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Natural Cross Pollination in California Commercial Tomato Fields

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The literature does not provide unanimous or compelling data to suggest how much natural cross pollination (NCP) occurs in California's commercial tomato fields, where 80% to 85% of U.S. processing tomatoes are grown. If pollen containment could be assured, testing genetically transformed tomato varieties under commercial conditions would be desirable from an industry viewpoint.

Lesley (1924) and Currence and Jenkins, (1942) suggested that maximum NCP was as high as 5% in three locations using normal, fertile, open-pollinated varieties with recessive genes, which could be progeny tested to determine NCP. Rick (1949) used male-sterile tomato lines in 16 diverse ecological-zone locations within California. When comparing hybrid seed yield per male-sterile plant as a percentage of the equivalent fertile plant yields, he found NCP varied from 1.9% to 47%. Because male-sterile plants do not produce functional pollen to compete with vector-transmitted pollen, Rick expected NCP rates based on male-sterile plants to be higher. Hafen and Stevenson (1956) used male-sterile lines in seven tests over 2 years in Indiana. After adjusting for selfing in the male steriles, only 0.0092% to 0.0207% NCP was found in the sterile plants compared to the fertile lines.

Richardson and Alvarez (1956) reported 0.3% to 1.9% NCP over 3 years at the Chapingo Research Station, Mexico. They used a recessive marker gene in two fertile varieties. However, they reported that at three other stations, having higher insect activity, NCP averaged 3.3%, 5.2%, and 7.0%, based on five harvests of two varieties in 1953. All authors have indicated that insect activity is the uncontrolled variable in tomato NCP.

In California, commercial seed is typically produced from stock seed strips in tomato production fields. Isolation, if any, may be a fallow row on either side of the seed variety separating it from the commercial variety by 1.65 m. Industry experience shows that <1% rogues are found in stock seed or commercial seed produced from stock seed in the Central Valley of California. These varieties are adapted to the area's high temperatures and typically set fruit well via self pollination. Style exsertion, which favors cross pollination, is not present.

Experiments were conducted in two fields over 3 years to estimate NCP in the Central Valley of California using a tomato line that contains the *ah* (Hoffman's anthocyaninless) recessive gene in a fertile inbred line. This line has typical commercial flower morphology with no evident style exsertion. R.W. Robinson in Geneva, N.Y., provided the tomato variety NY78-265 that possessed the gene. Two blocks (18 × 18 m) were established in each field to determine whether distance from an adjacent crop and associated insect pollen vectors might be a factor in NCP. The corner block was 4.5 m within a field on two sides. A center block was established 91 m from two sides of the field perimeter. A 27-kg sample of ripe tomatoes was harvested from each of nine sites (3.5 m apart) within each block in a north–south and east–west cross pattern. From each sample, 10,000 seeds were counted and germinated to evaluate hypocotyl color. Anthocyanin-pigmented hypocotyls were counted as hybrid seeds (*Ah–ah*) to determine percent NCP within each sample.

A low level (mean = 0.0721%) of natural cross pollination was measured from both blocks in all fields (Table 1). No significant difference ($P \leq 0.05$) in NCP could be found between corner and center blocks or between field locations. Although there was no obvious effect on NCP from the adjacent crops and associated insect vectors, the bean crop at 9-m distance was associated with the highest NCP in 1988. An attempt to repeat the bean crop environment in the 1990 experiment failed to yield the appropriate data.

Even the highest NCP (0.408%) in these commercial California fields was low compared to previous investigations using fertile plants.

Due to the experimental design, our results overestimate the effect of NCP on large commercial seed production. The results suggest that small test plots of genetically transformed varieties have a low probability of NCP with surrounding tomato plants.

Table 1. Natural cross pollination (NCP) of commercial tomato fields in California.[z]

Location	Block	NCP (%)	Adjacent crop (direction)[y]		Adjacent crop distance (m)[y]	
Woodland	Corner	0.0131[NS]	Alfalfa (N)	Corn (S)	15 (N)	30 (S)
	Center	0.0007[NS]	Alfalfa (N)	Corn (S)	120 (N)	120 (S)
Tracy	Corner	NA[x]				
	Center	0.0064[NS]	Beans (W)	Beans (S)	120 (W)	120 (S)
Woodland	Corner	0.0769[NS]	Wheat (S)[w]		9 (S)	
	Center	0.0104[NS]	Wheat (S)[w]		150 (S)	
Tracy	Corner	0.0168[NS]	Alfalfa (N)[w]		9 (N)	
	Center	0.0383[NS]	Alfalfa (N)[w]		120 (N)	
Woodland	Corner	0.0209[NS]	Wheat (N)[w]		9 (N)	
	Center	0.1023[NS]	Wheat (N)[w]		120 (N)	
Tracy	Corner	0.4080[NS]	Beans (W)	Alfalfa (S)	9 (W)	24 (S)
	Center	0.0994[NS]	Beans (W)	Alfalfa (S)	120 (W)	120 (S)

[z]Twelve 18-m-long plots carrying a recessive anthocyaninless gene were planted in commercial fields. The cross pollination distance was ≈1.5 to 10 m from any plant in the anthocyaninless block.
[y]N = north, S = south, W = west.
[x]Data not available due to commercial harvest of experimental plants.
[w]No adjacent crop planted to the west because of a highway or a levee.
[NS]Nonsignificance at $P \leq 0.05$.

Literature Cited

Currence, T.M. and J.M. Jenkins. 1942. Natural crossing in tomatoes as related to distance and direction. Proc. Amer. Soc. Hort. Sci. 41:273–276.

Hafen, L. and E.C. Stevenson. 1956. Natural cross pollination in tomato using several male-sterile mutants. Proc. Amer. Soc. Hort. Sci. 68:433.

Jones, D.F. 1916. Natural cross-pollination in the tomato. Science 43:509–510.

Richardson, R.W., Jr., and E. Alvarez L. 1957. Pollination relationships among vegetable crops in Mexico. I. Natural cross-pollination in cultivated tomatoes. Proc. Amer. Soc. Hort. Sci. 69:366–371.

Rick, C.M. 1949. Rates of natural cross-pollination of tomatoes in various localities in California as measured by the fruits and seeds set on male sterile plants. Proc. Amer. Soc. Hort. Sci. 54:237–252.

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