Rotation and biocide effects on the growth and yield of sugarcane

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Abstract

Plots of continual sugarcane (plough-out/re-plant or PO/RP), and 54-month pasture, crop and bare fallow (BF) breaks were split to six biocide treatments prior to re-planting to sugarcane. The biocide treatments were control, fumigated, nematicide applied twice or four times, fungicide, and fungicide plus nematicide. There was no significant difference in yield between the different breaks but on average they out-yielded PO/RP by around 38% when no biocides (control) were applied. Similar yields were achieved with fumigation, fungicide and fungicide plus nematicide but all three significantly out-yielded the control and both nematicide treatments. Nematicide alone produced a similar yield to the control. However, nematicide had a synergistic effect in combination with fungicide in terms of shoot development and a yield trend. The control crop and pasture breaks produced yields similar to fumigated PO/RP. However, there was a further response to fumigating crop, pasture and BF breaks, possibly due to either detrimental biota remaining in the soil following the breaks, nutritional differences created by the breaks or a combination of both. The results indicate that the percent increase in yield from fumigation can be re-produced by the combination of fungicide and nematicide following PO/RP, BF and crop breaks but not following pasture breaks.

Key Words

Biota, break crops, fumigation, monoculture, rotation.

Introduction

The Sugar Yield Decline Joint Venture (SYDJV) has been carrying out research to identify the causes of yield decline and develop solutions to the problem. In a number of rotation experiments it has been shown that breaking the sugarcane monoculture with either other crops, pasture or bare fallow can result in substantial yield increases over sugarcane monoculture or plough-out/re-plant (PO/RP) (1,2). The basis of improved yields following breaks is better crop establishment and early growth (1,2) and this is associated with a reduction in soil biota pathogenic to sugarcane and a general improvement in soil health (3,4). However, there is little strong evidence as to the relative importance of different groups of biota in reducing crop establishment and ultimately yield in PO/RP, although previous studies have certainly demonstrated that fungi were involved (5,6,7).

In this paper crop growth and yield data from a rotation experiment where crop, pasture, BF and PO/RP histories were split to a range of biocide treatments are reported.

Materials and methods

The experiment was established on land that was part of a long-term rotation experiment involving other crops (soybean, peanuts), pasture (grass/legume mix), bare fallow (BF) and plough-out/re-plant (PO/RP). It was planted on the SYDJV sub-station at Feluga, near Tully (17?52’ S, 145?57’ E) to variety Q117 on July 26, 2000. Design was a split plot, with three break types (crop, pasture and BF that had been in place for 54 months) and PO/RP as main plots and six different biocide treatments as sub-plots. There were three replications. Full details are available in (8).

Biocide treatments comprised a control, nematicide applied twice or four times, fungicide, fungicide + nematicide and fumigation. Both the fungicide and nematicide were applied at non-commercial (higher) rates for experimental purposes.

Measurements and data collection

Measurements included chemical analyses of soil and plant tissue, sequential shoot/stalk development, biomass accumulation and crop yield.

Results and discussion

When no biocide (control) was applied shoot/stalk numbers (data not presented) were highest following crop and pasture breaks, lowest following PO/RP and intermediate for the bare fallow break. These differences were still apparent at crop harvest and were reflected in a 38% increase in final yield following the breaks (Table 1 – control). The application of nematicide had no direct effect on shoot/stalk numbers and did not increase final yield compared with the control (Table 1). However, both fumigation and fungicide enhanced shoot/stalk development and substantially increased final yield in PO/RP by 50 and 35%, respectively. Although nematicide alone had no effect, it had a synergistic effect on fungicide terms of shoot/stalk development ($p < 0.001$ – data not presented) and yield (although not significant). This indicates that nematodes were only having an adverse effect on growth when fungi were controlled. Although there were substantial effects of the breaks *per se,* both fungicide and fumigation further increase yields when applied after crop and bare fallow breaks, whereas only fumigation increased yields after the pasture break. These responses could reflect either detrimental soil biota remaining in the soil after the breaks, changes in nutrient status following the breaks or a combination of both. Both crop and pasture with no biocide application produced similar yields to fumigated PO/RP. The results confirm the importance of soil biota in sugarcane yield decline.

Table 1. Effect of breaks from the monoculture and biocide treatments on millable stalk yield (t/ha).

Biocide	Break Type				Mean
	PO/RP	Bare Fallow	Crop	Pasture	
Control	54	70	77	78	70
Nematicide x 2	54	80	67	68	67
Nematicide x 4	55	74	74	85	72
Fungicide	73	80	87	79	80
Fungicide + Nematicide	79	90	86	81	84
Fumigation	81	85	87	96	87
Mean	66	80	80	81	

Lsd 5% = 12.4 (history), 6.1 (biocide), 12.2 (history x biocide).

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