A REPORT ON PREVIOUS WORK DONE WITH THE BIO-DYNAMIC HERBAL PREPARATIONS

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Introduction

The use of specifically fermented herbs in composting and manuring is an integral part of bio-dynamic agricultural management.[1] Although the experiences of practitioners and with field experiments have confirmed the beneficial effects of both the herbal preparations and the spray preparations, not as much detailed work has been done on the mode of action and actual effects of the herbal preparations as has been done with the spray preparations.[2]

A concise report is presented here of some of the experimental work done with the herbal preparations, little of which has previously been widely published. The works of L. Kolisko are omitted here as they have been published elsewhere in detail.[3] Experiments reported on here must be taken for what they are worth; further work in these areas will hopefully lead to either confirmation or rejection of the findings.

Research on the effects of these preparations can naturally be approached from two standpoints:

1) Effects observed when the preparations are applied directly to plants. In these cases the plant is employed as a biological test organism. Such work may entail variation of the growth conditions, at times with the induction of stresses to the plant.

2) The effects of herbal preparations on manures, composts, and liquid manures, and the effects of these, in turn, on plant growth.

The form of the following report will follow these two approaches.

Effects of Preparations on Plants
(see Table I)

M. Kuenzel studied the effects of various preparation seedbaths on crop plants.[4] Three-year experiments were conducted under field conditions with a preparation-crop plant combination before evaluation was concluded. Her work exists only in the form of reported results.

F. Lippert extensively observed the effects of seedbaths, foliar sprays and soil sprays produced from different preparations on the

TABLE 1

Effects of Several Bio-Dynamic Preparations on Plant Growth

Preparation	*Plant(s)*	*Mode of Application*	*Type of Experiment*	*Effects*	*Researcher*
500	All Crop Plants Tested Spinach, Chard, Beets	Seedbaths	3-Year Field Exp'ts.	General Positive*, Root Stimulation, Stronger Development	Kuenzel (1954)
	Beans, Peas, Vetch	Seedbaths, Soilsprays	Pot Exp'ts.	Higher Yields, Increased Nodulation	Lippert (1944)
	Lupines	Seedbaths	Pot Exp'ts.	Increased Root Growth	Pfeiffer (1938)
502	Grains Rye	Seedbaths	3-Year Field Exp'ts.	Starchy Grain with Lowered Protein Content General Positive*	Kuenzel (1954)
503	Peas, Beans Brassicas, White Radishes	Seedbaths	3-Year Field Exp'ts.	General Positive*	Kuenzel (1954)
	Beans, Peas, Vetch	Seedbaths	Pot Exp'ts.	Higher Yields, Increased Nodulation, Variable Results	Lippert (1944)
504	Barley	Seedbaths	3-Year Field Exp'ts.	General Positive*	Kuenzel (1954)
505	Lettuce, Bushbeans, Oats	Seedbaths	3-Year Field Exp'ts.	General Positive*	Kuenzel (1954)
507	Celery, Carrots Cucumbers Tomatoes, Potatoes, Peppers	Seedbaths	3-Year Field Exp'ts.	General Positive*, Led Plants in Direction of Tap-Root Formation	Kuenzel (1954)
	Grains	Seedbaths	3-Year Field Exp'ts.	Increased Stability Better Over-Wintering, Resistance to Heat, and Grain Formation	Kuenzel (1954)
	Legumes	Seedbaths	Pot Exp'ts.	Better Development, Increased Yields, Nodulation	Lippert (1944)

*Generally Favorable:
Better Ground Cover, Increased Root Formation, Higher Disease Resistance, Higher Yields.

development of legumes.[5] From many pot experiments conducted with a wide variety of legumes, he concluded that: 1) 507 (Valerian) has marked stimulatory effects on the development of legumes (beans, peas, and vetch). This reflected itself in higher yields and increased nodulation. 2) 500 has the same effects, but not to the same degree. 3) 503 (Chamomile) gives variable results; sometimes the above-mentioned favorable effects occurred, sometimes not. Lippert also studied the effects on pea development of ethylene gas exhaled by apples. Ethylene produced variable results, depending on the mode of application and time (in the plant's development) when applied, as well as on the length of the exposure. Effects on pea seedlings exposed for a prolonged period of time were a thickening of the root and stem, a disorientation in tropism of shoot and root growth, and a generally stunted morphology. Curling of the seedling shoot is sometimes induced. Application of preparations 501, 503, 504, and 507 appeared partially to counter these effects. Seedbaths of 503 and 504 (Nettle), most directly halted some of the initial symptoms of disturbance in the plant. The stunting effects observed over longer periods of plant development, due to the early exposure of the plant to the ethylene, were largely lifted by seedbath and spray application of the above preparations. With initial seedbaths of 503 and 507, the effects of disoriented tropism were significantly diminished. Through light exposures of the seedlings to gas it was observed that plants developed which gave higher wet and dry weights, i.e. higher dry matter contents. This effect could be enhanced by the addition of initial seedbaths of 507 (Valerian), which appeared to act synergistically with the ethylene. Similar effects were also found in field experiments with red beets where transplants were exposed to treatment with both ethylene and the preparation 503. Data was not subjected to statistical analysis, so its validity is hard to assess. In later work, Lippert mentions that 506 (Dandelion) and 503 stimulated the rooting of a wide variety of cuttings.[6] No data were brought forward to substantiate this.

E. Pfeiffer worked with the effects of the herbal preparations on the respiration of potato tubers.[7] When methylene blue was added to the tubers, the reduction of the methylene blue, which followed as a consequence of the respiration of the tubers, could be followed colorimetrically over time. Boron in the form of boric acid was applied to tubers at varying concentrations. Concentrations of 0.0006 percent led to the greatest stimulations of respiration. Solutions containing from 0.6 to 0.0006 percent of boric acid or one of the preparations 500-507 were tested for their effects. The order of stimulation (in given groupings, with no specific ordering within a group) was: 501, 502, 503, 505, 507; then the highest boron concentration; then 504 and 506 as a group; and finally the other boron concentrations. 501 showed a 15-20 percent increase of respiration over the best boron concentration. Effects achieved with boron were concentration dependent; the effects achieved with the preparations appeared concentration independent. Pfeiffer suggests that 501 may have the effect of replacing boron in the plant.

Eosin, aquinone dye (a sodium salt of tetrabromofluorescein), is another substance which disturbs the geotropic growth of plant roots.[7] If the roots of flax seedlings are dipped in an eosin bath when the roots are 3-4 mm long, Pfeiffer found that they lose their geotropic orientation in growth. This effect lasts for about 12 hours. If the roots were lightly dipped in distilled water after the eosin bath, or in solutions containing 501 or 507, those dipped in the 501 and 507 solutions showed a quicker correction of the proper geotropic growth response than those dipped in the distilled water. (See Table 2).

Table 2

Effects on roots of flax seedlings dipped in solutions containing 100 ppm. Eosin, then subsequently dipped in distilled water or Preparation 501 (73 ppm) or Preparation 507 (100 ppm).* Dipping times: 15 seconds. Plants were turned upside down after dipping. Percentage of seedling roots which grew back downward was recorded. (After Pfeiffer[7]).

Variant	*Percentage Positive Geotropism*
501 Expt.	
Untreated Roots	95
Eosin - Treated Roots	10
Eosin + 501 Treatment	87
Eosin + Distilled Water	20

Variant	*Percentage Positive Geotropism*
507 Expt.*	
Untreated Seed	24
Eosin - Treated Seed	12
Eosin + 507 Treatment	89
Eosin + Distilled Water	23

*Seeds were treated instead of seedling roots in the 507 expt. times on bathing are not presented.

Pfeiffer experimented with the effects of preparation seedbaths on the growth of radishes. Upon evaluation of the mature plants he found that the seedbaths had called forth morphological and taste differences.[8] Similar experiments carried out with barley also led to morphological differences.[9] He grew lupines with initial seedbaths of 500, 502-7, or 500+ 502-7.[10] Against a water seedbath control he found that after 13 days of growth seedbaths of 502-7 had decreased the growth of the root. 500 had stimulated it. The combination of both 500 and 502-7 in one seedbath led to plants which did not have decreased root lengths, but did have increases in the length of above-ground parts. Evaluation after 44 days of growth showed that the treatment with 502-7 decreased the weight of the above-ground parts, but when coupled with 500, increases in weight were observed. In the above-cited radish experiments, seedbaths of 502-7 +500 led to higher harvest weights than did treatments of 500 alone.[8] Seeds given the latter treatment showed greater weights than the control. Trial variants consisted of 20 plants; seedbath concentrations were not stated. Inimical effects obtained by using 502-7 in one seedbath for plants have also been noted by Kuenzel.[4]

To investigate interactions between nutrient factors and preparations, Pfeiffer grew maize seedlings in Knop solutions modified so as to be calcium-deficient. He found that small additions of 500, 503, and 505 to the solutions positively effected the growth of the seedlings.[11] This is of interest with respect to the intended effects of these preparations.[12]

I. Voegele investigated the effects of seedbaths of the different preparations on the growth of wheat.[13] He grouped the morphological differences called forth in the plants into two types. The growth type which is called forth by 500, 503, and 505 was found to be similar to growth types produced by excessive manuring, fertilization with soluble nitrogen fertilizers, or compact soil. Voegele speaks of this type as the "Calcium or Limestone" type. The plant shows a voluminous, somewhat bulky morphology; growth tends more to the horizontal. Preparations 501, 506, and 507 produced a somewhat more slender and vertical growth type, which was similar to effects called forth by light and warmth. Voegele speaks of these forms as constituting a "Silica" growth type. When sowing was done according to the phases of the moon, it was observed that the calcium type was called forth by the waxing phases and the silica type was called forth by the waning phases of the moon.

With all the work mentioned above, statistical analysis was not carried out on the data. It is difficult, therefore, to speak from that standpoint on the significance of the results. Often the work was not sufficiently described in the reports.

Effects of Herbal Preparations on Manures

The fact that the herbal preparations specifically affect the composting of manure by increasing the Cation Exchange

Capacity of the organic materials of the piles (the C.E.C./C ratio), was discovered in a number of cases by work done in a project between the Darmstadt B.D. Research Center, Hohenheim University, and a state agricultural testing institute. Funding was from the German Federal Government.[14]

Pfeiffer experimented with small cow manure piles kept under laboratory conditions with mostly anaerobic fermentation conditions.[15] He found: 1) The herbal preparations produced an inhibitory effect on the surface mould of manure piles in one experimental situation; 2) The preparations appeared to produce nutrient levels (nitrate, potassium, ammonia) that were different from the control piles.

In another experiment with manure-straw-soil mixtures, Pfeiffer found an apparently increased humification and change of smell, as well as increased nitrate levels, when piles had received the herbal preparations.[15] This was also a laboratory-conducted fermentation. Pfeiffer did not specify what the compost/preparations ratio was in this case.

U. Abele recently completed a three-year work project with liquid manure under funding from the German Ministry for Nutrition, Agriculture, and Forestry. The goal of this was to work out satisfactory methods with liquid manure to help reduce noxious smells, stabilize the nitrogen content, decrease negative effects on sensitive plants, and to better its nutrient availability and effect on yields.[16] He experimented with varying additions of straw, sawdust, barkmeal, compost, peat, bentonite, and the herbal preparations to cow and pig liquid manures. Pot and field experiments with cress, mustard, ley, red beets, and spinach were carried out to ascertain quality differences. With anaerobic fermentation the 0.5 percent addition of bentonite, as well as the addition of the herbal preparations, effected significant yield increases. The herbally treated, aerated liquid manure significantly bettered plant responses in all applications, as against the simply aerated liquid manures. Statistically significant increases in yield and, in part, better quality characteristics were found. In leys, aeration had the effect of eliminating "burning effects" as well as increasing the speed with which soils transformed the liquid manure. Addition of bentonite and of the herbal preparations with aerated liquid manure induced higher amounts of clover in the leys. The preparations effected a lower keeping quality for red beets and spinach. The liquid manure favorably affected root growth. Application of the preparations appeared to drop the ammonia contents of the liquid manure. From experiments done with individual preparations, it was seen that 503 exercised a stabilizing effect on the total nitrogen and dropped the ammonia levels of the manures. This ammonia reduction also appeared with 504 (Stinging Nettle). In cress seedling bio-assays with these tests, the 503-treated liquid manure gave the best results, closely matched by the variants which had received all the preparations.

H. Koepf conducted experiments to study the effects of prepared and unprepared liquid manures on wheat seedling development.[17] He found positive effects of the prepared liquid manure over the unprepared with respect to both size and dry weight differences. The results were statistically significant.

Discussion: Effects of the preparations have been observed indicating both *stimulatory and varying regulatory effects.* The latter were clearly seen with the case of *tropic* responses, when disorientation was caused by treatment of plants with ethylene or eosine. *Morphological* disturbances of pea seedlings due to exposure to ethylene gas appeared to be, in part, corrected by the addition of the various preparations. The ethylene effect on peas has been well studied by other authors.[18,19] It has been shown that treatment of dark-grown seedlings leads to several deeply-seated disturbances, resulting in:

1) a thicker and shorter stem and root; wider cells (cortex) with thickened cell walls.
2) curling of the apex of the seedling sprout.
3) disturbance of protein formation leading in the direction of the accumulation of hydroxy-proline rich proteins in the cell walls and low protein levels in the cytoplasm.

These biochemical responses (especially the hydroxy-proline rich protein synthesis) are similar to the natural responses of the matured plant when in flower.

Towards reviewing the potential significance of the preparation effects in relationship to ethylene, we quote from E. W. Russell's *Soil Conditions and Plant Growth:*[20] "Poor aeration affects root growth and functioning principally through products of reduction metabolized by bacteria when using an anaerobic metabolism; the root itself contains efficient cytochromeoxidase systems." "When the soil is first flooded and decomposition begins, a number of gases are given off; but until the advent of gas chromotography it was not possible to identify them. It is known that apart from nitrogen and nitrous oxide produced from the reduction of nitrates, hydrogen gas and a range of low molecular weight hydrocarbons are produced. These include methane, ethane, propane and N-isobutane and ethylene, propylene and butene 1, but do not include any acetylenic compounds. The production of these compounds only occurs in the initial stages of waterlogging and typically ceases after a few days, and the rate of production roughly parallels that of nitrous oxide, showing that it takes place under mild reducing conditions. . .Ethylene production begins within a few hours of the oxygen concentration of the soil falling below 1 percent, so it is presumably brought about by organisms that are also active in aerated soils, that is they are presumably facultative anaerobes. . .

"Ethylene is the only one of these hydrocarbons to have a marked effect on root development of many crops. . . Plant roots differ widely in their reaction to ethylene. Thus the seminal roots of tobacco and tomato will have their rate of elongation reduced by 75 percent if the solution contains 1 ppm of ethylene, and this concentration will reduce the rate of elongation of barley roots by 60 percent and of rye roots by 25 percent, but will not affect the rate of elongation of several varieties of rice. Even 0.3 ppm will reduce the rate of growth of barley roots by 50 percent, although this concentration is without effect on rye. Wheat and oats become intermediate between rye and barley. The sensitivity of these plants to ethylene is in line with field experience, for tomatoes and tobacco are known to be very intolerant of water-logging, and rye and wheat are known to be more tolerant than barley.

"Ethylene will persist in poorly drained soils in the field for periods of weeks, particularly in the sub-soil. . .It is very probable that the ethylene content of many poorly drained soils is a more common source of damage to crop growth than lack of oxygen or high CO_2 content in the soil.

"Field observers have often noted what they consider to be the crop wilting under these conditions, but the collapse of the leaf from the upright position may be due to an epinastic effect rather than to a wilt."

It can therefore be suspected that under the extreme conditions brought about by waterlogging, ethylene becomes a growth-limiting or pathological factor. It should also be considered, however, that the soil often contains anaerobic pockets and that ethylene is probably always naturally present when this is true. Many experimenters have shown that the effects of ethylene on plants are avoided when CO_2 concentrations are high, CO_2 acting as an antagonist to ethylene, so that the soil probably normally exists in a sort of balance with respect to ethylene effects on plant growth.[21]

The possible regulatory effects of the preparations with respect to unbalanced nutrient solutions were pointed out by Pfeiffer. That humic substances from manure composts may have regulatory effects also on maize grown in unbalanced or in intensified nutrient solutions has been shown by Fernandez.[22] Effects of several preparations on the respiration of potato tuber slices indicates possible effects directly on the metabolism of plants.

Although statistically unconfirmed, the work of Lippert on legume growth and nodulation with respect to seedbaths was far from cursory and seemed to indicate a definite stimulation due to 500, 507, and at times 503.

Results with composted manure indicated increased exchange capacity of the organic material due to the addition of the preparations. Pfeiffer's work was difficult to evaluate but seemed to show some fungistatic effects, changes in nutrient availability, and in one case, accelerated humification due to the herbal preparations.

As it has been established that the composting of farmyard manure leads to progressive increases in the exchange capacity of the organic materials,[23] it may be the above two findings which have led many B.D. people to the conclusion that the preparations lead in effect to an accelerated humification. Whether this is a positive virtue or a negative one is a matter of considerable debate, but it is not yet established that this is an actual effect of the preparations.

Work with liquid manure indicated decreased ammonia contents with similar total nitrogen contents due to the preparations. Preparation 503 also seems to exercise a stabilizing effect on the total nitrogen.

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