

Grapevine downy and powdery mildews cause major yield and quality losses if not properly managed. Control strategies still relies on fungicide treatments, but many have been banned or restricted due to environmental concerns, leaving growers with a lack of effective tools. Basic substances are safe compounds already used in food or medicine and can be approved for plant protection in only 1–2 years at a low cost (≈50 000 €). This two-year (2024-2025) field experiment explored the effectiveness of approved basic substances, potential basic substances like the essential oils (EOs), and other low-impact compounds following stand-alone application along the whole season in a naturally infected vineyard cv. Montepulciano

Treatment	Active ingredient (concentration)	Formulation; distributor	Tested dose
Essential oil (EO) mix a	<i>Thuja occidentalis</i> , <i>Foeniculum vulgare</i> , <i>Lavandula hybrida</i> , <i>Thymus vulgaris</i> , <i>Cymbopogon citrato</i>	Thuja, fennel, lavender, thyme, lemongrass EOS, Le Sorgenti	0.5%
Essential oil (EO) mix b			1%
<i>Rosmarinus officinalis</i> EO	<i>R. officinalis</i> (100%)	Pure rosemary EO; Società Agricola Officinali	1%
<i>Lavandula hybrida</i> EO	<i>L. hybrida</i> (100%)	Pure lavender EO; Società Agricola Officinali	1%
Chitosan 1	Chitosan hydrochloride (1.9%)	Chitosano; Biorend	0.10% of active ingredient
Chitosan 2	Chitosan hydrochloride (5%)	Chitosano; Serbios	
Chitosan 3		Prevatect; Ascenza	
Lecithins	Soy lecithin (phospholipids > 95%)	Lecitina 80; Serbios	4 L/1000L
<i>Equisetum arvense</i> L.	<i>E. arvense</i> (0.2%)	Equiset; Ascenza	500 mL/hL
<i>Urtica</i> spp.	<i>Urtica</i> spp. (15%)	Valesco; Ascenza	500 mL/hL
Magnesium hydroxide	Magnesium hydroxide (99.1%)	Magnesium hydroxide E528; Farmalabor	3.5 Kg/8hL
Sodium hydrogen carbonate	Sodium hydrogen carbonate (>99.5%)	Bicarbonato di sodio purissimo; Solvay chimica Italia	2 kg/hL
Talc E553B	Talc E553B (>85%)	Micronized talcum powder E553B; Farmalabor	8.5 Kg/3hL
Sodium chloride	Sodium chloride (>99.5%)	Sale alimentare fino; Italkali	2 kg/hL
Fructose	Fructose (>99.5%)	Oral levulose; Farmalabor	10 g/hL
Sucrose	Sucrose (>99.5%)	Granulated sucrose; Farmalabor	10 g/hL
Cow milk	Cow milk (13% d.m.)	Cow milk UHT; TreValli	40 L/hL
Liquid whey	Whey (7% d.m.)	Whey; Local farms	10% (0.7% d.m.)
Powdery whey	Whey (90% d.m.)	Whey for zootechnics; GreenVet	10% (0.7% d.m.)
<i>Salix</i> spp. cortex	<i>Salix alba</i> (>99.5%)	Chips for infusion; Fontana	222.22 g/hL
COS-OGA	COS (chitooligosaccharides) - OGA (oligogalacturonides) 12.5 g/L	Ibisco; Gowan Italia	3 L/1000L
Cerevisane	Cerevisane (94.1%)	Romeo; Sumitomo Chemical Italia	0.25 kg/hL
Laminarin	Laminarin (45 g/L)	Vacciplant; Upl Italia	2 L/1000L
Sweet orange EO	Sweet orange EO (60 g/L)	Prev-Am; Oro Agri	600 mL/hL
Sulfur	Sulfur (80%)	Tiovit jet; Syngenta Italia	500 g/hL
Copper	Copper oxychloride 20% + hydroxide 10%	Airone Extra; Gowan Italia	125 g/hL
Water control	-	-	1000 L/ha



Application
Spraying volume: 1000 L/ha
Number of treatments: 11 in 2024, 10 in 2025
Interval between treatments: 7-10 days
Start and end: 24 May – 02 Aug (2024), 16 May – 24 Jul (2025)

Disease assessments

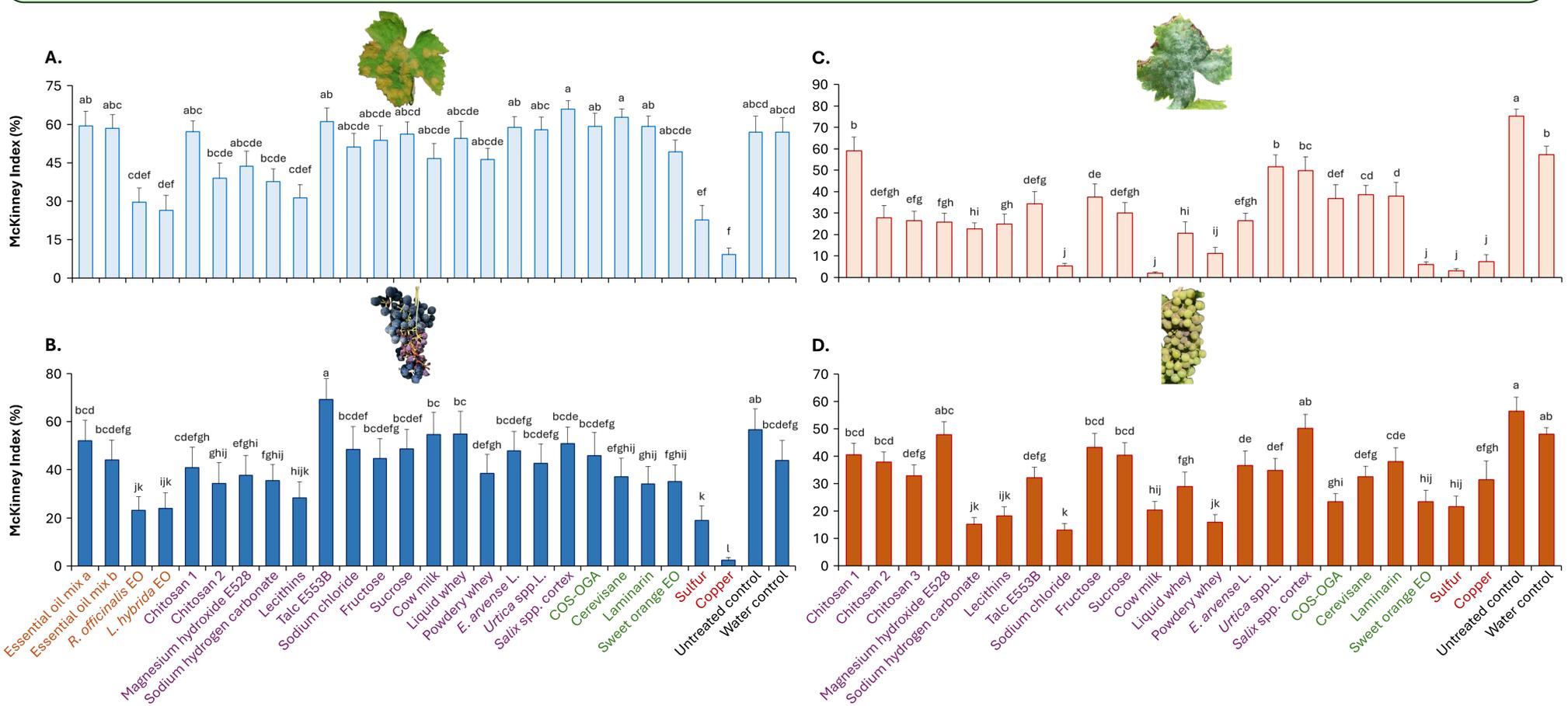
$$\text{Disease incidence (\%)} = \left(\frac{n}{N}\right)100$$

$$\text{Disease severity} = \frac{cf}{n}$$

$$\text{McKinney Index (\%)} = \left(\frac{cf}{NX}\right)100$$

n: number of fruits/leaves infected
N: total number of fruits/leaves
c: value of the empirical class (1-10 for leaves, 1-7 for clusters)
f: frequency of the class
c f: Sum of all the multiplications between classes and frequencies from the lowest class to the highest
X: value of the higher class in the empirical scale

***R. officinalis* EO, *L. hybrida* EO, and lecithins exhibited the greatest protection from downy mildew, on both leaves and bunches, with reductions of 59%, 58%, and 50% compared to the untreated control. Sodium hydrogen carbonate, lecithins, sodium chloride, cow milk, whey, and sweet orange EO were the most effective against powdery mildew on leaves and bunches at the same level of sulfur, with reductions of 73%, 68%, 77%, 64%, 72%, and 59% respectively**



Legend: **Pure essential oils**; **basic substances**; **low-risk active substances or other categories of plant protection products with low impact**; **fungicide controls**

Figure: McKinney Index of **downy mildew** on leaves (A) and bunches (B), and **powdery mildew** on leaves (C) and bunches (D) on grapevine cv. Montepulciano treated with different compounds along the season: 2025 for downy mildew, BBCH83 on leaves and BBCH89 on bunches; 2024 for powdery mildew, BBCH85 on leaves and BBCH79 on bunches.

Some natural compounds can be useful as support or potential alternatives to copper and sulfur for managing downy and powdery mildew. In some cases, they are also waste of the food industry (i.e. chitosan, whey), and demonstrated effectiveness in viticulture contributes towards their valorization. Large-scale trials are needed to define and validate the best strategies for the application of natural compounds