

Onion Response to Phosphorus Placement and Fumigation

B. D. Brown and R. G. Gibson

University of Idaho

Abstract

Appropriate phosphorus (P) placement for Treasure Valley onion bulb production is unknown. Placement was evaluated in a field study conducted for three years at the Parma Research and Extension Center on a Nyssaton silt loam (coarse-silty, mixed, superactive, mesic, Xeric Haplocalcids) with low to moderate soil test P (6.8-8.2 ppm Olsen P) and appreciable lime (11-12%). P rates (0 or 58 lb P2O5 per acre) were either broadcast prior to bedding or banded into 22 inch bed centers after bedding in the fall and the beds reformed. All P treatments were evaluated with and without fumigation (Vapam®) applied at 35 gal per A after beds were formed in the fall. Spring planted onions were consistently stunted by fall Vapam fumigation and P could not always compensate for Vapam effects. Vapam facilitated P treatment comparisons when P was the only limiting factor to production or grade. Banded P was less effective than broadcast P during early season growth.

Introduction

Unrestricted early season growth is essential for maximizing onion yields and financial returns. Early season onion stunting occurs in moderately low phosphorus (P) calcareous soils especially when fall fumigated (Vapam®). The stunting is commonly attributed to loss of beneficial mycorrhizal associations because onions are known to have limited root systems and to be more mycorrhizal dependent than most crops.

Though significant fumigation effects on mycorrhizal associations weren't measured in local research trials, broadcast applied P (80 - 160 lb P2O5/A) prior to fall bedding prevented onion stunting in soils fall fumigated with Vapam. Broadcasted P fertilizers followed by fall bedding is a common practice.

Surface distributed P from broadcast applications would seem to be less favorably positioned than P banded below and to the side of the onion seed. While broadcast and banded P have been compared for many crops, broadcast vs banded P have not been compared in the irrigated production of western Idaho.

Furthermore, fumigation may be useful as a research tool for lowering available P to onions in order to facilitate a comparison of P application methods..

Methods

The study was conducted for three years at the Parma Research and Extension Center on a Nyssaton silt loam (coarse-silty, mixed, superactive, mesic, Xeric Haplocalcids) with low to moderate soil test P (6.8-8.2 ppm Olsen P) and appreciable lime (11-12%). P rates (0 or 58 lb P205 per acre) were either broadcast prior to bedding or banded into 56 cm bed centers after bedding in the fall and the beds reformed. All P treatments were evaluated with and without Vapam (33%) applied at 35 gal/A after beds were formed in the fall. The added P treatments (broadcast vs banding) were nested within Vapam treated and non-treated main plots in a randomized incomplete block design with six replications.

Planted double rows of onions (4 inches apart) were centered on the original 22 inch beds after the tops of the beds were removed by tillage to the inter-row area. This configuration left onion double rows on the shoulder of larger slightly raised 44 inch beds.

Onion tops were collected from 24 inches of one double row in June and near the end of bulbing in August or early September and their P contents determined. Onion roots from ten plants of non-fumigated and fumigated soils were collected at bulb initiation for measurement of mycorrhizal infection. The percentage of onion tops fallen over was visually estimated periodically when bulbing was completed. Onion yield and grade were measured from a minimum of four double rows for a distance of 45ft. Onions were graded into <2", 2-3", 3-4", and >4" sizes. Marketable onions were considered all grades >3" and colossals were taken as those >4".

Data were analyzed using GLM procedures in SAS. Vapam and P added effects were analyzed as a 2x2 factorial. P method and Vapam were evaluated as a 2x2 factorial subset of the data .

Results

Fall fumigation consistently reduced onion dry matter in June of each year (Fig. 1, top) and June P uptake in two of three years (Fig. 1, bottom), but dry matter and P uptake were not significantly affected at maturity (data not shown). Whole plant P concentrations were not significantly affected by Vapam (data not shown). Mycorrhizal root infection was reduced by Vapam in 1998 (15.9 vs 2.9 vesicles per plant) but infection levels were low in subsequent years and Vapam effects on mycorrhizal infection in those years were not significant. Despite consistently reducing pink root infection in August, Vapam consistently delayed maturity (Fig. 2) and reduced bulb size at harvest, resulting in fewer marketable onions, especially collosals (Fig. 3).

Adding P in the fall increased June dry weight and P uptake significantly in only one of three years (1998) but the trend was the same in all years (Fig. 1). Whole plant P concentrations in June were

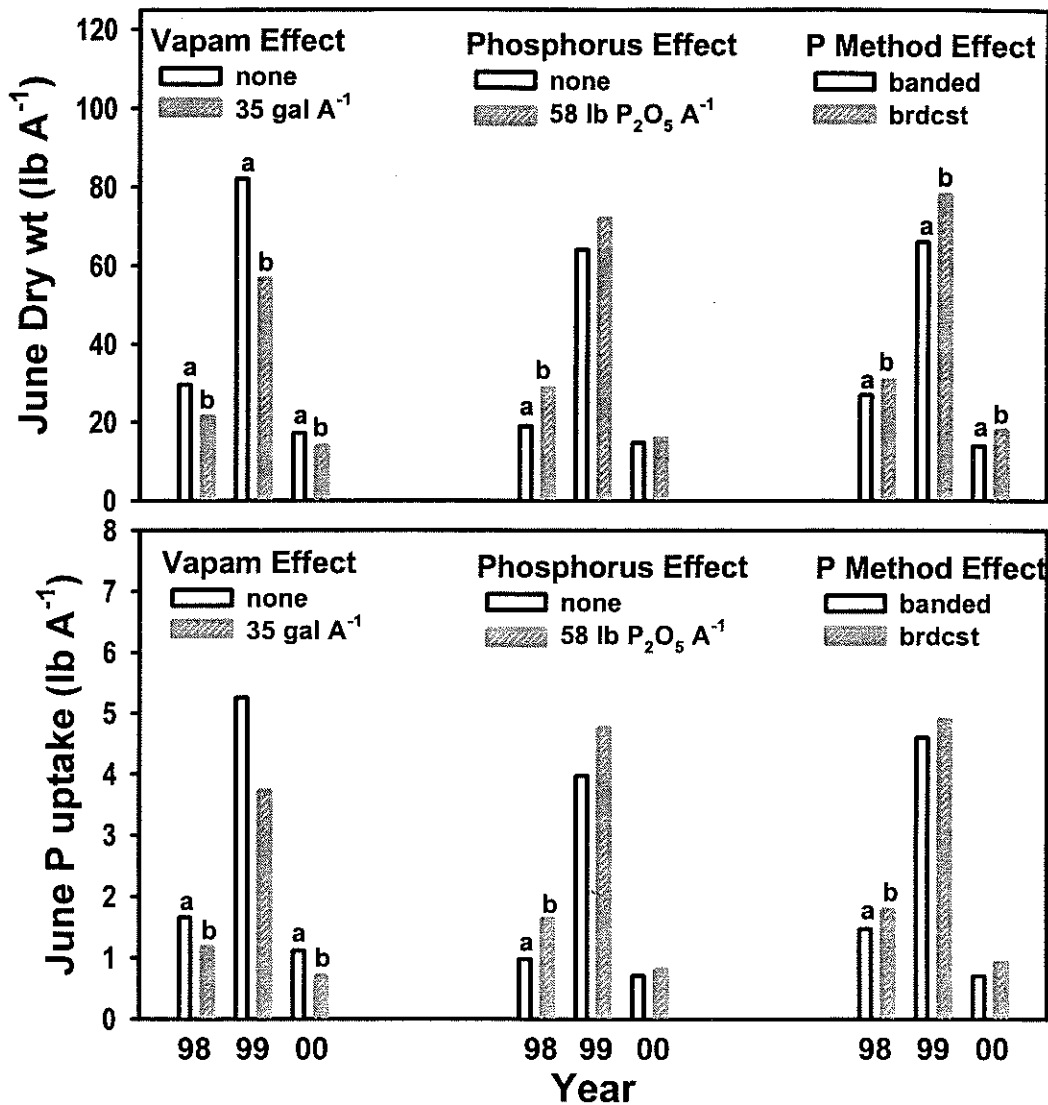


Fig. 1. Onion top dry weight (top) and P uptake (bottom) as affected by Vapam, added P, and P method of application in each year.

higher with P in two of three years (data not shown). In 1998 added P did not affect total dry matter at maturity, but P uptake at maturity was increased with added P. In other years, P uptake at maturity was not significantly affected by added P, though the trend for higher P uptake was consistent in each year. Added P consistently hastened maturity (Fig. 2) but yield of marketable onions (>3") increased significantly with P only in 1998. Onions showed a surprising ability to access P in this high lime soil, despite moderately low soil test P values, and particularly if not fumigated.

Reduced P availability does not explain the response to Vapam in all years. Other than 1998, the detrimental effects of Vapam could not be compensated for with added P. The lack of effective

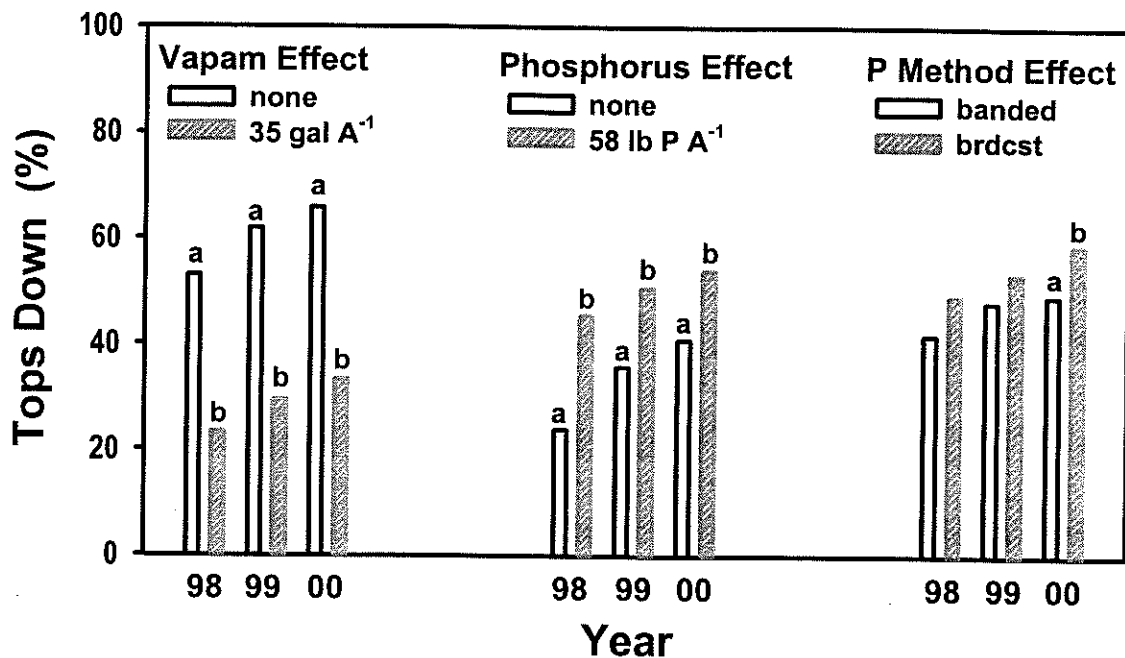


Fig. 2. Onion maturity (% tops down) in each year as affected by Vapam, added P, and method effects.

mycorrhizal infection possibly reduced the availability of other nutrients, but the uptake of K, Ca, Mg, and S were unaffected by Vapam in this study in any year (data not shown). Nitrogen was side-dressed and should not have been limiting. The micronutrients Mo, Zn, Mn, Cu, and Fe were measured in June plants and both Mn (30.1 vs 26.9 ppm) and Fe (462 vs 192 ppm) concentrations were significantly reduced by Vapam in 1999 despite DTPA extractable soil test values (4.0 ppm Mn and 6.8 ppm Fe) above published critical levels. The trend was similar in the 2000 season although differences were not significant. Whatever the reason, Vapam effects were at times clearly independent of any influence on available P.

Significant Vapam X P interactions occurred with P uptake at maturity and the grade or size fractions of onions at harvest. Added P fully compensated for Vapam effects in 1998 but this compensation did not occur to the same extent in the 1999 or 2000 seasons. Vapam fumigation facilitated the evaluation of P treatments in 1998. That is, with Vapam use, added P increased yield in 1998 and the proportion of the total yield that graded as collosals, but P had no effect with no fall fumigation.

Banding P in fall beds provided no advantage over broadcast P in any year. In fact onion dry weights were consistently greater in June with broadcast P than banded P and maturity was consistently delayed with banded P. Whole plant P concentrations and P uptake in June were higher with broadcast P in 1998 but did not differ significantly in other years though trends were the same. Broadcast P resulted in greater yield of collosals in 2000 and fewer small onions but did not differ in other years.

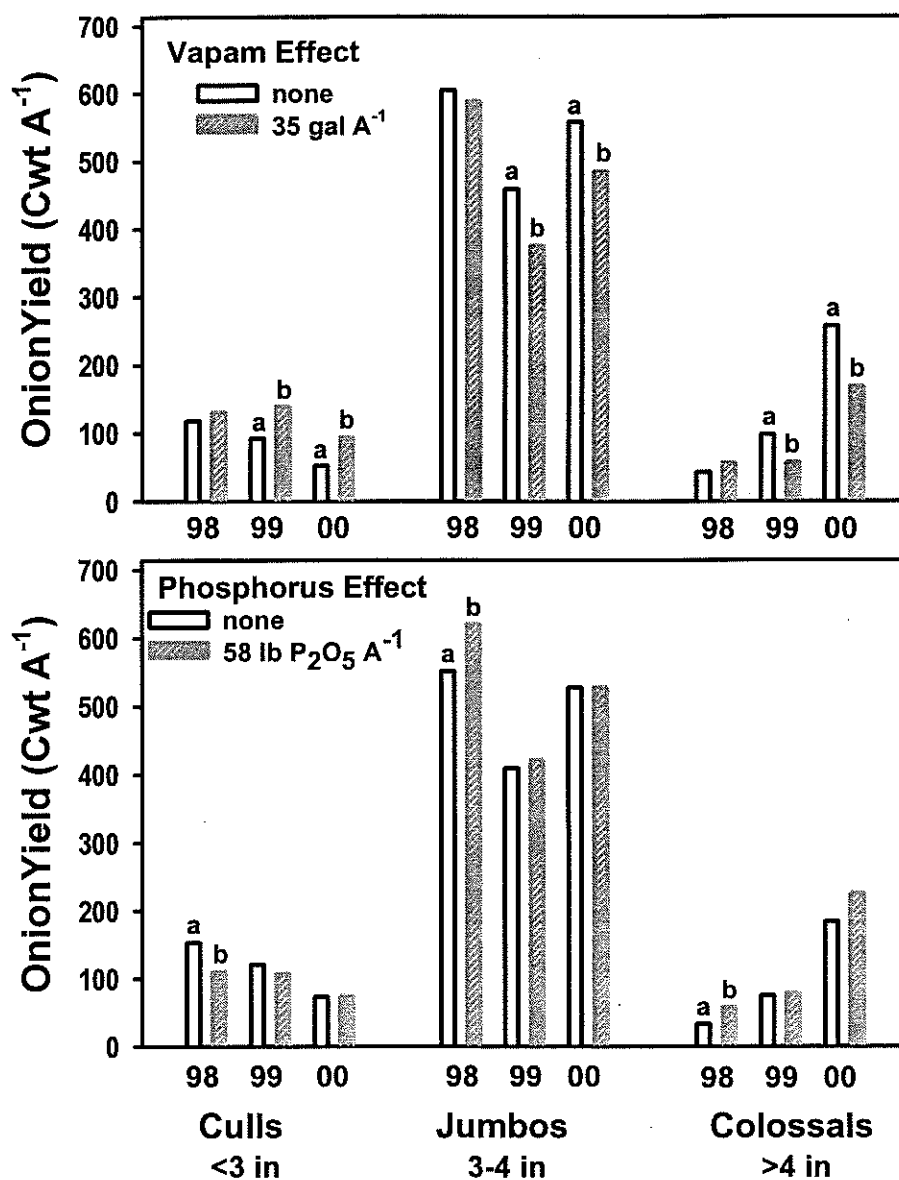


Fig. 3. Onion yield by grade in each year as affected by Vapam (top) and Padded (bottom) main effects.

Banded P appeared to be detrimental to early season onion growth in all years, but onions apparently recovered more in years other than 2000.

It is not clear why banded P should reduce early season growth as compared to broadcast P. The P rate was not originally considered excessive, in part because the salt index of treble super phosphate is not as great as other fertilizer salts and the fertilizer was not placed with the seed. However, onions are more sensitive to salts than many crops. It is possible that onions prefer P placement directly below the seed rather than below and to the side as has recently been reported.

In summary, spring planted onions were consistently stunted, their maturity delayed, and most years the marketable onion yield reduced by fall Vapam fumigation and applied P could not always compensate for Vapam effects. Vapam facilitated P treatment comparisons when P was the only limiting factor to production or grade. Banded P was less effective than broadcast P during early season growth.