Almond Culture and Orchard Management

Project No.: 03-JE-02

Project Leader: Mark Freeman, UCCE Farm Advisor, Fresno Co.

Project Cooperators: Roger Duncan, John Edstrom, Brent Holtz, Franz Niederholzer, Mario Viveros (Farm Advisors in Stanislaus, Colusa, Madera, Yuba-Sutter, and Kern Counties, respectively)

1) Business Tools for Tough Times

Mark Freeman, Karen Klonsky—UCD Specialist, Agricultural Economics

Objectives: To develop computerized software tools that allow growers to manage/ analyze information for the purpose of record keeping, profitability, and making decisions. To compare training methods in regards to successful adoption and usage by clientele.

The UCCE cost and return studies on commodities have been important financial tools for both farmers and agricultural lenders. The studies give an average cost of production for a given commodity, and are used as a baseline by lenders for loan approval and comparisons. In 1998, UCCE placed these studies in a PDF format on an Internet web site, and the usage has increased considerably. In 2003, we converted some of the data tables to *MS Excel* spreadsheets. We have worked with private lenders to create additional spreadsheets and linked the data to financial record keeping packages such as Intuit's *QuickBooks*.

We offered training sessions to show how certain business tools can help manage farm production costs. More specifically, these tools will help farmers organize and analyze information for the purpose of: record keeping for taxes, determining the relative profitability of different operations or inputs, showing trends for costs and returns over time, and assisting with production and investment. The first two sessions used the software program MS *Excel* and data tables from the University of California Cost and Return Studies. We are "improving" these documents by converting some of the data tables to a spreadsheet format that allows clientele to enter their own data and play "what if". The cash flow budgeting and forecasting will use spreadsheets to predict future performance of farm operations under different scenarios. The last two sessions will use the same data tables mentioned earlier with the software program *QuickBooks* (by Intuit). This is a simple record keeping system to streamline paying bills and tax preparation. The program can also be used to analyze the profitability of the farming business and for business planning.

The first training session of four night meetings (of two hours each) was held during April and May, 2003 in a Fresno based computer laboratory. Thirty-three people attended, and we had a waiting list of more than thirty people. The attendees were surveyed before and after the meeting and results will be presented at the December meeting. We are now organizing the next series of training. One of the goals is developing a product that can be offered by Farm Advisors and private cooperators throughout the state in the major almond producing areas.

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We have applied for a grant from the Western Center for Risk Management Education to continue and expand this project. We will be notified by May, 2004.

For the proposed continuation project, we will offer computer classes at two levels: a larger overview class of 35 work stations for "awareness" and a subsequent smaller intensive class for the purpose of "adoption". The overview class will have four two-hour sessions and be offered four times. The first two classes will teach Quick Books and the second two Excel. The follow-up intensive classes of 10 students each offered four times. These students will work from their own farm records to develop spreadsheets for decision-making and loan preparation.

The curriculum will use the cost and return studies developed by the University of California as the basic material. We will develop several farm situations as a starting point for in-class problem solving. The information from the cost and return studies will be entered directly into Quick Books and Excel spreadsheets for cash flow analysis that have already been developed by Fresno Farm Credit Association personnel.

The target audience is full - time and part - time growers of tree crops in Fresno County California grossing under $250,000,, especially beginning (primarily part time) and young (primarily full time) farmers. We expect the participants to take a hard look at their business operations with respect to profitability and cash flow and either develop or reassess their long - term business plans. We expect 75 per cent of the participants in the overview class and 100 per cent of the participants in the intensive classes to achieve this goal. These estimates of achievement are high because the participants will be self-selecting and invest a significant amount of time to the classes.

The third and final aspect of the project is making the cost and return study spreadsheets available on the Dept. of Agricultural and Resource Economics website alongside the cost and return studies available in pdf format. The impact of the classes will be analyzed with a mail survey of participants and their lenders. We will count the "hits" on the website.

Basically, we will be demonstrating the value of record-keeping in making decisions and understanding their financial position and credit needs. We will teach participants to play "what if" with cash flow spreadsheets going out seven years for long -range and short - run planning. Long - range planning will include looking at diversification, changing enterprises, adopting new technology, and respond to regulations that impact the choice of production inputs and practices. Short - run planning with focus on choosing a type of loan (line of credit vs. budgeted loan), cost control, and the impact of marketing outlets on cash flow.

2) Processed-Kaolin Particle Film on Almond

Brent A. Holtz[1] and Eric W. Hoffman[2]
Pomology Farm Advisor[1] and Staff Research Associate[2]
University of California, 328 Madera Avenue, Madera CA 93637, USA

Surround, a white clay like processed-Kaolin particle film, can easily be dissolved into suspension and sprayed onto trees. Several research reports have been published in the Journal American Society Horticultural Science and HortTechnology describing how Kaolin reflective film can reduce heat stress on a number of crops in several countries. These studies have shown that the processed-kaolin particle film (Surround) is highly reflective to ultraviolet wavelengths and has reduced solar injury to both leaves and apple fruit in Chile, Washington, and West Virginia (1). Other researchers described how Surround treatments increased leaf carbon assimilation and that canopy temperatures were reduced (2). In studies in New York and Idaho Surround reduced the incidence of sunburn to apples, but it also reduced the fruit weight and color and left an undesirable residue (3).

In 2001 processed-Kaolin particle film was applied to 15 year old Nonpareil, Sonora, and Carmel almond trees. Three in-season (April, May, and June) applications of Kaolin resulted in more return bloom, nut set, and yield on Carmel trees in 2002 when compared to non-sprayed Carmel trees (4). The Carmel trees in this orchard were showing symptoms of severe bud failure. The Sonora and Nonpareil varieties appeared unaffected by the Kaolin. Record hot temperatures were experienced in the San Joaquin Valley in May 2001. Hot temperatures at this time have been shown to worsen the severity of bud-failure on the Carmel variety (Dale Kester-personal communication).

It appears that Surround may have reduced heat stress in May 2001, and consequently more bloom was observed on Surround-treated Carmel trees. These Surround treated trees probably had less heat stress and consequently more carbon assimilation (2). In 2003 four applications of Kaolin (25 lbs/100 gallons water) were made to two year old Carmel trees in order to see if Kaolin can reduce heat stress and the onset of bud failure and to study its effect on tree carbon assimilation, canopy temperatures, and tree growth and yield. An orchard in Madera CA with 16 Carmel rows was divided into a replicated block design where 8 rows received four Kaolin applications in 2003. Mid day leaf

stem water potential, tree diameter, and shoot growth were examined. Canopy temperatures and yield will be examined in future years.

Results

In 2003 mid day leaf stem water potential measurements were performed once a month from June-September. In June and July mid day leaf stem water potentials were significantly less in the Surround treated trees when compared to non-treated trees (figure 1). In August and September there was no difference between Surround and non-treated trees. There was also no significance difference between current season shoot growth and trunk circumference between the two treatments. We hope to continue to monitor the effect of Kaolin in 2004.

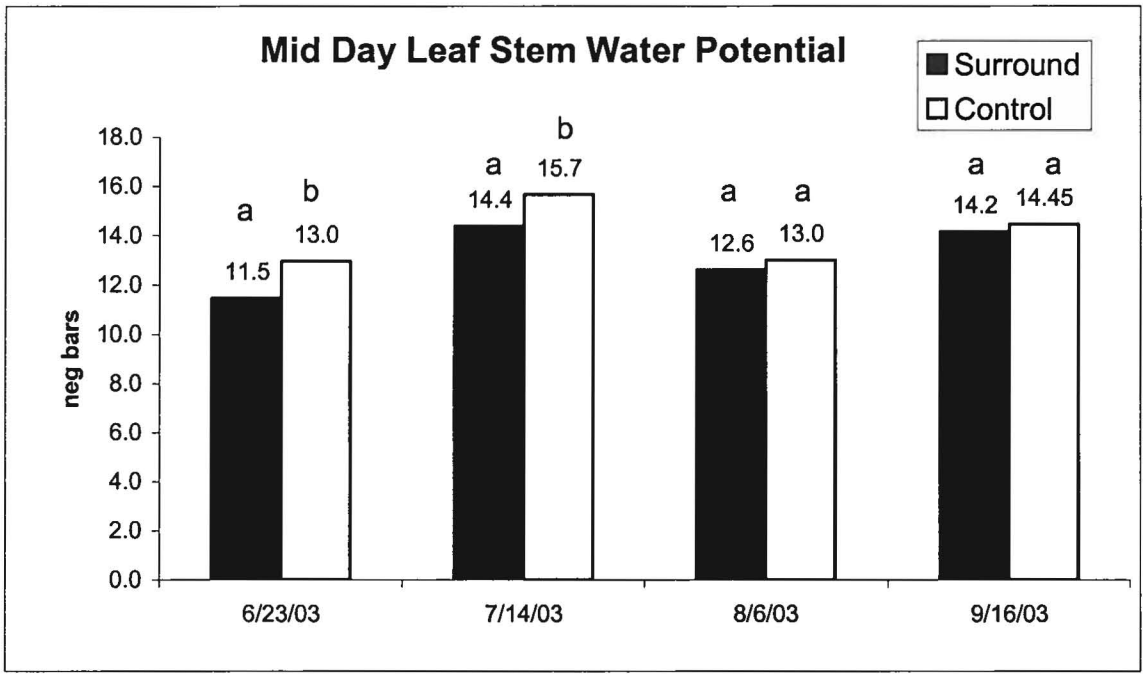

Figure 1. Paired columns within the date with different letters were statistically different when compared in a Student's T-test (P # 0.05).

Literature

1) Glenn, D.M., Prado, E., Erez, A., Mc Ferson, J., and Puterka, G.J. 2002. A reflective, processed-Kaolin particle film affects fruit temperature, radiation reflection, and solar injury in apple. J. Amer. Soc. Hort. Sci. 127(2):188-193.

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3) Schupp, J.R., Fallahi, E., and Chun, I.J. 2002. Effect of particle film on fruit sunburn, maturity, and quality of "Fuji" and "Honeycrisp" Apples. HortTechnology 12(1):87-90.

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3) Pellical Inking in Sonora –
Mario Viveros, UCCE Farm Advisor, Kern County

Inking of the pellicle of the Sonora variety has been a problem in almond orchards in recent years. The inking can be present after the endosperm is fully developed. It can appear in June before the hull opens. Once the pellicle changes from white to brown, the inking appears as dark blue spots. They vary in size from small to large spots. Some can cover more than 50% of the pellicle surface.

The cause of inking at this time is not known. We have been taking nut samples during the growing season from Sonora orchards under different irrigation systems. The samples have been analyzed for inking but the data has not been processed. This data however will be ready for the December research meeting.

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Inking of the pellicle of the Sonora variety has been a problem in almond orchards in recent years. The inking is only found on the pellicle and not on the endosperm. However, it has been considered as a defect in the Indian and Chinese markets. The staining has been bad enough that some brokers have been forced to sell Sonoras at a discount.

The pellicle ink-staining on Sonoras is widespread in the San Joaquin Valley. At this time, however, the causes are not known. There have been some suggestions that fungal infections may play a part. However, pellicle ink-staining can be found in June before hullsplit takes place.

It has been observed that the worst ink-staining occurs in high temperature years. Therefore, water management may play a role in ink-staining development in susceptible varieties. To determine if irrigation systems play a role in pellicle ink-staining in susceptible and non-susceptible varieties, orchards containing Sonora and Nonpareil under different irrigation systems were selected. Twenty-five nut samples per tree, per variety were taken every week during hullsplit. The irrigation systems selected were flood, single drip hose, subsurface, fan-jet solid set, sprinkler and double drip hose.

Each nut was cut open and placed into three categories. One, small ink-staining nuts were those with one or more dots on the surface of the pellicle. Two, medium ink-staining nuts were those that contained dark areas that covered up to one-quarter of the kernel surface. Three, large ink-staining nuts were those that contained dark areas that covered more than one-quarter of the kernel surface. The results of both Nonpareil and Sonora can be found in tables one and two.

Table 1. Nonpareil nuts (out of 25) showing degrees of ink-staining from different irrigation systems.

Irrigation Systems	Hullsplit	Small	Medium	Large
Flood	10.9 a	10.0 bc	1.0 b	0.0 a
Single Hose Drip	13.1 ab	12.1 c	0.2 a	0.1 a
Sub-surface Drip	15.9 bc	8.5 b	1.0 b	0.1 a
Fan-jet	21.1 cd	3.0 a	0.1 a	0.0 a
Sprinkler	20.6 d	9.0 b	0.0 a	0.0 a
Double Hose Drip	21.8 d	12.4 c	0.5 ab	0.0 a

*Numbers within a column that are followed by the same letter are not significantly different from each other.

Table 1. Sonora nuts (out of 25) showing degrees of ink-staining from different irrigation systems.

Irrigation Systems	Hullsplit	Small	Medium	Large
Flood	5.0 a	5.6 a	3.4 cd	6.6 c
Single Hose Drip	3.4 a	6.5 ab	3.5 cd	6.4 c
Sub-surface Drip	7.1 a	6.8 ab	2.7 bc	5.0 bc
Fan-jet	15.0 b	7.9 b	0.6 a	0.4 a
Sprinkler	17.0 b	11.7 c	1.8 b	3.9 b
Double Hose Drip	17.5 b	12.0 c	4.3 d	5.7 bc

*Numbers within a column that are followed by the same letter are not significantly different from each other.

The data shows that ink-staining can also occur in Nonpareil. The majority occurs in the small category. In this category, the Fan-jet irrigation system has less ink-staining nuts than any of the other irrigation systems. The highest amount of ink-staining took place in flood, single hose drip and double hose irrigation systems. In the case of Sonora, ink-staining occurred in all categories. The Fan-jet irrigation system produced less ink-staining nuts in the medium and large categories. In the small category, this irrigation system produced less ink-staining nuts than sprinkler and double hose drip.

In conclusion, the data shows that ink-staining is related to the orchard's irrigation system. The Fan-jet produced significantly less ink-staining nuts in both

Nonpareil and Sonora varieties. In contrast the double hose drip produced significantly more ink-staining nuts than any other irrigation system.

4) Integrating Tree Spacing, Rootstock Selection & Pruning for Efficient Almond Production.

Roger Duncan, UCCE Farm Advisor, Stanislaus County

Objective: To evaluate the interactive effects of rootstock, tree spacing and pruning strategies on yield and tree growth parameters of almonds.

Problem and its Significance

Several research trials have examined various pruning strategies on almond in California. Results have suggested almonds may not need to be pruned heavily or possibly not at all. Few studies have examined tree spacing and the effects on short and long-term yield or how orchard density may influence the need for pruning.

Early in the life of an orchard, it is important to fill available space quickly in order to maximize early yields and pay down principle on bank loans. However, after full canopy has been achieved, trees continue to grow. This results in intermingled canopies, shade-out of lower fruiting wood and potentially declining yields. It is important to determine how pruning may influence the long-term productivity and economic viability of variously spaced trees. While closely planted, minimally pruned trees may bring earlier financial rewards, long term profits could be lower.

Methods

In 2000, an almond orchard with the varieties 'Nonpareil', 'Carmel' and 'Sonora' were planted on Nemaguard, Lovell or Hansen 536 rootstocks at four different in-row spacings. The spacings were 10' x 22', 14' x 22', 18' x 22', and 22' x 22'. Four pruning strategies are being imposed across all rootstock and spacing treatments. They are:

1. **"Standard pruning".** Three permanent scaffold limbs were selected during the first dormant pruning, and will have "normal", annual pruning to keep centers open and remove crossing limbs.
2. **Three scaffolds with standard pruning for 2 years, then unpruned for the duration of the trial.**

3. **Untrained, unpruned.** No scaffold selection and no annual pruning other than removing root suckers, limbs originating too low on the trunk for shaker access, and limbs potentially dangerous for equipment operators.

4. **"Minimal" pruning**. Nonpareil trees were topped twice during the first growing season to stimulate secondary branching and establish a bushy tree. At the first dormant pruning, four to six scaffolds were selected to maintain a full canopy. Few, vigorous shoots growing in the center of the trees were removed. In the future, only 2-3 cuts will be made on each tree each year to maintain a minimally open tree.

Results

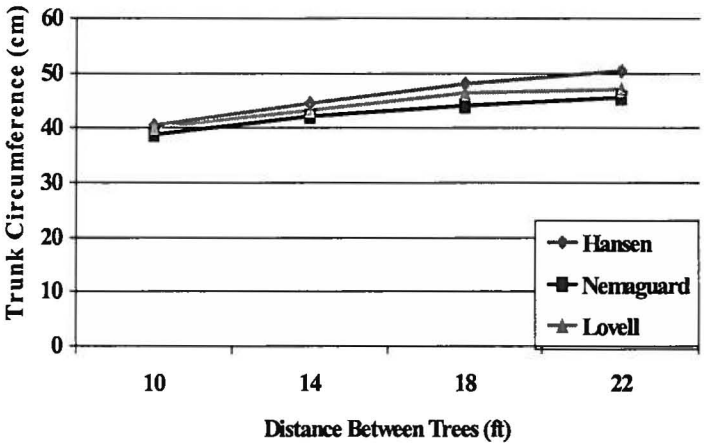
Time required to prune. A professional crew pruned the third-leaf trees in January, 2003 according to the guidelines for each treatment as outlined above. Workers were timed to determine the length of time required to prune in each treatment.

Table 1. Time required to prune third-leaf almond trees following the four outlined pruning treatments.

Pruning Treatments	Standard pruning	Standard training, then no pruning	Unpruned	Minimally pruned
Average time required to prune each tree	2 minutes & 50 sec.	0	0	42 sec.

Effects on tree growth. Trunk circumference has been measured at the end of each season to determine the effect rootstock, pruning and tree spacing has had on tree size. Untrained, unpruned trees have a larger trunk circumference than standard pruned trees. Trees on Hansen rootstock have larger trunks than trees on Nemaguard or Lovell. Even after just three seasons, tree spacing has had a significant effect on tree size. Trees on Hansen rootstock planted 22 feet apart were almost ten centimeters larger in circumference than trees planted 10 feet apart (Fig. 1).

Figure 1. The Influence of Tree Spacing on Trunk Size of Third-Leaf Almond Trees



Yield. In general, yield per tree was increased as tree spacing increased. Trees planted ten feet apart yielded on average 11.9 meat pounds per tree while trees planted 22 feet apart yielded 24.9 meat pounds per tree. However, when yields were calculated on a per acre basis, yield patterns were unclear and spacing did not appear to make a significant difference in yield. Conventionally trained and pruned trees had lower yields than unpruned and minimally pruned trees.

Yield **(pounds per tree)** of fourth-leaf Nonpareil					
Pruning Treatment	Tree spacing down the Row (feet)				
	10	**14**	**18**	**22**	**Avg.**
1	11.1	17.4	17.8	20.4	16.7
2	11.6	17.7	20.5	25.4	18.8
3	14.0	20.2	18.6	24.7	19.4
4	10.9	19.6	19.4	29.1	19.8
Avg.	11.9	18.7	19.1	24.9	

Yield **(pounds per acre)** of fourth-leaf Nonpareil					
Pruning Treatment	Tree spacing down the Row (feet)				
	10	**14**	**18**	**22**	**Avg.**
1	2190	2459	1960	1840	2112
2	2305	2499	2253	2288	2336
3	2780	2843	2050	2225	2475
4	2158	2766	2138	2617	2420
Avg.	2358	2642	2100	2243	

Summary

Trees in this orchard are vigorous and growing rapidly. By the end of just the third growing season, tree spacing significantly influenced tree size. Even though canopies of trees planted 14, 18, or 22 feet apart were far from touching, intra-tree competition was controlling tree vigor. Many growers feel high density orchards need to be pruned more severely to reduce shading and maintain yields. However, smaller tree size caused by competition may actually reduce the need for pruning.

The smaller tree size of more closely planted trees lead to a significantly smaller per tree yield. However, the lack of per acre yield difference between differently spaced trees was unexpected. While canopies of trees spaced ten feet apart are touching each other, trees spaced 18 and 22 feet apart have not nearly filled the space down the row. It is possible that larger tree canopy size in widely spaced trees compensated for the lack of tree density.

Although untrained and unpruned trees had the highest yields in this fourth-leaf orchard, shade out of lower fruiting wood in the future may lead to lower long-

term yields. Yield measurements need to be monitored in this trial for twenty years before orchard density and pruning recommendations can be made with confidence.

5) Is There a Cost Effective Alternative to Zinc Sulfate for Fall Defoliation?
Franz Niederholzer, UCCE Farm Advisor, Sutter and Yuba Counties

Objective: Evaluate alternatives to high rates of zinc sulfate (36%) for fall almond orchard defoliation.

A zinc sulfate foliar spray in the fall to treat zinc deficiency has been a common orchard practice for more than half a century. This spray also helps defoliate trees, which reduces the potential for tree blow-over and makes early pruning easier. However, a fall zinc sulfate spray is relatively expensive – primarily because it is usually applied alone, as other materials are not compatible with 20-30 pounds of zinc sulfate per 100 gallons of water.

Recent production research results, food quality challenges, advances in fertilizer formulation, and possible review of zinc usage by regulatory agencies point to the need to check out options in postharvest spray practices for almond orchards. Less phytotoxic foliar zinc materials have been developed, and can be tank-mixed with early season fungicides. Foliar boron applications can, where needed, consistently improve almond yield, but several boron spray formulations are not compatible with even 20 pounds of zinc sulfate/100 gallons of water. Food quality is now a major concern for the almond industry, and the postharvest/prebloom window is a good timing for "clean up" sprays if needed. Finally, zinc is toxic to fish, and its agricultural uses, especially at high rates, may soon be reviewed by regulatory agencies. However, since tree blow-over can be a problem in some almond growing areas, it could be beneficial to find a cost-effective, environmentally "soft" alternative defoliant that can be tank-mixed with boron and may have activity on microorganisms.

Different rates of two commercial cotton defoliants, along with differing rates of zinc and/or urea, will be applied to almond nursery stock in the first week of November. Leaf loss will be measured at 2 weeks after application. Trees will be lifted this winter and planted next spring. Tree growth and/or nutrient levels will be measured during the growing season. Effective, non-damaging treatments will be considered for further work in mature almond orchards.

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Different rates of sodium chlorate or pyraflufen ethyl, two commercial cotton defoliants with low environmental impact potential, along with differing rates of zinc sulfate and/or urea solutions, were applied to almond nursery stock ('Price' on 'Lovell") on November 17-18, 2003 using a backpack sprayer. Spray was applied so to runoff. Zinc sulfate or sodium chlorate solutions effectively defoliated the study trees within a week of application. Neither urea or pyraflufen ethyl effectively defoliated the study trees.

The study trees were lifted and placed in cold storage in December, 2003, and planted into 5 gallon pots to evaluate growth potential following fall sprays. Growth will be evaluated during the summer, 2004.

6) Slip Plow Tillage Effects in Almonds

John P. Edstrom, Colusa County Farm Advisor & Stan Cutter, Nickels Soils Lab

Expansion of orchard plantings in California has exhausted the supply of prime orchard ground, forcing new plantings onto poorer soils. These soils are often characterized by stratified layers of clay, hardpan or gravel and shallow topsoil. To overcome soil limitations, substantial new almond acreage has been established using deep tillage slip plows at considerable expense-$300-500/acre. At the same time, adoption of micro-irrigation has allowed growers to supply tree roots with a more optimal and continuous supply of moisture and nutrients. Limitations in soil physical/nutritional traits have been overcome by the use of micro-irrigation, especially under close tree spacings.

A trial at the Nickels Soil Lab in Arbuckle is evaluating the effects of slip plow soil modification on 'Nonpareil' almonds planted in 1997 at 16' X 22'. Prior to planting, replicated areas of this 20 acre block received a commercial slip operation on a 10 foot grid to a depth of 6 feet in a north/south direction and with

a diagonal pass (SE-NW) to a 5 ft. depth. The planting receives irrigation via micro-sprinklers. Trees are planted to Lovell rootstock on Arbuckle series gravelly loam Class II soil.

Results: The 2003 data represents the forth harvest on these 7th leaf trees. Yield results in the table show no difference in production between slip plowed areas and non-slip areas. Nut yields were down somewhat this season at about 2200 lbs per acre following exceptional production last year. Kernels sizes were larger but showed no difference between the soil areas. The test area consists of trees planted on Lovell peach and peach/almond hybrid rootstocks. Both rootstocks failed to respond to the slip plow treatment. Four consecutive years of yield data has shown no difference between trees planted in slip plowed and non-slip areas. However, a complete evaluation of slip plowing in almonds should consider surface/subsurface drainage during wet winters and the potential advantage to tree survival. This test site has this potential given a wet winter.

	Kernel - lbs./acre					
	Rep					
	1	**2**	**3**	**4**	**Total**	**Mean**
Slip Plow	2196	1921	2366	2278	8661	2165
No Slip Plow	2348	2215	2288	2440	9291	2323
						NS
	Weight - gms/Kernel					
	Rep					
Slip Plow	1.5	1.3	1.5	1.4	5.7	1.4
No Slip Plow	1.5	1.5	1.5	1.3	5.9	1.5
						NS