SOME EFFECTS OF SELECTED PREEMERGENCE HERBICIDES ON GROWTH OF *Carya illinoensis*

by

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TABLE OF CONTENTS

INTRODUCTION

Pecan (*Carya illinoensis*, Koch.) is one of the important edible nuts produced in the United States. The annual commercial production based on the period 1947 to 1956 has constantly shown an upward trend. Most of the commercial production of pecans is still from wild seedlings. However, in recent years, more and more selected varieties are propagated by grafting on pecan seedlings.

The control of weeds in pecan nurseries by hoeing or cultivation is an expensive procedure. By the use of suitable herbicides, the cost of production can be greatly reduced.

The present investigation was conducted to determine the tolerance of seeded pecans to selected preemergence herbicides at different stages of growth in an attempt to find promising herbicides to be used in pecan nurseries.

LITERATURE REVIEW

Several investigators have shown that physiological age may partially determine the response of plants to various herbicides. It has been reported that the susceptibility of grain crops followed a consistent general pattern during the various stages of growth (4, 22). Quimby and Nalewaja (17) reported that wheat height and yield were proportional to the rate of dicamba, but response to various rates was dependent on stage of growth at the time of application.

Tweedy and Ries (30) investigated the nature of tolerance of several species of deciduous fruit trees to many of the herbicides used in fruit tree plantings. The difference in tolerance between species of the same age was attributed to physiological resistance.

Ries _et al_. (18) found that peaches treated with the herbicide mixture of simazine and amitrole-T had higher leaf nitrogen and more vegetative growth than trees where the weeds were controlled by hand hoeing or black plastic mulch. Apples and peach trees in plots in which weeds were controlled by simazine resulted in greater total growth and higher leaf nitrogen than trees in weedy plots receiving supplemental nitrogen treatments. In a later paper, Ries and Gast (19) reported that the addition of simazine to nutrient solutions in which _Zea mays_ was growing increased the percent of nitrogen and total mg of nitrogen in one test regardless of nitrogen level in the solution. However, in a second experiment under environment more favorable for corn growth, the total mg of nitrogen was not increased, although the nitrogen percentage in the shoot was increased at the low nitrogen level. Their hypothesis is that low levels of simazine may increase the rate of respiration and nitrogen absorption and/or metabolism during periods of unfavorable environment for corn growth. The hypothesis was also used to explain the increased growth and nitrogen level in simazine-treated peaches and apples.

In studying the type of selectivity responsible for fruit tree tolerance, Tweedy and Ries (29) found that the relative tolerance to simazine and prometryne was greater for peach than apricot. From the study with reciprocal grafts, the scions were found to be responsible for the observed difference in tolerance.

Simazine is one of the effective herbicides for controlling weeds in several species of fruit tree planting (2, 9, 11, 18, 21). The important weeds controlled by simazine at crop rates are watergrass, mustard, chickweed, crabgrass, foxtail, jimsonweed, lambsquarter, purslane, ragweed, pigweed, Russian thistle, wild oats, velvetleaf, and many others (28). The phytotoxicity of simazine is related to its ability to inhibit drastically carbon dioxide fixation in light (3, 15). Singh and West (23) reported that simazine affects amino acid incorporation into chloroplasts in oat plants in darkness.

Sinbar (5-chloro-3-tert-butyl-6-methyluracil) is a relatively new herbicide originated by Dow Chemical Company. At 4.5 lb/A to 6 lb/A, it gave good control of annual weeds with no injury to citrus in Florida (20). It also showed promise for use in sugarcane in Louisiana when applied preemergence to weeds and sugarcane (14). Hilton et al. (10) found that uracil herbicides appear to act in higher plants as inhibitors of photosynthesis. Strong inhibition of the Hill reaction of isolated chloroplasts by substituted uracils was noted.

Diphenamid is an actamide compound used as a selective preemergence herbicide. The important weeds controlled are watergrass, cheat, chickweed, crabgrass, foxtail, goosegrass, Johnsongrass, knotweed, lambsquarter, pigweed, purslane, sandbur, stinkgrass, and many others. It has been used successfully in Solanum crops, peanuts, strawberries and ornamentals (28).

DCPA is a preemergence phthalic acid selective herbicide. It has been used successfully in turf, seed crops, vegetables, and ornamentals. The important weeds controlled are crabgrass, foxtail, watergrass, goosegrass, bluegrass, lambsquarter, spurge, purslane, chickweed, dodder, dock, and many others (28).

Trifluralin is a substituted toluidine used as a selective preemergence herbicide. It controls watergrass, cheat, chickweed, crabgrass, foxtail, goosegrass, Johnsongrass, lambsquarter, pigweed, puncturevine, purslane, Russian thistle, and many others. Trifluralin has been successfully used in ornamentals and some agronomic crops (28). Talbert (27) postulated that the principal mode of action of trifluralin in plants at the cellular level was as a mitotic poison. This postulation was later confirmed by Fisher's experiment on cotton (6). Parker (16) reported that trifluralin can exert its effect through direct uptake by the shoot, but root uptake seems to be much more effective.

Dichlobenil is a nitrile compound used as a preemergence selective herbicide. Important weeds it has controlled includes clovers, horsetail, smartweed, nutgrass, plantain, dandelion, purslane, quackgrass, and dodder. It has been successfully used in non-bearing fruit trees, forests and ornamentals (28). Dichlobenil acts via the root as well as by way of the green parts of the plants (12, 16). Milborrow (14) reported that there was no significant correlation between dichlobenil and plants with seed fat content. There was a negative correlation of increasing growth rate with increasing susceptibility and a negative correlation of seed size with susceptibility.

Literature is very limited regarding the use of herbicides at various pecan growth stages. A preliminary trial conducted by Amling and Dozier (2) showed that cacodylic acid at 10 lb/A, dichlobenil at 5 to 10 lb/A, dalapon at 5 lb/A plus 2,4-D at 4 lb/A, paraquat at 1 lb/A and simazine at 3.2 lb/A gave good weed control in pecans and with no apparent injury.

MATERIALS AND METHODS

The field experiment was conducted at the Horticulture Farm near Manhattan, Kansas, from April to October 1966. The soil type was a sandy loam.

Seeds of the Indiana pecan cultivar were stratified for 6 weeks before planting. They were planted 1 foot apart within rows spaced 3.5 feet apart.

Herbicides used in this study were 5-chloro-3-tert-butyl-6-methyluracil (sinbar) at 3 lb/A, N,N-dimethyl-2,2-diphenylacetamide (diphenamid) at 5 lb/A, 2,6-dichlorobenzonitrile (dichlobenil) at 6 lb/A, 2-chloro-4,6-bis(ethylamino)-s-triazine (simazine) at 3 lb/A, trifluoro-2, 6-dinitro-N,N-dipropyl-p-toluidine (trifluralin) at 2 lb/A, and dimethyl 2,3,5,6-tetrachloroterephthalate (DCPA) at 12 lb/A.

They were applied preemergence to the weeds at 3 different times: immediately after planting pecan seeds on April 22, just prior to the emergence of germinating pecans on June 15, and on August 25 when the seedlings were 10 to 18 cm in height bearing 4 to 6 juvenile leaves. The plots were kept free from weeds by hand hoeing before the application of herbicides. A mixture of weed seeds consisting of rough pigweed (*Amaranthus retroflexus*), yellow bristlegrass (*Setaria lutescens*), and large crabgrass (*Digitaria sanguinalis*) was overseeded to the plots after the treatment. All chemical formulations were prepared by the manufacturers for use as water-carried herbicides. Simazine, sinbar, diphenamid, and DCPA were wettable powders, while trifluralin was formulated as an emulsifiable concentrate, and dichlobenil as an emulsion. A spray volume of 272 gpa (1 quart per 20 square feet) was applied as an overall spray by using a compressed-air sprayer.

Treatments were arranged in a randomized complete block design with 4 replications. Each replication contained 24 plots including 6 checks, 3 weedy and 3 weed-free. Each plot was 2 × 10 square feet in area.

Weed control data were collected on a fresh weight percentage basis. Three samples of 4 square feet each were taken from each plot on October 2. The percentage of weed control was derived from the formula

$$\text{percent weed control} = (A-B)/A \times 100$$

where A = the fresh weight of the weeds present in the weedy plot, and

B = the fresh weight of the weeds present in the treated plot.

Leaf dry weights and stem dry weights per pecan plant were determined from 5 seedlings from each plot dug on September 29. The samples were washed and then dried in a conventional draft-air type oven according to the method described by Hall and Hacskaylo (8).

Total nitrogen contents of pecan leaf and stem expressed as percentages of dry weight of plant tissues were determined by improved Kjeldhal method (1).

Data were subjected to the analysis of variance. The replication effects were considered as random effects. Correlation analyses were made among the variables studied.

RESULTS

In order to simplify the tables of this paper, notations are designated for the dates of application as shown in Table 1.

Table 1. Notations designated for the times of application.

Notation	Date of application	Stage of pecan seedling development
A	April 22	immediately after planting - no visible growth.
B	June 15	just prior to emergence.
C	August 25	10 to 18 cm in height, bearing 4 to 6 juvenile leaves.

Weed growth in the plots consisted primarily of common lambsquarter (<u>Chenopodium album</u>), rough pigweed (<u>Amaranthus reflexus</u>), crabgrasses (<u>Digitaria spp.</u>), yellow bristlegrass (<u>Setaria lutescens</u>), prostrate spurge (<u>Euphorbia supina</u>), and goosegrass (<u>Elusine indica</u>). Since there were very few weeds in the plots after the last date of application on August 25, only the data collected from the first two applications were statistically analyzed as shown in Table 2. The analysis was performed on the angular transformed data to normalize the distribution.

All the herbicides used gave good season-long weed control at both dates of application except for diphenamid which controlled less than 60 percent of the weeds. Results are shown in Table 3.

The analysis of variance of leaf dry weight data is shown in Table 4.

Table 2. Analysis of variance of the angular transformation of the weed control percentages.

Source of variation	d.f.	Ms	F
Treatments	6	20634.82	664.57 **
Dates	1	175.07	1.03 ns
Replications	3	70.22	4.60 **
T X D	6	379.60	9.41 **
D X R	3	170.29	11.15 **
T X R	18	31.05	2.03 *
T X D X R	18	40.35	2.64 **
Samples	112	15.27	

ns - not significant at 5% level.
* - significant at 5% level.
** - significant at 1% level.

The herbicides applied at different dates exerted tremendous effects on leaf dry weight per plant. Sinbar and dichlobenil applied in late August caused severe damage to the leaves. The fully developed juvenile leaves had a scorched appearance and fell off, however, the apical buds were not injured and continued to make new growth. Plots treated with dephenamid in April and June had low yields in leaf dry weight. Plants treated with DCPA immediately after planting also gave low average leaf dry weight; the differences were significant at the one percent level. Other treatment combinations were not different from weed-free checks. The results are shown in Table 5.

Table 3. The effect of preemergence herbicides applied at two dates on weed control percentages.

Treatment	Date of application	Mean percent weed control	Transformed mean
Sinbar	A	97.3	82.09 ab[1]
	B	94.9	79.20 abc
Diphenamid	A	58.0	49.74 e
	B	52.7	46.56 e
Dichlobenil	A	97.9	82.79 a
	B	94.7	78.53 abc
Simazine	A	84.7	67.33 d
	B	91.5	73.87 c
Trifluralin	A	94.3	76.58 c
	B	96.2	78.99 abc
DCPA	A	81.8	65.08 d
	B	97.7	82.58 ab
Weedy check		0	0 f
Coefficient of variation[2]	11.80%		

[1] Values designated by the same lower case letter are not significantly different at the 5% level as determined by Fisher's LSD. LSD = 5.44.

[2] Coefficient of variation = (standard deviation/grand mean)×100%

Table 4. Analysis of variance of average leaf dry weight per pecan plant.

Source of variation	d.f.	Ms	F
Treatments	7	3.2437	13.54 **
Dates	2	0.3457	0.83 ns
Replications	3	0.2395	1.18 ns
T X D	14	2.6255	13.52 **
D X R	6	0.4176	2.05 ns
T X R	21	0.2657	1.31 ns
T X D X R	42	0.1942	0.95 ns
Samples	384	0.2034	

ns - not significant at 5% level.
** - significant at 1% level.

Table 5. The effect of herbicides and dates of application on average leaf dry weight per pecan plant.

Treatment	Date of application	Mean leaf dry weight g/plant
Sinbar	A	1.236 abc[1]
	B	1.163 abcd
	C	0.421 e
Diphenamid	A	0.493 e
	B	0.761 de
	C	1.438 abc
Dichlobenil	A	1.400 abc
	B	1.079 bcd
	C	0.551 e
Simazine	A	1.329 abc
	B	1.443 abc
	C	1.236 abc
Trifluralin	A	1.260 abc
	B	1.377 abc
	C	1.164 abcd
DCPA	A	0.592 e
	B	1.030 cd
	C	1.283 abc
Weedy check	A	0.533 e
	B	0.555 e
	C	1.470 ab
Weed-free check	A	1.519 a
	B	1.456 ab
	C	1.571 a
Coefficient of variation[2]	40.123%	

[1] Values designated by the same lower case letter are not significantly different at 1% level as determined by Fisher's LSD. LSD = 0.415

[2] Coefficient of variation = (Standard deviation/grand mean)×100%.

The analysis of variance of stem dry weight data is reported in Table 6.

Table 6. Analysis of variance of average pecan stem dry weight per plant.

Source of variation	d.f.	Ms	F
Treatments	7	1.1702	9.64 **
Dates	2	0.0366	0.43 ns
Replications	3	0.3933	5.22 **
T X D	14	0.7845	7.02 **
T X R	21	0.1214	1.61 *
D X R	6	0.0854	1.13 ns
T X D X R	42	0.1119	1.49 *
Samples	384	0.0753	

ns - not significant at 5% level.
* - significant at 5% level.
** - significant at 1% level.

Plants treated with simazine immediately after planting and just prior to emergence had higher stem dry weights than those grown in the weed-free plots. However, the differences were not significant at one percent level. The first two applications of diphenamid resulted in low yields of stem dry weights, while the August application did not affect the yields. Again, these differences were not significant at one percent level. Plants treated with sinbar in August and with DCPA immediately after planting also had lower stem dry weights than those grown in weed-free plots. The results are shown in Table 7.

Table 7. The effect of herbicides and dates of application on average stem dry weight per pecan plant.

Treatment	Date of application	Mean stem dry weight g/plant
Sinbar	A	1.258 abc[1]
	B	1.098 bcdef
	C	0.824 fgh
Diphenamid	A	0.833 efgh
	B	0.887 efgh
	C	1.169 abcde
Dichlobenil	A	1.238 abc
	B	1.005 cdefg
	C	0.908 defgh
Simazine	A	1.364 ab
	B	1.408 a
	C	1.208 abc
Trifluralin	A	1.183 abcd
	B	1.032 cdef
	C	0.926 defgh
DCPA	A	0.732 gh
	B	1.205 abcd
	C	1.263 abc
Weed-free check	A	1.141 abcde
	B	1.030 cdef
	C	1.114 bcde
Weedy check	A	0.690 h
	B	0.719 gh
	C	1.142 abcde
Coefficient of variation [2]	31.4850%	

[1] Values designed by the same lower case letter are not significantly different at 1% level as determined by Fisher's LSD. LSD = 0.286.

[2] Coefficient of variation = (standard deviation/grand mean) ×100%.

The analysis of variance of stem nitrogen content data is shown in Table 8.

Table 8. Analysis of variance of pecan stem nitrogen in percentage of dry weight.

Source of variation	d.f.	Ms	F
Treatments	7	0.0201	14.36 **
Dates	2	0.00005	0.24 ns
Replications	3	0.0042	3.50 *
T X R	21	0.0014	1.17 ns
T X D	14	0.0129	10.75 **
R X D	6	0.0018	1.50 ns
T X R X D	42	0.0012	1.00 ns
Samples	96	0.0012	

* significant at 5% level.
** significant at 1% level.
ns not significant at 5% level.

All plants receiving simazine treatments showed a significantly higher stem nitrogen content in percentage of dry weight regardless of time of application. Plants treated with trifluralin in August showed a low stem nitrogen percentage. The results are shown in Table 9.

There was no significant difference in leaf nitrogen percentage among seedlings receiving the different treatments.

The simple and partial correlations between the variables derived from the first two applications of herbicides are shown in Table 10. The results of the August application were left out of the correlation

Table 9. The effect of herbicides applied at three different dates on average pecan stem nitrogen percentage.

Treatment	Date of application	Mean stem nitrogen content, % dry weight
Sinbar	A	0.646 cdef[1]
	B	0.641 cdef
	C	0.601 efg
Diphenamid	A	0.604 efg
	B	0.666 bc
	C	0.658 cd
Dichlobenil	A	0.650 cde
	B	0.656 cd
	C	0.641 cdef
Simazine	A	0.716 ab
	B	0.681 bc
	C	0.750 a
Trifluralin	A	0.683 bc
	B	0.655 cd
	C	0.568 g
Dacthal	A	0.610 f
	B	0.625 ef
	C	0.673 bc
Weed-free check	A	0.634 cdef
	B	0.641 cdef
	C	0.650 cde
Weedy check	A	0.600 efg
	B	0.613 defg
	C	0.653 cde
Coefficient of variation[2]	5.338%	

[1] Values designated by the same lower case letter are not significantly different at 5% level as determined by Fisher's LSD. LSD = 0.036.

[2] Coefficient of variation = (standard deviation/grand mean) × 100% .

Table 10. Simple and partial correlations between variables, pecan leaf dry weight (L), pecan stem dry weight (S), pecan stem nitrogen percentage (1), and weed control percentage (2), derived from the first two applications of herbicides; n = 16.

Variables correlated	Correlation coefficient	
	Simple	Partial
L 1	r_{L1} = 0.4937 near*	$r_{L1 \cdot 2S}$ = 0.3500 ns
L 2	r_{L2} = 0.7895**	$r_{L2 \cdot 1S}$ = 0.5260 ns
S 1	r_{S1} = 0.6019*	$r_{S1 \cdot 2L}$ = 0.2962 ns
S 2	r_{S2} = 0.7055**	$r_{S2 \cdot L1}$ = 0.2139 ns
S L	r_{SL} = 0.8167**	$r_{SL \cdot 12}$ = 0.5089 near*
1 2	r_{12} = 0.3571 ns	$r_{12 \cdot SL}$ = 0.1308 ns

* significant at 5% level.
** significant at 1% level.
ns not significant at 5% level.
near* almost significant at 5% level.

analyses because no meaningful weed control data were available. The significance of correlation coefficients was determined by using a table prepared by Snedecor (24).

As shown in Table 10, there was no correlation between stem nitrogen and weed control percentage. There were positive correlations between leaf dry weight and weed control percentage, stem dry weight and stem nitrogen content, stem dry weight and weed control percentage, and stem dry weight and leaf dry weight. The correlation between leaf dry weight and stem nitrogen content was a little uncertain at 5 percent level. Partial correlation is the linear correlation between two variables after they are linearly adjusted for their relationships to the other variables and with the other variables held at fixed values (7). Partial correlation coefficients shown in Table 10 are notably smaller than their corresponding simple correlation coefficients. Therefore, it is reasonable to believe that these simple correlations were due in part to the common relationship of the variables studied to the other variables included in the analyses.

The multiple correlation among stem nitrogen content, weed control percentage, and leaf dry weight, $R_{L\cdot 12}$, and that among the former two variables and stem dry weight, $R_{S\cdot 12}$, are shown in Table 11.

The portion of the variation of leaf dry weight and stem dry weight accounted for by stem nitrogen content and weed control percentage are indicated by $R^2_{L\cdot 12}$ and $R^2_{S\cdot 12}$, respectively. It is shown that approximately one third each of the variations of leaf dry weight and stem dry weight was not accounted for since $1 - R^2_{L\cdot 12} = 0.3254$, and $1 - R^2_{S\cdot 12} = 0.3618$.

The relative importance of stem nitrogen content and weed control percentage in accounting for the variation of leaf dry weight and stem dry weight is shown in Tables 12 and 13.

Table 12 indicates that weed control percentage should be included in the correlation analysis with leaf dry weight either by itself or in addition to stem nitrogen percentage. However, correlating stem nitrogen percentage alone with leaf dry weight was a little uncertain at 5 percent level, and it had no significance in correlation with leaf dry weight after the weed control percentage was included in the analysis.

Stem nitrogen percentage and weed control percentage are significantly correlated with stem dry weight either individually or in addition to each other as shown in Table 13.

Table 11. Multiple correlations among stem nitrogen percentage, weed control percentage, and pecan leaf dry weight, $R_{L\cdot 12}$, and among the pecan stem nitrogen percentage, weed control percentage, and pecan stem dry weight $R_{S\cdot 12}$, and their corresponding coefficients of determination; n = 16.

Multiple correlation	Coefficient of determination
$R_{L\cdot 12} = 0.8213^{**}$	$R^2_{L\cdot 12} = 0.6746$
$R_{S.12} = 0.7989^{**}$	$R^2_{S\cdot 12} = 0.6382$

** significant at 1% level.

Table 12. Tests of importance of pecan stem nitrogen percentage (1), and weed control percentage (2) in accounting for the variation of pecan leaf dry weight; n = 16.

Difference	$n - v$[1]	F(1, n - v)
$r^2_{L1} - 0 = 0.2437$	14	4.51[near*]
$r^2_{L2} - 0 = 0.6233$	14	23.16**
$R^2_{L.12} - r^2_{L1} = 0.4309$	13	24.85**
$R^2_{L\cdot 12} - r^2_{L2} = 0.0513$	13	2.96 ns

* significant at 5% level.
** significant at 1% level.
near* almost significant at 5% level.
1 v = number of variables involved.

Table 13. Tests of importance of pecan stem nitrogen percentage (1) and weed control percentage (2) in accounting for the variation of pecan stem dry weight; n = 16.

Difference	n - v[1]	F(1, n - v)
$r^2_{S1} - 0 = 0.3623$	14	7.95*
$r^2_{S2} - 0 = 0.7055$	14	13.87**
$R^2_{S\cdot12} - r^2_{S1} = 0.2759$	13	9.91**
$R^2_{S\cdot12} - r^2_{S2} = 0.1405$	13	5.05*

* significant at 5% level.
** significant at 1% level.
1 v = the number of variables involved.

DISCUSSION

The competition for light, moisture, nutrients, and, possibly the production of toxic exudate due to the presence of weeds may have been factors in reducing the yields in leaf and stem dry weight of pecan seedlings grown in weedy plots and in those plots with poor weed control percentages.

Since it has been shown that dichlobenil acts via the root as well as by way of the green parts of the plants (12, 16), when it was applied as an over-all spray after the emergence of pecan seedlings, the absorption of the herbicides by plants might have increased, and thus resulted in leaf injuries as described earlier in this paper. This consequently may have brought about the reduction in leaf and stem dry weights due to the decreased photosynthetic function. Sinbar applied in August also caused leaf injuries and thus decreased leaf and stem dry weights of pecan seedlings.

Simazine application resulted in higher stem nitrogen percentage and dry weight, however, the increase was not substantial. This was probably due to the high food reserves in pecan seeds and favorable environmental condition for pecan seedlings growth during the period of the experiment which might have limited the higher nitrogen level effect on growth.

Leaf nitrogen content can be expected to be positively correlated with stem nitrogen content. The failure to detect differences in leaf nitrogen contents among plants subjected to the various treatments in the experiment was attributed to the inappropriate time of sampling. In late

September when samples were collected, plants had already hardened-off to some extent which may have eliminated differences in nitrogen contents produced by various treatments.

Experimental materials have characteristic coefficients of variation (25) which reflect the variation of materials. A knowledge of coefficient of variation is valuable in planning and in evaluating experiments. Note that the coefficients of variation of stem dry weight and leaf dry weight in this experiment were quite high (Tables 5 and 7). However, no previous experience and no literature found by the author can be used to judge whether these coefficients of variation were unusually high for pecan seedlings. Considering that pecan is genetically heterozygous in nature and that in commercial orchards varieties are interplanted so as to encourage cross-pollination (5), it is reasonable to attribute the high variation in indices of pecan seedling growth to the heterogeneity of seeds. Thus if the true coefficient of variation of pecan seedling growth is reflected by the results of this experiment, the following methods might be adapted to increase the precision of experiments dealing with pecan seedling growth: (A) the increase of sample size and/or the number of replications (25) and, (B) the choice of uniform seeds or the collection of seed weight data which can be used later in covariance analysis should there be a correlation between seed weight and subsequent growth. Stembridge (26) has shown that, by using convariance analysis, coefficients of variation were considerably reduced in the measurement of growth responses in young peach trees.

Stem growth was expected to be greatly affected by the weed control percentage and stem nitrogen content. However, the multiple correlation analysis indicated that only two-thirds of the variation of stem dry weight was accounted for by the two factors mentioned above. This also partly revealed the high heterogeneity of pecan seedlings.

CONCLUSION

All of the herbicides used in this experiment except for diphenamid gave good season-long weed control. Sinbar and dichlobenil applied in late August caused severe damage to the pecan seedling leaves and consequently reduced the yields in leaf and stem dry weight. Sinbar, dichlobenil, simazine, trifluralin, and dacthal showed promise of controlling weeds in pecan nurseries when applied in spring or early summer prior to the emergence of both crop and weeds. No evaluation on the herbicidal effects on winter annuals were made for there were very few weeds germinated in the plots after the last date of application on August 25.

Simazine applications increased the stem dry weights and stem total nitrogen percentage of pecan seedlings. However, the increases were not substantial.

Among the variables weed control percentage, stem nitrogen percentage, leaf dry weight, and stem dry weight, the simple correlations between any two were produced partly due to their common relationship to the other two variables.

Approximately one third each of the variation of leaf dry weight and stem dry weight was not accounted for by weed control percentage and stem nitrogen percentage. Stem nitrogen percentage was not a good index for leaf dry weight of pecan seedlings. It had no significance in correlation with leaf dry weight after weed control percentage was included in the analysis. Stem nitrogen percentage and weed control percentage were significantly correlated with stem dry weight either individually or in addition to each other.

The coefficients of variation of stem dry weight and leaf dry weight of pecan seedlings were quite high in this experiment which possibly reflects the heterogeneity of pecan. Therefore, it might be helpful to increase the precision of the experiment dealing with pecan seedling growth by increasing the size of the experiment, and/or by choosing uniform seeds or by collecting seed weight data which could be used later in covariance analyses should there be a correlation between seed weight and subsequent growth.

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SOME EFFECTS OF SELECTED PREEMERGENCE HERBICIDES ON GROWTH OF *Carya illinoensis*

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Six preemergence herbicides were applied as over-all sprays to pecan (*Carya illinoensis*, Koch.) seedlings at three dates: immediately after planting on April 22, just prior to the emergence of the germinating pecans on June 15, and on August 25 when the seedlings were 10 to 18 cm in height and bearing 4 to 6 juvenile leaves. The plots were kept weed-free by hand hoeing before the application of herbicides. Herbicides used were 5-chloro-3-tert-butyl-6-methyluracil (sinbar) at 3 lb/A, 2,6-dichlorobenzonitrile (dichlobenil) at 6 lb/A, 2-chloro-4,6-bis(ethylamino)-s-triazine (simazine) at 3 lb/A, trifuoro-2,6-dinitro-N,N-dipropyl-p-toluidine (trifluralin) at 2 lb/A, dimethyl 2,3,5,6-tetrachloroterephthalate (DCPA) at 12 lb/A and N,N-dimethyl-2,2-diphenylacetamide (diphenamid) at 5 lb/A. These, except for diphenamid, gave good season-long weed control when they were applied in spring and early summer prior to the emergence of both crop and weeds.

Sinbar and dichlobenil caused severe damage to pecan leaves when applied in late August, which consequently reduced the yields in leaf and stem dry weight of pecan seedlings.

Simazine applications resulted in high stem nitrogen contents and stem dry weights of pecan seedlings. However, the increases were not substantial.

Correlation analyses showed that approximately one third each of the variation of leaf dry weight and stem dry weight of pecan seedling was not accounted for by weed control percentage and pecan stem nitrogen content. This evidence in addition to the high coefficients of variation of stem dry weight and leaf dry weight reflected the high heterogeneity of pecan seedlings.

A suggestion was made for increasing the precision of the experiment dealing with pecan seedling growth: (A) increase the size of experiment by increasing the sample size and/or the number of replications, (B) select uniform seeds or take seed weight data and perform covariance analyses should there be a correlation between seed weight and subsequent growth.