1959-60 $1.69 per crate
1960-61 $1.71 per crate

Thus, in three of the five seasons, the average farm price was less than $2.00 per crate. One of the five seasons was a freeze year with inevitable short supply and high prices.

In comparison, the economic conditions or average farm prices per crate since the industry organized its programs have been as follows:

1961-62 $3.47 per crate
1962-63 $2.10 per crate
1963-64 $2.83 per crate
1964-65 $2.47 per crate
1965-66 $3.12 per crate

It should be noted that 1961-62 was also a freeze year. There was a short supply of approximately 7,000,000 crates which contributed to the $3.47 average price per crate. Conversely, last season, 1965-66, the average per crate price was $3.12, yet, a little over 8,000,000 crates were marketed. This was the greatset number of crates of celery ever shipped during any season from the State of Florida.

For the past five seasons farm prices have averaged over $2.00 per crate. Call it luck, coincidence or offer any other explanation as no one particular reason can be singled out as the sole factor. However, it is the longest period of consistant and reasonable returns ever experienced by the industry. Such did not occur until the industry developed the will and desire to work together for their mutual benefit. This espirit de corps is the key to market strength—a conviction or willingness to work together for the same aim or objective. Without this starting point, it is impossible to proceed on any sound basis or with any longevity. In addition, there must be a willingness by members of an industry to take the bad along with the good, as well as a readiness to give up a certain amount of individual freedom to undertake independent action. In any program, many of the actions and decisions are not equitable as applied to each individual's immediate situation; however, over a period of time, advantageous actions and decisions have a tendency to balance or offset inequities that might occur in the marketing program.

Therefore, the individual must be satisfied with the results in the long run rather than the daily short-run aspects. There must be a willingness to accept the day to day problems of working together, realizing fully that you do not get something for nothing. You must carry a fair share of the load as well as be ready to make sacrifices as may be required. Otherwise, do not encourage or give indications that you are making a team approach to marketing problems.

None of us can predict what the future holds for produce groups. The past should be viewed only as lost opportunities to guide us. With the present trends in marketing, however, it would appear that the path pioneered by the Florida Celery Industry could be a guide or aid in the future for other commodity groups who are seeking market strength. Already, similar or modified programs incorporating one or more of the features of the celery program have been utilized by the Florida sweet corn, pole bean and watermelon industries. Many such market efforts will be tried and will fail. Mountain tops are not reached on every attempt; yet, where a sincere desire exists, the mountain can be mastered the same as with basic marketing problems if the will to do so exists.

USE OF PLASTIC STRIPS OVER FERTILIZER BANDS TO REDUCE LEACHING[1]

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Abstract

Elevated plant beds, necessary for rapid water drainage from around roots in most sandy soils, promote serious leaching of certain nutrients. Work with narrow plastic strips was begun in an effort to reduce leaching at minimum cost where full bed cover with plastic is

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not feasible. Studies on the number and placement of plastic strip covered fertilizer bands in plant beds indicate one band 2-3 inches deep in the bed center, or two bands 16 inches apart are best. Comparisons of 10-inch wide strip plastic, full bed cover with plastic and the standard method of split-applications of fertilizer without plastic are reported. Test crops were transplanted tomatoes and field seeded onions.

Strip plastic plots produced higher tomato yields than did full bed cover and the standard method of applying the fertilizer in three applications without plastic. Fertilizer banded at time of seeding and covered with strip plastic produced much higher onion yields than the same treatment without plastic. However, highest onions yields were obtained without plastic from plots receiving the same fertilizer in equal amounts at 2-week intervals during plant growth, due probably to better placement in relation to onion root development.

Introduction

Leaching of nitrogen, potassium, and certain secondary and trace elements is a major problem in the sand soils of Florida. The cost of fertlizers washed away during periods of heavy rainfall represent only part of the loss to vegetable crop growers. Untimely rains reduce the rates and upset ratios of nutrients, and often result in lower yields and quality. Most of south Florida's sandy soils are underlain with a strata of hard-pan, clay or marl which is rather impervious to water. This sub-soil makes possible more effective irrigation, by preventing rapid downward movement of water. However, in order to protect plant roots from water damage, rather high plant beds are used. While elevated beds promote rapid drainage from around roots, the rain water removes large quantities of soluble fertilizer as it seeps out of the beds into the water furrows and is removed from the field.

Growers have been able to reduce losses from leaching by applying the fertilizer in smaller amounts periodically as the crop develops, by replacing leached nutrients, an by using natural organic sources of nitrogen. However, these methods increase cost, and it is difficult to determine the optimum replacement rates of the various fertilizer elements. In addition, there are periods of temporary deficiency between the time of leaching rains and the *availability of* replaced nutrients.

Recent research in Florida has shown the value of plastic film in greatly reducing the amount of leaching of soluble fertilizers. These studies were with wide strips of black polyethylene which completely covered the plant beds. In order to use the full bed cover system, land must be level, and a high water table maintained. The use of full bed cover with plastic will probably increase on those farms which have serious soil disease, nematode and weed problems because it makes fumigation more effective, provides protection from "ground rot" of crops such as tomatoes and cucumbers, and is a good method of weed control. However, the cost of plastic film and land leveling may prove excessive if the only need is to prevent leaching of fertilizer. Therefore, a less expensive method of solving the leaching problem is needed. A technique of banding fertilizer and covering it with 10-inch wide strips of black plastic has been investigated during the past few years. The results of the study are discussed in this report.

Experimental Methods

Experiments were conducted on Immokalee fine sand. Test crops were onions and unstaked tomatoes. Treatments were replicated 4 or 5 times in randomized blocks. Individual plots consisted of a single bed containing one or two rows of tomatoes and two or four rows of onions. Tomatoes were transplanted and onions were transplanted or field seeded. Tomato transplants were watered with ½ pint of starter solution (6 lbs. of 10-52-8 per 100 gal. water). Plant color and vigor ratings were made in some tests, and yield data were obtained in all experiments. All plots received an equal amount of major, secondary and trace elements. The method of applying the fertilizer, the location of plants on beds and the use of plastic were variables.

A description of (A) strip plastic, (B) full bed cover with plastic, and (C) split applications of fertilizer without plastic cover follows. (A) *Strip plastic.*—Plant beds were made by means of bedding disks and a bed press. The beds were about 10 inches high and 42 inches wide at the top, with slanting shoulders ending in a water furrow on each side of the beds. The bed centers were 7 feet apart. Just before field

seeding onions, one-fifth of the fertilizer was broadcast on the surface of the beds and incorporated to a depth of about 2 inches. The balance of the fertilizer was placed in bands under plastic strips. For transplanted crops, all fertilizer was placed in bands under plastic strips just prior to transplanting.

One or two furrows per bed were made to a depth of 2 or 3 inches. The single furrows were located (1) in the center, (2) 4 inches off center, and (3) 8 inches off center of the beds. Double furrows were located 8 inches to each side of the bed center, or 16 inches apart. Fertilizer was placed in the furrows and covered with about 1 inch of soil, leaving a shallow furrow to each side of the fertilizer band. Ten-inch-wide, 1.5 mil black plastic strips were placed over the fertilizer band in an inverted "U" fashion and the edges secured by pushing soil over them. (See also Figures 1 and 2)

(B) *Full bed cover with plastic.*—Plant beds were made as described for strip plastic, but the fertilizer and plastic were placed before final enlargement of the beds to full width. Before laying plastic, the fertilizer was placed in bands about 3 inches below the bed surface and 3 inches inside each bed shoulder. The location of fertilizer inside the bed shoulders was to insure against the soil drying out around the fertilizer bands, but to keep the fertilizer high enough to prevent leaching during periods of heavy rainfall. The 5-foot-wide black plastic covered the 30" bed top and extended over the slanting shoulders to slightly below the bottom of the water furrows. The beds were then enlarged by throwing soil to the shoulders against the plastic.

(C) *Split applications of fertilizer without plastic cover.*—This treatment was included as a standard for comparison with the single application of fertilizer at time of planting over which was placed the strip or full bed cover plastic film. For tomatoes, twenty percent of the fertilizer was incorporated in narrow beds just prior to transplanting. The balance of the fertilizer was applied in two equal amounts on the bed shoulders just prior to bed enlargement as "side-dress" and "lay-by" applications as the plants developed. This method is called "three-split application" in this report. The fertilization of seeded onions was similar, except that the second and third increments were applied in furrows made beside the onion rows in the wide beds. An additional treatment for seeded onions was 20 percent of the fertilizer incorporated in the bed surface just prior to seeding, followed by 10 equal applications of the balance at two-week intervals. The 10 applications were placed in shallow furrows between the rows of onions.

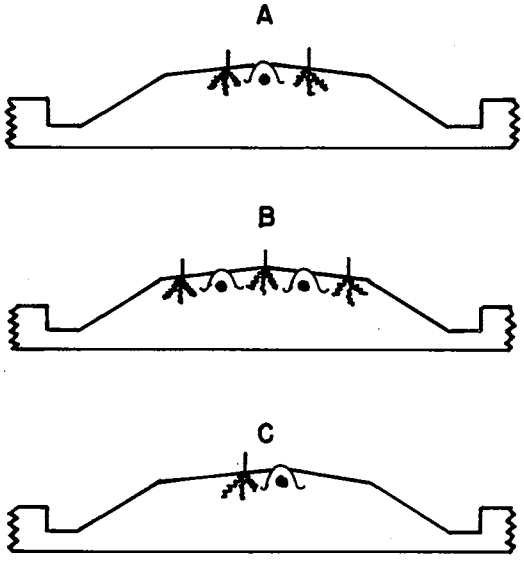

Fig. 1.—Diagram showing shape of bed and placement of fertilizer, plastic strips over fertilizer and plants. A—one band located in center of bed, crop planted 8 inches each side. B—two bands 16 inches apart, one center row, or three rows planted. C—one band located 4 inches off center, crop planted 8 inches from band.

Results

Tomatoes (transplanted).—In the Fall 1965 test, Homestead-24 tomatoes transplanted September 21 were harvested four times between December 17 and January 10. Several leaching rains fell during the experiment with heaviest rainfall in late October and early November. Color ratings made November 8 showed the three-split application treatment without plastic to be a paler green, indicating nitrogen deficiency. Yield data listed in Table 1 show highest yields from plots with one covered fertilizer band located in the center of the bed, and from plots with two plastic covered fertilizer bands, one 8 inches to each side of the bed center. In the Spring 1966 trial, Homestead Elite tomatoes transplanted February 2 almost froze a few days later and suffered a prolonged period of

cold weather. More plants failed to survive transplanting in plots with beds completely covered with plastic than in other treatments, and therefore, required more resetting. Heavy rains fell only during the last half of February, before the three-split application plots without plastic had received their first side-dressed fertilizer. Leaching, therefore, was not a great factor in this experiment. The tomatoes were harvested four times between May 3 and 16. Highest yields (Table 2) were obtained from plots having one or two plastic strip covered bands of fertilizer. The lower yield from the plots with a full bed cover of plastic may have been partially due to the heavier resetting necessary following the prolonged cold weather. It is of interest to note there was more than a 10-fold difference in the percent of *fruits with* graywall between the full bed cover with plastic and the no plastic, three-split application plots. The strip plastic plots were intermediate in amount of graywall.

Onions (seeded).—Texas Grano 502 onions seeded the week of November 11, 1963, were harvested April 28, 1964. The crop was grown during a fairly wet season. It became obvious that the 1/5 of the total fertilizer which was broadcast and incorporated in the plant bed before seeding was leached beyond the root zone, or inadequate to promote good plant growth. The seedlings became yellow and stunted in all plots except those which received side-dress and lay-by applications, and those which were fertilized each two weeks. The better growth from the

Fig. 2.—Method used in covering banded fertilizer with plastic strip. Top left—Fertilizer placed in furrow and covered lightly with soil. Top right—Furrow each side of band for burying sides of plastic. Bottom left—Plastic strip is placed over fertilizer. Bottom right—Fertilizer and plastic in place. Bed ready for final enlargement and planting.

Table 1. Yields of tomatoes from use of plastic covered fertilizer bands, Fall, 1965

Fertilizer placement in plant bed*/	10-inch plastic strip over fertilizer band	Lbs. per acre Total**/	Graded+/
Center band	yes	45,400	22,800
Band 8" one side of center	yes	31,600	16,500
Band 8" each side of center	yes	43,800	18,800
3-split applications	no	28,400	16,400

*/ 200-400-400 lbs. of N, P_2O_5 and K_2O per acre. Banded fertilizer about 2 inches deep.
**/ Total of four harvests. Culls plus graded.
+/ Total of first three harvests. Culls out.

Table 2. Tomato yields and percent graywall from plots containing strip, full bed cover and no plastic over fertilizer, Spring, 1966

Fertilizer placement*/	Plastic over fertilizer bands	Lbs. per acre Total	Graded	Percent of fruit with graywall 1st & 2nd harv. Ripes & Pinks	3rd harv. Mature greens
Two bands 16" apart	10-inch strips	46,500	19,900	31	7
One band 4" off center	10-inch strip	38,800	22,800	24	4
Two bands 16" apart	Full bed cover	31,300	15,800	5	2
3-split application	none	35,500	13,000	51	28

*/ 200-400-400 lbs. of N, P_2O_5 and K_2O per acre. Banded fertilizer about 2 inches deep.

Table 3. Onion yields and plant color rating from plots receiving two rates of fertilizer in bands with and without strip plastic, and from plots receiving split fertilizer applications. 1963-64

Fertilizer placement*/	Lbs. 4-8-8 per acre	10-inch plastic strip	Lbs. per acre Total	Lbs. per acre Graded	Color rating April 9**/
Banded in bed center before seeding	2,500	yes	22,600	18,900	1.8
Same	5,000	yes	34,900	27,300	3.0
Same	2,500	no	16,700	13,300	1.4
Same	5,000	no	19,100	14,200	1.4
2-split applications as side-dress & lay-by	2,500	no	32,300	25,800	5.0
200 lbs. each 2 weeks for 20 weeks	2,500	no	39,300	26,400	4.2

*/ All 2,500 lbs./acre plots received 500 lbs. incorporated in bed surface and 2,000 lbs. as described in table, and 5,000 lbs./acre plots received 1,000 lbs. incorporated, and 4,000 lbs. banded.

**/ Color rating: 1 = poor (yellowish-green with dead tips), 5 = excellent (deep green color).

Table 4. Onion yields and sizes from plots with and without strip plastic over banded fertilizer, and from plots receiving split applications. 1965-66

Fertilizer placement in plant bed*/	10-inch plastic	Lbs. per acre Total	Lbs. per acre Graded	Onion size (lb.)
2 bands - 16" apart	yes	30,000	25,600	.159
2 bands - 16" apart	no	5,900	3,100	.032
500 lbs. at seeding 200 lbs. ea. 2 wks. for 20 wks.	no	55,400	48,100	.281

*/ 2,500 lbs. of 8-8-8 per acre. Plots also received 200 lbs./acre of Magamp with K (7-40-6) incorporated in bed surface before seeding.

mutiple fertilizer applications was probably due to better fertilizer placement, as well as the replacement of leached nutrients following rains. The poor early growth in plots receiving all fertilizer in a band in the center of the beds at time of seeding resulted in a sharp reduction in yield (Table 3). At both rates of banded fertilizer, those plots with 10-inch plastic strips over the fertilizer yielded much higher than the same treatments without plastic. However, the split-application and bi-weekly application treatments without plastic produced much higher yields than comparable rates of fertilizer applied in bands and covered with plastic at seeding.

Onions seeded October 1, 1965 also became yellow and stunted soon after emergence even though treated with 200 lbs. per acre of Magamp with K (granulated magnesium, ammonium potassium phosphate, 7-40-6). This material was applied in broad bands in the seeding zone, and incorporated to a depth of about one inch just prior to seeding. Because of inadequate fertilizer available to the onion seedlings, roots were delayed in reaching the banded fertilizer. The yield data in Table 4 show a six-fold yield increase where the 10-inch strips of plastic were placed over the banded fertilizer as compared with the same fertilizer treatment without plastic. This difference reflects the protection against leaching provided by the plastic as shown in Figure 3. However, the highest yield was obtained from plots receiving 20 percent of the fertilizer incorporated in the bed at time of seeding, followed by 8 percent applied every two weeks for 20 weeks.

Discussion

The use of strip plastic over banded fertilizer in sandy soils is promising as a method of re-

Fig. 3.—Onion plots, top, received same fertilizer treatment. Top left, fertilizer bands without plastic. Top right, with plastic strips over fertilizer bands. Bottom left, transplanted onions, and bottom right, transplanted cabbage on beds containing plastic covered fertilizer bands.

ducing leaching and increasing yields of transplanted tomatoes. Preliminary trials with transplanted onions and cabbage indicate that these crops may also do well under this system (Figure 3). An important consideration is to locate the banded fertilizer deep enough in the plant bed to insure adequate moisture at all times, but high enough to prevent free water from moving through it. This would generally be in in the center of the bed at a depth of 1 to 3 inches below the bed surface. A slight crown to the bed would aid in run-off of water away from the banded fertilizer during heavy rainfall.

Advantages of strip plastic over full bed cover with plastic include (1) much lower cost of material, (2) strips are not blown away during hurricane winds, (3) beds will absorb rainfall and overhead irrigation, and (4) supplementary fertilizer can easily be applied outside the plastic strip if needed. Since cultivation is not possible near the plastic strips, chemical weed control must be used in weedy fields. Full bed cover with plastic also has advantages over strip plastic: (1) aids in fumigation of soil for nematode and disease control, (2) effectively controls most weeds, (3) aids in prevention of bed erosion, and (4) protects fruits from decay caused by soil borne diseases.

The trials with seeded onions were not as successful as those with transplanted tomatoes. This was primarily due to the distance of the banded fertilizer under plastic from the seed drill. The supplementary fertilizer applied outside the plastic strip and near the drill was not adequate, and rains leached the nitrogen and potassium before the plants developed roots into the banded fertilizer zone. As a result, the deficient seedlings made very slow growth until the roots finally reached the banded fertilizer. Root systems of individual plants reached the fertilizer at different times, and this resulted in nonuniform growth and bulb size. It appears that for seeded onions the strip plastic technique must be supplemented with several applications of fertilizer placed near the plants until the roots have reached the banded fertilizer beneath the plastic.

EFFECT OF PLASTIC MULCH ON THE YIELD OF SEVERAL VEGETABLE CROPS IN NORTH FLORIDA[1]

H. H. BRYAN[2]

Many investigators (1, 2, 3, 4. 7, 8) have shown the advantage of using plastic mulch to retain soil moisture, prevent nutrient leaching, provide weed control, reduce insect and disease damage, and increase earliness, yield and quality of certain vegetable crops. Locascio and Thompson (6) showed that increasing levels of fertilizer increased strawberry yields. Most commercial growers in North Florida, however, have not used plastic mulches and indicate little or no knowledge of the product.

Preliminary tests were conducted in 1964 to study the effects of black, clear, and white on black polyethylene mulches on the yield of pole beans, cantaloupes, Southern peas, squash, sweet potatoes and watermelons. Experiments in 1965 were carried out to determine if fertilizer levels had any effect on yields of cantaloupes, cucumbers, okra, pole beans, summer squash, butternut squash, sweet potatoes and watermelons grown on various types of polyethylene mulches. Variety trials with broccoli, cabbage, cauliflower and lettuce were grown with no mulch and with black polyethylene mulch in the fall, 1965. All experiments were conducted on a Ruston loamy fine sand soil at the North Florida Experiment Station, Quincy.

MATERIAL AND METHODS

1964 Experiments.—Six vegetable crops were seeded or transplanted through black, clear, white on black mulches and in unmulched check plots. Fertilizer as recommended in the "Commercial Vegetable Fertilization Guide" (Agricultural Extension Circular 225, University of Florida, Gainesville, Florida) was applied in bands 8 inches to each side of the bed center and covered with soil prior to application of the

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