the first harvest date showed no differences among the chemical treatments, but fruit treated with NAA from the second harvest date were more commonly graded into the processing category because of the excessive bruising of these softer fruit.

Summer pruning significantly increased estimated net return, as did the use of daminozide (Table 3). Summer pruning and daminozide increased net returns to a similar degree, 13% and 15%, respectively; however, it should be noted that daminozide did not control drop effectively in these trees in 1988. Daminozide may be expected to provide more economic benefit in years when it reduces drop significantly.

We have shown that summer pruning can significantly improve fruit coloring, allow more fruit to be harvested earlier, and reduce the losses to preharvest abscission. Pruning can be performed from 1 July to 1 Sept. in the climate of New England and in similar areas with similar benefits. This technique provides one means whereby apple growers can reduce the dependence on daminozide for 'McIntosh' production.

Literature Cited

- Autio, W.R. 1989. An overview of the New England apple industry. *Fruit Notes* 54(4):12-17.
- Greene, D.W. and W.J. Lord. 1983. Effects of dormant pruning, summer pruning, scoring, and growth regulators on growth, yield, and fruit quality of 'Delicious' and 'Cortland' apple trees. *J. Amer. Soc. Hort. Sci.* 108:590-595.
- Leahy, K., R.J. Prokopy, and W.M. Coli. 1989. New trap-capture

- thresholds for tarnished plant bug and European apple sawfly in Massachusetts apple orchards. *Fruit Notes* 54(2):8-11.
- Lord, W.J. and D.W. Greene. 1982. Effects of summer pruning on the quality of 'McIntosh' apples. *HortScience* 17:372-373.
- Marini, R.P. and J.A. Barden. 1982. Yield, fruit size, and quality of three apple cultivars as influenced by summer or dormant pruning. *J. Amer. Soc. Hort. Sci.* 107:474-479.
- Miller, S.S. 1982. Regrowth, flowering, and fruit quality of 'Delicious' apple trees as influenced by summer pruning. *J. Amer. Soc. Hort. Sci.* 107:975-978.
- Morgan, D.C., C.J. Stanley, R. Volz, and I.J. Warrington. 1984. Summer pruning of 'Gala' apple: The relationships between pruning time, radiation penetration, and fruit quality. *J. Amer. Soc. Hort. Sci.* 109:637-642.
- Myers, S.C. and D.C. Ferree. 1983. Influence of time of summer pruning and limb orientation on yield, fruit size, and quality of vigorous 'Delicious' apple trees. *J. Amer. Soc. Hort. Sci.* 108:630-633.
- Porter, G.M. 1988. Massachusetts apple report. *Mass. Dept. Food Agr.* 66(16):1-4.
- Preston, A.P. and M.A. Perring. 1974. The effect of summer pruning and nitrogen on growth, cropping and storage quality of Cox's Orange Pippin apple. *J. Hort. Sci.* 49:77-83.
- Stiles, W.C. 1980. Pruning, growth regulator, and nutrition studies with apples. *Annu. Rpt. Maine State Pomol. Soc.* 1980:25-34.
- Stiles, W.C. 1981. Summer pruning and growth regulator effects on 'McIntosh' apples. *Annu. Rpt. Maine State Pomol. Soc.* 1981:26-29.
- Vincent, C.C. 1917. Winter versus summer pruning of apple trees. *Idaho Agr. Expt. Sta. Bul.* 98.

J. AMER. SOC. HORT. SCI. 115(3):359-363. 1990.

Three-year-old Pecan Pollen Retains Fertility

I.E. Yates

Russell Research Center, Agriculture Research Service, U.S. Department of Agriculture, Athens, GA 30613

Darrell Sparks

Department of Horticulture, University of Georgia, Athens, GA 30602

Additional index words. *Carya illinoensis*, plant breeding, fruit set, fruit growth

Abstract. Stored pollen from pecan [*Carya illinoensis* (Wangenh.) C. Koch] was analyzed for in vitro germination, fertilization efficiency, final fruit set, and characteristics of mature fruits. We demonstrate pecan pollen can be stored for several years and set fruit. Pollen stored for 1, 2, and 3 years at -80C and 1 year at -196C retained the capacity for fertilization. Pollen stored at -196C was more viable than pollen stored at -80C, with no significant correlation between length of storage at -80C, as judged by fruit abortions during the second drop. Final fruit set was not affected by pollen storage conditions, except for pollen collected in a season of drought. Fruit set is a more reliable indicator of pollen viability than in vitro germination. With two minor exceptions, fruits produced with stored pollen were similar to those developing after pollination with fresh pollen.

Flowering within pecan is heterodichogamous. As a result of this developmental pattern, temporal differences exist both within and among cultivars for maturity of staminate and pistillate flowers. The degree of dichogamy may vary among seasons and locations (Smith and Romberg, 1940; Sparks, 1987). This reproductive mechanism sometimes results in the need for reserve supplies of viable pecan pollen for experimental breeding and commercial mass pollination programs. In breeding programs,

artificial maintenance of functional pollen over long periods would allow for crosses between cultivars with flowering extremes. Functional pollen stored for 1 year would be required to hybridize a cultivar with early pistillate flower receptivity (e.g., 'Moneymaker') with pollen from a cultivar whose staminate flowers mature late (e.g., 'Stuart'). In addition, prolonged pollen survival may serve as a means for long-term conservation of genetic material in pollen banks (Towill, 1985). Such germplasm preservation strategies can be efficient, economical, and space-saving, and these methods may be suitable as a supplement to more classical preservation systems using seeds and vegetative material.

In commercial pecan orchards, growers could mass-pollinate when pollen is limiting (Bennett et al., 1986). Like the breeder,

Received for publication 16 May 1989. Trade names are used in this publication to provide specific information. Mention of a trade name does not constitute a guarantee or warranty of the product or an endorsement by the USDA over other products not mentioned. The cost of publishing this paper was defrayed in part by the payment of page charges. Under postal regulations, this paper therefore must be hereby marked *advertisement* solely to indicate this fact.