The effect of preparations

Current test results

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The biodynamic compost and field preparations are at the heart of biodynamic farming. The first question that arises when dealing with the preparations is: Do the biodynamic preparations have an effect?

This question is very justified with application quantities of approx. 100 g of cow manure per hectare for horn manure, 4 g of quartz powder for horn pebbles and the low application quantities of compost preparations. This is difficult to imagine from a scientific point of view.

I wrote my doctoral thesis on the horn silica preparation (Fritz 2000). The work was my initiative, I was excited and committed. Whenever significant plant reactions appeared in the test results after horn silica treatment, I first went through all sources of error because the natural scientist in I couldn't imagine that the preparations would work.

As part of my doctoral thesis, I was able to see in an experiment that out of 192 pots, each containing 10 liters of soil, the 96 pots with horn silica treatment had darker bush bean leaves than the 96 pots without horn silica treatment. The pots were randomly distributed in the greenhouse during growth. This visually recognizable preparation effect in two 96 pots was just one of the many effects of the preparations. But these 96 visible repetitions particularly impressed me (Fritz 2000, p. 67). However, such an observation remains anecdotal. Therefore, scientific test results are presented in this text with appropriate repetitions and statistics.

Regardless of this, it seems important to me that practitioners also create their own comparison or test areas with and without preparations in order to check for themselves whether they can see an effect of the preparations. Pierre Masson, an experienced consultant, recommended this before and during the conversion of companies.

If the preparations have an effect, then the question is: which one? The goals that are described in the development of biodynamic preparations in Steiner's agricultural course in 1924 (Steiner 1979) are:

a) revitalization of fertilizer and soil,

b) improving plant health,

c) Improving food quality.

These goals are easy to understand. The larger heading “By Rationalizing Plant Growth” is more difficult to grasp. What does that mean and what connects these goals? For me, it means strengthening the self-organization of the plants and the soil so that the plants can better develop their predisposition - their type, their essence - even under difficult growing conditions. The goals described first are the expression of this. Type and constitution are no longer common concepts today. That's why I use the current term "increasing resilience" for the harmonization and normalization of plant growth.

Enzyme activity in the soil after horn manure administration		
	no	Horn manure treatment
Pumpkin 2012-2015	130 days	
Urease activity (mg NH3 per 1 g soil in 24 h)	0.28 a	0.54b
Sucrase activity (mg glucose per 1 g soil in 48 h)	33.22a	35.00 b
Potatoes 2013-2015	126 days	
Urease activity (mg NH3 per 1 g soil in 24 h)	0.37b	0.52 a
Sucrase activity (mg glucose per 1 g soil in 48 h)	32.60 b	37.73 a

Table 1: Enzyme activity in the soil with and without horn manure treatment. Average values from three years of field trials for pumpkin and potatoes. Different letters a and b show that the values are significantly different ($p < 0.05$).

Latest research

Over the last 45 years, the effect of biodynamic preparations has been tested in 19 doctoral theses, in two continuous fertilization experiments and in many scientific publications. Because in reviews by Geier et al. (2016), Spieß (2011) and Fritz (2009) the older test results have already been presented, in this text I will concentrate on the results of the most recent three doctoral theses

(Jukneviÿienÿ 2015, Meissner 2015, Vaitkeviÿienÿ 2016).

The experiments with pumpkin (Jukneviÿienÿ 2015) and potatoes (Vaitkeviÿienÿ 2016). The results of the field tests shown are mean values from three years of testing with four repetitions of each variant per year. Three varieties of pumpkins and potatoes were examined each year. The results presented therefore have a good database.

Table 1 shows the *enzyme activities* of urease, a nitrogen enzyme, and saccharase, a sugar enzyme, in the soil, with and without horn manure treatment. The measurement of enzymes was carried out 130 days after treatment with horn manure for pumpkin and 126 days for potatoes. A significant increase in enzyme activities was found in both pumpkin and potatoes after horn manure treatment in the soil. Different letters after the values show that the values are statistically significantly different. This supports the hypothesis of the development goal of "enhancing fertilizer and soil".

Figure 2 shows the *net photosynthesis productivity* in g per m² per day of pumpkin and potatoes, i.e. a yield parameter for the entire plant mass formed. The combined use of horn manure and horn pebbles led to productivity increases of 9 to 16% for pumpkin and 11 to 23% for potatoes. In five of the six varieties, the increase in productivity with horn manure and horn silica treatment was significant. The highest productivity increases

For pumpkin and potatoes, the values were in the variety that had the lowest productivity in the control variant without treatments. This supports the hypothesis of the development goal of "increasing resilience", harmonizing and normalizing plant growth. The individual applications of horn manure or horn pebbles led to a smaller, non-significant increase in yield.

The levels *of secondary plant ingredients,* especially the levels of antioxidants, are important parameters for food quality. Figure 3 shows the antioxidant contents of lutein and zeaxanthin (both play an essential role in human vision) and ÿ-carotene. ÿ-Carotene is a precursor of vitamin A.

Lutein, zeaxanthin and ÿ-carotene contents of pumpkin. Average values from three years of testing. Values with different letters a, b, c and d are significantly different ($p < 0.05$).

In two out of three varieties, lutein and zeaxanthin are gradually increased through a) horn manure, b) horn pebbles and c) combined use of horn manure and horn pebbles. Each treatment leads to a significant further increase in the contents. The combined application of horn manure and horn pebbles led to a significant increase of 15 to 109% in all three varieties compared to the control. What is also noticeable here is that the varieties that had low levels in the control achieved the highest increases in antioxidant levels with horn manure and horn silica.

This supports the hypothesis of the development goal of an "increasing

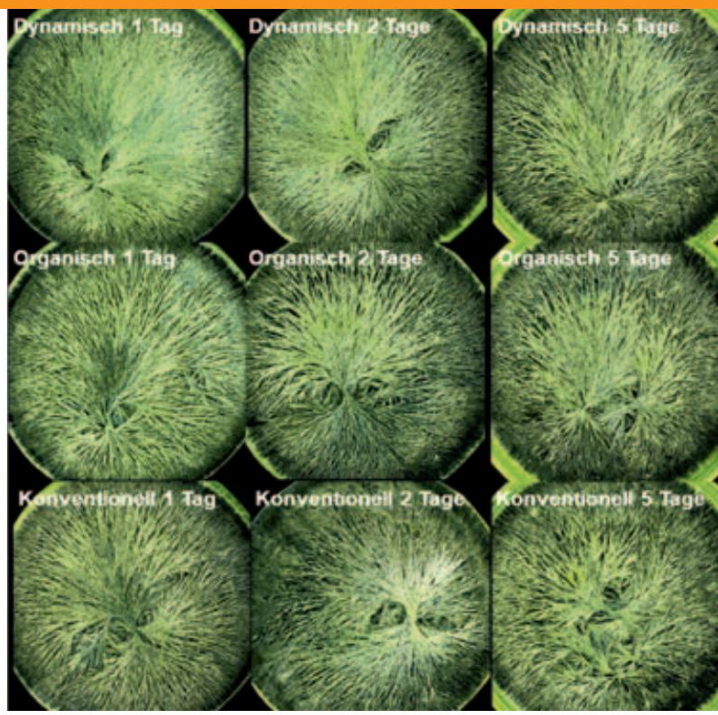

Fig. 1: Less degeneration in the order: Dynamic < Organic < Conventional. Grape juice of various types Cultivation method of Cultivation year 2010 from Long-term fertilization experiment University of Geisenheim (Meissner 2015). Store the juices for 1, 2 and 5 days at 6 °C in the refrigerator before Crystallization. All pictures included the same amount of CuCl2 and grape juice.

"Resilience" for the harmonization and normalization of plant growth. The increase in the content of the secondary plant ingredients lutein, zeaxanthin and ÿ-carotene-carotene supports the hypothesis that the development goal of the preparations is to "improve food quality".

Long-term fertilization experiment for wine

Georg Meissner's doctoral thesis (2015) was carried out in a continuous fertilization experiment (INBIODYN) at Geisenheim University. In viticulture, the following variants were compared between 2006 and 2009: Integrated - i.e. conventional organic and biodynamic. The –, organic and biodynamic variants only differ in the use of the biodynamic preparations.

From my agricultural point of view, the vine is a plant that has a tendency to grow too vegetatively. It has to be cut back twice a year. At

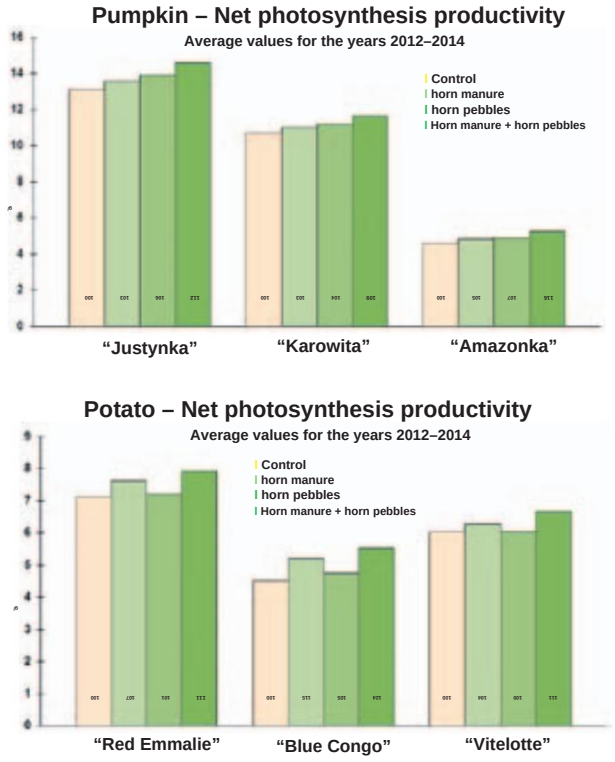

Fig. 2: Preparations - most effective in a set: net photosynthesis productivity in g per m² per day of pumpkin varieties (top) and potato varieties (bottom). Average values from three experimental years 2012–2014. Values with different letters a and b are significantly different ($p < 0.05$).

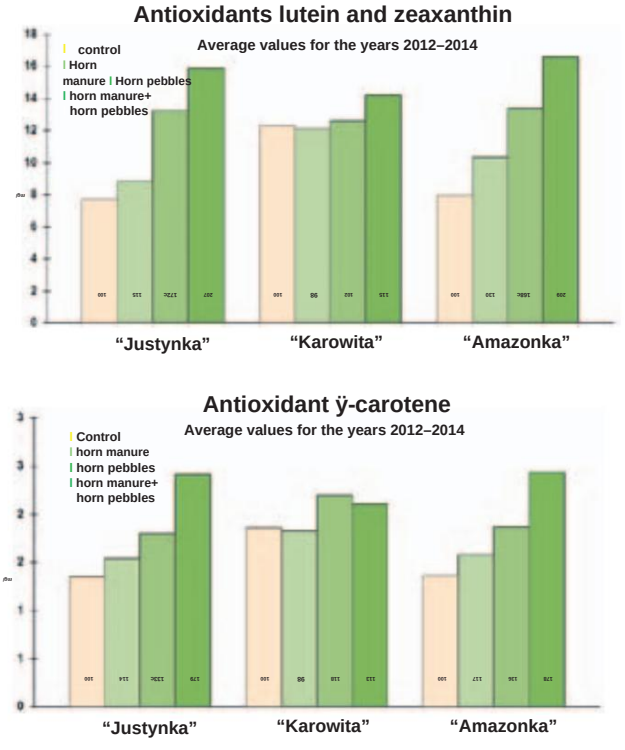

Fig. 3: Lutein, zeaxanthin and ÿ-carotene contents of pumpkin. Average values from three years of testing. Values with different letters a, b, c and d are significantly different ($p < 0.05$).

Of the wood cut between 2006 and 2009, the conventional/ integrated variant had the highest lumber weights and the biodynamic variant had the lowest *lumber weights.* The organic variant was between the two, closer to the biodynamic variant. Only the differences between conventional and biodynamic were significant.

The results of *vinegar rot infestation* of the pumpkins were credited years. The conventional/ integrated variant had the highest infestation, the biodynamic variant the lowest.
The organic variant was again between the two, closer to the biodynamic variant. This result structure was found for almost all parameters: Conventional and bio-dynamic-dynamic had the clearest differences. Organic **potato**

was between the two, closer to the biodynamic variant.

The evaluation of the individual parameters almost always led to the result that there were no significant differences between organic and biodynamic. One can therefore initially interpret the results as saying that there were hardly any significant effects of biodynamic versus organic. In statistics, principal component analysis makes it possible to analyze many **lutein** parameters evaluated at the same time. Points that are arranged together in groups have similar properties when the parameters are evaluated together. When the parameters were jointly evaluated in a principal component analysis, it was shown that the cultivation methods could be differentiated over four years on the PC 1 axis, see Fig. 4. The PC 1 axis explains 29% of the variation. **carotene**

number and primarily describes growth and disease infestation.
In the biodynamic variant, the preparations reduced the *growth parameters* somewhat more than in the organic variant.

This is desired in viticulture and promotes quality. In my opinion, the reduction in growth parameters for the vine is also an indication of increased resilience through biodynamic preparations.

Quality of life processes

Experimental results on yields, ingredients and plant ratings are very useful and important. During my experiments, I was also concerned with the question: Are there methods that are better suited to describing the quality of life processes?
I came across the image-creating methods using copper chloride crystallization.

On the one hand, the quality of life and food can be described by ingredients. We know this very well.
At the same time, the ability to form and maintain form is also important for "life". Copper chloride crystallization primarily captures the ability to form shape and, in the event of degeneration due to aging, the ability to maintain shape.

On page 39 you can see grape juice studies by the author for Georg Meissner's doctoral thesis (2015). During copper chloride crystallization, plant substance, here grape juice, is mixed with water and copper chloride salt. The liquid is crystallized on a glass plate with a 9 cm diameter at 30 °C and a humidity of approx. 53% in 12 to 15 hours. What is created are glass

plates with a crystal pattern. The crystal patterns change systematically in concentration series (more plant matter per plate) and in degeneration due to aging. The degeneration through aging of the grape juice was carried out by storing it in a refrigerator at 6 °C for several days.

Although the same amount of grape juice was used for all images, the images of the biodynamic variant with one and two days of aging had finer needle marks (Fig. 1) than the other variants. This is actually an indication of a higher amount of grape juice per picture. The images of the biodynamic variant showed less evidence of degeneration due to aging than the images of the organic variant. The images of the conventional variant most clearly showed degeneration due to aging. In terms of shape formation, degeneration due to aging occurred at different rates in the cultivation methods in the following order: Dynamic < Organic < Conventional.

Due to this different rate *of age degeneration in the formation* of the juices from the different cultivation methods, 37 samples from 39 coded grape juice samples from the Geisenheim University were correctly assigned to the cultivation methods in the five cultivation years 2006 to 2010 (Meissner 2015). In the long-term test, the organic variant only differed from the biodynamic variant in the application of biodynamic preparations. The fact that grape juice of the biodynamic variant was able to maintain its shape better during aging than juice of the organic variant is also an example of higher resilience at the level of shape formation through the use of biodynamic preparations in cultivation.

Summary and Conclusions

The test results presented here from the current three doctoral theses, like previous results, support the thesis that the goals of the biodynamic use of preparations are also reflected in the effects: revitalization of fertilizer and soil, improvement plant health, improving food quality. But the reproducibility of the plant reactions after treatments with the preparations is not as clear and simple as calculating the path of a billiard ball when it is hit. How clear the plant reactions are and the parameters in which they occur are not always the same. However, the results repeatedly show an increase in the *resilience* of the plants.

The frequency of significant plant reactions is so high that it is certain that the preparations are effective. This is also shown, among other things, by the results from three years presented here, with high agreement in three years each Varieties of pumpkin and potatoes (Jukneviÿienÿ 2015, Vaitkeviÿienÿ 2016). The work on the vine (Meissner 2015) shows that, even if the individual parameters in this work only rarely showed significant plant reactions after preparation treatments, a clear differentiation of the cultivation variants is possible when the parameters are jointly evaluated in a main component analysis was. Using the imaging methods, it was possible to assign 37 of 39 coded samples to the three cultivation methods (Meissner 2015). I

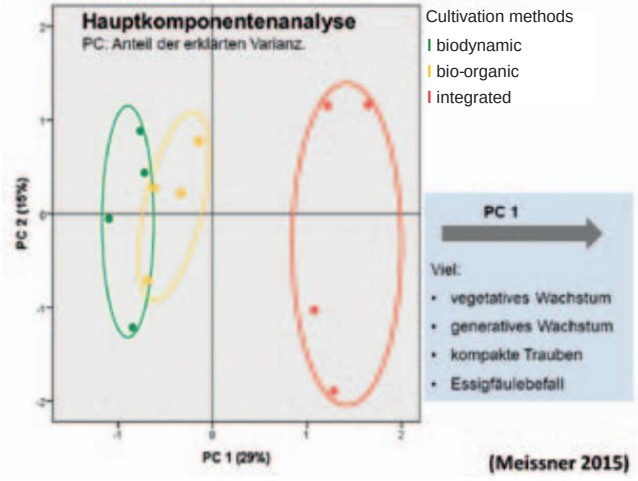

Fig. 4: Different effect patterns: Main component analysis of the continuous fertilization experiment in Geisenheim in viticulture from the experimental years 2006 to 2009 (Meissner 2015)

literature

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