Evaluation for potato tuber moth (Gelechiidae) resistance using the
*Bt-Cry5* and *Bt-Cry1c* genes in transgenic potatoes under field and
storage conditions in South Africa

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Potatoes containing one of two *Bacillus thuringiensis* (Bt) genes were evaluated against the
potato tuber moth, *Phthorimaea operculella* (Lepidoptera: Gelechiidae), under field and
storage conditions. The two genes were *Bt-cry1c* and *Bt-cry5*. The cultivars that were trans-
formed were Desiree, Shepody, O'Maya and Lady Rosetta (all transformed using the *Bt-cry1c*
gen), and Spunta and a glandular trichome line (both transformed using the *Bt-cry5* gene).
The *Bt-cry1c* transgenes were transformed by Vitality Biotechnologies in Israel, and the
*Bt-cry5* transgenes by the Michigan State University in the USA.

Three field trials, two at Roodeplaat in Gauteng (2001 and 2002), and one in Ceres in the
Western Cape Province (2002), were carried out using the *Bt-cry5* transgenes. One field trial
using the *Bt-cry1c* transgenes was planted at Ceres in 1999. Tubers of all the transgenes were
also tested under storage conditions. Both no-choice and free-choice experiments were
conducted in an insectary and a diffused-light store. All *Bt-cry1c* transgenes always displayed
100% resistance to the potato tuber moth in relation to the non-GMO controls. Except for one
line, all the *Bt-cry5* transgenes also showed 100% resistance in both the field and storage trials.
It is concluded that Bt-transgenic potatoes will give excellent control (if not absolute) against
severe attacks of the potato tuber moth under field and storage conditions in South Africa.

Permits issued to do research with the relevant GMOs: 14/2/2/1(1/99/81); 17-3(4-00-106);
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Potentials and prospects for biological control of mealybugs
(Hemiptera: Pseudococcidae) on citrus in the Western Cape

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The population density of some mealybug species on citrus in South Africa has in recent
years gradually increased to economic level. Therefore, the characterization of the natural
enemy complex, and quantification of its contribution to the control of *Planococcus citri*
(Risso), *Pseudococcus longispinus* (Targioni-Tozzetti) and *Pseudococcus calceolariarum*
(Maskell) on *Citrus limon* (L.) and *Citrus reticulata* (Blanco), were investigated through
intensive sampling. Eight primary and four secondary parasitoid species and two predator
species were identified from *P. citri* and *P. calceolariarum*. *Anagyrus pseudococci* (Girault) and
*Coccidoxenoides peregrinus* (Timberlake) were the most common parasitoid species,
accounting for 44% and 21% of the total, respectively. Of the five primary parasitoids reared
from *P. longispinus*, A. *pseudococci* and *Anagyrus* sp. were predominant, comprising 41% and
30% of the total, respectively. Nymphal and adult parasitism (range = 0–26% vs 0–66%) and
predation (range = 0–6% vs 0–4%) varied significantly between host trees and mealybug
species \( (P < 0.001) \). The numbers of nymphal instars and adult stages of \( P. \) calceolariae and \( P. \) longispinus and the nymphal stage of \( P. \) citri that were parasitized or killed by predators correlated significantly with the total number of hosts on which they acted \( (P < 0.01) \), suggesting a density-dependent association. No \( P. \) calceolariae was collected on \( C. \) reticulata. Laboratory bioassays of nine contact insecticides (methidathion, methomyl, methyl-parathion, parathion, profenofos and prothiofos) against \( C. \) peregrinus indicated that all were highly toxic, causing 98–100% mortality in less than six hours of treatment. The insect growth regulators fenoxycarb and triflumuron did not cause significant parasitoid mortality \( (P > 0.05) \). However, a mixture of pyriproxyfen and mineral oil caused marginally significant mortality \( (P < 0.05) \). The implications of these data in inoculation biocontrol of mealybugs in citrus orchards are discussed.

**Observations on the cabbage webworm **\textit{Hellula undalis} (Lepidoptera: Crambidae) and the diamondback moth **\textit{Plutella xylostella} (Lepidoptera: Plutellidae)

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Extensive work has been done on the diamondback moth (DBM), \textit{Plutella xylostella} (L.) (Lepidoptera: Plutellidae), but there is limited information on the biology and pest status of the cabbage webworm, \textit{Hellula undalis} (Fabricius) (Lepidoptera: Crambidae), in southern Africa. This moth is regarded as a major pest of all Brassicaceae in the Pacific, on islands such as Hawaii. It feeds mainly on broccoli, cabbage, cauliflower, Chinese cabbage, flowering white cabbage, Chinese mustard, mustard and radish.

In South Africa, sporadic outbreaks of \( H. \) undalis can cause serious crop losses, as observed in March 2002 at the Middel drift prison farm, Eastern Cape Province \( (32^\circ 48' S, 26^\circ 59' E; \) altitude 460 m). In this incident, a seemingly healthy cabbage crop at the head-forming stage suddenly started wilting. Most of the plants had \( H. \) undalis larvae feeding on leaf internodes and adjacent stem regions. The infestation was so serious that the entire crop had to be ploughed in to prevent the pest from multiplying and spreading. Here we report on observations made on \( H. \) undalis collected from that outbreak.

We also carried out electrophysiological bioassays to compare responses of the cabbage webworm, DBM and two parasitoids, \textit{Bracon} (\textit{Habrobracon}) \textit{breuicornis} Wesmael and \textit{Cotesia plutellae} Kurdjumov (Hymenoptera: Braconidae), to green leaf volatiles (GLVs), hexanal, 2-phenylisothiocyanate, alylisothiocyanate, hexanal, \((Z)-3\)-hexene-1-ol and hexyl acetate.

**Testing a diversity–productivity hypothesis at two spatial scales:**

**Lepidoptera in fungus galls**

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Numerous hypotheses have been proposed to explain the increase in species richness with