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Split N and P Fertigation Beneficial For Pear Production

Banding N and P also increases fruit yield and size in Oregon studies.

SUMMARY
Studies conducted on a Parkdale soil show that a shift from single surface broadcasting of dry nitrogen (N) and phosphorus (P) to split N and P fertigation benefits fruit yield and size as well as reduces fruit scald and N and P consumption. In addition, banding N and P also increases fruit yield and size and reduces fruit scald when compared with surface broadcasting.

The Mid-Columbia region in Oregon produces 40 percent of the winter pears and 20 percent of the summer pears in the U.S. Unlike annual crops, pear yields on a specific orchard block vary considerably from year to year due to training, pruning, and weather conditions. Yields below normal have been frequently observed over the seasons.

Presently, N fertilizer is mostly broadcast on the soil surface once per year (March or April) at a rate of 80 to 100 lbs/A as a dry material, followed by an intensive irrigation season. Nitrogen use efficiency (NUE) is low with this N management system because at this high rate of N the tree root system cannot take up all of the N in such a short time, resulting in much of the applied N being leached out of the soil. Water quality data collected since 1995 by various entities suggest that Hood River tributaries draining orchard lands have excessive N levels. Low NUE also increases losses of NO and N_2O gases into the atmosphere. Therefore, it is urgent that alternate sustainable N management systems be developed and demonstrated.

Similarly, P_2O_5 fertilizer is broadcast on the soil surface once per year (March or April) at a rate of 100 to 125 lbs/A as a dry material. Phosphorus use efficiency (PUE) is low with this P management system because P is highly immobile in the soil, and surface-applied P does not positionally match up well with the pear root system. Thus, much applied P is fixed by soil minerals, particularly on the orchards at Parkdale where the soil is derived from volcanic ash. Overall, inefficient P use with surface application of dry P results in excessive P consumption by orchards and increases pear production costs.

So far, very little research has been done on the effects of split N and P fertigation on the growth, yield, quality, and storability of pears or other orchard trees in the U.S. The objectives of this study were to:

- Evaluate the effects of fertigating N and P fertilizers under micro-sprinkler irrigation and

drip irrigation as two integrated production systems, on pear fruit yield, quality, and storability compared with current pear production

- Compare costs of installing and maintaining a fertigation plus micro-sprinkler system or fertigation plus drip irrigation system with the cost of current production systems.

Fertilizer treatments

In all treatments shown in either the tables or graph, fertilizer quantity applied in the five treatments ("Trt" in tables) were as follows:

- N at 100 lbs/A in treatments 1,2,and 3
- N at 80 lbs/A in treatments 4 and 5
- P_2O_5 at 125 lbs/A in treatments 1,2, and 3
- P_2O_5 at 100 lbs/A in treatments 4 and 5

Both N and P in treatments 1, 2, and 3 were applied once in early April. N and P in treatments 4 and 5 were applied in five equal split applications during May and August.

N and P were broadcast in treatment 1, banded in treatment 2, broadcast in treatment 3 along with soil disturbance caused by banding (no fertilizer was banded), and fertigated in treatments 4 and 5. Treatments 1, 2, 3, and 5 were drip irrigated, but treatment 4 was under micro-sprinkler irrigation.

Soil fertility

Soil total N content, amino sugar N content, or NH_4-N content with the two N and P fertigation treatments was not reduced compared with surface broadcasting although N fertilizer application rate was lowered by 20 percent for the two fertigation treatments (Table 1).

Overall, our results suggest that split fertigation of N and P fertilizer may increase the use efficiency of

applied N and P fertilizers on pear orchards in the Mid-Columbia region.

Leaf nutrition

Fertigation of N and P fertilizers under micro-sprinkler irrigation resulted in significantly higher leaf N concentration than surface broadcasting (Table 2). Both fertigation of N and P under drip irrigation and banding applications of N and P had insignificant but numerically higher leaf N level than surface broadcasting. The two N and P fertigations produced significantly higher leaf P concentration than surface broadcasting. However, the difference in leaf P between the banding application and surface broadcasting was not significant. Similar to leaf P, leaf S concentration was significantly greater under the two N and P fertigation treatments compared with surface broadcasting, and banding application also resulted in higher leaf S concentration than surface broadcasting. The effects of the two N and P fertigation or banding treatments on other leaf nutrient concentrations were statistically insignificant.

Fruit yield

Pear yield with broadcast application of N and P to the soil surface was 217.0 lbs/tree (Figure 1). Banding N and P produced a 4.6 percent yield increase over surface broadcasting N and P. Split fertigation of N and P under micro-sprinkler irrigation and split fertigation of N and P under drip irrigation increased yield by 4.2 and 5.7 percent, respectively, relative to surface broadcasting.

Fruit firmness was significantly greater with N and P fertigation treatment under micro-sprinkler irrigation relative to surface broadcasting application. Titratable acid was significantly greater with banding of N and P compared with surface broadcasting. Additionally, fruit size was larger with:

- Band application of N and P
- Split fertigation of N and P under micro-sprinkler irrigation
- Split fertigation of N and P under drip irrigation relative to surface broadcasting in terms of nine fruit categories (data not presented).

Fruit color did not differ among the five treatments.

On the average, the two fertigation treatments reduced both N and P requirements by 20 percent compared with broadcasting of N

and P to the soil surface.

Fruit scald

Visual evaluation of fruit surface scald was conducted after the fruit had been stored in a cold storage room for three months. Five categories of excellent, very slightly scalded, slightly scalded, moderately scalded, and severely scalded fruit were used in this evaluation. It was interesting that the two split N and P treatments and the banding application reduced the total of slightly scalded, moderately scalded, and severely scalded fruits by over 13 percent (absolute value) compared to surface broadcasting. Reducing surface scald seems to be another benefit of split N and P and banded N and P.

Summary

Overall, results suggest that shifting from our current N and P management system to split N and P fertigation shows beneficial effects:

- On fruit yield
- On fruit size
- On reducing fruit scald
- On reducing fertilizer application rates.

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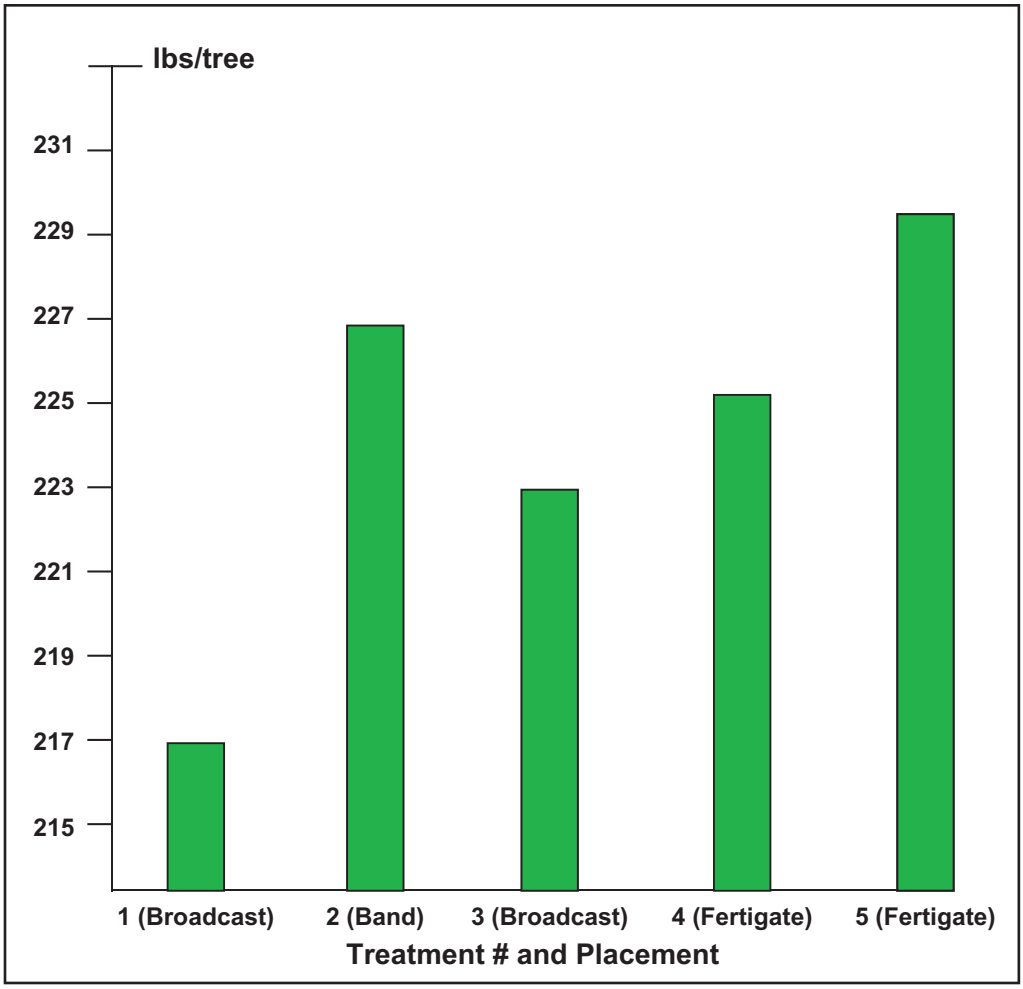

Figure 1. Effects of N and P application method on pear fruit yield.

Trt	Total N	Amino Sugar N	NH_4-N	NO_3-N	Total P	Available P
	(%)	(ppm)	(ppm)	(ppm)	(ppm)	(ppm)
1	0.208	259.0	1.48	36.6	1310.5	30.3
2	0.261	344.4	1.98	59.2	1387.0	43.5
3	0.271	233.1	1.53	67.6	1256.8	37.0
4	0.234	298.2	1.85	8.4	1195.3	36.0
5	0.295	302.4	1.80	14.4	1255.8	36.8

Table 1. Effects of N and P application method on soil nutrient concentrations after harvest.

Trt	N	P	K	Ca	Mg	S	B	Zn	Mn	Cu
	(%)	(%)	(%)	(%)	(%)	(%)	(ppm)	(ppm)	(ppm)	(ppm)
1	1.90	0.101	1.17	2.35	0.28	0.23	88.9	169.4	67.3	6.3
2	1.99	0.106	1.43	2.19	0.26	0.25	98.1	188.7	70.9	7.6
3	1.80	0.104	1.18	2.52	0.30	0.24	87.2	170.6	74.9	8.0
4	2.07	0.118	1.45	2.24	0.28	0.25	104.5	180.6	66.5	7.7
5	1.99	0.127	1.39	2.33	0.26	0.25	98.2	182.0	69.6	8.1

Table 2. Effects of N and P application method on leaf nutrient concentrations after harvest.