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Research Article

An Experimental Test of a Biodynamic Method of Weed Suppression: The Biodynamic Seed Peppers

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Abstract: An experimental test of a biodynamic agriculture method of weed suppression was carried out in growth chambers to establish the feasibility of the method as a preliminary to field trials. Four generations of *Brassica rapa* plants were used in a randomized block design. Treated flats received ashed seeds prepared according to biodynamic indications. Seed weight and counts were measured at the end of each generation, and germination of the control and experimental seed was investigated at the end of generation four. The biodynamic seed peppers, created and applied as described here, had no effect on seed production or viability, and did not effectively inhibit reproduction of the targeted species over the course of four consecutive treatments.

Keywords: Biodynamics; biodynamic agriculture; weeds; invasive plants

1. Introduction

Invasive plants (weeds) create serious ecological problems in both agricultural and natural systems. With each introduction the risks of detrimental effects increase. The intruders usually lack natural enemies to control their proliferation, often grow quickly, and can become major pests [1]. These conditions have necessitated the development of methods for removing or controlling the invasive plant. Unfortunately, invasive species control is costly, often involves the use of chemicals, and is often not appropriate for use in natural areas [2,3]. Under these conditions it is worthwhile to investigate alternative methods of invasive plant control, even if they are unconventional.

There are five currently accepted methods of weed control [3]: mechanical removal or destruction; prescribed fire; grazing; biological control; and the use of herbicides. These methods can be used alone or in combination, and are intended to produce a maximum effect on a targeted weed while minimizing harmful effects to the landscape. All but the last of these are acceptable organic practices. Unfortunately, all five approaches contain some risk of damaging habitats in which they are used, and all lack complete efficacy.

The damage caused by invasive species is massive. The annual damage has been estimated at U$33 billion, out of a total crop agricultural production of approximately U$267 billion in the United States [4]. Clearly, safe, efficient and cost effective methods for controlling or eradicating invasive species are badly needed.

In 1924 the founder of the first organic system of agriculture, Rudolf Steiner, proposed a method of weed control as part of his system of biodynamic agriculture [5]. This method uses an ash prepared from the seeds of the weed that is to be controlled, a “pepper”, that is spread over the affected area. Steiner asserted that this treatment, when properly prepared to take advantage of the forces of the moon, will eradicate the treated species after four years of applications. Although there are numerous anecdotal reports on the efficacy of this method [6] (Grant Lyon, Jon Lyerly, Hugh Courtney, personal communications), there have been no peer-reviewed tests of its efficacy.

Steiner's method for controlling a weed infestation is relatively simple. One collects the seeds of the weed and burns them over a wood fire at the proper moon phase. The resulting ash is then scattered over the affected area. Steiner claims that after two years of treatments there will be a noticeable reduction in the population of the weed. After four years of treatments the weed will cease to inhabit the treated area [5]. In order to test these claims we investigated Steiner's method of weed control under controlled growth chamber conditions, and measured its effects on seed production and seed viability over four generations.

2. Methods and Materials

Four generations of *Brassica rapa* L. plants [7] were grown under continuous light at 22° C in controlled environmental chambers (Environmental Growth Chambers, model: GCW15) at the University of North Carolina at Greensboro. *Brassica rapa* was chosen because it has a life cycle of approximately 45 days under continuous light, and because its seeds are retained within the fruit at maturity. Many weeds spontaneously release their seeds making it difficult or impossible to determine the reproductive output of the plant. Seeds were obtained from Carolina Biological Supply Company (Wisconsin Fast Plants, standard rapid cycling), and the Rapid Cycling Brassica Collection in Maddison, WI (www.fastplants.org; standard rapid cycling, RCI). We used four consecutive generations of the experiment to simulate the four years Steiner claimed would be effective in eradicating the weed.

Following Steiner's indications, we created the seed pepper by burning the seeds over a wood fire within 24 hours of the full moon (i.e., during the early waning moon) [5]. As the pepper was mixed with wood ash as a result of the combustion process, a second wood fire with no added seeds was used to create control replicates of untreated ash. The two fires were burned side by side, at the same time. The ashed seeds and wood ash were crushed to a powder using a mortar and pestle, and the resulting pepper and control ash were weighed and divided into equal packets to be spread over the flats.

The experimental apparatus consisted of twenty perforated half-flats (35.6 × 35.6 cm), 10 for the control group and 10 for the experimental group. Each flat was filled with approximately 3 L of Fafard 3b soil mix (Conrad Fafard Inc., U.S.). Thirty seeds were planted in each flat, two per hole, approximately 3mm below the soil surface.

Each flat was randomly assigned to either the control or treatment group. The 10 experimental flats were dusted with equal amounts of the seed pepper at the beginning of each generation, while the 10 control flats were treated with equal amounts of wood ash at the same time. All 20 flats were placed in growth chambers in a randomized block design. Soon after germination each flat was thinned to contain only fifteen seedlings, one per hole. For the length of the experiment the flats were watered through a reservoir system. Each flat received 1 L of water every other day. In order to assure continued plant health in the nutrient poor soil mix, generations 3 and 4 were fertilized once a week with Peter's 20–20–20 general purpose water soluble fertilizer (Scott's Co. LLC., U.S.). The fertilizer was mixed at a dilution of 0.24 L of fertilizer to 94.6 L of water. One liter of the fertilizer mixture was substituted for water every 7 days.

Brassica rapa requires cross pollination to set seed [8]. The pollen is sticky, and not easily susceptible to being carried by the wind [8]. Under field conditions outcrossing is accomplished primarily by physical contact between neighboring plants, presumably due to plant swaying [8]. In our growth chambers the flats were placed approximately 15 cm apart to minimize contact between plants in different flats. Pollination was accomplished by using bee-sticks, dehydrated bee thoraxes glued to the ends of small sticks (www.fastplants.org). Individual bee-sticks were assembled for each flat, and used only for pollinating within that flat. This restricted pollen flow to each flat. Plants were pollinated over a five day period beginning on day 17 of each growth period.

On day 35, watering was discontinued and the plants were left undisturbed for one week to allow for the maturation of the seeds. At the end of the maturation period, seeds from each flat were harvested and kept separate. Seeds produced from a particular flat were used to plant the next generation of the experiment in that same flat.

For all but the second generation, the seeds from each half-flat were weighed in aggregate. In generation two, which produced few seeds, the number of seeds per flat was counted directly.

To assess differences in mean seed production in each generation, one-tailed t-tests under the assumption of equal variances were performed with SPSS version 19 or 22 [9,10]. One-tailed tests were used because Steiner's hypothesis predicts lower seed numbers/weights following treatment with the seed peppers. The t-tests for generations one, three and four compared mean seed weights per treatment, while in generation two the number of seeds produced between the control and experimental groups was compared.

We also checked for differences in percent germination between the control and experimental groups using the seeds produced from the final generation.

3. Results

There was no significant difference between seed set in the control and experimental groups in any of the four generations (Table 1). Germination rates were not significantly different between seeds of the two treatments after four generations (Table 2). In all cases, Levene's Test for Equality of Variances was not significant. In generations two and four the control group produced fewer seeds than the experimental.

Table 1. Four generations biodynamic seed pepper treatments.

Gen.	Treatment	Seed number (mean ± SE)	Seed weight (g; mean ± SE)	p-value	95% CI
1	Control		2.44 ± 0.44	0.46	−0.44; 0.49
1	Experimental		2.42 ± 0.55		
2	Control	43.9 ± 8.5		0.46	−50.85; 46.05
2	Experimental	46.3 ± 21.5			
3	Control		11.0 ± 2.0	0.23	−3.14; 6.7
3	Experimental		9.22 ± 1.22		
4	Control		2.08 ± 0.20	0.15	−0.81; 0.26
4	Experimental		2.35 ± 0.15		

(Gen.: generation; SE: standard error; CI: confidence interval)

Table 2. Germination rates after four generations.

Treatment	Number seeds germinated (± SE; out of 30)	p-value
Control	22.70 ± 1.34	0.11
Experimental	24.70 ± 0.86	

(SE: standard error)

4. Discussion

Under the conditions detailed here we observed no decrease in seed viability or production in *B. rapa* with treatment with a biodynamic seed pepper.

We attribute the low seed production of generation two to the exhaustion of nutrients from the already nutrient-poor potting soil. The addition of fertilizer at the beginning of generation three restored normal yields.

The fact that the control group in generation four showed lower seed production (2.08 g versus 2.35 g), and had a lower germination rate (22.7/30 versus 24.7/30 seeds) than the experimental group is contrary to Steiner's prediction, though these results are not statistically significant.

Prior to carrying out this work, we performed preliminary experiments to test the effect of Biodynamic seed peppers on seed germination of okra seeds (*Abelmoschus esculentus* L. Moench) [11,12]. These experiments yielded negative results after three generations of treatments. An experiment testing the effects of a biodynamic pepper prepared from the burned skin of the brushtail possum (*Trichosurus vulpecula Kerr*) in New Zealand also gave negative results [13]. Similar negative results were obtained by Bächi-Kunz using a BD pepper to control the Red Flower Beetle (*Tribolium castaneum Herbst*) [14].

The most extensive series of experiments with the biodynamic seed peppers was performed in Germany over a seventeen year period, but the results were never published outside a little known conference proceeding [15], which was unknown to us until after we completed our experiments. Spieß tested the seed peppers on dandelions (*Taraxacum officinale* F.H. Wigg.) and other agricultural weeds growing in open fields, and in a variety of containers. The effects of the peppers on seed germination were also investigated. Biodynamic agricultural practices were used throughout these trials. In the field experiments, various preparations of the peppers were spread annually on the experimental fields, while no treatment was applied to the control fields. Three separate types of ash preparations were used on separate experimental plots: ash prepared at the full moon, ash prepared at the new moon, and ash prepared to a homeopathic potency of D8 following the suggestion of Thun [16]. Results of the treatments were measured as the number of dandelion inflorescences produced per square meter (Figure 1). Negative results were observed during the first four years, in which the number of inflorescences in the control group was consistently less than those of the experimental group. In the remaining thirteen years, Spieß observed only four years in which the control groups showed a higher number of inflorescences than the experimental groups (1988, 1993, 1995, 1999) but there was no consistent pattern of inflorescence production between the control and experimental groups, or even within the experimental treatments themselves. All groups had similar low production in some years and similar high production in others, regardless of treatment regime (Figure 1).

These results, and those reported here, will undoubtedly evoke debate within the biodynamic community over how the ash was prepared, and the susceptibility of Steiner's methods to experimental verification, though Spieß' extensive work using a variety of preparation methods on established biodynamic fields should mitigate these criticisms. Some critics will undoubtedly claim that Steiner's methods are effective, but cannot be verified in controlled experiments. These claims are in direct contradiction to Steiner's own expectations that his methods should, and would be verified experimentally [5].

In terms of ash preparation, Thun [16] has suggested that effective preparation should take both lunar position and zodiacal sign into consideration. She goes so far as to suggest that the moon's position in the zodiac is specific for a given species of weed, whose seed should only be burned when the moon is in that constellation. She also recommends that the ash be prepared in specific homeopathic potencies for effective use. Steiner's original presentation

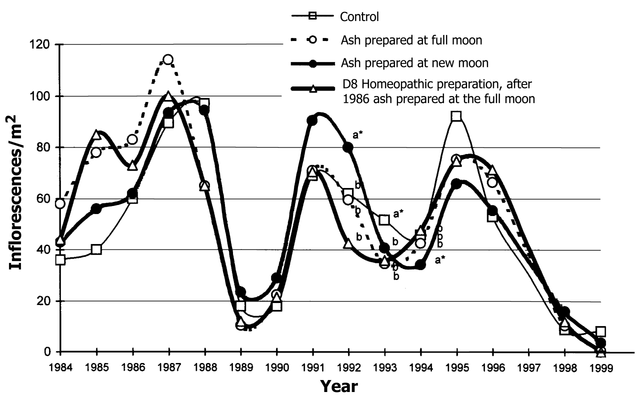

Figure 1. Results of a 17 year study (data was not collected for the first two years) on *Taraxacum officinale* occurrence after application of a BD seed pepper. Asterisks (*) indicate treatment/years where there was a significant difference in yield at the 0.5 level (Modified after [15], with permission).

of his method gives no specific recommendation on either the position of the moon in the zodiac, or in fact of any astrologically beneficial configuration for burning the seeds [5]. His published method is clearly and simply stated. The farmer is to gather the seeds, burn them and spread the ash "taking no special care to do so". In handwritten notes for the lecture in which he proposed this method, Steiner did give an indication of a favorable lunar position, burning during a waning moon. These notes were published in English in the 1993 edition of his Agriculture Course, which was used as the source for our methods [5]. Recommendations on zodiacal positions and homeopathic potencies arise from Thun's own research, which has not been peer reviewed [16]. We find Thun's recommendations implausible, given that Steiner's much simpler method has failed to yield positive results, and given Spieß' failure to achieve results using homeopathically prepared peppers (Figure 1) [15].

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