

Essential Oil-Based Biofungicide Against *Cercospora beticola*: Formulation Development and Field Evaluation

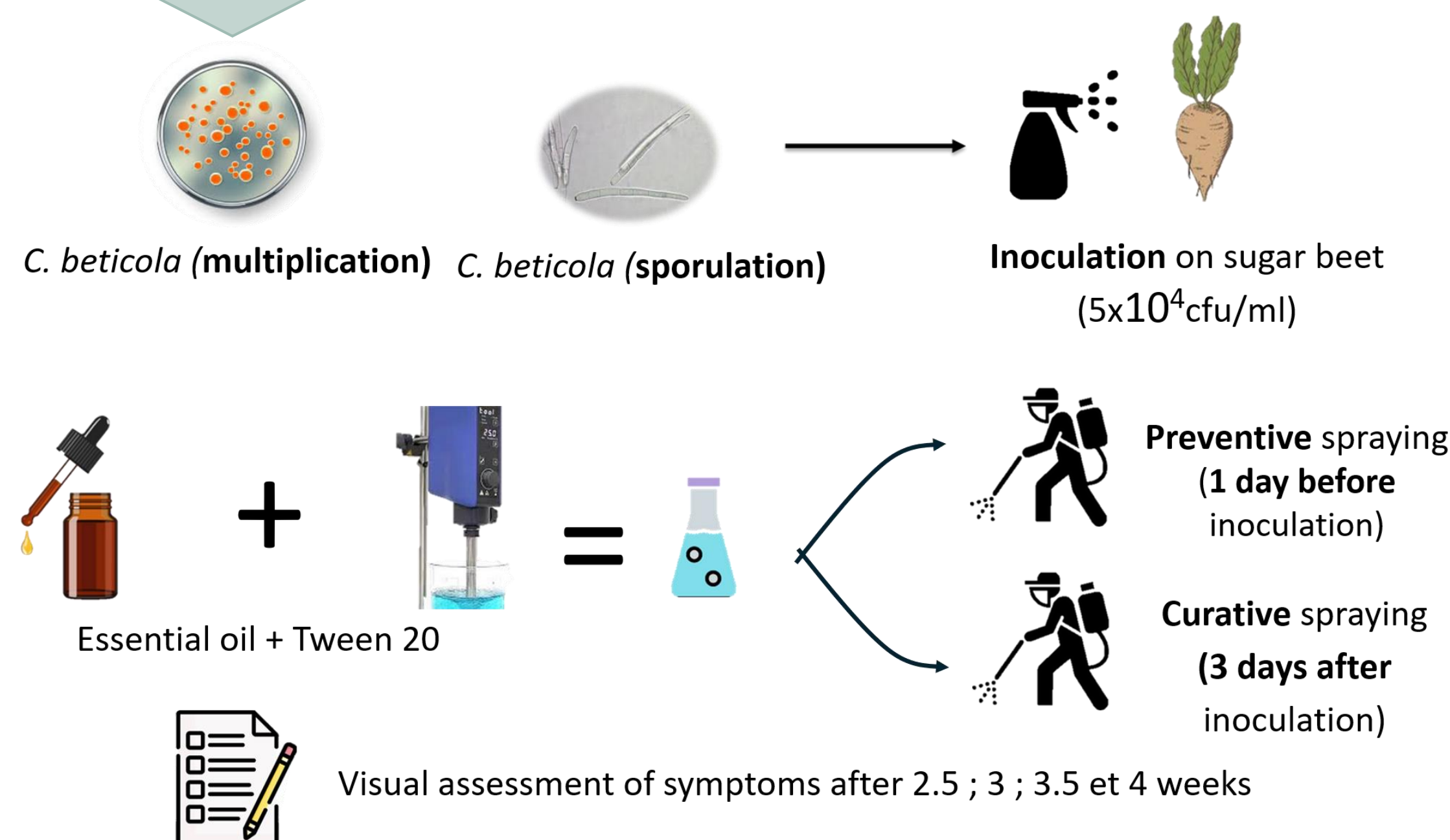
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Context and objective

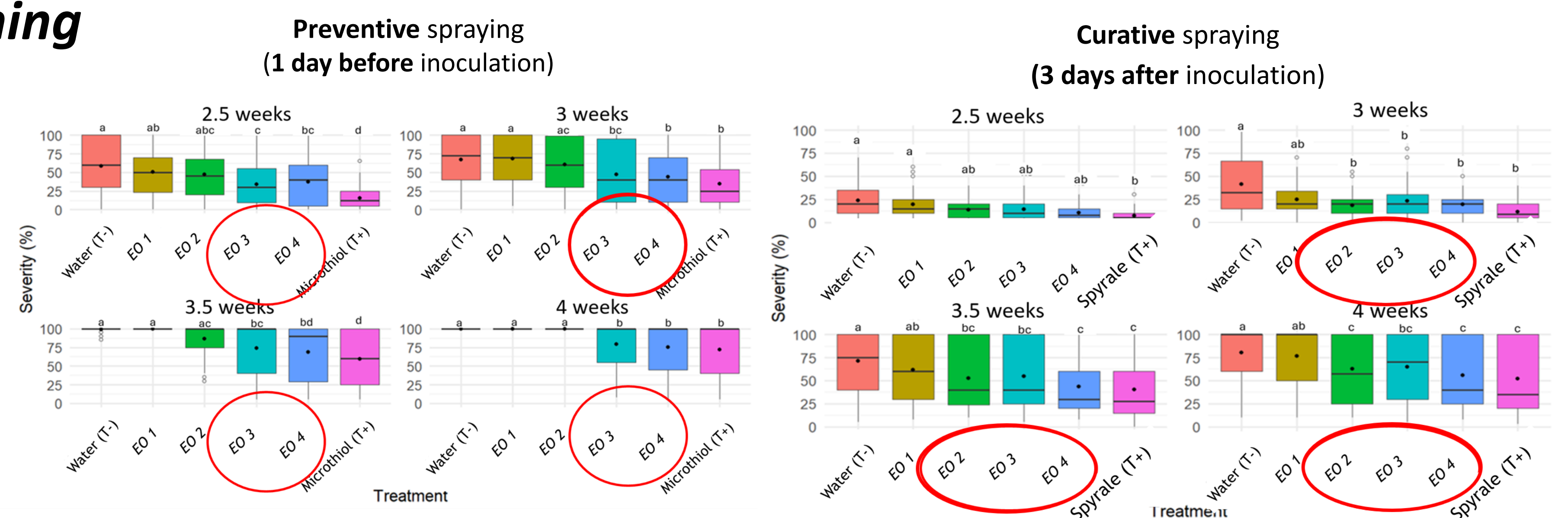
Cercospora leaf spot, caused by *C. beticola*, remains the most damaging foliar disease of sugar beet. Increasing resistance to fungicides highlights the need for alternative solutions. Essential oils, due to their intrinsic antifungal properties, represent a promising complementary strategy, and are being explored for the development of effective biofungicides. The objective of this study was to identify and develop an essential oil-based biofungicide against *Cercospora beticola* by: 1. Screening selected essential oils for antifungal activity, 2. Formulating the most promising active substance into a stable, easy to use product 3. Evaluating its efficacy under field conditions within a spray program.

Method

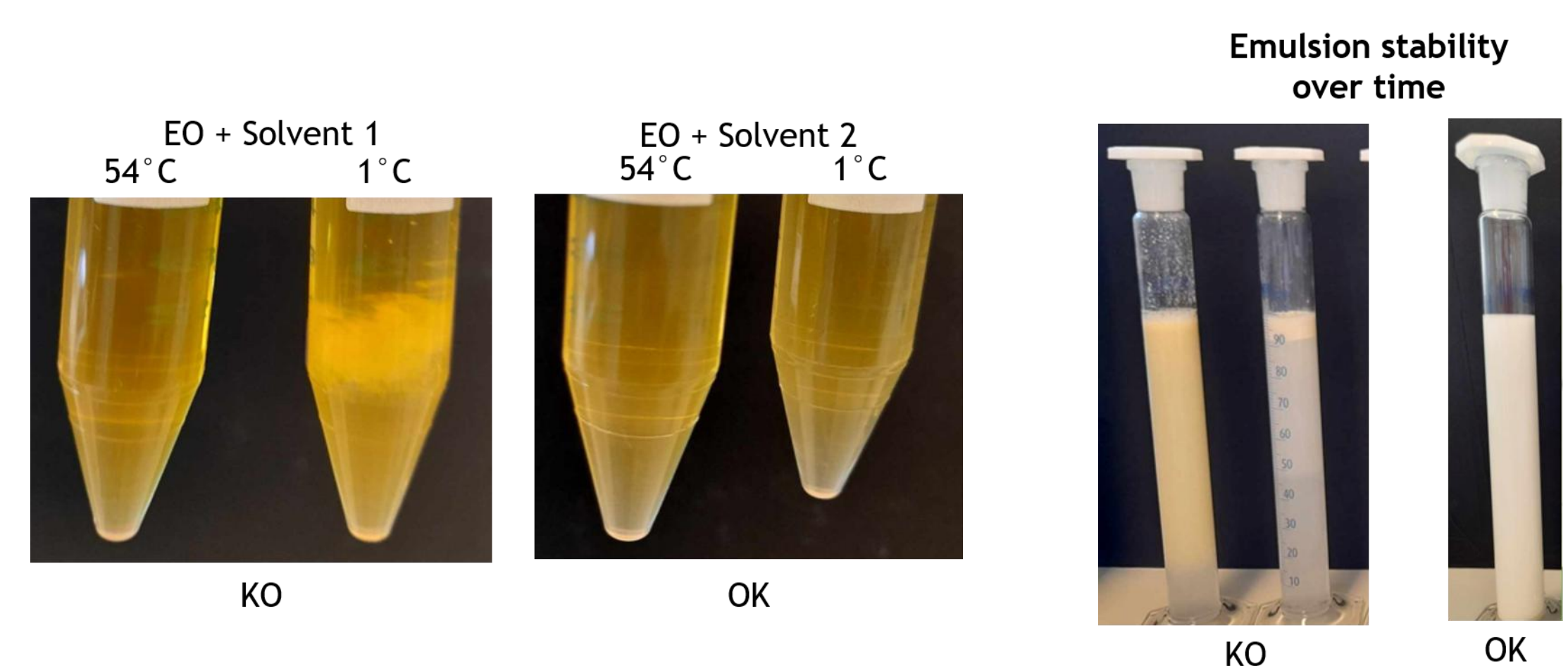
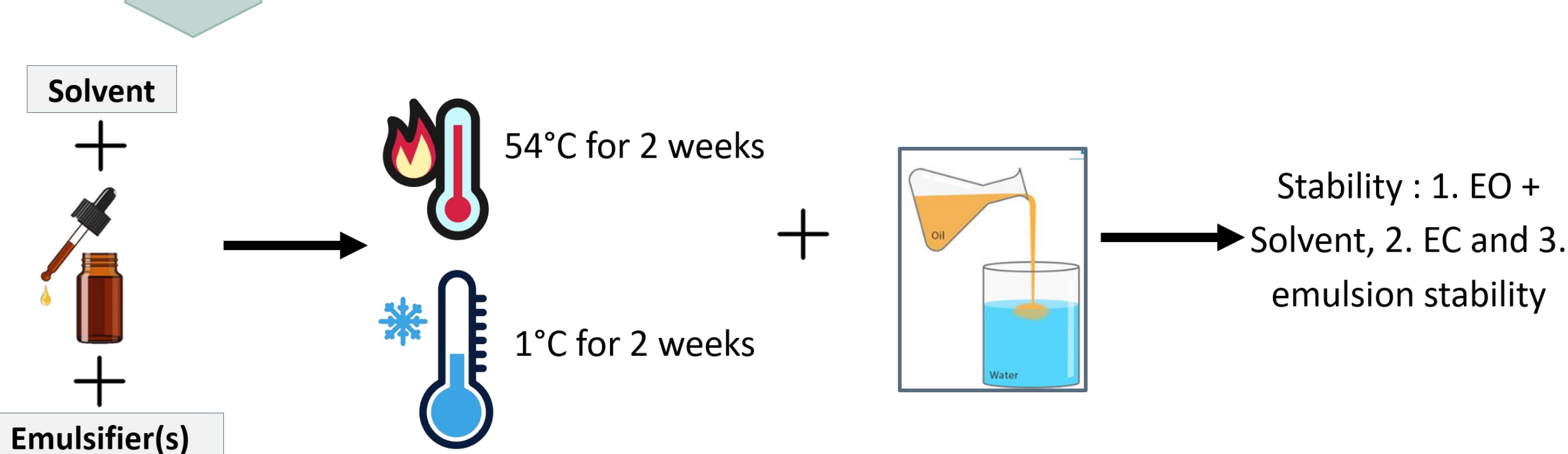
1 Essential oil *in vivo* efficacy screening



Results



2 Essential oil formulation

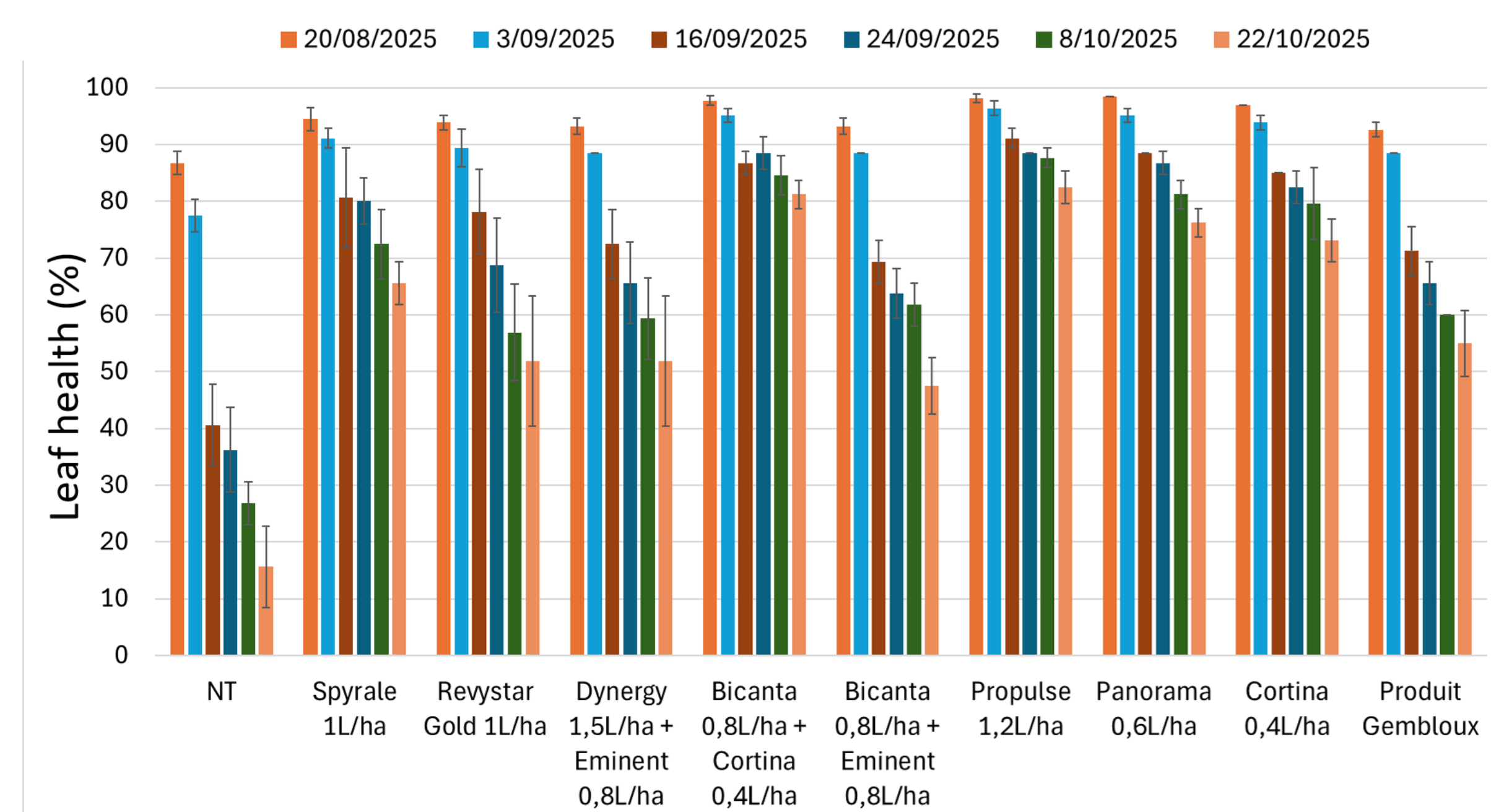


3 Efficacy evaluation in field conditions

Object n°	Preventive application	Curative application 1	Curative application 2	Curative application 3
1 (control)	/	/	/	/
2 (reference)	/	Spyrale 1 l/ha	Spyrale 1 l/ha	Spyrale 1 l/ha
3	/	Revystar Gold 1 l/ha	Revystar Gold 1 l/ha	Revystar Gold 1 l/ha
4	/	Dynergy 1,5 l/ha + Eminent 0,8 l/ha	Dynergy 1,5 l/ha + Eminent 0,8 l/ha	Dynergy 1,5 l/ha + Eminent 0,8 l/ha
5	/	Bicanta 0,8 l/ha + Cortina 0,4 l/ha	Bicanta 0,8 l/ha + Cortina 0,4 l/ha	Bicanta 0,8 l/ha + Cortina 0,4 l/ha
6	/	Bicanta 0,8 l/ha + Eminent 0,8 l/ha	Bicanta 0,8 l/ha + Eminent 0,8 l/ha	Bicanta 0,8 l/ha + Eminent 0,8 l/ha
7	/	Propulse 1,2 l/ha	Propulse 1,2 l/ha	Propulse 1,2 l/ha
8	/	Panorama 0,6 l/ha	Panorama 0,6 l/ha	Panorama 0,6 l/ha
9	/	Cortina 0,4 l/ha	Cortina 0,4 l/ha	Cortina 0,4 l/ha
17	EO- based biofungicide	EO- based biofungicide	Spyrale 1 l/ha	Spyrale 1 l/ha

All spray programs presented were experimental and designed to assess intrinsic product efficacy. These application schemes are not representative of current regulatory-approved practices.

Visual assessment of leaf health in plots from the 23rd of June until the 20th of August. Yield parameters assessment: root yield, % sugar, sugar yield



Object n°	20/08/2025	03/09/2025	16/09/2025	24/09/2025	08/10/2025	22/10/2025
	Leaf health (%)	Leaf health (%)	Leaf health (%)	Leaf health (%)	Leaf health (%)	Leaf health (%)
	Sig.diff.	Sig.diff.	Sig.diff.	Sig.diff.	Sig.diff.	Sig.diff.
1 (control)	86,6g	77,5h	40,6h	36,3f	26,9g	15,6i
2 (reference)	94,5def.	91,1def.	80,6cd....	80,0c....	72,5d....	65,6ef....
3	93,9def.	89,4fg.	78,1def.	68,8de.	56,9f.	51,9gh.
4	93,3ef.	88,5g.	72,5efg.	65,6de.	59,4f.	51,9gh.
5	97,8 ab....	95,1 ab....	86,8 abc....	88,5 ab....	84,6 abc....	81,3 abc....
6	93,3ef.	88,5g.	69,4g.	63,8de.	61,9ef.	47,5h.
7	98,1 ab....	96,4 a....	91,1 ab....	88,5 ab....	87,6 ab....	82,5 ab....
8	98,5 ab....	95,1 ab....	88,5 ab....	86,8 ab....	81,3 .bc....	76,3 .bcd....
9	97,0 .bc....	93,9 .bc....	85,0 .bcd....	82,5 .bc....	79,6 ..c....	73,1 ..cde....
17	92,6f.	88,5g.	71,3fg.	65,6de.	60,0f.	55,0gh.

Treatment n°	Root yield (kg/ha)	Sugar content (%)	Sugar yield (kg sugar/ha)
1 (control)	101 865e	17,81i	18137g
2 (reference)	109 259d.	19,29cde....	21080ef.
3	109 722ef.	18,74h.	20559f.
4	109 352d.	18,90gh.	20671f.
5	114 907 ab....	19,73 ab....	22660 abc....
6	109 881cd.	18,74h.	20584f.
7	117 262 a....	19,40cd....	22748 ab....
8	113 175 abcd.	19,49 .bc....	22050 .bcd...
9	113 479 abcd.	19,24cdef...	21829cde..
17	109 034d.	18,88gh.	20588f.

Conclusion

This study demonstrates the potential of essential oil-based biofungicides as a viable strategy to control *C. beticola*.

The developed formulation showed good stability and consistent efficacy under field conditions, with performance comparable to conventional fungicide programs and significant improvements over the untreated control.

These results highlight the potential relevance of EO-based solutions within integrated disease management strategies. Further work is required to optimise efficacy and confirm performance robustness across a wider range of environmental conditions and spray programs.

Affiliations

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