Effects of Potassium Chloride and Sulfate on Pineapple Yields and Quality

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INTRODUCTION

In most pineapple-growing areas in the world potassium sulfate is used as the potash source in fertilizing pineapples. Although potassium chloride is usually available to the pineapple grower at a few dollars less per ton than potassium sulfate, it is not preferred. This preference for the sulfate over the chloride is not entirely without foundation. Experiments as early as 1899, by Rolfs in Florida (*5*)[2] showed that the use of potassium sulfate gave higher yields of pineapples when compared with potassium chloride or Kainit[3]. Johansen in Natal (*3*), in 1911, found sulfate of potash and wood-ash gave good results, while chloride of potash produced a white color in the pulp.

In Puerto Rico, there appears to be no previous experimentation to serve as a basis for the choice of the sulfate over the chloride of potassium. Hendricksen (*2*), who did much of the early research work on pineapples in Puerto Rico in the 1920's, stated that potassium sulfate was preferable to potassium nitrate or potassium chloride for pineapples, but failed to cite the reason for his choice.

Although potassium sulfate has been the choice of pineapple growers in Puerto Rico for almost 50 years, there has been no actual local experimental basis for this choice. The preference of the sulfate over the chloride has been based on reports from Florida (*4*) and Hawaii that the chloride produced off-color in the fruit, and lowered yields.

Potassium chloride is used in all fertilizer analyses mixed in Puerto Rico, except those for pineapples and tobacco. If the pineapple grower cared to to use other fertilizer analyses than those especially mixed for pineapple, he would have more flexibility in his pineapple fertilization. However, he must be sure that the potassium chloride in the fertilizer analyses would give as good results as potassium sulfate. Thus, it was the object of this study to determine the differences, if any, in yields and quality of pineapples fertilized with potassium sulfate or potassium chloride under the growing conditions found in Puerto Rico.

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[2] Italic numbers in parentheses refer to Literature Cited, pp. 19–20.

[3] A mineral salt mixture containing potassium sulfate, magnesium sulfate, magnesium chloride, and a small amount of potassium chloride.

PROCEDURES

The experiment was planted on a Bayamón sandy clay at the Pineapple Farm, Manatí, of the Agricultural Experiment Station. The Bayamón sandy clay is found in the large valleys extending from Vega Alta to west of Arecibo. It has a friable brownish-red permeable granular surface soil underlain by a deep-red slightly plastic but permeable clay subsoil. The pH of the surface soil where the experiment was planted was 4.3.

The experiment had two treatments, one in which potassium chloride (60-percent K_2O) was the source of potassium, the second, in which potassium sulfate (50-percent K_2O) was the source of potassium. There were five replications to each treatment arranged in a randomized-block design.

The plots consisted of three 2-row plantings. The distance between the two rows was 2 feet, with 5 feet between each 2-row planting as a passageway. The distance between plants in a row was 16 inches. Two blocks had plots 44 feet long by 21 feet wide, and three had plots 55 feet long by 21 feet wide.

All plots received a total of 300 pounds of nitrogen per acre as ammonium sulfate (20-percent N), and 60 pounds of P_2O_5 per acre as superphosphate (20-percent P_2O_5). For potash, all plots received 240 pounds of K_2O per acre either as potasium chloride or sulfate, depending on the treatment. The fertilizer was placed in two applications.

The experiment was planted on October 10, 1957, with slips from the Red Spanish variety of pineapples, and harvested in six pickings from May 6 to June 17, 1959. Aside from weighing the fruits, representative samples of fruit were taken to the laboratory for testing as to color and chemical composition. The procedures used for these analyses are given in an earlier publication (*1*).

RESULTS

The results of the chloride and the sulfate of potassium on the yields and quality of the Red Spanish pineapple are given in table 1.

Higher yields of both fruit per acre and mean weight of individual fruit were obtained when the sulfate rather than the chloride of potassium was used, an increase of 2.2 more tons of fruit being obtained with potassium sulfate as compared with potassium chloride fertilization. The weight of the individual fruit was also increased from 3.32 pounds with chloride to 3.67 pounds with sulfate of potash.

Not only were there differences in yields due to the two potash sources but the color of the fruit was affected. The pineapples from plants fertilized with potassium chloride were distinctly off from the accepted color for Red Spanish pineapple. The flesh for the chloride-fertilized fruit was white as compared to the yellow found in the sulfate fertilized fruit.

The chemical composition of the fruit, as given in table 1, shows very little difference between the two potash sources as far as its influence on pH, Brix, and invert sugar goes. The titratable acidity of the chloride-treated fruit was lower than that for the sulfate, which gave the former a higher Brix-acid ratio than the latter (see table 1).

DISCUSSION

Thus, it appears that the use of potassium sulfate rather than potassium chloride for pineapples in Puerto Rico is a justifiable practice. As shown by the results, the use of the chloride source of potash reduced yields of pine-

TABLE 1.—*The effect of the chloride and the sulfate of potassium on pineapple yields and quality*[1]

Potassium[2] source	Yield of fruit per acre[3]	Mean weight of individual fruits	Chemical composition of fruit				
			pH	Brix	Invert sugar	Titratable acidity[4]	Brix-acid ratio
	Tons	*Pounds*		*Degree*	*Percent*	*Mgm.*	
Potassium chloride (KCl)	7.0	3.32	4.1	13.4	12.9	463	28.9
Potassium sulfate (K_2SO_4)	9.2	3.67	4.0	13.4	13.1	584	23.0

[1] Least significant differences needed between treatments at: 5-percent level 0.64 (yield of fruit) and 0.249 (mean weight of individual fruits); 1-percent level 1.05 (yield of fruit) and 0.413 (mean weight of individual fruits).

[2] All treatments received 300 lb. N, 60 lb. P_2O_5, and 240 lb. K_2O per acre.

[3] Fruit harvested green for shipping in a total of 6 pickings from May 6, 1959 to June 17, 1959.

[4] Titrated to a pH 8.1 and expressed as milligrams of citric acid per 100 ml. of juice.

apples per acre and also resulted in an unacceptable off-color of the fruit for canning purposes.

It is difficult to say why the sulfate of potassium gives higher yields than does the chloride. The toxicity of the chloride ion itself might be considered the cause. Potassium chloride contains 48 percent of chlorine, so that the 400 pounds of potassium chloride per acre used in the experiment contributed about 190 pounds of chlorine. Leaf samples taken revealed that the chloride-fertilized plants contained 0.61 percent of chlorine on the dry-weight basis as compared to 0.39 percent where potassium sulfate was applied. Sideris and Young (*6*) found that in the presence of adequate potassium, the chloride tolerance of the pineapple plant was high. They found that approximately 1 percent of chlorine (dry-weight basis) in the pineapple leaf did not cause leaf necrosis when potash fertilization was adequate.

Other than the toxic effect of the chloride ion we must consider the beneficial effect of the sulfate ion as a cause for the better yields obtained with potassium sulfate. Potassium sulfate has 55 percent of its weight as the sulfate ion. Cibes and Samuels (*1*) have shown that sulfur deficiency can reduce pineapple yields. Field observations by the authors of commercial harvested fruit in this area revealed visual symptoms similar to those obtained under sulfur deficiency in nutrient culture. The commercial use of ammonium sulfate and superphosphate, both of which contain sulfate sources, serves to complicate the picture. At present not enough information is available as to the sulfate needs or chloride toxicity for pineapples in the Bayamón sandy clay to correctly assess as to which of these two ions is directly responsible for the higher yields.

SUMMARY

An experiment was conducted on a Bayamón sandy clay to determine whether the chloride or the sulfate was the best source of potassium for pineapples. The results were as follows:

1. Pineapples fertilized with potassium sulfate gave a higher yield per acre and a larger mean weight per fruit than those which received potassium chloride.
2. The chloride-fertilized pineapples produced a fruit with off-colored pulp not as acceptable as the standard sulfate-fertilized fruit.
3. The possible roles of the chloride and sulfate ions in pineapple yields are discussed.

RESUMEN

Se llevó a cabo un experimento en un sue lo del tipo Bayamón arenoarcilloso para determinar si era el cloruro o el sulfato la mejor fuente de potasio para la piña.

Los resultados fueron los siguientes:

1. La piña abonada con sulfato de potasa produjo mayores rendimientos por acre y frutas de mayor peso en promedio que la abonada con cloruro de potasa.
2. La piña abonada con cloruro de potasa produjo frutas cuya pulpa no logró su color normal, por lo cual no fueron tan aceptables como las que fueron abonadas con sulfato de potasa.
3. Se presenta una discusión sobre las posibles funciones de los iones del cloruroy del sulfato en cuanto a los rendimientos de la piña.

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