Pollen Fertility as a Means of Selecting Male-Parent Plants in Pineapple Breeding

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INTRODUCTION

An important problem that is encountered by the plant breeder is the failure of seed-set after pollination. Apart from the application of pollen to the stigma, the success or failure of the pollination depends on several factors. Among these factors the fertility of the pollen grains occupies a very important place. There is a much better chance of obtaining seed when using a variety with a high percentage of fertile pollen as the male parent plant than when using a variety with a low percentage of fertile pollen.

Seed-setting in pineapples, *Ananas comosus* (L.) Merr., is difficult. According to Collins (*1*)[2], Rhoades (*2*), and Okimoto (*3*) pineapple plants produce seedless fruits because of self-incompatibility of the germ cells, but most of them will set seed when cross-pollinated. That means that most varieties are cross-fertile (*4*). By selecting varieties which have a high percentage of fertile pollen to be used as male parent plants, we might increase the production of pineapple seeds for our breeding program. It is understood that, beside selecting varieties with a high percentage of viable pollen to be used as male parent plants, these varieties must have some other desirable characteristics needed for the production of new varieties. With this idea in mind pollen fertility counts were made in various pineapple varieties and seedlings.

Before describing the material used, it is well to know that the basic haploid chromosome number in pineapple was established by Collins and Kerns (*5*) as being $n = 25$. Consequently diploids have $2n = 50$, and triploids $3n = 75$. Among the material studied there is one triploid, the rest are diploids.

MATERIALS AND METHODS

The five varieties and the two selected seedlings used were Smooth Cayenne, Baron Rothschild, Red Spanish, Natal, Cabezona, 1B 13, and 7D 18.

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[2] Italic numbers in parentheses refer to Literature Cited, p. 240.

VARIETIES

Smooth Cayenne is the most important variety with the pineapple planters all over the world. The plant is large with smooth leaves. The fruit has a cylindrical shape with a greater diameter near the base than near the top. Its weight varies from 4 to 8 pounds. The eyes are broad and flat, giving a smooth outer surface to the peel. Its flesh is slightly yellow, sweet, juicy, and with a very pleasant flavor. It is excellent for canning but does not ship well (fig. 1).

Baron Rothschild is a strain of the variety Smooth Cayenne. The plant is medium in size with spines on the margins of the leaves. The form of the fruit is oblong, tapering very slightly towards the crown. The weight of the fruit averages from 4 to 6 pounds. The flesh is whitish-yellow, firm, and of fair quality. (fig. 2)

Red Spanish is the leading variety of Cuba and Puerto Rico. The plant is vigorous. The leaves are slender and might have from few to many spines on the margins, depending on the strain. The fruit is small to medium in size, usually weighing from 2 to 5 pounds. The shape of the fruit will vary from almost spherical for the smaller fruits to a slightly tapered barrel-shape with the maximum diameter close to the base for the larger fruits. The flesh is white in color, firm with strong fiber, and has excellent flavor. This variety gives a very good dual-purpose fruit. It ships well as a fresh fruit and also gives a canned product of good quality (fig. 3).

Natal is a well-known variety planted commercially in South Africa. The leaves of the plant are short, broad, and stiff with spines on the margins. The fruit is cylindrical, small, weighing from 2 to 4 pounds. The flesh is yellow, slightly fibrous, sweet, juicy, and has a very pleasant flavor. This variety bears a large number of suckers (fig. 4).

Cabezona (*6*) is a variety grown in a certain area of Puerto Rico. Outside Puerto Rico it is known by the names of Puerto Rico and Bull Head (*7*). It is a triploid ($3n = 75$) (*8*) and the only triploid pineapple grown commercially (*1*). The plant is quite large. The leaves are wide, fleshy, and spiny. Its color is lighter than that of other varieties. The fruit is large, weighing from 12 to 15 pounds. Its shape is conical, being wider at the base and becoming thiner towards the crown. The flesh is whitish in color, fibrous, juicy, and with good flavor (fig. 5).

1 B 13 is a seedling obtained from a cross between Smooth Cayenne and Red Spanish. The plant is large with spiny leaves. The fruit is somewhat square in shape. The floral bracts are larger than in the other varieties, covering from half to three-fourths of the eye. Its weight varies from 5 to 7 pounds. The flesh is white, fibrous, juicy, and with a good flavor (fig. 6).

7D 18 is a seedling obtained from open-pollinated seed of the Red Spanish variety. The plant is large and very vigorous. The leaves are grayish in color

FIG. 1. Pineapple variety Smooth Cayenne.
FIG. 2. Pineapple variety Baron Rothschild.

FIG. 3. Pineapple variety Red Spanish.
FIG. 4. Pineapple variety Natal.

and with spines on the margins. The fruit is slightly square in shape, but is larger than the Red Spanish. Its weight varies from 6 to 8 pounds. The flesh is creamy white, with not much fiber, sweet and with a very palatable flavor (fig. 7).

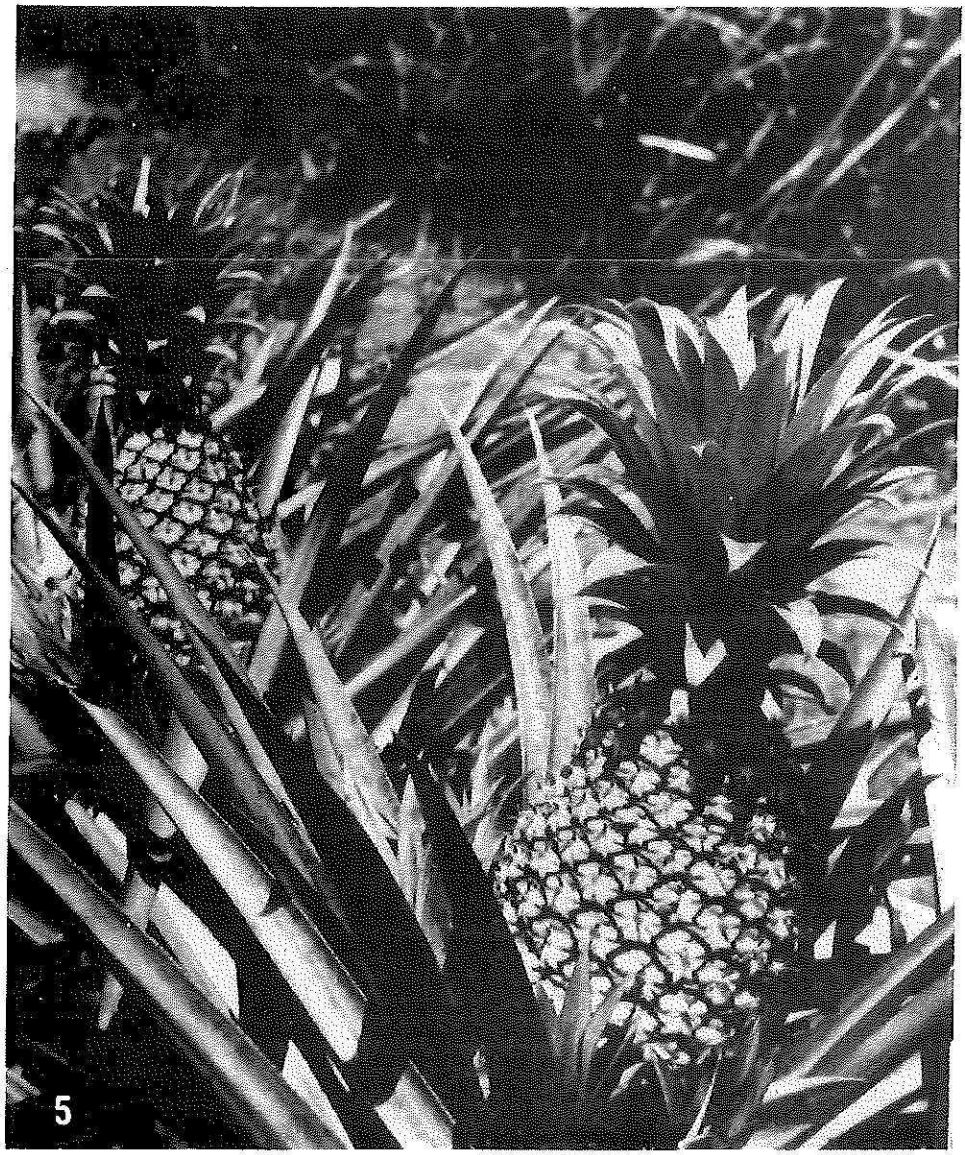


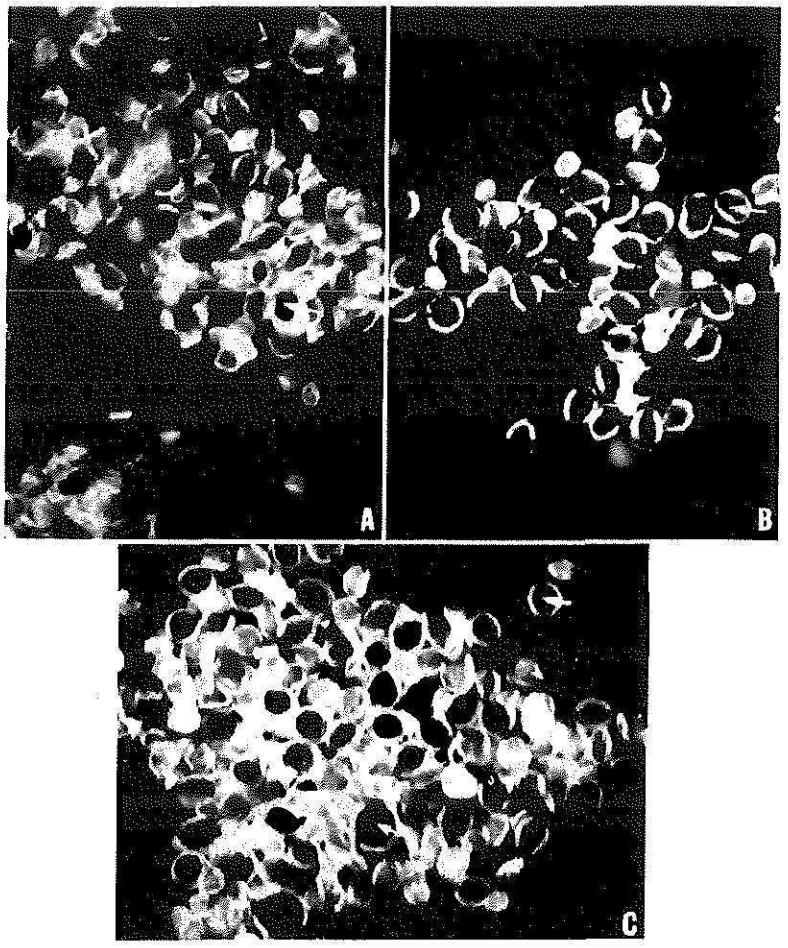
FIG. 5.—Pineapple variety Cabezona.

METHODS

In pollen-fertility studies many workers agree that the ability of the pollen grain to absorb certain dyes is an indication of its fertility—in other words, that they will be capable of germinating and so fertilize the ovule. Using this principle, pollen-fertility counts were made by the following method (*9*):

FIG. 6.- Pineapple seedling 1B 13.
FIG. 7.—Pineapple seedling 7 D 18.

A drop of Turtox CMC-10 mounting media in which a few drops of cotton blue-lactophenol had been added was placed on a slide. The pollen from an anther was shaken into the drop and then a cover slip was applied



A-C

FIG. 8.—Pollen grains of the various pineapple varieties and seedlings studied: Red Spanish (A), 1B 13 (B), Cabezona (C), Smooth Cayenne (D), Natal (E), Baron Rothschild (F), 7D 18 (G). Dark round pollen grains (arrows) are viable; light-collapsed, shrunken pollen grains are not viable. In Cabezona (C notice the large, dark, round viable pollen grains (arrow). For all figures the final magnification is 100× in a black field. (Original photos by Miss C. Purcell, Res. Asst. in Cytology.)

with slight pressure in order to flatten the preparation, but not break the cells. The prepared slides were placed to dry at room temperature. When dried, they were studied under the microscope and the viable and nonviable pollen grains were counted. The viable pollen grains absorbed the stain and looked bluish and round. The nonviable grains shrank, then collapsed, and no absorption of the stain was observed.

Several slides were prepared from each variety. In each slide several counts were made in different fields. The different counts were recorded and the percentage of viable pollen was calculated, for each variety and seedling (fig. 8).

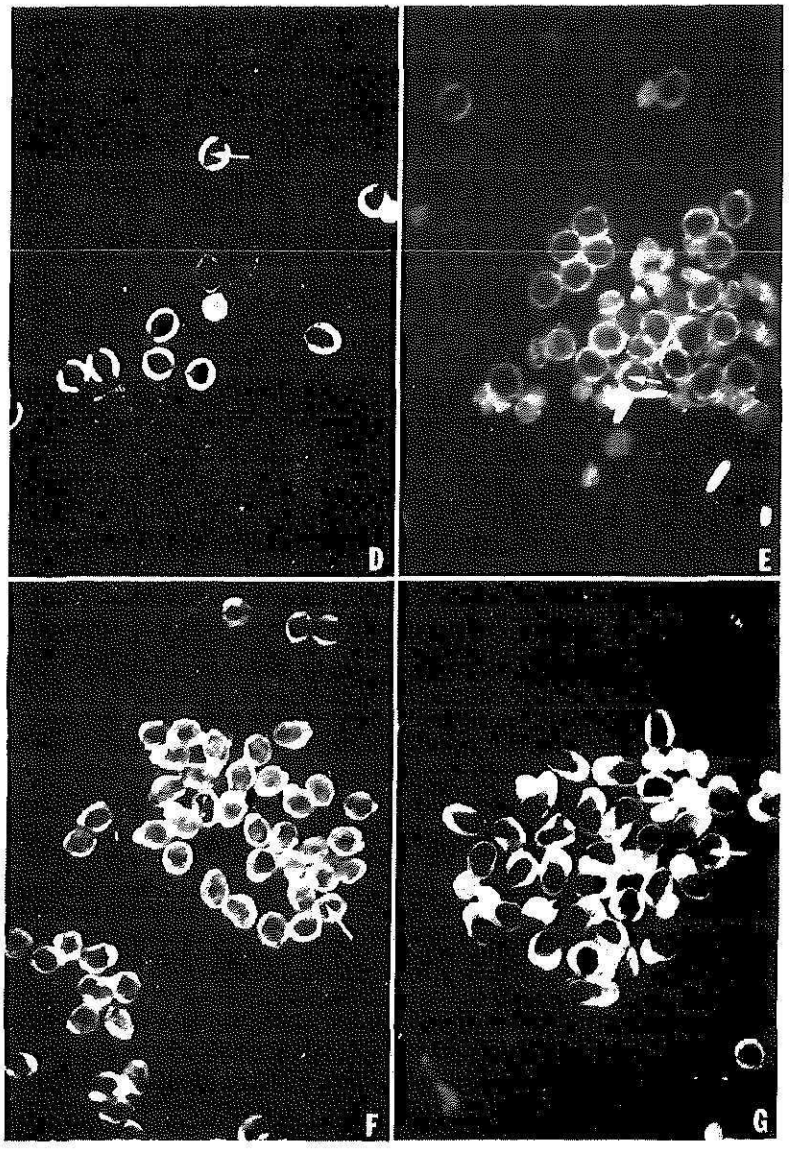


FIG. 8.—D-G

RESULTS AND DISCUSSION

Table 1 presents the pollen counts of the various varieties and seedlings. According to the data obtained there is a great variation among the different varieties of pineapple studied, as to percentage of viable pollen grains. Variety Baron Rothschild has the highest percentage of viable pol-

len grains. Because of this characteristic it might be considered as a good male parent plant and recommended as such. Also pollen of the Smooth Cayenne variety showed a desirably high percentage viability.

The Cabezona, a triploid pineapple, has the lowest percentage of viable pollen grains. This might be because of its triploid characteristic. Mendiola (*10*) said: "triploid pineapples show among other things partial or complete sterility". Also, discussing triploids, Collins said, "even though some of the grains appear almost normal they fail to form zygotes when used in crosses with diploids, and consequently triploids are considered to be totally sterile". Because of this the variety Cabezona should not be used as a male parent plant.

The rest of the varieties and selected seedlings tested can be used as male parent plants, even though the viability of the pollen grains appears not to

TABLE 1.—*Pollen-grain counts on 5 pineapple varieties and 2 selected seedlings*

Variety or selection	Total pollen grains	Total viable pollen grains	Total nonviable pollen grains	Viable pollen grains
	Number	*Number*	*Number*	*Percent*
Smooth Cayenne	2,650	2,252	398	84.98
Baron Rothschild	2,331	2,257	74	96.82
Red Spanish	2,344	795	1,549	83.91
Natal	1,165	566	599	48.58
Cabezona	1,192	353	839	21.22
1B 13	1,465	697	768	47.57
7D 18	2,120	1,157	963	54.57

be too high. But, if possible, the varieties with the highest percentage of viable pollen grains, should be used as male parent plants.

It was noticed that some pollen grains of the Cabezona variety were much larger than the grains of the other varieties and selected seedlings studied. These large pollen grains in triploid pineapple were also reported by Collins (*1*). It is possible that the large pollen grains may contain the diploid chromosome number ($2n = 50$) as has been reported by Cheesman (*11*) for bananas.

SUMMARY

Pollen-fertility counts were made in five pineapple varieties and two selected seedlings, with the purpose of selecting the ones with high percentages of viable pollen grains as male parent plants. The varieties and selections used were Smooth Cayenne, Baron Rothschild, Red Spanish, Natal, Cabezona, 1B 13, and 7D 15.

Among the varieties tested Baron Rothschild was the one with the high-

est percentage of viable pollen grains, followed by Smooth Cayenne. The rest were intermediate, except Cabezona which had the lowest percentage. The Cabezona variety is a triploid and triploid pineapples show, among other things, partial or complete sterility. Because of this it is a risk to use this variety as a male parent plant. Varieties with a high percentage of viable pollen should be used as male parent plants.

RESUMEN

Se informan aquí los resultados obtenidos en un estudio sobre el porcentaje de polen viable en dos selecciones y cinco variedades de piña.

Se encontró que la variedad Baron Rothschild tiene el porcentaje más alto de polen viable, seguida por la variedad Cayena Lisa. Las demás tienen un porcentaje intermedio con excepción de la variedad Cabezona, cuyo porcentaje es el más bajo.

A base de estos resultados, se recomienda usar las variedades con los porcentajes más altos de polen viable, como plantas-padres.

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