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AGENCY FOR INTERNATIONAL DEVELOPMENT
WASHINGTON, D.C. 20523

DATE: 10/2/88

MEMORANDUM

TO: AID/PPC/CDIE/DI, room 209 SA-18

FROM: AID/SCI, Victoria Ose

SUBJECT: Transmittal of AID/SCI Progress Report(s)

Attached for permanent retention/proper disposition is the following:

AID/SCI Progress Report No. 5 / V3

PR

Attachment

I. REGULATION OF CHILLING SENSITIVITY IN WARM-ZONE CROPS
AID PROJECT NO. 5.143

II. A REPORT SUBMITTED BY:

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III. WORK PERFORMED IN BRAZIL

EXPERIMENT A: Novel Storage Design For Field Maintenance of Sweet Potatoes.

1. Objectives: To evaluate post-harvest maintenance of sweet potatoes in a new storage system, and

To evaluate the long term field storage potential of five different cultivars of sweet potato.

2. Introduction:

Sweet potatoes are widely grown in Brazil and are an important part of the diet in Brazil, as well as other warm-zone countries. In the south of Brazil, the post harvest losses of sweet potatoes left in the field during the winter months are high due to frequent frosts which in combination with the rainy season, cause chilling injury and favors development of diseases.

The sweet potato is cultivated during the summer months (Dec to March). In the fall (around May) when the first frost occurs, the growers remove the vine for cattle feed, while the roots are left buried in the ground for later when prices are higher. When conditions of prolonged low temperatures accompanied by frequent rain persist crops located in flat land have to be harvested and sold to avoid further deterioration. Only those fields located in inclined areas can be spared from losses. However, these losses can be reduced if a good storage system is utilized.

In this study we aimed at evaluating the existing field storage conditions and post-harvest losses of five cultivars of sweet potatoes. Another objective was to develop a low cost storage system, which can effectively arrest the field chilling conditions.

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3. Materials and Methods:

Five cultivars of sweet potato including: Branca 1, Branca 2, Creme, Abobora and Roxa were obtained from local growers. The roots were cured for one week at 25°C and 95% relative humidity (R.H.). Afterward, approximately 2 kg of sweet potatoes were placed in nylon nets, immediately weighed, and stored in bambu silos for three months. These silos were constructed from bambu rods of approximately 1.20 meter in height, and were forced 10 cm deep in the ground next to each other in a circle. The top of rods were tied together forming a cylinder of 1.0 meter in diameter and then covered with dried weeds (Figure 1). Rice husks were piled 40 cm deep inside each silo to provide insulation from the soil temperature and moisture. The silos were then packed with alternating layers of sweet potato bags and rice husk (Figure 2). On top of each silo was placed a plastic cover to prevent water infiltration from the rain (Figure 3).

To measure temperatures of the storage system a set of thermocouples were installed. The first and third thermocouplers monitored the tubers temperature inside the silos. The second and forth thermocouplers monitored the silo temperature around the tubers. The fifth thermocoupler monitored the soil temperature next to the storage system.

Approximately 3 months later, the stored tubers were evaluated. The following parameters were measured: Percentage of weight-loss, firmness, disease, and general appearance and chilling injury. Chilling injury was estimated by the browning and loss of firmness of the treated tissues. These evaluations were done in three positions of each silo: top, middle, and bottom. Approximately 15 potato bags from each positions was used for evaluation.

4. Results:

The results in table 1 show that after 3 months in storage the following were obtained.

(1). Average weight losses were between 10 to 20% in all cultivars.

(2). Pest (mostly rodents) spoilage was mainly in cultivars Branca 2 and Creme. All other cultivars had none or lower incidence of pest attack.

(3). The cultivar Roxa had the highest incidence of disease, which was around 30%. The damage started from the bottom of the tuber and in some cases spread to the whole tissue.

(4). Two cultivars, Branca 1 and Abobora had high incidence of chilling injury. Except for these two cultivars all the other tubers had good appearance.

(5). Only the cultivar Roxa showed no sign of sprouting. All other cultivar showed less than 5 to 22% rate of sprouting.

The results in table 2 show some physical and chemical evaluation of all cultivars performed after the curing process. The usefulness of these measurements will be evaluated when the data gathering and analysis are completed.

EXPERIMENT B: A Study of Chilling Sensitivity of Five Cultivars of Sweet Potatoes Stored Under Controlled Temperature Conditions.

1. Objectives: To evaluate the chilling sensitivity of different cultivars of sweet potato.
To determine the length of time necessary to cause chilling damage in cold storage.

2. Introduction:

Sweet Potato are very sensitive to chilling temperatures. The chilling damage can occur in leaves and the roots while in the field or when stored for later consumption.

Other workers demonstrated that the degree of chilling damage depends on the temperature and the exposure time. Importantly, varieties differ in their chilling sensitivity.

We employed controlled cold storage conditions to test varietal response to chilling as basis for selection for field trials.

3. Materials and Methods:

Sweet Potatoes were harvested from local fields and allowed to cure for 48 hours. Some samples of the cured tubers were treated with Ionol, an antioxidant, and subjected to different regimes of chilling in refrigerated room at 5°C and 95% R.H. Samples were composed of approximately 2 kg of sweet potatoes placed in nylon net. Twenty two bags were separated and weighed. Half of them were wrapped with paper previously impregnated with 1.0% Ionol. Afterwards all bags were placed in cold storage. Bags were removed form cold storage after 2, 4, 8 hours and in longer term tests after 4, 8, 15 and 30 days. The samples were left to stand at room temperature for at least one week before evaluating for chilling injury.

4. Results:

The results from table 3 and 4 were obtained after exposing sweet potato to different regimes of chilling and allowing them to cure at room temperature for at least one week before analyses were made. Table 3 shows the degree of external chilling injury occurring in five cultivar of sweet potato after exposure to different chilling regimes. After 2 hours in cold storage all cultivars had some sign of chilling injury. After 4 hours, the cultivars Branca 1, Creme and Abobora showed a higher incidence of chilling injury. These cultivars were also highly sensitive to 2 hours of chilling temperatures.

Table 4 show the degree of internal chilling injury in five cultivars of Sweet Potato in cold storage. The cultivar Branca 1 and Creme showed higher

degree of internal chilling injury after 1 day. After 4 days in cold storage all cultivars were severely damaged by the chilling temperatures.

The antioxidant treatment (table 3) appears to ameliorate the external chilling injury symptoms (up to 15 days). After 30 days, however, no difference was noted between the treated and the untreated tubers (table 4). The antioxidant had no effect on the internal injury of the tubers.

The antioxidant treatment is in keeping with our hypothesis that oxygen activity may account for the chilling damage and accordingly antagonizing oxidation conditions may be beneficial. The antioxidant effect is reflected in some arrest of the chilling injury but only on the exterior of the tissue due to limited penetration. In future experiments, we will seek the use of a volatile antioxidant to allow maximal contact with and penetration into the bulk of the root tissue to extend the beneficial effect of the antioxidants. Also, atmospheric regimes (e.g., 1 to 2% oxygen) will be implemented to reduce the oxygen toxicity.

5. General Conclusions:

(1) The cultivars Branca 1 and Abobora showed higher sensitivity to chilling injury than the other cultivars when stored under field conditions or under controlled temperature conditions in refrigerated room.

(2) These cultivars may be an appropriate experimental material for testing antioxidants or other treatments for controlling chilling damage (in refrigerated storage).

(3) The cultivars Branca 2 and Roxa showed better potential then the other cultivars for long term storability under field conditions in an improved field-storage design. These cultivars will be recommended for production to local growers.

(4) A new and cost-affordable storage design appears to be an effective post-productin preservation method.

(5) Remedial treatments (antioxidants) for arresting the chilling stress show promise and will be further explored.

IV. WORK PERFORMED AT RUTGERS UNIVERSITY

1. Background

The research at Rutgers University is aimed at elucidating the basic mechanics of the chilling stress, by relating the chilling conditions to the onset of oxidative conditions which are persumably deleterious to tissues.

The working hypothesis views membrane lipid peroxidation as the origin of pathological membranal changes and furthermore, that lipid oxidation products may be the toxic oxidation agents. The process may be initiated by membrane destabilization due to the release of a lipase (a lipid hydrolase) activity

2. Results

We identified a proteinaceous lipase inhibitor in cotyledons of germinating cucumber seeds (a chilling sensitive tissue). Chromatographic methods are used to purify and characterize the lipase inhibitor. We discovered furthermore, that chilling temperatures lead to the de-activation of the lipase inhibitor. Hence, we may have the molecular basis for relating chilling conditions to the onset of lipid degradation and the subsequent toxicity resulting from lipid peroxidation. In future work, we will study:

(1) the time kinetics of the chilling-induced disappearance of lipase inhibitor and the accompanying emergence of lipase activity.

(2) Onset of lipid peroxidation as related to lipase activity.

(3) The mechanism of the temperature-deactivation of the lipase-inhibitor.

The process according to the above scheme is central to the whole process, since the release of lipolytic activity may set in motion membranes lipids degradation and peroxidation. The chilling induced inhibitor de-activation may be of a bio-physical nature (perhaps changes in the hydration state of the lipase inhibitor).

V. WORK PERFORMED BY OTHER COLLABORATIVE COUNTRY:

Report on the Panama collaboration was submitted previously. CATIE, Costa Rica was identified as a potential future collaborator to replace Panama. An October meeting (in Costa Rica) is scheduled for making the appropriate arrangement for joint work with Costa Rica.

VI. SUMMARY:

An important chilling-sensitive commodity (sweet potato) was selected for field studies.

Novel low cost storage design was tested for field post production maintenance of sweet potatoes and has shown promise.

Field and laboratory variety trials led to selection of chilling resistant cultivars which may be recommended for production.

Remedial treatments for chilling (with antioxidants) suggest that this direction may be viable and will be explored further.

Basic studies revealed that under chilling conditions membrane lipid degradation and subsequent peroxidation, may be initiated by the de-activation of a lipase inhibitor. Future studies will focus on the mechanism of the temperature de-acativation of the enzyme inhibitor, and the accompanying release and peroxidation of membrane lipids.

TABLE 1 - Post Harvest Losses of Sweet Potatoes Stored Under Improved Field Conditions During the Winter of 1988

CULTIVAR*		Percent Weight loss	Percent Change Pest Spoilage	Percent Fungus spoilage	CHILLING INJURY** (Percent)			GENERAL APPEARANCE *** (Percent)			SPROUT (Percent)
					low	medium	high	good	average	bad	
	A	18.08	0	4.63	35.71	50.00	7.14	92.85	7.14	0	5.22
BRANCA 1	B	20.11	0	2.68	28.57	42.85	28.57	78.14	7.14	7.14	2.14
	C	16.14	0	5.24	21.42	42.85	28.57	71.42	28.57	0	0.81
	A	13.38	7.65	2.04	21.42	0	0	100.00	0	0	0
BRANCA 2	B	13.13	6.38	10.31	0	0	0	92.85	7.14	0	3.97
	C	12.23	7.85	9.92	0	0	0	100.00	0	0	0
	A	18.18	11.67	2.21	0	0	0	100.00	0	0	4.62
CREME	B	14.89	20.71	4.76	7.14	0	0	100.00	0	0	2.77
	C	15.07	17.66	0	7.14	0	0	100.00	0	0	3.53
	A	14.66	0	7.97	15.38	3.84	30.76	46.15	3.46	7.59	14.17
ABOBORA	B	16.84	1.50	11.43	14.28	50.00	35.71	42.85	50.00	7.14	2.85
	C	14.98	3.21	7.57	35.71	14.88	50.00	50.00	57.14	35.71	4.90
	A	14.32	1.02	33.33	7.14	0	0	100.00	0	0	0
ROXA	B	12.51	0.89	29.94	0	0	0	100.00	0	0	0
	C	10.11	0	31.32	0	0	0	100.00	0	0	0

*A = Upper part of the silo
B = Middle part of the silo
C = Bottom part of the silo

**Low = < 10% chilling injury
Medium = Between 10-30% chilling injury
High = > 30% chilling injury

*** Good = more than 70% of roots had good appearance
Average = Between 40-70% of the roots had good appearance
Bad = Less than 30% of root had good appearance

Table 2 Physical and Chemical Changes in Five Cultivars of Sweet Potato After Harvest and Curing.

CULTIVAR	TOTAL ASH Percent Fresh Tissue Weight	MOISTURE Percent Fresh Tissue Weight	SHEAR PROSS Kg/mm^2
BRANCA 1	0.77	56.11	5.9
BRANCA 2	0.77	54.42	7.3
CREME	0.68	54.75	5.5
ABOPORA	0.62	58.96	5.9
ROXA	0.56	57.94	4.8

Table 3 - Degree of external chilling injury in five cultivars of sweet potatoes after different time exposure in cold storage (5°C 90% RH) with and without Ionol (an antioxidant)

	Chilling time													
	2 HOURS		4 HOURS		1 DAY		4 DAYS		8 DAYS		15 DAYS		30 DAYS	
CULTIVARS	-	+	-	+	-	+	-	+	-	+	-	+	-	+
BRANCA 1	1	x	2	2	1	1	2	1	2	2	3	3	3	3
BRANCA 2	1	x	1	1	1	1	1	1	2	2	2	1	3	3
CREME	1	x	2	2	1	1	2	2	1	1	2	1	3	3
ABOBORA	1	x	2	2	1	1	1	1	2	1	3	3	3	3
ROXA	1	x	1	1	1	1	1	1	2	1	2	1	3	3

- = Minus Ionol

+ = Plus Ionol

0 = No chilling injury

1 = Less than 10% chilling injury

2 = Between 10-30% chilling injury

3 = More than 30% chilling injury

Table 4 - Degree of internal chilling in five cultivars of sweet potato after different exposure of time in cold storage (5°C 90% RH) with and without Ionol (an antioxidant).

	Chilling time													
	2 HOURS		4 HOURS		1 DAY		4 DAYS		8 DAYS		15 DAYS		30 DAYS	
CULTIVARS	-	+	-	+	-	+	-	+	-	+	-	+	-	+
BRANCA 1	3	3	3	3	3	3	3	3	3	3	3	3	3	3
BRANCA 2	1	1	1	1	1	1	2	2	3	3	2	2	3	3
CREME	3	3	3	3	3	3	2	2	3	3	3	3	3	3
ABOBORA	2	2	2	2	2	2	2	3	3	3	3	3	3	3
ROXA	1	1	1	1	2	2	2	3	3	3	3	3	3	3

- = Minus Ionol

+ = Plus Ionol

0 = No chilling injury

1 = Less than 10% chilling injury

2 = Between 10-30% chilling injury

3 = More than 30% chilling injury

LEGEND FOR THE COMBINED FIGURES
Number 1, 2, and 3

Figure 1 (top) shows the use of bambu for the construction of a storage silo for sweet potatoes.

Figure 2 (middle) is a top view of the silo packed with alternating layers of rice husks and sweet potato roots (in nylon nets).

Figure 3 is view of the finished and functional silo with plastic cover for shielding against rain.

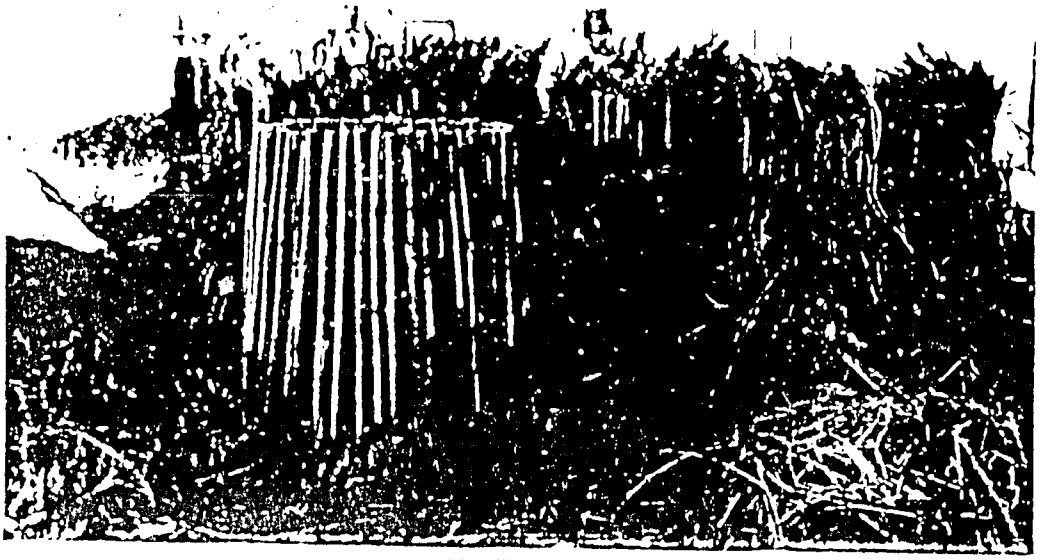

FIG. 2

FIG. 3