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ORCHARD FACTS

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Sacramento Valley Prune Newsletter

Using Urea Efficiently

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Summary: Soil applied fertilizer is intended for root absorption by plants. Manage fertilizer nitrogen (N) to keep as much of it as possible in the root zone to maximize crop N uptake, crop yield, and protect the environment. To keep urea fertilizer N in the root zone 1) incorporate urea into the soil with water or cultivation within a day or two of application and 2) don't over irrigate when incorporating urea using water. Inject liquid fertilizers containing urea (for example, UAN32) into irrigation systems in the middle third of the irrigation set. This delivers urea N evenly through the root zone, avoiding leaching that can occur when urea is injected too early in the set and limited root zone distribution when injected too late in the set.

Background. Urea is the most commonly used dry nitrogen (N) fertilizer in the U.S. It provides half of the nitrogen in UAN (Urea Ammonium Nitrate) 28 or 32 liquid fertilizers. Dry and liquid fertilizers that contain urea have several advantages -- relatively high N content (28-46% N), ease of handling and reasonable price relative to other N sources. However, nitrogen from applied urea can be lost from the root zone when used improperly, wasting money, reducing plant available N, and risking reduced crop growth and yield. The lost N can also be an environmental contaminant. Growers and PCAs should be aware of how to avoid N losses and get the most from urea fertilizer dollars.

Within days of application, urea N can be lost from the crop root zone in two ways – through ammonia volatilization or urea leaching. This article will briefly describe how these losses can occur and how to manage urea to avoid them.

The uncharged urea molecule ($H_2N\text{-}CO\text{-}NH_2$) breaks down in or on the soil into two ammonium molecules (NH_4^+) and a bicarbonate molecule (HCO_3^-) within days of application. Urease, a naturally occurring enzyme in soil and on plant surfaces, drives this reaction. Ammonium produced by urea breakdown (urea hydrolysis) has many potential fates. It can shift form to ammonia (NH_3; a gas), a process accelerated by high temperatures (over 70ºF) and high pH. It can be held by the cation exchange capacity of clay or organic matter, absorbed by soil microorganisms or plants or changed into nitrate (NO_3^-) by certain soil bacteria (nitrification). Where urea transformation occurs has a major impact on whether the N applied actually enters and stays in the root zone.

Ammonia volatilization. Urea fertilizer – dry or liquid – applied to the soil surface and left there for days to weeks can lose >50% of N content into the air through ammonia volatilization. High soil pH, high soil temps (>70ºF), sandy soils with low cation exchange capacity (CEC), weeds or turf, and moist soils/heavy dew are all factors that increase the ammonia losses from unincorporated urea. Incorporate urea into the soil within a day or two of application to avoid significant N loss.

Urea Leaching. Dissolved urea moves with water. Why? Urea hydrolysis takes several days to complete. Until hydrolysis occurs, the uncharged urea molecule won't bind to soil particles. This helps with water incorporation, but can result in leaching of urea below the root zone during irrigation if excess water is applied. The most efficient use of urea fertilizer requires good irrigation management. Don't over irrigate when incorporating surface applications or injecting urea-containing fertilizers through irrigation systems. When injecting urea fertilizer in a micro-irrigations system, a good general rule is to add the fertilizer in the middle third of an efficient irrigation set, a set that won't push water down below the bottom of the root zone. For example, in a 12 hour irrigation set, add the urea in hours 4 to 8. This reduces the chances of pushing urea below the root zone or at least deeper in the root zone where there are fewer roots. Urea-containing fertilizer added late in the set is concentrated near the water source and not evenly distributed in the root zone.

Review. Surface-applied dry or liquid urea fertilizer must be incorporated as soon as possible or significant nitrogen losses can occur. Incorporation within 2 days of application is best. When irrigating to incorporate urea, don't over irrigate. When injecting liquid urea fertilizer into an irrigation system, apply fertilizer in the middle third of the irrigation set for the most even distribution in the root zone. How you use urea can go a long way to helping you get the most out of your fertilizer dollar.

**Helpful reviews and comments on this article were provided by Rob Mikkelsen, International Plant Nutrition Institute, and Sebastian Braum, Yara North America, Inc.*

In-Season Potassium Fertilization Options for Prunes

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Potassium (K) is the most important nutrient required for good prune tree health and consistent production under California conditions. Potassium is associated with water, nutrient and carbohydrate movement in plants as well as several key biochemical processes. Through the season, K accumulates in fresh fruit so that dried prunes contain 1% K. Potassium deficiency in prune trees produces small fruit size, high drying ratios, and dieback in the top of the tree. Branch dieback usually begins mid to late season and is more prevalent in trees bearing heavy crops. Defoliation due to K deficiency can lead to scaffold sunburn and *Cytospora* infection. On the positive side, if trees have adequate K, fruit size is increased, drying ratios decreased, and a larger crop can be carried by the tree compared to a K deficient tree. July leaf samples should be between 1.3% and 2.0% K. There is no economic benefit to growers if July leaf K levels exceed 2.0%.

Potassium can be added to the orchard in three ways: first, a fall application of potassium sulfate (K_2SO_4) or potassium chloride (muriate of potash) banded onto or shanked into soil, second, foliar sprays of potassium nitrate (KNO_3), and third, injected through micro irrigation as potassium sulfate, potassium thiosulfate (KTS) or potassium nitrate. Any one or combination of these methods can give your trees the required amount of K.

Where and how potassium fertilizer is applied affects how quickly and by how much tree K levels increase. Because many soils can "fix" fertilizer potassium so that it is only slowly available to plants, the most efficient application practices for soil-applied potassium fertilizer are local, concentrated applications. Banding or fertigation through micro-irrigation apply enough K to 1) saturate the K fixing capacity of the soil around the relatively small application zone and 2) leave plant available K in the root zone. Fertigation produces faster results than application in bands or 'shanking'. Prune leaf K levels increase within 2 months of the start of fertigation application, whereas leaf K levels increased 4 months after dry potassium was 'shanked' into the soil in a sprinkler irrigated orchard.

Potassium fertilization is an expensive input, but essential to successful prune growing. A fall application of an annual maintenance rate of 400-500 pounds of potassium fertilizer can cost $150-200/acre, not including application cost. However, since fruit demand is the biggest driver of orchard potassium use – 70% of the entire tree K content has been measured in the cropload on a heavily cropped tree – annual applications of expensive potassium fertilizer may not be needed. Spring frosts or hot weather at bloom can reduced the crop so that only limited K fertilizer -- or none at all -- is needed. Growers may chose to wait until the spring, when crop load can be measured, to determine potassium requirements.

Making the decision for in-season application

The decision to apply an in-season application of K depends on your crop size, previous application of K, the cost of material, and history of the orchard. Crop assessment is key! In late April or early May, make a fruit count in each of the orchard blocks. If it is a heavy crop consider thinning the fruit and adding more K. If the crop is light and K was applied last fall, in-season application of K may not be needed. July leaf analysis results will help you decide on the need for a fall soil application following this year's harvest. A heavy crop and the desire for large prunes and a healthy orchard may encourage you to look at a possible in-season application of K.

Foliar application of Potassium

A three year study by S. Southwick et. al. in the early 90's shows the best rate and timing when applying foliar KNO_3. (Dried Plum Research Reports can be found at http://ucanr.org/sites/driedplum/)

Recommendations: In Southwick's research, 4 foliar applications of 25 lbs of KNO_3 per acre per application; equaling a minimum of 100 lbs KNO_3 per acre over the season; provided the same crop yield and July leaf K levels as 600 pounds potassium chloride/acre applied the previous fall. The best timings were found to be 2 sprays in spring (April/May) and 2 in summer (June/July) or one application every 2-3 weeks starting in mid to late April. A combination of fall soil application and in-season foliar application produced the highest summer leaf K levels, but did not improve crop yield compared with summer K sprays or fall soil-applied K fertilizer. So even if you applied K in the fall, if you have a heavy crop this year you may want to consider adding an in-season application. This additional K input is likely to be needed if a heavy crop is not thinned.

Foliar fertilization using materials other than KNO_3 may be effective, but to be effective, the amount applied per acre per season must be equivalent to the 100 lb KNO3/acre/year determined in Southwick's work.

Potassium Fertigation

Injecting fertilizer into soil via micro-irrigation systems is called fertigation. In general, potassium fertigation is done by regular applications between mid-April and June or July. Some growers purchase dry materials and use "gypsum machines" or other equipment to dissolve and inject the fertilizer into the irrigation system, while others purchase liquid potassium fertilizers (0-0-12, 1-0-8, KTS, etc.). Choice of material depends on price, convenience, and risk tolerance. Potassium chloride is the cheapest potassium fertilizer available, but chloride can burn trees and so presents a significant risk. Dry fertilizer may be cheaper than liquid materials of the same source, but it must be dissolved first and so more labor is usually involved with using dry fertilizer as the source for fertigation materials compared with delivered liquid material.

Potassium fertigation is more efficient than banded soil applications. Growers tend to apply less actual potassium through fertigation than in fall applications where the potassium is banded on or into the soil. For example, a common fertigation rate for potassium sulfate is 300 pounds (0-0-50)/acre, while 400-500 pounds of the potassium sulfate is the recommended application rate for an application banded on or into the soil.

Summary:

Adequate potassium nutrition is essential to a healthy prune orchard and good production potential. Rising farming costs are driving prune growers to consider all options when planning a potassium fertilization program.

Foliar sprays and/or fertigation are viable alternatives to the traditional potassium fertilizer soil-applied in the fall. Growers should assess current cropload, material costs and additional labor required when deciding on the most cost-effective potassium fertilizer program.

The following table is a general comparison of potassium fertilizer programs for orchards with adequate potassium levels the previous year. Use of potassium chloride fertilizer in season should be approached with caution, as chloride can be toxic to prune trees if high levels are present in the root zone.

Fertilizer material	Applied by	Fertilizer rate/year
Potassium sulfate (dry)	Banded in fall	500 lbs/acre
Potassium chloride (dry)	Banded in fall	400 lbs/acre
Potassium sulfate (liquid: 1-0-8)	Fertigated	1875 lbs/acre*
Potassium chloride (liquid: 0-0-12)	Fertigated	1250 lbs/acre*
Potassium nitrate	Foliar spray	100 lbs/acre

*equal to 300 lbs/acre/year of dry potassium sulfate (0-0-50)

A New Season – When to Begin Irrigating and How Much Water to Apply?

Richard P. Buchner – UC Farm Advisor, Tehama County
Allan E. Fulton – UC Farm Advisor, Tehama County

Crop load has a major effect on the final fruit size and quality of French prune. Once the crop load is establisehd in the spring, good management of water and plant nutrition throughout the season is important to achieve large fruit size and quality. If crop load is too heavy, careful and intensive management of water and plant nutrition may not be enough to achieve large, high quality fruit.

Water management and tree water status affects all of the physiological processes within the tree that influence tree growth, fruit size and fruit quality. Retired UC Irrigation Specialist, Dr. Dave Goldhamer and colleagues evaluated the effect of water stress applied at specific times and durations during the growing season. The research was done on drip irrigated French prune in the Gridley area of Butte County. Eight irrigation management strategies or treatments were evaluated for their effect on tree growth, fruit yield, and fruit size.

T1 represents an unstressed control where irrigation began in April
T2 represents withholding irrigation until May 4
T3 had irrigation off from May 5 until June 6
T4 had irrigation off from June 7 to July 18
T5 had irrigation off from May 5 to July 18
T6 had irrigation off from July 16 to September 5
T7 had irrigation off following harvest.

Figure 1 shows the effect of these irrigation treatments on fruit size. Notice that withholding water and creating even mild water stress at all pre-harvest stages of tree and fruit development between May 4 and September 5 (T2, T3, T4, T5 and T6 in figure 1) decreased fruit diameter at harvest. When mild water stress was created early in the spring by delaying the start of irrigation until May 4 (T2) final fruit diameter was decreased about 10 percent. Final fruit size was reduced the greatest (about 25 to 35 percent) when water was withheld during the months of May through mid July. The negative effect on fruit size increased as the duration of withholding water was lengthened. Since the fruit had been harvested, post-harvest water stress (T7) had no effect on fruit size of the current crop. The purpose of the T7 treatment was to evaluate carryover effects from post-harvest water stress to the next crop season. The complete report is available at the on-line prune research reports http://ucanr.org/sites/driedplum. Search and click on 1990, scroll to the bottom and select "Sensitivity of French Prune Seasonal Growth Stages to Water Deprivation: Second year results 89 CPB 2" then access the pdf file.

The Goldhamer experiment emphasizes the importance of good water management, even early season water management, to produce more valuable large fruit. So, when should the irrigation season begin? This is a difficult question to answer because the answer depends on highly variable orchard settings. Soils store different amounts of winter rainfall that contribute to orchard water needs depending on soil type and rooting depth. The rooting depth may be influenced by pre-plant tillage practices, past irrigation management, and water table influences. Furthermore, there is the concern of how much deep stored soil moisture to deplete in the early season versus preserving it to help supply crop water needs later in the summer when crop water use is higher and fruit sizing is more sensitive. This concern increases on orchard soils with slow water infiltration rates. Different irrigation systems and water application rates also influence when to begin irrigation. Cover crops or resident vegetation are depleting moisture at different rates depending on management, trees are leafing and canopies are developing, root systems are growing, weather conditions fluctuate from cool to warm which influences canopy development and increases or decreases evapotranspiration (ET), and spring rainfall may or may not increase soil moisture storage in the rootzone.

General recommendations about when to begin irrigating can be suggested based upon past field experiences but how well they apply to a specific orchard or different growing season is questionable because of all of the variables described above. For instance, in the Goldhamer experiment, irrigation in the unstressed treatment (T1) which produced the largest fruit size began before May 4. Soil moisture monitoring data from the experiment suggests irrigation began by at least mid April possibly earlier. Equally as important, irrigation water was applied with the drip irrigation system daily according to estimates of real-time ET for prune and the irrigation set times and amount of applied water were gradually increased during April and May until a maximum was reached in June and July.

Increasingly, orchard producers are using various methods of monitoring and science-based information to more precisely decide when to begin irrigating and how much water to apply in specific orchard settings. This is, especially true for those with drip and microsprinkler irrigation systems which enable greater control of the water application rate.

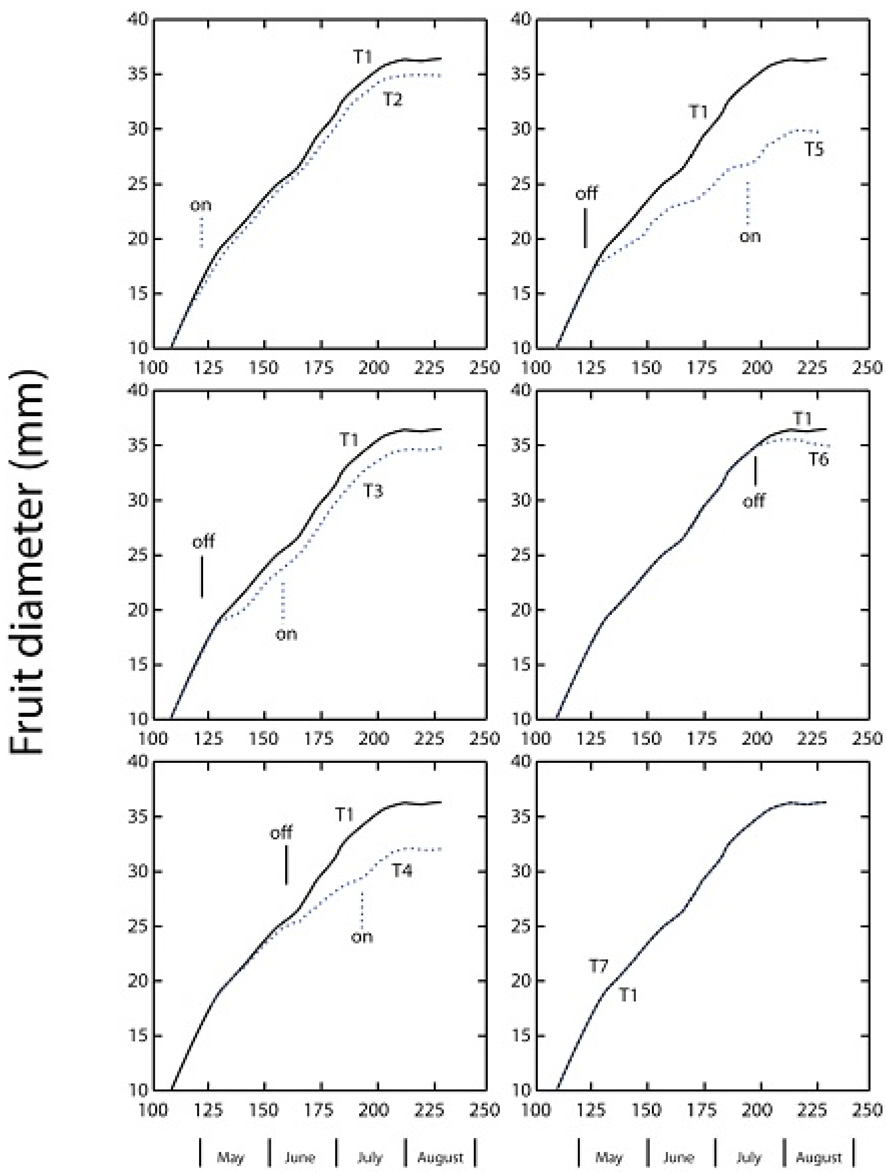
Some growers track real-time, weekly estimates of crop ET and in-season rainfall. This information can be related to the soil water holding capacity of specific orchard soils and to the specific water application rates of their irrigation systems to help estimate how much soil moisture storage has been depleted before irrigation begins and then determine how long to run their irrigation system to replenish a portion of the depleted soil moisture. One strategy is to start irrigating when trees have used enough soil water to make room in the "soil water bank" to hold irrigation water. The challenge is to avoid water logging on the wet side and tree stress on the dry side. A fairly accurate estimate of soil moisture depletion can be made by adding up daily water use. Start summing daily water use when you know the soil profile is full. One way to approach the answer is to consider how much water can be applied per set time and start when at least that much water has been depleted. A convenient source of weekly, real-time estimates of crop ET for French prune can be found on-line at http://cetehama.ucdavis.edu. Select the "Water/Irrigation Program" option from the menu on the left. Then, select "On-farm Irrigation Scheduling Tools" from the expanded menu. This information is also published weekly in several local newspapers throughout the northern Sacramento Valley. Weekly email reports can be requested by contacting aefulton@ucdavis.edu.

Weekly estimates of crop ET and soil moisture depletion are based upon real-time, regional weather conditions and other reasonable assumptions about orchard health and development for French prune. Actual soil moisture depletion in specific orchards is likely to be different. Many growers recognize this limitation and have employed advances in soil moisture monitoring. A variety of sensors are available to monitor soil moisture in the root zone of an orchard. They measure either soil moisture content or soil moisture tension. Advancements in remote data access enable soil moisture to be monitored continuously and relayed to growers on-line so that the information can be viewed anytime to guide irrigation decisions. General information about these advanced methods of soil moisture monitoring can be found at the "cetehama" website referenced previously. More information about specific soil moisture devices and services can be found on-line. Some suggested key words for searching additional information are "AgTelemetry.com", "Irrigate.Net", "Irrometer", and "PureSense".

In some situations, placing soil moisture sensors in areas that accurately represent an entire orchard can be challenging. Natural variability of soils and water infiltration properties, preplant tillage practices such as slip plowing, partially wetted soils by drip and micro sprinklers, water table influences, and uncertainty about root development and distribution may influence soil moisture monitoring. Recognizing this, other growers directly monitor tree stress with a pressure chamber. More information on the use of the pressure chamber to monitor "Midday Stem Water Potential" can be found at the "cetehama" website cited previously and by searching the UC Fruits and Nuts Center at Davis. Direct measurement of crop water stress coupled with estimates of crop ET or soil water depletion can be used to monitor orchard water status and how trees integrate complex orchard environments as well as estimate the soil moisture depletion and the need for irrigation.

Water management is a critical part to consistently producing large, high quality French prunes. A variety of useful tools are available to assist with deciding when to begin irrigating, how often to irrigate, and how much water to apply.

Figure 1. The effect of irrigation management on fruit diameter. The off arrows indicate when irrigation was withheld and the on arrows indicate when water was reapplied. T1 is the no stress comparison and T2,T3,T4,T5,T6 and T7 represent various water stress time and duration strategies. Goldhamer, et.al. 1990



Crop Load Assessment and Adjustment

Bill Krueger, UC Farm Advisor, Glenn County

We are just finishing the bloom period and prune growers are anxiously waiting until the crop load can be accurately assessed. We all know there is no money in small prunes and much of what is being covered in this edition of the Sacramento Valley Prune Newsletter has to do with producing a good crop of large prunes.

Matching the crop load with the tree's ability to size the fruit and achieve desired size is the goal. Fruit size at reference date, when the endosperm is visible in 80 to 90% of the fruit (Figure 1), can be used to estimate fruit dry fruit size at harvest (Table 1.). Reference date in the Sacramento Valley usually occurs in early May about one week after the pit tip begins to harden but may be later this year because bloom was delayed. At reference date, a random sample of sound (non-yellow) fruit should be collected and the number of fruit per pound determined. Sample 20 fruit from 20 trees. Use orchard history to determine the sizing potential of the block being considered. Unfortunately, with large crops this procedure may overestimate fruit size. Having a good estimate of the number of fruit per tree will help avoid this. Estimate the number of fruit per tree by removing as much of the fruit as possible with a shaker (prune or walnut) from a representative tree or two. Place a tarp under the entire tree before shaking. The remaining fruit should be removed by hand or estimated. Weigh all the fallen fruit. A subsample of at least 100 sound fruit is taken from the removed fruit. The number of sound fruit per pound is determined. Multiply the weight of the total fruit removed from the tree by the subsample count per pound to determine the number of fruit per tree. Adjust this number to allow for fruit drop from reference date until harvest to estimate the fruit per tree at harvest. Work done in the Sutter-Yuba area in the 1970's suggested that approximately 40% of the fruit would drop between reference date and harvest. More recent work in Glenn and Tehama Counties has suggested that fruit drop may be closer to 20%.

Figure 1. Extracting endosperm at reference date.

By dividing the estimated fruit number at harvest by the estimated or desired dry count per pound and then multiplying by the number of trees per acre, you can estimate the dry pounds per acre. This number will allow you to judge if your estimated fruit size at harvest (from Table 1) is realistic, based on comparisons with crop history - size and yield - from that orchard. You can then determine how many fruit of the desired dry size are necessary to give the expected dry yield and adjust the number upward by 20% to allow for drop. Now compare the two sets of numbers. If the number of fruit per tree measured in your orchard matches the number of fruit per tree at harvest needed to produce a certain size and tonnage of fruit (plus added 20% to account for drop), then you don't need to thin. If the number of fruit measured in your orchard far exceeds the needed number of fruit at harvest (+20% for drop) then you should thin. For example, if your orchard trees should carry 5000 fruit to produce a solid crop in your orchard (for example, 3 dry tons of 60 count fruit) and your trees have 10,000 fruit/tree at reference date - regardless of what Table 1 predicts -- you should thin.

Prune Reference Size Table

Reference Size Green (count/lb)	Harvest Size (dry) (count/lb) Orchard Sizing Potential Average	Good	Excellent
50	32	31	30
55	36	34	32
60	39	37	35
65	42	40	38
70	46	43	41
75	59	45	43
80	53	48	46
85	56	51	48
90	60	54	41
95	67	70	56
100	67	70	56
105	70	63	59
110	74	66	61
115	77	68	63
120	81	71	66
125	84	74	68
130	88	77	70
135	92	79	73
140	95	82	75

Table 1. Prune reference date and average harvest dry size table. Use the reference size fresh count per pound and read across for orchards with average, good or excellent sizing potential.

Mechanical thinning with the same machinery as is used for harvest can be used to remove the desired amount of fruit. Shake a tree and, and using the same methodology described above, calculate how much fruit was removed. Adjust the shaker and repeat the procedure until the desired amount of fruit is removed. Set the shaker and thin the block. The earlier thinning can be done, the greater effect it will have on fruit size at harvest.

Crop Load Evaluation Field Meeting Planned

A prune field meeting, co-sponsored by UC Cooperative Extension and Sunsweet Growers, Inc., is planned for Wednesday, May 4 in Sutter County. The topic will be cropload evaluation and thinning options for this season. The practice of cropload evaluation will be demonstrated. The meeting is free and open to the public.

Location: Reason Farms, South Township Road just north of the O'Banion X South Township intersection.

Time/Date: 9 - 11 AM, Wednesday, May 4

Driving directions to field day from NORTH: Take Hwy 99 about 8 miles south from Yuba City to O'Banion Road. Turn right (west) and go 3 miles to Township. Turn right (north) and look for yellow meeting signs.

Driving directions to field day from SOUTH: Take Hwy 99 north from Hwy 99 x Hwy 113 intersection to O'Banion, the first cross street north of Hwy 113. Go left (west) on O'Banion and drive 3 miles to Township. Turn right (north) and look for yellow meeting signs.

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