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Developing Fruit and Vegetable Production in the Comayagua Valley

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A Progress Report

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Introduction

This project was initiated in November 1982 with the purpose of examining alternative systems for the production of vegetables for processing in the Comayagua valley. The ultimate goal of the project has been to explore methods to improve cultural practices to ensure a more reliable source of raw product to sustain an established processing plant which has operated in the valley for approximately 12 years. Primary emphasis has been directed to processing tomato production which represents the major commodity currently being grown for processing in the Comayagua valley.

The first requirement to initiate this project was to develop the logistical support required to develop a relevant research effort. The lack of public research facilities in the valley oriented to production research on processing crops necessitated developing these facilities and support equipment and personnel with the cooperating private sector (Agricola de Honduras). Recently, participation by the public sector in Honduras (Recursos Naturales) has been secured and an effective "working team" has now been formed to carry out the proposed work. The following personnel are directly involved with the project:

Marco Alvarez - Galaxia S.A. de C.V.

Sakae Mogoshi - Agricola de Honduras

Freddy Maradiaga - Recursos Naturales

G.E. Wilcox - Purdue University

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In addition, equipment, some supplies and labor has been provided by Agricola de Honduras. It is felt that the major logistical needs to successfully carry out the project are now in place. Secural of a small tractor with support

equipment to give greater flexibility in research planning and implementation would be desirable to minimize dependence on Agricola de Honduras and ensure that operations are carried out on a timely basis.

Tomato Research (1982-1983)

Several experiments were completed during the 1982-1983 tomato cropping season. By design, these experiments were kept simple in order to examine the effects of single variables on yield and crop development. During the second year of the project, the intent is to examine the effects of multiple variables on yield, emphasizing those variables to which large responses were obtained in the first year.

A. Land Preparation Study:

A preliminary and relatively crude study was performed to compare conventional with deep land preparation prior to crop establishment. Two 35′ wide strips were disc plowed as deeply as possible with available equipment. This area and 2 adjacent "conventionally prepared" areas were then direct seeded with the varieties Napoli and UC 82 using equipment provided by Agricola de Honduras. Subsequent crop management from seeding to harvest was identical to that practiced by Agricola de Honduras. Two 20 foot lengths of row in each of 4 land preparation areas were designated for harvest to estimate yield differences from land preparation. Harvest was initiated on March 15 and completed April 6. Results of this study are given in Table 1.

This study confirms earlier suggestions that soil compaction and land preparation represent a major barrier to successful tomato production on many soils in the Comayagua valley. A single "pass" with a disc plow prior to seeding increased yields from 18.2 tons/Mz to 25.2 tons/Mz without any additional changes in crop culture and management. Improved crop development

was evident with deep land preparation as early as 4 weeks after planting and these differences persisted through harvest. As a consequence, the practice of disc plowing prior to seeding has been adopted by Agricola de Honduras for the 1983-84 season.

The major effect from deep land preparation appears to result largely from increased fruit number rather than larger fruit size (Table 1B). Further studies are planned in 1983-84 to more carefully quantify response to land preparation and examine its interaction with fertilization and irrigation practices.

B. Fertilization Studies:

Two studies were completed to examine crop response to applied nitrogen and phosphorous. Nitrogen rates were varied from 0 to 160 lbs/A (Table 3) and P rates from 0 to 200 lbs/A (Table 2). In addition, all treatments received approximately 27 lbs/A of P banded under the row at the time of seeding. Applied N and P in contrast, were broadcast incorporated into beds prior to bed formation. All other cultural practices were identical to those used by Agricola de Honduras.

Results of these studies are given in Tables 2 and 3. No yield response was observed from applied P (Table 2) and only minor yield improvements were obtained from applied N (Table 3). Foliar analysis from 4 week old seedlings from the P rate study (Table 4) indicated adequate levels of all major nutrients (except possibly Mg) in the test area. Results clearly suggest that in both of these studies, factors other than crop fertility are limiting yields. Crop development in both experimental areas was excellent to 7-8 weeks after seeding at which time premature yellowing and wilting of the developing seedlings occurred. It is suspected that the primary cause for this

developmental abnormality was a high incidence of Phytophtora root rot caused by Phytophtora parasitica and/or Phytophtora capsici. This disorder results in atrophy and ultimately death of the root system which virtually stops crop development and dramatically reduces yields. Losses are controlled by crop rotation and careful soil and water management. Since the areas on which these studies were conducted had been planted to tomato for several previous seasons and had not been disced deeply prior to seeding, we feel that a major cause for the high incidence of this disorder was a result of high disease inoculum and poor water infiltration into soils in the affected area. The adjacent area which had been "deep disced" prior to seeding showed a much lower incidence of this disorder with correspondingly higher yields. As suggested earlier, better land preparation prior to planting is essential to facilitate both fertility and water management. Subsequent studies of land preparation will emphasize the intraction between land preparation and fertilization and water management. In addition, studies are planned to explore chemical methods for control of the devastating effects of Phytophtora root rot.

C. Herbicide Studies on Direct Seeded Tomatoes:

Weed competition has become a serious problem in direct seed established tomato plantings in the Comayagua valley. Nutsedge and sandbur occur almost universally in areas used for tomato production. In addition, several broadleaf weeds and grasses may interfere with crop development in some areas. The objective of these 2 studies was to examine preemergence and postemergence herbicides on direct seed established tomatoes with particular emphasis on materials which provide full season grass control and suppression of early nutsedge development.

In the first experiment set out on 12-1-82, nine treatments including preemergence and postemergent applications of commonly used tomato herbicides were compared with an untreated control (Table 5a and b). Each treatment was replicated 5 times in 25′ single bed plots. Weed counts were taken 4 weeks and 8 weeks after planting and a final rating of weed populations were made at the end of the season using a numerical rating scale (1=no control, 5=complete control). One half of each experimental unit was manually weeded for yield measurements, however, due to a severe infestation of Phytophtora root rot, it was decided that yield comparisons would be meaningless. As a consequence, only weed control data is given for this study. A second experiment including only those preemergence treatments which appeared useful in experiment 1 was established on 1-5-83 (Table 6).

Experiment one (Table 5a) showed that none of the herbicides reduced plant stand or vigor compared with the untreated plants. Grass control and broadleaf control was generally improved by all treatments at 4 weeks (5a) and also at 8 weeks (5b) compared to untreated plots. The devrinol and tillam treatments gave excellent control of grass and broadleaves. Nutsedge control was poor as expected at both rating dates for all herbicides, but treatments containing tillam, although not reducing nutsedge numbers, did result in severe stunting and suppression of nutsedge growth compared to other treatments. The suppression of nutsedge growth is important for providing a competitive advantage to the tomato plants. Weed ratings supported the weed number data as all herbicides except sencor or sencor + poast resulted in significantly better overall weed control. Sencor treatments were the least effective treatments.

The second preemergence test on direct seeded tomatoes (Table 6) resulted in similar results as experiment 1. Treatments with tillam suppressed nutsedge growth and tillam combinations with enide or devrinol resulted in excellent grass and broadleaf control.

These 2 experiments have provided a base for future weed control trials on direct seeded tomatoes in Honduras. The early season suppression of nutsedge allows for a more competitive tomato plant. This suppression is important for hand hoeing operations, as a healthy vigorous tomato seedling is not as susceptible to hoeing damage as a weak seedling growing among vigorous nutsedge plants. Grasses especially sandbur have been shown to be easily controlled by these preemergence treatments and control is now possible with devrinol and/or enide.

D. Transplant Population Study:

Crop establishment by transplants is an alternative to direct field seeding. When weed control complicates crop establishment by direct seeding, transplants are often preferred to allow the crop to develop ahead of competing weeds. The objective of this study was to demonstrate the feasibility of crop establishment by transplants and examine the response to 2 planting patterns which result in similar plant populations but different spacing between rows (twin versus single rows).

This study was planted January 6, 1983 using transplants from the adjacent land preparation plot which had been seeded on December 2, 1982 (i.e. 5 week old seedlings). The experimental area was deep disced and fertilizer broadcast manually in the area of beds (100 lbs N/A, 150 lbs P/A) prior to bed formation. Beds were formed using equipment provided by Agricola de Honduras. Transplanting was done manually using a spade to place plants to the proper depth. Plants were pulled just prior to planting and approximately 1 pint of water was applied to each plant immediately after planting to minimize wilting. The entire area was furrow irrigated 4 days after planting.

Two planting patterns were compared. The first involved the conventional pattern used with direct seeding (Fig. 1) whereas the second involved use of the "dead bed" which gave approximately equidistant spacing between rows (Fig. 1). Yield results of this study are given in Table 9.

Dramatically higher yields were obtained using single rows with equidistant spacing (30") than by using twin rows 12-14" apart on beds with 60" between centers (32.3 tons/Mz vs. 20.7). Further, this study clearly demonstrates the feasibility of crop establishment by transplanting and obtaining adequate stands and competitive yields when compared with direct field seeding. To be successful, however, land must be well prepared and personnel involved in the planting operation properly trained to ensure that planting is carried out to guarantee high survival and rapid recovery and growth following transplanting.

E. Response of Transplant Established Tomatoes to Starter Fertilizer:

This study was carried out to determine the response to starter fertilizer applied in transplant water at the time of planting (January 6, 1983). Land preparation, fertilization and transplanting were carried out as in study D with 2 major differences. Single rows were used with 60" row spacings and 2 liquid fertilizer treatments were compared with a water control applied at approximately 1 pint per plant at the time of planting. Liquid fertilizer treatments included diammonium phosphate (DAP: 16-46-0) at a rate of approximately 1 lb/5 gal. H_2O and starter fertilizer (10-52-17) at a similar rate.

No major differences were observed between the 3 treatments in transplant recovery and/or growth rate. It was assumed that fertilizer applied in the beds prior to planting adequately met early transplant needs such that no response occurred to the incremental increase in fertilizer applied via transplant water.

F. Chemical Weed Control on Transplant Established Tomatoes:

A preliminary study was carried out to examine preemergence weed control on transplant established tomatoes. Land preparation, fertilization and transplanting were carried out as in D except that single rows on 60" centers were used for all treatments. Herbicides were applied after bed formation but prior to planting and incorporated manually using a rake. Weeds were manually removed in 1/2 of each plot and left in the remaining half for weed count data. The total area was harvested 3 times beginning March 15, 1983 and concluding April 6, 1983. Results are given in Tables 7 and 8.

Weed control was excellent in all herbicide treated plots (Table 7). Nutsedge control was not significantly improved by the herbicides, but early season suppression was evident in all treatments containing tillam. Grass control and broadleaf control was excellent in all herbicide treated plots and the weed rating data supports the effectiveness of the herbicide applications. Yield data (Table 8) was quite variable, but general trends indicated slight yield increases in plots treated with herbicides.

The transplant test resulted in several important findings. The use of transplants in a situation where a difficult to control weed such as nutsedge exists results in a competitive advantage to the crop. The tomato plant in a transplant situation grows fast and can form a shading canopy to inhibit the growth of nutsedge. This advantage is not possible in the direct seeded tomatoes where the tomatoes and nutsedge emerge at the same time. With the use of nutsedge suppressing herbicides such as tillam the competitive advantage of the tomato is magnified. Further tests during 1983-84 will help in refining the tomato transplant cultural system in Honduras.

G. Tomato Variety Observation Trial:

Twenty varieties were direct seeded January 2, 1983 in single row plots to compare performance with varieties currently in use. Several of the varieties under observation possessed resistance to race 2 of Fusarium wilt. It was suspected at that time that this new race might be present in the valley and be contributing to crop losses.

At approximately 10 weeks after seeding, this area was severely affected by a rapid yellowing and wilting of virtually 100 percent of the plants. Symptoms were most severe at the lower end of the field, however, plants of virtually all cultivars succumbed to the disorder. Symptoms and conditions for expression (high soil moisture) suggested Phytophtora root rot which had also occurred in an adjacent trial area and commercial adjacent fields. An isolate of Fusarium from plants in commercial fields showing similar for pathogenecity against 3 cultivars (susceptible to Fusarium and resistant to races 1 and 2). Pathogenicity could not be demonstrated. As a consequence, it appears that the disorder observed in the trial area, as well as in several commercial plantings, probably represents Phytophtora root rot rather than a new race of Fusarium. Symptomology and conditions under which the disease appears more closely resemble Phytophtora root rot.

Studies are urgently required to establish control measures against this disorder. Plans are being made for 1983-84 to examine cultural and chemical treatments to reduce the incidence and severity of this disorder.

As a result of this disorder, evaluations of this trial area were not possible.

H. Land Preparation and Rotation Crop Studies (April-October, 1983):

Land areas destined for 1983-84 tomato research were selected in April, 1983 and chisel plowed at that time. In addition, 4 distinct soil types were selected and prepared for land preparation studies to be carried out in 1983-84. Spring land preparation studies included the following treatments:

1. No chisel plowing
2. Chisel plowing in one direction
3. Chisel plowing in two directions
4. Chisel plowing in three directions

One of the four areas was left fallow for the summer months (May-October) and the remaining 3 land preparation areas planted to sorghum, corn and soybeans, respectively. If possible, response of the summer crops to land preparation will be quantified before planting these areas to tomatoes. These areas will then be used in 1983-84 to examine the interaction of land preparation with fertilization and irrigation practices on tomato crop development and yield.

Accomplishments

1. A team of research and production expertise has been formed representing the private sector (Agricola de Honduras), an Honduran public agency (Recursos Naturales) and a U.S. Institution (Purdue University) to carry out project goals. It is felt that the major logistical needs to implement the proposed project are now in place.
2. Preliminary research carried out in 1982-83 has allowed for prioritization of research needs during the term of the project. Studies in 1982-83 have shown the following:
    a) Dramatic responses in crop development and yield result from simple improvements in land preparation.

b) Little or no yield response to applied fertilization occurs with inadequate land preparation where soil compaction prevents normal root development. A disorder very similar to Phytophtora root rot may occur under compacted soil conditions and appear to be the major factor contributing to the observed small yields response to applied fertilizers in the present study.

c) Several preemergent herbicides (most notably devrinol and tillam) provide good suppression of major problem weeds in direct seeded and transplanted tomatoes. With such suppression, manual control of weeds should be facilitated.

d) Crop establishment with transplants is a viable alternative to direct field seeding. Dramatic yield responses were observed using single rows at 30 inch spacings as compared with the conventional system using twin rows 12-14 inches apart on 60 inch centers. Adequate land preparation, preplant fertilization and development of effective plant production and planting techniques are required to successfully establish the crop by transplants.

e) A major and longer term effort than is possible under this project will be required to develop rotation and land use programs to more effectively use, maintain and conserve the land resources in the Comayagua valley. A major effort will also be required to modify irrigation practices in conjunction with changes in land preparation to more efficiently use applied water and reduce erosion losses during furrow irrigation. Preliminary studies will be initiated in 1983-84.

f) Hand equipment for crop establishment and cultivation has been purchased for evaluation in 1983-84. Quotes have also been

obtained on a small tractor and support equipment. The intent is to design a prototype unit which can be adapted to fit the cultural needs of the crop as determined by experimental results (e.g., row spacing, fertilizer placement, land preparation and cultivation, etc.). Where feasible, small hand equipment will be adapted for use by small scale producers and to utilize the large labor pool available in the area.

Needs

1) Improved communications and assignment of project responsibilities must be developed among the participating individuals and agencies. It is hoped this can be accomplished in early 1983-84.

2) A mechanism to effectively communicate results of these studies is required. It is hoped that participation by Recursos Naturales will provide an effective dissemination system to potential users of information derived from this project.

Table 1. Response to deep land preparation on tomato yield in Comayagua, Honduras (1982-83).

A. Yield (tons/Mz)

Variety	Deep Range	Deep Avg.	Shallow Range	Shallow Avg.
Napoli	17.0-30.6	25.5	7.9-22.4	18.0
UC 82	19.7-29.5	24.8	(1 row only)	21.3
Average		25.2		18.2

B. Fruit Size (wt/100 fruit)

Variety	Deep	Shallow
Napoli	10.1	9.9
US 82	13.3	12.6 (1)

Seeded 12/2/82

Harvested 3/15/83 to 4/6/83

Table 2. Yield response of processing tomatoes to soil applied phosphorous in Comayagua, Honduras (1982-83).

Phosphorous rate (lbs/A)	Yield (tons/Ha) 1	2	3	4	Mean
0	7.9	13.4	12.8	10.6	11.2
50	15.2	11.3	9.7	6.0	10.5
100	6.6	6.7	9.8	13.1	9.0
150	10.7	5.8	10.8	12.9	10.0
200	14.9	11.7	5.6	14.5	11.7
Average	10.9	9.8	9.7	11.4	

Seeded 12/2/82

Harvested 3/15/83

Table 3. Yield response of processing tomatoes to soil applied nitrogen in Comayagua, Honduras (1982-83).

Nitrogen rate (lbs/A)		Yield (tons/Mz)				
Preplant	Sidedress	1	2	3	4	Mean
0	0	9.4	6.4	9.7	11.0	9.1
40	0	11.0	10.7	8.8	7.8	9.6
80	0	7.8	12.7	13.8	9.3	10.9
120	0	13.8	14.4	13.9	8.7	12.7
160	0	10.2	9.9	16.9	–	12.3
80	40	11.4	15.1	11.0	12.2	12.4
80	80	10.6	14.5	16.6	9.8	12.9
40	80	11.1	15.1	11.2	10.7	12.0
Average		10.6	12.3	12.7	9.9	

Seeded 12/2/82

Harvested 3/15/83

Table 4. Composition of tomato seedlings (4 weeks) from Comayagua Valley as influenced by various phosphorus treatments.

Treatment[1] P in bed lbs/A	Composition (% dry wt.) whole plant N	P	K	Ca	Mg
0	4.2	.80	5.2	2.6	.41
50	4.4	.87	5.1	3.0	.43
100	4.2	.93	5.2	3.2	.43
150	4.6	.90	5.1	2.8	.42
200	4.5	.95	5.2	2.7	.38
28 day old seedling from O'Neall Farm	4.2	.45	4.2	2.9	.79

[1] In addition to the P in the beds all treatments received 27 lbs P/A banded under the row at seeding. (704 mg P/ft row).

Table 5a. Weed control response with preemergence herbicides applied to direct seeded tomatoes at Comayagua, Honduras (1982-83)[1].

Treatment 12-1-82	lbs/A (ai)	Plant stand	Plant vigor	Nutsedge	Grass	Purse lane (1-4-83)	Venus mallow
				# weed/ft			
1. Control	-	58	6.4	23	19 b	1.8 bc	7
2. Devrinol	1	64	7.0	30	3 a	0.8 abc	3
3. Devrinol	2	54	2.8	25	.4 a	2 c	4
4. Enide	6	73	6.4	22	6 a	0.4 ab	5
5. Enide	8	51	6.4	28	6 a	1 abc	4
6. Devrinol+Tillam	1+3	56	4.4	26	1 a	0 a	.2
7. Devrinol+Tillam	2+6	45	7.6	22	1 a	0.2 a	1.2
		N.S.	N.S.	N.S.			N.S.

[1]Means within columns followed by a different letter are significantly different at the α=.05 level.

[2]Vigor rating based on 1=plants dead, 10=plants healthy.

Table 5b. Weed control response with preemergence and postemergence herbicides applied to direct seeded tomatoes at Comayagua, Honduras (1982-83)[1].

Treatment	lbs/A (ai)	Nutsedge	Grass	Venus mallow	Weed control rating[3] (2-10-83)
		# weeds/ft (2-10-83)			
1. Control	-	26 bc	24 a	4 bc	1.0 e
2. Devrinol	1	37 ab	4 b	4 bc	2.7 ab
3. Devrinol	2	41 a	1 b	3 bc	2.8 a
4. Enide	6	38 ab	5 b	3 bc	2.7 ab
5. Enide	8	41 a	4 b	2 c	2.6 abc
6. Devrinol+Tillam	1+3	35 abc	2 b	1 c	1.9 bcd
7. Devrinol+Tillam	2+6	32 abc	2 b	2 c	2.8 a
8. Sencor	.5	23 c	35 a	10 a	1.2 de
9. Sencor+Poast	.5+.2	29 abc	24 a	5 bc	1.8 cde

[1]Means within columns followed by a different letter are significantly different at the α=.05 level.

[2]Treatments 1-6 applied 12-1-82, treatments 8 and 9 applied 1-5-83, treatments 2-5 received sencor 1/2 + poast 1/5 on 1-5-83.

[3]Rating based on 1=no control, 5=total control.

Table 6. Weed control response with preemergence herbicides applied to direct seeded tomatoes at Comayagua, Honduras (1983).

Treatment 1-5-83	lbs/A (ai)	Nutsedge	Grass	Other
		# weeds/ft (2-10-83		
1. Control	-	9	31 a	5 a
2. Tillam	6	4	6 b	2 b
3. Enide+Tillam	8+6	3	1 b	1 b
4. Devrinol+Tillam	1+6	4	5 b	2 b
5. Devrinol+Tillam	2+6	4	2 b	0 b
		N.S.		

[1]Means within columns followed by a different letter are significantly different at the α=.05 level.

Table 7. Weed control response with preemergence herbicides applied to transplanted tomatoes at Comayagua, Honduras (1983).

Treatment 1-5-83	lbs/A (ai)	Nutsedge	Grass	Other weeds	Total weed control rating (2-10-83)
		# weeds/ft (2-10-83)			
1. Control	-	3 ab	39 a	4	1.7 c
2. Treflan	3/8	4 ab	6 bc	4	2.7 bc
3. Treflan	3/4	8 a	2 c	3	2.0 bc
4. Devrinol	1	5 ab	11 b	3	3.2 ab
5. Devrinol	2	5 ab	3 c	1	4.0 a
6. Tillam	6	2 b	7 bc	1	2.2 bc
7. Treflan+Tillam	3/8+6	1 b	1 c	1	2.8 bc
8. Treflan+Tillam	3/4+6	2 b	1 c	1	2.8 bc
9. Devrinol+Tillam	1+6	2 b	4 bc	2	2.5 bc
10. Devrinol+Tillam	2+6	3 ab	1 c	1	3.2 ab
				N.S.	

[1]Means within columns followed by a different letter are significantly different at the $\alpha = .05$ level.

[2]Rating based on 1=no control, 5=total control.

Table 8. Yield response of transplanted tomatoes to preemergent soil applied herbicides at Comayagua, Honduras (1983).

Treatment	lbs/A (ai)	Yield (tons/Mz) Replication 1	2	3	Mean
1. Control	-	17.2	20.1	13.5	16.9
2. Treflan	3/8	9.5	19.8	11.1	13.5
3. Treflan	3/4	17.7	18.6	19.4	18.5
4. Devrinol	1	17.9	17.5	24.4	19.9
5. Devrinol	2	27.6	18.7	18.1	21.5
6. Tillam	6	22.4	15.9	24.3	20.9
7. Treflan+Tillam	3/8+6	22.8	20.1	18.0	20.3
8. Treflan+Tillam	3/4+6	21.0	28.7	11.7	20.4
9. Devrinol+Tillam	1+6	23.1	16.5	15.2	18.3
10. Devrinol+Tillam	2+6	23.5	11.4	19.6	18.2

Table 9. Yield response in tomatoes to twin versus single rows in Comayagua, Honduras (1982-83).

Planting pattern	Total yield tons/Manzana				
	1	2	3	4	Mean
Twin rows (60")	18.0	25.9	16.3	22.5	20.7
Single rows (30")	25.4	31.7	37.9	34.4	32.3

Transplanted - January 6, 1983

Harvested (3x) - March 15-April 6