Effect of soil pH and calcium base saturation on severity of clubroot on canola, 2023.

K.A. HOLY, B.D. GOSSEN, M.R. MCDONALD

Dept. of Plant Agriculture, University of Guelph, Guelph, ON ; and (B.D.G.) Agriculture and Agri-Food Canada, Saskatoon, SK, Canada.

INTRODUCTION

Plasmodiophora brassicae (Woronin) is the causal agent of clubroot disease in Brassicaceae crops and weeds. Clubroot causes deformed (clubbed) roots, stunting, wilting, and losses in quality and yield.

Application of calcium as lime is used to reduce clubroot severity in Brassica vegetables[1]. The efficacy of calcium products has been attributed to the increase in soil pH, as *P. brassica* is suppressed at high pH[2], but calcium base saturation of soil was overlooked.

The objective of the study was to determine if soil calcium base saturation of 80% was effective at reducing clubroot relative to alkaline pH (7.2-7.5).

METHODS

Location: Ontario Crops Research Centre-Bradford on high organic matter soil naturally infested with *P. brassicae.*

Design: RCBD with four blocks.

Treatments: 1, 2) gypsum ($CaSO_4$) at 0.86 or 1.7 t/ha, to increase calcium base saturation; 3, 4) potassium bicarbonate ($KHCO_3$) at 3.8 or 5.4 t/ha to increase pH without changing Ca conc., 5,6) gypsum + potassium bicarbonate (low rate or high rate of both); 7) hydrated lime ($Ca(OH)_2$) at 4.3 t/ha, to raise both pH and Ca; and 8) nontreated control.

Actions: Soil testing was done prior to amendment application and after seeding. Soil amendments were applied ***(Fig 1a)*** and rototilled into the soil one week prior to seeding. A clubroot-susceptible canola cultivar, InVigor L233P, was seeded on 29 June.

Fig. 1. Soil amendments (a) prior to incorporation, and (b) impact in plant biomass and wilt symptoms.

Assessment: Wilting was assessed on 8 Aug. using a 0-6 scale adopted from Cebula et al. 2010[3]. Plants were harvested on 16 Aug., six weeks post planting. Clubroot severity was measured on a 0-3 scale (50 plants per plot) and shoot weight was assessed (10 plants per plot).

Analysis: ANOVA and correlations performed in RStudio. The fourth block was excluded from analysis due to non-uniformity of *P. brassicae* presence.

RESULTS

Table 1. Mean soil pH and CBS (%) values for pre-amendment soil, and post-amendment soil treated with hydrated lime ($Ca(OH)_2$), or high rates of gypsum ($CaSO_4$), and/or potassium bicarbonate ($KHCO_3$).

	Pre-Amendment	Post-Amendment				
	Untreated	**Control**	**$CaSO_4$ (High)**	**$KHCO_3$ (High)**	**$CaSO_4$ + $KHCO_3$ (High)**	**$Ca(OH)_2$**
pH	6.4	6.4	6.5	7.7	8.1	7.4
CBS (%)	84.7	81	83	70	67	84.5

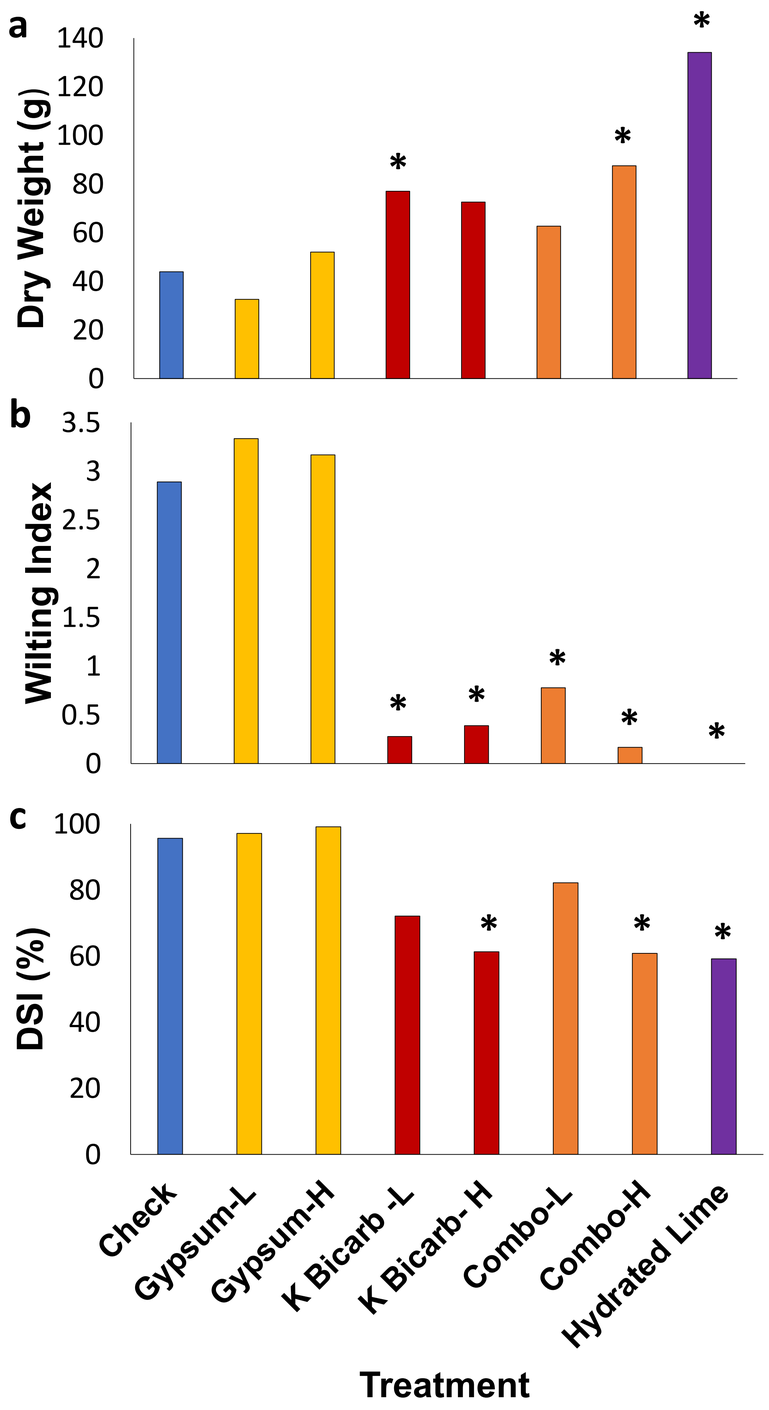

Fig. 2 (on left). Effect of rates and combinations of gypsum, potassium bicarbonate and hydrated lime on (a) shoot weight, (b) wilting index, and (c) clubroot severity (DSI) on canola. Treatments that differed from the control at p >0.05) are indicated by *.

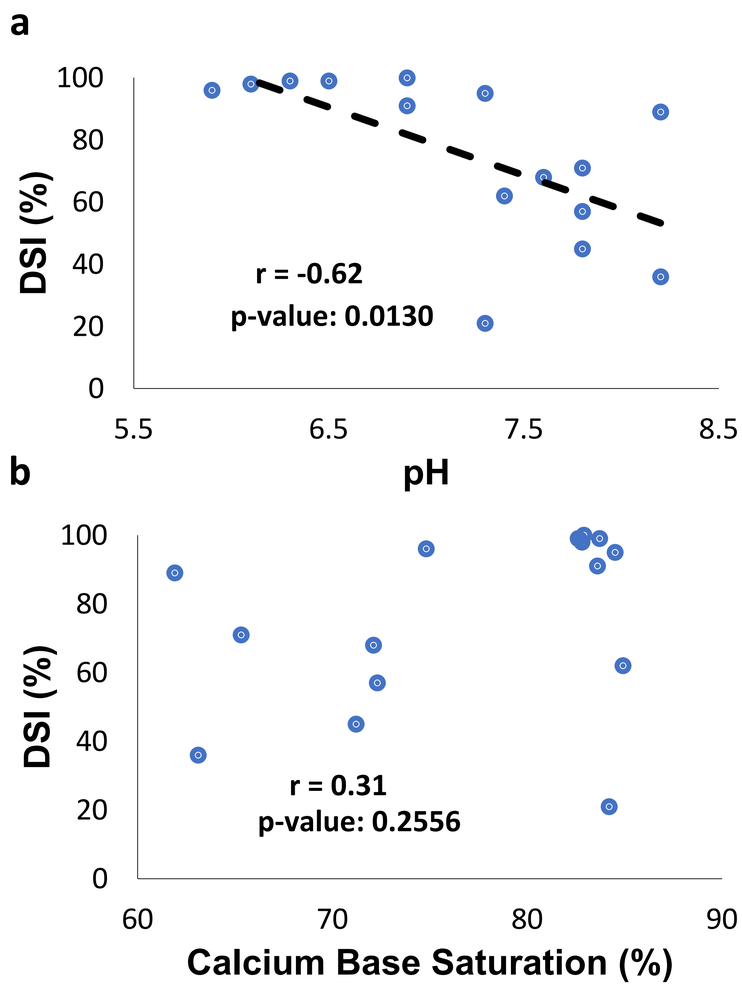

Fig. 3. Correlation between (a) pH and clubroot disease severity index (-0.62), and correlation between (b) calcium base saturation and clubroot disease severity (0.31).

DISCUSSION & CONCLUSIONS

- Potassium bicarbonate (high rate), gypsum + potassium bicarbonate (high rate), and hydrated lime significantly reduced clubroot severity by ~40% ***(Fig 2c).***
- Potassium bicarbonate (low rate), gypsum + potassium bicarbonate (high rate), and hydrated lime produced plants with significantly higher weight than the control ***(Fig 1b, 2a).***
- Potassium bicarbonate (both rates), gypsum + potassium bicarbonate (both rates), and hydrated lime significantly reduced wilting associated with clubroot to low levels ***(Fig 1b, 2b).***

Overall, the most effective amendments all increased the soil pH.

The elevated CBS (%) of the soil prior to amendment application meant that the initial objective could not be tested. However, treatments that failed to increase the CBS (%), but increased the pH, and reduced disease, show the effectiveness of increased soil pH ***(Table 1).***

There is a significant correlation between disease severity and soil pH, but no significant relationship exists for CBS (%) ***(Fig 2).*** Together, this shows that **pH had a greater effect on disease reduction**, and amendments should be chosen accordingly.

REFERENCES

1. Gossen, Bruce D, Mcdonald, M. R., Hwang, S.-F., Strelkov, S. E., & Peng, G. (2013). A comparison of clubroot development and management on canola and Brassica vegetables. *Canadian Journal of Plant Pathology*, *35*(2), 175–191.
2. Campbell, R. N., Greathead, A. S., Myers, D. F., & de Boer, G. J. (1985). Factors related to control of clubroot of crucifers in the Salinas Valley of California. *Phytopathology*, *75*, 665–670.
3. Cebula, S., Mazur, S., & Kalisz, A. (2010). Evaluation of Productive Value of Several White Cabbage Cultivars Resistant to Clubroot (Plasmodiophora brassicae Wor.). *Ecological Chemistry and Engineering. A*, *17*(9), 1083–1088.

FUNDING

CANADIAN AGRICULTURAL PARTNERSHIP
UNIVERSITY OF GUELPH
ONTARIO AGRICULTURAL COLLEGE
canolacouncil OF CANADA
Agriculture and Agri-Food Canada
Canada