ANNUAL REPORT TO THE ALMOND BOARD OF CALIFORNIA

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Potassium Fertilization Regimes on Almonds
(Project No. 99-RM-o0)

by

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Objectives:

(1) To evaluate the effects of different placement, source and rate of applied potassium under micro-sprinkler, single and double line drip irrigation systems on growth, nutrient concentrations in leaves and nut yields of almonds.

(2) To assess the extent of potassium movement in soil with different placement, source and rate of application treatments under micro-sprinkler, single and double line drip irrigation systems.

Problem and its Significance:

High yielding almond orchards with declining leaf potassium levels on the West side of the Sacramento Valley and other areas of the state have given growers cause for concern regarding how best to apply potassium. The irrigation of almonds is accomplished with a number of different systems that may apply the necessary water to a very limited soil volume or wetted area up to flooding the entire soil surface and wetting all of the soil. Fertilizers may be applied to the soil surface in a band or broadcast before irrigation or winter rains, or through the irrigation system to help place the fertilizer in the wetted soil or move the materials into the soil where plant roots will come in contact with the potassium. If added through a low volume or smaller wetted area system, even potassium fertilizers which are not easily moved in soils have been taken up readily by trees. Some fertilizers are not dissolved easily or water quality characteristics prohibit trouble free injection into irrigation systems. Growers choose to apply potassium fertilizers on the soil surface in a band 3-4 feet from the tree row as an alternative. The availability of several new formulations of potassium; as sulfate, phosphate and thiosulfate make it easier to inject into irrigation systems. Potassium chloride is the most economical source of potassium but the addition of chloride represents a potential detrimental effect. Given the different types of application now being utilized, it seems prudent to evaluate the relative efficiency of potassium uptake from several sources and methods of placement under three of the more typical low-volume irrigation systems.

Experimental Procedures:

The potassium sources: sulfate, chloride, thiosulfate and mono-potassium phosphate are compared as injected through three irrigation systems (micro sprinkler, single line drip and double line drip) versus higher rates applied on the soil surface as bands 3-4 inches wide approximately 4 feet from the tree on both sides of the tree row. Potassium chloride is the most economical source of potassium but the addition of chloride represents a potential detrimental effect. A preliminary experiment with 9 rates of KCl (0-1 lb

K_2O/tree/application with 4 applications) indicated no toxicity (see Proceedings Almond Research Conference, December 3-4, 1996 and March 31, 1997 Annual Report to the Almond Board) and was therefore included in the large study at 1/4 of the highest rate. The trial was initiated with the band applications being made the fall of 1995 which is the normal grower practice. Injection treatments were applied beginning the summer of 1996.

The Butte and NonPareil rows of the irrigation system comparison trial on the Marine Avenue location of Nickels Soil Laboratory, Arbuckle, California were selected for this study. The orchard was planted in the spring of 1990 to 4 varieties: Butte (B), NonPareil (N), Carmel (C), and Monterey (M) in a B-N-C-B-N-M sequence. The soil at the site is an Arbuckle gravelly loam (Fine-loamy, mixed, thermic Typic Haploxeralf) having a pH of just below neutral (~6.7). Each individual plot size is 5 trees with a 16 feet in-row spacing and 22 feet between rows in a "diamond" arrangement (124 trees/A). There is a total of 72 individual plots each having 5 trees in this experiment. Tree circumference measurements were recorded for each tree and the five tree plot totals were ranked from low to highest for each of the three irrigation systems and used to establish the two or four blocks or replications. Treatments listed for each of the three irrigation systems were then randomly assigned. Since there were an uneven number of plots for the three irrigation systems, the trial was initiated with the following treatments and replications: (1) single-line drip has 9 treatments and 4 replications, (2) micro-sprinkler has 12 treatments and 2 replications and (3) double-line drip has 6 treatments and 2 replications. Several higher rates are also included in the micro-sprinkler treatments because the wetted soil area is larger. Liquid K_2SO_4 is applied as Great Salt Lake ESP (1-0-8), potassium thiosulfate (KTS) is a liquid 0-0-25, mono potassium phosphate (MKP) is a dry granular material added to water, and KCl is dissolved in water to apply as a liquid.

Single line drip (4 replications)

*1. Control (No K)
*2. 1 lb K_2O/tree K_2SO_4
*3. 2 lbs K_2O/tree K_2SO_4
*4. 1 lb K_2O/tree MKP
5. 2 lbs K_2O/tree MKP
*6. 1 lb K_2O/tree KTS
*7. 2 lbs K_2O/tree band K_2SO_4
8. 4 lbs K_2O/tree band K_2SO_4
9. 1 lb K_2O/tree KCl

Double line drip (2 replications)

*1. Control (No K)
*2. 1 lb K_2O/tree K_2SO_4
*3. 2 lbs K_2O/tree K_2SO_4
*4. 1 lb K_2O/tree MKP
*5. 1 lb K_2O/tree KTS
*6. 2 lbs K_2O/tree band K_2SO_4

Micro-sprinkler (2 replications)

*1. Control (No K)
*2. 1 lb K_2O/tree K_2SO_4
*3. 2 lbs K_2O/tree K_2SO_4
4. 4 lbs K_2O/tree K_2SO_4
*5. 1 lb K_2O/tree MKP
6. 2 lbs K_2O/tree MKP
7. 4 lbs K_2O/tree MKP
*8. 1 lb K_2O/tree KTS
9. 2 lbs K_2O/tree KTS
10. 2 lbs K_2O/tree KCl
*11. 2 lbs K_2O/tree band K_2SO_4
12. 4 lbs K_2O/tree band K_2SO_4

*Potassium fertilizer treatments common to all three irrigation systems.

Liquid fertilizer injection units were designed, built and installed the summer of 1996 to inject fertilizer for each 5 tree plot. The two main irrigation systems, one for the drip (both single and double line) and one for the micro sprinkler, are turned on approximately 1 hour before any fertilizer is injected to improve the uniformity of application. Dry granular potassium sulfate (0-0-50) is applied on the soil surface in a band 3-4 inches wide approximately 4 feet from the tree on both sides of the tree row in the fall of the year

(November-December). These band applications of potassium sulfate represent normal grower practice. Liquid materials are injected during May and June through injection cylinders which are 6" diameter and various lengths to accommodate the different volumes of liquid fertilizer having a range in potassium concentration. All liquid treatments are split and applied as two to four injected applications on approximately May 15 and June 15. The basis for using the four pound rate with the micro sprinkler is that water is applied to an area of about 12 feet in diameter whereas the drip application zone is only about 4 feet in diameter.

Tree circumference measurements (one foot above soil surface) are recorded in January of each year to assess individual tree growth during the season. Leaf samples (25 leaves from each of the 5 trees per plot) are taken three times each year (April 1, July 1 and October 1) and analyzed for Total N, P, K, S, Zn, Mn, B, and Cl to evaluate the nutrient status. Yield data are collected in September (NonPareil variety) and October (Butte variety) to determine treatment effects. Eight to ten pound samples are taken from each plot for moisture and meat shellout percentage determination. One hundred twenty five nut samples are collected for meat, shell and hull percentages as well as number of doubles, blanks and average kernel (meat) weights for each plot. Potassium fertilizer injection treatments were applied in July, August and September of 1996; May, June and July of 1997; and June and July of 1998 and 1999 with the higher rates being split into 2-4 applications. The application devices used to inject the different potassium sources worked very effectively. Two units needed to be replaced during the season because they developed leaks. Leaf samples were taken on April 4, July 7, and October 7, 1997; April 2, July 7, and October 8, 1998; as well as March 31, June 29, and October 13, 1999 to evaluate nutrient concentrations. Yield data were collected on August 27, (NonPareil variety) and September 23, 1997 (Butte variety); September 22, (NonPareil variety) and October 9, 1998 (Butte variety) as well as September 20, (NonPareil variety) and October 4, 1999 (Butte variety) to determine treatment effects. The 1996 data represent the baseline meat yields prior to any potassium treatment effects (Table 1). Soil samples will be taken early in 2000 to evaluate potassium and phosphorus movement and distribution in the soil.

Results:

Yield results in 1999 indicate either a strong trend or a significant increase in response to potassium applications (Table 1). There was a slight trend for yields to increase as rates of applied potassium were increased but most of the increase came from the 1 lb K_2O/tree rate or 124 lbs K_2O/acre for four annual applications. Considering the four potassium sources, the mono potassium phosphate or MKP give the highest yields followed by the injected potassium sulfate, the potassium chloride and the potassium thiosulfate. The banded potassium sulfate treatments gave good yields under both the double-line drip and the micro-sprinkler irrigation systems but the single-line drip treatments were only slightly above the control.

There were significant differences between the 1998 meat yields for treatments in all three irrigation systems with one or several of the mono-potassium phosphate (MKP) treatments resulting in the highest yields and the banded K_2SO_4 treatments having among the lowest yields (Table 1). There was no Table 1. Almond meat yields for 1996, 1997, 1998 and 1999 for the fall banded versus source and rate of potassium injected through three irrigation systems experiment at Nickels Soil Laboratory.

Irrigation and Potassium Fertilizer Treatments	**1996 Yield**	**1997 Yield**	**1998 Yield**	**1999 Yield**
Single line drip (4 replications)	(lbs meats/A)	(lbs meats/A)	(lbs meats/A)	(lbs meats/A)
*1. Control (No K)	1933	2132	2449ab	2383 c
*2. 1 lb K_2O/tree K_2SO_4	1954	2526	2469ab	2944abc

*3. 2 lbs K_2O/tree K_2SO_4	1809	2170	2494ab	2607 bc
*4. 1 lb K_2O/tree MKP	1985	2398	2786a	3280a
5. 2 lbs K_2O/tree MKP	1819	2301	2355ab	3231a
*6. 1 lb K_2O/tree KTS	1999	2520	2307ab	2741abc
*7. 2 lbs K_2O/tree band K_2SO_4	1754	2386	2102 b	2431 c
8. 4 lbs K_2O/tree band K_2SO_4	2009	2191	2257 b	2601 bc
9. 1 lb K_2O/tree KCl	1765	2783	2170 b	3168ab
$LSD_{0.05}$	407	664	524	567
	NS	NS		
Double line drip (2 replications)				
*1. Control (No K)	1827	2455	2628ab	3075
*2. 1 lb K_2O/tree K_2SO_4	1997	2285	2347ab	3218
*3. 2 lbs K_2O/tree K_2SO_4	1784	2529	2335ab	3290
*4. 1 lb K_2O/tree MKP	1899	2289	2729a	3345
*5. 1 lb K_2O/tree KTS	1664	2745	2079 b	2873
*6. 2 lbs K_2O/tree band K_2SO_4	1984	2368	2358ab	3109
$LSD_{0.05}$	391	732	631	730
	NS	NS		NS
Micro-sprinkler (2 replications)				
*1. Control (No K)	2023	2223 c	2645abc	2332 e
*2. 1 lb K_2O/tree K_2SO_4	2437	2418 bc	2916abc	2725 cde
*3. 2 lbs K_2O/tree K_2SO_4	2312	2844ab	2698abc	3054abcd
4. 4 lbs K_2O/tree K_2SO_4	2196	2686abc	2685abc	2826 bcde
*5. 1 lb K_2O/tree MKP	2192	2962a	2952ab	3475ab
6. 2 lbs K_2O/tree MKP	1925	2692abc	2843abc	3587a
7. 4 lbs K_2O/tree MKP	2182	2882ab	3140a	3606a
*8. 1 lb K_2O/tree KTS	2422	2378 bc	3207a	2500 de
9. 2 lbs K_2O/tree KTS	2277	2657abc	2663abc	2728 cde
10. 2 lbs K_2O/tree KCl	2300	2762abc	2628abc	3220abc
*11. 2 lbs K_2O/tree band K_2SO_4	2312	2887ab	2325 c	3456ab
12. 4 lbs K_2O/tree band K_2SO_4	2220	2542abc	2428 bc	3002abcde
$LSD_{0.05}$	549	542	619	709
	NS			

*Potassium fertilizer treatments common to all three irrigation systems.

clear trend for all of the potassium treatments to have a higher almond yield than the control. The control (no potassium applied) treatment yields for each of the three irrigation systems were slightly above (single and double line drip) or below (micro-sprinkler) the average yields for all plots under each system. As was the case in 1997, yields in 1998 did not show a consistent trend as rates of applied potassium were increased.

Meat yields in 1997 were significantly different between treatments under the micro-sprinkler system but there were no significant differences between treatments in the single or double line drip irrigation systems (Table 1). There was a consistent trend for all potassium treatments to give higher yields than the control under the micro-sprinkler system. Yields did not show a consistent trend as rates of applied potassium were increased, particularly with the injected potassium sulfate (K_2SO_4) and mono-

potassium phosphate (MKP) sources. It is interesting to note that the banded potassium sulfate (K_2SO_4) treatments under the micro-sprinkler resulted in good yields compared to other sources and rates whereas there was a trend for the banded treatments not to yield as well under the single or double line drip systems. This would be expected under the drip systems since the irrigation water was not wetting the area where the potassium had been applied. Only winter rains would have wetted the soil and provided for some uptake of potassium early in the spring.

Average yields in 1999 for the three irrigation system treatments were nearly the same: 2820 meat lbs/A for the single-line drip, 3152 meat lbs/A for the double-line drip and 3043 meat lbs/A for the micro-sprinkler. The 1998 average yield of 2762 meat lbs/A for the micro-sprinkler irrigation treatments was significantly higher than the double line drip irrigation treatments of 2412 meat lbs/A and the single line drip irrigation treatments of 2377 meat lbs/A. Average yields for the three irrigation systems in 1997 were as follows: micro-sprinkler 2661 meat lbs/A, double-line drip 2445 meat lbs/A, and single-line drip 2379 meat lbs/A. Average yields in 1999 for the two varieties were 2978 meat lbs/A for NonPareil and 3032 meat lbs/A for Butte. The 1998 average yield for the NonPareil variety was 2284 meat lbs/A and for the Butte variety 2791 meat lbs/A. In 1997 the average yield for the NonPareil variety was 2213 meat lbs/A and for the Butte variety 2763 meat lbs/A.

Potassium leaf concentrations for 1997 reflect the potassium availability of fall banded fertilizer as April leaf levels were fairly high for all banded treatments, dropped somewhat in the July leaf samples, and increased to some extent in the October leaf samples for all irrigation systems but particularly in the micro-sprinkler treatments (Table 2). Potassium leaf concentrations in the July 7th samples were generally in the adequate range but several were below 1.25%. In general, leaf potassium concentrations were higher in April and October than in July samples except for the double line drip system where the July and October concentrations were more similar. There was a fairly consistent trend for potassium leaf concentrations to increase over the control for all injected treatments under the single line drip system. The banded treatments had somewhat higher potassium concentrations than the control in April but not in the July or October leaf samples. Leaf potassium concentrations were not significantly different in the April and October samples under the double line drip system, but indicated some increases over the control, particularly the injected potassium sulfate treatments in the July samples. There was a consistent trend for all potassium treatments to result in higher leaf potassium concentrations than the control under the micro-sprinkler system on all three sample dates. Leaf potassium concentrations did not show a consistent trend as rates of applied potassium were increased, particularly with the injected mono-potassium phosphate (MKP) source on any of the three sample dates under the micro-sprinkler irrigation system. As might be expected, potassium chloride (KCl) increased potassium concentrations in the leaves but chloride levels were also increased, not to significant concentrations to effect tree production however. The highest concentration observed was near 0.2% under the micro-sprinkler system. It should be pointed out however, that concentrations exceeded 0.4% in the 1996 potassium chloride rate study without any leaf burn or observed toxicity to the trees. There was a trend for phosphorus leaf concentrations to be increased in the July 7th samples from the MKP treatments under all irrigation systems with a significantly higher level recorded under the double line drip system.

Table 2. Almond leaf potassium concentration in 1997 for the banded versus source and rate of potassium injected through three irrigation systems experiment at Nickels Soil Laboratory.

Irrigation and Potassium Fertilizer Treatments	**Leaf Potassium**		
Single line drip (4 replications)	**April 4** (%)	**July 7** (%)	**October 7** (%)
*1. Control (No K)	1.35 b	1.12 d	1.27 d
*2. 1 lb K_2O/tree K_2SO_4	1.61a	1.46a	1.77a

*3. 2 lbs K_2O/tree K_2SO_4	1.56ab	1.50a	1.59ab
*4. 1 lb K_2O/tree MKP	1.35 b	1.22 bcd	1.52abcd
5. 2 lbs K_2O/tree MKP	1.49ab	1.38abc	1.71a
*6. 1 lb K_2O/tree KTS	1.58ab	1.43ab	1.56abc
*7. 2 lbs K_2O/tree band K_2SO_4	1.51ab	1.20 cd	1.34 bcd
8. 4 lbs K_2O/tree band K_2SO_4	1.35 b	1.19 cd	1.30 cd
9. 1 lb K_2O/tree KCl	1.65a	1.45a	1.55abc
$LSD_{0.05}$	0.231	0.221	0.269
Double line drip (2 replications)			
*1. Control (No K)	1.63	1.38 bc	1.43
*2. 1 lb K_2O/tree K_2SO_4	1.72	1.63ab	1.59
*3. 2 lbs K_2O/tree K_2SO_4	1.60	1.67a	1.65
*4. 1 lb K_2O/tree MKP	1.47	1.33 c	1.39
*5. 1 lb K_2O/tree KTS	1.74	1.52abc	1.50
*6. 2 lbs K_2O/tree band K_2SO_4	1.60	1.43abc	1.65
$LSD_{0.05}$	NS	0.257	NS
Micro-sprinkler (2 replications)			
*1. Control (No K)	1.47 c	1.25 h	1.44 e
*2. 1 lb K_2O/tree K_2SO_4	1.54 c	1.44 fgh	1.64 de
*3. 2 lbs K_2O/tree K_2SO_4	2.00ab	1.89ab	2.23ab
4. 4 lbs K_2O/tree K_2SO_4	2.03ab	1.99a	2.26a
*5. 1 lb K_2O/tree MKP	1.72abc	1.41 fgh	1.65 de
6. 2 lbs K_2O/tree MKP	1.66 bc	1.78 bcd	2.03abcd
7. 4 lbs K_2O/tree MKP	1.98ab	1.60 def	1.77 cde
*8. 1 lb K_2O/tree KTS	1.64 bc	1.39 gh	1.60 de
9. 2 lbs K_2O/tree KTS	1.78abc	1.52 efg	1.92abcd
10. 2 lbs K_2O/tree KCl	2.00ab	1.55 efg	1.81 bcde
*11. 2 lbs K_2O/tree band K_2SO_4	1.97ab	1.68 cde	2.13abc
12. 4 lbs K_2O/tree band K_2SO_4	2.10a	1.83abc	2.17abc
$LSD_{0.05}$	0.423	0.197	0.197

*Potassium fertilizer treatments common to all three irrigation systems.

Table 3. Almond leaf potassium concentration in 1998 for the fall banded versus source and rate of potassium injected through three irrigation systems experiment at Nickels Soil Laboratory.

Irrigation and Potassium Fertilizer Treatments	**Leaf Potassium**		
Single line drip (4 replications)	**April 2 (%)**	**July 7 (%)**	**October 8 (%)**
*1. Control (No K)	1.54 b	1.18 d	1.19 c
*2. 1 lb K_2O/tree K_2SO_4	1.78ab	1.78 b	1.90 b
*3. 2 lbs K_2O/tree K_2SO_4	1.85a	1.87ab	1.91 b
*4. 1 lb K_2O/tree MKP	1.80ab	1.77 b	1.91 b
5. 2 lbs K_2O/tree MKP	2.03a	2.10a	2.28a
*6. 1 lb K_2O/tree KTS	1.78ab	1.73 bc	1.77 b
*7. 2 lbs K_2O/tree band K_2SO_4	1.74ab	1.48 c	1.42 c
8. 4 lbs K_2O/tree band K_2SO_4	1.86a	1.47 c	1.38 c

9. 1 lb K_2O/tree KCl	1.82ab	1.71 bc	1.77 b
$LSD_{0.05}$	0.306	0.281	0.281
Double line drip (2 replications)			
*1. Control (No K)	1.94	1.41	1.44 b
*2. 1 lb K_2O/tree K_2SO_4	2.02	1.78	1.85ab
*3. 2 lbs K_2O/tree K_2SO_4	1.58	1.88	1.99a
*4. 1 lb K_2O/tree MKP	1.87	1.72	1.78ab
*5. 1 lb K_2O/tree KTS	2.14	1.77	1.85ab
*6. 2 lbs K_2O/tree band K_2SO_4	1.95	1.82	1.81ab
$LSD_{0.05}$	NS	NS	0.481
Micro-sprinkler (2 replications)			
*1. Control (No K)	1.81 b	1.26 f	1.27 g
*2. 1 lb K_2O/tree K_2SO_4	1.81 b	1.71 e	1.79 f
*3. 2 lbs K_2O/tree K_2SO_4	1.79 b	2.33 bc	2.25 cd
4. 4 lbs K_2O/tree K_2SO_4	1.78 b	2.59ab	2.70a
*5. 1 lb K_2O/tree MKP	2.16ab	2.06 cde	2.01 def
6. 2 lbs K_2O/tree MKP	1.92 b	2.39abc	2.36 bc
7. 4 lbs K_2O/tree MKP	2.54a	2.77a	2.56ab
*8. 1 lb K_2O/tree KTS	1.85 b	1.81 de	1.86 ef
9. 2 lbs K_2O/tree KTS	2.13ab	2.06 cde	2.11 de
10. 2 lbs K_2O/tree KCl	2.23ab	2.15 cd	2.08 de
*11. 2 lbs K_2O/tree band K_2SO_4	1.88 b	2.11 cd	2.14 cd
12. 4 lbs K_2O/tree band K_2SO_4	2.04ab	2.20 bcd	2.22 cd
$LSD_{0.05}$	0.526	0.394	0.251

*Potassium fertilizer treatments common to all three irrigation systems.

April 1998 leaf potassium concentrations were somewhat inconsistent with respect to rates and sources of applied potassium under the three irrigation systems (Table 3). Only the control treatment (1.54%) under the single line drip system and the 2 lbs K_2O/tree K_2SO_4 treatment (1.58%) under the double line drip system had somewhat lower leaf potassium levels than most other treatments. The July samples indicated a significant increase in leaf potassium concentrations for all sources and rates under all three irrigation systems over the controls. This was most evident under the micro-sprinkler system where 9 out 12 treatments had leaf potassium levels greater than 2.00%. The average leaf potassium concentrations for the three irrigation systems were 1.68% for the single line drip, 1.73% for the double line drip, and 2.12% for the micro-sprinkler. Leaf potassium levels were consistently increased as the rate of applied potassium for each source was increased under all three irrigation systems. The October samples indicated a significant increase in leaf potassium concentrations for all sources and rates under all three irrigation systems over the controls. As was the case in the July samples, it was most evident under the micro-sprinkler system where 9 out 12 treatments had leaf potassium levels greater than 2.00%. Leaf potassium levels were consistently increased as the rate of applied potassium for each source was increased under all three irrigation systems except for the K_2SO_4 treatments (#2, 3, 7 and 8) for the single line drip irrigation system. It is interesting to note that the fall banded potassium sulfate (K_2SO_4) treatments under the micro-sprinkler and double line drip systems resulted in relatively high leaf

potassium levels compared to other sources and rates whereas the banded treatments did not have nearly as high leaf potassium levels under the single line drip system. This would be expected since the irrigation water was not wetting the area where the potassium had been applied. Only winter rains would have wetted the soil and provided for some uptake of potassium early in the spring. July leaf phosphorus concentrations ranged from 0.12 to 0.155% but there were not significant differences between any of the treatments for the three irrigation systems.

The average leaf potassium concentrations were higher on all three dates March 31, June 29, and October 13, 1999 for the micro-sprinkler potassium treatments, 1.82, 2.28 and 2.00%, than for the single-line drip, 1.54, 1.60 and 1.46%, or the double-line drip irrigation system potassium treatments, 1.58, 1.79 and 1.59% (Table 4). The control treatments had somewhat low to adequate potassium concentrations on the June 29, 1999 sample date with the single-line drip irrigation system being the lowest at 1.09%. As the rate of applied potassium was increased, leaf K concentrations were consistently increased under the three irrigation systems and on all sample dates. The four potassium fertilizer sources gave nearly the same leaf K concentrations on all sample dates for the same rate of applied K. The banded potassium sulfate treatments consistently had among the lowest leaf potassium levels, particularly considering the rates of potassium application.

Perhaps the most consistent trend across all years is that the fall banded potassium sulfate (K_2SO_4) treatments under the micro-sprinkler and double line drip systems have resulted in relatively high leaf potassium levels compared to other sources and rates whereas the banded treatments have not had nearly as high leaf potassium levels under the single line drip system. This would be expected since the irrigation water was not wetting the area where the potassium had been applied. Only winter rains would have wetted the soil and provided for some uptake of potassium early in the spring.

Table 4. Almond leaf potassium concentration in 1999 for the fall banded versus source and rate of potassium injected through three irrigation systems experiment at Nickels Soil Laboratory.

Irrigation and Potassium Fertilizer Treatments	**Leaf Potassium**		
Single line drip (4 replications)	**March 31 (%)**	**June 29 (%)**	**October 13 (%)**
*1. Control (No K)	1.36 d	1.09 d	0.98 e
*2. 1 lb K_2O/tree K_2SO_4	1.67ab	1.73ab	1.54 bc
*3. 2 lbs K_2O/tree K_2SO_4	1.67ab	1.94a	1.70ab
*4. 1 lb K_2O/tree MKP	1.58 bc	1.37 cd	1.36 cd
5. 2 lbs K_2O/tree MKP	1.75a	1.91a	1.88a
*6. 1 lb K_2O/tree KTS	1.55 bc	1.71ab	1.56 bc
*7. 2 lbs K_2O/tree band K_2SO_4	1.34 d	1.53 bc	1.27 d
8. 4 lbs K_2O/tree band K_2SO_4	1.43 cd	1.46 bc	1.33 cd
9. 1 lb K_2O/tree KCl	1.54 bc	1.71ab	1.52 bcd
$LSD_{0.05}$	0.153	0.284	0.257
Double line drip (2 replications)			
*1. Control (No K)	1.43	1.36 c	1.16 b

*2. 1 lb K_2O/tree K_2SO_4	1.70	1.79abc	1.72a
*3. 2 lbs K_2O/tree K_2SO_4	1.55	2.10a	1.90a
*4. 1 lb K_2O/tree MKP	1.55	1.58 bc	1.51ab
*5. 1 lb K_2O/tree KTS	1.64	1.89ab	1.60ab
*6. 2 lbs K_2O/tree band K_2SO_4	1.65	2.06a	1.68a
$LSD_{0.05}$	0.373	0.460	0.488
	NS		
Micro-sprinkler (2 replications)			
*1. Control (No K)	1.39 e	1.38 f	1.22 g
*2. 1 lb K_2O/tree K_2SO_4	1.59 de	1.87 e	1.68 ef
*3. 2 lbs K_2O/tree K_2SO_4	1.97abc	2.63 bc	2.31ab
4. 4 lbs K_2O/tree K_2SO_4	2.05ab	2.91ab	2.58a
*5. 1 lb K_2O/tree MKP	1.71 cd	2.04 de	1.71 def
6. 2 lbs K_2O/tree MKP	1.97abc	2.56 bc	2.12 bcd
7. 4 lbs K_2O/tree MKP	2.22a	3.08a	2.62a
*8. 1 lb K_2O/tree KTS	1.72 cd	1.91 e	1.65 f
9. 2 lbs K_2O/tree KTS	1.81 bcd	2.10 de	1.99 bcdef
10. 2 lbs K_2O/tree KCl	1.93 bc	2.43 cd	2.09 bcde
*11. 2 lbs K_2O/tree band K_2SO_4	1.72 cd	2.07 de	1.87 cdef
12. 4 lbs K_2O/tree band K_2SO_4	1.76 cd	2.45 cd	2.16 bc
$LSD_{0.05}$	0.270	0.446	0.423

*Potassium fertilizer treatments common to all three irrigation systems.

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