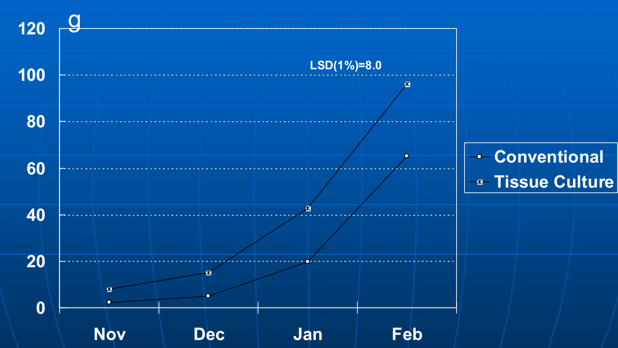
Mean Functional Leaf Area



Planting Date OCTOBER (spring)

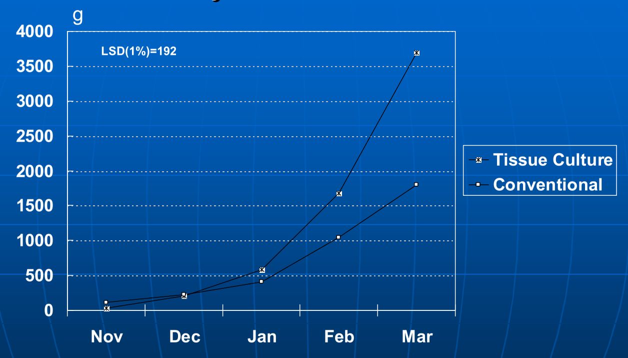
LEAF AREA DOUBLED AFTER 5 MTHS WITH TC

Root Dry Matter



Planting Date OCTOBER (spring)

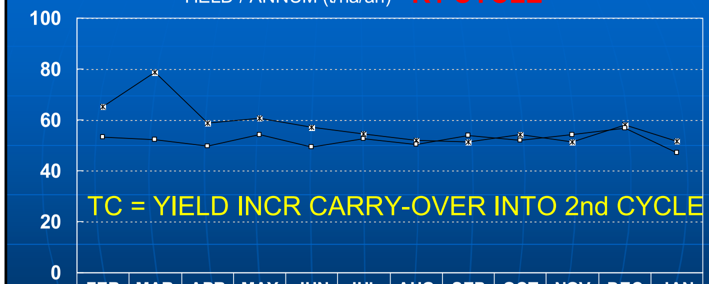
Total Dry Matter Production



Planting Date OCTOBER (spring)

GRAND NAIN – YIELD/ANNUM

YIELD / ANNUM (t/ha/an) – R1 CYCLE



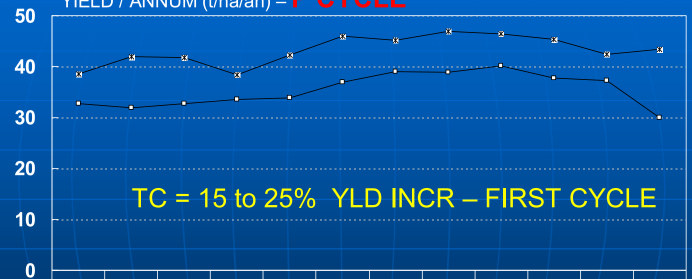
	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN
TC	65.1	78.8	58.7	60.5	57.1	54.4	51.8	51.2	54.1	51.4	58.2	51.6
CON	53.2	52.2	49.8	54.2	49.4	52.7	50.2	53.8	51.9	54.3	56.7	47.2

TC · CON

MONTH OF PLANTING

GRAND NAIN – YIELD/ANNUM

YIELD / ANNUM (t/ha/an) – P CYCLE



	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	JAN
TC	38.5	41.9	41.7	38.4	42.3	45.9	45.1	47	46.4	45.4	42.4	43.4
CON	32.8	31.9	32.7	33.6	33.9	36.9	39.1	38.9	40.1	37.7	37.2	30

TC · CON

MONTH OF PLANTING

MANAGEMENT – TISSUE CULTURE

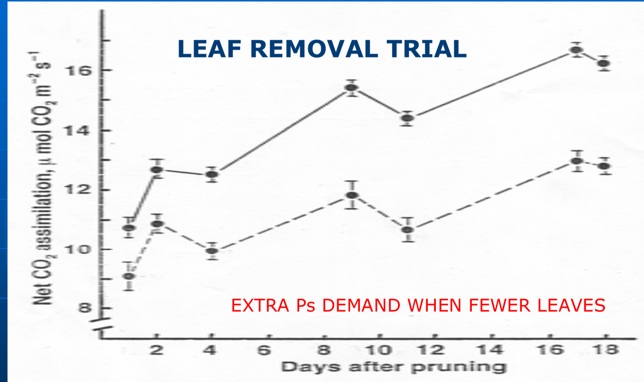
PHYSIOLOGICAL ADVANTAGES OF TC SUGGEST IMPORTANT MANAGEMENT CRITERIA:-

1. BOOST NURSERY GROWTH POTENTIAL WITH FUNGAL ENDOPHYTES, MYCORRHYSAE AND RHIZOBACTERIA – VARIOUS PRODUCTS !!
2. INTENSIVE EARLY NITROGEN NUTRITION
3. LEAF WETTING IN FIELD TO COOL AND PROTECT LEAF AREA AND INCREASE Ps
4. COMPLETE NEMATODE AND WEED CONTROL AND KEEP SOIL AT FWC > ROOT HEALTH

5. PHOTOSYNTHETIC

COMPENSATION

±30 % INCR IN P/S AFTER 9 DAYS = COMPENSATION



The effect of removing the majority of 'Williams' banana leaves at flower emergence, on net CO_2 assimilation in leaves 2, 3 and 4, over an 18 day period. ●——● = pruned plants (4 leaves retained); ●- - -● = unpruned plants (±12 leaves present). Each point represents the mean of 45 individual measurements ± SE (5 plants × 3 leaves × 3 readings per leaf).

<u>TREATMENTS (WILLIAMS)</u>

1. PLANTS UNPRUNED AT FLOWERING (12 LEAVES PRESENT)
2. PLANTS PRUNED TO 4 YOUNGEST LEAVES AT FLOWER EMERGENCE

P/s RESPONSE MEASURED ON LEAF 3 AT INTERVALS AFTER PRUNING

<u>RESULTS</u> – P/S 9 DAYS AFTER PRUNING

LEAF 3 (12 LEAVES PRESENT – 11.8 μMOL CO2/m2/S

LEAF 3 (4 LEAVES PRESENT – 15.4 μMOL CO2/m2/S

30 % INCR IN PHOTOSYNTHETIC COMPENSATION

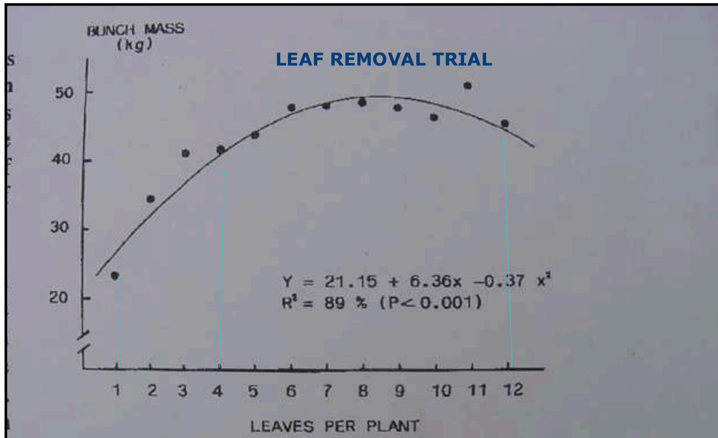


FIG. 1 - The relationship between leaves per plant at flowering and bunch mass

6. PARENT TO SUCKER INTERACTION

(INFLUENCE OF PARENT PLANT ON SUCKER GROWTH)

RESULTS

DRY MATTER/SUCKER (kg)
6 months AFTER SELECTION

AC	SUCKER ATTACHED - + CANOPY	2.7 (cont)
AR	SUCKER ATTACHED – NO CANOPY	5.2
SC	SUCKER SEVERED - + CANOPY	0.5
SR	SUCKER SEVERED - NO CANOPY	1.3

(MEANS OF 16 PLANTS/TREATMENT)

STUDY WITH DWARF CAVENDISH BANANAS

TREATMENTS

1. AC – R1 SUCKER LEFT ATTACHED TO PARENT. CANOPY AND BUNCH RETAINED (CONTROL)
2. AR - R1 SUCKER LEFT ATTACHED TO PARENT. CANOPY AND BUNCH REMOVED AT R1 SELECTION
3. SC – SUCKER CONNECTION SEVERED FROM PARENT AT R1 SELECTION BUT SUCKER LEFT IN SITU. CANOPY AND BUNCH RETAINED.
4. SR – SUCKER CONNECTION SEVERED FROM PARENT AT R1 SELECTION. CANOPY AND BUNCH REMOVED AT R1 SELECTION

CONCLUSION

1. REMOVING LEAF CANOPY AND NEWLY-EMERGED BUNCH AT SUCKER SELECTION DOUBLED TOTAL DRY MASS AND LEAF AREA OF SUCKER 6 mnths LATER COMPARED WITH SUCKER ATTACHED TO NORMAL PARENT – MORE LIGHT AND RESERVES RE-ALLOCATED TO SUCKER
2. SEVERING VASCULAR CONNECTION BETWEEN SUCKER AND PARENT REDUCED SUCKER DRY MASS TO 20% OF THAT FROM A NORMAL ATTACHED SUCKER AFTER 6 MONTHS. SUCKER IS PHYSIOLOGICALLY VERY DEPENDANT ON ITS MOTHER FOR EARLY GROWTH. MUST SELECT A WELL-CONNECTED SWORD SUCKER

7. DISTRIBUTION OF DRY MATTER OVER A WHOLE CROP CYCLE

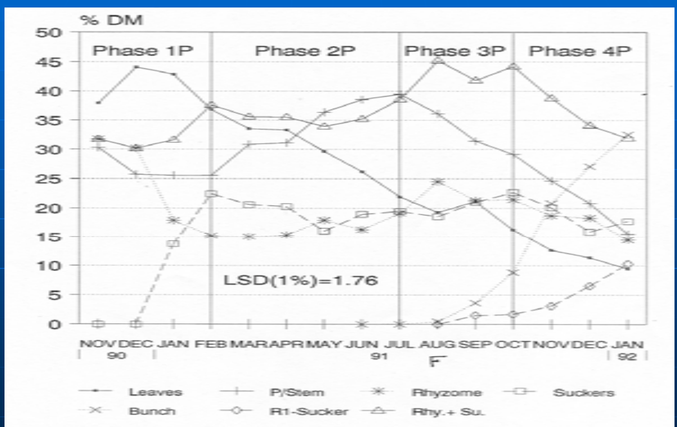
MANAGEMENT TO OPTIMISE SOURCE /SINK INTERACTIONS

CARE FOR LEAF AREA DURING FIRST FOUR MONTHS AFTER PLANTING

- ADEQUATE NITROGEN FERTILISER
- PREVENT LEAF SPOT INFECTION
- PREVENT LEAF TEARING AND SHADING
- ADEQUATE SOIL WATER - PREVENT LEAF FOLDING, WILTING OR BURNING
- EVAPORATIVE COOLING > INCR P/s RATE
- PREVENT WEED AND NEMATODE COMPETITION

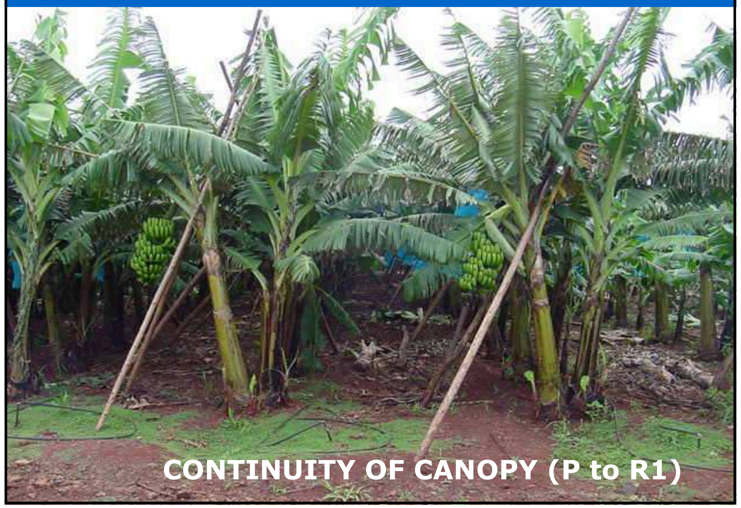
SELECT R1 SUCKER 6 MONTHS AFTER PLANTING AND NOT AFTER 10 MONTHS WHEN IT COMPETES DIRECTLY WITH FILLING BUNCH FOR AVAILABLE ASSIMILATES. SUCKER SHOULD BE INDEPENDENT BEFORE FLOWERING.

Dry Matter Distribution (P-Crop)



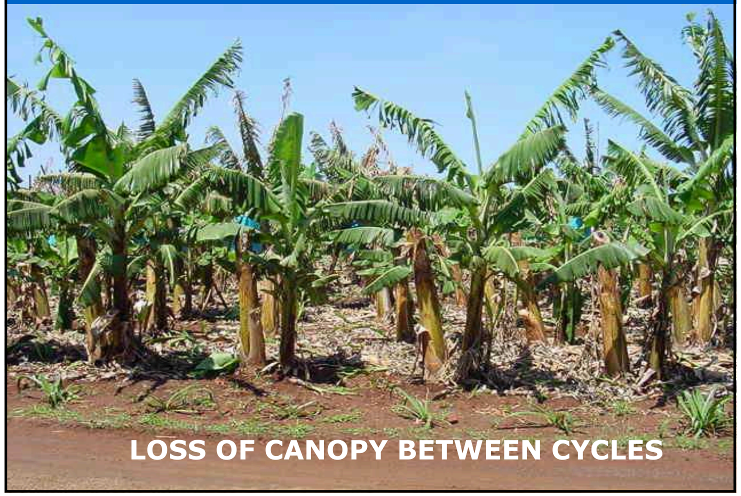
Planting Date: 15.10.1990
Cultivar: Williams

EARLY R1 SUCKER SELECTION



CONTINUITY OF CANOPY (P to R1)

LATE R1 SUCKER SELECTION



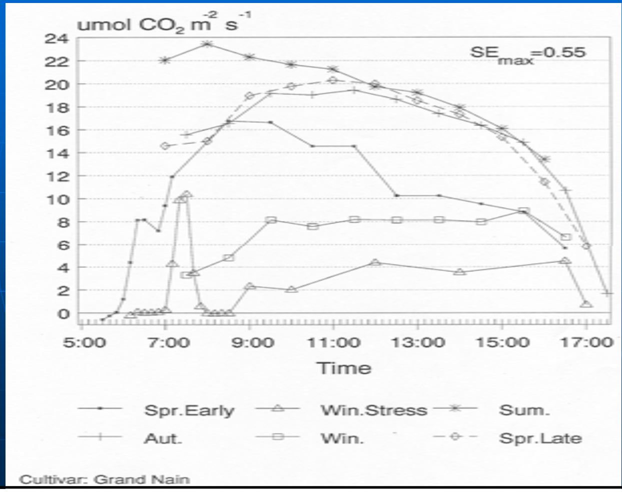
THANK YOU

NEXT LECTURE IS ON THE INFLUENCE OF EXTERNAL ENVIRONMENTAL FACTORS ON BANANA PHYSIOLOGY

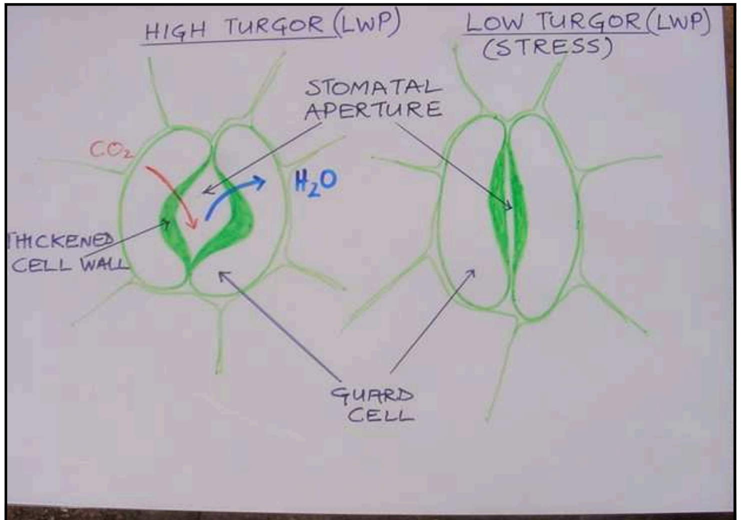
EXTERNAL ENVIRONMENTAL FACTORS

1. DIURNAL AND SEASONAL CLIMATIC EFFECTS IN THE SUBTROPICS

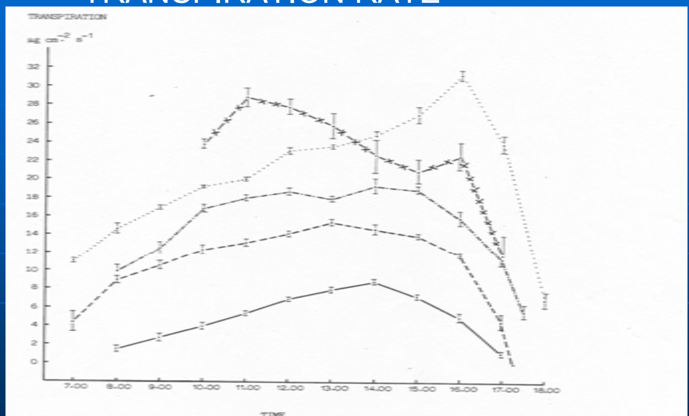
PHOTOSYNTHESIS RATE



STOMATAL MECHANISM

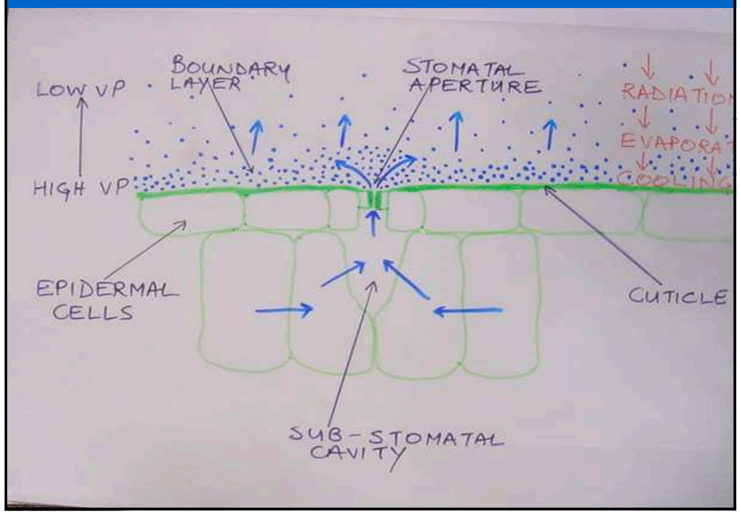


TRANSPIRATION RATE

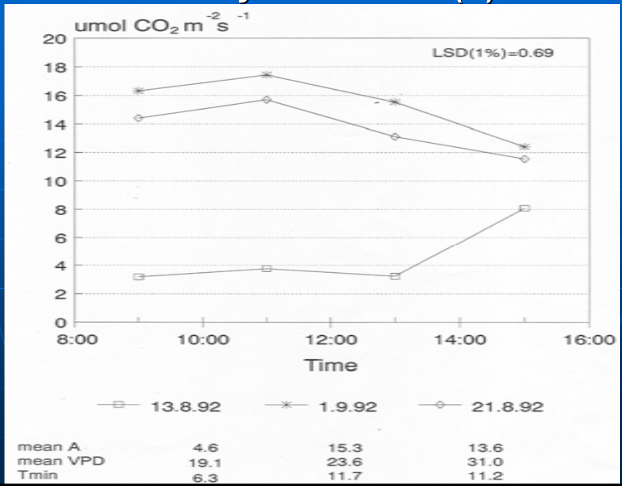


Tr time-course of 'Williams' banana over 4 representative cloudless days in summer, spring, autumn and winter at Burgershall, and of 'Dwarf Cavendish' banana on a hot summer day at Malelane. Soil moisture was at field capacity for all measurements. Each point is a mean of 10 uniform plants using a standardised measuring procedure. Vertical bars represent S.E. of the mean. · · · ·, summer; ·—·—·, spring; ·— — —·, autumn; ·———·, winter; ·—X—X—·, summer stress (Malelane).

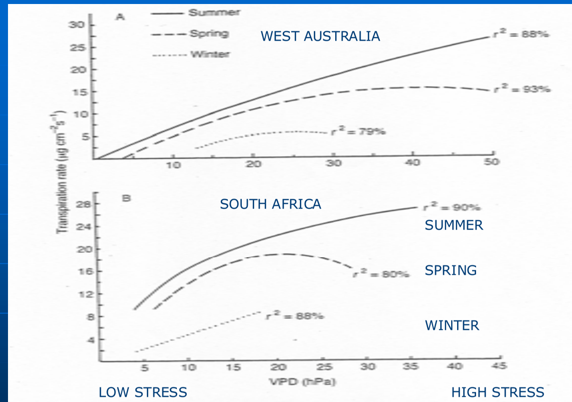
TRANSPIRATION MECHANISM



Photosynthesis Rate (A)

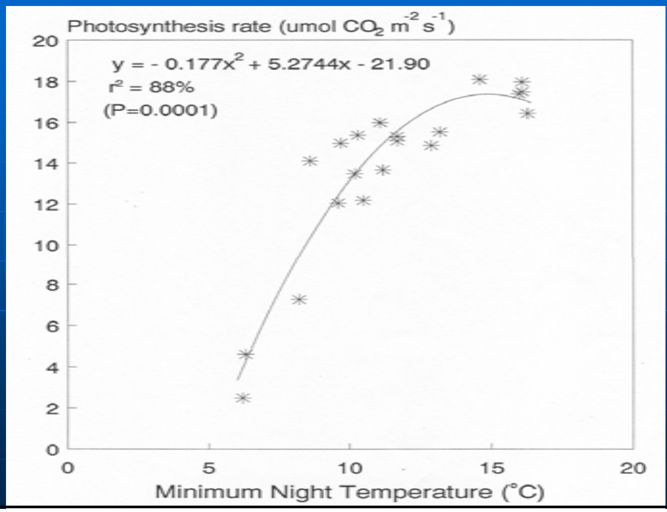


TRANSPIRATION AND VPD



The relationship between transpiration rate in AAA 'Williams' banana and diurnal changes in vapour pressure deficit (VPD) during summer, spring and winter, at (A) Carnarvon, Western Australia and (B) Burgershall, South Africa. The regression lines of best fit are very similar between these two subtropical localities. Data indicate that for a specific level of VPD, transpiration efficiency was greatest in summer, somewhat less in spring and very suppressed in winter, due to internal plant constraints resulting from cold night temperatures. Data for A and B redrawn from Hoffman (1990) and Robinson and Bower (1988) respectively.

EFFECT OF PREVIOUS NIGHT T min ON NEXT DAY Ps



MANAGEMENT - SUBTROPICAL SEASONS

1. **SUMMER - OPTIMAL CONDITIONS AND NEED INTENSIVE MANAGEMENT A/C TO PHENOLOGY**
2. **AUTUMN - INTENSIVE MANAGEMENT DUE TO WARM SOIL AND VIGOROUS ROOT GROWTH FROM PREVIOUS SUMMER**
3. **WINTER - MINIMAL MANAGEMENT. CLIMATE IMPOSES CONSTRAINTS WHICH CANNOT BE OFFSET. DO NOT WASTE INPUTS TRYING TO PROMOTE GROWTH.**
4. **SPRING - EARLY SPRING - MINIMAL MANAGEMENT DUE TO LOW SOIL TEMPS AND POOR LEAF CANOPY. INTENSIFY MANAGEMENT IN LATE SPRING**

2. PHOTOSYNTHETICALLY ACTIVE RADIATION (PAR)

LOSS IN Ps ACTIVITY OF CAVENDISH BANANA LEAVES IN SUMMER DUE TO REDUCED PAR FROM OVERCAST WEATHER AND LEAF SHADING

EXPOSURE	PAR RECEIVED	Ps RATE
(leaf 3,4 or 5)	µmol/m²/sec	µmol CO_2/m²/sec
SUNNY DAY	1974	17.2
OVERCAST DAY	477	11.4
SUNLIT LEAF (3)	1652	20.9
SHADED LEAF (4)	80	6.8

Ps RATE OF CAVENDISH BANANA LEAVES IN SUMMER IN RELATION TO PAR (WHILEY, 1993)

PAR RECEIVED	Ps RATE	% INCREASE
µmol/m²/sec	µmol CO_2/m²/sec	
500	12.2	
1000	17.3	42
1500	19.5	13
2000	20.3	4

OPTIMAL PAR BETWEEN 1500 AND 2000 µmol

Ps SEVERELY REDUCED UNDER 1000 µmol

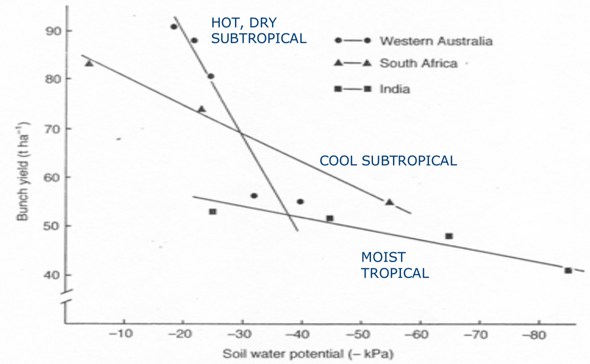
P/s RATE A/C TO PL DENSITY – (LEAVES EXPOSED TO LIGHT)

Density (pl/ha)	Photosynthesis rate (µmol CO_2/m²/sec)			
	20 May	16 July	21 August	26 August
2 222	12.9	10.3	13.0	15.4
2 777				14.2
3 333				15.5
4 444	13.5	9.7	12.3	
5 555				
6 666	6.6	7.7	8.2	

MANAGEMENT FOR PAR

1. CANNOT ALLEVIATE OVERCAST WEATHER. DRY AREAS = MORE SUN = GOOD FOR SUBTROPICAL LOCALITIES
2. AVOID HIGH DENSITIES – HIGH % LEAF SHADE > LOSS OF GROWTH POTENTIAL
3. AVOID DOUBLE ROW PLANTING SYSTEMS
4. KEEP SOIL WATER POTENTIAL HIGH TO MAINTAIN LEAF TURGOR AND FLAT LEAVES. FOLDED (WILTED) LEAVES INTERCEPT LESS PAR AND LESS Ps
5. IN S. HEMISPHERE PLANT ON NORTH FACING SLOPE TO INTERCEPT MORE PAR. ALSO HIGHER TEMP. SOUTH-FACING SLOPE FOR N. HEMISPHERE

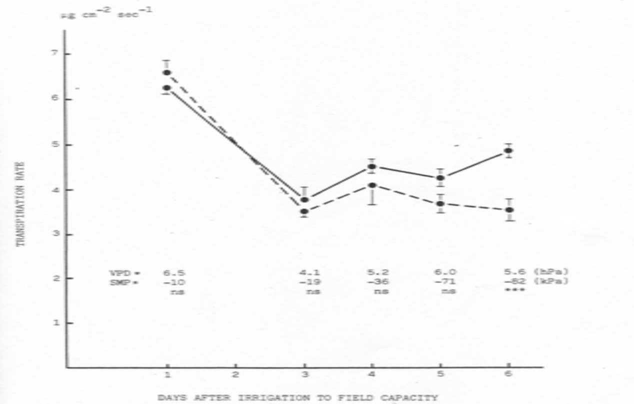
SWP x ENVIRONMENT ON YIELD



The interaction between soil water potential (SWP), bunch yield (t ha^{-1}) and environment, for AAA Cavendish subgroup bananas. Data from India are from a moist, tropical area in South India (Hegde, 1988), whereas data from Western Australia are from Carnarvon, a hot, dry area with no summer rain (Hill, 1990). Data from South Africa are from a cool, subtropical site with intermittent summer rain (Robinson and Alberts, 1986). Note that the yield response of banana to a reduced SWP is very severe in the hot, dry site, very mild in the moist, tropical site and intermediate in the cool, subtropical site.

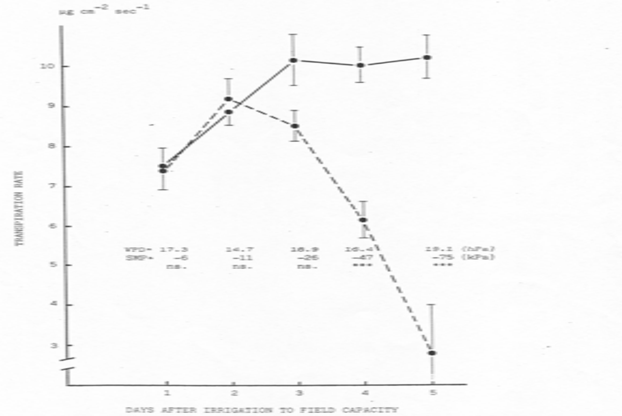
3. SOIL WATER POTENTIAL (SWP)

Tr IN RELN TO SOIL DRYING AT LOW VPD



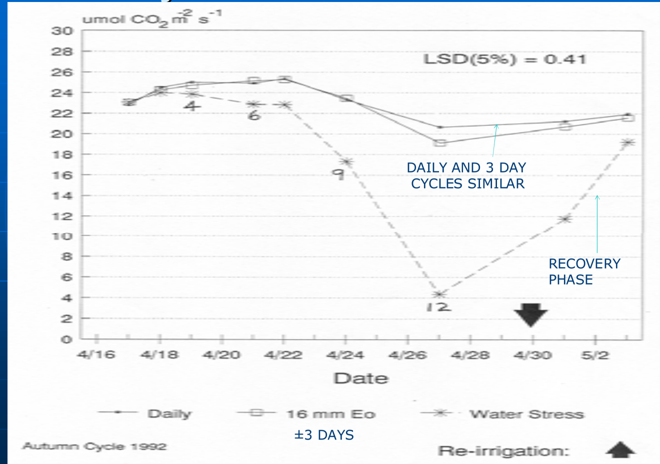
Transpiration pattern of 'Williams' banana plants under fibreglass cover grown in soil at continuous field capacity (solid line) and subjected to 6 days progressive drying (broken line), under mild conditions of VPD. Soil moisture potential (SMP) is a mean of 6 daily tensiometer readings in the progressive drying treatment. VPD calculated for maximum ambient tunnel temperature each day. n.s. and *** represent daily treatment differences as non-significant or significant at $P=0.001$, respectively (t-test). Each point is a mean of 6 replicate plants. Vertical bars represent S.E. of mean.

Tr IN RELN TO SOIL DRYING AT HIGH VPD



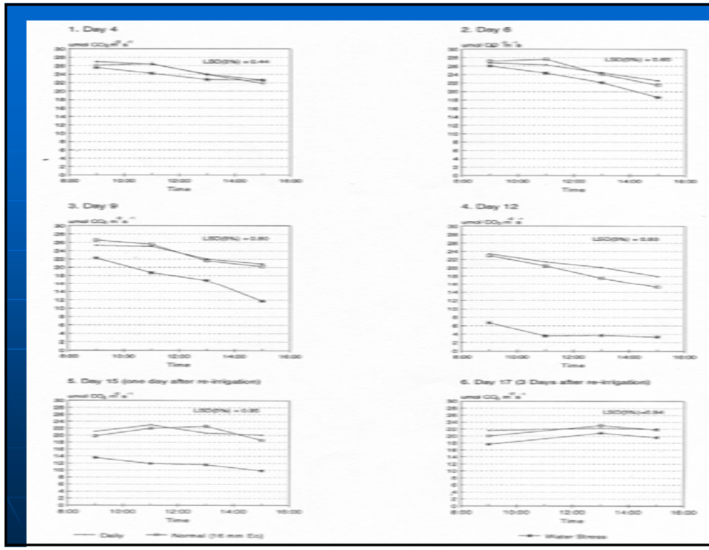
Transpiration pattern of 'Williams' banana plants under fibreglass cover grown in soil at continuous field capacity (solid line) and subjected to 5 days progressive drying (broken line) under enhanced conditions of VPD. Soil moisture potential (SMP) is mean of 6 daily tensiometer readings in the progressive drying treatment. VPD calculated for maximum ambient tunnel temperature each day. n.s. and *** represent daily treatment differences as non-significant or significant at $P=0.001$, respectively (t-test). Each point is a mean of 6 replicate plants. Vertical bars represent S.E. of mean.

Photosynthesis Rate – water stress



PHOTOSYNTHESIS AND SOIL WATER POTENTIAL

SOIL WATER POTENTIAL (kPa) (Autumn)	PHOTOSYNTHESIS RATE (µmol CO2 m^{-2}s^{-1})	PERCENTAGE REDUCTION IN Ps
a) Unstressed plants	26.4	
Stressed for 4 days (-12 k Pa)	24.2	8.3
b) Unstressed plants	22.6	
Stressed for 6 days (-25 k Pa)	18.6	17.7
c) Unstressed plants	20.8	
Stressed for 9 days (-53 k Pa)	11.7	43.8
d) Unstressed plants	18.0	
Stressed for 12 days (-70 k Pa)	3.3	81.6



MANAGEMENT FOR SOIL WATER

ONE ESSENTIAL RECOMMENDATION:-

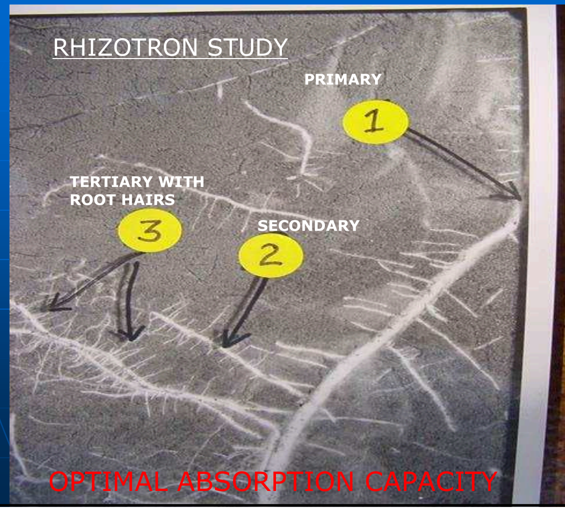
ENSURE SWP DOES NOT BECOME LOWER (MORE NEGATIVE) THAN -20kPa BETWEEN IRRIGATIONS AT ANY TIME OF THE YEAR.

TIME TAKEN TO REACH - 20 kPa DEPENDS ON:-

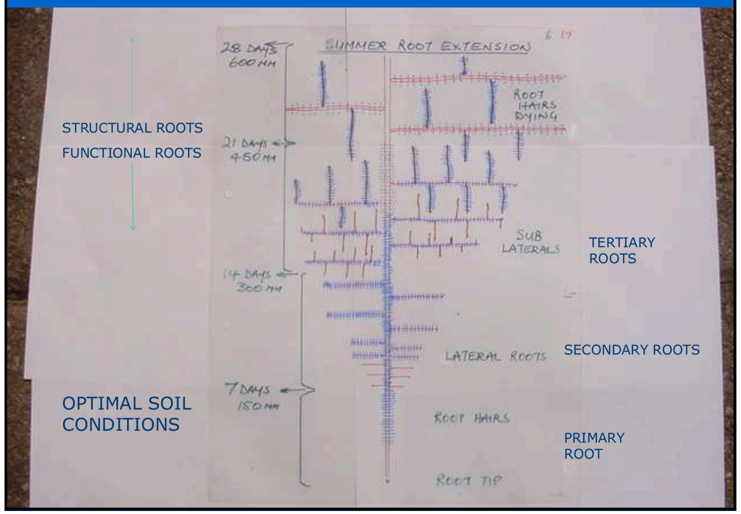
a) **SOIL TYPE (WHC)**
b) **CANOPY COVER (LAI)**
c) **EVAPORATIVE DEMAND (VPD)**
d) **FUNCTIONALITY OF THE ROOTS (CONSTRAINTS LIKE WINTER, COMPACTION**

IRRIGATE "LITTLE AND OFTEN" AND MONITOR SWP CONTINUOUSLY USING NEUTRON PROBE OR TENSIOMETERS

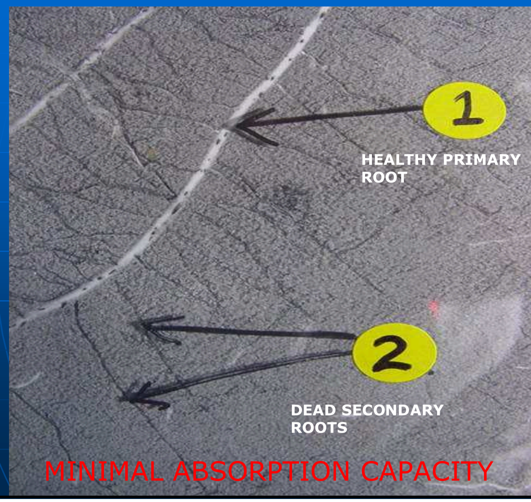
HEALTHY BANANA ROOTS – SUMMER CONDITIONS

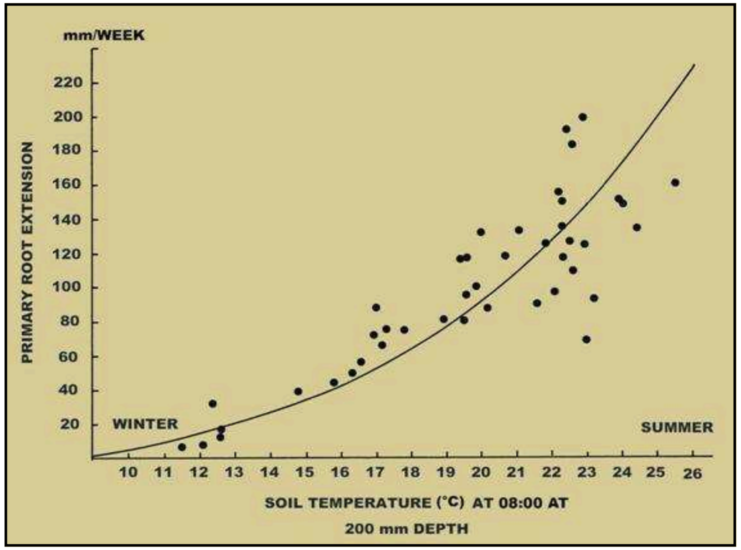


PRIMARY ROOT EXTENSION + FEEDER ROOTS



UNHEALTHY BANANA ROOTS – WINTER CONDITIONS





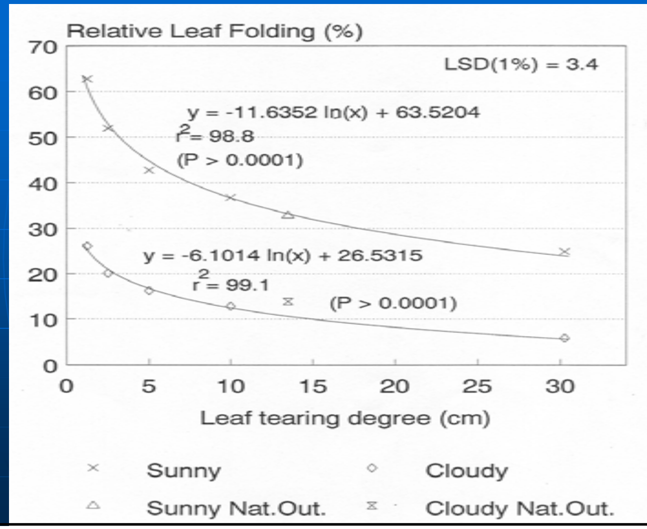
4. LEAF TEARING

AND

WIND DAMAGE

INFLUENCE OF EXPERIMENTAL LEAF TEARING INSIDE SHADECLOTH WINDBREAK, ON Ps OF DWARF CAVENDISH BANANA PLANTS

TEARING TREAT. STRIP WIDTH (mm)	P/SYNTH RATE µmol $CO_2/m^2/sec$	% REDUCTION
CONTROL (untorn)	20.5	
100 mm strips	20.4	0.5
50 mm strips	18.3	10.7
25 mm strips	16.5	19.5
12 mm strips	13.7	33.2
+/- 130mm strips (outside w/break)	16.7	18.5



1. LEAVES TORN TO 12 MM STRIPS; 2 = UNTORN LEAVES

NB TORN LEAVES FOLD EASIER AND DESICCATE QUICKER

INFLUENCE OF LEAF TEARING TREATMENTS INSIDE A WINDBREAK ON COMPONENTS OF YIELD OVER TWO CROP CYCLES

TEARING TREAT. STRIPS (mm)	PLANT TO R1 HARVEST (wks)	BUNCH MASS P + R1 (Kg)	YIELD/AN (t/ha/an)
12	138.5	59.4	37.5
25	136.0	62.9	40.4
50	134.4	69.2	44.9
100	135.6	69.4	44.8
CONT (untorn)	133.0	72.3	47.4
LSD (p=0.01)	2.5	3.2	2.3
CONT (outside) +- 130 mm	135.6	62.0	39.7

MANAGEMENT FOR WIND

1. CHOOSE HIGHER DENSITY IN WINDY AREAS
2. AVOID DOUBLE ROW PLANTATIONS BECAUSE THEY CHANNEL WIND
3. PLANT ON SLOPES FACING AWAY FROM PREVAILING WIND
4. USE A WINDBREAK IF ITS BENEFIT OUTWEIGHS SHADING EFFECT ??
5. USE PROPS AND BUNCH COVERS EFFECTIVELY
6. USE SHADE NETTING IN VERY WINDY AREAS

MAIN CONCLUSIONS

STUDIES ON Ps AND Tr HAVE GIVEN INSIGHT INTO INTERNAL CONTROL MECHANISMS AND RESPONSE TO EXTERNAL FORCES IN THE SUBTROPICS

MEASURES HOW THE PLANT "FEELS" AND THE SPEED AND INTENSITY OF REACTION TO STRESS

EARLY WARNING SIGNS OF INITIATION OF STRESS – SHOWS WHEN AND HOW TO REACT – THIS IS NOT POSSIBLE WITH YIELD TRIALS IN THE FIELD

SUGGESTS APPROPRIATE MANAGEMENT GUIDELINES

THIS RESEARCH WORK AND KNOWLEDGE GENERATED HAS UNIVERSAL APPLICATION.

IMPLICATIONS FOR CANARY ISLANDS

TENERIFE – MEAN MAX AND MIN TEMPS

	J	F	M	A	M	J	J	A	S	O	N	D
H	18	19	20	20	21	23	25	26	25	24	21	10
L	12	12	13	13	14	16	18	19	18	17	15	13
M	15	16	17	17	18	20	22	23	22	21	18	16
HU	31	42	93	90	120	180	248	279	240	217	120	62

TOTAL HEAT UNITS = 1722 = MILD SUBTROPICAL
HU (JUNE – OCTOBER) = 1164 (68%)
TOTAL HEAT UNITS B/HALL, S AFRICA = 2205
TOTAL HEAT UNITS COSTA RICA = 3800
HU FORMULA = (MAX+MIN)÷2-14 x No OF DAYS

THREE CRITICAL PROBLEMS IN THE TROPICS (high heat units)

1. TOO MUCH WATER WITH ALL ITS CONSEQUENCES
2. REDUCED LEVEL OF Ps ALL YEAR ROUND
3. BLACK SIGATOKA WITH ALL ITS CONSEQUENCES AND COSTS

THEY CANNOT DO ANYTHING ABOUT THESE !

TENERIFE – RAINFALL (mm/month)

J	F	M	A	M	J	J	A	S	O	N	D
66	55	42	31	11	5	1	3	13	41	69	75

TOTAL = 412 mm/yr
ONLY 63 mm FROM JUNE TO OCTOBER
(IRRIG CRITICAL DURING THIS PERIOD)
Compare - 3000-4000 mm/yr in Costa Rica

TENERIFE SUNSHINE (hours/day)

8 9 9 10 10 10 11 10 10 9 8 7

COMPARE WITH COSTA RICA = 4 to 5 hrs/day

THREE CRITICAL ADVANTAGES IN TENERIFE (low heat units)

1. HIGH Ps AND GROWTH POTENTIAL IN SPRING, SUMMER AND AUTUMN
2. EASE OF FIELD MANAGEMENT UNDER DRY CONDITIONS + NO DISEASES
3. ABILITY TO ENHANCE GROWTH AND YIELD POTENTIAL UNDER SHADEHOUSES (WIND PROTECTION)

THANK YOU