Cold Therapy of Bean Rust

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ABSTRACT

When bean leaves infected with rust (Uromyces phaseoli on Phaseolus vulgaris 'Pinto') for 3-6 days were dipped in ice water after heating at 45 C, the dosage of heat necessary for therapy was only about one-fourth of that necessary if the leaves were not dipped in ice water after heating. Cold alone was ineffective as a therapeutic agent. Phytopathology 64:1044-1046.

Heat may predispose plants to infection (2), may activate infections (5), and may cure infections (6). It is a common belief that after a specified heat treatment, the heated material should be immediately cooled (4). It might therefore follow that dipping plants in cold water immediately after heating would be a logical treatment to quickly terminate the heat treatment. Cold water treatment has proved effective in reducing injury from human burns (1). Surprisingly, this cold treatment may greatly increase the therapy of bean rust, as reported here.

Beans growing in 7.6 cm (3-inch) diam pots of a sand:peat:fertilizer mixture in the greenhouse were inoculated with rust at about 10 days after seeding. At various times after inoculations, the two primary leaves were immersed in water at 45 C for a series of time intervals such as 4, 8, 12, 16, 20, 24, 36, 42, and 50 seconds.
Immediately after heating, one leaf of each pair (or one-half of each leaf) was immersed in ice water for 5 sec and
the plants returned to the greenhouse bench. At about 15
days after inoculation, living rust was recorded on a scale
of 0-10 (0 = no living rust pustules, 10 = normal rust
development), and the dosage of heat for 50% therapy
(ED50) was estimated from interpolation of the records.
A typical treated leaf is illustrated in Fig. 1 and average
results of all tests of this type are graphed in Fig. 2. There
was a sharp division between the chilled and nonchilled
portions of bean leaves. There was no apparent injury to
the leaves from any of the treatments listed here. The
dosage of heat for 50% therapy averaged about 30 sec at
45 °C for the unchilled leaves and 10 sec at 45 °C for the
chilled leaves, but the necessary dosage for therapy was
greatest for young and old infections.
Cold alone was not therapeutic, and rusted leaves were
held for up to 2 h in ice water without apparent injury to
the leaves, or clear suppression of rust. The duration of
time between heating and chilling was critical. The
greatest cold therapy resulted when the time from heating
to chilling was about 1 sec, which was about the
minimum time necessary to remove a leaf from hot water
and place it in cold water. As this interval increased to 40
sec, cold therapy gradually disappeared. The duration of
chilling was not critical. The shortest duration of dip in ice
water was about 1 sec, and this was about as effective as
dips of up to 30 sec duration. The chilling temp was also
not critical. No difference was detected between chilling
at 0 °C and 3 °C, but chilling at 10 °C was significantly less
effective. Cold therapy could be detected up to 15 °C.
Cold therapy was also tested with the following
infections: Uromyces phaseoli var. vignae on Vigna
sinesis, Erysiphe polygoni on Phaseolus vulgaris,
Sphaerotheca fuliginea on Cucumis sativus, cucumber
mosaic virus on Vigna sinensis, and tobacco mosaic virus
on Cucumis sativus. Cold treatment was clearly demonstrated with Uromyces on Vigna, but not with the
other host-pathogen combinations. Cold injury was
detected with leaves of Phaseolus vulgaris, Vigna sinensis,
Cucumis sativus, Stachys rigida, and Nicotiana tabacum,
and was best expressed in Phaseolus (8 sec at 55 °C
followed by ice water), but the dosage for injury was
always greater than the dosage for therapy and this is
another story.
How cold therapy works is not clear. It is likely a type
of cold shock (3), but this also does not explain it. The
important finding is that for rusted bean leaves given a
sublethal dosage of heat, a 1 sec treatment at 0 °C is equal
in therapeutic value to 10-35 sec at 45 °C. This is not true
with certain other diseases and the application, if any, of
this finding to practical disease control remains to be
determined.
The phenomenon of cold therapy could be quantified
as heat equivalents as above, or perhaps better as the
ratios of ED values for heat therapy without cold
treatment and with cold treatment. From the data in Fig.
2, this ratio is about 1.6 at 12 h after inoculation, 2.9 at 3
days, 4.4 at 6 days and 4.1 at 12 days.

LITERATURE CITED

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