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The use of season specific assessment of mite population growth and SMR level in selection programs for Varroa resistant honeybees

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Background and introduction

Varroa resistance in honeybees represents a complex trait caused by multiple environmental effects, polygenic background, and/or gene regulatory networks. However, measuring reliable and cost-effective resistance traits in the framework of honeybee breeding programs still remain an open issue to many breeding organisations and breeding companies.

Material and methods:

In this study we used commonly applied phenotyping approaches to characterize resistance traits in Austrian Apis mellifera carnica populations of different genetic background. The basic concept of this study was to use date dependent mite population growth to filter out colonies with low infestation rates and higher SMR (suppressed/non mite reproduction) level at the end of season. The field study was performed in the years 2022 to 2024 and included 205 colonies from two genetic origins (origin a) = long term selected population; origin b) = rather unselected population with introgression of resistance traits of origin a). Phoretic mite infestation got measured from early August on (30th week) and measurements were periodically repeated every three-weeks using dust shaking method. When phoretic mite infestation reached thresholds defined by AGT (2018), worker brood combs were sampled from each colony. Those got evaluated for brood infestation and SMR and were classified for resistance status using empirical thresholds given by Grindrod et Martin (2021).

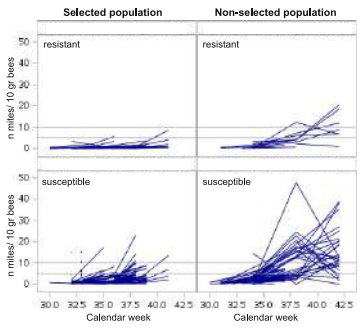


Figure 2: Individual growth curves of phoretic mite infestation rates from week 30 (1st August) to week 42 (20th Octobre) for selected and unselected populations by resistance categories (resistant and susceptible)..

Conclusions:

As a conclusion, the combination of behavioural traits (SMR) with bee- or brood infestation rates within a time window of substantial mite population development, can aid to discriminate resistant colonies from those, not being successful in controlling mite population growth. Consequently, this approach can assist in the selection of successfully operating colonies as mating partners in a breeding population.

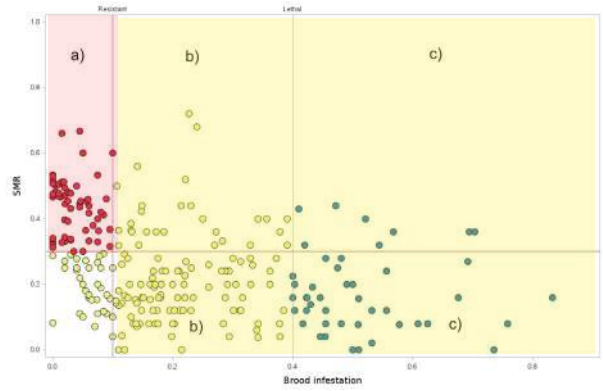


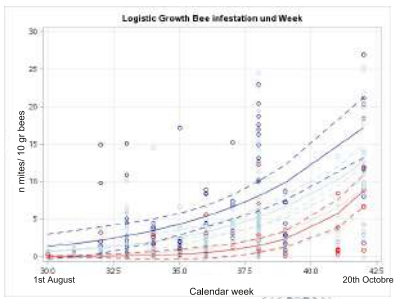
Figure 1: SMR and brood infestation profile plot of the 205 A.m.carnica colobiies. Successfully operating colonies (resistant) were able to keep brood infestation in late season below 10% and exhibited SMR level above 30%. Susceptible (non successful) colonies could not shift mite infestation below 10% level.

Results:

By segmentation of the data applying empirical thresholds for SMR and brood infestation (SMR>30% and Brood infestation <10%), 16.1% of colonies could be characterized resistant (mean SMR=56.2%; brood infestation rate=4.7%) and remained untreated up to week 39 (+/- 24th septembre). Susceptible colonies (67.8%) showed on average a SMR level of 23.7%, brood infestation rate of 33.1% and remained untreated up to week 38 (+/- 18th septembre). Phoretic mite infestation rates derived from this longitudinal study were in correspondence to resistance categories and SMR/brood infestation level. In resistant colonies phoretic final mite infestation reached a level of 3.7% (1.9% in selected and 6.9% in unselected population) and susceptible populations had an infestation level of 7.2% (5.6% in selected and 9.2% in unselected population). In general mite population levels were significantly higher in unselected population underlining intervention effect of resistant bees in controlling mite population growth.

Table 1: Percentage of Population in Resistance categories, mean values for SMR level, brood infestation rate, phoretic mite infestation rate (n mites/10 gr bees) for the selected, unselected and the total population studied.

	Category		SMR		Brood infestation		Phoretic mite	
Population	resistant	susceptible	resistant	susceptible	resistant	susceptible	resistant	susceptible
selected	18,92	67,57	55,65	26,55	4,15	33,59	1,90	5,56
unselected	12,77	68,09	57,08	20,30	5,65	32,52	6,86	9,19
all	16,10	67,80	56,20	23,70	4,70	33,10	3,70	7,20



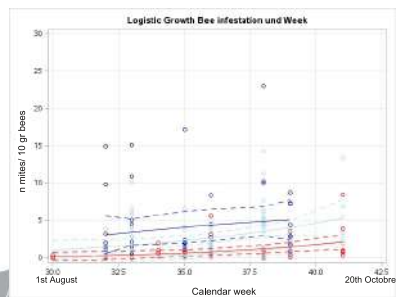


Figure 3 and 4: Estimated growth curves for phoretic mite infestation in the total population (left) and in the selected population (right). Red curve (solid = mean; dotted = +/- 95% confidence interval) illustrates mite population growth in resistant colonies and blue (dark and light) curves illustrate mite population growth in susceptible colonies.

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Varroa resistance in honeybees represents a complex trait and measuring of reliable and cost-effective resistance traits still remain an open issue to many breeding organisations and breeding companies. In this study we used commonly applied phenotyping approaches to characterize resistance traits in Austrian Apis mellifera carnica populations. The basic concept was to use date dependent mite population growth to filter out colonies with low infestation rates and higher SMR (suppressed/non mite reproduction) at the end of season. The study was performed from 2022 to 2024 and included 205 colonies from two genetic origins (a) = long term selected population; b) = unselected population genetic introgression of origin a)). Phoretic mite infestation got measured from early August on (29/30th week) and measurements were periodically repeated every three-weeks using dust shaking method. When colonies reached thresholds defined by AGT (2018), a brood comb was sampled to evaluate brood infestation and SMR. By segmentation of the data applying empirical thresholds for SMR and brood infestation (SMR>30% and brood infestation <10%; (Grindrod and Martin 2021)), 16.1% of colonies could be characterized resistant (mean SMR=56.2%; brood infestation =4.7%) and remained untreated up to week 39 (+/- 24th septembre). Susceptible colonies (67.8%) showed an average SMR level of 23.7% and brood infestation rate of 33.1%. Phoretic mite infestation rates were in correspondence to resistance categories and SMR/ brood infestation level. In resistant colonies phoretic mite infestation reached a level of 3.7% (1.9% in selected and 6.9% in unselected population) and susceptible population had an infestation level of 7.2% (5.6% in selected and 9.2% in unselected population). In general mite population levels were significantly higher in unselected population. We further derived growth curves of phoretic mite population over time to support additional threshold data for decision process in selecting resistant breeding colonies. As a conclusion, the combination of behavioural traits (SMR) with bee- or brood infestation rates within a time window of substantial mite population development, can aid to discriminate resistant colonies from those, not being successful in controlling mite population growth. Consequently, this approach can assist in the selection of successfully operating colonies in resistance breeding programs.