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MANAGING CROP LOADS IN PECAN

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ALTERNATE BEARING

Pecan fruit production is erratic and is typified by a year of high production followed by one or more years of low production. Lack of return bloom has been associated with early defoliation (Hinrichs 1962, Worley 1979) and with the inhibitory effect of developing fruit on return bloom (Crane et al. 1934, Malstrom and McMeans 1982, Smith et al. 1986, Reid et al. 1993). Crane et al. (1934) reported that 8 to 10 leaves per nut was the optimum leaf to fruit ratio for young 'Moore' trees (≈140 nuts/lb.) to induce annual crops. Removing 'Stuart' fruit during the early dough stage of kernel development improved return bloom (Sparks and Brack 1972). Fruit removal increases the leaf to fruit ratio and removes the inhibitory effect of developing fruit on pistillate flower induction.

Pecan flower and fruit development (Sparks 1986), and the alternate bearing problem (Sparks 1974, Wood 1991) have been reviewed. Alternate bearing is apparently caused by a lack of stored carbohydrates during the fall, coupled with certain phytohormonal or growth-regulator balances to control flower induction and development (Sparks 1974, 1986; Smith et al. 1986, Wood 1991). Sparks (1974, 1986) and Wood (1991) pointed out that although both endogenous growth regulators and carbohydrate reserves regulate flowering, carbohydrates are often the most limiting factor controlling flower initiation and development. This hypothesis supports orchard management which promotes healthy leaves with a high leaf to fruit ratio to reduce alternate bearing.

FRUITING STRESS

Excess fruit loads cause several problems in addition to alternate bearing. Heavy fruit loads frequently result in a large percentage of poorly developed kernels that are either not marketable or have little value (Hunter 1968, Reid 1986). This problem is more severe in cultivars with large fruit size or that have several fruit per cluster. Also the problem of over-production resulting in poor fruit quality becomes more severe as the trees mature, probably because leaf to fruit ratios decline.

Susceptibility to cold damage is substantially increased when trees are over-loaded with fruit (Smith and Cotten 1985, Wood 1986, Smith et al. 1993a). Cultivars vary in susceptibility to cold injury (Cochran 1930, Hinrichs 1965, Madden 1978, Payne and Sparks 1978, Smith and Couch 1984, Wood 1986, Smith et al. 1993a), but susceptibility can be highly confounded by crop load. In fact, relative crop loads should be reported when cold hardiness of cultivars is reported after a test winter.

Shuck (involucre) disorders have also been associated with crop over-loads. Stick-tights (shucks which would not open at fruit maturity) were decreased in over-loaded 'Mohawk' trees by partial crop removal (Smith and Gallott 1990). Shuck decline (also called shuck dieback, shuck disease, and tulip disease) was decreased in 'Wichita' trees by partial crop removal (Sparks et al. 1994).

Tree breakage is increased by over-production. Breakage becomes common on over-loaded trees when fruit reach the dough stage, and is more severe on certain cultivars, on trees that are poorly trained, cultivars with an upright tree structure, and in climates subject to violent thunder storms. At times loss from tree breakage can be substantial, both from clean-up costs and tree losses.

FRUIT THINNING

Substantial evidence exists that fruit thinning can be used with good cultural practices to reduce the deleterious effects of over-production. Fruit thinning is commercially successful on other crops, such as apple and peach, to manage crop loads for high fruit quality and uniform annual cropping. Work on pecan suggested that fruit removal would enhance return bloom (Sparks and Brack 1972), that there was an optimum leaf to fruit ratio to achieve relatively uniform annual cropping (Sitton 1931, Crane et al. 1934), and that over-production caused poor-quality, low-value nuts (Hunter 1968, Reid 1986).

Several scientists have evaluated various chemical fruit thinning agents on pecan (Dodge 1944, Sharpe 1955, Smith and Harris 1957, Amling and Dozier 1965, Hinrichs et al. 1971, Wood 1983, 1985). Although some of these thinning agents have shown promise, none have been registered for use on pecan, and the likelihood that one will is minimal.

The first mechanical fruit thinning trials were conducted in 1984 on over-loaded 'Mohawk' trees in central Oklahoma. We used a tractor-mounted trunk shaker fitted with hard neoprene pads, typical of trunk shakers used in Oklahoma. The bark on ≈10% of the trees we shook during August was damaged. Therefore, we converted the pads to a donut style, typical of those used for cherries. Grease was applied under the flaps covering the donut pads to allow any slippage at this site rather than damaging the bark. This arrangement eliminated all trunk damage.

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Preliminary mechanical fruit thinning trials in 1986 and 1988 indicated that partial crop removal while fruit were in the liquid endosperm stage (water stage) improved kernel percentage of 'Mohawk' and 'Shoshoni' and increased nut weight and kernel grade of 'Mohawk' (Smith and Gallott 1990). Return bloom of 'Shoshoni' was substantially increased; however, neither thinned nor unthinned 'Mohawk' trees flowered the following year. These results suggested that mechanical fruit thinning was a viable approach to combating the problems of poor fruit quality during years with over-production and alternate bearing. However, we needed to determine the optimum time to thin fruit and the optimum crop load to achieve high-quality fruit with adequate return bloom.

First we determined the optimum time to thin by hand removing fruit at selected times, then measuring return bloom. Fruit were removed on 'Mohawk', 'Giles', and 'Gormely' trees at five times during the growing season as determined by fruit phenological age: immediately after post-pollination drop, at 50% ovule expansion, at 100% ovule expansion or water stage, during the onset of the dough stage, and 2 weeks after the dough stage (Reid et al. 1993). Return bloom of all cultivars was increased by fruit removal during ovule expansion. Removing 'Mohawk' and 'Giles' fruit shortly after pollination induced the greatest return bloom. Return bloom in the small-fruited 'Gormely' was equally stimulated by fruit removal at any time from post-pollination through ovule expansion, a result indicating that early fruit removal may be more important for large- than for small-fruited cultivars. Our studies indicated that the fruit should be thinned as soon as feasible, with the benefits of thinning diminishing rapidly when nuts reach the dough stage. Experience has indicated that fruit cannot be dislodged from the tree with a trunk shaker until the ovule is about 50% expanded.

Next we used two cultivars, 'Mohawk' a large- fruited cultivar and 'Giles' a medium-fruited cultivar, to determine optimum crop load (Smith et al. 1993b). Trees bearing an excessive crop load were thinned during ovule expansion with a trunk shaker to give a wide range in the percentage of shoots that retained fruit clusters. Fruit thinning improved the kernel percentage (Fig. 1), nut weight, and kernel grade (Fig. 1) of 'Mohawk', but nut characteristics of 'Giles' were not affected by fruit thinning. Cold injury of 'Mohawk', caused by a sudden temperature drop in the fall, was decreased by fruit thinning (Fig. 2). Fruit set of both 'Mohawk' and 'Giles' (Fig. 3) the following year was improved by fruit thinning. Relatively uniform yields of 'Giles' were obtained in 1991 and 1992 when trees were thinned to 60% to 70% of the shoots retaining fruit in 1991 (Table 1). We recommend that 'Mohawk' trees be thinned so that 50% to 60% of shoots at mid-canopy height retain fruit after thinning, and 'Giles' be thinned to 65 to 70% of the shoots retaining fruit. Although our recommendations are based on the percentage of shoots retaining fruit, we want to point out that cluster size is reduced in the clusters that remain (Smith et al. 1993b, Sparks et al. 1994). Thus, if thinning reduces the fruit load from 90% of the shoots with fruit clusters to 50% of the shoots with clusters, about 60% to 70% of the fruit may be removed.

Several production problems associated with over-production were addressed in a fruit thinning study conducted in south Texas by Sparks et al. (1994). Pecans grown in climates with warm temperatures during fruit maturation frequently germinate before shucks open (vivipary), rendering them unmarketable. This study was conducted in an area of Texas that frequently experiences problems with vivipary. Also, certain cultivars are extremely susceptible to shuck decline, resulting in unmarketable nuts. 'Wichita', one of the most susceptible cultivars to shuck decline, was thinned with a mechanical shaker to reduce the crop by 0% to 77%. Fruit thinning decreased shuck decline and premature germination, and increased the percentage of edible kernels (see Pecan Shuck Disorder — A Horticultural View in this proceedings). The maximum marketable kernel yield corresponded to 72% of the shoots retaining fruit. Subsequent observations indicated that return bloom was adequate when about 25% of the shoots retained fruit.

We have frequently observed that nut quality of some medium- to large-fruited cultivars can be substantially improved by thinning with little effect on return bloom. Adequate return bloom of these cultivars can be achieved, but the trees must be thinned more severely. In some cases, sufficient thinning to achieve adequate return bloom is not feasible because little crop would remain. On other medium- to large-fruited cultivars improved nut quality with adequate return bloom can be achieved with moderate thinning levels. The most consistent response observed with small-fruited cultivars has been improved return bloom. There is usually little effect on nut quality of small-fruited cultivars, unless they have large fruit clusters.

Pecan growers in several states are using mechanical thinning on a trial basis. If mechanical thinning proves to be commercially feasible, both scientists and growers will refine techniques and recommendations. For instance, by shaking a large tree at right angles thinning uniformity can be improved. It is likely that thinning goals will need to be developed for each of the major cultivars. Also, thinning goals may be developed to ensure good nut quality, and a second goal that would ensure good quality and return bloom. Limited observations suggest that the tree structure of some cultivars are more adaptive to mechanical thinning than others. Estimating crop loads while thinning is difficult, and improved methods may be needed. Also, if mechanical thinning is adapted by the industry, several of the prolific cultivars that were discarded may need to be reevaluated.

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Table 1. Yield of 'Giles' the year fruit were thinned (1991) and the following year (1992).

		Yield (kg/tree)		
Thinning	Fruiting shoots retained (%)	1991	1992	Total
None	90 - 98	31	3	34
Light	70 - 80	28	5	33
Medium	80 - 90	21	10	31
Heavy	60 - 70	18	16	34

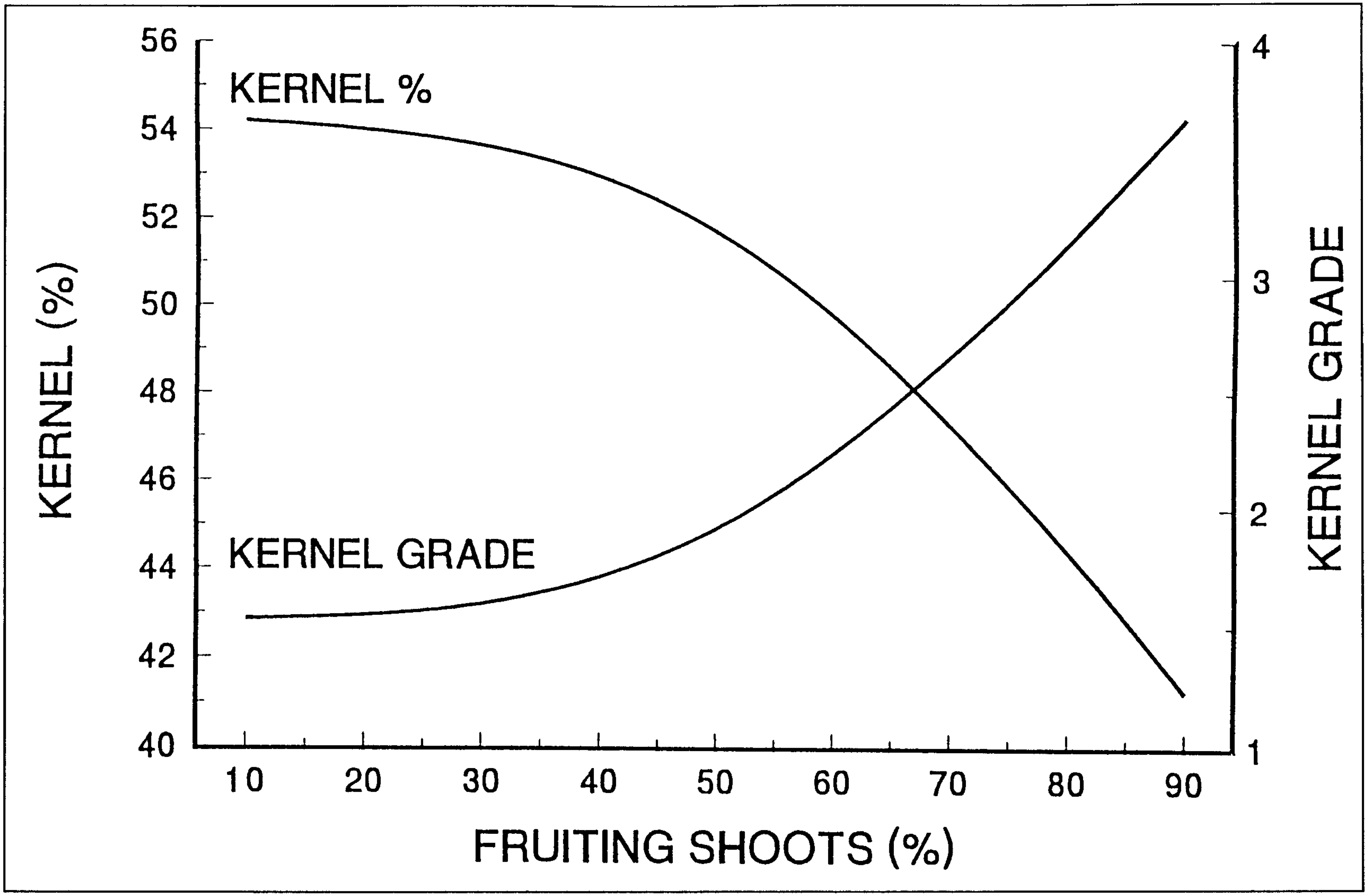

Figure 1. The relationship between the percentage of fruiting shoots per tree after fruit thinning 'Mohawk' pecan and the kernel percentage ($y = 54.4 - 2 \times 10^{-5}x^3$, $r^2 = 0.64$***) or kernel grade ($y = 1.6 + 2.8 \times 10^{-6}x^3$, $r^2 = 0.73$***). Kernel grade: 1 = brightly colored, full bodied and solid, 2 = brightly colored and light weight, 3 = amber, and 4 = poorly developed and shriveled. The kernel rating system did not consider insect damage.

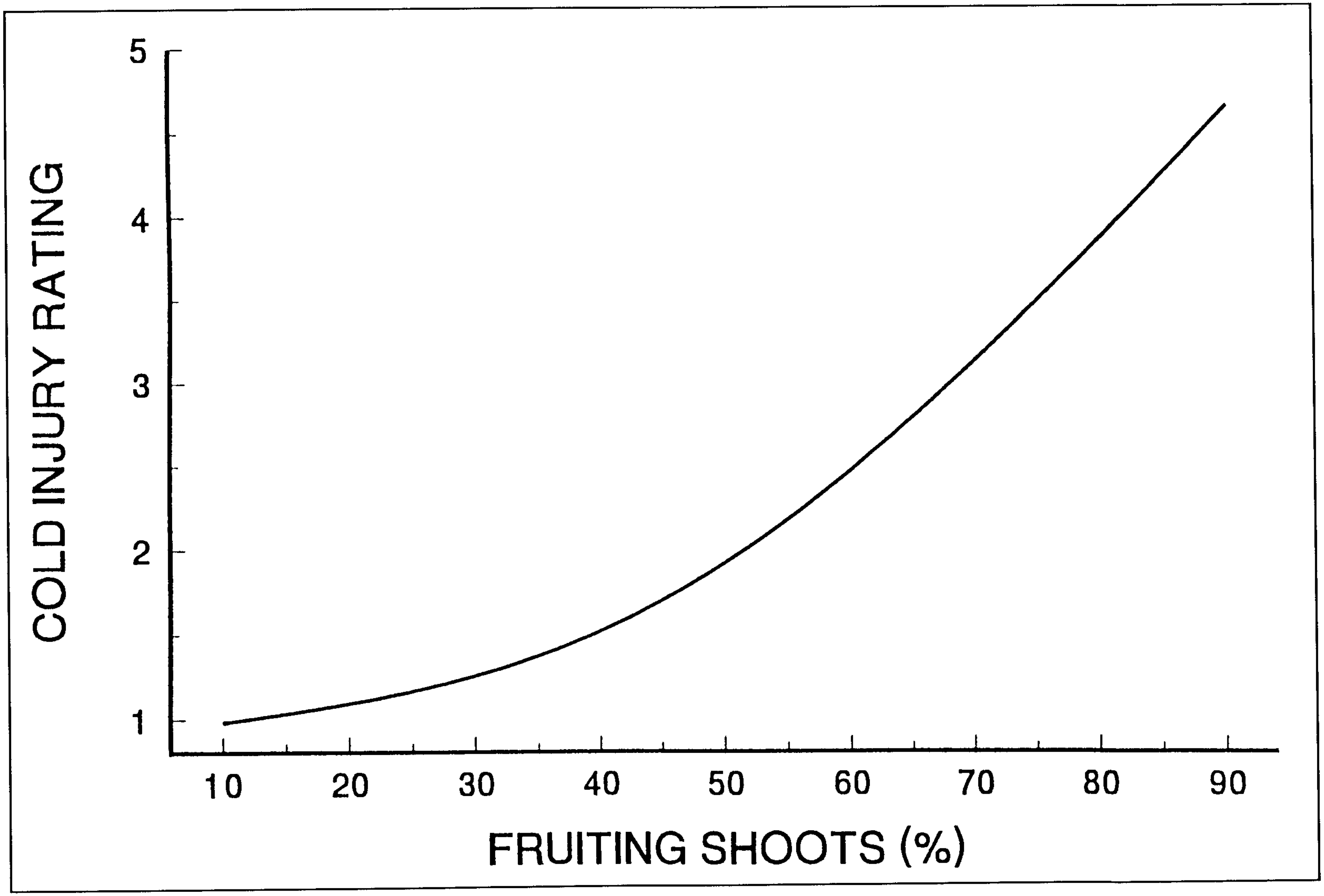

Figure 2. The relationship between the percentage of fruiting shoots per tree after thinning 'Mohawk' pecan on 31July 1991 and the tree cold injury that occurred on 2 and 3 Nov. 1991 ($y = 1.1 + 5.1 \times 10^{-6}x^3$, $r^2 = 0.72$***). Cold injury was rated during June 1992 using the following scale: 1 = no injury, 2 = death of many 1- and 2-year-old shoots, 3 = death of ≥ 3-year-old branches, but no scaffold death, 4 = death of at least one scaffold limb, and 5 = tree death.

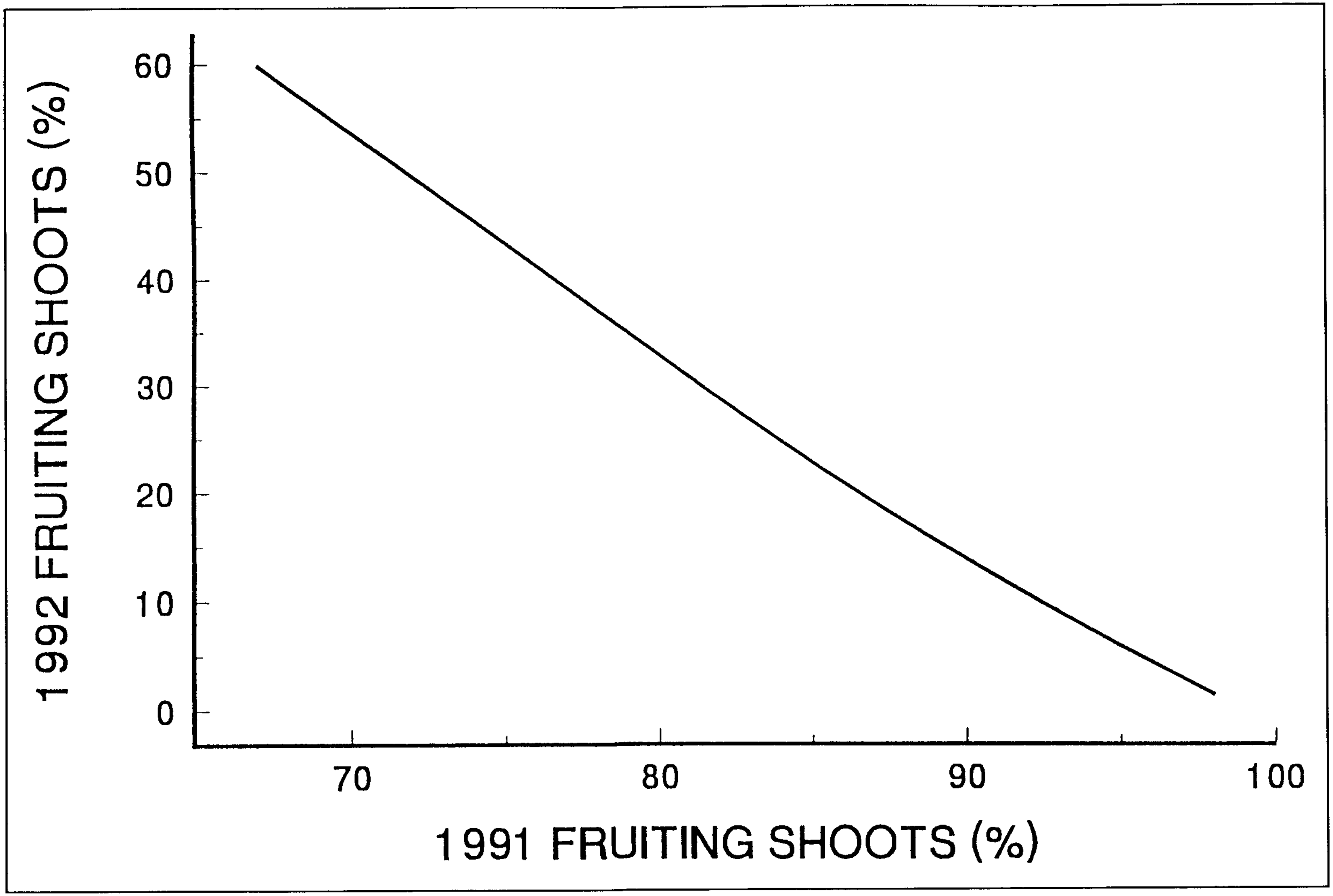

Figure 3. The relationship between the percentage of fruiting shoots per tree after thinning 'Giles' pecan in 1991 and the percentage of fruiting shoots in 1992 ($y = -46.1 + 469576/x^2$, $r^2 = 0.51$***).