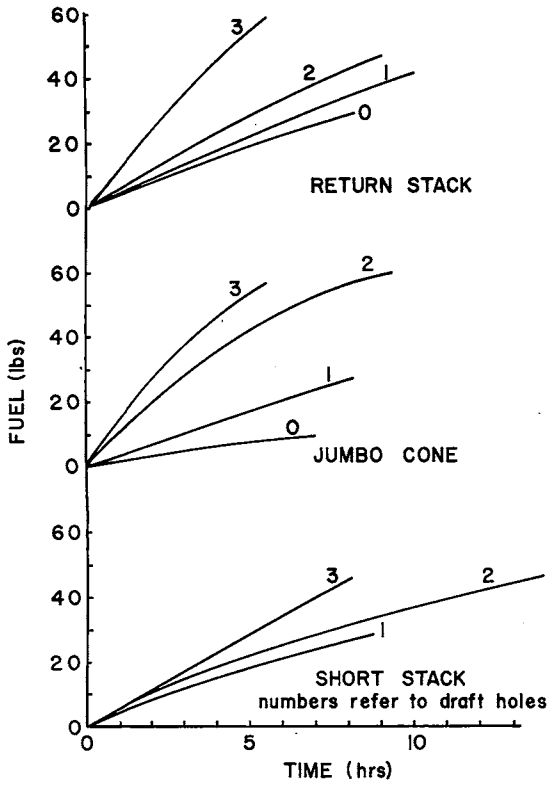

Figure 3.—Typical values of rates of fuel combustion for 'Return Stack,' 'Jumbo Cone' and 'Short Stack' heaters fueled with fresh, clean No. 2 diesel fuel oil.

Thus, the values obtained for radiant heat production may be slightly higher than one could expect under field conditions. These results are certainly not exhaustive, but they generally agree with the results obtained elsewhere, and the comparative since all were evaluated under essentially similar conditions.

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WHAT, HOW AND THE GROWER

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Problems in agriculture have been more numerous than have been solutions thru the years. This applies to citrus as with other crops. Florida's position in this regard has been unique. Infertile soils and a climate favorable to the development of insect and disease pests are basic problems in the citrus producing areas of the state. They are so basic, in fact, that Florida's agricultural scientists were called upon early in the development of the citrus industry to work on the problems of poor soil productivity and the serious entomological and pathological disorders of which so many were peculiar to the area. In quick succession many and varied additional problems confronted the citrus industry and these too required solutions. Budgetary problems existed along with the production problems. This resulted in insufficient technical manpower to keep abreast of all of the problems as they arose. In spite of these limitations the story of agricultural research in Florida is a success story unsurpassed in any other part of the world and the Florida citrus industry owes its very existence to its agricultural researchers.

As indicated above, problems arose faster than solutions and the county agent, being close to the growers in his county, was familiar with

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their problems. As new research results became available he quickly brought them to the attention of his growers thru so-called "method" and/or "result" demonstrations.

Some types of demonstrations were conducted by county agents to help find answers when research was lacking. One value of these so-called "fact-finding" demonstrations was to give researchers leads as to what growers felt were problems requiring investigation.

In the decades between 1910 and 1930 lime fell into disrepute on grove soils as fruit yields declined and tree condition deteriorated following its use. As yields declined to the vanishing point fertilizer manufacturers prepared special soil amendments which included hardwood ashes, rock phosphate and bonemeal. These usually gave favorable results. Coincident with the lime scare there developed the widespread problem of "bronze-leaf" which was especially severe on ridge soils in seedy varieties and during the fall months of the year. Growers were considerably alarmed. In the fall of 1932 Dr. Wilmon Newell, Director of the Florida Agricultural Experiment Stations and Extension Service, called county agents of the citrus counties to his office for a conference on "bronzing". The following summer demonstrations were put out in groves thruout the state to determine if varying calcium and phosphorus levels might improve grove conditions, particularly the acute "bronzing" or "copper leaf" symptoms. Mr. K. C. Moore, retired Orange County agent, reported in March, 1933 tests were put out in several Orange County groves. The plots contained: (1) a check, (2) dolomite imported from Tennessee, along with the growers' usual fertilizer practices, (3) Ocala ground limestone with the growers' usual fertilizer practices and (4) Ocala limerock with the growers' fertilizer practice less phosphorus. These trials were put out by the county agent with the advice of E. F. DeBusk, then Florida Extension Service citrus specialist and Dr. O. C. Bryan, then Professor of Soils at the University of Florida. Mr. Moore reports that by the fall of 1933 foliage in the dolomite plot in the Karst Grove showed slight but definite improvement in contrast to the other plots in the trials and that by the fall of 1934 the improvement was so pronounced that news of it spread thruout the state.

The Karst Grove gave the first recorded response of citrus to magnesium in Florida (although Averna-Sacca had reported on its essentiality to citrus in Brazil in 1912). DeBusk and Bryan published on this in 1936*. By 1938 all researchers working with the problem were getting responses to bronzing from applications of magnesium thru dolomite and later, soluble magnesium, and county agents in all citrus counties were conducting demonstrations full speed ahead on the use of dolomite and soluble magnesium to control bronzing of citrus, improve cover crops and bring up the soil pH without adversely affecting the availability of other nutrients. The use of dolomite went from zero tons per year in 1930 to a half million tons per year in 1960.

(Although we were unable to find a reference to it in the literature, both K. C. Moore and J. R. Winston of the USDA have told us of their knowledge of a statement of the late Dr. P. Phillips of Orlando made in the late '20's that "double manure salts were the best source of potash for citrus because this source keeps my trees green and they do not take on the bronze color in the Fall." No mention was made of magnesium, but this was likely the "greening" factor.)

The mottle-leaf or 'frenching" of citrus is another story of considerable interest and the discovery that zinc would control this condition was of great importance. Chandler and associates in California had shown that zinc would control "frenching" in 1933 and 1937 Camp and Reuther of the Lake Alfred Experiment Station staff demonstrated its value in this regard in Florida.

Bart and Hughes of the USDA at Orlando demonstrated that manganese would correct the typical mottle-leaf symptoms of citrus exhibited by manganese deficient foliage.

Copper was known to prevent ammoniation and die-back in citrus as far back as 1900, but it was the work of Haas and Quayle in California in 1935 that showed it was necessary for the growth of citrus. The work of Fudge at Lake Alfred about this time stabilized the understanding of the nutritional role of copper in Florida citrus.

County agents, taking these results from research workers, developed dozens upon dozens of grove demonstrations, beginning in about 1936, in which the use of dolomite, soluble magnesium, manganese and zinc were demonstrated to growers to be highly profitable for increasing production of citrus fruits.

In 1933 O. C. Ryan published on the accumu-

*W. L. Tait reported to the Society in 1936 on the favorable response he had obtained from magnesium sources in trials started in Polk County in 1932.

lation and availability of phosphorus in old groves. In 1936 this writer started a series of demonstrations in Lake County in which phosphorus was omitted from the mixture. This practice became so popular in Lake County that at one time prior to World War II there were 86 demonstration groves on the "no phosphorus" practice. Many of these groves have remained on this program ever since except for a few years during World War II when growers were unable to get fertilizer grades that did not contain phosphorus.

Collison reported in Florida Agricultural Experiment Station bulletin 154 in 1919 that inorganic sources of nitrogen "are usually the least expensive per pound of nitrogen and, as a rule, have given the best results in practice". Others, such as F. E. Baer and A. T. Wiancka, made similar observations in other areas. Although most growers were using 40 to 60% of their nitrogen in the summer and fall from organic sources, grove demonstrations were being conducted in Lake County beginning in 1939 with organic nitrogen sources being eliminated from the fertilizer schedule. In 1940 and in subsequent years in Lake County there were "fact finding" demonstrations thruout the county using such schedules as 15-0-14 in the spring and 10-0-15 mixtures in the summer and fall.

The work of Reuther and Smith of the USDA with potash on Valencia oranges started in 1951. Subsequent work by Smith on grapefruit confirmed the industry's luxury consumption of this compound. Many demonstrations were conducted to acquaint growers with this research work.

Stewart's discovery at Lake Alfred that chelated iron would quickly correct chlorosis and the work of Stewart and Leonard in 1951 in finding that yellow spot was due to acute molybdenum deficiency were all excellent material for grove demonstrations and county agents set up many of them under the supervision of the researchers doing the work or the Extension Service citrus specialists.

In 1949 Smith and Reuther identified boron deficiency symptoms and demonstrated the need for boron in citrus nutrition. Early demonstrations on the need for boron in citrus were conducted thru county agents.

Florida Experiment Station bulletin 536, authored by personnel of the Citrus Experiment Station at Lake Alfred and the United States Department of Agriculture at Orlando, released in January, 1954 was a tremendously stabilizing influence in the industry and eliminated *the need* for the large number of demonstrations carried on by county agents. It did not, however, elminate the need for all grove demonstrations and particularly not the "research" demonstrations (as the fact-finding demonstrations became known).

In the mid 1940's a new leguminous cover crop, hairy indigo (*Indigofera hirsuta*, L.) was introduced to Florida agriculture by researchers of the Florida Agricultural Experiment Station. This cover crop showed a great deal of promise for use on citrus grove soils and many demonstrations on planting and growing the crop were conducted by county agents with their growers. The crop was rather extensively evaluated by Extension agents and specialists and in 1962 the Agricultural Extension Service published Circular 227 by Norris and Lawrence which gave a detailed report on grower demonstrations with hairy indigo.

Several demonstrations were conducted in recent years which led to later research investigations and which might be of interest here. A county agent endeavoring to help find the solution to the age old problem of grove cultivation and plowing to conserve moisture in a bearing grove set up replicated "fact finding" demonstrations in a grapefruit grove. At the end of 7 years the data were evaluated statistically and Norris and Smith reported to the Society in 1957 on the results on this cultivation trial which showed, in brief, that of the three variables which included early fall plowing in one series, frequent cultivation thruout the winter months in a second series and two cultivations a year in the third series, that the minimum cultivation practice was the least expensive and most profitable operation.

During the depression years when grove costs were reduced to a bare minimum and pest control was confined to sulfur dusting in many groves, the Manatee tree snail (*Drymaeus dormani*, Binney) made its appearance and wherever populations of snails became abundant the wood, foliage and fruit appeared to be highly polished. In Lake County the snails were quite plentiful for a number of years and they were spread by natural and artificial means to many groves. This writer took a great deal of interest in the snails. The demonstrations and conversations emanating from Lake County induced some research on tree snails by Griffiths in 1949 and by Muma in 1954 and 1955. In 1963, Muma, Selhime and Clancy reported to the Society that

"snail infested groves maintained heavier infestations of scales and mites than sprayed groves and this is reflected in reduced yield and grade of fruit". This complemented the results obtained by Griffiths. The snails appear not to be as effective as our "depression" years demonstrations led us to believe.

Commencing in 1949 Norris conducted a series of "fact finding" demonstrations in cooperation with production managers in Lake County to study the effect of hedging on the percent of pack-out of tangerines and grapefruit. He reported in Agricultural Extension Service Circular 115 in June, 1953 that hedging significantly increased the percentage of pack-out in both tangerines and grapefruit. Subsequently, Kretchman and Jutras of the Lake Alfred Station confirmed these findings based on their research and reported to the Society in 1962.

The first work in herbicides in citrus with which this writer is familiar was a series of very limited demonstrations in a citrus nursery in Lake County about 1955. Our advisor was Clyde Helms, agronomist with the Watermelon and Grape Investigations Laboratory at Leesburg. F. P. Lawrence, Extension Citriculturist, and Norris subsequently carried out some demonstrations using MH-30 in Bermuda and Guinea grasses. J. T. McCown, former Associate Citriculturist and now Polk County Agent became interested in herbicide work and induced E. O. Burt of the main station at Gainesville to set up a number of demonstrations in the control of several types of weeds in groves. McCown continued his interest in herbicide problems in citrus and work successively with Burt, Krezdorn, Kretchman and briefly with Ryan, all of whom are or were Florida Agricultural Experiment Station researchers.

Extensive demonstrations were conducted by Lawrence and county agents with growers following the freeze of 1962. These demonstrated techniques in the use of special tools and how to prune trees properly. Experiment Station and industry personnel cooperated in carrying out these demonstrations.

Research type demonstrations are becoming increasingly popular. Research, industry and Extension personnel are conducting joint studies looking into such matters as "fertigation" (the application of fertilizer thru irrigation systems), the application of fertilizer materials by the liquid-dry system, all liquid ground application systems, citrus nutrition studies on the organic soils, timing fertilizer application on the basis of the total amount of moisture the trees are receiving, spacing studies and "training" trees by hedging and topping techniques. These are but examples of the type work going on in research demonstrations in citrus producing counties thruout the state.

The activities of the Agricultural Extension Service have complemented the work of the researchers. As additional highly trained and specialized young men enter the Extension Service as citrus specialists in the counties the industry should benefit accordingly. The implication of the DARE studies would indicate that the need for citrus specialists at the county level to complement the work of the researchers is badly needed if the citrus industry is to move forward at top efficiency.