Formulation of a Granulovirus-based Biopesticide for Managing the Potato Tuber Moth in Stored Potatoes in Nepal

Abstract
This study evaluated the efficacy of a talcum-formulated biopesticide based on granulovirus (PhopGV) for protecting stored potatoes against potato tuber moth. Different virus concentrations, product application rates and two formulation methods were tested. PhopGV showed 10-times higher efficacy in the wet-mixed than in the dry-mixed formulation. Dry-mixing requires less production time and space but the virus concentration needs to be increased in the formulation to adjust for reduced efficacy.

Introduction
The potato tuber moth, Phthorimaea operculella (Zeller), is one of the major pests causing significant economic losses during potato storage. The granulovirus infecting P. operculella (PhopGV) has been used as a dust-formulation for protecting stored potatoes in several South American and North African countries. Commonly, 20 infected larvae are mixed in 1 liter water with 1 kg talcum and the dried product is applied at a rate of 5 kg per ton of stored potatoes. In Nepal, a PhopGV was isolated in 2008 and in vivo multiplied for further propagation as a biopesticide. Due to variation in biological activity of PhopGV isolates, the objective of our study was to determine the optimal virus concentration in a talcum product formulation. In addition, we tested a dry-mixing formulation method.

Materials and Methods
Two series of bioassays were conducted: (i) 3 application rates of talcum (5, 7, and 10 g kg⁻¹ potato) with 6 virus concentrations from 0.7 to 2.24×10⁻⁶ larval equivalents (LE) kg⁻¹ potato and talcum used alone with 5 application rates between 1.5 and 15 g/kg potato. (ii) 4 application rates (3, 5, 8 and 12 g/kg) with virus concentrations from 7×10⁻⁷ to 6.8×10⁻⁸ LE kg⁻¹. Wet formulation: for each concentration the virus suspension was added to talcum:1 water, plated out and crushed after drying (3 days) using a spatula. Dry formulation: virus suspensions with a 20-fold (series 1) and 60-fold increased virus concentration were dry-mixed with talcum alone to obtain similar virus levels in the powder as in wet formulation (in series 1 dry-formulation was only tested at an application of 5 g kg⁻¹ potato).

Bioassays: 50 neonate P. operculella larvae were placed on 100 g treated potato (4 replications per treatment, completely randomized). Virus concentration-mortality lines and relative potencies were determined through Probit regression for each product application rate and formulation type in a parallel line assay. Mortalities observed were adjusted for natural and talcum-caused mortality.

Results and Discussion
PhopGV revealed regression lines with a common slope of 1.3 (0.24) (Fig. 2). Talcum-caused mortality could also be described by a probit regression line (Fig. 2D, Table 1). The wet-formulated product of PhopGV revealed a LC₅₀-value of 0.30 (CL₉₅: 0.25-0.35) LE ton⁻¹ potato, independent of the talcum application rate. For the dry-formulated product, LC₅₀-values were variable ranging from 1.34 to 6.55 LE ton⁻¹ potato, corresponding to relative potencies of 0.22 and 0.04-0.14 for the 20 and 60-fold increased virus concentration preparation, respectively, compared to the wet formulation (Table 1).

Conclusions
The product should be applied at a rate of 5 g kg⁻¹ potato. The wet-formulated product should contain 3.6 LE PhopGV kg⁻¹ of talcum (corresponding to LC₅₀). Dry formulation might be simpler to produce; however, the virus concentration should be increased approximately 10 times to adjust for reduced homogenous virus distribution in the formulation and thus reduced potency.

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Bibliography