MYCORRHIZAL COLONIZATION AS IMPACTED BY CORN HYBRID

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ABSTRACT

Colonization of crop roots by mycorrhizal fungi can improve phosphorus uptake and thus reduce needs for phosphorus fertilizer application. Reductions in fertilizer application decrease environmental risks from run-off and decrease farmers' input costs. This study was conducted in 1996 and 1997 at the Kansas State University Irrigation Experiment Station near Bellville, Kansas to determine the effects of corn (*Zea mays,* L.) hybrid on mycorrhizal colonization. Twelve hybrids were selected for the study. A phosphorus starter fertilizer treatment was imposed as a split plot and the study was arranged in a randomized complete block design. Root samples were collected when corn reached the 6-leaf stage. Samples were washed, cut in to 1 cm lengths, cleared, and stained. The procedures of Giovannetti and Mosse were used to assess the percentage of root length colonized by hyphae, arbuscules, and total mycorrhizae. No differences, due to fertilizer or hybrid, in percent hyphae or percent arbuscules were found. Hyphae ranged from 60-90% and arbuscules ranged from 65-98%. The range in total mycorrhizal colonization (13-98%) suggested that hybrids varied in mycorrhizal colonization, but the variability was too high within each hybrid to result in statistically significant differences between the hybrids.

Keywords

Mycorrhizae, corn hybrid, P fertilizer.

INTRODUCTION

Vesicular-arbuscular mycorrhizal (VAM) fungi are found in all kinds of habitat and have been shown to have a beneficial effect on crop growth, especially in low fertility soils (Black and Tinker, 1979). Soil disturbances (tillage) have been shown to decrease mycorrhizal colonization by reducing the innoculum potential (mycelia and spores) in the soil (Anderson et al., 1987; Jasper et al., 1989; and Evans and Miller, 1988). Crop species also influences the species composition of mycorrhizae in the soil (Johnson et al., 1991).

Public interest in alternative agricultural systems is growing. Practices are designed to protect agricultural resources and prevent environmental damage to the farm and off-site land, water, and air (Poincelot, 1990). Reduced tillage systems coupled with more efficient phosphorus fertilization can protect surface water from the effects of phosphorus run-off. Rapid mycorrhizal colonization of crop species, could reduce the need for phosphorus fertilization in early spring, when the risk of run-off is highest.

Objectives

The objectives of this study were: 1. To determine the effects of phosphorus starter fertilizer on phosphorus uptake and mycorrhizal colonization of corn (*Zea mays,* L.) hybrids; and 2. To determine if corn hybrids differed in mycorrhizal colonization.

METHODS

A field study was conducted at the Kansas State University, Irrigation Experiment Field near Bellville, Kansas in 1996 and 1997. Twelve corn (*Zea mays*, L.) hybrids were planted as whole plots with phosphorus starter fertilizer as the split plot. The test was arranged as a randomized complete block with three replications. The twelve hybrids planted were Pioneer 3563, 3489, 3346, 3394; Cargill 6327, 7777; Dekalb 591, 626, 646; Northrup King 7333,6330; and ICI 8599. Split-plot fertilizer treatments were 0 fertilizer and 15 kg ha^{-1}.

Corn samples were collected at the V6 growth stage. Twenty corn plants per plot were randomly selected and carefully removed from the soil. Roots were washed, separated from top-growth at the soil line, and frozen until VAM analyses could be performed. To evaluate mycorrhizal infection, terminal feeder roots were cut into 1 cm segments and 0.5 g of randomly selected segments were placed in plastic capsules, cleared in 10% KOH overnight and stained with trypan blue in lactoglycerin (Phillips and Hayman, 1970). The grid-intersect method of Giovannetti and Mosse (1980) was used to assess root colonization. Percentage root colonization by arbuscules, hyphae, and total (arbuscule and/or hyphae) was calculated as:

Percentage root colonization = (VAM roots/total root intersects) X 100.

To assess the phosphorus content in the plant, plant top tissue samples were dried and ground to pass a 0.10 cm screen. A 0.25 g sub-sample of ground material was digested with sulfuric acid and hydrogen peroxide. phosphorus concentrations were measured with a dual-channel Technicon AutoAnalyzer.

Effects of starter fertilizer and hybrid on VAM colonization and phosphorus concentrations were compared using SAS Proc Mixed (Littell et al., 1996).

RESULTS

Plant phosphorus concentrations were significantly different due to starter fertilizer application, but not corn hybrid. There were no significant interactions between starter fertilizer and corn hybrid. In 1996 the mean P concentration was 0.30% in non-fertilized plots compared to 0.35% in fertilized plots (Fig. 1). In 1997 concentrations were 0.32% in non-fertilized and 0.35% in fertilized plots (Fig. 2). The range in P concentration by hybrid was 0.29 – 0.37% (Fig. 3) in 1996 and 0.32-0.36% (Fig. 4) in 1997. Pioneer 3489 consistently had the highest P concentration while Cargill 7777 was one of the lowest during both years of the study. The response to P fertilization and the range in concentrations are typical of early plant growth.

No differences in mycorrhizal colonization, due to starter fertilizer or corn hybrid were found in either year. There were no significant interactions between starter fertilizer and corn hybrid. The percent colonization was slightly higher in non-fertilized plots than fertilized plots (Figs. 5 and 6), which is consistent with the literature (Arias et al., 1991). In 1996, the range in percent col-

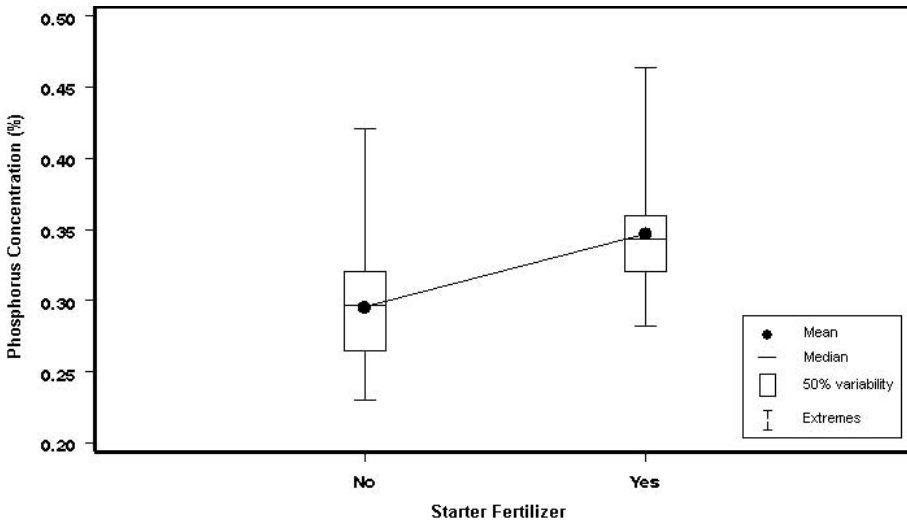

Figure 1. Plant phosphorus concentration as influenced by starter fertilizer in 1996, Pr > F = 0.0001.

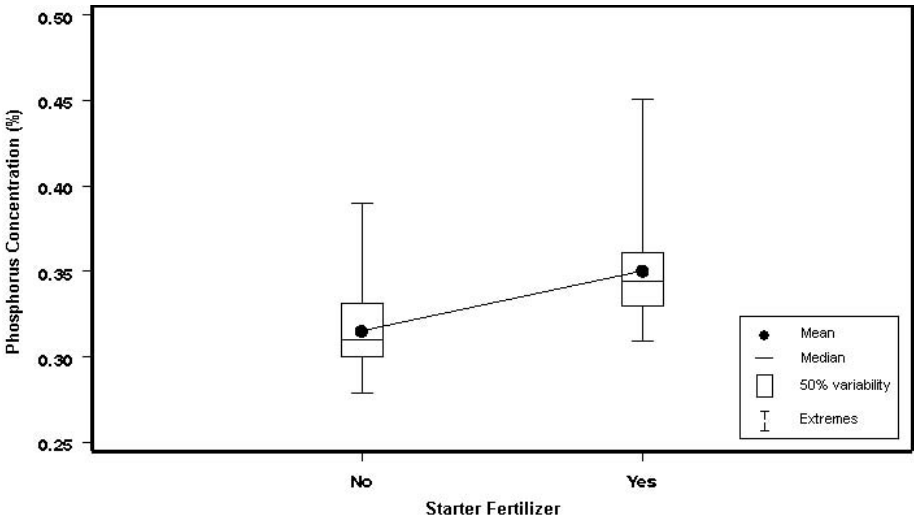

Figure 2. Plant phosphorus concentration as influenced by starter fertilizer in 1997, Pr > F = 0.0001.

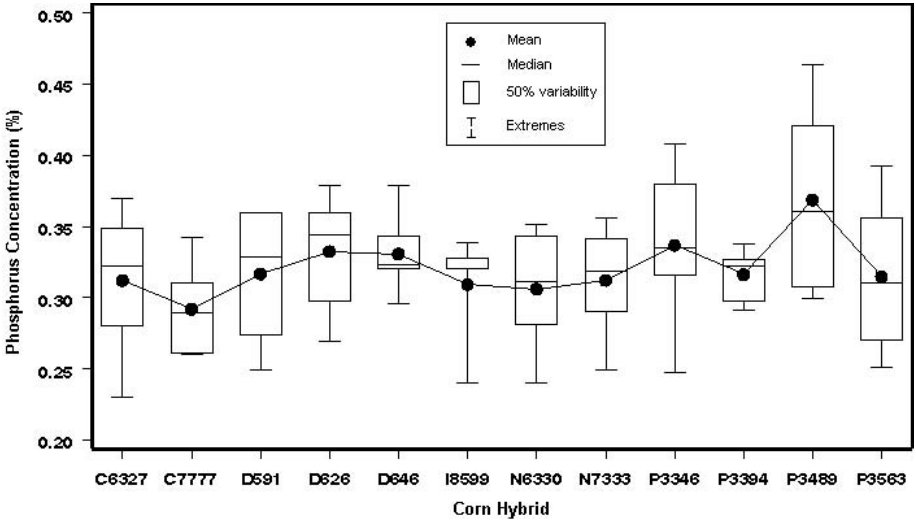

Figure 3. Plant phosphorus concentration as influenced by corn hybrid in 1996, Pr > F = 0.0429. Corn hybrids: C = Cargill, D = Dekalb, I = ICI, N = NK, P = Pioneer.

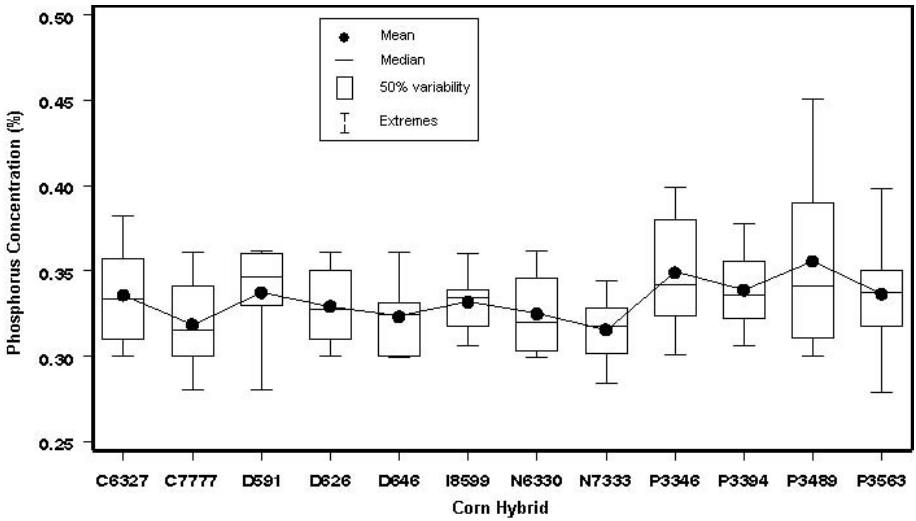

Figure 4. Plant phosphorus concentration as influenced by corn hybrid in 1997, Pr > F = 0.6497. Corn hybrids: C = Cargill, D = Dekalb, I = ICI, N = NK, P = Pioneer.

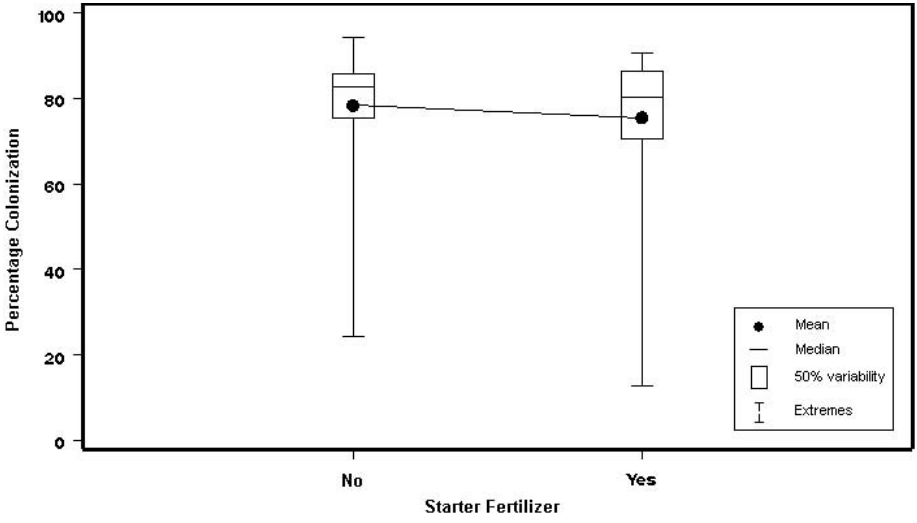

Figure 5. Percentage of mycorrhizal colonization as influenced by starter fertilizer in 1996, Pr > F = 0.0833.

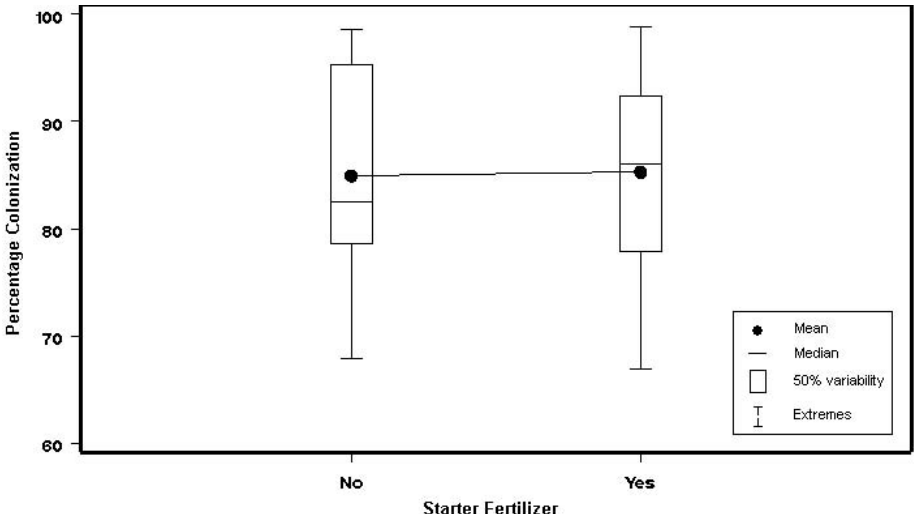

Figure 6. Percentage of mycorrhizal colonization as influenced by starter fertilizer in 1997, Pr > F = 0.9181.

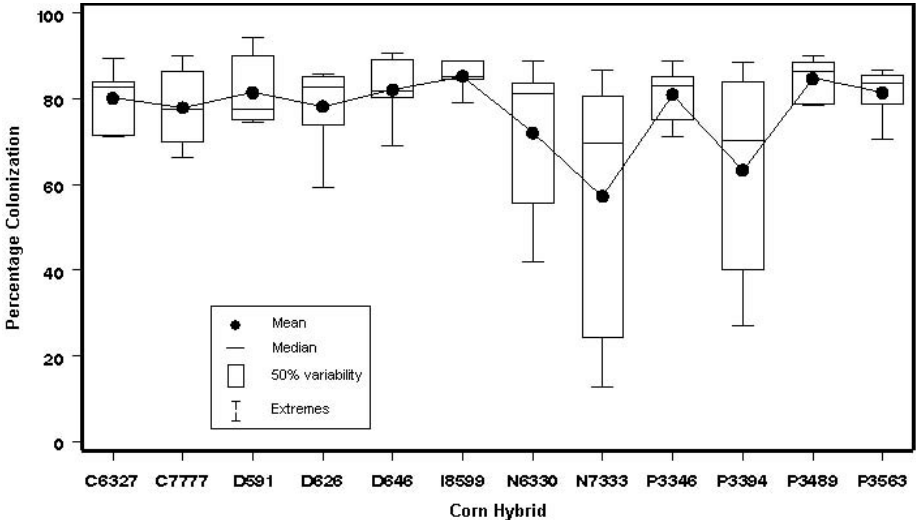

Figure 7. Percentage of mycorrhizal colonization as influenced by corn hybrid in 1996, Pr > F = 0.4456. Corn hybrids: C = Cargill, D = Dekalb, I = ICI, N = NK, P = Pioneer.

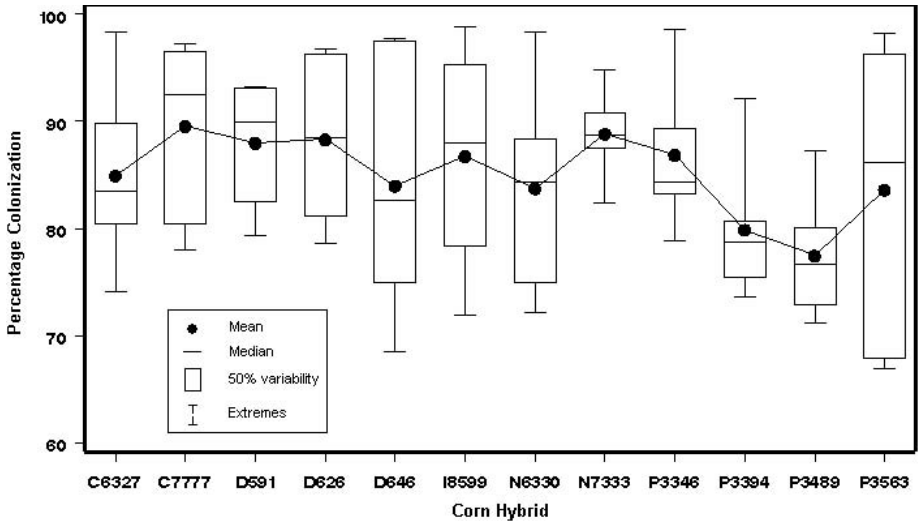

Figure 8. Percentage of mycorrhizal colonization as influenced by corn hybrid in 1997, Pr > F = 0.5520. Corn hybrids: C = Cargill, D = Dekalb, I = ICI, N = NK, P = Pioneer.

onization among hybrids was 57-85% and in 1997 it was 77-89%. The variability in colonization within hybrids was very high and probably prevented statistical significance.

DISCUSSION

Several factors may have contributed to the lack of difference in mycorrhizal colonization among corn hybrids. The most obvious is the highly variable nature of colonization. If the study were to be repeated, it might be better to sample at a younger growth stage to detect early differences. The level of colonization in our samples from the V6 growth stage was quite high among all hybrids. Finding a site with low soil P concentrations would also be useful since high soil fertility can reduce the influence of mycorrhizae.

The concept of using hybrid selection to reduce fertilizer needs may become more important as environmental concerns grow. Another approach would be to manipulate genes for improved mycorrhizal colonization and/or phosphorus uptake.

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