Onion Response to Phosphorus Placement as Affected by Fumigation

By Brad Brown

Unrestricted early season growth is essential for maximizing onion yields and financial returns. The fumigant Metam Sodium (Vapam®) is commonly used as a non-selective biocide for controlling soil borne diseases, insects, nematodes, and weeds for Idaho's Treasure Valley onions. But it can stunt early season growth, especially in high lime soils. The stunting is commonly attributed to loss of beneficial soil fungi called mycorrhizae that help onions access certain immobile soil nutrients such as P.

Mycorrhizal filaments extend from infected roots and essentially serve as root extensions, allowing the onions to explore greater soil volumes. Onions in high lime soils are particularly susceptible to stunting with Vapam® because available soil P is reduced with lime, and mycorrhizae in the fumigated soil are not available to compensate.

Previous research by the University of Idaho indicated that fall broadcast P reduced or altogether prevented onion stunting in high lime soils fall fumigated with Vapam®. The P requirements of onions were clearly increased when fumigant was used. Broadcast P fertilizers followed by fall bedding is a common practice for this production area.

Banding P for onions has been more effective than broadcasting P in the Midwest, but not always in other onion production regions. Such evaluations had not been conducted in the Treasure Valley. Our research objective was to further evaluate the stunting effects of Vapam® in relation to applied P, to compare broadcast vs. banded P for the area's production system, and to determine whether fumigation affected soil P availability for subsequent wheat crops.

Crops such as onions which depend on mycorrhizae fungi are especially vulnerable to marginal phosphorus (P) conditions in fumigated soils. Experience in the Treasure Valley of Idaho has shown that fumigation of high lime soils can stunt early season onion growth, but P can fully compensate in some cases. Our research showed that broadcast fertilizer P prior to bedding was more effective for supporting early season growth than P banded below and to the side of planted onion seed.

The study was conducted for three years at the University of Idaho Parma Research and Extension Center on a Nyssaton silt loam soil with low to moderate available P [6.8 to 8.2 parts per million (ppm) sodium bicarbonate P] and appreciable free lime (11 to 12 percent). Phosphorus rates (0 or 58 lb P_2O_5/A) as triple superphosphate were either fall broadcast or fall banded in bed centers. All P treatments were evaluated with and without Vapam® (33 percent active ingredient) injected at 35 gal/A after beds were formed in the fall. The treatments were evaluated with six replications. Onions followed a previous wheat crop.

Yellow Sweet Spanish onion double rows (4 in. apart) were planted on the 22-in. beds in early spring to straddle the banded P. Nitrogen (N) was sidedressed as urea prior to bulbing according to University of Idaho fertilizer guide recommendations. The onions were furrow-irrigated as needed. Weeds and thrips were controlled with labeled pesticides.

Fall fumigation consistently stunted early season onion growth (June dry weight) if no P

was fall applied or if the P was fall banded (**Figure 1**). Broadcast P in two of three years was the only P application that fully compensated for the fumigant-induced stunting of early season growth. Where Vapam® was utilized, banded P was clearly less effective than broadcast P.

The importance of mycorrhizae in the stunting of onions could not be determined in this study. Whereas the stunting effects of fumigation in one year were associated with greatly reduced mycorrhizal colonization, mycorrhizal colonization was uniformly low in other years and not influenced by fumigant, although stunting of the onions was just as severe.

Fumigation did not affect the uptake of potassium (K), calcium (Ca), magnesium (Mg), and sulfur (S) in any year. But it did reduce the uptake of zinc (Zn), manganese (Mn), iron (Fe), and copper (Cu) in 1999, and the concentrations and uptake averaged lower in 2000. The differences were not statistically significant (data not shown). Fumigant-induced micronutrient shortages, therefore, may contribute to onion stunting in some years in the Treasure Valley.

The uptake of P by onions in June was not affected by fall-applied P, unless the soil had been fumigated. When fumigated, June P uptake and tissue P concentrations generally

Onion stunting in the foreground resulted with fall fumigation without P. Onions in the background were non-fumigated, with P. At far right, onions were non-fumigated, without P.

increased with added P, especially broadcast P. The results confirm that early season onion requirements for fertilizer P are higher for fumigated soils.

Onion yields were limited by P deficiency in only one year without fumigation, but were limited in two of three years with fumigation.

Fumigation consistently delayed maturity regardless of fall-applied P, ultimately reducing bulb size and yield at harvest. Among the fumigated treatments, yield of small bulbs usually tended to be greater with fumigation and banded P, (**Figure 2**) whereas yield of large bulbs or colossals was greater with

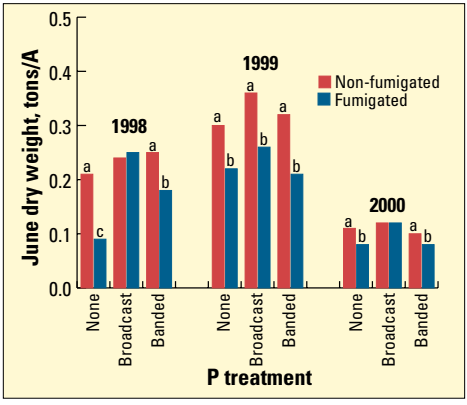

Figure 1. Early season onion growth as affected by P treatment and year. Parma, 1998-00. Different letter denotes a statistical difference between non-fumigated and fumigated treatments at $p < 0.05$ within a given year.

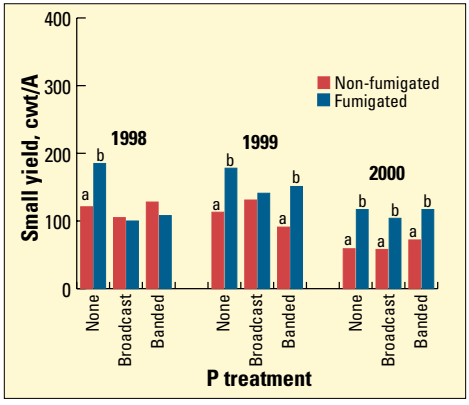

Figure 2. Small onion yield as affected by P treatment. Parma, 1998-00. Different letter denotes a statistical difference between non-fumigated and fumigated treatments at $p < 0.05$ within a given year.

fumigation and broadcast P (**Figure 3**). But fall-applied P fully compensated for the effects of fumigation on bulb size and yield in two of three years if P was broadcast and one of the three years if it was banded. Additional available P was required for fumigated soil to match yields from soils not fumigated. Whereas onion yield did not differ for broadcast and banded P in two years, yield was lower with banding in one year.

The effects of fumigation on subsequent crops have not been widely reported. Winter wheat was fall planted after the onions to measure residual effects from the previous year P fertilizer and fumigation treatments. The adverse effects of fumigation on available soil P extended into the following wheat crop in both of the seasons for which data are available. Either P uptake by wheat at heading or grain yield at maturity was reduced the year following onions grown on fumigated soils. However, wheat grain yield and P uptake were not affected by fumigation the previous year if P had been applied to the onions.

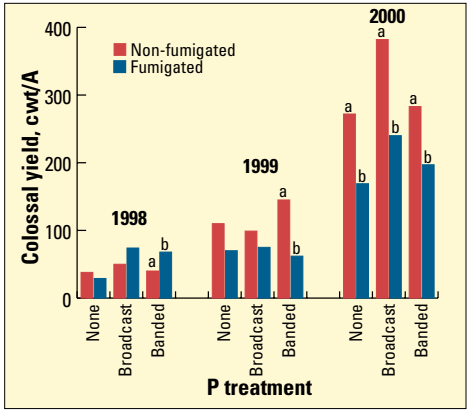

Figure 3. Colossal onion yield as affected by P treatment and year. Parma, 1998-00. Different letter denotes a statistical difference between non-fumigated and fumigated treatments at $p < 0.05$ within a given year.

Summary

Fumigation-induced stunting of onions prior to bulbing was striking and consistent each year in this high lime soil, and fall-applied P could not fully compensate for the effect in all years. Other factors appear to be involved which this study was not designed to evaluate. Banded P with soil-injected Vapam® was less effective than broadcast P. There are compelling pest control reasons to fumigate onion production fields in the Treasure Valley, but adequate levels of P, and possibly other nutrients, are essential to avoid reduced yields of both onions and subsequent wheat in high lime soils. BC

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