Evaluating TOMCAST model for predicting timing of fungicide applications to control Alternaria diseases in Carrot and Potato

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INTRODUCTION

- Leaf blight, caused by fungi such as *Alternaria dauci*, *A. radicina*, and *Cercospora carotae* is a serious threat to carrot cultivation (Fig.1)
- Early blight of potato, caused by the large-spored *Alternaria solani* and the small-spored *Alternaria alternata* adversely affects potato production (Fig.2)
- Disease development in both carrots and potatoes are influenced by various factors, including temperature and leaf wetness
- Predictive models can aid in determining the optimal timing and interval between fungicide applications to effectively control these diseases while minimizing unnecessary fungicide usage
- The TOMCAST model, originally developed to forecast fungal disease development in tomatoes (Madden et al., 1978), has been adapted for managing Alternaria diseases in carrots (Bounds et al. 2007) and potatoes (Abuley and Nielsen, 2017)
- The objectives were to evaluate the applicability of the TOMCAST model for managing Alternaria diseases in carrot and potato crops in Norway.

Fig. 1. Leaf blight symptoms and signs on carrot. (A) Symptom of Alternaria leaf blight, (B) Close-up reveals sporulation, (C) formation of Alternaria conidia chains, (D) Characteristic symptom of Cercospora leaf blight. (E) Close-up of *Cercospora carotae* spore (F) Carrot leaf blight symptoms, possibly includes various pathogens and physiological disorders. Photo: Belachew Asalf, NIBIO

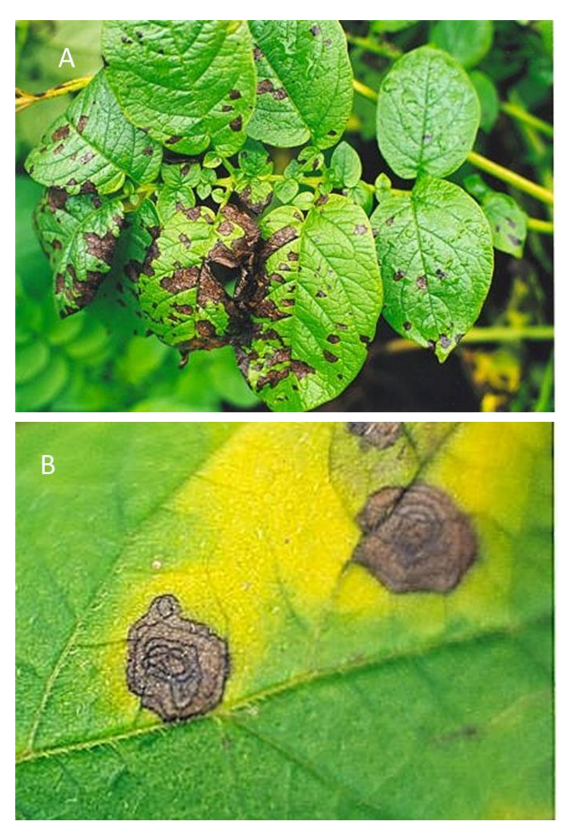

Fig. 2. Characteristic symptom of Early blight of potato. Photo:Siri Abrahamsen, NLR

Materials and Methods

Field trial

- Field trials were conducted in 2022 and 2023 for carrot diseases and in 2023 for potato
- The experiments were in areas historically prone to Alternaria infection
- There were three treatments: (i) standard fungicide application administered biweekly, (ii) TOMCAST predictions (DSV = 20), and (iii) untreated control plots
- Carrot fields were treated with i) Signum (boscalid + pyraclostrobin), ii) Switch (cyprodinil, fludioxonil), and iii) Amistar (azoxystrobin), while potato field treated with i) Propulse (fluopyram + prothioconazole) and ii) Revyona (mefentrifluconazole)
- Each treatment was replicated four times within the carrot fields and three times in potato.
- The first application was initiated when the diseases were observed, and subsequent applications aligned with TOMCAST warnings (DSV = 20).
- Weather data essential for model input were sourced from three proximate weather stations (Fig.3).

TOMCAST model

- The model utilized daily air temperature data and hourly leaf wetness information to calculate and accumulate daily disease severity values (DSVs), as outlined in Table 1
- Each fungicide applications, prompts the model to reset the DSV accumulation to zero and starts accumulation again (Fig. 4)
- The use of TOMCAST model was facilitated through incorporation into the Norwegian decision support system VIPS (www.vips-landbruk.no).

Table 1. Daily Disease Severity Values (DSVs) as a function of hours of leaf wetness and mean air temperature during the wetness periods per day.

Mean temperature of a day (°C)*	Daily Disease Severity Values (DSVs) and hours of leaf wetness required to produce DSVs**				
	0	1	2	3	4
10-17	0 - 6	7 - 15	16 - 20	21+	
18-20	0 - 3	4 - 8	9 - 15	16 - 22	23+
21-25	0 - 2	3 - 5	6 - 12	13 - 20	21+
26-29	0 - 3	4 - 8	9 - 15	16 - 22	23+

*We have adopted a minimum temperature threshold of 10°C, which differs from the original model's threshold of 13°C.
** DSV scales range from 0 to 4, with 0 indicating environmental conditions unfavorable for sporulation, and 4 indicating highly favorable conditions. Alternaria is favored by warm and wet weather.

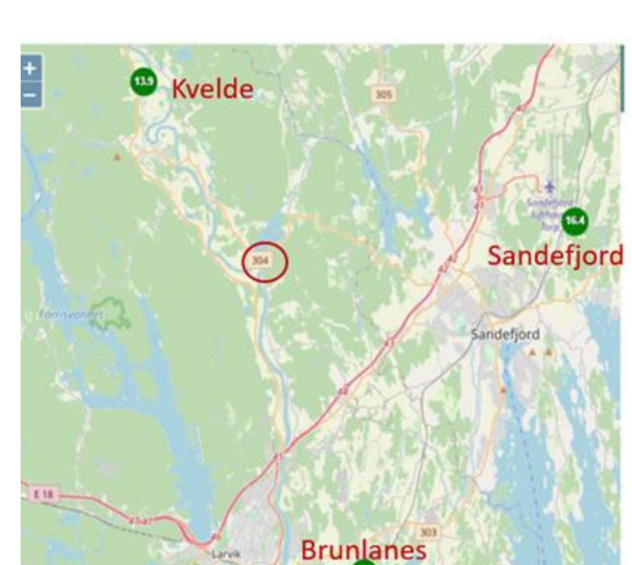

Figure 3. The map illustrates the experimental field's location marked by a red circle. Additionally, it highlights the positioning of three key weather stations: Kvelde, ca. 7 km; Sandefjord, ca. 14 km; and Brunlanes, ca. 19 km away from the carrot field.

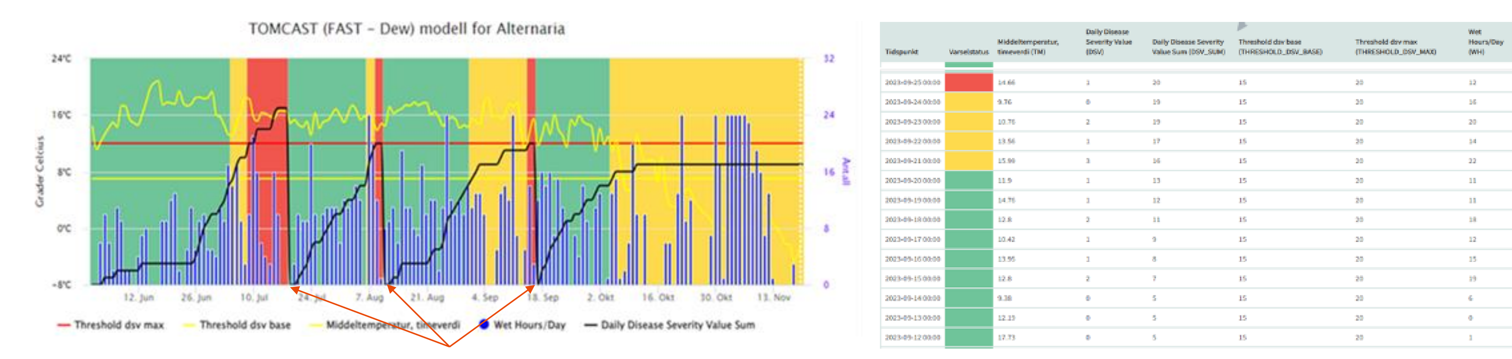

Fig.4. TOMCAST model warnings are presented in both graphical and tabular formats. Disease risk levels are color-coded: green background represents DSV 0 to 15, yellow background indicates DSV 15 and 20, and red background signifies DSV values exceeding 20. Additionally, upon each fungicide application and entry of the application date into the model system, the DSV accumulation resets to zero, restarting the accumulation process, as depicted by the red arrows in the above figure.

RESULTS

Carrot: Results from carrot field trials showed no significant difference among treatments in diseases incidence and severity in both years.

In 2022 for the second assessment (on September 09), Alternaria leaf blight incidence was 60% in control, 53% in standard and 50% in TOMCAST (Fig. 5A), whereas Cercospora leaf blight incidence was 40% in control, 33% in standard and 25% in TOMCAST (Fig. 5B).

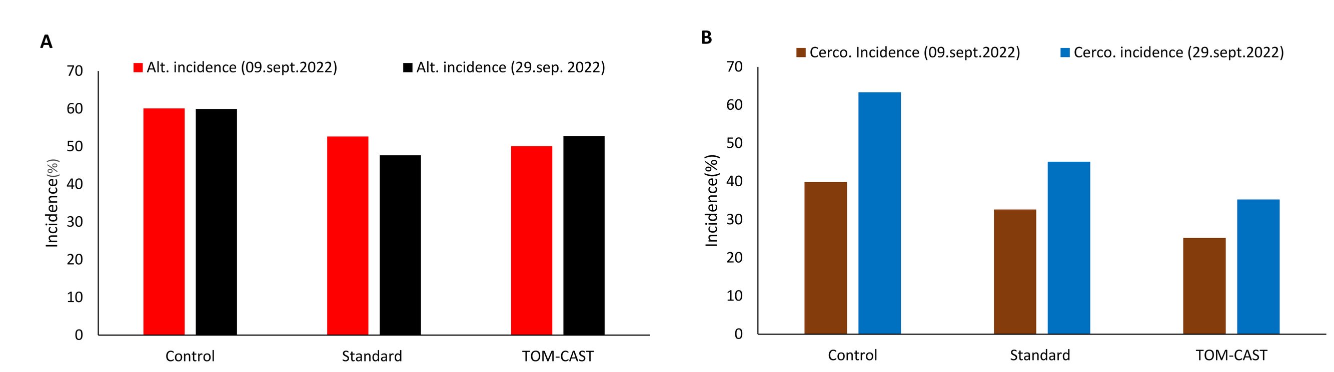

Fig.5. Effect of treatments on carrot leaf blight incidence on Septmeber 09 and 29, 2022 assessments. Alternaria leaf blight incidence (A), and Cercospora leaf blight incidence (B).

- In 2023, carrot leaf blight incidence remained low in the trial field, with mean incidence ranging from 2-8% across all treatments
- Disease scouting was important to initiate the first application (Fig.6)
- For the standard application, five applications were made on July 14, July 28, August 10, August 23, and September 6, 2023
- TOMCAST predictions varied among weather stations (Fig.6)
- Applications recommended based on each weather stations were:
  - Sandefjord weather station: July 19, August 5 and 25, 2023
  - Kvelde weather station: July 19, August 6 and 31, 2023
  - Brunlanes weather station: July 19, and August 11, 2023.

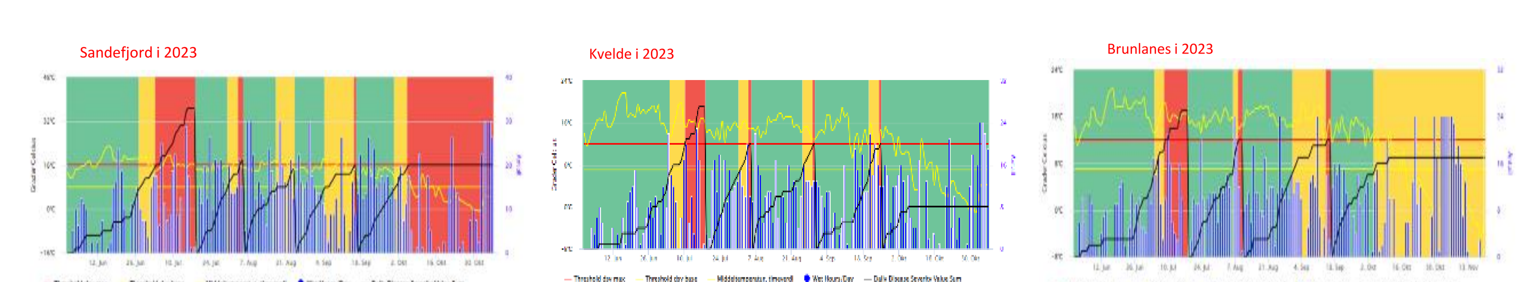

Fig.6. TOMCAST predicted three application based on Sandefjord and Kvelde, and two application based on Brunlanes weather stations. Carrot harvest took place on September 27, 2023, hence no spraying was necessary for warnings issued within 10 days prior to harvest.

Potato: In potato field, spraying based on the model resulted in 3 fungicide applications, which was the same as farmers practice

- Both sprayed treatments had significantly less disease compared to unsprayed plots
- There were no differences in potato yield.

DISCUSSION

- VIPS is an open-source technology platform for prognosis, monitoring, and decision support in plant pest and disease management
- VIPS providing growers with a tool to monitor and manage diseases in a sustainable and environmentally responsible manner
- With TOMCAST growers can make informed decisions, precisely target control measures, significantly reducing unnecessary fungicide applications and associated costs.
- The model will be further validated and refined by placing portable weather station in the carrot and potato farm and by adjusting the threshold values (DSVs).

CONCLUSION: Utilizing TOMCAST with disease scouting to initiate the first application seems to be a valuable decision support system. It aids in determining spray intervals, reducing unnecessary fungicide applications and maximizing fungicide efficacy to control Alternaria and Cercospora leaf blight in carrots and early blight in potatoes in Norway.

References:

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