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INFLUENCE OF SMOOTH PIGWEED AND COMMON PURSLANE DENSITIES ON LETTUCE YIELDS AS AFFECTED BY PHOSPHORUS FERTILITY[1]

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Abstract. **Field research was conducted to determine the effects of smooth pigweed and common purslane population densities on the yield of crisphead lettuce grown in organic soils under two different phosphorus (P) fertility regimes. Phosphorus was applied either broadcast (250 kg·ha^{-1}) or banded (125 kg·ha^{-1}) five cm below lettuce rows. Weed densities used were 0, 2, 4, 8, or 16 plants per 6 m of row (5.4 m^2). In weed-free situations, lettuce yields increased when P was banded compared to broadcast applications. When P was broadcast, lettuce yield reductions were observed between 2 and 4, and between 0 and 2 plants per 5.4 m^2 for smooth pigweed and common purslane, respectively. However, with banded P, the critical density of smooth pigweed occurred between 8 and 16 plants per 5.4 m^2. Season-long interference of these weeds caused lettuce yield reductions of up to 24 and 48% for smooth pigweed and common purslane, respectively. Lettuce head weight increased when P was banded within each weed density. Apparently, banding P gave additional advantage to lettuce to compete against these two weeds.**

Lettuce (*Lactuca sativa* L.) is the leading leafy vegetable crop in terms of acreage planted and value in the U.S. (Dusky and Stall, 1995). Major lettuce production areas in Florida are concentrated in the organic soils (50-80% organic matter) of the Everglades Agricultural Area (EAA) and around Lake Apopka. Among the many pests that occur in lettuce fields, weeds can cause significant losses in yield and quality. Traditionally, hoeing and cultivation have been used for weed control in lettuce. These methods are costly and time consuming for farmers. At the same time, these mechanical procedures can cause significant damage to the shallow rooting system of the crop.

Currently, few herbicides are registered for weed management in lettuce produced on organic soils. The cost of herbicide registration along with environmental concerns about herbicide carry-over and movement to ground water justify the search for alternative weed management strategies. A key component within these alternative methods is the use of cultural means within an overall weed management program. Cultural weed control implies the use of crop rotation and enhanced crop competitiveness against weeds for essential factors such as light, water, and nutrients (Anderson, 1983). However, to develop effective cultural weed management techniques, research needs to be conducted to better understand crop-weed interactions. For example, little is known about the relationship between weed density and crop yields (McWhorter and Shaw, 1982).

Usually, competition for nutrients is not independent of competition for other resources, affecting also the balance for water and light (DiTomaso, 1995). Several reports have emphasized the influence that nitrogen fertility has on providing an additional advantage to weeds or crops (Carlson and Hill, 1986; Morales-Payan et al., 1996; Okafor and DeDatta, 1976; Santos et al., 1996). However, scarce information is available about phosphorus (P) influence on leafy vegetable competitiveness. Shrefler et al. (1994) showed that banding P beneath lettuce rows provided a competitive edge to the crop against spiny amaranth (*Amaranthus spinosus* L.) interference. Previous research has shown that P manipulation can be a potential tool for changing the competitive balance of in favor of lettuce (Santos et al., 1997). No research has been conducted to determine the impact of different P fertility regimes on the lettuce yield reductions caused by smooth pigweed (*Amaranthus hybridus* L.) and common purslane (*Portulaca oleracea* L.). These two species have been recognized to cause tremendous weed pressure on lettuce fields in the EAA.

Phosphorus fertility is a key component of lettuce production in the EAA, since these soils are naturally deficient of this element (Hochmuth et al., 1994). In addition, P is a relatively immobile nutrient in the soil profile (Sample et al., 1980). Therefore, plants with large root volume, such as smooth pigweed and common purslane, may capture P more efficiently than lettuce. The objectives of this research were to a) determine the effects of two different P fertility regimes on lettuce yields as affected by different smooth pigweed and common purslane densities, and b) quantify lettuce yield reductions due to interference by the weed species.

Materials and Methods

Lettuce-smooth pigweed and lettuce-common purslane competition studies were conducted at the Everglades Research and Education Center of the University of Florida in Belle Glade. Soil type was a Pahokee muck (Euic hyperther-

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mic Lithic Medisaprist) with a organic matter content of approximately 75% and pH of 6.3. Average day/night temperatures were 28/17°C. Water-extractable P was 3.0 mg P/L of soil, which is insufficient for commercial lettuce production (Hochmuth et al., 1994; Sanchez et al., 1990). Phosphorus was either broadcast (250 kg·ha^{-1} P) or banded (125 kg·ha^{-1} P) five cm beneath each lettuce row. These rates were provided for maximum crop yield (Sanchez et al., 1990). Other plant nutrients were applied following soil analysis and recommendations for the area. Crisphead lettuce (cv. South Bay) was direct-seeded in double rows on top of 0.9-m planting beds. Seeds of smooth pigweed and common purslane were germinated in multiple cell trays (24 cm^3/cell) 10 days before lettuce planting. At lettuce emergence, weed seedlings in the two-true leaf stage were transplanted in between lettuce rows at the following densities: 0, 2, 4, 8, or 16 plants per 6 m of row (5.4 m^2), equivalent to 0, 0.37, 0.75, 1.50, and 3.00 plants per m^2. Undesirable weeds were removed by hand and/or hoeing.

Treatments were factorially arranged with two P fertility regimes, two weed species, five weed densities, and four replications within a split-plot design, where P fertility regimes were main plots and weed densities were subplots. The central 50% of the surface area of each experimental unit was harvested when lettuce plants in weed-free controls reached maturity based on head firmness, size, and appearance. Outermost wrapper leaves were removed at harvest time. Lettuce head number and fresh head weights were collected. Data were subjected to analysis of variance (ANOVA) to test for single factor effects and interactions (SAS Inst., 1987). Treatment means were separated and compared by standard errors calculated from the resulting data for each measured variable.

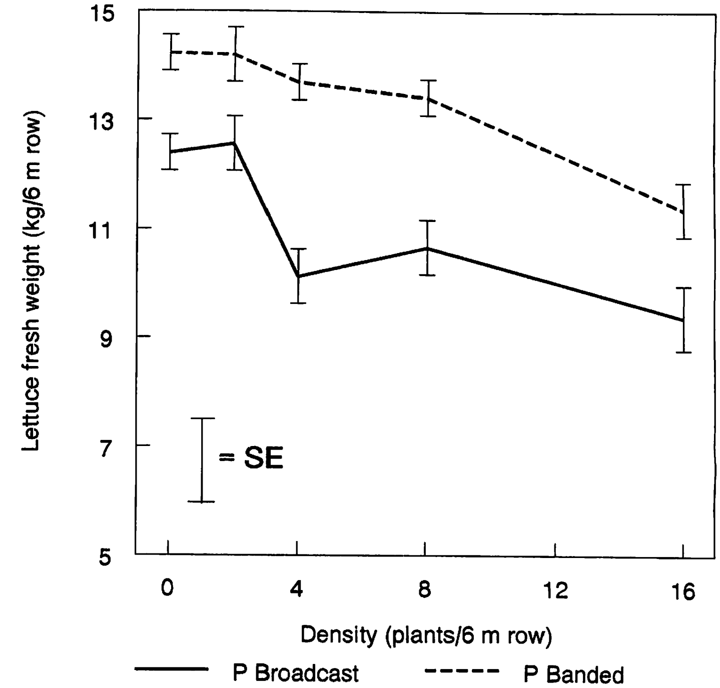

Figure 1. Effects of different smooth pigweed (*Amaranthus hybridus*) population densities on lettuce head fresh weight with banded and broadcast phosphorus (P) applications. Treatment means are separated by standard error bars.

Results and Discussion

Smooth Pigweed-Lettuce. There was a significant interaction between P fertility and density on lettuce fresh weight, but not on lettuce head number. In all cases, marketable fresh weight was greater when P was banded than when broadcast, including weed-free situations. Lettuce fresh weight tended to decrease as density increased within each P regime (Fig. 1). However, P fertility regime differentially impacted the critical smooth pigweed density where head fresh weight reductions were observed. With broadcast P, significant yield reductions were observed between densities of 2 and 4 smooth pigweed plants per 6 m of row, equivalent to approximately 20%. When P was banded, lettuce yield reductions occurred between 8 and 16 plants per 6 m of row, representing in average 24% decrease. Since, lettuce head number was not affected, the effect of the weed on lettuce was probably due to reduction of fresh and dry weight accumulation on a per head basis.

Smooth pigweed has been reported not to respond to P fertility (Santos et al., 1997). Because smooth pigweed has a profuse rooting system, one possible mechanism of competition is luxurious consumption of P by smooth pigweed to the detriment of lettuce. It has been demonstrated that lettuce utilized P more efficiently when this element is banded, diminishing the impact of spiny amaranth on lettuce yields (Sanchez et al., 1990). Banding P seemed to provide a competitive advantage to the crop, changing the critical smooth pigweed density necessary to reduce marketable lettuce yields.

Common Purslane-Lettuce. Phosphorus fertility and weed density independently influenced lettuce marketable fresh weight, but not head number (data not shown). There were significant differences in lettuce fresh weight when P was banded compared to broadcast P within each common

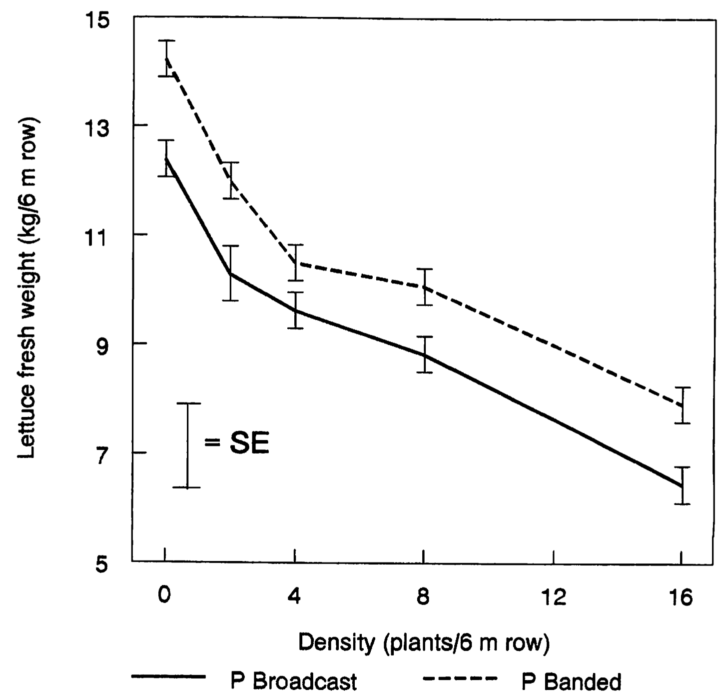

Figure 2. Effects of different common purslane (*Portulaca oleracea*) population densities on lettuce head fresh weight with banded and broadcast phosphorus (P) applications. Treatment means are separated by standard error bars.

purslane density. There was about a 13% increase in lettuce fresh weight with banded P compared to broadcast P (Fig. 2). In all cases, lettuce fresh weights decreased as weed density increased. Maximum yield reductions of 48 and 44% occurred with 16 common purslane plants per 6 m of row for broadcast and banded P, respectively.

Contrary to smooth pigweed, where critical densities varied as P regimes changed, common purslane critical density remained between 0 and 2 plants per 6 m of row, diminishing about 16 and 17% of lettuce fresh weight for banded and broadcast P, respectively. However, banding seemed to allow lettuce plants to utilize and capture P better by placing and concentrating P closer to its rooting system away from common purslane roots. This weed is known to respond to P fertility (Santos et al., 1997), thus competition for P may constitute the main mechanism of interference in lettuce-common purslane complexes. However, as indicated previously competition for nutrients can interact or enhance competition for other essential factors, such as light and water. This is a possible occurrence in broadcast P situations, where common purslane grows more quickly and subsequently shades lettuce more effectively due to enhanced P uptake.

These nutrient-light interactions are not rare in weed-crop interactions, where weeds are favored by high soil fertility more than crops, growing taller and reducing the amount of solar radiation received by the crop canopy (Liebman and Robichaux, 1990; Morales-Payan et al., 1997; Okafor and De-Datta, 1976). Further research is needed to determine the extent of interference of these weeds on the growth of lettuce when different initial removal times are imposed, as well as studies about the specific mechanisms of smooth pigweed and common purslane interference with the crop.

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