Effect of Source and Timing of Potassium Fertilizer Application on Potato Tuber Yield, Tuber Size Distribution, and Quality.

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STUDY OBJECTIVE

The objective of this study was to evaluate the effect of source and timing of potassium fertilizer application on tuber yield, tuber size distribution, and quality of Russet potato.

MATERIALS AND METHODS

Study Site, Experimental Design, and Treatments

The field study was conducted at the San Luis Valley Research Center, Colorado State University, during the 2014 potato growing season.

The study was laid out as a randomized complete block design. There were six treatments, each replicated four times. Treatments included 1. Application of Bio-K pre-plant (Bio-K Pre [2 gal]), 2. Application of Bio-K pre-plant followed by foliar application of Bio-K (Bio-K pre [2 gal] + foliar [2 gal]), 3. Foliar application of Bio-K (Bio-K foliar [2 gal]), 4. Application of KCl pre-plant (KCl Pre [64.5 lbs]), 5. Application of KCl pre-plant followed by foliar application of Bio-K (KCl pre-plant [64.5 lbs] + Bio-K foliar [2 gal]). A control treatment was included where no K fertilizer was applied. Foliar application of Bio-K was done at tuber initiation AND during tuber bulking. Bio-K material has analysis of 0-0-24 and weighs 10.6 lbs/gal. Foliar applications of Bio-K were at tuber initiation and at mid-bulking. KCl material has analysis of 0-0-62 and was applied as a broadcast treatment first, then hills were formed prior to planting. This is common practice in the San Luis Valley.

Data Collection and Petiole Analysis

Petiole samples were taken from 48 to 69 days after planting (DAP) for petiole nutrient concentration analysis. Tubers were sampled from each plot during mid tuber bulking (99 DAP) to evaluate the effect of the treatments on earliness of tuber bulking.

At harvest, tubers from each plot were weighed for total yield. The harvested tubers were separated into various size distribution groups based on weight (> 4 oz., 4-16 oz., > 6 oz., 4-10 oz., 10-16 oz., and > 10 oz.).

Tubers harvested from each plot were evaluated for external (growth cracks, knobs, and misshapes) and internal (hollow heart and brown center) defects.

Ten large tubers were randomly selected from each plot for tuber specific gravity evaluation. Tuber specific gravity was measured using the weight-in-air/weight-in-water method.

RESULTS AND DISCUSSION

Tuber Bulking

The application of Bio-K pre-plant or foliar application of Bio-K increased the rate of tuber bulking. This is evidenced by the higher tuber fresh weight observed at mid tuber bulking (99 DAP) when Bio-K was applied pre-plant or as a foliar application (fig 1).

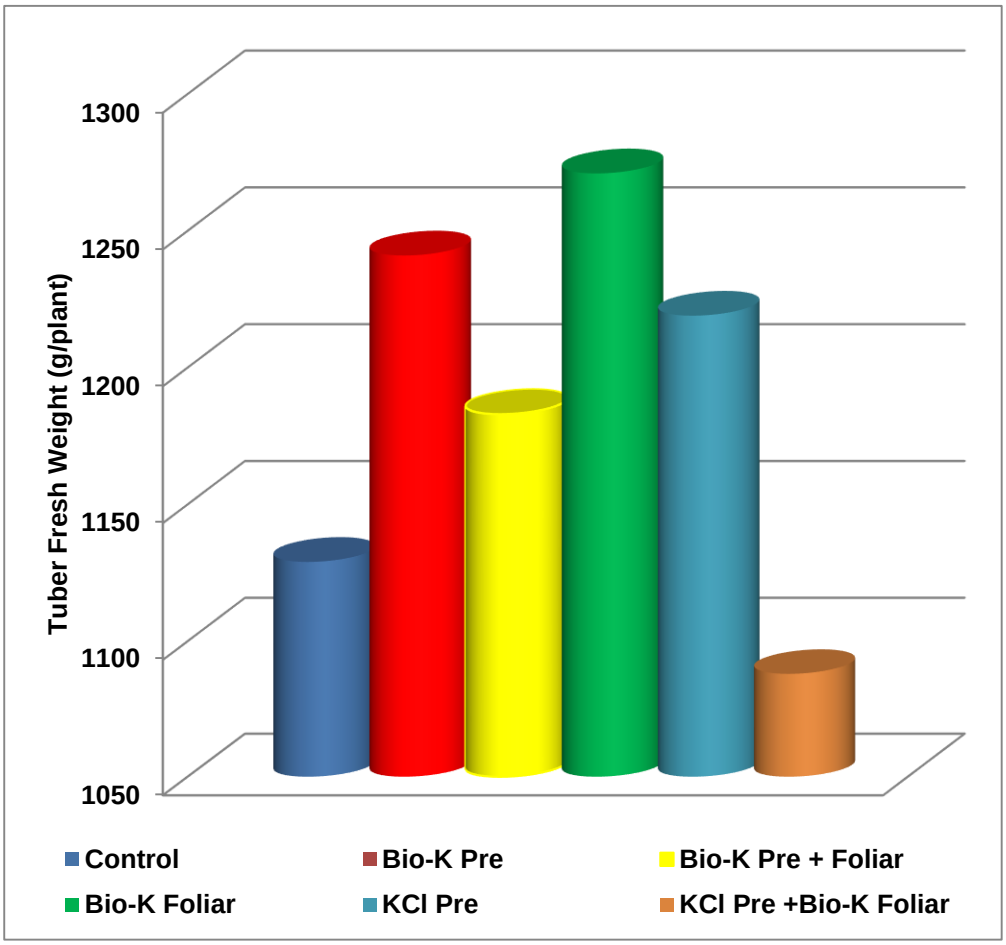

Fig 1. Effect of source and timing of potassium fertilizer application on tuber fresh weight at mid tuber bulking.

Tuber Yield and Tuber Size Distribution

The application of potassium (K) fertilizer, irrespective of source or timing of application did influence total tuber yield. All K fertilizer application treatments did increase total tuber yield compared to the control (Table 1). Differences in K fertilizer treatments were observed for marketable (> 4 oz.), large marketable (> 6 oz.), and premium size (> 10 oz.) tuber yield, indicating that the source and time of K fertilizer application did influence tuber size distribution and tuber quality. In this study, the application of Bio-K pre-plant did increase marketable, large marketable and premium size tuber yield by 20, 34, and 18%, respectively, compared to the control treatment (Table 1). The yield increases observed for Bio-K pre-plant in each of the size

distribution groups were also higher than the yields obtained from all other treatments (Table 1). The application of Bio-K pre-plant did increase the percentage of tubers in the marketable (> 4 oz.) and large marketable (> 6 oz.) tuber size groups.
Even though there was no statistical difference among K fertilizer treatments in total tuber yield, the yield obtained from Bio-K pre-plant treatment plots were higher than the yields from all other treatments. It should be noted that for premium size (> 10 oz.) tubers, the yields obtained were statistically similar when K fertilizer was applied as Bio-K pre plant (48 cwt/ac), Bio-K applied pre plant and followed with foliar application (36 cwt/ac), and Bio-K applied as foliar (47 cwt/ac). The yields were higher than the yields obtained for all other treatments (Table 1).

Tuber External and Internal Defects and Tuber Specific Gravity

In this study, the highest tuber external defects (1.4%) were observed when KCl was applied pre plant and later followed with foliar application of Bio-K (KCl pre + Bio-K foliar) – Table 2. An evaluation of tuber internal defects showed that 1.8% of the tubers from the Bio-K Pre treatment plots had hollow heart, compared to tubers from the Bio-K foliar (0.5%), and control (0.6%) plots. All other treatments did not show hollow heart in the tubers evaluated (Table 2).
Specific gravity was highest for tubers harvested from the Bio-K Pre + foliar (1.091) and Bio-K foliar (1.090) treatment plots (Table 2).

Petiole Nutrient Concentration

Petioles were sampled at approximately seven days interval from 48 to 69 days after planting, during the crop growing season, and analyzed for macro and micro nutrient concentration (fig 2a-l).The effect of source and timing of K fertilizer application on petiole nutrient concentration varied depending on the nutrient of interest (fig 2a-l). It will be of benefit to analyze for total plant nutrient concentration in order to determine the effect of the treatments on nutrient uptake and accumulation in the plant.

Table 1. Effect of source and timing of potassium fertilizer application on potato tuber yield and tuber size distribution.

Treatment	Total	> 4 oz.	> 6 oz.	> 10 oz.	4-10 oz.	10-16 oz.	> 16 oz.
	Yield (cwt/ac)						
Control	381*b*[x]	276*c* (72)[y]	164b*c* (43)	22*b* (6)	254*b* (67)	22*b* (6)	0*b*
Bio-K Pre	430*a*	332*a* (77)	220*a* (51)	48*a* (11)	284*a* (66)	44*a* (10)	4*a* (0.9)
Bio-K Pre + Foliar	407*a*	309*bc* (76)	185*b* (45)	36*ab* (9)	273*ab* (67)	29b (7)	7*a* (1.5)
Bio-K Foliar	407*a*	311*bc* (76)	188*b* (46)	47*a* (12)	264*b* (65)	47*a* (12)	0*b*
KCl Pre	424*a*	314*b* (74)	181*b* (43)	28*b* (7)	286*a* (68)	28*b* (7)	0*b*
KCl Pre + Bio-K Foliar	410*a*	292*c* (71)	156*c* (38)	27*b* (6)	265*b* (65)	27*b* (6)	0*b*

[x] figures in the same column and bearing the same letters are not significantly different at the 0.05 level of probability
[y] figures in brackets represent percent of total yield.

Table 2. Effect of source and timing of potassium fertilizer application on potato tuber external and internal defects, and on tuber specific gravity.

Treatment	Tuber External Defects[x]	Hollow Heart	Tuber Specific Gravity
	%		
Control	0	0.6	1.089
Bio-K Pre	0.4	1.8	1.088
Bio-K Pre + Foliar	0	0	1.091
Bio-K Foliar	0.5	0.5	1.090
KCl Pre	0.6	0	1.088
KCl Pre + Bio-K Foliar	1.4	0	1.089

[x] Includes growth cracks, knobs, and misshapes.

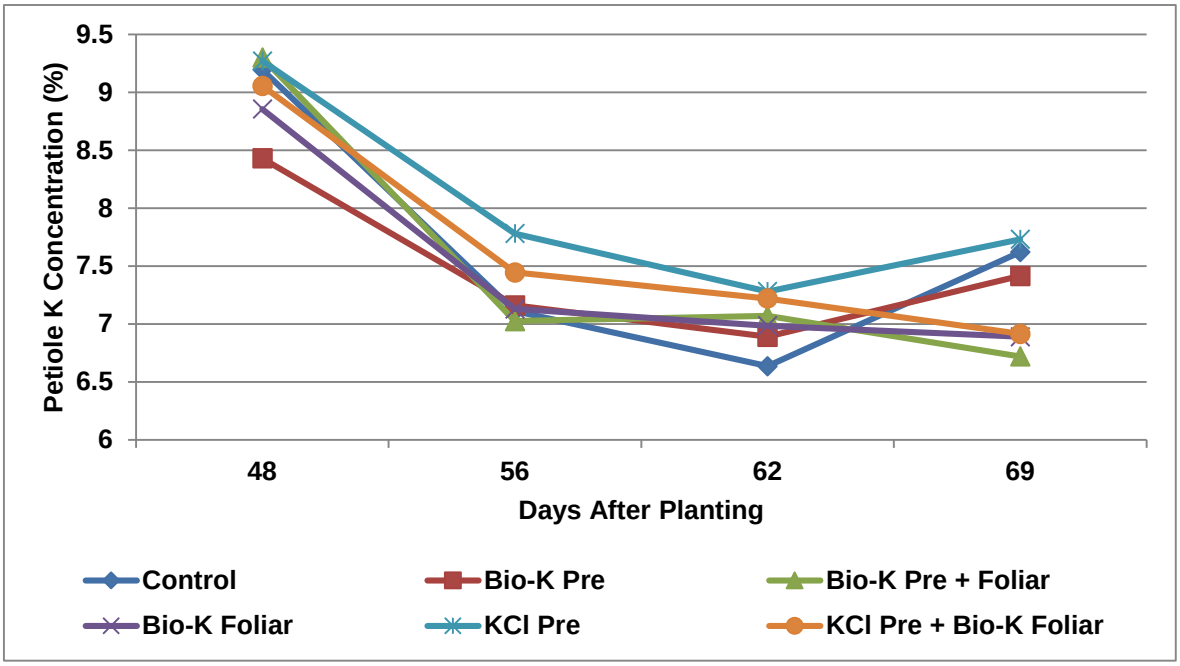

Fig. 2a. Effect of Source and timing of K fertilizer application on petiole K concentration

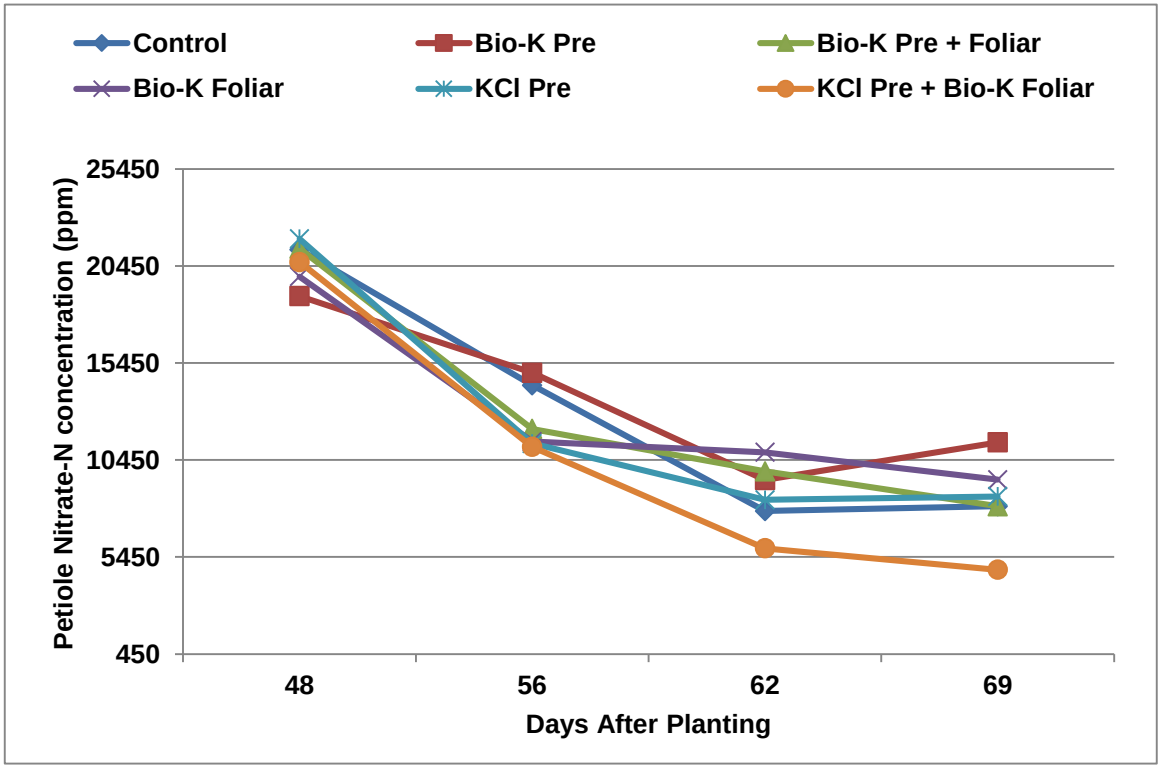

Fig. 2b. Effect of Source and timing of K fertilizer application on petiole Nitrate-N concentration

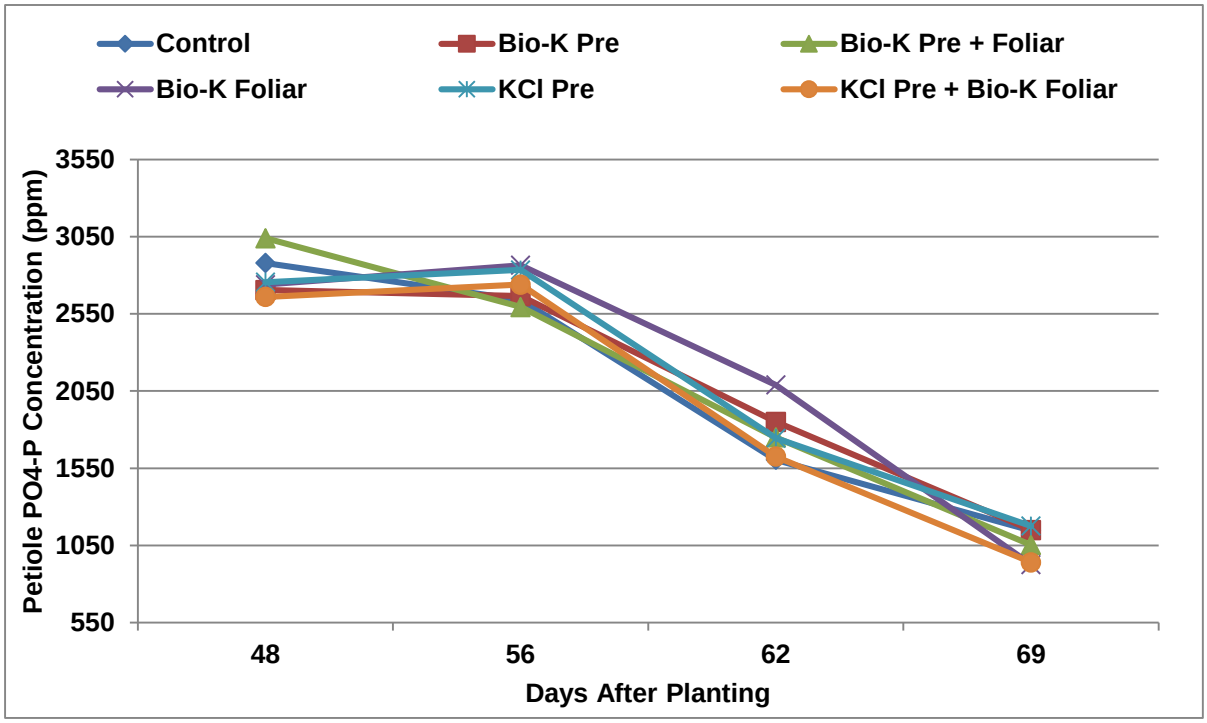

Fig. 2c. Effect of Source and timing of K fertilizer application on petiole PO4-P concentration.

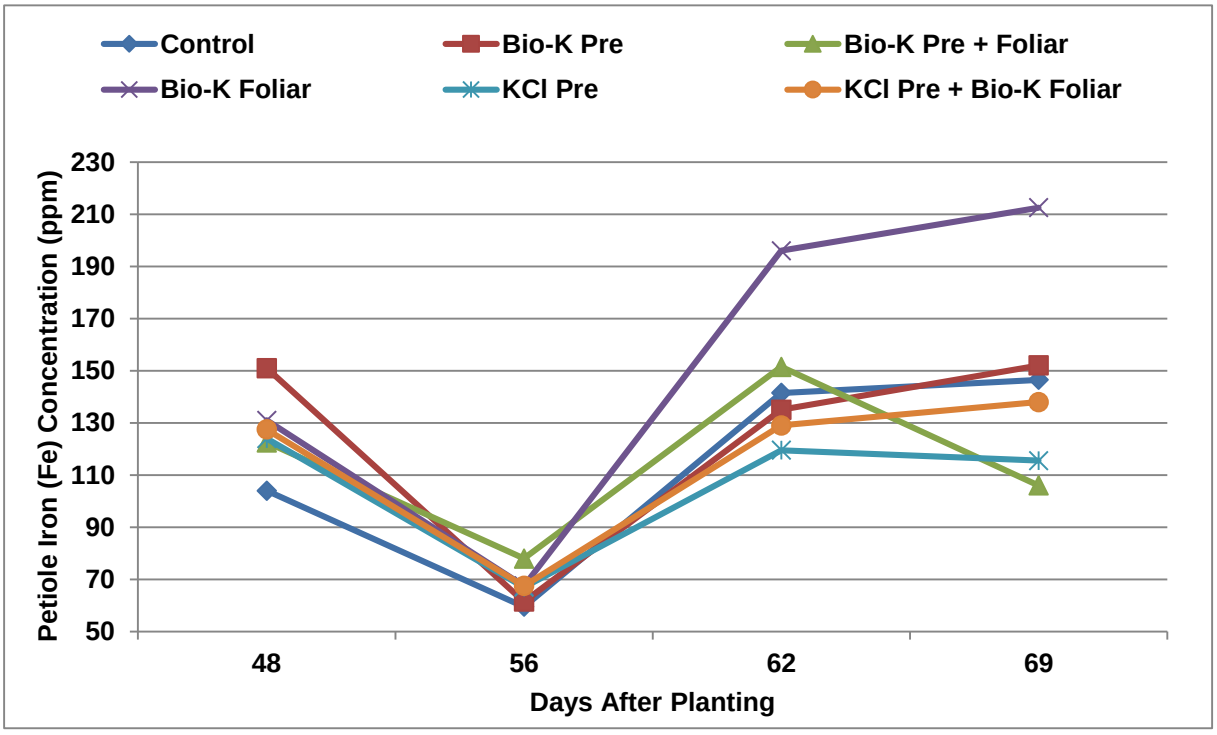

Fig. 2d. Effect of Source and timing of K fertilizer application on petiole Iron concentration

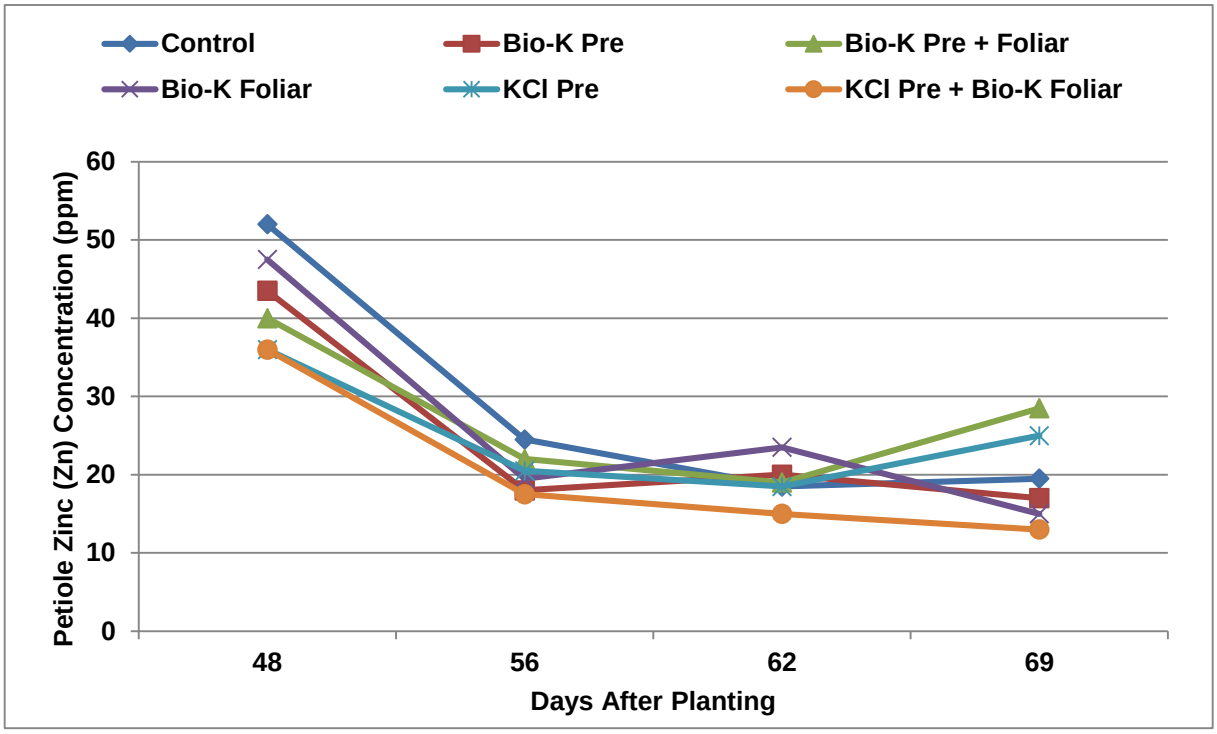

Fig. 2e. Effect of Source and timing of K fertilizer application on petiole Zinc concentration

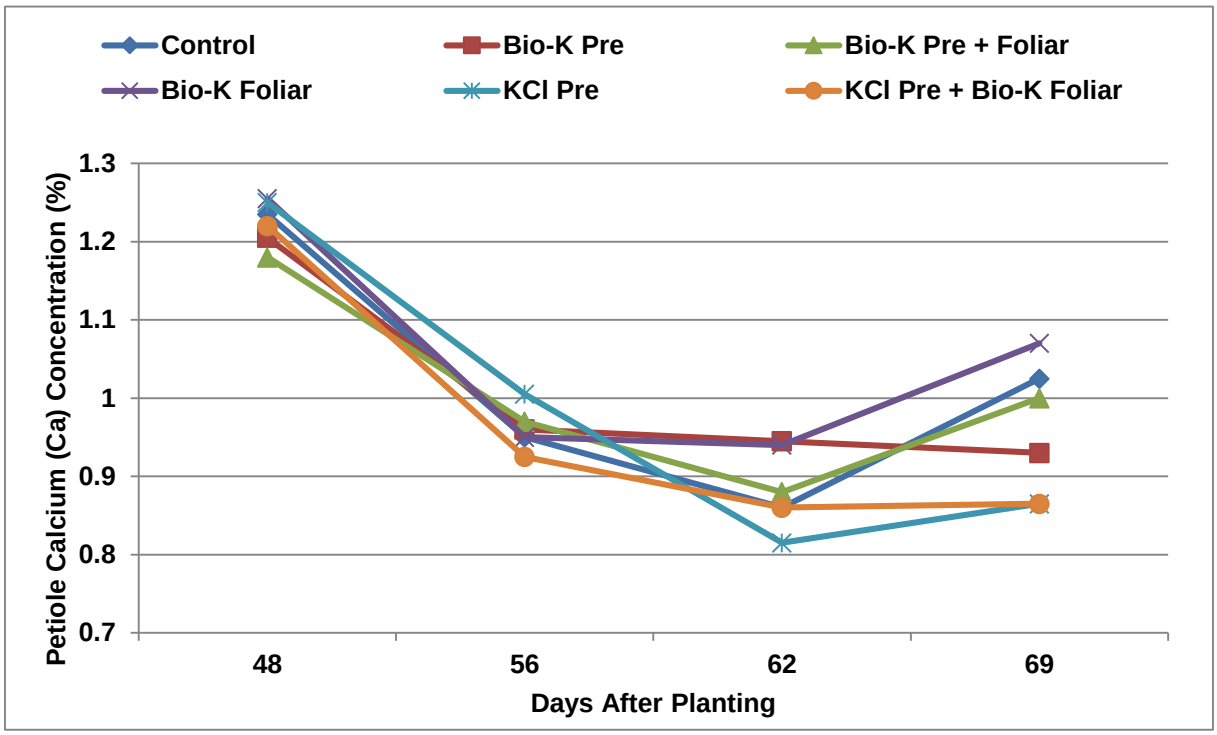

Fig. 2f. Effect of Source and timing of K fertilizer application on petiole Calcium concentration

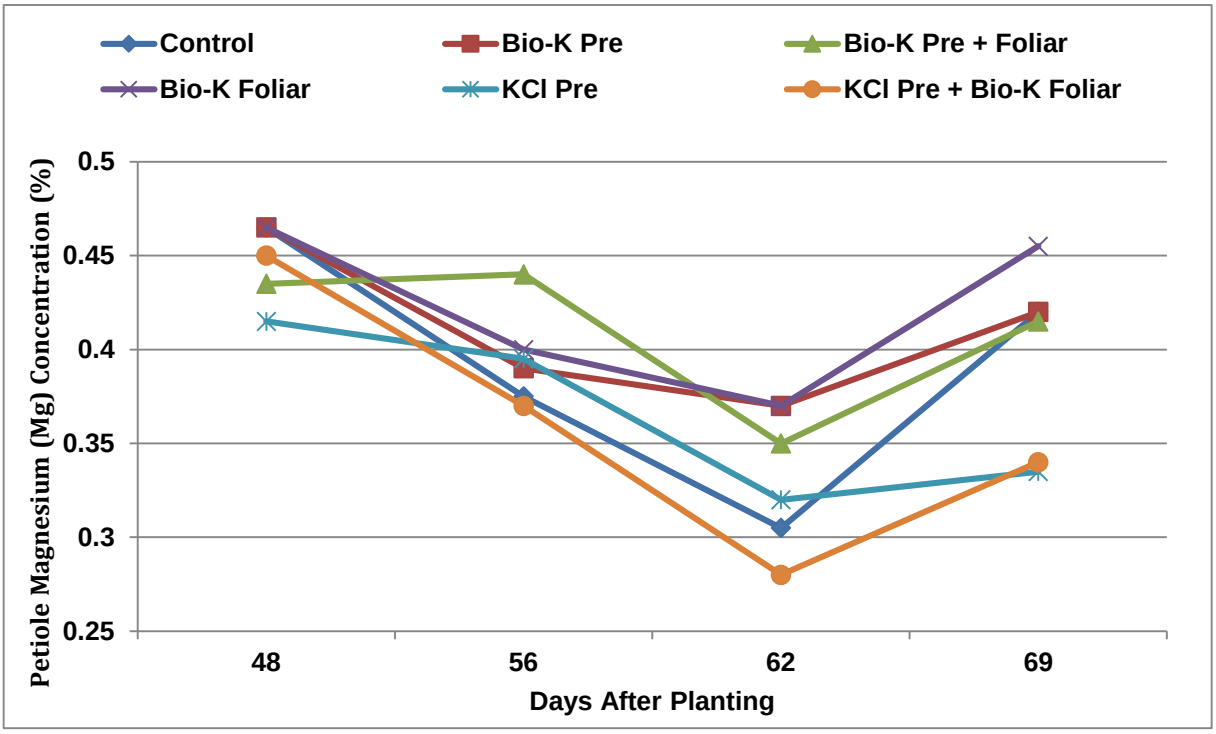

Fig. 2g. Effect of Source and timing of K fertilizer application on petiole magnesium concentration.

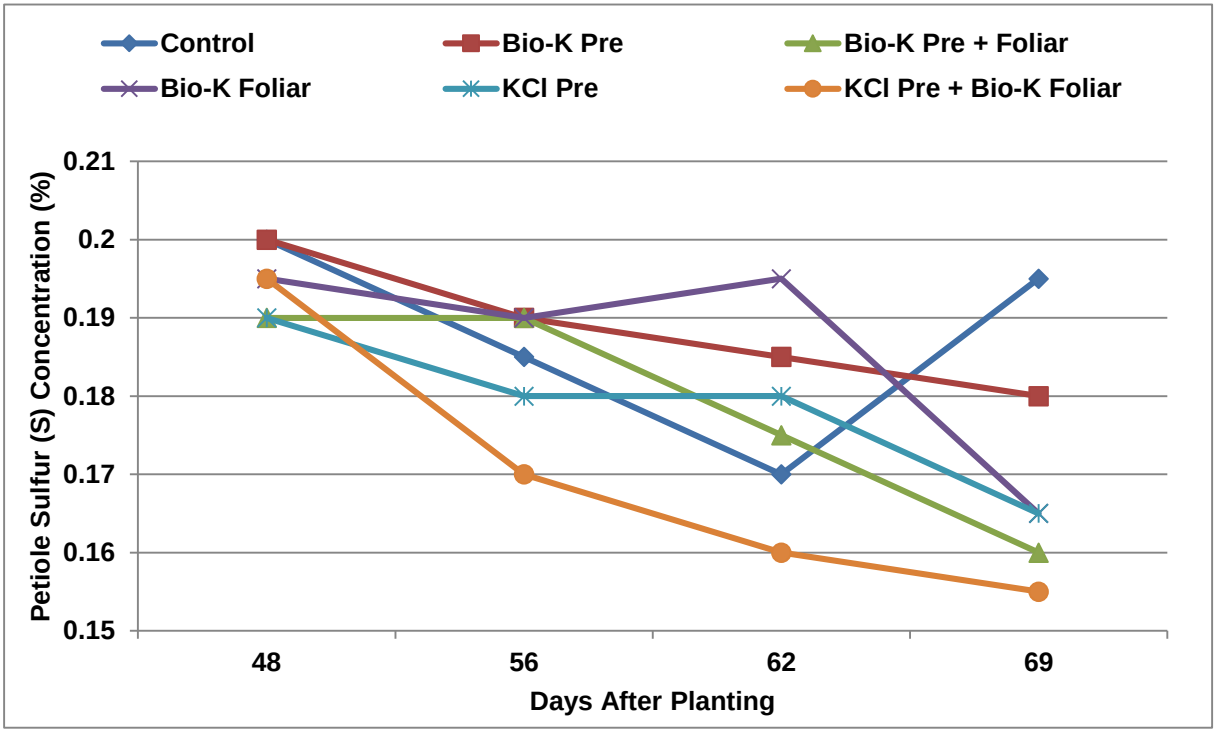

Fig. 2h. Effect of Source and timing of K fertilizer application on petiole sulfur concentration

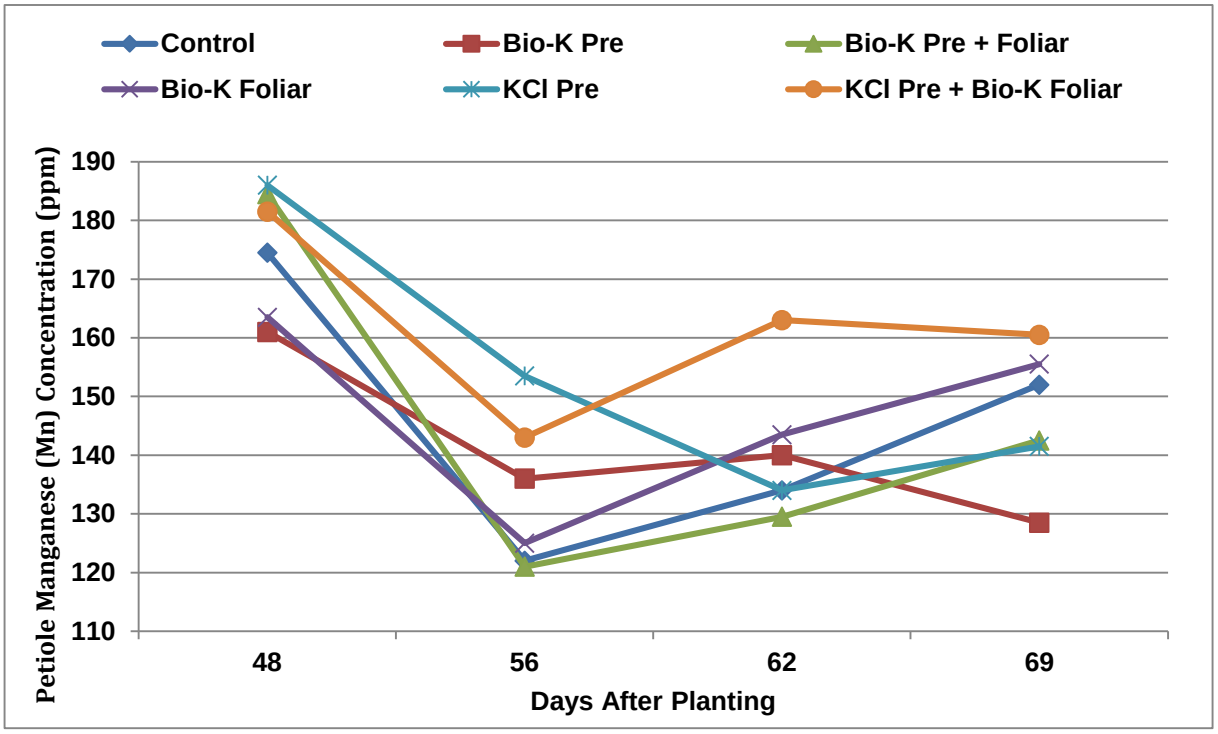

Fig. 2i. Effect of Source and timing of K fertilizer application on petiole manganese concentration.

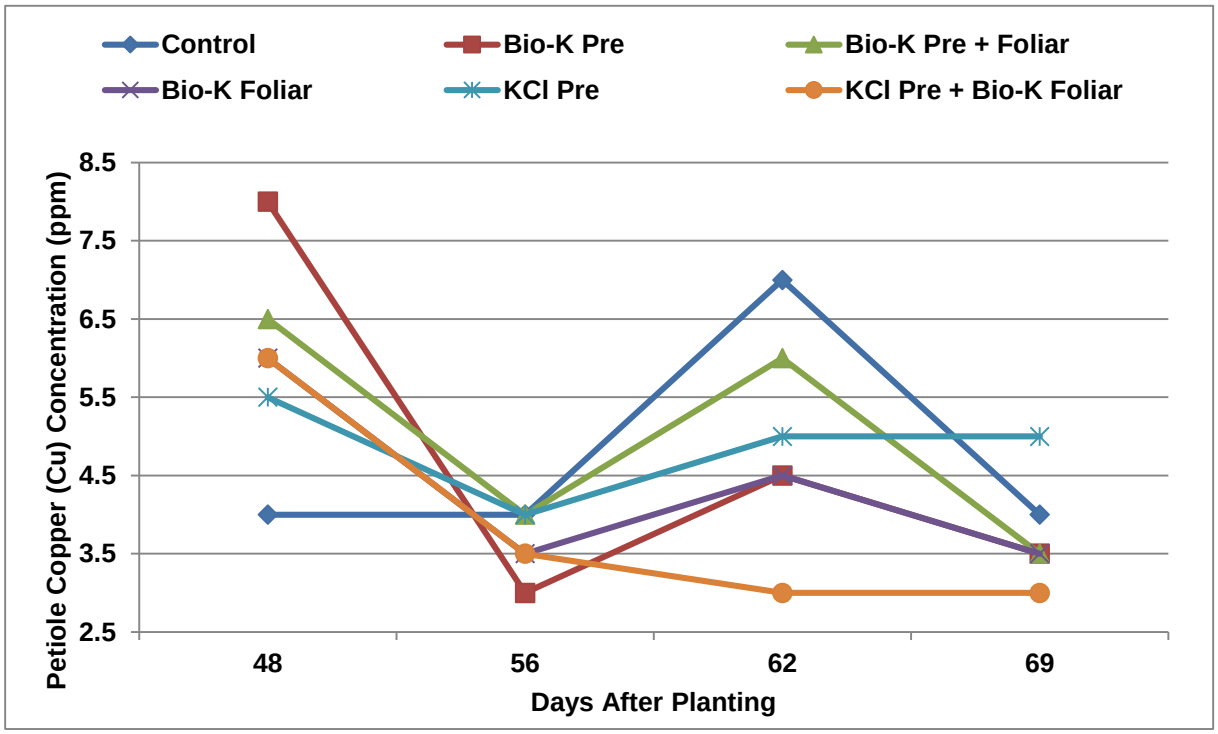

Fig. 2j. Effect of Source and timing of K fertilizer application on petiole copper concentration

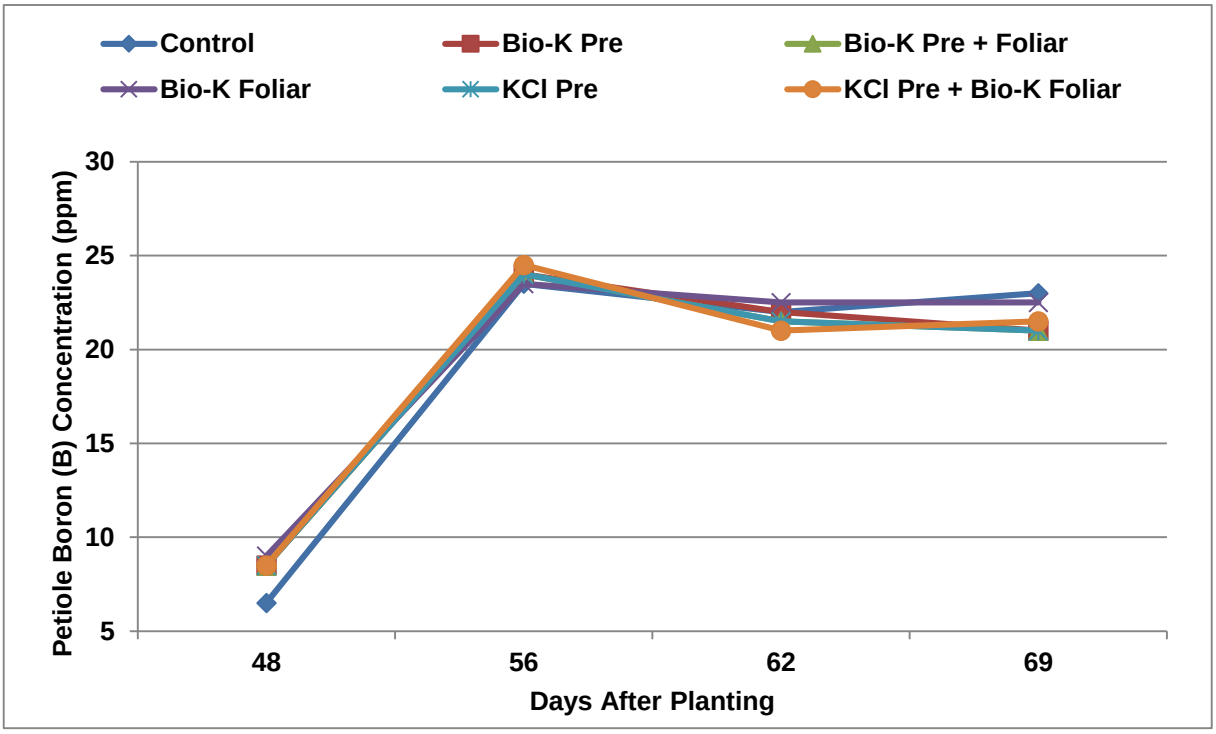

Fig. 2k. Effect of Source and timing of K fertilizer application on petiole Boron concentration

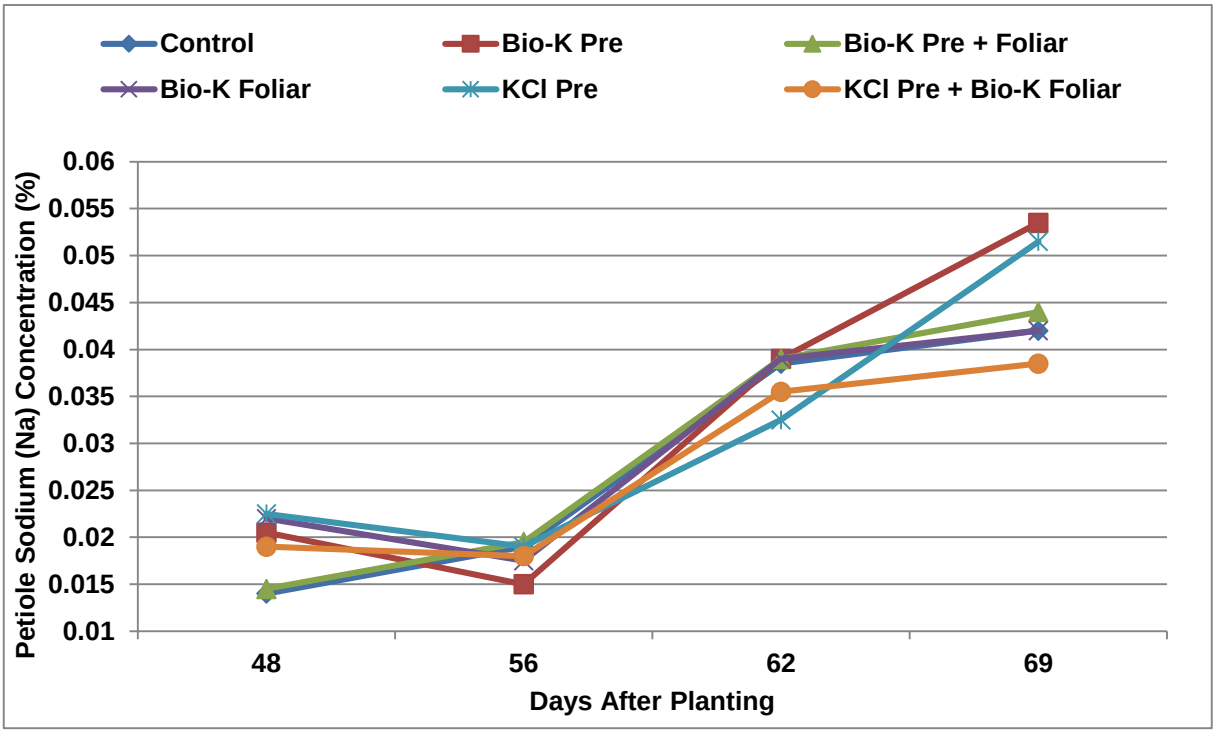

Fig. 2l. Effect of Source and timing of K fertilizer application on petiole sodium concentration

SUMMARY AND CONCLUSION

Data from this study clearly indicate that the source and timing of potassium fertilizer application do influence tuber bulking, tuber yield and tuber quality. In the present study, the application of Bio-K pre plant increased the rate of tuber bulking. The yield of marketable and premium size tubers were significantly increased when Bio-K was applied pre plant.