THE EFFECT OF VARIABLE POTASH FERTILIZATION ON THE QUALITY AND PRODUCTION OF DUNCAN GRAPEFRUIT

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Introduction

For many years potash has been a major constituent in the fertilizer mixtures applied to citrus in Florida. The use of potash in modern amounts has seemed reasonable, for citrus soils in Florida are not well supplied with potassium containing minerals. There is consequently, only a minimum supply of potassium for utilization by growing citrus trees in Florida except as furnished in the form of fertilizer. Like nitrogen, potassium does not accumulate in these sandy soils (15) and much of that not absorbed by the roots of the trees is lost. Unlike nitrogen however, potassium deficiency symptoms are not quickly discernable under field conditions. A number of papers have been published covering one phase or another of the work on the use of potash on grapefruit at the Citrus Experiment Station and at this time it seems desirable to summarize these findings up to date. In this paper the symptoms which have been found to be associated with potassium deficiency in the field, and the effect of variable potash fertilization on the internal and external quality and on production of Duncan grapefruit are presented and related papers reviewed.

Literature Review

A study of the literature dealing with potassium nutrition of citrus reveals that a large number of symptoms have been associated with potassium deficiency. It should be kept in mind that in most cases these symptoms have been observed where citrus was growing under artificial conditions in pot or sand culture, and that to-date, many of these symptoms have not been observed under field conditions. The reported symptoms include dying-back of the uppermost branches of the tree with the lower branches showing little signs of deficiency (2); splitting and gumming of the twigs; scorching and excessive drop of leaves, resinous spotting, fading of the chlorophyll, and development of a bronze-yellow color (Haas 11-12-13-14). Tucking, and twisting of the leaf blades is still another symptom, (4). With the exception of results reported by Bryan (2), the deficiency symptoms referred to were associated with orange varieties and not grapefruit. Whether all of these symptoms apply to grapefruit has not yet been established.

Fruit symptoms associated with potassium deficiency have also been fairly well classified, although there are some controversial reports as to the effect on the external appearance of the fruit. Bryan (2) reported that in the few cases where fruits were produced on trees grown in pot culture, under deficiency conditions, the fruit did not appear to differ from fruit produced by trees which received potassium in sufficient amounts. Eckstine *et. al.* (8) have described fruit produced under potassium deficiency as being thick-skinned, coarse, and with poor color. Fruit of small size has been reported by most workers to be characteristic of fruit produced by potassium deficient trees, (1, 6, 13, 14, 19). It is generally agreed that oranges produced by trees deficient in potassium will contain a lower percentage of citric acid in the juice, (17, 1, 19, 13, 14). Roy (17) has further reported that Valencia oranges not supplied with potassium produced fruit with a higher content of reducing sugar, a lower content of non-reducing sugar, and a lower pH of the juice.

Although it was believed for many years that muriate of potash was an inferior source of potassium for the fertilization of citrus, investigations by Roy (17), Cowart (7) and Bahrt and Roy (1) have shown that either potassium sulfate or chloride are satisfactory fertilizer salts. An explanation of the background concerning these sources of potassium is necessary for it emphasizes the importance of magnesium in relation to potash fertilization practices, and to some extent the effect of magnesium on the interpretation given to some of the earlier potassium experiments. During World War I, this country was forced to depend largely on domestic sources of potassium. One of these, potassium chloride caused trouble because of the boron which it contained. Because of these experiences, combined with unsatisfactory results from using muriate on other crops, especially tobacco and potatoes, potassium chloride was held in disfavor and preference was given to sulfate as a source of potassium for citrus.

Kainite also used as a source of potassium contained appreciable amounts of magnesium as magnesium sulfate and chloride. As magnesium deficiency became more wide-spread in Florida in the late twenties and early thirties it was found that larger applications of Kainite improved the quality of fruit on these magnesium deficient groves. Large, coarse fruit is associated with magnesium deficiency and when Kainite was applied to deficient trees the fruit quality improved not because of the potassium but because of the added magnesium.

The potash source experiment started in 1924 at the Citrus Experiment Station and continued until 1942, furnishes another good example of the effect of magnesium on the interpretation of results of a potassium experiment. This experiment was initiated to ascertain the effect of muriate, sulfate and sulfate of potash and magnesia on the growth and production of citrus. After several years the sulfate of potash and magnesia appeared to be a superior source of potassium. When under the direction of Dr. A. F. Camp, magnesium sulfate was added to the muriate and sulfate of potash treatments in amounts equivalent to the magnesium contained in the sulfate of potash and magnesia treatments, the differences between the plots disappeared (7).

These examples illustrate the multiplicity of factors which are frequently involved in studying fertilizers for tree crops, some of which may not even have been considered when the experiment was initiated.

Methods

The experiment discussed in this paper was first started in 1921, as reported by Ruprecht (18). At that time a block of Duncan grapefruit was laid out into six plots in such a manner that plots designated as 1, 3 and 5 received 3 percent, and plots 2, 4 and 6 received 10 percent potash in the fertilizer mixture. In the 1924 report, Ruprecht stated that the potash treatments for plot 5 were changed so that 3 percent potash was applied in the spring, 5 percent in the summer and 10 percent in the fall applications. During the period between 1924 and 1929 the plots were changed again so that plot 5 received 5 percent potash at each application and plot 6 received 3 percent potash in the spring, 5 percent in the summer and 10 percent in the fall applications. The plots were continued in this manner until 1936, at which time the original experiment was discontinued and the plots were turned over to Dr. A. F. Camp and his co-workers at the Citrus Experiment Station.

In the 1930 report, Ruprecht (18) had stated that the trees in the plots receiving 10 percent potash were in an unsatisfactory condition. It later developed that the cause of this condition was due to deficiencies of magnesium, copper, zinc, and manganese, with magnesium deficiency being especially acute. In order to correct this condition nutritional sprays were applied, and 4000 pounds of dolomitic limestone was applied to part of this block during 1936, 1938 and 1939, with the same potash treatments as used by Ruprecht being continued.

Beginning with the fall application in 1939, plot 6 was changed to a 0 percent potash treatment and the trees in this plot have received no potash fertilizer since that time. During the period since 1936 the trees have been on a 3 percent nitrogen program, and since 1939 have received a mixture with the formulas shown in Table 1. These mixtures are applied three times a year in February, June and October. The poundage has varied somewhat through the years, having been increased as the trees became larger. Since 1939 the poundage has varied between 15 and 20 pounds per application. Zinc is applied annually as zinc sulfate at the rate of 3 pounds per 100 gals. as a dormant spray. Except as noted, the plots all receive identical treatment in keeping with good grove management practice.

The term internal fruit quality as used in this paper refers to internal characteristics of the fruit based on soluble solids, citric acid, and ascorbic acid content of the juice. Total soluble solids were measured with a Brix hydrometer and the readings corrected to a temperature of 17.5°C. Total titratable acidity, (calculated as anhydrous citric acid) was determined by the titration of a 25 ml. aliquot juice against .3125 N sodium hydroxide solution. The ascorbic acid (vitamin C) content was determined by the method of Menaker and Guerrant (16) and reported as milligrams of ascorbic acid per 100 milliliters of juice.

Results

Visual Deficiency Symptoms under Field Conditions—Under artificial conditions, it is possible to grow citrus trees which manifest deficiency smptoms of potassium rather rapidly. This is not true under field conditions because it is not possible to eliminate potassium from a soil as can be done with a nutrient solution. The increased period of time required for deficiency symptoms to become evident in the field is due to several factors. The tree stores potassium, which apparently may be redistributed and reassimilated to such an extent, that the growth centers are not immediately affected. Also, a citrus tree appears to

TABLE 1.
FERTILIZER PROGRAM FOR THE PLUS MAGNESIUM PLOTS, BLOCK V. 1939–TO-DATE.

Plot No.	Formula (Percentage)					
	N	P_2O_5	K_2O	MgO	MnO	CuO
6	3	6	0	3	1	½
1 & 3	3	6	3	3	1	½
5	3	6	5	3	1	½
2 & 4	3	6	10	3	1	½

be relatively efficient in absorbing and utilizing potassium ions with which its root system comes into contact, (20). Still another factor is the reutilization of potassium resulting from the decomposition of dropped fruit in the grove. Where potash fertilization was withheld entirely from the trees in plot 6, beginning in 1939, no symptoms of potash deficiency developed until the spring of 1943. Following the cold period of February 15-18, 1943, it was observed that the trees in this plot suffered more cold damage than in the plots where potassium was supplied. It was also becoming evident at this time, that the trees were showing less top growth and that the leaves were smaller, but very marked differences in tree appearance were still not evident. At about the same time, it was noted that more fruit was dropping previous to harvest where potash was withheld. This condition continued to develop and by the 1945-46 season was very evident. The trees not supplied with potash have thus far continued to bloom and set fruit, but beginning sometime in July a heavy pre-harvest drop occurs which usually continues through the harvesting season. Table 2, shows the percentage of the crop which dropped during the past two seasons. The larger number of drops listed for the 1949-50 season includes fruit which was blown from the trees during the August 27th hurricane. During the past three seasons the drops have been removed regularly from the grove and since starting this practice the trees appear to be declining more rapidly from potassium deficiency than before, indicating the potassium reserve in these trees is becoming low. It should be noted that had the experiment been discontinued before the spring of 1943, say at the end of 3 years, a flat but erroneous conclusion could have been drawn that potash fertilization was unnecessary.

Another potassium deficiency symptom which has been apparent on occasions is the tendency for the trees not supplied with potash to lose young shoots during windy periods. During the early part of March, 1950, rather high winds with light rains occurred for several days shortly after the spring flush of growth had appeared. About a week later it was observed that a number of young shoots 3 to 15 inches in length had been blown from the trees and were lying on the ground. The number of shoots blown off in each of the potash plots is recorded in Table 3. The break always occurred at the point of emergence of the shoot from the stem or branch.

TABLE 2.

The Effect of Variable Potash Fertilization on the Pre-harvest Drop of Duncan Grapefruit.

Fertilizer Treatment	Percentage of Dropped Fruit*	
	1948-49	1949-50
N-P_2O_5-K_2O-MgO-MnO-CuO		
3 - 6 - 0 - 3 - 1 - ½	45.7	82.5
3 - 6 - 3 - 3 - 1 - ½	37.3	67.2
3 - 6 - 5 - 3 - 1 - ½	29.5	68.5
3 - 6 -10 - 3 - 1 - ½	29.5	62.9

*Values represent percentage of total number of fruits. Drop counts were made from September 23 through Dec. 3, 1948, and from August 31 through Nov. 25, 1949.

At the present time there are no distinct observable differences in tree condition between the trees which are receiving the 3, 5 and 10 percent potash applications, but there is a sharp contrast between the potash fertilized trees and those which receive no potash fertilizer. Trees in the latter plot are decreasing in size, the tops are thin and the leaf size now appears small on a number of trees. Leaf symptoms denoting potassium deficiency are not obvious. Some twisting and tucking of the leaves of a few trees have been noted on occasion.

Internal Fruit Quality. Sampling and analyses of the fruit produced by the trees in the potash plots has been continued regularly since 1939. A considerable amount of data relative to fruit quality has been obtained, but only data for the past three years covering soluble solids, percent citric acid, solids/acid ratio and the vitamin C content is being presented at this time. This is representative of the data as a group and shows the difference in these juice characteristics as influenced by the potash treatments which the trees have received.

Contrary to results reported by Roy (17) and Bahrt and Roy (1) in their study of Valencia oranges, the soluble solids content of the juice of Duncan grapefruit from potassium deficient trees is significantly lower in most cases than *where* potassium is supplied. Variations in the rate of potash application between 3 and 10 percent in most cases caused no significant difference in the soluble solids content of the juice (Table 4). The percentage of titratable acid is consistently and very sharply reduced where potash is limiting, and is increased significantly with increasing applications of potash up to 10 percent in the fertilizer mixture (Table 4).

TABLE 3.
Loss of New Shoots as Affected by Variable Potash Fertilization.

Fertilizer Treatment	Average Number of Shoots Lost Per Tree
$N-P_2O_5-K_2O-MgO-MnO-CuO$	
3 - 6 - 0 - 3 - 1 - ½	182.8
3 - 6 - 3 - 3 - 1 - ½	11.3
3 - 6 - 5 - 3 - 1 - ½	19.3
3 - 6 -10 - 3 - 1 - ½	10.7

In as much as the ratio, (soluble solids/acid) of grapefruit juice is usually the factor determining earliness of maturity for grapefruit, the effect of potash applications on the ratio is of particular interest. The ratio of soluble solids to acid is increased where potash is limiting, and is decreased significantly with increasing applications of potash. The decrease in the ratio where the

TABLE 4.
THE EFFECT OF VARIABLE POTASH FERTILIZATION ON THE INTERNAL QUALITY OF DUNCAN GRAPEFRUIT*.

Fertilizer Treatment	Percent Soluble Solids			Percent Citric Acid			Solids/Acid Ratio			Vitamin C		
	1947-48	48-49	49-50	47-48	48-49	49-50	47-48	48-49	49-50	47-48	48-49	49-50
$N-P_2O_5-K_2O-MgO-MnO-CuO$												
3 — 6 — 0 — 3 — 1 — ½	8.64	9.04	9.50	1.12	1.07	1.29	7.77	8.52	7.35	36.1	36.9	35.9
3 — 6 — 3 — 3 — 1 — ½	9.19	9.67	9.76	1.29	1.30	1.45	7.12	7.48	6.77	40.8	37.9	40.4
3 — 6 — 5 — 3 — 1 — ½	9.11	9.55	9.80	1.40	1.32	1.59	6.56	7.12	6.20	41.1	39.2	40.6
3 — 6 — 10 — 3 — 1 — ½	9.24	10.06	10.05	1.40	1.48	1.61	6.61	6.82	6.24	41.8	41.1	43.4
L.D.N.S. 1% level	0.380	0.316	0.998	0.091	0.099	0.149	0.397	0.442	0.453	3.107	2.142	3.714
L.D.N.S. 5% level	0.281	0.227	0.702	0.067	0.071	0.105	0.293	0.317	0.318	2.293	1.536	2.61

* Values given are seasonal average values and represent the mean of all of the samples taken throughout each season. Sampling was usually started in September and continued until February or March of each year at intervals of two to three weeks.

potash application has varied between 5 and 10 percent has been significant some seasons and not in others, Table 4. In general however, the trend has been for the ratio of the juice to continue to decrease with application of potash up to 10 percent in the fertilizer mixture. The differences in the time of passing legal maturity as influenced by these fertilizer treatments for the past two seasons are presented in Table 5.

The effect of potassium deficiency and variable potash application on the vitamin C content of the juice, follows a pattern very similar to that discussed for soluble solids. Where potassium is limited, the vitamin C content of the juice is significantly decreased. Variation in the application of potash from 3 through 10 percent has resulted in slight increases in the vitamin C content at the higher applications but the differences are slight (Table 4).

External Quality.—The conclusions drawn by Eckstein, Bruno and Turrentine (8) that potash deficiency is manifested by the production of large, coarse fruit are apparently incorrect. The reports of investigators working with oranges, and a previous study by the author (19) show clearly that small fruit, with thin rind, and good texture, are produced where potash is limited. There has been no consistent difference in the proportion of Duncan grapefruit meeting the several standard U. S. Grades, due to potassium deficiency, or to variations in the level of potash fertilization. Early in the season there appears to be a rather large differential in size of fruit produced between trees which receive no potash fertilization and those which do. As the season progresses this is less apparent, probably due to the increased number of drops and the smaller number of fruit left on the deficient trees. During the past five years the fruit from the trees not supplied with potash has averaged about 0.10 inches smaller in diameter than fruit from trees supplied with potash. This is slightly less than the difference in average diameter between one commercial size. During the entire period the fruit from these plots has always been held late into the season, which probably accounts for the differential in size not being greater. No consistent differences in size of fruit produced has been found to-date where potash has been applied, even though the N/K_2O ratio has varied from 1-1 to 1-3.3.

Production.—Table 6, presents a summary of the production of fruit as affected by variations in the level of potash fertilization during the period from 1940-41 through 1949-50. These data, based on the average production for the past nine years, show that the trees receiving 5 percent potash fertilization have yielded significantly more fruit than the trees receiving the other treatments. The difference between the production of these trees, and those to which 3 per-

TABLE 5.
ESTIMATED DATES OF PASSING LEGAL MATURITY STANDARDS AS AFFECTED BY VARIOUS POTASH FERTILIZATION TREATMENTS.

Treatment	1948-49		1949-50	
$N-P_2O_5-K_2O-MgO-MnO-CuO$	Estimated Date	Difference in Days	Estimated Date	Difference in Days
3 — 6 — 0 — 3 — 1 — ½	September 10		October 15	
3 — 6 — 3 — 3 — 1 — ½	October 2	22	December 10	56
3 — 6 — 5 — 3 — 1 — ½	October 15	35	January 3	80
3 — 6 — 10 — 3 — 1 — ½	October 18	38	January 6	83

cent potash is applied, is of greater interest when tree condition as affected by previous treatment is considered. The reports of Ruprecht frequently indicated that trees receiving the 3 percent potash treatment were producing the most fruit during the period from 1921 until 1936, with the exception of one year, 1934. Further, Camp (3) reported that the 3 percent trees were affected the least by magnesium deficiency at the time that the original experiment was stopped, and corrected, in 1936. Based on previous performance, the highest production should be from the trees supplied with 3 percent potash. The indications are that 3 percent potash, which is equivalent to 1:1 nitrogen-potash ratio at the rate of application used, has not been sufficient to maintain production as compared to the higher 1:1.6 ratio which corresponds to the 5 percent treatment. Statistically there is no significant difference in the production of fruit from trees receiving the 0 percent, 3 percent or the 10 percent potash treatment as ascertained by the nine year average. It is evident from the data, however, that the production of the trees receiving no potash has fallen off badly since the 1946-47 season, the average yield per tree since that time being only 295 pounds. The nine year average value for the trees not supplied with potash is comparatively high by virtue of the fact that these trees were producing heavily during the early part of the experiment.

Discussion

Under the present maturity law in Florida, earliness of maturity for grapefruit, once the juice content requirements are met, is determined in most cases by the solids to acid ratio of the juice. Reported earliness of maturity of grapefruit as affected by a low nitrogen to potash ratio (19), together with similar results having been reported for

TABLE 6.
THE EFFECT OF VARIABLE POTASH FERTILIZATION ON THE PRODUCTION OF DUNCAN GRAPEFRUIT.*[1]

Fertilizer Treatment	Avg. Yearly Production-lbs./Tree						Average for First 5 Years	Avg. Yearly Production-lbs./Tree				Average for Past 4 Years	9 Year Average
$N-P_2O_5-K_2O-MgO-MnO-CuO$	1940-41	41-42	42-43	43-44	44-45	45-46		46-47	47-48	48-49	49-50		
3 - 6 - 0 - 3 - 1 - ½	616	773	798	1175	......	790	830	217	561	281	121	295	594
3 - 6 - 3 - 3 - 1 - ½	250	475	421	1022	......	596	553	527	857	453	315	538	545
3 - 6 - 5 - 3 - 1 - ½	686	755	765	1289	......	1093	914	573	1073	522	417	646	797
3 - 6 - 10 - 3 - 1 - ½	311	468	599	1221	......	598	639	581	846	555	370	588	616

L.D.N.S. between treatment average for 9 year period=224 at 1% level
164 at 5% level

* No production figures are available for the 1944-45 season, the crop was lost as a result of the hurricane which occurred that year.

[1] The author wishes to express thanks to Mr. H. O. Sterling, Citrus Experiment Station, who cooperated in securing the production data.

oranges has resulted in a more widespread use of lower nitrogen-potash ratios in fertilizer mixtures. Ruprecht reported in 1936 that based on the results of the potash rate experiment at that time that there appeared to be no advantage in using a ratio of nitrogen to potash higher than 1:1. The fact that production appears to be falling off in the plots which are receiving this treatment and that the number of drops is usually higher than in either the 5 or 10 percent plots would seem to indicate that this ratio may be too narrow to obtain maximum yields at the rate of application used in this experiment.

It should be emphasized that it has not been possible under the conditions of this experiment to see immediate effects from changes in potash fertilization either as related to tree condition, production or fruit quality. The rather quick responses which have been evident in citrus from correcting zinc deficiency, or from applications of nitrogen have not been observed as a result of variations in the applications of potash. Thus, if the lower production which has been found in this experiment where a 1-1 nitrogen-potash ratio has been used, may be considered as indicative of what happens under field conditions generally, the production may be decreased so gradually in a commercial grove as to go unnoticed except by the most discerning growers.

The nitrogen to potash ratio in a 4-6-8-3-1-½ fertilizer mixture applied in the fall and summer applications, followed by an 8-0-8-6-2-1 spring topdresser, is approximately a 1-1.67 ratio of nitrogen to potash and not a 1-2 as it is frequently referred to. This corresponds to the 5 percent potash application used in this experiment which has to date resulted in the highest average yields. Even where this ratio is applied, as was pointed out earlier by Fudge (19), a large percentage of the applied potassium is removed annually by the harvested crop. It is of course, a matter of conjecture as to the results which might have been obtained had the rates of application of these mixtures also been varied but this was not included in this experiment.

Summary

Potassium deficiency under field conditions for Duncan grapefruit was manifested by slow growth and thinning of the tops of the trees, loss of young shoots by wind, pre-harvest drop of fruit and decreased production. The fruit produced was small in size, with good texture and thin rind. Internal quality was characterized by decreased soluble solids, citric acid and vitamin C content. Fruit from deficient trees matured earlier as judged by the soluble solids/citric acid ratio. The acid content of the juice increased and the ratio decreased in fruit produced by trees supplied with potash applications ranging up to 10 percent in the fertilizer mixture.

Continuous use of a 1:1 nitrogen-potash fertilizer ratio at the rate of application used in this experiment resulted in decreased yield of fruit as compared to a 1:1.67 nitrogen-potash ratio.

LITERATURE CITED

1. Bahrt, George M., and Roy, Wallace R. Progress Report of the effects of no potassium and various sources and amounts of potassium on citrus. *Fla. Sta. Hort. Soc. Proc.* 53: 26-38. 1940.
2. Bryan, O. C. Potash deficiency in grapefruit. Identifying symptoms developed in tests. *Florida Grower.* 43(1): 14-16. 1935.
3. Camp, A. F. A resume of feeding and spraying citrus trees from a nutritional standpoint. *Fla. Sta. Hort. Soc. Proc.* 56: 60-79. 1943.
4. Camp, A. F., Chapman, H. D., Bahrt, George M., and Parker, E. R. Hunger signs in crops. *Judd & Detwiler,* Washington, D. C. 267-311. 1942.
5. Chapman, H. D., Brown, M. Analysis of orange leaves for diagnosing nutrient status with reference to potassium. *Hilgardia.* 19: 501-540. 1950.

6. CHAPMAN, *H. D.*, BROWN, S. M., AND RAYNER, D. S. Some effects of potash deficiency and excess on orange tree growth, composition and fruit quality. *Calif. Citrograph.* 33(7): 278, 279, 290. 1948.
7. COWART, F. F. Effect of source of potash upon fruit composition. *Fla. Agr. Exp. Sta. Ann. Rept.* 146-148. 1944.
8. ECKSTEIN, OSKAR, BRUNO, ALBERT, AND TURRENTINE, J. W. Potash deficiency symptoms. 1-235. *Illus. Berlin.* 1937.
9. FUDGE, B. R. AND FEHMERLING, G. B. Some effects of soils and fertilizers on fruit composition. *Fla. Sta. Hort. Soc. Proc.* 53: 38-46. 1940.
10. *Fudge*, B. R. *Fla. Agr. Exp. Sta. Ann. Rept.* 150-152. 1946.
11. HAAS, A. R. C. The growth of citrus in relation to potassium. *Calif. Citrograph.* 22(1 & 2): 6, 17, 54, 62. 1936.
12. .... Potassium in citrus leaves and fruits. *Calif. Citrograph.* 22: 154-156. 1937.
13. .... Effect of potassium on citrus trees. *Calif. Citrograph.* 33(11): 468, 486, 487, 488, 490. 1948.
14. .... Potassium in citrus trees. *Plant Physiology.* 24: 395-415. 1949.
15. KIME, C. D., JR. Leaching of potash from sandy citrus soils of Florida. *Fla. Sta. Hort. Soc. Proc.* 56: 43-48. 1943.
16. MENAKER, M. H., AND GUERRANT, N. B. Standardization of 2-6 Dichlorophenolindophenol an improved method for determination of vitamin C. *Jour. Ind. and Eng. Chem. (Anal.)* 10: (1) 25, (5) 269. 1938.
17. ROY, W. R. Effect of potassium deficiency and of potassium derived from different sources on the composition of Valencia oranges. *Jour. Agr. Res.* 70(5): 143-169. 1945.
18. RUPRECHT, R. W. Effect of potash on composition, yield and quality of the crop. *Fla. Agr. Exp. Sta. Ann. Repts.* 1922-1936.
19. SITES, JOHN W. Internal Fruit Quality as related to production practices. *Fla. Sta. Hort. Soc. Proc.* 60: 55-62. 1947.
20. WANDER, I. W. (Unpublished Data). *Citrus Experiment State*, Lake Alfred, Fla.

PANEL ON PARATHION

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Mr. President, Members of the Florida Horticultural Society and Guests:

The Executive Committee of the Society requested that a panel be developed on Parathion to be presented at this meeting.

In planning the panel the assistance of Dr. J. T. Griffiths, Mr. W. L. Thompson and Mr. Frank L. Holland was sought.

Due to the keen intellect and efforts of these three gentlemen, plus the very fine cooperation of the twenty-two gentlemen seated before you, we have the panel prepared according to the outline that has been distributed to you.

These gentlemen, no doubt, are among the best qualified to speak on Parathion and its uses that could be found in the world today. They each have prepared questions which they are qualified to discuss intelligently. Many have prepared questions, they want others in other fields of work to answer. The opportunity has been given all of you to submit questions and many of you have done so.

All of these questions have been sorted and grouped and will be answered by the person or persons qualified in that particular field.

Whether or not the Moderator will allow questions from the floor will depend entirely on time. The outline covers all phases of the subject and we feel that all phases should be covered rather than too much time be spent on certain phases and others neglected.

While Parathion is undoubtedly an outstanding insecticide, it like all material, has its limitations. It is expected that the discussions here today will deal with the limitations as well as the outstanding qualities of this material.

On behalf of the Society and personally, I wish to thank each of you gentlemen who have helped plan the panel and all of you who are participating in it.

I now turn the panel over to our most efficient Moderator, Mr. Frank Holland.

Moderator: We will go right to work if members of the panel are ready. Before we get into detailed questions there is a preliminary question which the mod-