A COMPARISON OF CHISEL AND MOLDBOARD TILLAGE ON DRY BEAN AND SOYBEAN YIELD AND ROOT ROT SEVERITY IN MINNESOTA

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Adoption of conservation tillage practices has been accompanied by increased prevalence of root rot diseases caused by altered soil physical properties which favor pathogen survival. Restricted bean root growth and development caused by either soil impedance layers or compaction resulting from shallow chisel plowing or disking increase plant vulnerability to water and nutrient stress and increase susceptibility to root rots. Soil compaction slows drainage and prolongs periods of soil saturation that favor root rot development. Increase concentration of residue near soil surface increases inoculum density in vicinity of germinating roots. The effects of chisel and moldboard tillage on root rot of dry bean and soybean were evaluated during the 2000 growing season on the Central Lakes Agricultural Experimental Station at Staples. The study site was a field naturally infested with *Fusarium solani* f. sp. *phaseoli*, *Rhizoctonia solani* AG-4 and *Fusarium oxysporum*, the causal organisms of bean root rot. Soybean cultivar McCall, and dry bean, cultivar Montcalm, were sown after seed inoculation with *Bacillus subtilis* MBI600 *and Rhizobium etli* strain RCR3622 (beans) and *Bradyrhizobium japonicum* RCR3407 (soybean) in a peat carrier. Chisel tillage resulted in lower bean and soybean yields than moldboard tillage. In contrast, bean and soybean in the moldboard tilled plots had greater plant height and dry weight at flowering (Figs. 1 and 2). Disease severity in both the moldboard and chisel tilled plots was reduced when bean seed was treated with *Bacillus subtilis* MBI600 plus *Rhizobium etli* RCR3622 (Table 1). Plant height of dry beans and soybean at flowering was significantly greater in moldboard versus chiseled tilled soil (Fig. 1). Moldboard tillage soil also significantly increased the dry weight of dry bean and soybean when compared to chisel tillage (Fig. 2).

Bacillus subtilis MBI600 and *Rhizobium etli* RCR3622 seed treatment significantly increased yield in both chisel (1,252 Kg/ha) and moldboard (1,919 Kg/ha) when compared to untreated control (Table 1). Disease severity was reduced by seed treatment chisel and moldboard tillage when compared to the untreated control (Table 1). Soybean yield was higher with moldboard tillage (5,240 Kg/ha) regardless of seed treatment (Table 2). Seed treatment did not have a significant effect on soybean yield because of low root rot severity (Table 2).

Moldboard tillage enhanced dry bean and soybean root growth. This was probably a combination of reduced impedance, placement of crop residue and/or decreased pathogen inoculum. Populations of *Fusarium solani* f. sp. *phaseoli* when quantified after harvest from the chisel tilled bean plots were lower at 15 cm than at 30 cm. In the moldboard tilled bean plots the highest numbers of *F. solani* were found at 15 cm. In contrast in soybean plots populations of *F. solani* were similar at 15 and 30 cm in both chisel and moldboard. In soybeans plots, cone penetrometer measurements indicated that penetration resistance was significantly higher in chisel tilled plots than in moldboard tilled plots. Cone penetrometer measurements at 15 to 20 cm depth averaged greater than 2000 Kpa in the chisel tilled plots while the moldboard were approximately 1000 Kpa. Penetration resistances greater than 1500 Kpa can impair plant root growth in sandy soils. Also, there were significant increases in dry bean yield associated with

seed treatment in chisel tilled and moldboard tilled plots because of reduced disease severity.

Our research indicates that declining dry bean yields resulted from a combination of factors including use of a susceptible cultivar, increasing levels of disease inoculum, and stress caused by the effects of compacted soils. Implementation of a strategy combining disease resistant dry bean and soybean, biocontrol seed treatments, and deep tillage to alleviate the effects of soil compaction could benefit growers and help sustain the strength of the dry bean and soybean industry in Minnesota.

Fig. 1 Effect of Tillage on Plant Height on Dry Bean and Soybean at Flowering

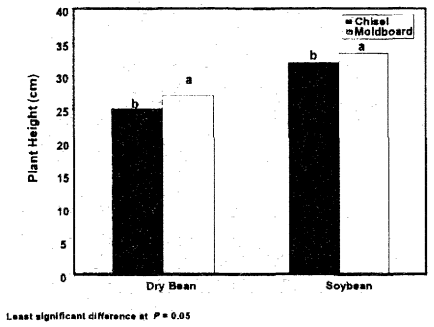

Fig. 2 Effect of Tillage on Plant Weight on Dry Bean and Soybean at Flowering

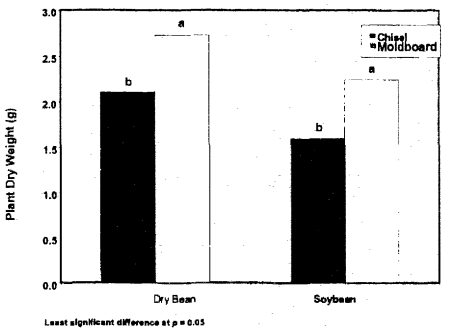

Table 1(a). Effect of Tillage on Root Disease Severity and Yield on Dry Bean

Tillage	Seed Treatment	Disease Severity 1-9	Yield Kg/ha
Chisel	Untreated	4.2	1,049
Chisel	Treated	3.7	1,252
Moldboard	Untreated	4.1	1,593
Moldboard	Treated	2.9	1,919

Table 1(b).

Average Yield* Kg/ha	
Tillage	**Seed Treatment**
1150 b (chisel)	1321 b (untreated)
1756 a (moldboard)	1585a (treated)

*Yield Differences significant at $P \leq 5$ %

Table 2. Effect of Tillage on Root Disease Severity and Yield on soybean

Tillage	Treatment	DS 1-9	Yield** Kg/ha
Chisel	Untreated	3.3	4,829
Chisel	Treated	3.1	4,917
Moldboard	Untreated	3.3	5,240
Moldboard	Treated	3.2	5,240

**Yield Differences not significant at $P \leq 5$ %