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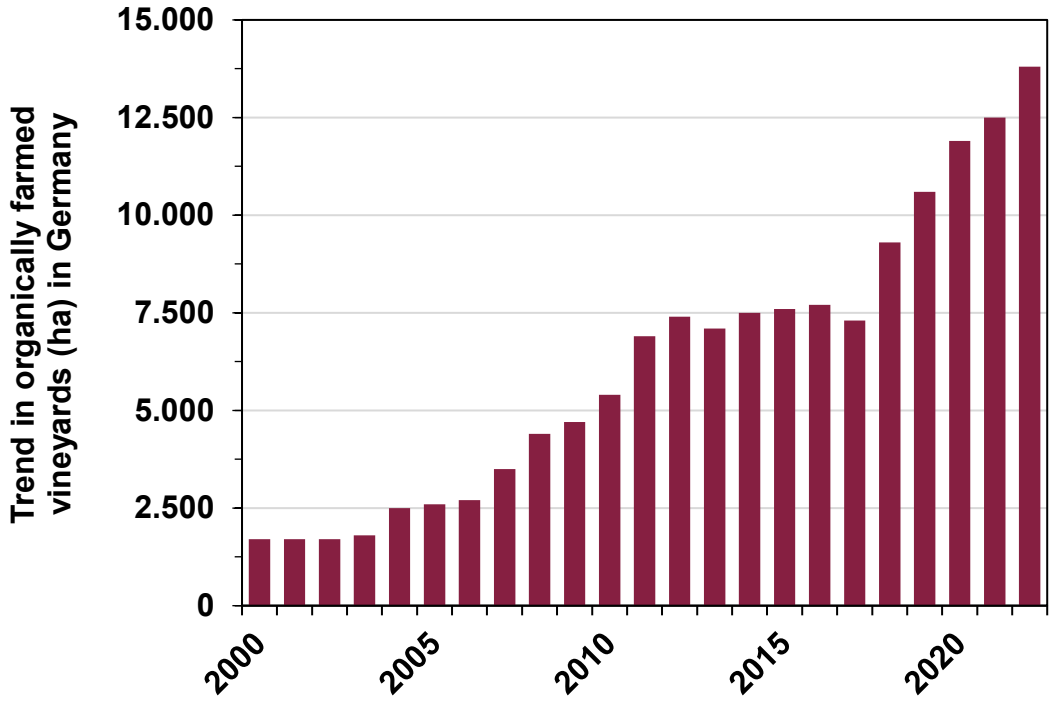
# The situation of grapevine protection and potential solutions: Potassium phosphonate for organic viticulture

Since the beginning of the new millennium, organic viticulture has become increasingly popular and important in Germany. More and more wineries are converting to organic viticulture (Fig. 1). The current organically certified vineyard acreage in Germany is approx. 13,800 ha.

**Figure 1**
**Organically cultivated vineyard acreage (ha) in Germany between 2000 and 2022**




Source: AMI Strukturdatenerhebung, DWI

This development is very positive, but it is also highly jeopardised. The reason for this is the inadequate and, in extreme cases, existence-threatening situation regarding crop protection in organic viticulture.

As a result of climate change and increasingly extreme weather conditions, the risk of high yield losses due to downy mildew (*Plasmopara viticola syn. Peronospora*) has become very high. It has reached an extent that is no longer economically viable for many organic wineries. Despite the best efforts of winegrowers and intensive research, it has not yet been possible to develop a stable crop protection strategy in all years that will secure the economic existence of organic winegrowers in extreme infestation situations such as 2016 or 2021. Some long-standing organic winegrowing businesses are considering leaving certified organic viticulture. On the other hand, many conventional wineries willing to convert are hesitant to switch to organic viticulture due to the current framework conditions and production risks. At the same time, the EU has set ambitious targets to increase organic farming at a European level to 25% by 2030.

## Grapevine protection in organic viticulture

Sustainable framework conditions for a future facing organic viticulture are needed to support the willingness to convert and to counteract negative developments.

European cultivated vines (*Vitis vinifera var.)* have no resistance of their own to the fungal diseases of downy and powdery mildew (*Erysiphe necator*, Oidium) introduced in the 19th century. They are therefore dependent on direct, preventive plant protection measures if weather conditions give rise to fears of imminent infection. In combination with climate change and the associated epidemiological conditions, the course of the disease caused by downy mildew in particular is becoming increasingly severe and can lead to a total loss of the harvest.

In years with prolonged periods of rain, economically significant harvest and quality losses cannot be averted if no effective fungicide is available for organic viticulture apart from copper.

In addition to the plant protection products currently authorised for organic viticulture that contain copper compounds as active ingredients, there are currently no known preventive measures or substances that provide sufficiently effective protection against downy mildew and are in line with the principles of organic farming, despite many years of intensive research. In Germany, leading German viticultural research institutions joined forces with organic winegrowers' associations and partners from industry and organic winegrowing in a joint project (VITIFIT) in 2019 in the search for alternatives to protect vines in organic viticulture[1]. It turned out that under local, warm and humid conditions, alternative active substances other than potassium phosphonate do not provide sufficient protection against vine peronospora[2]. Plant protection products such as COS OGA and Cerevisane do not show a reliable effect in challenging years such as 2016 and 2021, especially in regions with increased rainfall. The problem is that large-scale summer weather conditions are now often stable for long periods, i.e. wet or dry. The jet stream appears to be responsible for this. During prolonged periods of rain, the copper-containing plant protection products authorised in organic viticulture are not sufficiently effective as they are washed away by the rain. This means that the vines have to be repeatedly re-treated to protect them. The protection of new plant growth also requires a high treatment frequency.

Copper is currently listed as a candidate for substitution and is in the process of being re-authorised at EU level. This means a shortened authorisation as an active ingredient and a stricter approach in the authorisation of corresponding plant protection products. For a long time, the entire organic sector has been striving to minimise the use of copper in plant protection[3].

The use of potassium phosphonate therefore can play a key role in viticultural crop protection and the reduction of copper in organic viticulture. Potassium phosphonate was used in Germany and other

[1] Dienstleistungszentrum Ländlicher Raum (DLR) – Rheinpfalz Institut für Weinbau & Oenologie. (o. D.). *Projekt VITIFIT*. Abgerufen am 27. Januar 2024, von https://vitifit.de/news-intern/projekt/.

[2] Behrens F., Hoffmann C., Sachstandsbericht zu Kaliumphosphonat im ökologischen Weinbau, Julius Kühn-Institut (JKI), Bundesforschungsinstitut für Kulturpflanzen – Institut für Pflanzenschutz in Obst- und Weinbau, Geilweilerhof, Siebeldingen, Dezember 2023

[3] Cu-Minimierung - kupfer.julius-kuehn.de und ifoam_eu_copper_minimisation_in_organic_farming_may2018_0.pdf (organicseurope.bio)

Central and Eastern European member states until 2014 in the form of a plant strengthening agent for use in organic viticulture. Based on experience in organic viticulture, potassium phosphonate is generally very suitable for effectively combating downy mildew and reducing the use of copper whilst at the same time reducing the production risk. It supports the plant's own defence reactions and has a good effect against downy mildew. In the actual application, the protection of the vine can be increased beyond the maximum protection achievable with just copper, especially under the extreme weather conditions described above. In integrated viticulture, the supplementary use of potassium phosphonate is therefore widely used throughout the entire vegetation period.

The use of potassium phosphonate in viticulture can lead to residues of potassium phosphonate in the plant and in the wine. However, these residues can be minimised by limiting the application period (until the vine has finished flowering). According to EFSA (2012)[4], potassium phosphonates show low toxicity. No safety concerns for users, bystanders or consumers have been identified. Potassium phosphonates are neither skin-sensitising nor irritating to the skin or eyes.

Organic viticulture is recognised by society as a particularly sustainable method of cultivation. The need for plant protection in organic viticulture is and remains a reality. However, society expects that less plant protection product and where possible agents with the least ecotoxicologically harmless concerns are used in viticulture. Therefore, a new, holistic approach of suitable means and possibilities is required.

## Fungus-resistant grape varieties

In order to minimise the effects associated with the use of plant protection products, a number of additional measures are required. The increased cultivation of new grape varieties that are better able to withstand pathogens should be mentioned here first and foremost. Fungus-tolerant, partially resistant grape varieties have defence mechanisms against the diseases downy and powdery mildew. A considerable selection of these new grape varieties is now available. However, the establishment of these new grape varieties is a long and difficult process. Nevertheless, fungus-tolerant grape varieties are an important component of future-proof and sustainable viticulture.

To avoid false expectations, it is important to emphasise the danger of pathogens overcoming resistance[5]. Although the new, resistant grape varieties enable a high reduction in the use of plant protection products (up to 75%), moderate plant protection is still necessary to protect the biological resistance in the grape varieties and thus maintain it in the long term. Even the newest grape varieties cannot lead to the complete avoidance of plant protection products (e.g. copper or other fungicides) on organic land. Otherwise, the resistance of the grape variety will be overcome, and it will lose its resistance advantage.

Despite all the problems with the new grape varieties in terms of marketing and consumer acceptance, the availability of planting material is currently the biggest obstacle. Many winegrowers are prepared to plant part of their new vineyards with these new grape varieties. However, demand cannot yet be met.

[4] EFSA (2012). Conclusion on the peer review of the pesticide risk assessment of the active substance potassium phosphonates. *EFSA Journal 10*: 2963, 1-43.

[5] Johnson T. (1961) Man-Guided Evolution in Plant Rusts. *Science 133*:357-362. https://www.science.org/doi/abs/10.1126/science.133.3450.357; Peressotti E., Wiedemann-Merdinoglu S., Delmotte F., Bellin D., Di Gaspero G., Testolin R., Merdinoglu D., Mestre P. (2010) Breakdown of resistance to grapevine downy mildew upon limited deployment of a resistant variety. *BMC Plant Biol 10*:147; Wingerter C., Eisenmann B., Weber P., Dry I., Bogs J. (2021) Grapevine Rpv3-, Rpv10- and Rpv12-mediated defense responses against Plasmopara viticola and the impact of their deployment on fungicide use in viticulture. *BMC Plant Biology 21*:470. https://doi.org/10.1186/s12870-021-03228-7.

## Further aspects for increasing the existing sustainability efforts in organic viticulture

It is necessary to point out that although the results of many scientific studies on plant protection in viticulture are worthy of recognition, under the extreme infection conditions described above they are not sufficient to produce healthy grapes, the basis for every good wine. Especially in humid regions in Europe, the many extreme years lead to the most difficult growing conditions in terms of keeping the vines healthy.

The studies that have been published to date show that methods that are sufficiently effective under laboratory conditions or moderate infection conditions in the field are not effective enough in practice under extreme conditions and are therefore not really relevant[6]. It is therefore necessary to make a new, objective assessment of the overall situation of plant protection in organic viticulture.

As contact fungicides in plant protection that are prone to wash-off, copper products do not offer sufficient protection against downy mildew infections, especially in vintages with prolonged or repeated rainfall. The further development of adhesive agents can certainly offer optimisation possibilities here but will probably not be sufficient in the event of extreme precipitation. In years such as 2021 or 2016, which were characterised in parts of Europe by prolonged moisture during sensitive vine growth phases, vineyards became impassable, making it difficult to carry out the necessary plant protection measures and greatly increasing the risk of accidents.

By using potassium phosphonate, especially in the pre-flowering phase, it is possible to achieve good protection against downy mildew (*Plasmopara viticola*) while at the same time reducing the amount of copper applied to the vine. In addition, the number of pesticide applications and thus crossings in the vineyard is reduced. This increases the sustainability of organic viticulture, relieves the soil structure and improves the energy and CO2 balance.

The authorisation of potassium phosphonate would be a very useful addition to plant protection in organic viticulture, as viticulture could be made more environmentally friendly through a parallel reduction in copper, while at the same time increasing production reliability. This could be achieved by authorising the use of phosphonates in organic viticulture, either limited to certain stages or linked to climatic conditions. At the same time, this would ensure a contribution to copper optimisation and minimisation.

In Germany, intensive efforts have been underway for years to minimise copper and optimise the use of copper in organic cultivation[7]. With the current authorisation conditions for copper active substances in combination with extreme weather conditions, the ecological and economic pain threshold of many organic winegrowing operations has been reached.

[6] Behrens F., Hoffmann C., Sachstandsbericht zu Kaliumphosphonat im ökologischen Weinbau, Julius Kühn-Institut (JKI), Bundesforschungsinstitut für Kulturpflanzen – Institut für Pflanzenschutz in Obst- und Weinbau, Geilweilerhof, Siebeldingen, Dezember 2023.

[7] s. https://vitifit.de/news-intern/projekt/, Cu-Minimierung - kupfer.julius-kuehn.de und ifoam_eu_copper_minimisation_in_organic_farming_may2018_0.pdf (organicseurope.bio).

## Potassium phosphonate as a solution for more sustainable organic viticulture in Europe

The positive development of organic viticulture in Europe is jeopardised if there are no sufficiently sustainable strategies for maintaining the health of vines. People who are successful in organic viticulture have a right to be able to continue their businesses in a regular manner, i.e. in accordance with the EU legal provisions on organic farming and in a sustainable manner, i.e. ecologically, socially and economically successful. Winegrowing businesses that have been operating organically for decades report that the problems with crop protection have increased significantly in recent years due to various changes. Within the framework of existing EU legislation, successful organic viticulture is hardly possible in wet years.

The logical next step is to strengthen and further develop strategies for maintaining the health of vines in organic viticulture. The authorisation of the plant protection agent potassium phosphonate is the best and most proven alternative here. The salts of phosphonic acid, as well as phosphonate, play an essential role in prebiotic chemistry and the development of life on earth. From a scientific point of view, the salts of phosphonic acid as well as phosphonic acid and anhydrite are very reactive and highly soluble in water. They are therefore described in science as intermediate carriers in prebiotic chemistry. The discovery of phosphite oxidation to phosphate by anaerobic bacteria in marine sediments using sulphate as an electron donor closes the biological cycle of phosphorus and is regarded as essential proof of the prebiotic presence of phosphonic acid. Phosphonate has been shown to be oxidised by many different microorganisms, especially in phosphate deficiency situations. The ability to utilise phosphonate represents an evolutionary advantage for these microorganisms. A US patent for the production of phosphonate via microbial fermentation describes processes in which phosphate or phosphate rock is converted to phosphonate/hypophosphite by microorganisms under controlled, anaerobic conditions with a yield of up to 18%. Lightning strikes, geothermal fluids, metamorphic rocks and the reaction of the mineral schreibersite with water have been identified as natural abiotic sources of phosphonates. Based on these inputs and biochemical processes, it can be concluded that the substance in question is identical to nature. According to Nader et al. (2023), not only perennial crops, but also legumes (symbiotic nitrogen fixation) or buckwheat, for example, in which storage in survival organs is excluded, have been shown to have phosphonate contents, regardless of conventional or organic farming methods were applied. The formation of phosphonate by bacteria and the subsequent uptake of microbially formed phosphonate by the plant under appropriate site conditions are therefore highly probable.[8] The EGTOP stated in 2014 that phosphonates were discovered in exceptional, rare natural environments[9].

Potassium phosphonate causes a rapid natural defence reaction in the vine (induction of natural resistance mechanisms) comparable to the defence reaction in tolerant and resistant varieties. It oxidises in the soil to potassium oxide and phosphate and is thus completely available as a plant nutrient. At the same time, it can have positive effects on the soil biome.[10] In addition, potassium phosphonate has been successfully authorised and tested in viticulture in several EU member states. Without this authorisation, organic viticulture in parts of Europe cannot be maintained or expanded in its current, i.e. successful, form on the market.

[8] Nader, W., Zahm, A., & Jaschik, J. (2023). Phosphonic acid in plant-based food and feed products–Where does it come from? *Food Control*, 109701.

[9] Expert Group for Technical Advice on Organic Production (EGTOP): Final Report On Plant Protection Products (II, adopted at the 9th plenary meeting of 28-30 April 2014).

[10] Su, L., Feng, H., Mo, X. et al. Potassium phosphite enhanced the suppressive capacity of the soil microbiome against the tomato pathogen Ralstonia solanacearum. Biol Fertil Soils 58, 553–563 (2022). https://doi.org/10.1007/s00374-022-01634-z

## The EU's organic farming objective - creating a framework for more organic viticulture

The aim is to secure the future of European organic viticulture in terms of economic viability and profitability and thus achieve the target of expanding the area with organic vine cultivation to 25% (30% in Germany) by 2030. This means increasing the proportion of fungus-resistant grape varieties, further improving forecasting models, optimising cultivation conditions and, if necessary, designing the options for action for organic viticulture in plant protection in such a way that organic viticulture can also be operated economically successfully and sustainably in all wine-growing regions.

We see this as a key requirement for achieving the EU's target of 25% organic farming and for securing the future of organic viticulture throughout Europe. The potential of organic viticulture should be made accessible to wine businesses and maximised for the cultural landscapes in Europe. Many winegrowers are ready to switch to organic farming, provided that the risks involved in maintaining the health of the vines are significantly minimised. Applications for the inclusion of potassium phosphonate in the EU Organic Regulation with the restriction of its use to viticulture and only until the end of flowering[11] have failed in the past. This is why this paper gives the background for an intended renewed application for which we hope we can gain your support.

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[11] Restrictions beyond the horizontal authorisation are possible in Annex I to Reg. 2021/1165 – an authorisation in this Annex is only envisaged for viticulture.