

# Agronomic and Economic Crop Responses to Weed Management Systems in Field Crops

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## Introduction:

This study was initiated to investigate the effect of various crop and weed management systems on grain yield and quality and on the weed population and density over time in a four year wheat – canola – barley – pea rotation. A second objective was to measure the impact of annual fungicide applications on the yield and quality of the four crops grown in rotation. The trial was conducted from 1997 through 2000 at the Kernen Crop Research Farm (KCRF), Saskatoon, Saskatchewan. Within each rotation there were 6 cropping systems; #1 - High Herbicide / Zero till (HH/ZT), #2 - Medium Herbicide / Zero Till (MH/ZT), #3 - Low Herbicide / Zero Till (LH/ZT), #4 - Low Herbicide / Low Till (LH/LT), #5 - Medium Herbicide / Medium Till (MH/MT) and #6 - No Herbicide / High Till (NH/HT). Within each of these systems there were differences in seeding rate, fall weed control, pre-seeding weed control, in-crop herbicide rate and seeding date. Half of each plot was sprayed with a fungicide and the other half was left untreated. Every crop was grown each year in each of the cropping systems.

## Results & Conclusions:

### Yield, Quality & Weed Biomass

In general, zero-till systems resulted in higher yields and yields declined as the intensity of tillage was increased. The High Herbicide/Zero Tillage system always resulted in the highest yield. The Medium Herbicide/Zero Tillage, Low Herbicide/Zero Tillage and Medium Herbicide/Medium Tillage systems always resulted in similar yields just slightly lower than the HH/ZT system. Canola yields declined the most and barley and pea yields the least when herbicide inputs were reduced. Management system had little or no effect on crop quality characteristics and weed biomass tended to be greatest when herbicides were not used. As herbicide intensity decreased, weed biomass increased and yield decreased in all crops. Application of fungicide generally increased seed yield of barley, wheat and field pea with the greatest increases occurring in barley. In most cases where yield responses were significant, the magnitude of the increase was relatively small and so the economic impact of fungicide application was often not positive. The greatest response to fungicide occurred in the wetter years of 1999 and 2000. Fungicide application increased seed weight of all crops except for canola, tended to reduce protein concentration of cereals and field pea and increased barley kernel plumpness.

### Economics

Total production cost was highest for the HH/ZT treatment and typically lowest for NH/HT. Total costs for the medium-herbicide treatments (MH/ZT and MH/LT) were similar and ranked second highest, while total costs for the low-herbicide treatments (LH/ZT and LH/LT) ranked third highest. Typically treatments that used zero tillage management practices required lower

expenditures for machinery operation and labor, but higher expenditures for herbicides compared to those that included mechanical tillage. Cash outlays were highest for fertilizer and chemical inputs, and together they represented from 24 to 46% of the total costs for most cropping systems. The total costs of producing individual crops within each cropping system were highest for pea, intermediate for canola and lowest for wheat and barley.

### **Net Returns**

Overall, the blanket application of in-crop fungicide was not profitable with net returns averaging \$30 to \$70 ha<sup>-1</sup> lower than for the comparable no-fungicide treatments. Net returns for the no-fungicide treatments were highest and similar for the zero-till managed systems (HH/ZT, MH/ZT, and LH/ZT), and lowest for NH/HT. On an annual basis, net returns were highest in 1999, a year with cool and wet growing season conditions, which resulted in the highest, recorded grain yields. Under these favourable growing conditions, HH/ZT was the most profitable management method (no-fungicide treatments only). This was followed by MH/ZT which ranked second highest, and then by LH/ZT and MH/MT. In the relatively dry years of 1998 and 2000, the HH/ZT, MH/ZT and LH/ZT systems generally performed best, reflecting the improved soil moisture conditions with zero tillage management. In all years except 1997, the NH/HT system, and to a lesser extent LH/LT, provided the lowest net return, reflecting in part the difficulty of adequately controlling weeds when relying primarily on tillage

### **Effect of Changes in Grain Prices on Net Returns**

Changes in grain prices had a major impact on the absolute level of net returns earned, but had relatively little impact on the rankings of net returns for the various cropping systems. These results reflect the rather small impacts of the different management methods on grain yields and quality. The HH/ZT, MH/ZT, and LH/ZT management methods provided the highest net returns and NH/HT provided the lowest net return under all grain price scenarios when no fungicide was applied. When the treatments included in-crop fungicide, the most profitable methods were HH/ZT and LH/ZT when prices for all grains together, and for individual crops, were high, while at low grain prices LH/ZT was typically the most profitable management system.

### **Conclusions**

The results of the economic analysis support the use of the LH/ZT management method at Saskatoon when using a 4-year wheat-canola-barley-pea crop rotation. This cropping system provided the highest net return and displayed the lowest income variability, despite not being the lowest cost production system. The least profitable management system was typically NH/HT, in part because of the lower grain yields resulting from increased competition with weeds. Changes in grain prices had little impact on the profitability of cropping systems because the different management methods had only a small or no impact on grain yields or grain quality. The use of blanket applications of in-crop fungicide was not profitable for any management system, despite the positive yield responses of barley, wheat and pea to fungicide application. The maximum breakeven price that could be paid for the fungicide under this method of application was estimated at about 25% to 33% of its current market cost.