MODERATOR STEAVENSON: Our final discussion for this morning's session will be presented by Mr. Loy Shreve, who is a guest of the Society. Mr. Shreve is from Manhattan, Kansas, and will discuss "Some Effects of Gibberellic Acid on Year-Old Pecan Seedlings".

SOME EFFECTS OF GIBBERELLIC ACID ON YEAR-OLD PECAN SEEDLINGS[1]

BY LOY W. SHREVE AND RONALD W. CAMPBELL[2]

Pecan seedlings may require several growing seasons to reach a size suitable to graft or bud. Reducing that time would reduce production costs. Also, pecan growers who propagate their own trees could have producing trees sooner.

Gibberellic acid applications increased the height of one-year seedling yellow poplar, sweet gum, cherrybark oak, willow oak, and southern red oak (Nelson, 1957). GA_3 increased stem elongation of newly germinated pecan seedlings grown under greenhouse conditions (Martin and Wiggins, 1961). GA_3 treated black walnut, willow oak, and loblolly pine seedlings were 40% taller and twice as thick as untreated seedlings (U.S.D.A., 1958).

This study attempted to determine: 1. if field applications of GA_3 increased pecan seedling growth for budding and grafting earlier than untreated pecan seedlings; 2. if time of application affected response; and 3. response of pecan seedlings to repeated GA_3 treatments.

MATERIALS AND METHODS

Stratified northern hardy pecan seed was planted in a sandy loam soil at the Ashland Horticultural Farm near Manhattan, Kansas, in April, 1965. Seeds were planted six inches apart in three rows spaced four feet apart.
Seedlings were weeded and irrigated as needed. Twenty-four plots each containing nine seedling pecan trees were used. Ten unsprayed control seedlings separated sprayed plots. Five seedlings in each of the 24 plots were sprayed June 20, 1966, with an aqueous solution of 5,000 ppm GA_3. Each sprayed tree in each treated plot was separated from the other treated trees by an unsprayed guard tree.

Sixty trees in twelve untreated plots, laid out as described above, were sprayed July 20. Sixty trees sprayed June 20, received a second application of GA_3 at 5,000 ppm July 20.

Spray applications were made with a hand operated compressed air sprayer. Three drops of a surfacant, Tween 20, was added to each 135 ml. of spray. The pH of the spray solution was 3.2. Plants were sprayed to run off. Excessive dam-

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age from spray drift was prevented by covering seedlings with a polyethylene bag and inserting the spray nozzle into the bag.

A side dressing of 20-10-5 fertilizer at 350 pounds per acre was applied August 20, 1966, to all seedlings in uniform eight-inch bands on each side of the row just before irrigating.

Twenty trees selected at random from groups treated once in June and in July and others sprayed twice were dug and prepared in early December and prepared for study, as were 118 unsprayed control trees. Measurements recorded included stem and root length, collar and stem diameter four inches above the collar. All samples were cut to approximately half inch pieces and oven dried ten days at 70°C. Data then collected included dry weights of stems, roots and entire plants. The ratio of dry weights of stem: root was calculated. Analysis of variance was calculated for each value obtained, and effects of treatments were compared by the Duncan Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Table 1 shows response in growth of pecan seedlings to spray applications of GA_3 at 5,000 ppm. Comparisons can be made among trees sprayed in June or in July and those sprayed both months.

Seedlings sprayed with GA_3 in July had longer stems, greater stem diameters and heavier stems than controls. However, average dry weights of roots and root length were less than for control trees. The stem: root ratio was greater for sprayed trees than for controls while the average collar diameters and total dry weights did not differ significantly.

The same pattern was repeated essentially for trees receiving two sprays except that differences were greater, as shown by significance at the 1% level and a much greater stem: root ratio.

Cumulative effects of the two GA_3 sprays gave significantly longer stems, greater stem dry weights, and lighter roots than trees sprayed only once in June or July (Table 11). Also, trees sprayed twice had significantly larger stem diameters than June sprayed trees and significantly greater stem: root ratios than seedlings sprayed only once in June or July.

The only significant difference between trees sprayed only in June or only in July was in stem: root ratio, which was larger for July sprayed trees.

Date-of-spraying differences probably resulted from the amount of GA_3 that penetrated into leaves of trees treated later. Both temperature (Van Overbeek, 1956) and surface area treated (Sargent, 1965) apparently affect the penetration into leaves. Average high temperature June 15 to 25 was just above 85°F. Average high temperature July 15 to 25 was nearly 94°F. Those two factors may also account for differences in response between trees sprayed twice and those sprayed once in June or July.

Table 1 Some effects on growth of year-old pecan seedling trees from aqueous sprays of GA_3 at 5,000 ppm in 1966

Date treated		Mean Measurements, inches: Stem length	Root length	Collar diameter	Stem diam 4 in above collar	Mean Weights, grams: dry wt Stem	dry wt Root	dry wt Total	Ratio dry wt stem root
6/20/66	a.	17.930	18.952	.388	.333	11.894	25.868	37.761	.544
		**	ns	ns	ns	*	*	ns	**
	b.	11.180	21.280	.441	.295	8.450	36.342	44.788	.238
7/20/66	a.	21.515	20.280	.437	.388	14.927	15.245	30.172	1.058
		**	*	ns	**	**	**	ns	**
		9.700	24.674	.415	.268	5.891	33.011	38.953	.182
6/20/66 and 7/20/66	a.	27.833	21.718	.442	.411	22.947	11.276	34.223	1.983
		**	ns	ns	**	**	**	ns	**
	b.	11.180	21.280	.441	.295	8.450	36.342	44.788	.238

(a) treated seedlings
(b) control seedlings

* significant at 5%
** significant at 1%

ns non-significant at 5%

Table 2 Effects of spray applications of 5,000 ppm GA_3 on growth and development of year-old pecan seedlings.

	Mean measurements, inches				Mean weights, grams			
Date treated	Stem length	Root length	Collar diameter	Stem diam 4 in above collar	Stem dry wt	Root dry wt	Total dry wt	Ratio dry wt stem root
6/20/66	17.930a	18.952a	.388a	.333a	11.894a	25.868a	37.761a	.544
7/20/66	21.515a	20.280a	.437a	.388ab	14.927a	15.245a	30.172a	1.058
6/20/66 and 7/20/66	27.833b	21.718a	.442a	.411b	22.947b	11.276b	34.223a	1.983

Values with the same letter are not significantly different at 5%
Values with unlike or no letters differ significantly at 5%

This study generally confirms findings of Martin and Wiggins (1961) with one exception. They reported only limited growth of pecan seedlings over 51 days of growth regardless of concentration used or number of spray applications. We found repeated application of GA_3 increased stem growth of year old pecan seedlings. They found that increasing soaking time of pecan seeds with GA_3 from 12 to 192 hours reduced root dry weight and total dry weight and total dry weight of seedlings germinated.

Seedlings sprayed in June were larger than untreated trees when both groups were sprayed in July. The greater surface area of seedlings treated in June allowed them to receive more spray solution and therefore a higher concentration of GA_3 which apparently increased stem length and dry stem: dry root ratio over trees sprayed only in July.

Mango seedling stocks sprayed a second and third time with GA_3 responded with stem elongation within a month after each treatment and had longer stems and larger stem diameters than trees treated once (Thomas et al., 1963). Three applications of GA_3 to black walnut seedlings caused them to produce several seasons' growth in one year (Marth and Mitchell, 1961). Repeated spraying of roses with GA_3 increased stem length over one treatment (Mastaterz, 1965). Supplemental spraying belladonna with GA_3 doubled stem height and reduced root dry weight. However, stem dry weight was not affected (Kuskova, 1965).

Increased stem: root ratio from greater concentrations of GA_3 probably results from increased stem growth at the expense of root development. Halevy et al. (1964) found that the effect of GA_3 on translocation of assimulates is to increase the mobilization of stored materials and to enhance redistribution toward stem tips. Nanda and Purohit (1965) have reported that increased growth in *Salmalia malabarica* caused by gibberellin treatment probably results from mobilizing stored food so it becomes readily available for growth extension.

SUMMARY

Field application of GA_3 at 5,000 ppm in July or in June and July to year-old pecan seedlings significantly increased stem diameter. Stem diameters were less on the seedlings sprayed in June only. However, the diameter increase was enough in both cases to improve suitability of seedlings for budding and grafting.

Time of treatment is a factor in seedling response to GA_3. Seedlings treated in July had a significantly higher dry stem: dry root ratio than those treated in June.

A second application of 5,000 ppm GA_3 in July to seedlings previously treated in June gave significant increases over other treatments in stem length, dry stem: dry root ratio, and stem dry weight. Root dry weight was significantly less than

root dry weight of June sprayed seedlings and those sprayed in July only. Stem diameter was significantly larger than for trees treated only in June but not significantly different from stem diameters of trees treated only in July.

In this study, GA_3 reduced root length of seedlings when sprayed in July only. Additional research is needed to determine the ideal combinations of time, treatments, and concentrations of GA_3 to optimize benefits to growers. Also, other gibberellins (Van Overbeek, 1966) may hold promise in such research.

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MODERATOR STEAVENSON: We will now have time for questions dealing with the previous three papers.

BEN DAVIS, II: What type of gibberellin did you use? Who makes it and where can it be obtained?

LOY SHREVE: I used GA_3 and it was supplied by Merck Company. It was a 90% preparation. The "3" refers to the type of GA that I used. There are some twelve or thirteen different types of gibberellic acid.

CHARLES SCHEER: I would like to ask Mr. Bedger how much water was placed on top of the Vapam and what was the rate that you used?

RICHARD BEDGER: We applied Vapam at approximately sixty gallons per acre. The water seal was formed by mak-

ing three passes of the sprayer which puts on about a quarter of an inch of water or until you form a type of crust on the soil.

RICHARD JAYNES: I would like to ask Pete Vermeulen if he ever stratifies *Kalmia latifolia* seed and what does he consider to be a normal percent germination?

PETE VERMEULEN: No, we do not stratify *Kalmia latifolia* seed. I don't really have an answer for the percent of germination. We use a given volume of seed per flat and we do not really have an actual count of the number of seeds in that volume. The volume used is based on past experience.

JOHN VERMEULEN: It is very difficult to count the seeds. You may get as high as 500 to 1000 seedlings from 1/16 of a teaspoonful of seed.

MARTIN USREY: I would like to ask Mr. Bedger if he has made any comparisons between Vapam and methyl bromide for soil sterilization?

RICHARD BEDGER: It's not that we prefer the Vapam because actually I would prefer to use methyl bromide. Unfortunately, when you treat some twenty acres of seed beds and particularly the way we prepare our seed beds, the methyl bromide just is not feasible to use.

MODERATOR STEAVENSON: I would like to ask Mr. Bedger if he is using the Vapam primarily for weed control, or is he also using it for the control of nematodes and insects?

RICHARD BEDGER: All of the soil fumigants give us better plant growth. This is particularly true of our rooted cuttings of azaleas, rhododendrons, and *Ilex* species. We do get some weed control, it's not 100%, but it does give us quite a bit of help in the early spring. We get pretty good control until May. I feel the fumigant helps control the nematodes and some of the other soil organisms.

ARIE RADDER: We use Mylone and find it is easier to apply than Vapam.

JOHN KNAPP: I'd like to ask Mr. Bedger what type of jars does he use for seed storage?

RICHARD BEDGER: We use five gallon jugs; the same type as is used on water coolers. The jugs are filled with seed and then we drive in a cork. We do not wax in the cork as is done by some of the state nurseries. We have stored Red Pine up to ten years in this type of a jug. The temperature in our refrigerator where the seed is stored runs about 34° to 36°F. Bruce Briggs at Washington State Research Center did some work on the time of transplanting rhododendron and azalea seedlings. He found that just as soon as you could obtain the true leaves that this was the best time for transplanting; there was no shock or setback. He transplanted seedlings every two weeks for several months. He found that those seedlings which were left in the seed flat for six weeks, as compared to seedlings which were transplanted as soon as the first true leaves appeared, were only about one third as large as the early transplanted seedlings.