A combination of biopesticides effective against fall armyworm, *Spodoptera frugiperda*, and mitigation of their defence mechanisms

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Introduction

Fall armyworm (FAW), *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera:Noctuidae) (Fig 1) is a cosmopolitan crop pest species that has evaded integrated pest management (IPM) strategies in many countries. Native to Central America, the pest is found in >40 African countries (Feldmann et al., 2019) and has spread across South and East Asia (Lamsal et al., 2020) and is now considered a global threat and is a quarantined pest in the EU.

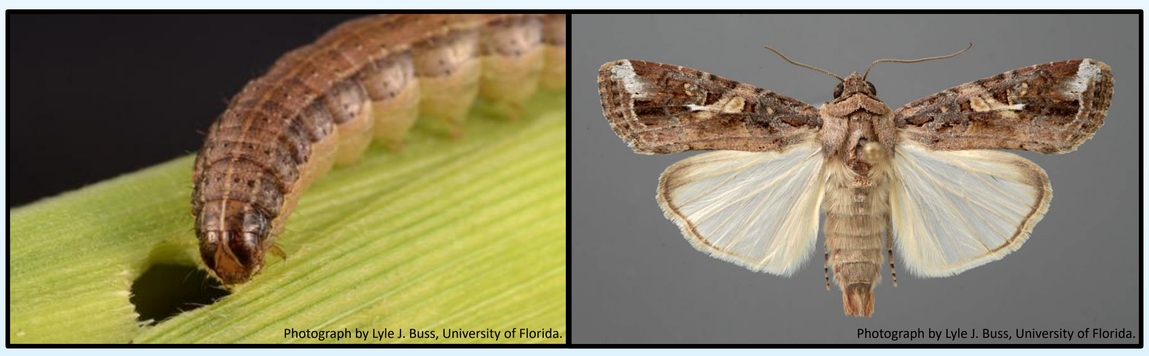

Fig 1. Fall armyworm, *Spodoptera frugiperda* (J.E. Smith) (Lepidoptera:Noctuidae) in its larval (left) and adult (right) life stages.

Current control for FAW is intense use of synthetic pesticides, with pesticide resistance and environmental impacts becoming an increasing problem (Assefa and Ayalew, 2019). Here, we combined a botanical insecticide, pyrethrum, with an entomopathogenic fungi, *Beauveria bassiana*, in an effort to develop an effective management tool for control of FAW and other Lepidoptera pests.

Methods

FAW were collected from wild populations around Fujian, China where the effectiveness of the combination treatment was assessed by:

- *Beauvaria bassiana* radial growth assays in the presence of pyrethrum at different temperatures (Fig 2).
- Mortality assays of FAW 3rd instar larvae, using topical application of biopesticides at different concentrations (Fig 3).

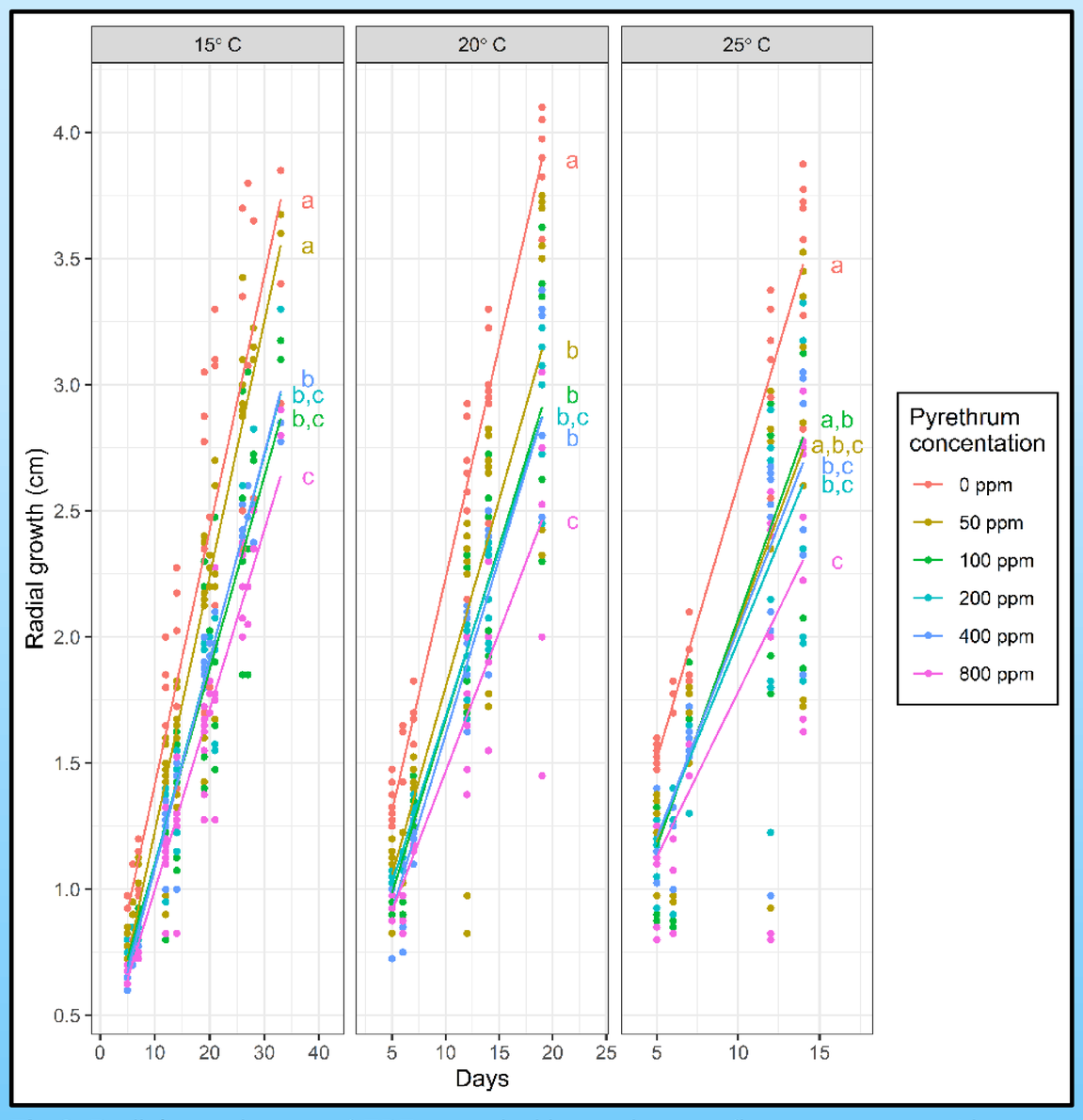

Fig 2. Radial growth rates of EPF treated with pyrethrum at five temperatures. Lines are predictions of fixed effects from generalized linear models. Treatments labelled with different letters have significantly different radial growth rates (Tukey's tests on line slopes, P<0.05).

Results

The radial growth assays showed that at the higher concentrations tested that pyrethrum inhibits the growth of *B. bassiana* (Fig 2). However, the combined biopesticide applications with 100 ppm pyrethrum were the only treatments found to be significantly different to the control (Fig 3).

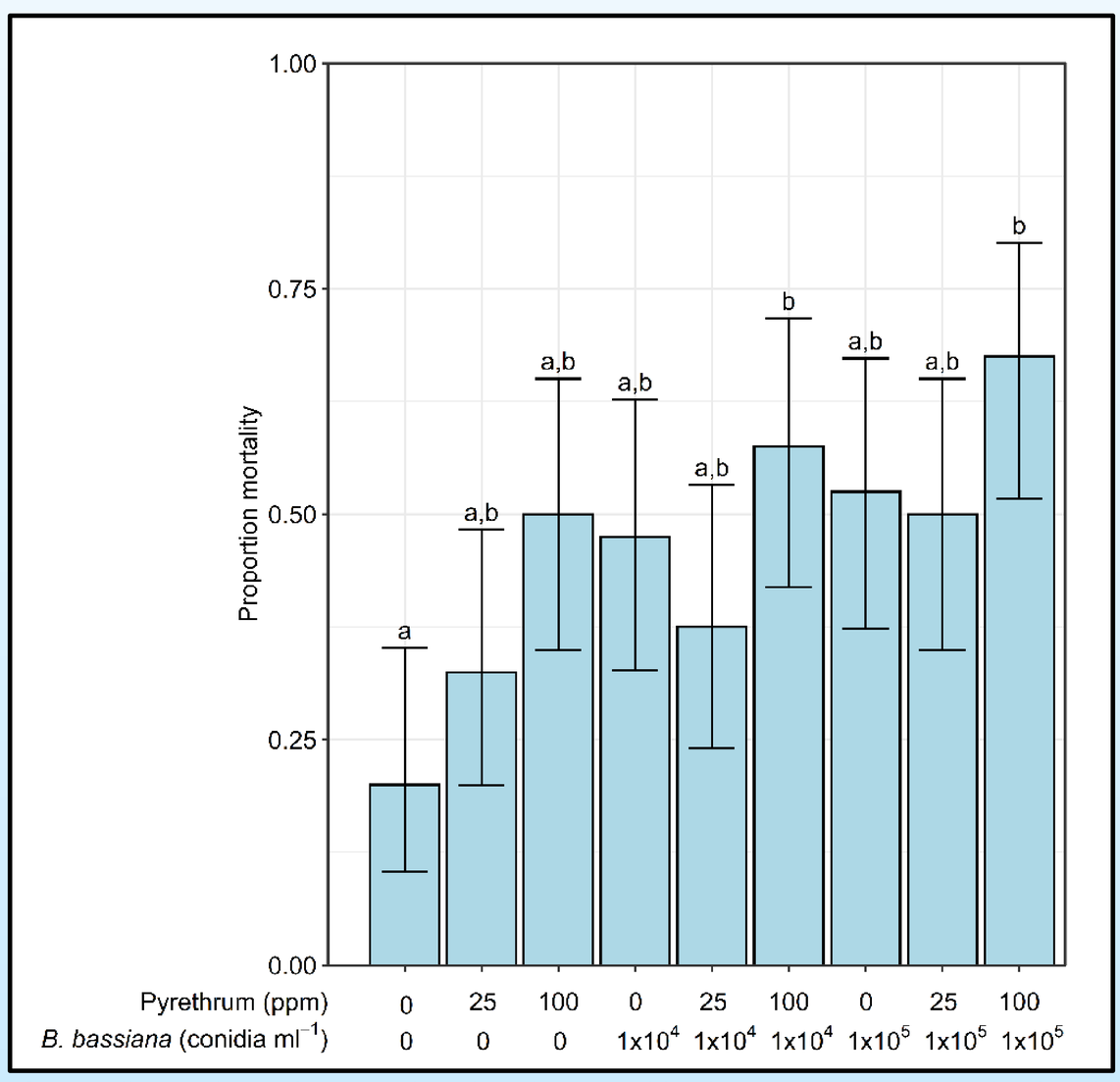

Fig 3. Effects of pyrethrum and *B. bassiana* combination treatments on *S. frugiperda* mortality. Estimates are marginal means with 95% confidence intervals. Treatments with different letters are significantly different from each other (Tukey's tests, P<0.05).

Furthermore, hyphal growth experiments on the cadavers found that there was little to no effect of pyrethrum past this initial infection stage (Table 1).

Table 1. Hyphal production on cadavers resulting from mortality assay treatments.

B. bassiana (conidia ml^{-1})	Pyrethrum (PPM)	Total dead FAW	No. dead FAW which produced hyphae	Percentage dead FAW which produced hyphae (%)
0	0	8	0	0
0	25	13	0	0
0	100	20	0	0
1 x 10^4	0	19	10	53
1 x 10^4	25	15	6	40
1 x 10^4	100	23	16	70
1 x 10^5	0	21	12	57
1 x 10^5	25	20	14	70
1 x 10^5	100	27	21	78

The results shown here indicate that there is mitigation of the inherent limiting factors of each biopesticide treatment when used in combination. These results also highlighted the potential for the use of these combination treatments in IPM strategies for even the most damaging of crop pests.

References

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