Application of seasonal weather forecasts on selected pest and disease algorithms in Austria

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01 Objective of the study

With the help of the GIS-based simulation tool ARIS (Agricultural Risk Information System), various agro-climatic indicators can be calculated on a daily time step for the Austrian agricultural area on a 1 km grid scale. These indicators can be used to monitor or predict the impact of adverse weather conditions on crops. Within this study, we focused on the application potential and performance of three insect pest and one disease algorithm (European grapevine moth, grapevine cicada, plum moth and grapevine downy mildew) where the first occurrence of relevant development stages (i.e. nymphs) for the pests and the start of infection and incubation period of grapevine downy mildew throughout the whole year are calculated.

02 Aim

To enhance the resilience and sustainability of Austrian agricultural systems under changing climate, the application potential for short-term to seasonal forecasts were tested at two sites for the mentioned pest and disease indicators.

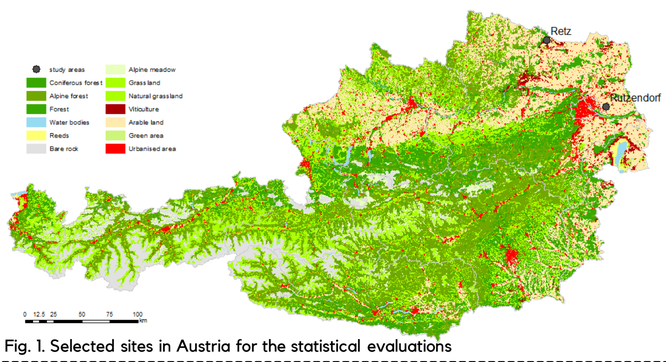


Fig. 1. Selected sites in Austria for the statistical evaluations

03 Methods

For the evaluation, different forecast weather data inputs in ARIS with various lead times of short term and seasonal forecasts were applied and statistically analysed. The latest ECMWF long-range ensemble forecast system 5 (SEAS5, in operation since November 2017) with forecasts of up to 7 months were used as meteorological input in combination with ECMWF medium-range forecasts (10-d) and nowcast INCA analysis data (all in 1 km gridded data). Spatial downscaling methods were applied to the forecasts during the growing seasons (spring, summer, and autumn) and included downscaled 10-day ECMWF data as well as downscaled 7-month seasonal forecasts of temperature (min, max), precipitation and global radiation on a daily basis with a resolution of 1x1 km.

04 Results

Two locations in Austria were chosen for the analysis: Retz in the north-east of Austria as a typical wine region and Rutzendorf in the east of Austria, one of the most important agriculture areas (Fig. 1). Both sites represent central European continental climate with warm and dry summer period.

4.1 European Grapevine Moth

For European grapevine moth (Lobesia botrana) and European grape berry moth (Eupoecelia ambiguella) the first occurrence day in Retz was calculated. The empirical model is based on mean daily temperatures, days < 11°C, days with precipitation and precipitation sum from January till May.

Fig. 2 a,b shows the observed (red line) and predicted (boxplots) ensemble forecasts with starting dates February, March, April and May for the years 2018 until 2021.

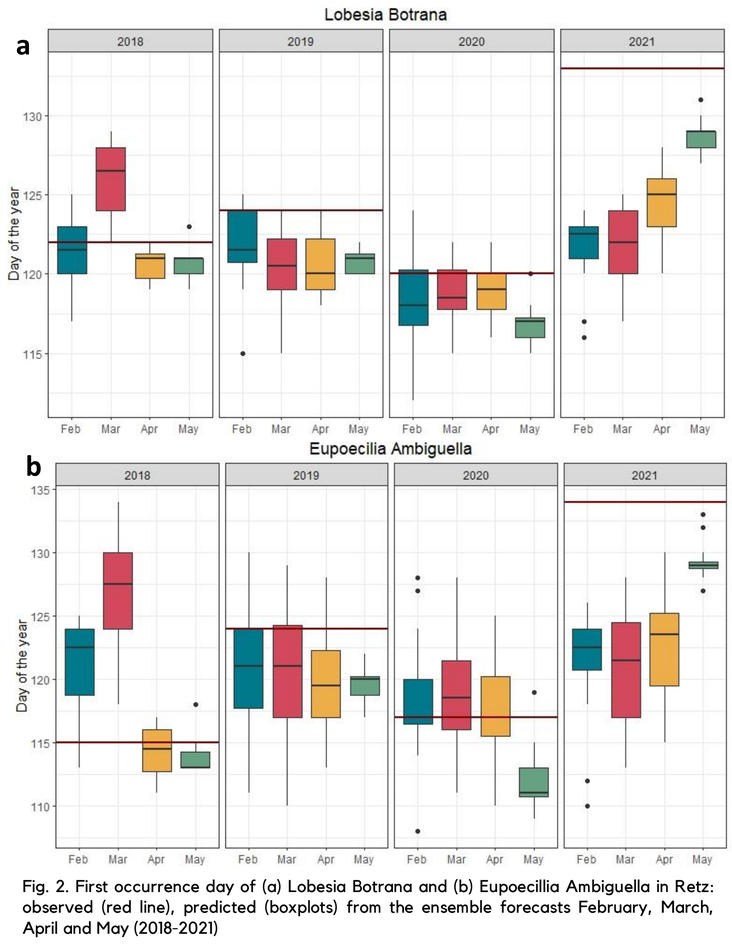


Fig. 2. First occurrence day of (a) Lobesia Botrana and (b) Eupoecillia Ambiguella in Retz: observed (red line), predicted (boxplots) from the ensemble forecasts February, March, April and May (2018-2021)



Insect trap for standardized pest monitoring (LKÖ)



Vineyard (Austria)

4.2 Plum Fruit Moth

Linear multiple regression was used as well to calculate the first day of occurrence for the Plum fruit moth (Grapholita funebrana). The temperature sum (Tmean>11°C), the global radiation sum and the maximum temperature from February to April were taken into account.

Fig. 3 shows observed (red line) and predicted (blue line = mean value, grey area = max and min values of the ensemble) first occurrence day of the plum fruit moth for the years 2018 and 2019 in Rutzendorf for three forecast starting months (February, March, April).

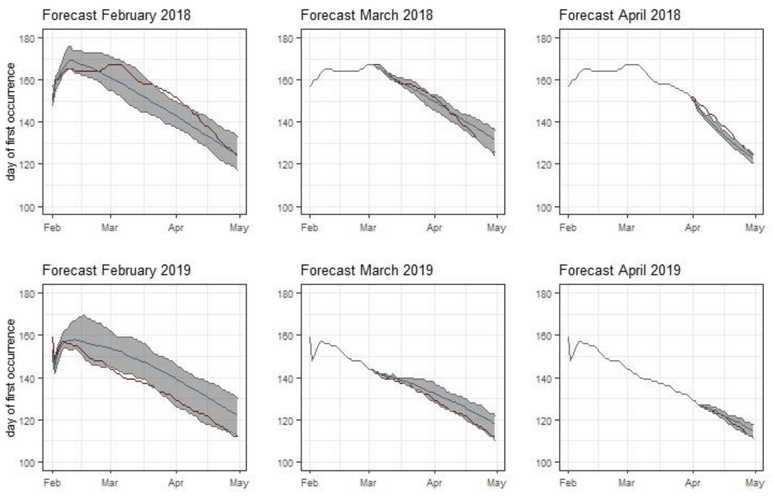


Fig. 3. First occurrence day of Grapholita funebrana in Rutzdendorf: observed (red line) vs predicted (blue line = mean value, grey areas marks max and min values of the ensemble); seasonal forecast from February, March, and April 2018-2019

4.3 Grapevine Downy Mildew

The estimation of the onset of infection and incubation period of grapevine downy mildew throughout the whole year was calculated under the assumption of presence of oospores and shoot length in the vineyard is at least 10 cm using an algorithm where the average temperature is above 10°C and there was more than 10 mm of rain fell in the last 48 hours. In Fig. 4 the calculated number of incubation days per year and in Fig. 5 their temporal course in Retz from April to July 2020 are presented. For forecast ensemble the starting months February, April and June were chosen.

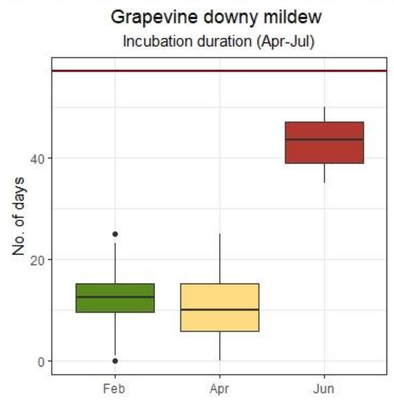
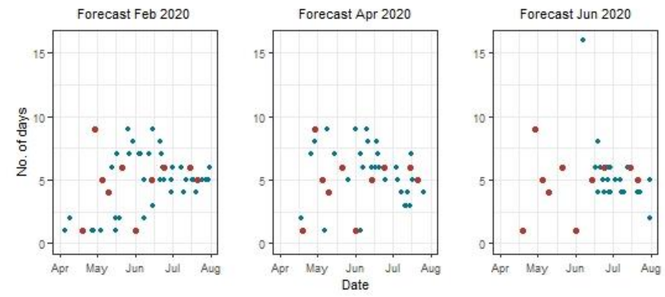


Fig. 4. Accumulated incubation days of grapevine downy mildew in Retz for the year 2020: observed (red line), predicted (boxplots) from the ensemble forecasts February, April and June

Fig. 5. No. of days of grapevine downy mildew in Retz as time series: observed (red dots), predicted (blue dots) from the ensemble forecasts February, April and June in 2020



4.4 American Grapevine cicada

For the American grapevine cicade (Scaphoideus titanus) the first hatching (day of the year) of the nymphal stage 1 and 3 in Retz was calculated: the observed (red line) and predicted (boxplots) ensemble forecasts for February, March, April and May for the years 2018 until 2021 (Fig. 6 a,b). The calculation algorithm includes global radiation, temperature sums and maximum temperature from February to May.

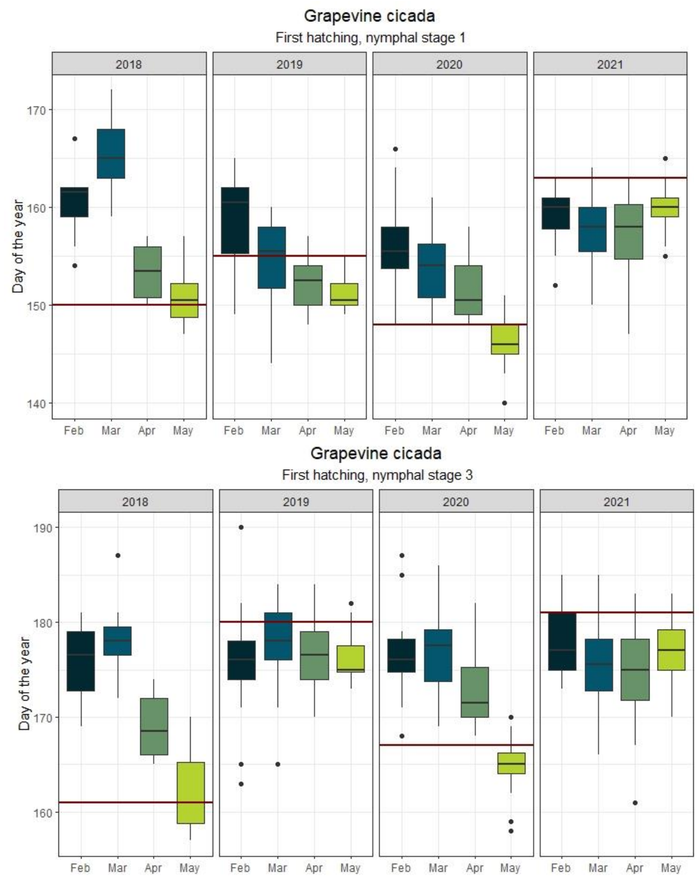


Fig. 6. First hatching (day of the year) of the nympal stage 1 (a) and stage 3 (b) of Scaphoideus titanus in Retz: observed (red line), predicted (boxplots) from the ensemble forecasts February, March, April and May (2018-2021)

05 Conclusions

The sensitivity, uncertainties and performance of different prediction ranges for the studied indicators are demonstrated in our study.
The results of forecast performance for the various pests show in general increasing accuracy and decreasing uncertainty with shorter prediction periods (later start or forecasts within the season). However, there is a strong variation between years, where also in some years all forecast periods may perform relatively well. This behavior depends, beside the weather forecast performance itself, on the seasonal weather conditions and the weight of the specific weather variables in the algorithm. Further analysis on more sites of different conditions will be elaborated to analyze performances in a spatial context. Moreover, the results are discussed with stakeholders in regard to performance and potential adaptation needs for crop protection service and pest management applications.

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