Potato plant damage caused by pneumatic removal of Colorado potato beetles

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Khelifi, M., Laguë, C. and Lacasse, B. 1995. **Potato plant damage caused by pneumatic removal of Colorado potato beetles.** Can. Agric. Eng. 37:081-083. The effects of air speeds used for pneumatic control of Colorado Potato Beetles (CPB), *Leptinotarsa decemlineata* (Say), on three different varieties of potato plants (Superior, Norland, and Kennebec) were evaluated. Plant samples were exposed to airstreams of different velocities in the 12.5 to 31 m/s range at three different stages of growth for 20 s. Results show that young potato plants, 0.40 m tall or less (less than 12 leaves), can tolerate airflows of up to 27.5 m/s without suffering any visual injury.

Keywords: vacuum, damage, leaves, potato.

Les effets des flux d'air utilisés à des fins de contrôle pneumatique du doryphore de la pomme de terre, *Leptinotarsa decemlineata* (Say), sur trois variétés de pomme de terre (Superior, Norland et Kennebec) ont été déterminés. Des plants ont été exposés à des flux d'air ayant des vitesses moyennes d'écoulement, au niveau du feuillage, comprises entre 12,5 et 31 m/s durant 20 s et ce, pour trois stades de croissance. Les résultats démontrent que de jeunes plants de pomme de terre, dont la hauteur est inférieure à 0,4 m (moins de 12 feuilles), peuvent résister à des flux d'air dont la vitesse est de 27,5 m/s ou moins sans subir de blessures visuellement discernables.

Mots clefs: aspirateur, dommage, feuilles, pomme de terre.

INTRODUCTION

The Colorado Potato Beetle (CPB), *Leptinotarsa decemlineata* (Say), is the major insect pest of potato crops in North America and Europe (Hare 1980; Boiteau et al. 1992). Large amounts of insecticides are used to control this pest. In Québec, 18.9% of the total amount of applied pesticides is used solely for the potato crop, which only represents 1% of the total cropped area in the province (Chagnon and Payette 1990).

The use of chemical pesticides in agriculture has contributed to the increase of crop yields. However, heavy reliance on these chemicals can often lead to serious health and environmental problems. In addition, insects such as CPB can develop a resistance to many insecticides (Forgash 1981).

In the last few years, vacuum machines have emerged as an alternative solution to insecticides as they can remove insects at various life stages (larvae and adults) from the crops. Many California growers now find this technique effective in removing adult insect pests, in particular from strawberry and lettuce crops (Inman 1990). However, the use of vacuum machines in potato fields has only been partially successful and has often resulted in significant damage to the foliage of potato plants (Moore 1990).

deVries (1987) carried out a limited number of tests on a single 46 day old and 0.76 m tall potato plant of the cultivar Rosa. In a wind tunnel test, this plant resisted air speeds of 12.5 m/s with little foliar damage. The deVries study only provides a rough estimate of the maximum allowable air speed for pneumatic pest insect control as many other factors are involved: cultivar, plant stage of growth, plant cellular water content, and the period of exposure to airflow.

The determination of airstream induced plant damages requires a fundamental study of the main vacuuming parameters, in particular, the threshold of airflow velocities that can be safely applied to plant foliage. The objective of our study was therefore to measure the effect of different air speeds on different cultivars of potato plants at different stages of growth.

MATERIALS AND METHODS

Potato plants

The three most popular potato cultivars in Québec (Superior, Norland, and Kennebec) were seeded at intervals of three weeks in order to simultaneously obtain three stages of growth of potato plants in their vegetative phase. Each potato plant was grown in a 150 mm diameter pot and watered three times a week. By the end of the fifth week, three potato plant groups were organized according to number of leaves and height:

- 9 to 10 leaves at a mean height of 0.26 m.
- 10 to 12 leaves at a mean height of 0.40 m.
- 13 to 15 leaves at a mean height of 0.58 m. These plants were showing their first floral buds.

Experimental design and procedure

Each variety was equally represented in each group. The pneumatic test bench as described by Khelifi et al. (1992) was used to apply the different airflows. A completely randomized factorial design was used to test three factors: air speed (A) (seven levels in the 12.5-31 m/s range), potato stage of growth (G) (three levels as described above), and potato variety (V) (three). All treatments were replicated three times.

The degree of damage caused to the potato plants (leaves, stems, and floral buds) was visually evaluated. A damage scale was constructed as follows:

0: No apparent damage,
1: Temporary deformation (plant flexion),
2: Breaking (torn leaves) which was considered as the

damage limit, and

3: Severe breaking (pulled up leaves and buds, broken stems).

Each plant was exposed to a horizontal airflow for 20 s after which the degree of damage was visually evaluated. The exposure period was considered to be long enough to observe the behavior of the plants under the effect of airflows. Air speed was measured at the foliage level (0.20 m away from the air supply hood) using a 2% precision telescopic anemometer (Model MPM 500e, Solomat Instrumentation Division, Norwalk, CT). During the course of the experiments, the prevailing air temperature and relative humidity were 25°C and 33%, respectively.

Statistical analyses

A nonparametric method, the rank transformation, was used to analyze the data according to Montgomery (1984). The technique consisted in ranking the observations in ascending order and replacing each observation by its rank with the smallest observation having rank 1. In the case of equal scores, the average rank was assigned to each of these observations. Thereafter, the usual analysis of variance was applied to the ranks using the General Linear Models (GLM) procedure (SAS Institute Inc. 1988). Significantly different groups of treatments were further analyzed using the LSD test at the 5% level of significance.

RESULTS AND DISCUSSION

The analysis of the results reveals that the effects of air speed and stage of growth are highly significant (Figs. 1, 2, 3, and 4). The effects of the variety of potato plants are, however, not significantly important.

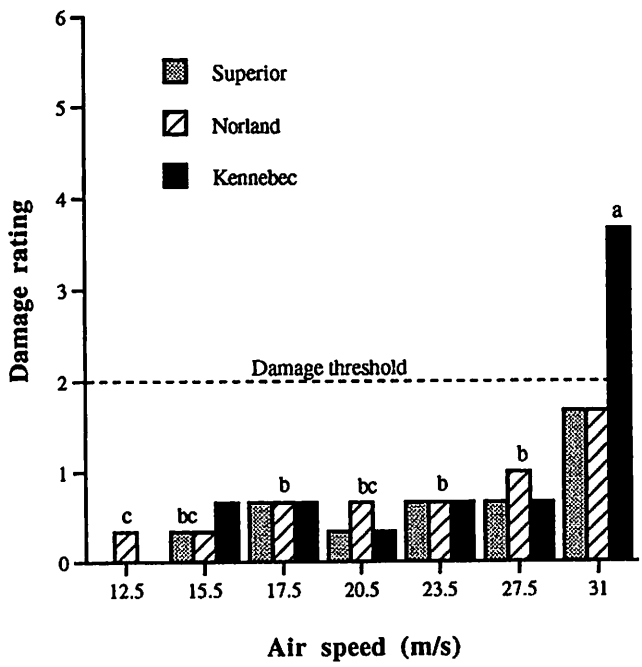

Fig. 1. Damage ratings for the three varieties of potato plants at the first growth stage under different air speeds. Means with the same letter are not significantly different at the 5% level.

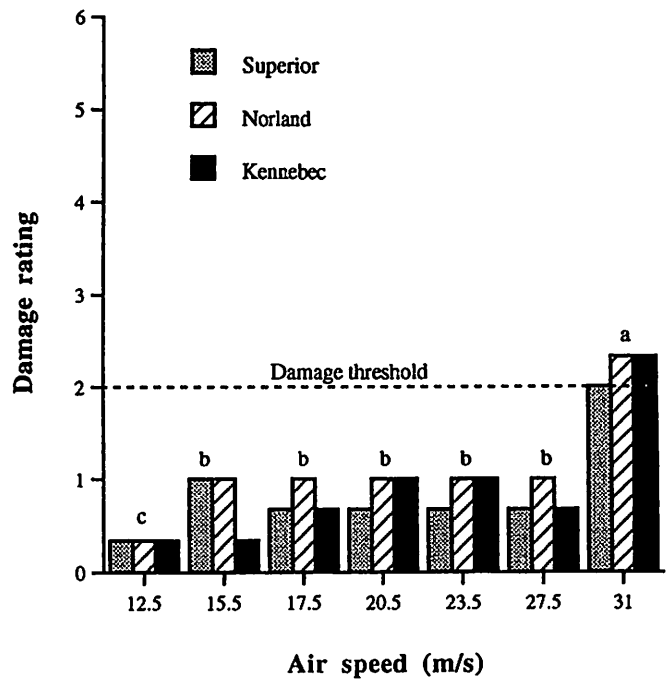

Fig. 2. Damage ratings for the three varieties of potato plants at the second growth stage under different air speeds. Means with the same letter are not significantly different at the 5% level.

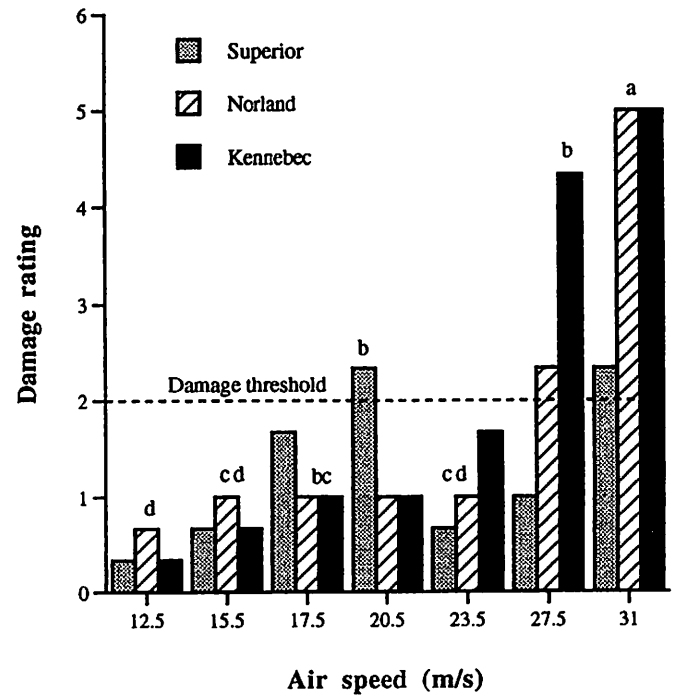

Fig. 3. Damage ratings for the three varieties of potato plants at the third growth stage under different air speeds. Means with the same letter are not significantly different at the 5% level.

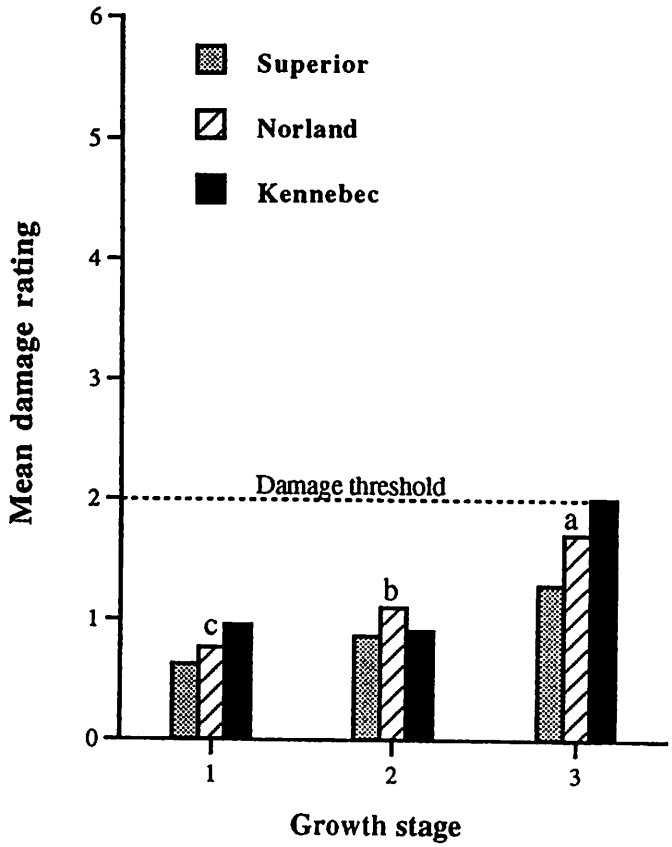

Fig. 4. Mean damage ratings for the three stages of growth of the potato plants. Means with the same letter are not significantly different at the 5% level.

Up to a speed of 27.5 m/s, no damages were caused to potato plants shorter than 0.40 m (first and second groups) regardless of the variety as only slight flexions of the plant stems were observed. Beyond 27.5 m/s, the plants suffered considerable damage (Figs. 1 and 2). The reason for having a response axis scale ranging from 0 to 6 on the figures is that in the worst case, all three types of damage can happen simultaneously (flexion, torn leaves, pulled up leaves and buds and broken stems) for a total response equal to 6 (1 + 2 + 3) according to the numerical scale presented earlier.

The resistance of the oldest plants (third group) varied with the variety (Fig. 3). For air velocities up to 23.5 m/s, Norland and Kennebec plants showed more resistance than those of the variety Superior. Norland plants, in particular, were subjected to more flexion than Kennebec plants, even if no damage was observed. Beyond 23.5 m/s, Superior plants demonstrated a remarkable resistance to airflows as no substantial damage was recorded for air speeds up to 27.5 m/s. On the other hand, Kennebec plants experienced severe damage at 27.5 m/s. These damages got worse at higher air velocities.

Potato plants exposed to different airflows were subjected to gradually increasing flexion from the first to the third group. This is not surprising as plants of the third group, especially for the Norland cultivar, were much taller than those of the first and second groups. Nevertheless, the considerable difference in flexion was not accompanied by any kind of damage. On the contrary, the tall plant stems demonstrated a remarkable elasticity towards airflows. Even at very high speeds, they would bend until becoming parallel to the airstream and yet gradually regain their initial position as soon as the airflow was interrupted.

CONCLUSION

Potato plant resistance to airflows was found to be highly related to both air speed and the stage of growth of the plants. Although Superior plants have shown slightly more resistance than Norland and Kennebec plants during the course of the experiments, overall results revealed that plant variety is not a significant factor. Finally, potato plants shorter than 0.40 m having 12 leaves or less, can resist air speeds up to 27.5 m/s without incurring any visual damages.

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