



Pathways to phase-out contentious inputs from organic agriculture in Europe

Organic-PLUS is an EU Horizon 2020 project involving 25 partners in 12 countries (EU and non-EU), working to find alternatives to some of the contentious inputs currently permitted in certified organic production, including copper fungicides, mineral oils and sulphur, with a special focus on perennial Mediterranean crops such as citrus and olives, and greenhouse crops like tomato and aubergine

WHAT ARE THE ALTERNATIVES TO CONTENTIOUS INPUTS IN MEDITERRANEAN ORGANIC CITRUS GROWING?

CITRUS



This factsheet provides an overview of some alternative treatments and methods to replace or reduce the use of contentious inputs (namely copper, mineral oils and sulphur) that are used to control diseases and pests in citrus crops. Alternative compounds cannot be considered as one-for-one substitutes of contentious inputs, but they should be integrated within more complex strategies for crop protection. In general, plant health should rely on preventive and indirect care measures in preference to off-farm inputs. The choice of varieties adapted to local conditions, the use of resistant varieties and other general measures which ensure a resilient agricultural system, strongly contribute to reduce dependency on external inputs to control pests and diseases.

The citrus industry is one of the most important fruit industries worldwide. The Mediterranean countries are second only to China for fruit production, and are the largest fruit exporter after South Africa (FAO 2016).

However, the citrus yield is threatened by pathogens and pests, which limit productivity in the field and also the shelf life of fruit post-harvest. In addition to common and often devastating phytopathogenic fungi and bacteria (*Plenodomus tracheiphilus*, *Phytophthora* spp., *Fusarium* spp., *Penicillium* spp., *Pseudomonas syringae*) commonly found in Mediterranean regions, recent infections caused by *Colletotrichum* spp. and *Alternaria* spp. strongly compromise citrus production in different Mediterranean countries. These can be considered to be emerging diseases which could become a serious limiting factor for citrus growers in the future.

In organic citrus orchards, pathogens are primarily controlled by the regular spraying of copper-based products. The demonstrated noxious effect of copper [Cu] on soil microbial communities and other soil fauna has led to regulatory restrictions in its use in the EU. The use of copper for crop protection purposes has been permitted in the EU to a maximum amount of 6 kg/ha/yr of metal Cu up to the end of 2018 but was reduced to 4 kg/ha/yr starting from January 2019.

According to data collected in interviews of experienced advisors in the first 6 months of the Organic-PLUS project, the old limit was, on the whole, acceptable to Mediterranean citrus growers. The only exception is in regard to lemons. Many alternative compounds to reduce or replace copper inputs are under development, but few are currently available on the market.

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WHAT ARE THE ALTERNATIVES TO CONTENTIOUS INPUTS IN MEDITERRANEAN ORGANIC CITRUS GROWING?

ALTERNATIVES TO COPPER

The previous limit of 6 kg/ha/year of copper was generally considered acceptable among organic citrus farmers and advisors surveyed in 2018. The only exception was for lemons which are particularly susceptible to Mal secco disease. Since no effective alternatives to copper are available against this disease, in years with adverse weather conditions, the new limit (4 kg/ha/year or 28 kg over 7 years from 01/01/2019) may not be considered sufficient by some organic growers.

Alternatives to copper currently in use:

Low copper grade formulations, with reduced copper content (2-6%), allow a smaller amount of copper to be applied per hectare.

Natural alternative formulations, applied to replace or reduce copper dosage, used alternately or in combination with copper. Some of them are included in Annex II to Commission Regulation (EC) 889/2008, permitted for plant protection in organic crop production.

- **Plant extracts** with biocidal properties and which stimulate plant defences.
- **Inorganic substances:** potassium salts of fatty acids and potassium hydrogen carbonate.
- **Biological control agents** with a variety of mechanisms of action against fungal and bacterial pathogens and which have a stimulating effect on plant defences. (such as *Trichoderma* spp.).
- **Seaweed extracts** such as *Ascophyllum nodosum* and *Laminaria digitata*. Laminarin extracted from *L. digitata* does not have a bactericidal or fungicidal effect, but enhances plants' resistance to pathogens.
- **Chitosan**, a natural polymer derived from chitin, reported to be directly effective against a variety of microorganisms, coupled with the stimulation of plant defence mechanisms.
- **Essential oils:** commercial formulations of citrus essential oils are approved for use in organic systems.



ALTERNATIVES TO MINERAL OILS

Mineral oils are applied in citrus orchards to control insects and mites. Their use ranges between 30-100 litres/ha/year. The wide spectrum of effectiveness of mineral oils makes them more versatile than other alternatives which currently include:

- **Soft potassium soaps**
- **Plant defence stimulators**
- **Biological controls:** *Aphytis melinus*, *Cryptolaemus montrouzieri*, *Leptomastix dactylopi*, *Amblyseius andersoni*, *Phytoseiulus persimilis*

ALTERNATIVES TO SULPHUR

The use of sulphur in Mediterranean citrus crops is generally low and restricted to certain circumstances. Application rates range between 3-6 kg/ha/year.

No alternatives are currently known to be in use.

Main goals of Organic-PLUS in relation to citrus

In laboratory and growth chamber tests, biological control agents, resistance inducers, innovative formulations, vegetable extracts, GRAS (hydrogen peroxide; potassium bicarbonate; calcium polysulphide) will be evaluated as alternatives to Cu against *Colletotrichum* spp., *Alternaria* spp., *Penicillium* spp. and *Pseudomonas syringae*.

The best of these products will then be tested in open field trials and monitored for 2 years. These trials will evaluate: (a) rate of incidence/severity, (b) susceptibility to diseases, (c) impact on crop production, (d) best application strategy (e) synergic activity between products and (f) phytotoxicity.

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