Preliminary Investigations on the Effect of Commercial Glyphosate Formulations on Pathogenic *Fusarium* spp.

K.G. Hanson and M.R. Fernandez

Semiarid Prairie Agricultural Research Centre (SPARC), Agriculture and Agri-Food Canada, Swift Current, Saskatchewan

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Introduction

Diseases of cereal crops caused by pathogenic fungi can lead to estimated economic losses of over $100 million to producers annually in western Canada. One fungal disease that is becoming more prevalent in Saskatchewan is Fusarium head blight (FHB), caused primarily by *Fusarium graminearum* and to a lesser extent *F. avenaceum*. These pathogens can reduce grain yield and quality. There is a very low tolerance for Fusarium damaged kernels in grain samples due to the presence of mycotoxins that are very detrimental to human and animal health. This disease also causes reductions in seed germination and seedling vigour. Cultural practices including crop rotation and fungicide use have done little to reduce the impact of FHB. However, recent studies have shown significant reductions of FHB severity in fields under zero-till production systems compared to minimum-till systems. One factor which may contribute to the lower FHB in zero-till than min-till may be the greater use of glyphosate-based herbicides in the zero-till systems. A study was conducted to evaluate the effect of different commercial glyphosate-herbicide formulations on the *in vitro* growth of cereal pathogenic *Fusarium* spp.

Materials and Methods

Cooled (50°C) potato dextrose agar (PDA) (Acumedia, Baltimore, MD) was amended with glyphosate-based herbicides at the following concentrations: 0, 0.05, 0.10 and 0.20 µL/mL of media. Approximately 20 mL of the cooled agar was then poured into sterile petri dishes. These concentrations correspond to field application levels of 0 to 6300 mL of herbicide/ha. The herbicides used in this study were: Glyfos (Cheminova Ltd.), Renegade and Roundup Transorb (Monsanto Canada Ltd.), Touchdown 600 (Syngenta Ltd.), and Vantage Plus (Dow AgroSciences Ltd.) which contained 356-360 g/L glyphosate and Rustler (Monsanto Canada Ltd.) that contained 132 g/L of glyphosate and 60 g/L of dicamba. Three mm plugs from actively growing fungal colonies of two strains (isolates A & B) each of *F. graminearum* and *F. avenaceum* were applied to the center of agar plates. The plates were then incubated in the dark at 26°C. Herbicides were tested in groups of three as shown in the results section. There were four replicates arranged in a randomized complete block design. The diameter of fungal growth on the medium's surface was measured after three and five days of incubation. Data was analyzed using ANOVA and means separation done with single degree of freedom contrasts. Each study was repeated once.

Results and Discussion

The *in vitro* growth of *F. graminearum* isolate A was stimulated by three of the herbicides tested but inhibited by the other three herbicides (Figure 1). The other *F. graminearum* (isolate B) showed some stimulation of fungal growth with all the herbicides tested but most only showed significant differences from the control at the low concentration. *F. avenaceum* showed similar trends to that of *F. graminearum* (Figure 2). Overall, the herbicides tested either stimulated *Fusarium* spp. growth or had no effect. In addition to herbicide differences, some herbicides showed concentration to be significant but again this was not consistent.

The growth of the fungal isolates on the control plates (0 µL/mL of agar) varied considerably among trials of the different herbicides. This may have contributed greatly to the inconsistent responses found for the herbicides between isolates of the same species.

From field studies that were conducted in the summers of 2000 and 2001, fields under zero-till production were found to have significantly lower FHB severity than fields under min-till. However, when each tillage system was analyzed further, FHB severity increased with glyphosate herbicide use (Table 1). The percentage of heads and seed infected with *F. avenaceum* and *F. graminearum* was also higher when glyphosate use was taken into consideration (data not shown).

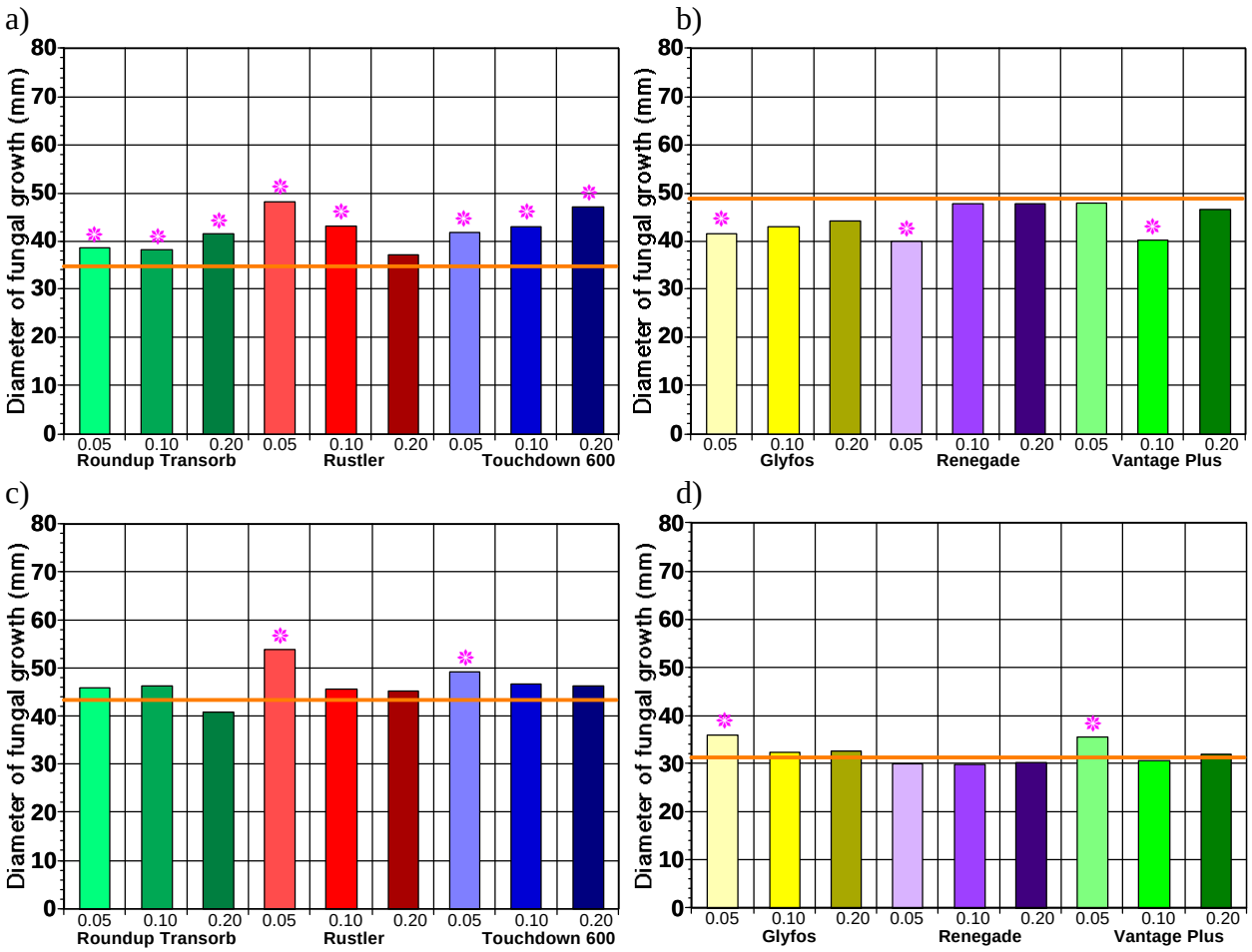

Figure 1. Effect of different glyphosate-based herbicides at various concentrations on the *in vitro* growth of *Fusarium graminearum* isolate A (a & b) and isolate B (c & d) after three days of incubation. The values above each herbicide type are the concentration expressed as µL/mL of agar. The diameter of the control treatment fungal growth (0 µL/mL of agar) is indicated by the wide line across the graph. Fungal growth on the herbicide-amended agar that is significantly different (p=0.05) from the control is indicated by *.

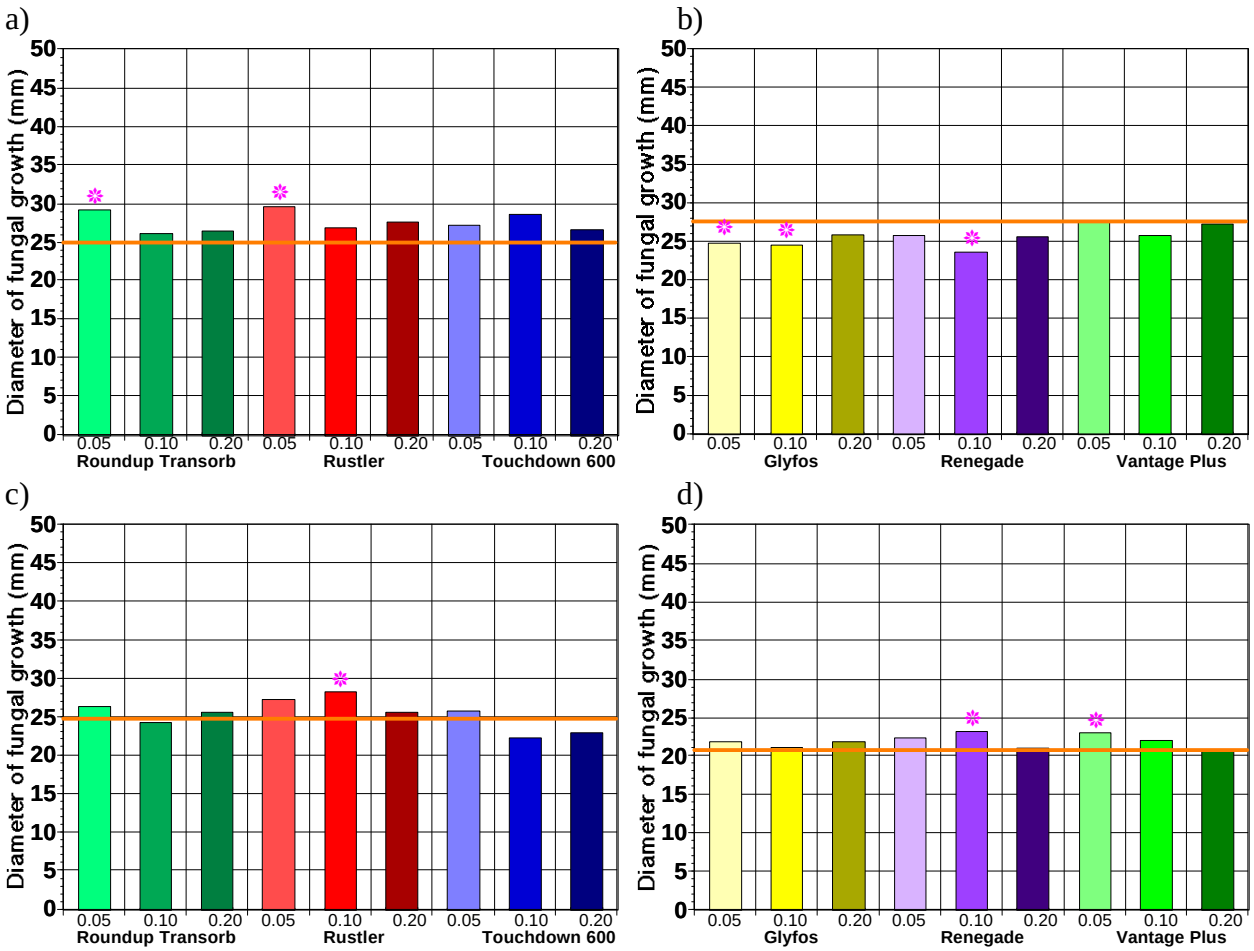

Figure 2. Effect of different glyphosate-based herbicides at various concentrations on the *in vitro* growth of *Fusarium avenaceum* isolate A (a & b) and isolate B (c & d) after three days of incubation. The values above each herbicide type are the concentration expressed as µL/mL of agar. The diameter of the control treatment fungal growth (0 µL/mL of agar) is indicated by the wide line across the graph. Fungal growth on the herbicide-amended agar that is significantly different (p=0.05) from the control is indicated by *.

Table 1. FHB severity analysis of fields in southeast Saskatchewan under different tillage systems and glyphosate herbicide usage from 2000 and 2001.

Year	Glyphosate-Herbicide Applied In Last Year	FHB Index in Production System Tillage Categories		
		Conventional	Minimum	Zero
2000	No	1.24	2.27	1.63
	Yes	5.38	3.93	1.90
	Significance	***	*	ns
2001	No	7.78	7.89	3.56
	Yes	5.12	15.39	7.84
	Significance	ns	***	*

FHB index is calculated using the percentage of *Fusarium graminearum* infected heads multiplied by the disease severity as rated in the field. Significance is shown for comparisons of field averages that used glyphosate-based herbicides versus those that did not and is as follows: ns = not significant, * = 0.10 and *** = 0.01.

The stimulation of *Fusarium* spp. when grown on certain herbicide-amended agar, although not consistent, appears to correspond well with the increase in FHB severity found in fields when glyphosate-based herbicides were used. A closer examination of the specific herbicides used may produce further interesting results. Factors other than glyphosate use thus appeared to have caused a reduction in FHB levels in zero-till as compared to minimum-till systems.

Conclusions and Future Work

The effect of the glyphosate-based herbicides on the *in vitro* growth of *Fusarium* spp. tested appeared to be specific to the commercial formulation. An expanded trial to test all the herbicides at the same time will be conducted. In addition to vegetative growth, sporulation will also be evaluated in future trials. Field data will be analyzed further for effect of specific herbicides on FHB severity.

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