

Desiccation stress increases the efficacy of *Beauveria bassiana* for stored-product pests

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A dominant and unfortunate belief about entomogenous fungi is that their efficacies are inexorably linked to elevated ambient humidity. There is abundant evidence that the interaction of entomogenous fungi with ambient humidity depends on strain, host, and environment. Furthermore, we have found that *Beauveria bassiana* is most efficacious for *Rhyzopertha dominica* with stressful dryness. The purpose of this study was to determine if desiccation stress improves the performance of *B. bassiana* against a range of stored-product pests, especially *Tribolium castaneum*, which is to serve as the model insects for determination of mechanism and applicability to other stresses.

Materials and Procedures

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Unformulated conidia of *Beauveria bassiana* isolate GHA (Laverlam, Butte, MT) were mixed into moisture-equilibrated crimped wheat. Grain was supplemented with brewer's yeast for *Plodia interpunctella* and *Lasioderma serricorne*. Incubation was for 8 or 10 days at 30°C except for the experiment wherein *T. castaneum* larvae were exposed to 3.31 kPa of vapor pressure deficit (VPD) prior to and at the start of exposure to *B. bassiana*, when incubation in fungus-free grain was continued through adult emergence. Humidities were maintained over saturated salt solutions. There were four or more replicates of each assay with 20 insects. Replicates were over time to avoid pseudoreplication.

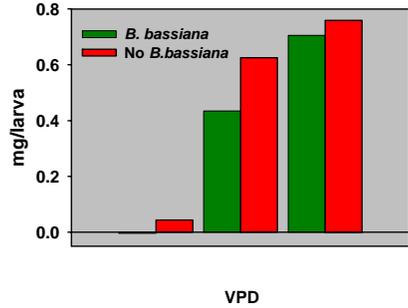
Table 1. Probit analysis of *Beauveria bassiana* for *Tribolium castaneum* larvae at three humidities (n=90)

VPD	LD50 (95% FL) (mg conidia/kg grain)	Slope ± SE	χ ²
1.06	259.6 (173.9-399.7)	0.97 ± 0.08	56.3
1.87	111.6 (61.6-180.2)	0.84 ± 0.07	62.2
3.31	66.4 (34.1-107.2)	0.84 ± 0.08	55.4

Findings

- Stressful desiccation increases the susceptibility of many stored-product insects to *B. bassiana*.
- The range of moistures over which the transition from stress-free to stressful, as indicated by increased susceptibility to fungus, varies greatly among insects.
- The dry environment of stored product may be advantageous for mycoinsecticides.

Weight gain of *T. castaneum* larvae after four days of incubation with and without 300mg/kg of *B. bassiana*



Grain and ambient moistures achieved with saturated salt solutions at 30°C

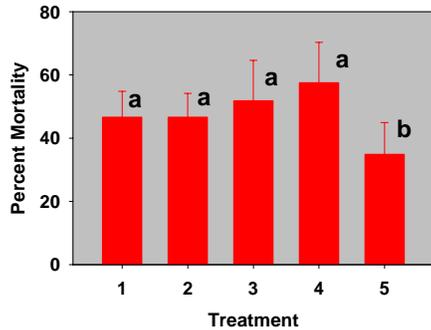
% RH	% grain moisture	VPD (kPa)	Salt
75	13.2	1.06	Na
56	11.0	1.87	NaB
43	10.0	2.42	K ₂ CO ₃
32	9.5	2.97	MgCl ₂
22	7.9	3.31	KAc
16	6.3	3.56	CaBr ₂
12	5.1	3.78	LiCl

Percent mortality of adult *Sitophilus oryzae* and *S. zeamais* exposed to 400 mg *Beauveria bassiana*/kg wheat at 3 vapor pressure deficits (control mortality).

	2.42 kPa	1.87 kPa	1.06 kPa
<i>Sitophilus oryzae</i>	31.7Bb(5.0)	43.2Aa(4.2)	22.9Ab(1.7)
<i>Sitophilus zeamais</i>	67.0Aa(23.3)	61.6Aa(5.8)	25.1Ab(3.3)

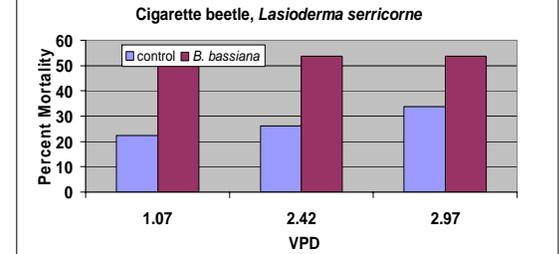
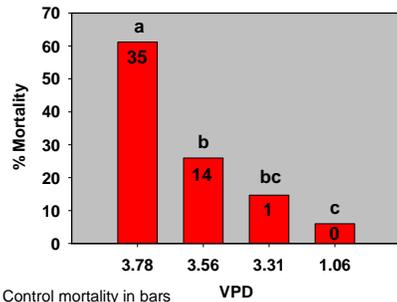
Lower case letters refer to row means, upper case letters refer to column means

Percent mortality of *T. castaneum* exposed to 100 mg/kg *B. bassiana* with various periods of 3.31 kPa incubation before 1.06 kPa



Treatments: 3.31 kPa VPD incubation times relative to fungus exposure were, 1. One day prior, 2. One day prior and first day, 3. First day only, 4. First 2 days, 5. No 3.31 kPa incubation. Bars=SD.

Percent Mortality of *Tribolium castaneum* adults exposed to 500 mg *B. bassiana*/kg at four vapor pressure deficits



Plodia interpunctella larval mortality after exposure to *B. bassiana* at 3 vapor pressure deficits (kPa)

