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Observation on Natural Outcropping in the Tomato (Lycopersicon Esculentum L.) in Northwest Arkansas

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An Observation on Natural Outcrossing in the Tomato (*Lycopersicon esculentum* L.) in Northwest Arkansas

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ABSTRACT

A single tomato plant homozygous for the recessive anthocyaninless mutant, ae, was grown in the middle of an experimental tomato plot at the University of Arkansas Agronomy Experimental Station Farm in Fayetteville. Progeny tests of seeds harvested from this plant indicated that only 0.7% of the seeds were the result of outcrossing to other plants.

In genetic studies on tomato at the University of Arkansas it has been common to produce F_2 generations by establishing the F_1 plants in field plots and allowing them to set seed. These seeds were presumed to have resulted from self pollination, and the progeny to have represented a true F_2 family. Recently such practice was questioned when, in explaining low yields of the mutant **Cu** from field grown F_1 plants, Alexander et al. (1971) noted that "in this area (Wooster, Ohio), most if not all tomato flowers are pollinated by bumblebees."

Jones (1916) reported a minimum of 2-3% outcrossing in Connecticut. Lesley (1924) showed that the length of the style was a factor in the extent of outcrossing in California: 5% for the long styled variety Magnus and 0.6% for the short styled Dwarf Champion. Bumblebees were seen to visit the flowers in this experiment. The role of the short style in facilitating self pollination has since been shown by Schneck (1928), Robbins (1931), Rick and Dempsey (1969), and Free (1970).

Myers and Lewis (1930) reported only 0.53% outcrossing in Pennsylvania. Young (1940) found up to 1.8% in Texas and even 0.7% in greenhouse plants. Currance and Jenkins (1942) compared the degree of outcrossing in South Carolina with that in Minnesota. Both areas gave a maximum of 5% outcrossing with 6-ft separations between plants. This amount decreased with an increase in distance from the foreign pollen; no outcrossing was seen beyond 72-90 ft.

Rick's (1947) observations substantiated these findings. He reported that the solitary bees which pollinate tomato flowers in northern California work over small areas before returning to the hive. This resulted in 4% seed set on male sterile plants only 6 inches removed from a fertile plant, but reduced amounts of fruit set on male sterile plants separated from the pollen source by more than 6 inches.

Much higher rates of outcrossing can be obtained with male sterile plants in different localities (Rick, 1949). In certain areas with plants 4½-5 ft apart, 47% of the normal seed set was obtained. Two factors are involved: proximity to pollen vector and lack of competition for self fertilization. The studies of Richardson and Alvarez (1957) eliminated the second factor; they used a recessive leaf shape mutant rather than male steriles to test for outcrossing. At certain times of the year 17% outcrossing was obtained in areas near good pollinator habitats. (The pollinator was the halictid bee, *Augochloropsis ignita* Sm.) However, in some areas only 0.3% outcrossing was found, even with plants as close as 1 m to the pollen source. In Peru a similar study showed from 15 to 26% outcrossing (Rick, 1958).

It appears that although the stigma position, proximity of foreign pollen, and competition of pollen from the same plant all play a role in determining the amount of outcrossing, the activity of the pollinators is the most important factor. Therefore, one might expect great differences between different areas. However, all of the studies in the United States east of the Rocky Mountains have shown less than 5% outcrossing, indicating uniformly low pollen vector activity.

MATERIALS AND METHODS

A recessive anthocyaninless mutant, **ae**, in the genetic background of *Lycopersicon esculentum* cv Kokomo was chosen for study. Throughout the summer of 1972 (28 April to 28 August) a single plant homozygous for **ae** was grown in the middle of a 76-m row of tomatoes being used in other genetic studies at the University of Arkansas Agronomy Experimental Station Farm, Fayetteville, Arkansas. This row was bounded on either side by two or three rows of additional tomato plants. The unstaked plants were 46-61 cm apart and were allowed to intertwine on the ground between and within rows. Flowering time of the experimental plant was completely overlapped by the flowering time of one or more adjacent plants. Although the other plants in the plot represented several mutants and several varieties, there is no reason to suspect any incompatibilities between them. None of the other plants carried the **ae** gene in homozygous or heterozygous condition.

The stigmas of the test plant flowers were effectively exerted up to 1 mm beyond the tips of the anthers. (Most of the extension was due to the reflexed tips of the anthers rather than to a greatly elongated style.)

Seeds of the test plant were harvested on 28 August 1972 and sown in the greenhouse to screen for progeny having the ability to produce anthocyanin. Those progeny producing anthocyanin were presumed to have arisen by outcrossing, although no observations of pollen vector activity were recorded.

RESULTS

From the one **ae** plant 660 seeds were harvested and sown. Of these only 420 germinated. Three (0.7%) of the 420 progeny had the ability to produce anthocyanin. To rule out the possibiltiy that these were due to accidental seed mixture, each of these plants was selfed by hand in the greenhouse and F_2 progenies raised. All three F_2 populations contained approximately 25% green stemmed plants.

The three plants presumed to have resulted from outcrossing were among the earliest germinating and most vigorous of the 420 progeny. Thus the effect, if any, of the low rate of

germination was probably to inflate the value obtained for outcrossing.

Previous workers (Jones, 1916; Lesley, 1924; Rick, 1958) have applied correction factors to their data, stating that some crossing between flowers on the same plant or between plants carrying the same recessive allele must have occurred. Because crossing between flowers of the same plant was not considered outcrossing in the writer's study, and because all other plants in the area were known not to contain the **ae** allele, no correction factor was applied.

The degree of outcrossing found in the study would lower the expected percentage of homozygous recessives in an F_2 from 25 to 24.8% , a difference which would not be detectable unless very large numbers of progeny were raised. Hence the present practice of obtaining F_2 families from open pollinated F_1 plants can be expected to give reliable results. Production of seed without significant outcrossing may be accomplished with a minimum of separation between plants of different varieties.

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