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Which fruit characteristics affect susceptibility of grapes to *Drosophila suzukii*?

The invasive spotted wing drosophila *Drosophila suzukii* Matsumura (Diptera: *Drosophilidae*) attacks various crops [1]. For oviposition, females use their serrated ovipositor to cut through the epicarp of soft-skinned fruit. The larvae then develop inside the fruit, feeding on fruit pulp [2]. In this study, we measured various fruit characteristics of wine grapes and evaluated effects on oviposition and larval development of *D. suzukii*.

Oviposition over time

Conclusions: The force needed to penetrate the fruit skin determined grape susceptibility for oviposition. Infestation risk in unripe grapes with high skin firmness is low. pH could also be used to estimate specific grape susceptibility.

Methods: The force to penetrate the fruit skin, sugar, phenols, pH, carbon and nitrogen content were assessed in 10 varieties (Cabernet Cortis, Chardonnay, Gamaret, Garanoir, Divico, Johanniter, Muscat bleu, Pinot noir, Riesling x Sylvaner, Solaris) beginning two weeks before harvest until one week after harvest. Every week, three berries per variety were exposed for 24 h to 18 females (six replicates per variety and week) in a climate chamber (22 °C, 70 % relative humidity) to assess oviposition.

Results:

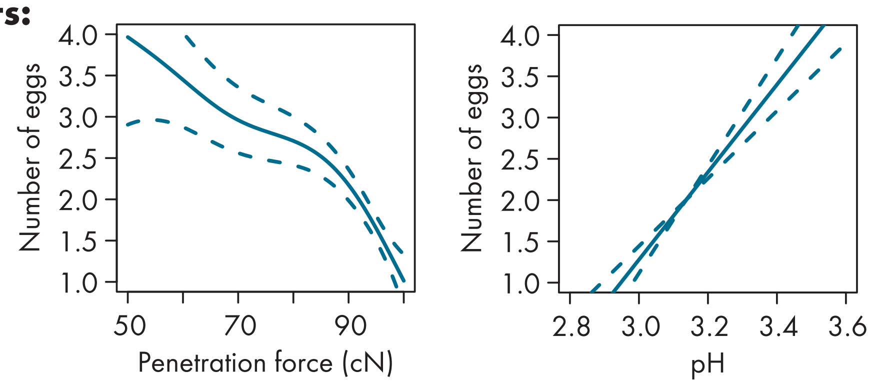

Fig. 1: Number of eggs laid in relation to the force needed to penetrate the fruit skin and pH (mean ± SE).

The statistical analysis (linear mixed effect models) showed that penetration force decreased ($t_{1,167} = -6.9$, $P < 0.001$), whereas sugar content ($t_{1,166} = 5.6$, $P < 0.001$), phenols ($t_{1,166} = 2.0$, $P = 0.05$), pH ($t_{1,167} = 14.4$, $P < 0.001$), carbon ($t_{1,159} = 13.0$, $P < 0.001$) and nitrogen content ($t_{1,159} = 9.2$, $P < 0.001$) increased over time. The number of eggs laid increased significantly with decreasing penetration force (generalized additive model: $F_{3,166} = 19.8$, $P < 0.001$), with a threshold at ~85 cN (fig 1). pH was strongly, positively correlated with the number of eggs ($F_{1,166} = 77.1$, $P < 0.001$, fig. 1), reflecting increasing oviposition with fruit ripening.

Larval development at harvest

Conclusions: Complete harvest of grape varieties providing suitable sugar content and pH for high reproduction is important in order to minimize pest pressure of later varieties.

Methods: Larval development time, survival and size of larvae (represented by wing vein measures [3]) were assessed at harvest: 25 freshly hatched larvae were transferred to five berry halves (5 larvae / half) per variety (six replicates per variety).

Results:

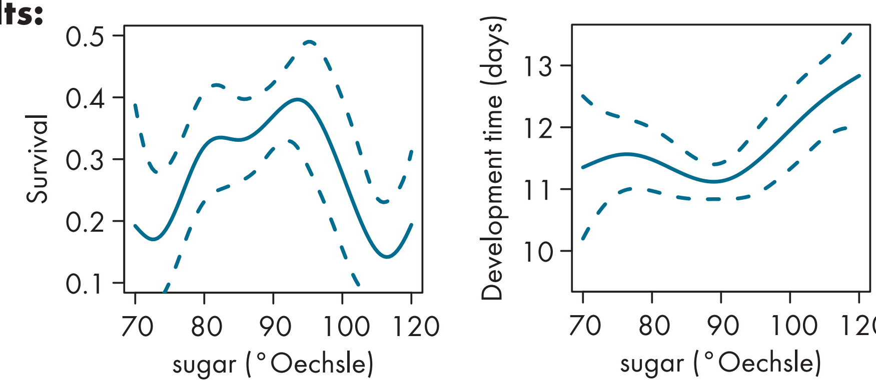

Fig. 2: Larval survival and development time at harvest in relation to sugar content (mean ± SE).

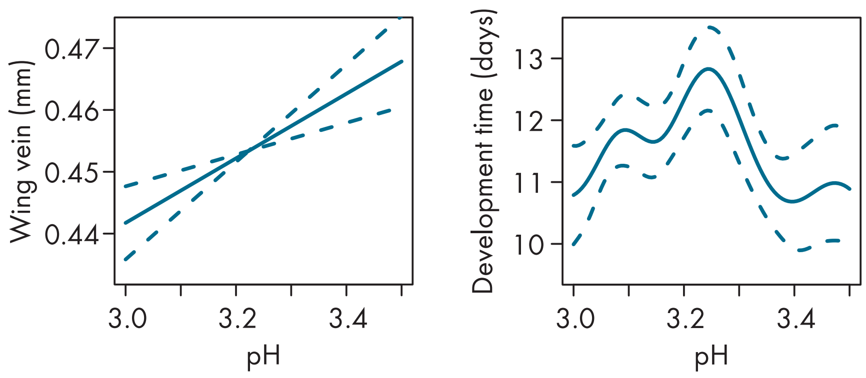

Fig. 3: Fly size (wing vein measures [3]) and larval development time at harvest in relation to pH (mean ± SE).

Larval survival in grape berries was relatively low, but reached a maximum at a sugar content of ~95 °Oechsle (generalized additive model: $F_{7,51} = 3.2$, $P = 0.006$, fig. 2). Increasing development time of larvae at sugar contents over 90 °Oechsle confirmed the negative effect of too high sugar concentrations (generalized additive model: $F_{4,44} = 3.5$, $P = 0.01$, fig. 2). Fly size significantly increased with increasing pH (linear model: $t_{1,104} = 3.9$, $P < 0.001$, fig. 3). Decreasing larval development time after a peak at a pH between 3.25 and 3.3 (generalized additive model: $F_{8,44} = 3.2$, $P = 0.006$, fig. 4) confirmed the beneficial effect of higher pH.

References
[1] Asplen MK, et al. 2015, J Pest Sci 88 (3):469-494; [2] Kaneshiro KY 1983, P Hawaii Entomol Soc 24:179; Wolf LL, et al. 2000 Heredity 85:521-529