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WESTERN PECAN GROWERS ASSOCIATION
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The Annual

Western Pecan Growers Association Conference

WPGA Pecan Show

Pecan Food Fantasy

And

Pecan Trade and Equipment Show

sponsored jointly by

New Mexico State University
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Western Pecan Growers Association

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Exotic Pecan Pest Survey Program

Greg Watson[1], Mike Wallace[2]
[1]New Mexico Department of Agriculture, [2]Arizona Department of Agriculture

The pecan growing regions of New Mexico, West Texas, Arizona, California and northern Chihuahua Mexico continue to be considered pecan-weevil-free growing regions. These regions have retained their pecan weevil-free status due to, in part, to isolation from other weevil infested growing regions and the limited amount of in-shell pecans being shipped into the region for processing.

Recently there has been significant increase of in-shell pecan exports to Hong Kong and China from western growing regions and a concentration of pecan processors in West Texas and southern New Mexico. Both developments have resulted in significant increase in shipments of raw nuts from eastern growing regions for either processing in western facilities or continued travel to Long Beach for export. The resulting increase in the import of raw pecans to western states has resulted in an increase in the movement of pecan pests from other regions, primarily pecan weevil.

Recognizing the importance of limiting the number of new pecan pests to the western region, Western Pecan Growers Organization, New Mexico Pecan Growers Organization, Arizona Pecan Growers Organization, and Arizona and New Mexico Departments of Agriculture are collaborating on a region wide nut pest surveys. The purpose of this unique approach was to attempt to detect and respond appropriately upon the detection of new pecan pest as a region rather than a state.

The initial focus of the surveys was three serious pecan pests which have very limited distribution in the western region. Pecan weevil (*Curculio caryae*), hickory shuckworm (*Cydia caryana*) and the Mexican strain of pecan nut casebearer (*Acrobasis nuxvorella*). Hickory shuckworm has limited distribution in New Mexico and is a regulated pest in Arizona. Pecan Weevil is currently being successfully eradicated in New Mexico and it is considered a regulated pest in both Arizona and New Mexico. The Mexican strain of pecan nut casebearer has the potential to elude current Integrated Pest Management strategies directed at the existing strain.

The response to an interception of a new serious pecan pest in New Mexico or Arizona would be determined by joint committee composed of industry representatives, extension, and departments of agriculture. The current program formalizes previous arrangements between entities interested in pecan production.

Pecan pest survey programs are conducted in the field and at buying stations and cleaning plants in both states. The inspection occurs at each cleaning plant twice weekly. Survey results from New Mexico have yielded one potential new infestation of pecan weevil (currently in 3rd year of eradication), and no additional westerly movement of pecan nut casebearer in New Mexico. Survey results have not indicated any detection of serious pests in Arizona.

PHYMATOTRICHUM ROOT ROT

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Phymatotrichum root rot, also known as cotton root rot or Texas root rot, is caused by the soil-borne fungus, *Phymatotrichopsis omnivorum*. Of all diseases known to occur on broadleafed plants, this is one of the most destructive and difficult to control. The pathogen has an incredibly wide host range affecting over 2,300 plant species, and surefire survival techniques; two features which make management a nightmare for the unfortunate growers faced with the disease.

Fortunately this fungus is limited in distribution and does not readily spread from one location to another. The fungus is restricted geographically to the Southwest US and Northern Mexico in alkaline soils with low organic matter content. It also occurs only at elevations below 5,000 feet and is typically found in relatively small, isolated areas. In New Mexico, it occurs only in the southern counties, and is most prevalent in agricultural areas along the Rio Grande and Pecos Rivers. It spreads slowly from plant to plant when a fungal strand from an infected root grows through the soil to a nearby healthy root. It has no means of air-borne spread.

The fungus is active in summer months when air and soil temperatures are high. The greatest incidence of disease occurs when soil temperature 12" deep is greater than 80°F and the air temperature in the plant canopy is above 104°F. When environmental conditions are favorable for fungal activity, the pathogen invades plants through their root systems. Infected roots rot and cannot transport water to the above-ground portion of the plant. Symptoms on above-ground plant parts resemble water stress. The first evidence of disease is slight yellowing of the leaves. Leaves quickly turn to a bronze color and begin to wilt. Permanent wilting of the branches can occur very rapidly; as little as two weeks from the first expression of disease. The tree dies with leaves remaining firmly attached and a reddish lesion around the crown of the plant may develop. Pecan trees are considered to be “moderately tolerant” to the disease. Although susceptible to the fungus, the disease progresses more slowly in pecans than in more susceptible hosts. As a result, it may take several years before a pecan tree is killed by the disease.

Evidence of *P. omnivorum* can also be found on or near infected trees. The pathogen produces fungal strands on the surface of infected roots. These strands look like threads and are visible with a good hand lens. When strands are observed under a compound microscope, cruciform (cross-shaped) hyphae unique to this fungus can be seen. Another sign is the formation of a white to tan colored spore mat on the surface of the soil around infected plants. Spore mats develop during periods of high moisture. The spores in these mats have never been germinated and are considered to have no function in survival or infection of the pathogen. Therefore, spore mats do not spread disease, but are evidence of the presence of the organism.

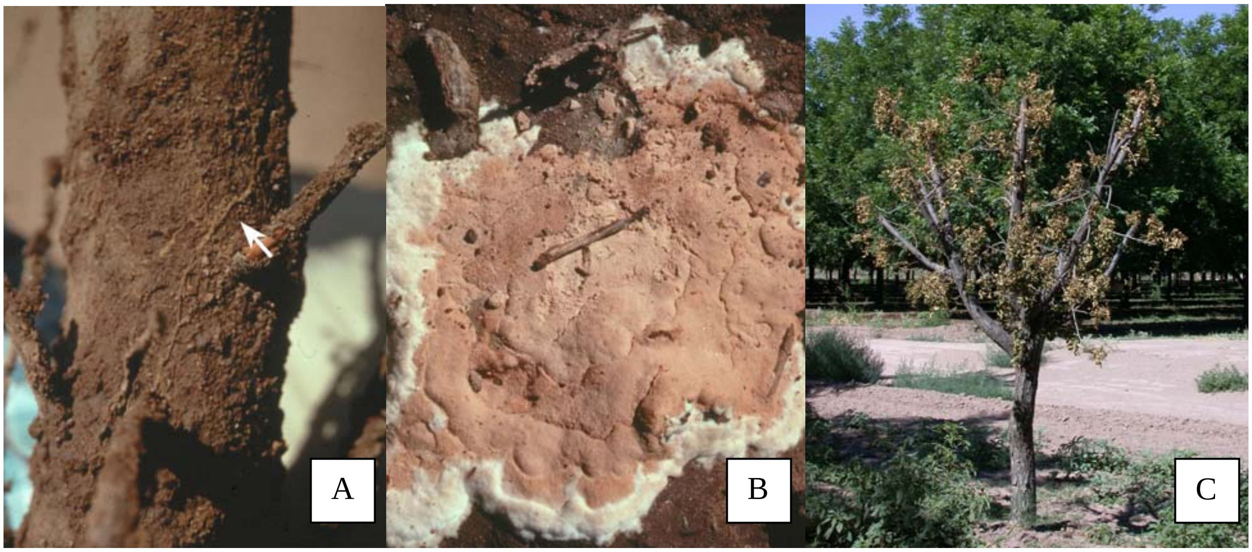
Research to control this disease has been extensive and yet there are no good control methods available. There is no resistance or tolerance to this disease in most of the commonly infected hosts. The best recommendation is to avoid land known to be infested with the fungus. Furthermore, it is recommended that fruit and nut orchards not be planted in old cotton or alfalfa fields. If mesquite land is to be cleared for orchard planting, it may be worth the time and money to preplant the area in cotton. Cotton is highly susceptible and serves as a good indicator plant for the presence of the pathogen.

The fungus has the ability to survive deep in soil (survival structures have been found over 12 feet deep) has eliminated the possibility of using fungicides and fumigants to control the disease because these materials can only penetrate a limited distance into the soil. There are practices that can be used to try to alter the soil environment so that it no longer favors *P. omnivorum*. These practices may help reduce the effect of the pathogen if they are followed every year. If not, the soil environment returns to its typical state (high pH and low organic matter) and again favors the fungus. The procedure consists of loosening the soil in a broad (just beyond the drip line) and comparatively shallow basin around infected trees. The area is then covered to a depth of 2 inches with manure or similar organic matter. Layered on top of the organic matter is ammonium sulfate and sulfur, each at a rate of 1 lb/10 sq ft. The basin should be immediately flooded with enough water to wet the soil to a depth of 3 feet. This high level of soil moisture must be maintained for several weeks. If trees are treated before permanent wilting, they may recover. It is recommended that known root rot infested areas be treated every year in March or April.

Some success reducing the effect of the disease has been achieved by growing and incorporating a green manure cover crop over the orchard floor. This helps to stimulate vigorous rooting of the trees, enabling them to better withstand disease pressure. Additionally, the incorporation of the cover crop into the soil may help to stimulate soil microflora which compete with *P. omnivorum*.

The best thing that can be said about this fungus is that it is not wide spread. It is found only in small pockets and does not spread much from its point of origin. There are no viable spores to help spread the disease from one location to another. The only known spread between plants occurs when fungal threads from infected roots contact healthy roots.

For More Information, Contact:



A. Fungal Strand on pecan root. B. Spore mat formed by *P. omnivorum.* C. Pecan tree killed by *P. omnivorum* (dead leaves still attached to tree).

PECAN NUT CASEBEARER MANAGEMENT

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During the almost 20 year period pecan nut casebearer (PNC, *Acrobasis nuxvorella)* was first introduced into West Texas, it has continued to spread to the pecan growing regions of the Mesilla Valley, Pecos Valley, and eastern New Mexico. Although tools and strategies used to manage PNC in other areas of the country (primarily south Texas) have served the western region well, they have nevertheless continued to be developed and be refined for the western region by both growers and university personnel. The primary goal of any PNC management program is to reduce economic loss to the grower by ensuring both the use and selection of control strategies are appropriate. In general, PNC management requires a survey program to determine if a control practice is required, a control decision, and control strategy. Individual PNC management tools and strategies have varying degrees of risk (incorrect decision) and compliance with respect to the practice of "Integrated Pest Management".

SURVEY: The author believes the most significant PNC management tool developed within the last 20 years was the commercialization of the PNC pheromone. With an understanding of its limitations, the use of PNC pheromone to determine moth emergence has proved to be invaluable to producers (Knutson et al. 1998). The pheromone treated lure attracts male PNC moths and should only be considered as an indicator of adult emergence and not an indicator of population density or need for an insecticide application for a specific orchard (specifically in high density orchard areas). Points to remember: traps located only on the orchard edge should be placed to ensure the pheromone plume is carried by the predominate wind <u>into</u> the orchard and not away from the orchard; replace lures prior to each generation (three generations); do not discard old lures or traps in the orchard (competes with other traps); understand the characteristics of the three PNC pheromone trap designs used in the west (wing, delta, and universal moth trap); be aware that other moth species will be found in traps, especially where mass releases of sterile pink bollworm (*Pectinophora gossypiella*) moths are made; depending on the control strategy, check traps several times a week; and elevating traps to a height of 10-15 feet has shown to increase the number of moths trapped when moth population densities are low (particularly for the universal moth trap). In general, PNC pheromone traps should be in place by 20 April (1st generation larvae), 20 June (2nd generation), and by 15 August (3rd generation). Regional differences and temperatures may shift the aforementioned dates. Approximately one trap per 20-40 acres with a minimum of two traps is recommended.

The emergence of adult PNC in the spring and subsequent egg hatch and nut entry by larvae is temperature dependent and thus somewhat predictable. Historically pecan producers have used the results of a degree-day-model (Jackman 1983) to help determine approximate survey and insecticide treatment dates for 1st generation PNC. The degree-day-model has been adjusted for western pecan growing regions and is used to determine approximate survey and treatment dates for West Texas, Mesilla Valley, and Pecos Valley regions (available on various internet sites or extension offices). Use of degree-day-models has not been shown to be accurate for predicting insecticide applications for controlling 2nd and 3rd generation PNC.

CONTROL DECISION: Field scouting is required to determine the need for and to further refine the timing of insecticide applications. Normally the economic portion of a control decision is based on comparing percent PNC egg infested or damaged nut clusters to published economic levels. Economic injury levels for a specific orchard can also be calculated by growers. To calculate potential damage by PNC for a specific orchard yourself, the economic loss due to PNC is based on estimated percent egg and damaged nut clusters. Additional information required to calculate loss due to PNC damage includes: estimated number nut clusters per acre derived from yield per acre and nuts per cluster; number of nuts damaged per cluster specific for each PNC generation (2.5-3 nuts damaged for 1st PNC generation, 2 nuts for 2nd, and 1 for 3rd generation); estimated nuts per pound and expected price per pound. The expected economic damage is compared to the cost of an insecticide application. Additional points to remember include: mortality rate for PNC eggs and larvae in western growing regions can be greater than 50%; not all nuts damaged by 1st and 2nd generation larvae will mature ("August Drop"); low PNC populations result in a concentration or clumping of egg infested nut clusters (survey nut clusters from several areas in the orchard); if a generation is not controlled, subsequent generations of PNC populations may increase in density and number of days eggs are deposited.

CONTROL STRATEGY: Insecticide applications are normally timed for egg hatch. Too early of an application will minimize nut damage but may result in the need for subsequent applications. Too late an application results in unnecessary early damage. Applications timed at the first evidence of nut entry have proved to be the most reliable. Recently growers have developed a second strategy based on directing insecticide applications at controlling adults (moths) rather than egg hatch. Little research data has been collected on PNC adult targeted insecticide applications, but it appears the practice has been successful in larger orchards for the past six years. Although directing insecticide applications for the control of adults significantly increases the risk of unnecessary insecticide applications, it does offer pecan producers the capability of adjusting insecticide application dates if irrigations conflict with predicted spray dates. Specifics of insecticide applications timed to control PNC adults will be covered in the presentation.

The number of insecticides and insecticide classes registered for PNC control continue to increase. Insecticides vary with respect to price, environmental consequences (impact on non-target organisms), application methods, and residual activity. General points to remember regarding insecticide selection to control PNC include: broad spectrum insecticides tend to increase blackmargined aphid (*Monellia caryella*) population densities faster than narrow spectrum insecticides (Carver 2007); efficacy of insecticides dependent on feeding for activity is reduced when applied aerially; residual of insecticides containing tebufenozide (active ingredient) provide longer residual than other currently registered insecticides; insecticide selection for PNC should also consider other potential pests (i.e. webworm, aphids); control costs can vary significantly from approximately $8.-$20 per acre; and viable insecticides are available for organic orchards. Insecticide attributes will further be covered in the presentation.

1. Carver, O. 2007. Impact of Insecticide Spectrum Used to Control Pecan Nut Casebearer (*Acrobasis nuxvorella*) on Blackmargined Aphid Populations (*Monellia caryella).* M.S. Thesis, New Mexico State University. 75 pp.

2. Jackman, J. A. 1983. Implementation of a pecan nut casebearer degree day model, a major pest of pecans in Texas. Proceedings of Texas Pecan Growers Association. P. 40-43.

3. Knutson, A.E., M. K. Harris & J. G. Millar. 1998. Effects of pheromone dose, lure age, and trap design on capture of male pecan nut casebearer (Lepidoptera: Pryalidae) in pheromone-baited traps. J. Econ. Entomol.91:715-722.

The Effects of Weeds on Orchard Establishment

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Vegetation in the close proximity to pecan trees dramatically reduces growth and even survival. Vegetation competes with trees for water, nutrients and at times even sunlight. It also reduces tree growth by producing chemicals that inhibit growth of other plants. This growth inhibition by chemical means is called allelopathy. The combination of competition and allelopathy is termed interference.

Studies were designed to evaluate the allelopathic affects of bermudagrass, tall fescue and cutleaf evening primrose on seedling pecan tree growth. The two grass and one dicot species in 1-gallon containers plus a control (container with media but no plant) were placed in funnels with tubes running to pecan trees below. When the plants above were irrigated, water leached through the containers to irrigate the pecan trees. After three months, pecan tree root and top dry weight was about 15% less than the control when irrigation water was from bermudagrass or tall fescue. Irrigation water from primrose reduces root dry weight about 20% and top dry weight 25%.

A field study was designed to evaluate interference of cutleaf evening primrose and Palmer amaranth on growth of 'Apache' pecan seedlings growing in a Teller sandy loam that was not irrigated. Rainfall during the 3-year study averaged 32 inches. Cutleaf evening primrose is a low-growing, cool-season annual that germinates in the fall and completes its life-cycle about June. Palmer amaranth, a member of the pigweed family, is a warm-season annual up to five feet tall that germinates during late May and grows until fall freeze. Treatments were two weeds of either species or in succession planted one foot on either side of the tree within a 12 feet diameter circle maintained vegetation-free. After three growing seasons, either primrose or Palmer amaranth alone also reduced tree growth. The combination of the two species was additive, reducing tree growth 350 % compared to the control (vegetation-free).

Another study determined the optimum vegetation-free area surround young pecan trees in a bermudagrass groundcover. 'Kanza' trees on Giles rootstock were six feet tall when transplanted into a Teller sandy loam soil. Trees were irrigated with a solid-set sprinkler system as needed and fertilized following standard practices. Treatments were 0, 3, 6, 12 or 24 ft diameter vegetation-free circles centered on the trees. Vegetation was controlled with glyphosate and oryzalin. The optimum size of the vegetation-free area increased as tree size increased. A 3-ft diameter vegetation-free was adequate through the third growing season. The fourth season a 6 ft or larger diameter circle produced trees with the maximum growth. Beginning in the fifth growing season and thereafter, trees in the 24 ft diameter vegetation-free circles grew more than in the other treatments. Production began in the fifth growing season, but yield was small until the seventh season. Yield was positively related to the size of the vegetation-free area surrounding the tree. During the seventh growing season, trees without vegetation control, other than mowing, produced 4 lbs/tree and those in 24 ft diameter vegetation-free circles produced 18 lbs/tree, a 334% increase.

These results strongly support maintaining a vegetation-free area surrounding trees during establishment through the first years of production. The data further supports the vegetation-free area to be as large as practical. Mitigating circumstances that limit the size of the vegetation-free area surrounding trees are erosion potential of the site, equipment access into the orchard, ease of harvest and pollution potential from dust. In addition, there may be negative impacts from large vegetation-free areas in the long-term. For instance, maintaining an area vegetation-free may make the soil more susceptible to compaction and will lead to a reduction in soil organic matter. Reduced organic matter and compaction reduce water infiltration rates and availability of some nutrients. It is likely that optimum management may include vegetation-free areas as large as practical initially, and then the size reduced as the trees mature to avoid some problems created by an absence of vegetation.

Preemergence Herbicides for Young Pecan Orchards[1]

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Why Control Weeds in Pecan?

Weeds are a significant impediment to the efficient production of flood, furrow, micro-sprinkler and drip irrigated tree crops in the Western United States where water is a limiting resource. Numerous studies in tree crops have shown that weeds and cover crops reduce tree yields by using irrigation water and other resources such as nitrogen (Hogue and Neilsen, 1987). For example, weed or cover crop competition reduced pecan tree trunk cross-sectional area 47 to 79% after 3 years of growth and reduced three year cumulative yields 28 to 65% (Foshee et al., 1995; Wolf and Smith, 1999). Soil moisture depletion mirrored reductions in shoot growth suggesting that the weeds competed with the pecan trees for water (Wolf and Smith, 1999). In a long-term pecan experiment, the cumulative yield of the weed free-herbicide treatment was 42% greater than the disk treatment, 289% greater than the mowed treatment, and 405% greater than the weedy treatment (i.e., no weed control) after 9 years (Foshee et al., 1997). In a recently published study evaluating weed control systems in newly established pecan, the greatest tree growth rates (based on trunk diameter) and early nut yield were in treatments that utilized both preemergence and postemergence herbicides (Faircloth et al., 2007). Orchard floor management systems that maintain a vegetation free zone of 6 to 8 feet around the trees provide optimum pecan growth and nut yield (Faircloth et al., 2007). A common management system in Arizona is to maintain a vegetation free strip on each side of the tree row and mow the resident vegetation in the remaining area between tree rows.

Weeds are successful biological organisms well adapted to disturbed habits as attested by their wide-spread occurrence in agricultural production systems. Weed populations are dynamic and respond to weed management practices. Historically weed control was accomplished by disking and mowing. Tillage (e.g., disking) for weed control prunes feeder roots near the surface of the soil and the level of root injury increases when the equipment is used to control weeds closer to the tree (Hogue and Neilsen, 1987). Tillage both incorporates weed seeds into the soil inducing seed dormancy, and brings seed up near the surface exposing them to light, breaking seed dormancy and stimulating weed germination (Radosevich et al., 2007). Mowing results in a species shift from upright broadleaf annual and perennial weeds to annual and perennial grass and sedge weed species that are very competitive with the trees. Tillage of the orchard floor can aid orchard floor management by providing a trash free surface for applying preemergence herbicides, tillage can be used to incorporate preemergence herbicides (e.g., oryzalin, pendimenthalin and trifluralin), it may be needed to facilitate irrigation and is often used to prepare for harvest.

Difficult to Control Weeds and Herbicide Resistant Weeds

The discovery and development of modern herbicides provided powerful chemical tools for managing weeds. Weed populations have responded in two ways to the intense selection pressure exerted by

[1]*This information is intended to summarize suggestions for chemical control of weeds in Arizona nut crops. Herbicide labels are subject to frequent change; always consult the product label before using any herbicide. The user must assume responsibility for proper application of herbicides and for residues on crops as well as for damage or injury caused by herbicides referred to in this article, whether to crop, person or property.* ***Any products, services or organizations that are mentioned, shown or indirectly implied in this publication do not imply endorsement by the University of Arizona.***

herbicides; species that are hard to kill have replaced easy to kill weed species in many agricultural production systems and some formally susceptible weed species (i.e., easy to kill) are now resistant to some herbicides. Both changes in weed populations are problematic but herbicide resistant weeds may be the greater threat. Worldwide there are currently 183 herbicide resistant weed species of which 110 are dicots or broadleaves and 73 are monocots which include grasses and sedges. These herbicide resistant weeds occur in over 290,000 fields across the agricultural regions of the world. Herbicide resistant weeds typically evolve because of the over-reliance on a single herbicide mode of action. For two decades, pecan weed management programs in the southwest have relied heavily on the herbicide glyphosate which is the active ingredient in 38 products (i.e., trade names) registered in New Mexico including Buccaneer, Credit, Gly Star, Glyfos, Glyphomax, Honcho, Roundup, Touchdown and many others. Currently, there are 13 weed species resistant to the herbicide glyphosate including *Amaranthus palmeri* (Palmer amaranth or careless weed), *Conyza bonariensis* (hairy fleabane), *Conyza canadensis* (horseweed or mare'stail), *Ambrosia artemisiifolia* (common ragweed), *Ambrosia trifida* (giant ragweed), *Echinochloa colona* (junglerice), *Eleusine indica* (goosegrass) and *Sorghum halepense* (Johnsongrass) which all occur in Arizona and New Mexico. For more information on herbicide resistant weeds refer to the website www.weedscience.org .

The risk of developing herbicide resistant weeds can be minimized by using a diversity of weed management tools or strategies in an integrated weed management (IWM) program. Integrated Weed Management practices include:

1) Use non-chemical control measures in addition to herbicides (e.g., cultivation). A single cultivation or a few cultivations a year can make a big difference.
2) Use herbicide mixtures (i.e., use different mechanisms of action) or combinations of herbicides annually. In other words don't use a single herbicide exclusively. Rotating herbicides with different trade names that have the same active ingredient is not effective.
3) Alternate or rotate herbicides with different target site from year to year or application to application.
4) Use labeled herbicide rates up to the maximum labeled rate to kill all sprayed weeds; this is most important for avoiding herbicide resistance due to metabolism (as opposed to a resistant enzyme).
5) Limit seed dispersal so as to reduce or eliminate small resistant or difficult to control weed species.

All of these strategies may incur added cost and require more management compared to using a total postemergence weed control program that repeatedly sprays the broad-spectrum herbicide glyphosate throughout the year. A simple way to add diversity to a weed management program is to use a preemergence herbicide applied in the winter or early spring before bud break and then spray weed escapes with postemergence herbicides. The use of preemergence herbicides usually results in fewer postemergence applications per year (especially after two or more years of preemergence herbicide use) and the weeds that do emerge grow slower and stay smaller longer providing a larger "window of opportunity" to spray them when they are small. Depending on the weeds that emerge, different postemergence herbicides can be used to maximize efficacy at different times of the year.

Weed Control in Pecan with Preemergence Herbicides

Small plot experiments were conducted in 2005 and 2006 in a recently transplanted, flood-irrigated a pecan orchard near Red Rock, Arizona to compare the efficacy of various preemergence herbicides. The pecan trees were planted on a 30 ft by 30 ft spacing and were grown in the orchard for 4 and 40 months before we started our experiments in 2005 and 2006, respectively, and during that time the orchard was sprayed with glyphosate. The soil type in the orchard was a Mohall clay loam with 0.98% organic matter and 42% sand, 22% silt, and 36% clay, with a pH of 7.7. A randomized complete block experimental design with four replications was used and the Plots were 20 ft by 60 ft in 2005, and 20 ft by 90 ft in 2006. Trees were grown using commercial practices common to southern Arizona and received about 10 cm of water per irrigation and were irrigated up to 12 times annually depending on weather. Small amounts of urea ammonium nitrate (32N-0P-0K) were added to the water in several irrigation events so that a total of 84 and 90 kg N ha^{-1} were added in 2005 and 2006, respectively. Zinc was foliarly applied five times in 2005 and 2006 at a rate of 5.6 kg Zn ha^{-1} per application using 36% $ZnSO_4$. The experimental sites were located in newly established areas of the orchard with natural and fairly uniform populations of spurred anoda [*Anoda cristata* (L.) Schlecht.], common purslane [*Portulaca oleracea* (L.)], Palmer amaranth [*Amaranthus palmeri* S. Wats.], Wright groundcherry [*Physalis acutifolia* (Miers) Sandw.], little mallow (*Malva parviflora* L.), junglerice [*Echinochloa colona* (L.) Link], and Mexican sprangletop [*Leptochloa fusca* (L.) Kanth var. uninervia (J. Presl) N. Snow]. Nursery grown pecan trees were transplanted to the site after it had been fallow for several years.

In the 2005 preemergence (PRE) herbicide experiment, flumioxazin at either 6 or 12 oz/A, oxyfluorfen (GoalTender) at either 40 or 64 oz/A, and pendimethalin (Prowl H_2O) at either 2 or 4 qt/A were applied alone and in combinations and followed by glyphosate at 1.125 lb ae/A (32 oz/A of Roundup WeatherMAX) with ammonium sulfate on an as-needed basis for the remainder of the growing season. The same PRE herbicide treatments were evaluated in 2006 with the addition of a flumioxazin (6 oz/A) plus oxyfluorfen (GoalTender, 64 oz/A) tank-mix treatment. The PRE herbicides were applied on 6 April 2005 and 1 March 2006 which was two or one days before irrigation, respectively. The treatments were evaluated approximately every three weeks by counting the number of individuals of each weed species in each plot. If the weed density and size at the time of evaluation was great enough, the plot was sprayed with glyphosate on the same day. The PRE herbicides were applied with a CO_2-pressurized backpack sprayer using Teejet XR8004 VS flat-fan nozzles at a pressure of 21 PSI and a carrier volume of 20.6 gal/A at 3 MPH. Glyphosate was applied with a tractor-mounted sprayer[9] using Teejet XR8003VS flat-fan nozzles at a pressure of 21 PSI and a carrier volume of 13 gal/A at 4.2 MPH in 2005. In 2006 glyphosate was applied with a tractor-mounted sprayer using Teejet XR8002VS flat-fan nozzles at a pressure of 35 PSI and carrier volume of 10.8 gal/A at 5.5 MPH. We made visual ratings of weed control approximately two weeks after application using a scale of 0 to 100%, with 0 representing no weed control and 100 representing complete weed control. We also calculated the total number of weeds that emerged in each plot throughout the growing season using the weed counts collected throughout the season. Weeds were counted on 15 June, 20 July, 29 August, and 16 September in 2005 and on 7 June, 23 June, 13 July, and 12 September in 2006. Weed control ratings were transformed using an arcsine square root transformation and weed density counts were square root transformed prior to analysis of variance to improve homogeneity of variance. However, all data are expressed in their original form for clarity. SigmaStat 3.1[10] was used for ANOVA and for separating both weed control and weed density treatment means at the 5% significance level using the Student-Newman-Keuls means separation test. Specific treatment comparisons were done using orthogonal contrasts in JMP[11] 5.1 statistical software (Sall et al., 2001).

When flumioxazin, oxyfluorfen, and pendimethalin applied alone or in combination were included in the weed management systems, spurred anoda, common purslane, Palmer amaranth, junglerice, and Mexican sprangletop densities were less than 1.0 plant m^{-2} 105 days after the PRE herbicides were applied in 2005 and 2006. Almost five months after the PRE herbicides were applied, only the treatments receiving pendimethalin alone (1.9 lb ai/A or 3.8 lb ai/A) required a POST application of glyphosate to control spurred anoda and Wright groundcherry in 2005. Cumulative emergence counts in 2005 (Table 1) showed that only flumioxazin applied alone at 0.191 or 0.382 lb ai/A, or flumioxazin (0.191 or 0.382 lb ai/A) tank mixed with pendimethalin (1.9 lb ai/A) reduced spurred anoda, Wright groundcherry, common purslane, Palmer amaranth, and junglerice emergence compared to not using a PRE herbicide. In 2006, most PRE herbicides reduced weed emergence compared to not using a PRE herbicide (Table 1). The lowest cumulative weed density in 2005 (0.40 plants m^{-2}) occurred in the flumioxazin (0.382 lb ai/a) plus pendimethalin (1.9 lb ai/A) treatment while the highest weed density occurred in the treatment receiving only POST applications of glyphosate (5.31 plants m^{-2}). Similarly, the lowest cumulative weed emergence in 2006 occurred in the oxyfluorfen (1.25 lb ai/A) plus pendimethalin (1.9 lb ai/A) treatment (1.53 plants m^{-2}) while the greatest occurred in the treatment receiving only POST applications of glyphosate (7.97 plants m^{-2}). Applying the higher rate of flumioxazin, oxyfluorfen, and pendimethalin in both years resulted in lower total weed emergence counts compared to applying the lower rate of the herbicides. No pecan tree damage was observed in any treatment indicating the tree tolerance to these herbicides.

Table 1. Influence of treatment on cumulative weed emergence per m^2 in a non-bearing pecan orchard in 2005 and 2006.[a,b,c]

Treatment	Rate	Product Rate	Total Weeds 2005	Total Weeds 2006
	(lb ai/A)		---------- plants m^2 -----------	
1. Glyphosate	1.125	32 fl oz/A	9.69 a	7.97 a
2. Flumioxazin	0.191	6 oz/A	1.97 c	4.99 b
3. Flumioxazin	0.382	12 oz/A	1.36 c	2.94 cd
4. Oxyfluorfen	1.25	40 fl oz/A	2.59 c	2.87 cd
5. Oxyfluorfen	2.0	64 fl oz/A	1.57 c	1.55 d
6. Pendimethalin + Glyphosate	1.9 1.125	2 qt/A	5.40 b	3.93 bc
7. Pendimethalin + Glyphosate	3.8 1.125	4 qt/A	2.96 c	3.62 bc
8. Oxyfluorfen + Pendimethalin	1.25 1.9	40 fl oz/A 2 qt/A	1.26 c	1.53 d
9. Oxyfluorfen + Pendimethalin	2.0 1.9	64 fl oz/A 2 qt/A	0.98 c	1.64 d
10. Oxyfluorfen + Flumioxazin	1.25 0.191	40 fl oz/A 6 oz/A	1.63 c	2.24 cd
11. Flumioxazin + Pendimethalin	0.191 1.9	6 oz/A 2 qt/A	1.54 c	3.00 cd
12. Flumioxazin + Pendamethalin	0.382 1.9	12 oz/A 2 qt/A	0.60 c	1.60 d

[a] Data were square root transformed before statistical analysis with non-transformed data shown.
[b] Means followed by the same letter in each column are not significantly different at P = 0.05 according to analysis of variance and the Student-Newman-Keuls mean separation test.
[c] Because pendimethalin does not have POST herbicide activity as do the other preemergence herbicides, glyphosate was tank mixed with pendimethalin in the pendimethalin + glyphosate treatments to equalize the treatments at the start of the experiments.

Herbicide Recommendations for Pecan

Herbicides that provide good weed control in Arizona pecan orchards (and by proximity, New Mexico) are categorized by type in Tables 2 and 3*(X=bearing and nonbearing trees; NB=nonbearing trees only which means trees that will not bear nuts for at least 1 year)*. Several herbicides registered for use in pecans do not perform consistently under arid southwestern environmental conditions, do not perform as well as other herbicides, or may cause injury. For the sake of brevity, these herbicides are not listed in this herbicide summary. For example: 2,4-D (registered for bearing pecans) has significant injury potential, diquat (nonbearing registrations only) is not as effective as paraquat, and napropamide (registered for bearing pecans) has a limited weed spectrum and performs erratically except if immediately incorporated by sprinkler irrigation.

Table 2. **Preemergence herbicide** options for New Mexico pecan orchards. These herbicides should be applied to a clean soil surface and will not control emerged plants **except as noted**. These herbicides can be moved into the soil using irrigation water (or rainfall) unless otherwise noted. The herbicides diuron and norflurazon are somewhat mobile in soils and can be moved into the root zone of trees by irrigation causing tree injury especially in coarse textured soils (e.g., sandy loams, etc.). Preemergence herbicides with postemergence activity (i.e., diruon, flumioxazin and oxyfluorfen) should be applied with a non-ionic surfactant or crop oil concentrate to obtain burn-down activity.

Common name	Trade name(s)	Pecans	Weeds controlled
norflurazon	Solicam DF	X	Grasses & broadleaves, suppresses perennials such as nutsedge and bermudagrass
oryzalin	Surflan, Oryzalin	X	Grasses & small-seeded broadleaves
pendimethalin	Prowl H_20, Prowl 3.3	X	Grasses & small-seeded broadleaves
trifluralin	Treflan, Trifluralin, Triap	X	Grasses & small-seeded broadleaves; must be mechanically incorporated into the soil (e.g., by disking).
diuron	Karmex, Diuron	X	Grasses and some broadleaves; do not use on trees established less than 3 years. Has postemergence activity.
flumioxazin	Chateau *Note: registration on bearing trees expected in 2008.*	NB	Broadleaves (weaker on grasses); do not use on trees established less than 1 year. Postemergence contact activity similar to carfentrazone and oxyfluorfen.
oxyfluorfen	Goal, GoalTender	X	Broadleaves (weaker on grasses); postemergence contact activity similar to carfentrazone and flumioxazin.

Herbicide labels can be viewed at the following websites: www.cdms.net or www.greenbook.net.

Weeds that emerge after the application of preemergence herbicides should be sprayed with post-emergence herbicides. It is generally not a good idea to use tillage to control weed escapes because this reduces or eliminates the activity of preemergence herbicides (e.g., flumioxazin and oxyfluorfen).

Systemic herbicides are translocated or moved in plants and are superior choices when attempting to control perennial weeds. Contact herbicides are not translocated in plants; spraying perennial weeds with contact herbicides causes shoot death but new shoots are produced by surviving roots. All postemergence herbicides must be applied with adjuvants (e.g., ammonium sulfate, non-ionic surfactant or crop oil concentrate) to obtain acceptable weed control.

Table 3. **Postemergence herbicide** options for New Mexico pecan orchards; read herbicide labels for rates and specific application directions (labels can be obtained at the following websites: www.cdms.net or www.greenbook.net). Most postemrgence herbicides perform well at carrier volumes of 10 to 25 gallons per acre (GPA) using flat-fan nozzles at pressures of 20 to 30 PSI at the nozzle tip.

Common name	**Trade name(s)**	**Pecan**	**Application Notes**	**Type, Weeds controlled**
clethodim	Select Max, Select	NB	1, 2, 3	Systemic, selective; controls only grass weeds
fluazifop-p-butyl	Fusilade DX	X	1, 2, 3	
sethoxydim	Poast, Poast Plus	X	1, 2, 3	
halosulfuron	Sandea	X	4, 5	Systemic, selective; controls nutsedge and some broadleaf weeds
glyphosate	Roundup, Credit, Touchdown, Honcho, Glyphosate, others	X	5, 6, 7	Systemic, non-selective; controls green herbaceous plants
glufosinate-ammonium	Rely 200	X	8	Contact, non-selective; controls green herbaceous plants
paraquat *(restricted use pesticide)*	Gramoxone Inteon	X	2, 4, 8	
carfentrazone	Aim	X	2, 8	Contact, selective; controls only broadleaf weeds, should be applied with a shielded sprayer.

Notes:
[1]Should be applied at higher pressure (e.g., 30 to 60 psi) to obtain small spray droplets in a carrier volume of 10 to 20 gallons per acre (GPA).
[2]Greatest efficacy is obtained with methylated seed oil or crop oil concentrate.
[3]Efficacy may be improved by adding liquid fertilizer (10-43-0, 28%N or 32%N) or spray grade ammonium sulfate (AMS) at the labeled rate.
[4]Use with 0.25 to 0.5% v/v non-ionic surfactant.
[5]Performance on nutsedge species is enhanced by using a tank-mixture of glyphosate and halosulfuron and by spraying in mid to late summer; two applications are generally required for nutsedge control.
[6]Should be applied with spray grade ammonium sulfate (AMS) as described below.
[7]Some glyphosate formulations do not include a surfactant; read label and add surfactant if necessary.
[8]For contact herbicides use a minimum of 15 GPA to obtain good spray coverage; use 20 to 40 GPA on dense weed canopies.

Herbicide Spray Adjuvants

Non-ionic Surfactants (NIS) reduce surface tension and allow droplets to spread resulting in better contact between the spray solution and plant surfaces. Rates typically range from 0.25 to 0.5% v/v of the total spray volume with 0.5% v/v (2 qt/100 gal) being recommended in the hot arid climate of Arizona.

Best results are obtained using a non-ionic surfactant that contains at least 80% active ingredient.

Crop oil Concentrates (COC) also reduce surface tension and usually contain between 17 to 20% surfactant mixed with light petroleum, vegetable oil, or methylated vegetable oil. The surfactants in these adjuvants contain emulsifiers that allow them to mix with water generally producing a milky-looking solution. Certain herbicides such as sethoxydim, carfentrazone, flumioxazin and oxyfluorfen consistently have more foliar activity when mixed with a methylated seed oil or crop oil concentrate than when mixed with a non-ionic surfactant. Crop oil concentrates are typically used at a rate of 1% v/v (1 q/25 gallons or 4 qt/100 gal) but some labels recommend 1 quart per acre.

Ammonium sulfate (AMS) effectively protects glyphosate from chelation or binding with monovalent (e.g., Na^+ and K^+) and divalent cations (Ca^{+2}, Mg^{+2} and Mn^{+2}) in the spray tank water (which renders glyphosate inactive) and should be added to the water before adding glyphosate. Ammonium sulfate also enhances the uptake or absorption of many postemergence, systemic herbicides and is particularly effective in enhancing glyphosate activity in hot, arid climates. For glyphosate herbicides, add 8.5 to 17 lb of spray grade AMS to 100 gallons of water; for other postemergence herbicides, consult the product label for the recommended AMS rate. Ammonium sulfate is also available in liquid form. Ammonium sulfate cannot protect glyphosate from chelation with trivalent cations (e.g., Fe^{+3} and Al^{+3}) but some new commercial water conditioners are available that may protect glyphosate from chelation with these cations.

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How to Conduct Your Own On-Farm Research

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We often get asked whether one fertilizer, management practice, chemical, etc., is better than another. Maybe you are considering using a new product or changing management practices, and you'd like to know if these changes affect nut yield and quality, and if so, how much of a difference they make. The only way to answer these questions is to conduct an experiment and to statistically analyze the results. It's actually quite easy.

First, we must recognize that there is variability – in the soil, the trees, and the crop in a given year. There's even variability in our data collection. Imagine that you collected two sets of leaf samples from one block in an orchard. Even if the laboratory did a perfect job of analysis, you'd never get exactly the same numbers twice. There is *error* or *variability* associated with your data collection. Because of built-in variability, we can not just put treatment 'A' on one row of trees, put treatment 'B' on another row, then collect and compare data from the two rows. We must know something about the variability in the orchard. For this reason we repeat the treatments several times, and calculate an average or mean value for the *replicates*. Furthermore, we know that soil, climate, etc. change from one part of the orchard to another, so to make sure these differences don't affect our results, it is important that our replicates are randomly arranged (that is, we don't put all the treatment 'A's in one block and all the treatment 'B's in another block). The mean we calculate for each treatment, then, includes the variability between different rows or blocks in the orchard.

The spread of values going into each mean gives us information about the variability, or consistency of the data. In statistics, we call this the *variance*, or the *standard deviation* associated with the mean. A statistical analysis will take the variance of data into consideration when comparing two means or averages (in fact, the analysis we will use is called an 'Analysis of Variance' or ANOVA). The statistical analysis uses this information to decide the probability that two means are actually different. In other words, if treatment 'A' yielded an average of 42 pounds of nuts per tree, and treatment 'B' yielded 44 pounds of nuts per tree, was there really a difference between the two treatments, or was the measured difference just a result of the variability or the 'slop' in our data? A statistical analysis will help us decide which. You probably have the software necessary to conduct a simple statistical analysis. We'll learn how to use Microsoft Excel to conduct statistical analyses, and how to interpret the results.

The important part of conducting a field research experiment is to set up the experiment properly with appropriate replication and randomization. We'll show you how. If you have a properly constructed field experiment, then your Extension Agent or Specialist will be able to help you statistically interpret your data if you're not sure how to do it yourself.

Microirrigation of Pecans

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When considering conversion of an established orchard from flood irrigation to microirrigation or establishing a new orchard under microirrigation, a number of issues should be carefully considered. They include:

1. Why should microirrigation be used?
   - (i) In most cases, microirrigation is more efficient than flood irrigation. In other words, less water will be needed to adequately irrigate the orchard when microirrigation is used. With microirrigation, close to the amount of water needed by the orchard (its evapotranspiration - ET) can be applied with little water lost to inefficiencies. This can be very important if water is expensive or in limited supply.
   - (ii) Microirrigation systems are designed to apply water frequently. In the middle of summer, drip systems often apply water daily and microsprinkler systems are often operated every few days. This frequent water application keeps the soil moisture at optimum growing conditions, often resulting in improved high quality production.
   - (iii) Microirrigation systems are easily automated. This can be a great advantage when labor for flood irrigating is in short supply. If designed properly, microirrigation system pumping costs can be reduced using off-peak power rates.
   - (iv) Microirrigated orchards do not need to be land leveled as do those flood irrigated. For new orchards, this eliminates the initial land leveling costs and may allow orchard development on land with topography unsuited to flood irrigation.
2. Are there drawbacks to using microirrigation?

   Yes, there are definitely issues which need to be carefully considered when deciding to use microirrigation in orchards. They include:
   - (i) Cost. The initial cost of microirrigation systems is high. $1000-$1500/acre are good ballpark figures. Much of the cost is tied up in pumps, filters, and pipelines—items which can last easily 10 to 20 years or more. Polyethylene lateral lines and emission devices have shorter lives but even they can last ten years or more with good maintenance. Thus, while initial costs may seem high, annualized costs are much more reasonable.
   - (ii) Maintenance requirements. Do no underestimate the maintenance requirements of microirrigation systems. Drippers and microsprinklers have small flow passageways that can be clogged by particles, organic matter, and chemical precipitates. Good filtration and water treatment chemigation can mitigate most clogging problems, but such maintenance requires diligence. Less frequently, insects can cause clogging problems. Animals, machinery, and humans damaging the system can cause leaks. Good maintenance also requires frequent inspection of the system, attention to detail in repairing leaks and clogging, and flushing of the system to rid it of contaminants.
   - (iii) Adequate wetting volume. Orchards with large tree spacing, like pecans, are a challenge to irrigate with microirrigation systems. An adequate soil volume around

each tree must be wetted by the microirrigation system to attain maximum production. The rule-of-thumb is that 40% or more of the orchard area dedicated to a tree should be wetted. For large trees, this will require multiple drip lines or a large microsprinkler(s). On large trees, microsprinklers or minisprinklers (larger than microsprinklers but smaller than normal solid-set sprinklers) may thus be a good irrigation system choice. Wetting an adequate soil volume is even more important if an orchard is to be converted from flood irrigation to microirrigation. Especially during the first season, tree roots have to adapt to the new wetting pattern. The roots need time to proliferate in the volume wetted by the microirrigation system. Two strategies have been useful when converting an orchard from flood to microirrigation—begin irrigations early in the spring to ensure that the tree has adequate water when it's needed, and some growers will apply a flood irrigation to the converted orchard to ease the transition to microirrigation.

(iv) Power costs should be considered when converting from flood irrigation to microirrigation. The higher pressure requirements of a microirrigation system as compared to a flood irrigation system will likely increase power costs.

Microirrigation systems can be very efficient orchard irrigation systems with many advantages but their initial cost and maintenance requirements should be considered prior to their adoption.

Freeze/Cold Damage in Pecans

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Throughout the western US there are two types of freeze events that may present a threat of freeze injury to pecan trees:

1) *Radiation frosts* occur on clear winter nights when winds are calm. Under these nighttime conditions, the ground and the air near the ground quickly cool down as the ground radiates its heat toward the cold sky. Because the cold air near the soil surface is denser than warm air, it tends to flow downward where it can and accumulate in valleys and basins. This phenomenon can create a "temperature inversion" in which a layer of warm air (the "ceiling") can be found above the cold air at the bottom of a basin.

2) *Advection frosts* occur when strong, cold arctic winds blow into the region. With advection frosts, the temperatures remain cold even during the day.

The tissues of fully dormant and healthy pecan trees can typically withstand sub-freezing temperatures with very little damage. However, as temperatures drop below the freezing point, ice crystals form inside actively growing pecan tree tissues (whether they be shoot, leaf, flower or nut tissues), which leads to dehydration of those tissues and tissue death. Thus, pecan trees are at their most vulnerable to freeze injury not when temperatures are typically at their coldest in mid-winter, but in the fall time before the nuts have fully matured and in the spring time as the tree comes out of dormancy

The possibility that freezing temperatures occur in late spring and early fall exists throughout many of the traditional western pecan growing areas. But, with the trend of increasing pecan acreage across the west in recent years, there has a push for pecan plantings into new higher latitude (or sometimes higher elevation) areas characterized by colder temperatures and shorter freeze-free periods. With this comes an increased risk that pecan growers will suffer losses due to freeze event. Nevertheless, there are a number of pre-plant and orchard management choices that western pecan growers may make which can significantly decrease the likelihood that their orchard will suffer freeze injury:

- **Site Selection.** When winds are calm cold air tends to move down a slope, so planting orchards in low spots should be avoided if late and early radiation frosts are common in your area. Assuming that there are no barriers to drainage of cold air down the slope, the warmest locations on a slope are usually midway between the top and bottom.

- **Cultivar Selection.** For new pecan orchard plantings in more northern or higher elevation locations where the number of frost free days is lower, use of early-ripening cultivars, such as 'Pawnee', 'Kanza', 'Shoshoni' and 'Lakota' instead of the traditional western pecan cultivars, may prevent freeze damage to unripe nuts near the end of the growing season. There are also numerous “northern” cultivars adapted to locations with extremely cold and long winters (e.g., Iowa, Illinois and Indiana), but these cultivars are typically characterized by much lower quality nuts than those of the traditional western pecan varieties.

- **Tree Health.** Healthy trees with large dormant-season carbohydrate storage reserves are better able to quickly acquire adequate coldhardiness than trees with meager carbohydrate reserves. Improper irrigation, nitrogen deficiency, soil salinity, black or yellow pecan aphid infestation, over-cropping and orchard crowding are all in-season tree stress factors that may lead to compromised carbohydrate storage, and consequently reduced coldhardiness, in the subsequent winter.

- **Timing of Nitrogen Fertilizer Applications.** With respect to coldhardiness, timing of nitrogen fertilizer application makes little difference for mature, bearing pecan trees in most places. Non-bearing trees, however, may continue to grow actively into the autumn if they are given late-season nitrogen applications. This greatly increases the risk for late season freeze damage to the shoots. In most western locations, nitrogen fertilizers should be applied to non-bearing pecan orchards no later than June 30th.

- **Trunk Painting.** In mid-winter in many of the western pecan growing areas, trees’ bark becomes very warm each day from the sun’s heat and then re-freezes again during the night. Especially for younger trees with tender bark, this freezing-thawing cycle may result in damage to the tissues known as “southwest injury”. “Southwest injury” may easily be prevented by painting the susceptible trunks and limbs with a latex paint diluted to 50% with water.

- **Orchard Floor Management.** It is best to keep orchard floors untilled, moist and free of groundcover or mulch during the winter because smooth, moist, bare orchard floors are most efficient at absorbing solar radiation during the day and re-radiating that heat up into the tree canopies at night. During radiation frosts when there is a temperature inversion (especially when there is a “low ceiling”) this may provide some protection against freeze damage. Under windy advection frost conditions, any additional heat provided by the orchard floor is likely to be quickly blown out of the orchard and be of little benefit for frost protection.

- **Irrigation.** On nights when there is a radiation frost and temperature inversion (again, especially when there is a low ceiling), an orchard may gain a few degrees of frost protection if irrigation water is applied before freezing temperatures are reached. The relatively warm irrigation water can directly warm the plant tissues it contacts and, then, as the water freezes it also releases its latent heat of fusion. Sprinkler and/or microsprinklers which spray water into the tree canopies increase canopy temperatures more than does flooding of the orchard floor, but the weight of ice built up in the tree canopy may result in limb breakage. Since an irrigation system is needed anyway, the irrigation approach to frost protection may be cost effective in locations where springtime or fall time radiation frosts are a problem, but it is not very effective for protection against (and may even increase) damage by advection frosts.

- **Wind Machines/Helicopters.** When there is a radiation frost with a temperature inversion, large fans or low flying helicopters have been used effectively to bring up the orchard temperature by mixing warmer air layers above the orchard with the colder air in the orchard. This is an expensive option and may actually increase freeze injury if implemented during an advection frost event.

- **Orchard Heaters.** The use of heaters for frost protection has fallen out of favor as air quality regulations (esp. in California) have become stricter and as energy has become more expensive. Orchard heaters, however, can effectively warm an orchard both by introducing radiant heat to the trees and by creating air convection near the surface. This approach is more effective when many smaller heaters are scattered throughout an orchard than when few larger (i.e., hotter) heaters are used. Heaters are most effective under radiation frost conditions, but, unlike most other "active" frost protection methods, they can provide some help in advection frosts.

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'Lakota' and Recent USDA Pecan Releases

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Lakota' is a new pecan cultivar released by the U. S. Department of Agriculture (USDA), Agricultural Research Service (ARS) and the Kansas Agricultural Experiment Station, Kansas State University. 'Lakota' is being released because of its high nut quality, high yield potential, early nut maturity, and excellent tree strength. Pecans from this cultivar can be sold in-shell or shelled to produce a large proportion of halves and large pieces.

Origin

USDA conducts the only national pecan breeding program. Crosses are made at Brownwood and College Station, Texas (Grauke and Thompson, 1996; Thompson and Grauke, 1991; Thompson and Young, 1985). Seedling clones are established on their own roots or budded to pollarded trees for the initial 10-year testing phase at College Station. Superior clones then enter NPACTS (National Pecan Advanced Clone Testing System), where they are tested across the U.S. pecan belt in cooperation with state researchers and private growers. After several years, the best clones are given Native American tribe names and released to nurseries for propagation to sell to growers. USDA cultivars are never patented, and after release, growers can propagate the new cultivar as much as desired.

The ‘Lakota’ are a Native American tribe, and one of the seven tribes that make up the Great Sioux Nation (Hodge,1975). They speak Lakota, one of the three major dialects of the Sioux language. They are the westernmost of the three Sioux groups that occupy land in both North and South Dakota. Today they are found mostly in the five reservations of western South Dakota.

‘Lakota’, tested as selection 64-6-502, is a progeny from a 1964 cross between the ‘Mahan’ and ‘Major’ cultivars made by L. D. Romberg at Brownwood, Texas. ‘Mahan’ originated in Kosciusko, Atttala County, Mississippi by J. M. Chestnutt (Brooks and Olmo, 1956). Parentage of ‘Mahan’ is unknown, but probably one parent is ‘Schley’ (‘Eastern Schley’) (Thompson and Young, 1985). ‘Mahan’ has proven to be a superior parent in the USDA Breeding Program, being the parent of five other USDA cultivars. It contributes nut size, scab resistance, precocity, superior leaf health, and tree vigor. All seedlings of ‘Mahan’ are protogynous since this cultivar is homozygous dominant for this genetic characteristic (Thompson and Romberg, 1985).

‘Major’ is an old native from the Green River, Henderson County, Kentucky (Thompson and Young, 1985). ‘Major’ is scab resistant and has early nut-maturity. It was long considered the best of the northern cultivars, but now has been largely replaced by newer superior USDA/state cultivars. It is also the female parent of two other USDA cultivars, ‘Osage’ and ‘Kanza’. It has been a main source of early nut maturity and scab resistance for the USDA Pecan Breeding Program.

Description

‘Lakota’ was initially grown and evaluated at Brownwood, Texas. On the basis of preliminary performance, extensive testing was started in 1972. Yield data indicate that ‘Lakota’ has good precocity, similar to ‘Pawnee’. In a seven-year NPACTS yield test at Chetopa, Kansas, ‘Lakota’ averaged 977 pounds per acre, compared to 799 lb. for ‘Osage’ and 471 lb. for ‘Witte’ (Table 1). The alternate bearing index (Table 1) for ‘Lakota’ is high as is usually the case for high-yielding cultivars. The alternate bearing tendency of ‘Lakota’ (obvious when looking at the yield data and a result of large cluster size and high percent fruiting shoots) can be managed by mid-summer fruit thinning when it does occur. In another NPACTS test at Comanche, Texas, ‘Lakota’ had 4.0 nuts per cluster, compared to 2.9 for ‘Pawnee’ and 3.9 for ‘Wichita’. Also in this test, percent terminals with clusters was 44.9 for ‘Lakota’, compared to 30.3 for ‘Pawnee’ and 40.9 for ‘Wichita’.

Average nut weight (nuts per pound) in the Chetopa test was 67 for ‘Lakota’, compared to 60 for ‘Pawnee’ and 75 for ‘Kanza’ (Table 2). At College Station, Texas, ‘Lakota’ has produced larger nuts (average of 59 per pound).

Nut percent kernel averages 56.8, and kernel color is excellent (Fig. 1). ‘Lakota’ has proven to be a producer of high quality nuts that has become a favorite among customers who buy pecans from the Kansas Agricultural Experiment Station at Chetopa.

Time of spring budbreak is similar to ‘Kanza’ and ‘Pawnee’. ‘Lakota’ is protogynous, with early to mid-season receptivity and mid-season to late pollen shed (similar to ‘Kanza’) (Fig. 2). ‘Lakota’ should be a good pollenizer for, and well pollenized by ‘Pawnee’, ‘Osage’, and ‘Giles’. Time of nut maturity is early, similar to ‘Giles’, and about two weeks after ‘Pawnee’.

‘Lakota’ has performed well in tests in the northern pecan production areas of Kansas, Missouri, Illinois, Oklahoma and Texas.

Trees are upright in growth habit and develop strong limb angles and a wind-resistant tree structure. ‘Lakota’ is very resistant to scab disease where tested, mainly in northern locations (Table 3). It has not been tested in severe southeastern U.S. environments. It has medium susceptibility to yellow and black aphids.

‘Lakota’ is a potential commercial cultivar for all pecan production areas. Initial data indicate that it is early enough in nut maturity to be grown in the northern production area, and is scab resistant enough to be grown throughout the southeastern U.S. It should be considered a trial cultivar until more production data is obtained by commercial growers.

Availability

Graftwood was supplied to nurserymen in the spring of 2007. The USDA does not have any trees for distribution. Genetic material of this release will be deposited in the National Plant Germplasm System where it will be available for research purposes, including development and commercialization of new cultivars. It is requested that appropriate recognition be made if this germplasm contributes to the development of a new cultivar.

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Thompson, T. E. and E. F. Young, Jr. 1985. Pecan cultivars: past and present. Texas Pecan Growers Assn., College Station, Texas.

Table 1. National Pecan Advanced Clone Testing System (NPACTS) data from a replicated test at Chetopa, Kansas comparing the yield (pounds per acre) of the 'Lakota' pecan to other cultivars.

Cultivar	1999	2000	2001	2002	2003	2004	2005	Yearly mean	Alternate Bearing Index
Lakota	**1098**	**0**	**1178**	**336**	**1536**	**420**	**2268**	**977**	0.754
Osage	844	131	439	491	1361	319	2008	799	0.484
Witte	567	175	600	406	441	463	646	471	0.267
Canton	637	148	847	290	654	905	1508	713	0.473

Table 2. National Pecan Advanced Clone Testing System (NPACTS) nut quality data from a replicated test at Chetopa, Kansas comparing the 'Lakota' pecan to other cultivars for the years 1999-2005.

Cultivar	Nut wt. (g)	Nut wt. (nuts/pound)	Kernel wt. (g)	Kernel content (%)
Canton	5.42	83.7	2.65	48.86
Chetopa	6.17	73.5	3.21	52.09
Giles	5.20	87.2	2.61	49.45
Kanza	6.06	74.8	3.09	50.86
Lakota	**6.81**	66.6	**3.89**	**56.75**
Osage	5.27	86.1	2.76	51.93
Pawnee	7.61	59.6	4.72	61.24
Posey	7.33	61.9	4.08	55.67
Witte	6.20	73.2	3.17	51.05
LSD	0.927		0.779	5.77

Table 3. Scab ratings for six pecan clones growing near Chetopa, Kansas. Ratings recorded in 1995 using the Hunter-Roberts (Hunter and Roberts 1978) 1 to 5 scale (1 = no scab and 5= >50% coverage with scab lesions).

Cultivar	Leaf scab rating	Nut scab rating
Canton	3.34	3.14
Lakota	**1.00**	**1.00**
Osage	2.64	1.45
Witte	3.50	2.50
USDA 62-12-1	3.17	4.73
USDA63-16-182	2.83	3.73
LSD	0.45	0.43

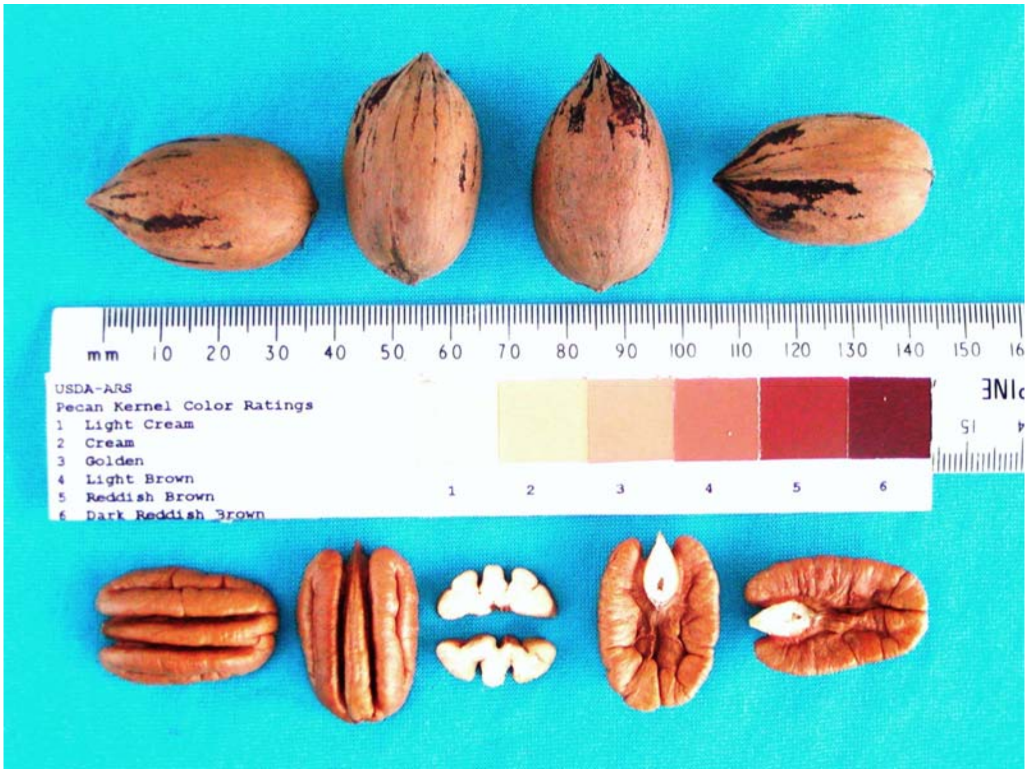

Fig. 1. Nuts and kernels of the 'Lakota' pecan

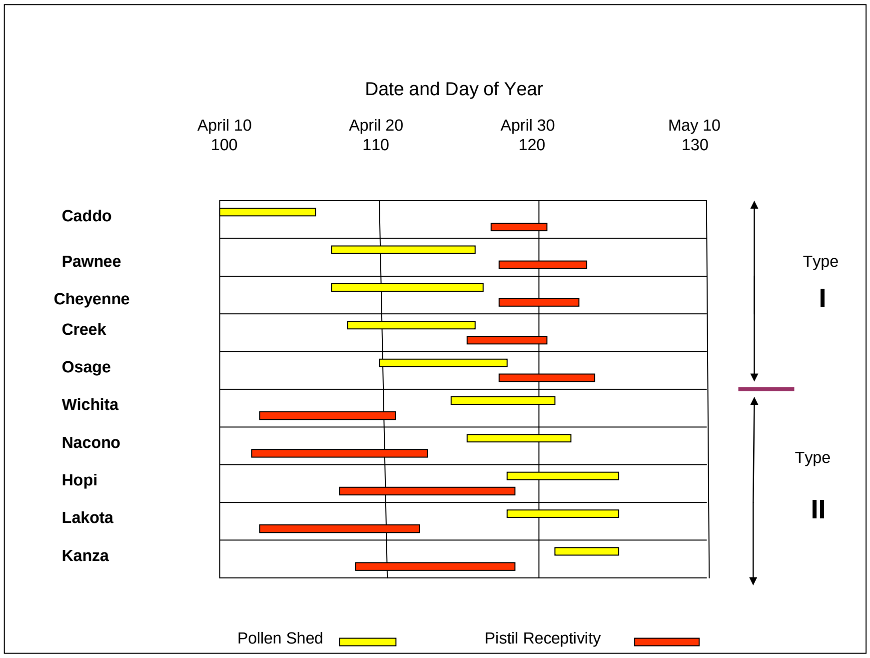

Fig. 2. Pollen shed and pistil receptivity for the 'Lakota' pecan and check cultivars at College Station, Tex. in 2007.

Pecan Rootstocks

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Improved pecans are grafted onto seedling rootstocks. Rootstocks affect tree performance, but not as much as the grafted top. As a result, it is necessary to control sources of variation, especially site differences, in order to be able to see rootstock differences. This has implications for nurserymen, pecan growers and researchers who are interested in understanding rootstock differences. Poor choice of a rootstock can result in the death of the plant. We will discuss how to avoid this.

The seed of a pecan is the nut. In order to understand variation in rootstocks, it helps to understand the floral biology of the pecan tree. Every seed has a female or nut parent (the tree that matures the nut) and a male or pollen parent (the tree that produced the pollen that fertilized the nut). In “self-pollinated” nuts, the nut parent and the pollen parent are the same. This is a type of inbreeding, and results in reduced nut fill and reduced seedling vigor. “Cross-pollinated” nuts have different nut and pollen parents. This gives the nut a type of “hybrid vigor” that results in better fill than self pollinated seed, and results in better seedling growth. Using well filled seed is very important in producing the most vigorous seedlings, regardless of which seed stock is planted. Seed is “open-pollinated” if the female flowers are left unprotected at bloom, and can receive pollen from any available source. Most nurserymen use “open-pollinated” seed. A tree with complete separation of male and female bloom will have the advantage of producing fewer “self pollinated” nuts. It might receive pollen from any tree planted close by that sheds pollen when its own pistillate flowers are receptive. A certain level of control can be exercised by grouping selected cultivars together to insure their bloom overlap. These cultivars can be chosen for maximum uniformity and vigor in the seed.

Nurserymen who plant seed from different cultivars often continue to use seed from selected cultivars that make the most vigorous, uniformly high quality seedlings. This level of selection has resulted in different seed stocks being used in different regions. Most nursery selection has been for vigor and uniformity. We are also interested in selecting for improved salt tolerance, nematode resistance and size control. In general, seed originating south of the planting location will produce larger seedlings than seed originating north of the planting site. However, seed collected too far south of the planting site will be poorly adapted due to patterns of early growth in the spring and late growth in the fall. In the west, differences in elevation make major differences in season length, so care should be taken to insure hardy seedstocks for the orchard location. We will discuss some of the boundaries that influence regional use of rootstocks.

The strong patterns that occur within families of open-pollinated seedling rootstocks might be due to “maternal inheritance”. There are sets of genes present in the chloroplasts of plants that influence the biochemistry of photosynthesis and are inherited directly from the female or nut parent. “Controlled cross” nuts result from protecting the female flowers by bagging, then introducing pollen from a selected pollen parent. By making “reciprocal crosses” where the same cultivars are used as parents, but crosses differ in which is the nut parent and which is the pollen parent, we can see evidence of maternal inheritance. There are other methods for directly measuring the genetic contribution of the female parent that are being pursued and will be discussed.

We will discuss steps that nurserymen, growers, and researchers can take to control critical variables of rootstock within each of their production systems.

Nutrient Element Interactions In Pecan Orchards

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Pecan trees are remarkably capable of maintaining a satisfactory internal balance among essential macro-, micro- and beneficial nutrients; however, this balance is potentially disrupted when trees are sufficiently stressed. Stress can be due to many factors, but is most typically linked to either excessive fertilization, dry soils, disrupted or poor soil microflora, or soils possessing unique soil chemistry or chemical composition. These interactions are complex, and are often difficult to predict or diagnose; thus, easily misleading orchard manages or extension specialists to attribute tree maladies to a particular element where in reality it is being caused by one or more different and interacting elements. This interaction is usually apparent in situations where one element is exceedingly high and another element is exceedingly low. Adverse nutrient interactions are most typical in intensely managed orchards on sites differing greatly from the river bottom soils in which the species evolved. This presentation addresses only two-way interactions; yet, in reality, three-, four-, or even five-way element interactions potentially cause orchard maladies. A basic understanding of how elements interact in both the soil solution and within the tree itself is necessary for sufficiently understanding what is happening within trees and orchards. This complexity highlights the importance of avoiding repetitive annual applications of fertilizers without proper chemical analysis of soil and tree foliage, and at least a basic understanding of the consequences on the uptake or bioavailability of other nutrients. It is a basic principal in ecosystems that when one factor is altered, it usually has unanticipated consequences on many other factors. The same principle applies to pecan nutrition management. Orchard managers must therefore be cautious about routine long-term application of nutrient elements, sewage, or waste and recognize that too much of a good thing can lead to unanticipated consequences that can be difficult and expensive to correct. Careful evaluation of annual foliar nutrient analysis and an occasional soil analysis (with separate analysis of the soil zones) are therefore important to ensuring long-term optimization of nut productivity of orchard enterprises. This presentation presents information about a multitude of antagonistic and synergistic interactions. The most important antagonistic interactions in most pecan orchards are those involving zinc.

Light Management in Pecan: Applications for Mechanical Hedging

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Light Use and Distribution

It is only through the design of an efficient orchard system that profits can be maximized. Doing so can be complicated and involves integrating many different factors, issues and concepts. Before discussing other horticultural specifics, it pays to keep in mind four essential principles of orchard design:

- The primary goals of a tree are to 1) keep itself alive and 2) to perpetuate the species.
- Grower goals are not necessarily the same as the “goals” of the tree.
- Trees can be viewed as solar collectors that convert sunlight into carbon.
- An acre of ground provides one with access to an acre of sunlight – never more.

A thorough understanding of these general concepts will help lay the foundation for better light management strategies and tactics; and it is useful to review them whenever making management decisions regarding light.

Using the process of photosynthesis, trees convert light and water into carbon and oxygen. Mediating this process are environmental factors including the quality and quantity of light, temperature, overall tree stress. The resultant carbon structures, called photosynthates, can then used to produce shoots, roots or fruits, or simply to maintain the plant. It is important to note that trees usually have an abundance of photosynthates – however, they are not always used to produce fruit. The challenge then becomes in helping the tree use the photosynthates in the most efficient way possible. One of the best ways of doing so is through improving light interception by the orchard and light distribution throughout the tree. To do this requires an understanding of the tree species in question and the planting system in which it is grown.

Orchard Design

Vigor, density, and tree configuration are critical issues in orchard design, as is tree species. An acre of land buys access to an acre of sunlight, and the properly designed orchard will intercept and use that sunlight as efficiently as possible. A poorly designed orchard will waste that sunlight – either it will fall uselessly to the orchard floor in too great an amount, or it will be intercepted mostly by the top or periphery of the tree and not penetrate into the middle and lower portions of the canopy. Because the sun moves during the day, canopy “gaps” must be present to ensure that light penetrates throughout the tree and orchard. A useful rule of thumb is that a fully leafed-out, hand-harvested orchard should intercept about 75% of available sunlight at any given moment. Shading problems can occur at light interception levels greater than that.

A well-accepted axiom of orchard design is that a tree should fill its allotted space as quickly as possible and then maintain itself in that space as easily as possible. During the first several years of orchard life the emphasis should be placed on maximizing vegetative growth – building the ability to intercept light. After that, the grower should try to reduce vegetative growth and bring the tree into a reproductive mode and ensure light penetration and distribution throughout the entire tree canopy. That type of balance is difficult to achieve in the real world however, and is why it is so important to understand the vigor of the species in question, the vigor of the location – in terms of both climate and soil – and the vigor induced by other management decisions and practices. This can especially be a challenge with large trees like pecans where light is "wasted" during the first few years of orchard development. Tighter plantings that reduce this problem tend to result in crowded, light-limited situations at orchard maturity. As such, a well-understood plan that is constantly being monitored is necessary for successful orchard design.

Growth Habit and Pruning Responses – Apical Dominance

In order to make proper decisions regarding light management it is necessary to understand how growth occurs and how pruning influences subsequent growth. Apical dominance is the influence or control of the growth and development of lower buds and shoots by the upper (apical) buds and shoots. There are three manifestations of apical dominance:

1) Correlative inhibition – suppression of lateral buds by terminal buds
2) Apical Control – upper shoots suppressing growth of lower shoots
3) Shoot Epinasty – tendency of upper shoots to suppress the branch angle of lower shoots

While it is not necessary to remember these terms exactly, it is essential to grasp the concept that the uppermost apical bud exhibits considerable influence over the amount and type of growth that occurs below it. The removal of the apical bud then affects tremendously the type of subsequent regrowth that occurs.

There are two types of pruning cuts: 1) heading cuts, and 2) thinning cuts. Heading cuts remove the apical bud and tend to stimulate vigorous regrowth in the buds remaining below the cut. Thinning cuts stimulate much less vigor because they remove both the apical bud and the subservient buds below it, and are useful in inducing fruiting and suppressing vigor. All pruning is a combination of these two types of cuts.

Pruning Decisions and Management Practices

All pruning should be viewed as a method of managing light. Since pecans are mechanically harvested, there is not the need to keep tree size as small as with hand-harvested crops. Additionally, pecans are sensitive to light and can quickly regenerate themselves when given adequate light. The key is to head off problems early ensure that trees do not become shaded or "light starved."

Options to improve light distribution within the orchard include tree removal, selective hand pruning, mechanical pruning, or some combination of these. Tree removal can be an effective method of improving orchard light distribution but is almost always practiced several years too late to be of maximum efficacy. This practice must fit into the overall orchard design and tree-density philosophy, and must be constantly monitored and evaluated during orchard development. Mechanical topping and hedging consists of virtually all heading cuts and serves to stimulate growth. Consequently, this type of pruning is frequently viewed as remedial. The key to successful implementation requires that it be practiced as an adjunct to other management practices. Hand pruning is much more selective – and expensive – and can include both heading and thinning cuts. Often considered the “best” pruning, it is not always the wisest economic choice.

Each specific orchard situation typically requires a different – and frequently combined – management method. An understanding of tree response to light, and the vegetative response to the different types of pruning cuts, is necessary to design and implement a successful strategic and tactical plan for managing light.

NUTRITION RESEARCH OVERVIEW

Maureen Ternus, M.S., R.D., Executive Director,
INC NREF

This presentation will discuss both recent and current projects of the International Tree Nut Council Nutrition Research & Education Foundation (INC NREF) including:

RESEARCH

<u>Diabetes Study</u>

This two-year study at the University of Toronto is titled, "Effect of nuts on glycemic control and cardiovascular disease risk factors in non-insulin dependent diabetes." Preliminary data should be ready by this summer and the study should be completed and ready for publication by the beginning of 2009. The U.S. Peanut Institute is also contributing funds to the study.

<u>EPIC Study</u>

The study titled, "Consumption and portion sizes of tree nuts, peanuts and seeds in the European Prospective Investigation into Cancer and Nutrition (EPIC) cohorts from 10 European countries" (co-funded by INC and INC NREF) was published in the November 2006 issue of the British Journal of Nutrition. The purpose of the study was to describe and compare consumption of total nuts and seeds and different types of nuts and seeds in men and women participating in the EPIC study (37,000 participants from 23 centers in 10 European countries).

<u>Nut Consumption in the U.S.</u>

Until now, the only good consumption data on tree nuts has been from Europe—the INC- and INC NREF-sponsored EPIC study that was published in 2006. There has been no comprehensive data for North America and the U.S. specifically. The purpose of this study is to determine the nutritional contribution of nuts and nut products to the U.S. population using the National Health and Nutrition Examination Survey (NHANES) data and to determine the relationship of nuts and nut products consumption to certain health parameters, namely anthropometric measures, blood pressure, blood lipids, blood folate levels, etc. Risk of metabolic syndrome (a precursor to diabetes) will also be evaluated.

<u>Tree Nuts and Heart Disease: A Meta-analysis</u>

Dr. Joan Sabaté, at Loma Linda University in California, has completed a meta-analysis on tree nuts and heart disease. Most of the data was originally pulled in 2003 for the qualified health claim petition. Over 20 studies were included in the petition and Dr. Sabate analyzed those, along with more recent studies, to look at the protective effect of nuts on heart disease. The manuscript has been submitted for publication.

<u>2007 Nut & Health Symposium</u>

INC NREF collaborated with the US Department of Agriculture Western Human Nutrition Research Center (USDA WHNRC) on the 2007 Nuts & Health Symposium. This was the second time the two groups had worked together. The first was in 1995 for a meeting on Nuts and Health held at the Presidio in San Francisco. The purpose of the 2007 meeting was to review what had happened with regard to nut research worldwide in the last decade or so and to determine what areas of research the industry should focus on in the future. In addition, the proceedings from the meeting will be given to the Dietary Guidelines Advisory Committee in hopes of positioning nuts in a more favorable position in the 2010 USDA Dietary Guidelines.

PROFESSIONAL OUTREACH

INC NREF Nuts & Health Session at the 10th Asian Congress of Nutrition

The 10th Asian Nutrition Congress (ACN) was held at the International Convention Center, Taipei, Taiwan on September 9th-13th, 2007. This conference is held once every four years and attracts approximately 3,000 attendees. INC and INC NREF sponsored a session held on September 11th. This was the first time nuts and health had been highlighted to Asian health influencers, researchers and policy makers from organizations like WHO and FAO. The session included five speakers and highlighted major outcomes from the 2007 Nuts & Health Symposium. The session proceedings will be published in the *Asia Pacific Journal of Clinical Nutrition (APJCN)* in 2008.

5th International Congress on Vegetarian Nutrition

INC NREF is sponsoring a session at the upcoming 5th International Congress on Vegetarian Nutrition. The congress will convene on the campus of Loma Linda University in Southern California, March 4-6, 2008. This is the premiere scientific conference on the health effects of plant-based diets.

The INC NREF-sponsored session will include a panel which will discuss “How to better position a vegetarian diet in the upcoming dietary guidelines.” The session will be moderated by David Jacobs, PhD, from the University of Minnesota, USA and there will be four panelists, one of whom is Victor Fulgoni, PhD. Dr. Fulgoni is doing the INC NREF-funded nut consumption analysis in the U.S. and will be talking about his findings from the study.

INC NREF Exhibits – Every year INC NREF exhibits at a number of health professional meetings including the American Association of Diabetes Educators and the American Dietetic Association.

PUBLICATIONS

New Book on Tree Nuts

“Tree Nuts: Nutraceuticals, Phytochemicals and Health Aspects” is a new book on tree nuts scheduled for publication in 2007. The book is a result of a session that was held at the 2006 International Food Technologists Meeting in Orlando, FL. The organizers of that session decided to write a book about tree nuts and asked INC NREF to write an overview chapter on nuts and healt

Pecan Production Internet Resources

Robert E. Call
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The Internet has become ubiquitous not only in the United States but the entire world. Those who say they don't need to use the Internet are similar to those who say they do not need to know how to read. Many source of information can be found on the worldwide web. However, care must be exercised and not believe all that is found on the Internet. A Google search of the word "pecan" showed 10,500,000 "hits." To choose Internet sites that are less bias look for those that end in: .edu (education), .gov (government) or .org (organization). Those that have .com (commercial) endings many times are trying to sell something. Below are some websites that contain good information and may answer questions concerning your orchard and/or business. Most sites contain numerous topics. You can not break the Internet, so go ahead and surf around and see what you can find!

Associations
Arizona Pecan Growers Association- http://www.arizonapecangrowers.com/
California Pecan Growers Association- http://www.californiapecangrowers.org/
Georgia Pecan Commission- http://www.georgiapecansfit.org/
International Tree Nut Council- http://www.nuthealth.org/
National Pecan Shellers Association- http://www.ilovepecans.org/
New Mexico Pecan Grower Association- http://www.nmpecangrowers.org/
Oklahoma Pecan Growers Association- http://www.hortla.okstate.edu/pecan/opga/index.html
Texas Pecan Board- http://www.texaspecans.org/
Texas Pecan Growers Association- http://www.tpga.org/

Horticulture/Production
Agricultural Research Service (ARS) Pecan Research-
http://www.ars.usda.gov/research/publications/publications.htm?seq_no_115=154171 ATTRA: National Sustainable Agriculture Information Service- http://attra.ncat.org/attra-pub/pecan.html
ARS Kids Pecan Page- http://www.ars.usda.gov/is/kids/nutrition/story6/pecanindex.html
Evaluating Pecan Problems- http://extension-horticulture.tamu.edu/fruit/pecan1.html
Georgia Pecan Information- http://www.tifton.uga.edu/ugapecan/
New Mexico State University Pecan Management- http://cahe.nmsu.edu/ces/pecans/pecan-management.html
Pecan Cultivars- http://extension-horticulture.tamu.edu/CARYA/PECANS/cvintro.htm
Oklahoma State University Pecan Management- http://www.hortla.okstate.edu/pecan/ & http://pecan.okstate.edu/
Texas A & M Home Fruit & Nut Production- http://aggie-horticulture.tamu.edu/extension/homefruit/pecan/pecan.html
University of Arizona Publications- http://cals.arizona.edu/pubs/garden/az1400.pdf
University of California Pecan- http://fruitsandnuts.ucdavis.edu/crops/pecan.shtml

Marketing

Georgia Pecan Consumer Research- http://www.georgiapecansfit.org/Marketing.html
New Mexico State University Marketing Channels for Pecans http://cahe.nmsu.edu/pubs/_z/Z-307.pdf
USDA Market News- http://marketnews.usda.gov./portal/fv

Pest Identification & Control
Green Book Pesticide Labels- http://greenbook.net/
National Pesticide Information Center- http://npic.orst.edu/
Organic Materials Review Institute- http://www.omri.org/
Pest Facts- http://www.pestfacts.org/
Pesticide Labels- http://www.cdms.net/
Texas A & M Pecan Kernel- http://pecankernel.tamu.edu/
University of California IPM Online-
http://www.ipm.ucdavis.edu/PMG/selectnewpest.pecans.html
University of Arizona Publications- http://cals.arizona.edu/pubs/
Western IPM Center- http://www.wripmc.org/

Recipes
National Pecan Shellers Association- http://www.ilovepecans.org/recipes.html
Texas A & M University- http://aggie-horticulture.tamu.edu/plantanswers/recipes/pecanrecipes/recindex.html
Texas Pecan Growers- http://www.tpga.org/cgi-bin/public.cgi?action=categories

Soils and Fertility
NRCS Soil Surveys- http://soils.usda.gov/survey/printed_surveys/
University of Arizona Publications- http://cals.arizona.edu/pubs/diseases/az1410.pdf

State Departments of Agriculture
Arizona- http://www.azda.gov/
California- http://www.cdfa.ca.gov/
New Mexico-http://nmdaweb.nmsu.edu/
Oklahoma- http://www.oda.state.ok.us/
Texas- http://www.agr.state.tx.us/agr/index/0,1911,1848_0_0_0,00.html

Weather
Arizona Meteorological Network- http://cals.arizona.edu/azmet/
National Weather Service- http://weather.noaa.gov/
Oklahoma AgWeather- http://agweather.mesonet.org/
The Weather Underground- http://www.wunderground.com/
Texas State Climatologist- http://www.met.tamu.edu/osc/
University of California Weather Data- http://ipm.ucdavis.edu/WEATHER/wxretrieve.html

Overview of Pecan Production in Mexico

Humberto Núñez Moreno
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Pecan is a native tree in Mexico. Native areas are scattered in small spots from Rio Bravo to lower latitudes as 18 °N. Pecan production is located in the Northern part of Mexico. Principal production states are Chihuahua, Coahuila, Sonora, and Durango. The Mexico Department of Agriculture (SAGARPA) reported pecan industry situation to the period 1999-2005. Yearly average production was 68,507 ton. Pecan area in 2005 was 67,847 ha, and 80 % of this area was harvested. Most of the pecan production is irrigated (97 %).

Several varieties from USA and Mexico had been tested, but ‘Western Schley’, usually called “Western”, and ‘Wichita’ are the main varieties. Former variety is most used in areas with the presence of late season freezes. However, the use of the latter is coming more common in warmer areas of production. Advantages of ‘Western’ are more regular production and less nut pregermination (vivipary).

Most popular plant density is 10 x 10 m (100 trees per ha), but recently 12 x 6 m is planted (139 trees per ha). Trials with narrow spaces (6 x 6 m and 7 x 7 m) have being tested. Manual and mechanical pruning are used to control canopy. The most popular manual system is Selective Limb Pruning which consist in eliminate one big limb affecting light penetration. Mechanical hedging and topping are used too.

Nitrogen and Zinc are the most deficient nutrients. Nitrogen is applied mainly based on foliar analysis and crop production. Forming acid fertilizers as urea and ammonium sulfate are used. Zinc is sprayed two to five times weekly, beginning in bud break, and the most common source are nitrate zinc solutions. Some growers apply phosphorus and potassium (Núñez, et al, 2001; INIFAP, 2002).

Drip and sprinkler irrigation is coming more popular in pecan orchards. Chihuahua and Sonora are leaders in this type of irrigation. Water irrigation quality is good, but salinity problems are arising in some overexploited aquifers.

Scab is not common, but some humid areas can show it. Pest presences are black and black margined aphids, pecan nut case bearer and hickory shuck worm. Presence of wood borers and webworms are also common in areas close to the native areas.

From 1998 to 2002 exports to USA 24,432 ton, and imports from USA are 3,213 ton (Hadjigeorgalis, et al, 2005). Major problems are alternate bearing and vivipary. Both affect production, quality and market. This industry has a fast growth in the recent years due to high demand and strong market. From1999 to 2005 pecan area was increased from 49,444 to 67,647 ha (37 %) (SAGARPA, 2007).

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42nd ANNUAL WESTERN PECAN GROWERS ASSOCIATION CONFERENCE SPEAKERS

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