# Effects of Dolomitic Limestone and Micronutrients

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## INTRODUCTION AND LITERATURE REVIEW

More than a dozen research studies have been conducted over the last 25 years related to addition of dolomitic limestone to pine-bark-based potting mixes. Many of the studies also investigated the effects and interactions between dolomitic limestone and minor element supplements. Results from these studies have been non conclusive, since amending potting substrates with dolomitic limestone and micronutrients has increased growth, decreased growth, and had no effect on growth of ornamental crops. Chrustic and Wright (1983) found that incorporation of dolomitic limestone decreased 'Helleri' holly and 'Rosebud' azalea growth and increased juniper growth only at 2.0 kg $m^{-3}$ (3.3 lb $yd^{-3}$). They concluded that lime addition increased pH leading to increased $NH_4$ adsorption in the pine bark. They also concluded that if Ca and Mg supplies were adequate in container solution, substrate pH had little effect on plant growth. The duration of the study was 8 weeks. Whitcomb (1983, 1990) stated that container media pH between 4.0 and 7.0 had little effect on availability of micronutrients, except when high concentrations of Ca, Mg, Na, or bicarbonates influenced micronutrient nutrition.

Sartain and Ingram (1984) grew 'Andorra Compacta' juniper and *Rhododendron sinsii* 'Redwing' for 6 months in three potting substrates and two lime rates. They reported growth of azaleas was reduced by the high rate of lime 4.1 kg $m^{-3}$ (7.1 lb $yd^{-3}$) but juniper growth was unaffected. Starr and Wright (1984), in a 7-month winter-greenhouse study grew cuttings of *Ilex crenata* 'Helleri' fertilized with one of four rates of dolomitic limestone including 0, 1.9, 3.7, and 7.5 kg $m^{-3}$ (0, 3.4, 6.8, and 13.6 lb $yd^{-3}$). They found that addition of dolomitic limestone increased the concentrations of Ca and Mg in container solution, but unamended bark supplied both elements in quantities sufficient for growth. Leda and Wright (1997), studying effects of particle size of dolomitic lime, grew *Buxus sempervirens* 'Suffruticosa' liners for 2 years in a pine bark and peat moss medium. The finer particles of dolomitic limestone were more effective in adjusting pH. In more recent work, Amy Wright et al. (1997) conducted a lime and micronutrient study where nine species of landscape trees were grown for 19 weeks in a pine bark only substrate (Wright et al., 1997). Results showed that adding micronutrients increased height of some species, while adding lime either had no effect or suppressed height. Adding micronutrients without lime increased concentrations of Ca, Mg, Fe, Mn, Zn, and Cu whereas these concentrations were diminished with addition of lime except for Mg. They concluded that an increase in pH may have reduced elemental concentrations when lime was added. While micronutrients were necessary for optimal growth, lime did not increase growth of any species and some species had suppressed growth with addition of lime.

In a study conducted at Auburn University, addition of dolomitic limestone to a pine bark and peat moss (3 : 1, v/v) potting medium increased the size of *Nandina*, *Hosta*, chrysanthemums (*Dendranthema*), and 'Green Luster' and 'Burfordii' holly

after 360 days, but had no effect on *Rhododendron formosum* or October Glory® red maple (Cooper et al., 1997). However, quality of red maple, dwarf nandina, and hosta declined with increasing amounts of lime when micronutrients were not added. A second study was conducted for 330 days, either 2.8 or 5.5 kg $m^{-3}$ (5 or 10 lb $yd^{-3}$) of a fine ground or pelletized dolomitic limestone were applied (Murphree et al., 1997). Application of 2.8 or 5.5 kg $m^{-3}$ (5 or 10 lb $yd^{-3}$) to 'Fashion' azalea lead to decreased growth compared to the no lime control and the finely ground dolomitic limestone formulation decreased growth more than the pelletized formulation. However, 'Soft Touch' holly growth was unaffected by rate or lime formulation. In a study in Georgia, growth of *Buddleja davidii* 'Royal Red' was optimized at 2.2 kg $m^{-3}$ (4.0 lb $yd^{-3}$) of dolomitic limestone, although plants grown with 4.8 kg $m^{-3}$ (8.0 lb $yd^{-3}$) had greatest shoot lengths (Gilliam et al., 1998). Plants grown without dolomitic limestone had Ca and Mg levels below recommended concentrations for normal growth.

Differing results may be due to differences in duration that have ranged from a few weeks ( Sartain and Ingram, 1984; Star and Wright, 1984; and Wright et al., 1997) to 2 years (Cooper et al., 1997; Leda and Wright, 1991; and Murphree et al., 1997). Most studies have been summarized with recommendations that irrigation water pH, bicarbonate levels, nutrient content and substrate potting components be considered as dolomitic lime application rates are determined for any specific nursery. In short, no one "recipe" is necessarily appropriate for every nursery and the choice to apply dolomitic limestone and the rate should be nursery specific.

## EFFECTS OF LIME PRODUCTS AND RATES ON MICRONUTRIENT PRODUCTS EXPERIMENT

Several standard nursery crops such as *Juniperus conferta* 'Blue Pacific', *Abelia* 'Edward Goucher', *Myrica cerifera* (southern wax myrtle), *Ternstroemia gumnanthera* (syn. *Cleyera*), *Nandina domestica* dwarf form, and some azalea cultivars have shown considerable chlorosis by mid to late growing season. Problems related to irrigation water quality, dolomitic lime rates, and minor element supplements were suspected, after foliar, leachate, and/or soil analyses did not provide explanations for the chlorotic appearances of the plants.

To study relationships between micronutrient packages and dolomitic limestone products, we initiated a study on 22 May 1996 (Bilderback and Warren, 1998). The study was terminated 420 days later on 16 July 1997. Plants were harvested and analyzed after 92, 194, and 420 days. The main plots were two dolomitic limestone products [pulverized (James River Limestone, Buchanan, Virginia) and ground (Rockydale Quarries Corp., Roanoke, Virginia)] incorporated at rates of 0, 2.8, 5.5, and 8.3 kg $m^{-3}$ (0, 5, 10, and 15 lb $yd^{-3}$) at potting. Greater than 75% of the pulverized limestone passed through a 100 mesh screen whereas < 45% of the ground limestone passed through a 100 mesh screen. James River and Rockydale dolomitic limestone were selected for study since these two lime products are used frequently in nurseries as potting amendments. Subplots in the study consisted of micronutrient packages (MicroMax and Step); a fertilizer containing micronutrients (Osmocote Plus 15N-9P-11K), and no micronutrients. Each subplot consisted of three containers for a total of 12 plants per treatment. MicroMax 0.8 kg $m^{-3}$ (1.5 lb $yd^{-3}$), STEP 0.7 kg $m^{-3}$ (1.25 lb $yd^{-3}$) and Osmocote Plus (equivalent to 4 g N per container) were incorporated at potting. Substrates containing MicroMax, STEP, and no micronu-

trients were incorporated with Osmocote High N Southern Blend 23N-4P-8K at 4 g N per container at potting. Irrigation volume of 800 ml was applied daily before dawn via pressure compensated spray stakes (Wade Rain Acu-Spray Stick, Wade Manufacturing Co., Fresno, Calif.) at a rate of 0.7 cm $min^{-1}$ (0.3 inches $min^{-1}$). Osmocote Southern Blend and Osmocote Plus were surface applied on 31 March 1997 at the same rate. We also included a control with no dolomitic limestone and no minor element amendment and another treatment where Ca was supplied by gypsum and Mg was supplied by Crop Mag 36, a product produced by Martin Marietta. Our intent in this study was not to pick a winner, but to learn more about how lime products and rates and micronutrient packages interacted and affected plant growth and nutritional chemistry.

## RESULTS AND DISCUSSION

Results from all portions of the plants measured (tops, roots, and total dry weight) gave the same response in respect to limestone products, limestone rates, micronutrients, time, and their respective interactions.

**Micronutrient Results.** The response of juniper growth to micronutrients changed during the experiment (Fig. 1). At 92 days of production the top, root, and total juniper dry weight were unaffected by micronutrients regardless of limestone product and limestone rate. Junipers grown with no micronutrients were similar in weight to those grown with MicroMax, OsPlus, and STEP. At 194 days, dry weights of juniper grown without micronutrients (none) were less (smaller plants) than junipers grown with MicroMax, OsPlus, and STEP. By 420 days, total dry weight of junipers grown with MicroMax, OsPlus, and STEP were 133% to 151% greater than junipers grown without micronutrients. Thus, results here agree with previous reports that micronutrients enhance growth and may explain where the debate over the use of micronutrients originates. A short-term study (i.e., 92 days) would have concluded that incorporating micronutrients is not necessary for maximizing growth whereas, results at 194 and 420 days of production illustrated the value of incorporating micronutrients. In addition, top, root, and total dry weight of junipers grown without micronutrients (none) were significantly smaller than junipers grown with MicroMax, OsPlus, and STEP regardless of the limestone product (Fig. 2).

**Limestone Products and Rates.** Differences among the micronutrient products were affected by limestone product (Fig. 3). MicroMax, OsPlus, and STEP produced similar dry weights when grown with ground limestone (Rockydale). Even though micronutrients were added with OsPlus at potting (22 May 1996) and reapplied with OsPlus on 31 March 1997 whereas, MicroMax and STEP were only incorporated at potting, the growth was similar. This illustrates that MicroMax and STEP can provide adequate micronutrients for 420 days of production.

Junipers grown with ground limestone (Rockydale) increased quadratically with increasing rate of limestone incorporation with maximum dry weight occurring at 2.8 kg $m^{-3}$ (5 lb $yd^{-3}$) (Fig. 4). Total dry weight of junipers grown with 5.5 and 8.3 kg $m^{-3}$ (10 and 15 lb $yd^{-3}$), decreased 20% and 42%, respectively. In contrast, total dry weight of junipers grown with pulverized limestone (James River) decreased linearly with increasing rate of limestone incorporation. Maximum dry weight occurred with no limestone added 0 kg $m^{-3}$ (0 lb $yd^{-3}$). Dry weight of junipers grown with pulverized limestone decreased 28%, 29%, and 36% for 2.8, 5.5, 8.3 kg $m^{-3}$ (5,

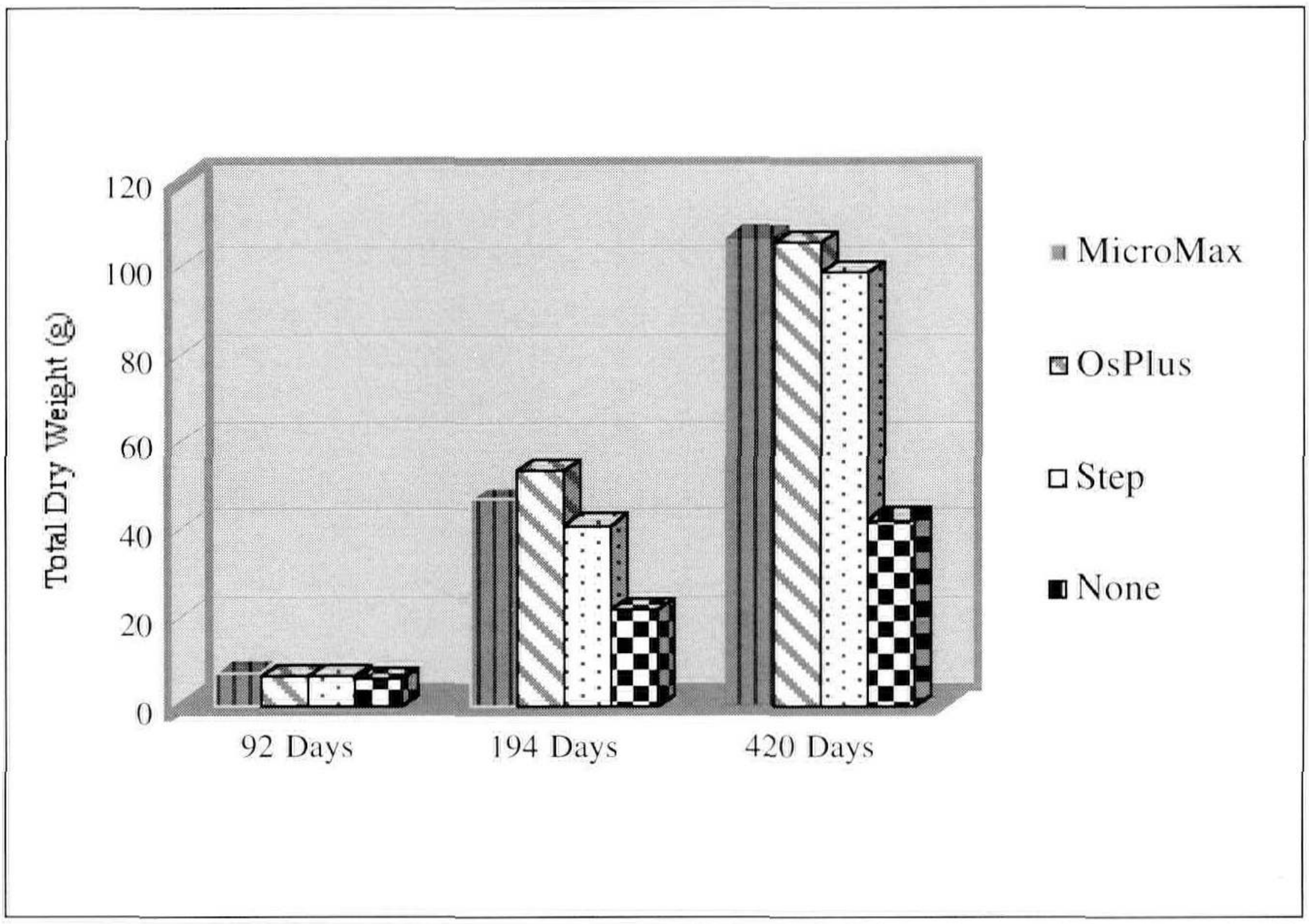


**Figure 1.** Micronutrient effects on growth of 'Blue Pacific' juniper at 92, 194, and 420 days of production.

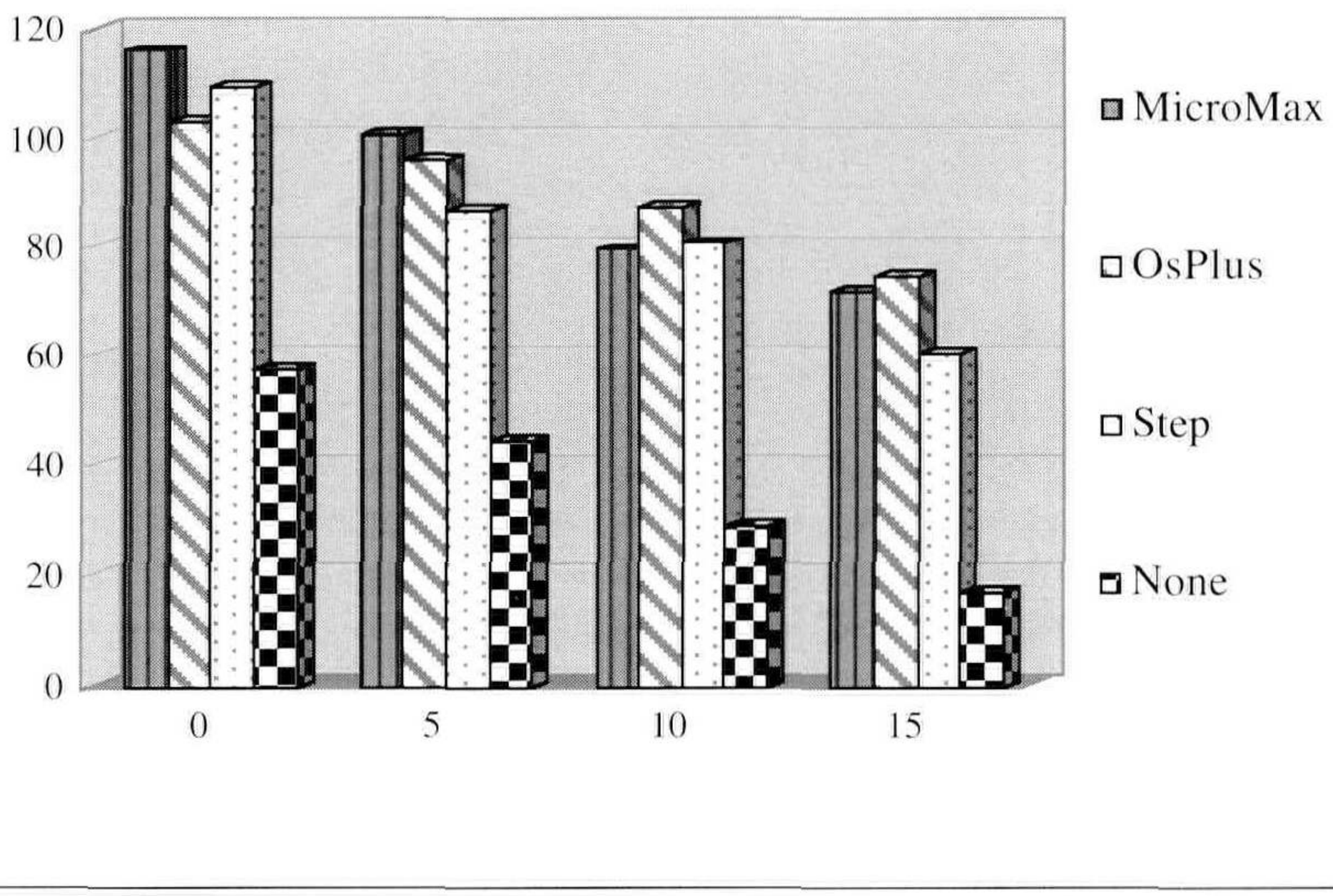


**Figure 2.** Growth of 'Blue Pacific' juniper as affected by micronutrients and increasing rates of dolomitic limestone.

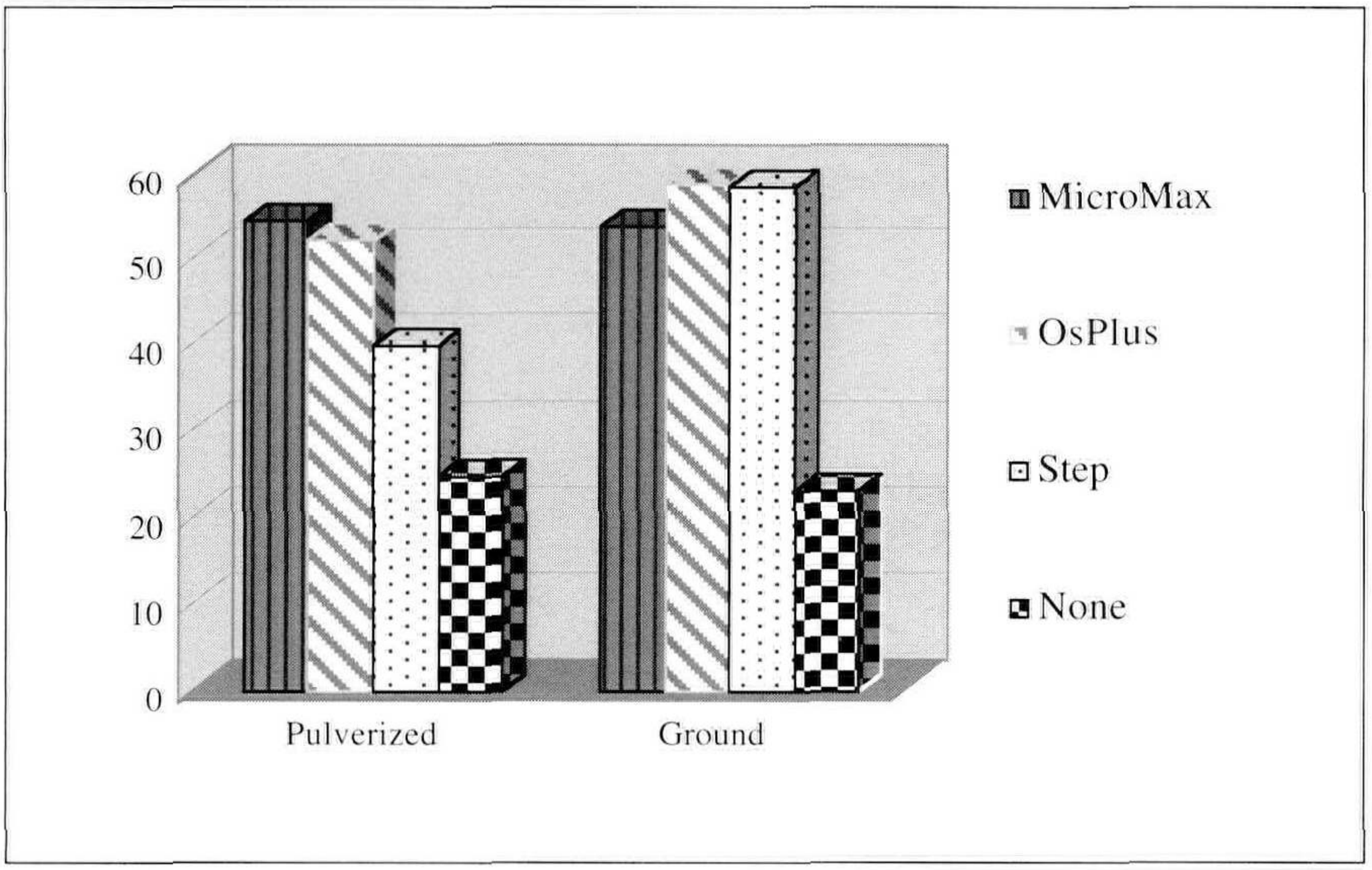


**Figure 3.** Effect of pulverized and ground limestone on micronutrient products and the growth of 'Blue Pacific' juniper.

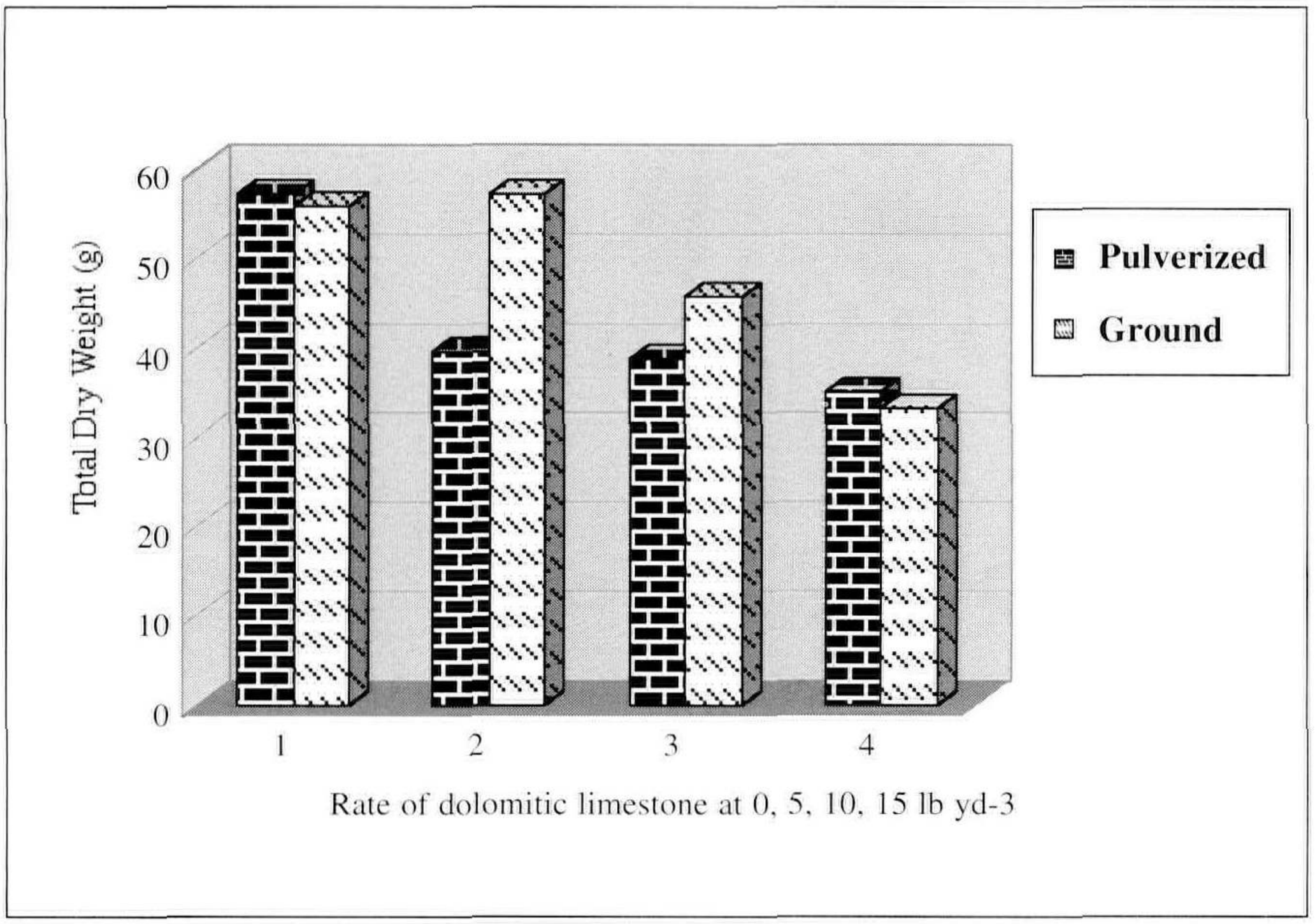


**Figure 4.** Growth of 'Blue Pacific' juniper as affected by rate of pulverized and ground limestone.

10, and 15 lb $yd^{-3}$), respectively. Junipers grown with ground limestone (Rockydale) were significantly heavier compared to pulverized limestone (James River) at 5.5 and 8.3 kg $m^{-3}$ (5 and 10 lb $yd^{-3}$).

Unfortunately, limestone is currently used as a generic term, i.e., that all limestones are created equal and thus are used interchangeably. These results agree with results reported by Murphree et al. (1997) and illustrate that the particle size of the limestone affects the growth of the plant. These data suggest that the current recommendations for limestone need to also consider recommendations for micronutrient products, and mesh size of the limestone products.

## LITERATURE CITED

**Bilderback, T.** and **S. Warren**. 1998. Problem plants. North Carolina Association of Nurserymen Nursery Notes (3):35-37.

**Chrustic, G.A.** and **R.D. Wright**. 1983. Influence of liming rate on holly, azalea, and juniper in pine bark. J. Amer. Soc. Hort. Sci. 108:791-795.

**Cooper, J.C., D.J. Eakes, C.H. Gilliam, G.J. Keever,** and **J.W. Olive**. 1997. Dolomitic lime and mirconutrient rates affect container plant growth and quality. Proc. SNA Res. Conf. 42:17-19.

**Gilliam, J.H., M.A. Dirr,** and **S.K. Braman**. 1998. Effects of dolomitic lime on growth and nutrient uptake of *Buddleja davidii* ' Royal Red' grown in pine bark. J. Environ. Hort. 16:111-113.

**Leda, C.E.** and **R.D. Wright**. 1991. Dolomitic lime particle size and container medium pH. J. Environ. Hort. 9:226-227.

**Murphree, B.H., C.H. Gilliam, J.W. Olive, J.L. Sibley,** and **D.J. Eakes**. 1997. Influence of dolomitic limestone form and rate on 'Fashion' azalea and 'Soft Touch' holly. Proc. SNA Res. Conf. 42:135-136.

**Sartain, J.B.** and **D.L. Ingram**. 1984. Influence of container medium, lime, and nitrogen source on growth of woody ornamentals. J. Amer. Soc. Hort. Soc. 109:882-886.

**Starr, K.D.** and **R.D. Wright.** 1984. Ca and Mg requirements of *Ilex crenata* 'Helleri'. J. Amer. Soc. Hort. Sci. 109:857-860.

**Whitcomb, C.E.** 1983. Does pH really have an effect on nutrition of container-grown plants? Amer. Nurseryman. 160(9):33-35.

**Whitcomb. C.E. 1990**. Recycling Irrigation Water. Comb. Proc. Intl. Plant Prop. Soc. 40:444-448.

**Wright, A.N., J.K. Fanelli, A.X. Niemiera, J.R. Harris** and **R.D. W**right. 1997. Amending pine bark with lime and micronutrients affects growth of nine landscape tree species. Proc. SNA Res. Conf. 42:71-73.