The effect of a homoeopathic preparation of sweetpotato whitefly (*Bemisia tabaci* Genn.) in the control of the invasion of tomato plants (*Lycopersicon esculentum* L.) by sweetpotato whitefly

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A dissertation submitted in partial compliance with the requirements for the Masters Degree in Technology in the Department of Homoeopathy at Technikon Natal.

I, Angela Moira Carey, hereby declare that the research and results presented in this dissertation are of my own work and have not been presented for any other degree at another University or Technikon.

Approved for final submission.

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Dedication

To John Carey, my father, for always believing in me and encouraging me when I didn't believe in myself. Thank you for making it possible for me to study such a wonderful career.

To Dorothy Carey, my mother, for always being there for me and for helping me realise in times of stress that if I had tried my best that was good enough.

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Abstract

The most common and difficult insect to control in the greenhouse is the whitefly. Sweetpotato whitefly (*Bemisia tabaci* Genn.) was the species of whitefly selected to be investigated in this trial. Sweetpotato whitefly is a major pest on a variety of plants, ranging from ornamental flowers to agricultural crops such as tomato and cotton, resulting in important financial losses. Effective control options of sweetpotato whitefly are limited.

The aim of this study was to investigate the relative effectiveness of a homoeopathic substance as an insecticide, in the control of sweetpotato whitefly on tomato plants (*Lycopersicon esculentum* L.), as compared to an agrochemical and natural insecticide, Lannate® (methomyl) and a garlic (*Allium sativum* L.) extract, respectively.

Seven different substances were used as insecticides: four different potencies of sweetpotato whitefly preparations (9CH, 30CH, 200CH and 1M) were used as the homoeopathic substances, Lannate® as the agrochemical insecticide, an extract of garlic as the natural insecticide and a control using non - potentised, distilled water. All the treatments were sprayed onto the plants once a week.

A randomised block trial design was used consisting of 56 trays, containing six plants each, with a total of 336 plants. The whiteflies were caught from invaded plants and introduced onto the tomato plants. Yellow sticky traps were set up and a count of whiteflies was taken twice weekly, using a hand magnifying lens.

After a period of six weeks the plants were cut off at ground level and placed into an oven for 48 hours to dry. The dry weights of the plants were taken, in order to determine if any of the treatments had any effect on the growth of the plants, assuming that whitefly feeding would reduce dry weight of unprotected tomato plants.

The results showed no significant differences between any of the treatments. However, a trend was evident that the Lannate® counts were lower than any of the other counts. In regard to the dry weights of the plants, a block effect was evident.

The results suggest that either the trial design was incorrect and cages were needed around each tray, in order to decrease interplot interference, or that the whitefly population tested was resistant to the carbamate group of insecticides.

The homoeopathic substances investigated in this trial were prepared according to the isopathic principle, and proved not to be effective as an insecticide against sweetpotato whitefly. However, this does not exclude the homoeopathic practice as an alternative to agrochemical methods. Other substances prepared homoeopathically may be effective. Perhaps it would be better to use a remedy that will "treat" the plant, thereby helping the plant to become stronger, and thus able to fight against the invasion of sweetpotato whitefly instead of aiming the remedy at the insect.

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Definition of terms

Carbamates - Insecticides derived from carbamic acid, where mode of action is that of inhibiting cholinesterase activity, thereby affecting the nervous system (Ware, 1986).

Homoeopathy - Homoeopathy is a therapeutic method which clinically applies the "Law of Similars" and which uses medicinal substances in infinitesmal doses (Jouanny, 1991).

Isopathy - Treatment of disease by means of the presumed exopathic or endopathic casual agent, or by a product of the manifestation of the same disease (Gaier, 1991).

Organophosphates - A generic term which includes all insecticides containing phosphorus, derived from phosphoric acid. They are generally the most toxic of all pesticides to vertebrate animals. Like the carbamates, their mode of action is to inhibit cholinesterase activity (Ware, 1986).

Pesticide - Any substance used for controlling, preventing, destroying, repelling, or mitigating any pest. The word pesticide is a broad term which covers a large number of more accurate names such as, insecticides, herbicides, fungicides, etc. (Ware, 1986).

Potentization - Potentization is a physical process through which latent curative powers of medicine are aroused into activity, though these may not have been evident in their crude states. By this process, quantitative deconcentration of drug substance occurs as qualitative increment takes place (Gaier, 1991).

Succussion - The action of shaking up vigorously a liquid dilution of a homoeopathic medicine in its phial or bottle, where each stroke ends with a jolt, usually by pounding the hand engaged in shaking action against the other palm (Gaier, 1991).

Chapter One

Literature Review

1. 1 Identification of the sweetpotato whitefly (*Bemisia tabaci* Genn.)

The sweetpotato whitefly is a flying insect belonging to the family Aleyrodidae. This family belongs to a larger classification, order Homoptera, which all possess piercing-sucking mouthparts. Sweetpotato whitefly hold their wings "rooflike" over their bodies, at an angle of about 45 degrees. They are approximately 1,5 mm long and appear white owing to white powdery wax secretions, hence the common name whitefly. Whiteflies have six life stages (Fig. 1), the egg, the crawler, two nymph instar stages, the pupa and the adult. The life cycle of sweetpotato whitefly takes approximately 39 days to be completed. Species identification is always done at the pupa 1 stage. The pupa of sweetpotato whitefly is domed shaped, with no raised parallel sides. It lacks a fringe of long filamentous projections around its periphery. It usually has several pairs of filaments arising from the upper surface of the pupa which are fairly short (Fig. 2) (McHugh, 1991).

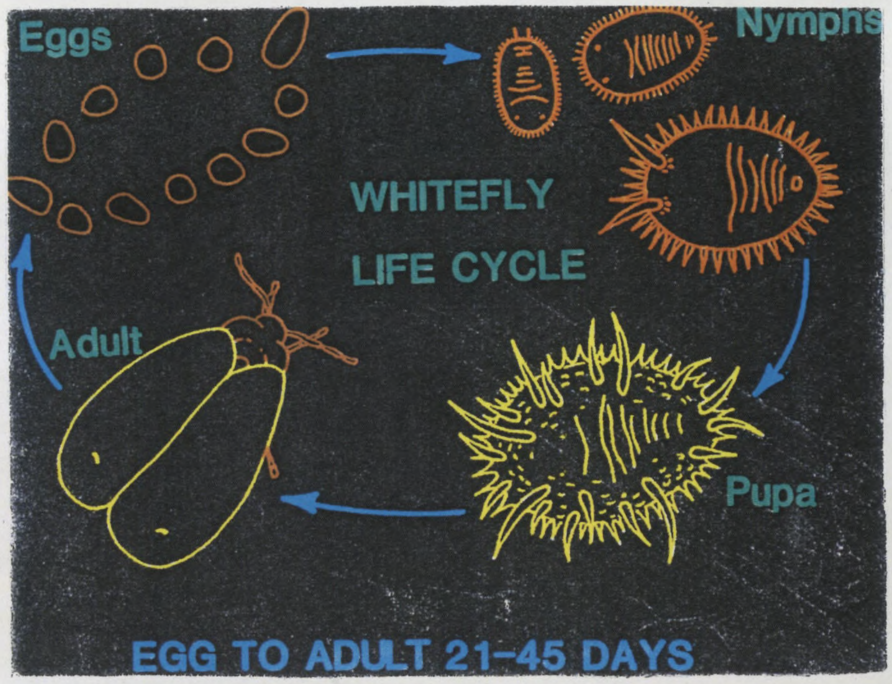

Figure 1 - Whitefly life cycle (McHugh, 1991)

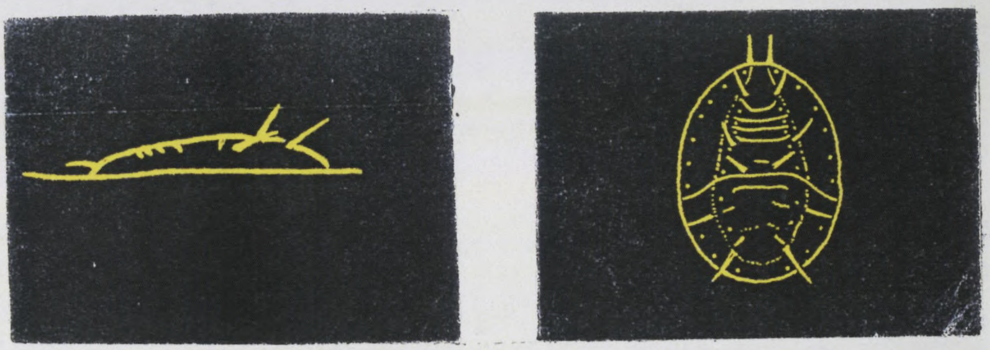

Figure 2 - Pupa of sweetpotato whitefly (McHugh, 1991)

1.2 Feeding preferences

Colour is the most important factor in sweetpotato whitefly's selection of a host plant. Sweetpotato whitefly is attracted most strongly to yellow/green, hence the use of yellow sticky traps in the management of sweetpotato whitefly. The hairiness of the leaf is another distributing factor to the selection of the host plant. Sweetpotato whitefly tend to prefer moderately hairy leaves. The direct effect of leaf hairiness may be twofold: hairs provide a physical protective barrier and they provide a favourable microclimate (Gerling, 1990). Sweetpotato whitefly are known to select ornamental plants; e.g., poinsettias, gerbera, hibiscus, petunia and agricultural plants; e.g., tomato, eggplant, cucumber, cotton and tobacco as host plants (McHugh, 1991).

1.3 Damage caused by sweetpotato whitefly

Although sweetpotato whitefly had been identified in various agricultural regions throughout the southern United States prior to 1980, few outbreaks were recorded. Then in 1981, a serious outbreak of sweetpotato whitefly occurred in the Imperial Valley of California where populations grew to enormous densities on cotton, leading to entire cotton fields being killed (Fig. 3). Thus the importance of sweetpotato whitefly as a major pest was brought to the fore (Toscana *et al*, 1998).

Figure 3 - In 1981, high densities of sweetpotato whitefly feeding on Imperial Valley cotton killed entire fields and contaminated cotton lint with honeydew (Toscana *et al*, 1998)

Sweetpotato whitefly causes direct feeding damage to plants by sucking the sap of the plant tissue, using their piercing-sucking mouthparts. The sap is then digested and large quantities of excrement, referred to as honeydew, is produced. Honeydew is sticky by virtue of its high sugar content and thus provides an ideal substrate for the growth of fungi called sooty moulds. The sooty moulds cover the leaf surface, thereby interfering with photosynthesis, causing symptoms such as chlorosis, mottling and tissue death (McHugh, 1991). Whitefly indirectly cause damage to plants due to the ability of whitefly to transmit virus diseases. The tomato yellow leaf curl geminivirus (TYLCV) is specifically transmitted by sweetpotato whitefly. (Blancard, 1994). TYLCV may be the most damaging virus to tomatoes because if the plants are infected at an early stage of growth, fruit fail to be produced, resulting in yield losses of up to 100%. Plants infected by TYLCV have leaves that are yellow, except for the margins, and which tend to curl upwards, resulting in a small, crumpled appearance (Fig. 4). Plants that are infected at an early stage have stunted growth, with new shoots growing straight upwards, resulting in small, compact bushy tops that are commonly referred to as 'broccoli` or 'bonsai` plants (Fig. 5) (Gilbertson *et al*, 1998).

Figure 4 - Symptoms of tomato yellow leaf curl geminivirus in leaves of an infected tomato plant (Gilbertson *et al*, 1998)

Figure 5 - A plant infected at a young age, resulting in 'broccoli' or 'bonsai' plants (Gilbertson *et al*, 1998)

1. 4 Control measures

1. 4. 1 Agrochemical control

The traditional means of control of whitefly has been the use of agrochemicals. In greenhouses, the most commonly used insecticides are classified under the organophosphate, carbamate, synthetic pyrethroid and chlorinated hydrocarbon groups (McHugh, 1991). Due to the frequent use of insecticides to control whitefly, a strong selection pressure has been placed on it, resulting in the development of resistance to the effective classes of insecticides (Gerling, 1990). Resistance occurs due to superior ability of individual insects to metabolise an insecticide. In others, the rate of penetration and transport of the chemical to the site of action may be reduced, while yet others may succeed in detecting and avoiding insecticide treated surfaces. Some are merely less sensitive. Those that survive spray applications because of genetic characteristics will transmit these traits to the next generation. Through repeated selective action by subsequent sprays, a resistant population can eventually develop (Giliomee and Glavovic, 1992). Studies on whitefly resistance reported by Castle *et al.* (1996), show that before 1997 in the San Joaquin Valley countries of Kern and Tulare, insecticides bifenthrin and chlorpyrifos killed all the whiteflies in insecticide coated yellow sticky traps, whereas in 1997, yellow sticky traps showed that bifenthrin and chlorpyrifos applied at the rates recommended on the labels killed only 35 - 92% and 30 - 87% of the whiteflies, respectively (Toscano *et al*, 1998).

Methomyl (Lannate®) was the agrochemical insecticide used in this study as it has been effective in the control of sweetpotato whitefly (Laing, personal communication, 1998). Lannate® is classified under the carbamate group of pesticides. Both carbamates and organophosphates are effective by virtue of their ability to affect the nervous system by inhibiting cholinesterase synthesis (Ware, 1986). Cholinesterase is an enzyme present in the synaptic junction between a nerve and an effector organ; i.e., gland, muscle or nerve. When the electrical impulse of a nerve transmission arrives at a synapse, it is transmitted across the synapse by a chemical agent, acetylcholine (Ach), which is released into the synaptic cleft. Ach moves across the synapse to attach to receptors on the other side, which triggers the next electrical nerve impulse. Any left over Ach is attacked by cholinesterase which splits Ach into acetate and choline, so that choline can then be actively transported back into the terminal to be used once more for synthesis of new acetylcholine. If cholinesterase activity is inhibited, Ach levels in the synapse are affected, thereby interfering with nerve transmission (Fig. 6) (Guyton, 1987).

Lannate® not only affects insects in this manner but has the same effect on humans, if direct exposure occurs. Early symptoms of carbamate exposure include weakness, dizziness and sweating. Headaches, salivation, vomiting and diarrhoea are also common. Later symptoms include constricted pupils, lack of co-ordination and slurred speech. Tightness of the chest and coughing may lead to respiratory depression and death (Spencer and Willcutt, 1997).

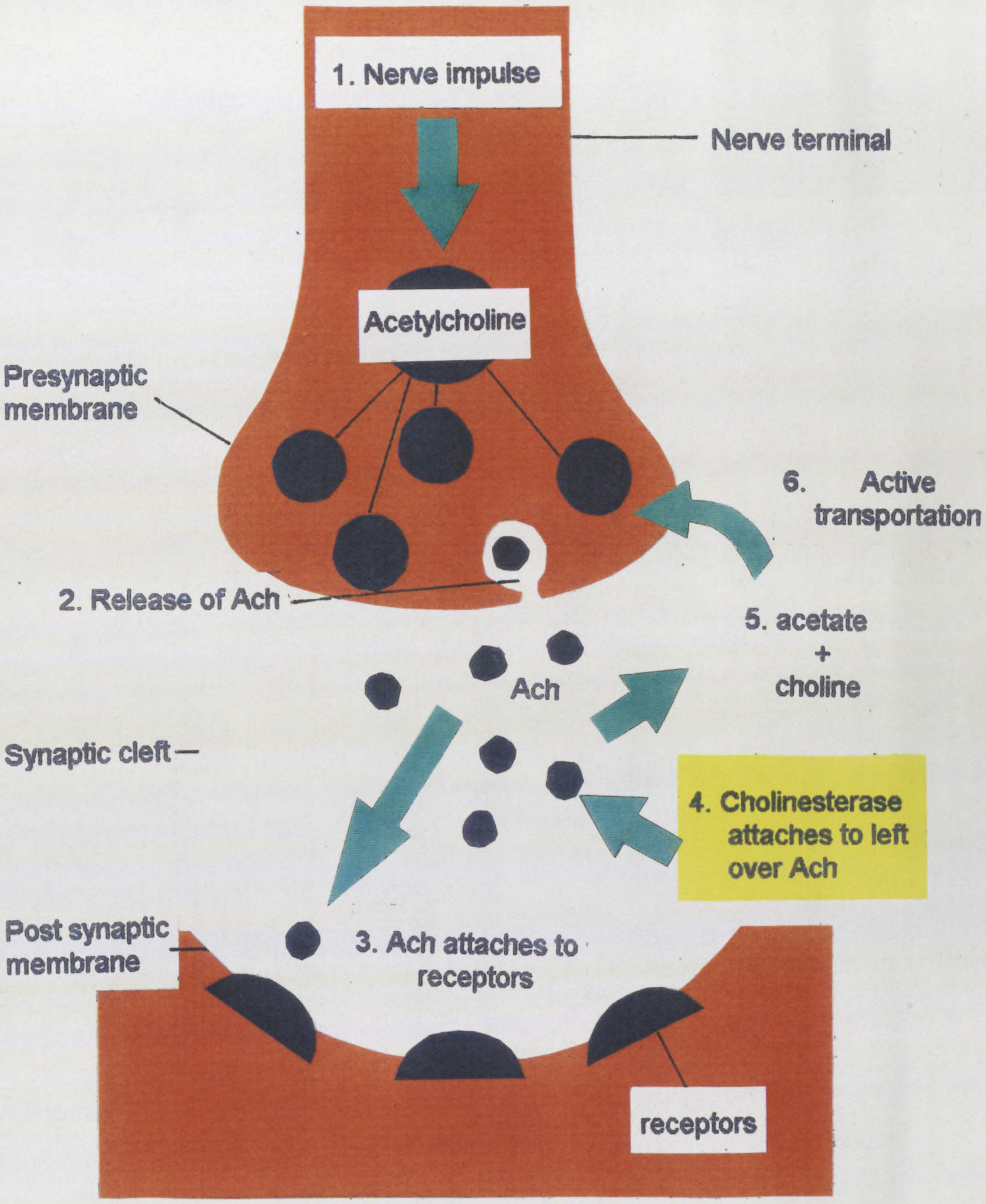

Figure 6 - The role of cholinesterase in nerve impulses

There is a growing concern over the toxic effects that the use of pesticides has on humans and other non- target organisms. Investigations have shown that some agrochemical pesticides may have carcinogenic properties (Giliomee and Glavovic, 1992). Reports from investigations done on agricultural workers directly exposed to pesticides have shown that higher death rates occur within this group from malignant brain tumours and testicular cancer than the average population, not subjected to direct exposure of pesticides (Arnold, 1992).

Environmentalists also point out that pesticides may cause the death of non-target organisms; e.g., vultures may be killed when poison is placed by farmers in sheep, in an attempt to poison troublesome carnivores like the black-backed jackal. Guinea-fowl and blue cranes can also be killed when wheat or maize lands are sprayed or seeds treated with insecticides. The pesticides may also kill useful natural predators of the targeted organism, thereby adding to the problem (Giliomee and Glavovic, 1992).

It is not only the direct exposure to the pesticide that is a threat but indirect exposure of the general population through food residues, may also cause chronic toxicity. Pesticide residues in food are of major concern, given the great range of pesticides used, the variety of products in which they can occur and the many marketing outlets for foodstuffs, which means that it is very difficult to obtain adequate monitoring of food residue levels in food produce (Giliomee and Glavovic, 1992).

1. 4. 2 Natural control

With the growing concerns about the harmful effects of agrochemicals, and the increasing occurrence of resistance to pesticides, alternative, non - chemical, less harmful pest management strategies are being investigated. New trends in pest management strategies include practices such as introducing natural predators of the pest, companion planting, diversification and variety planting, and the use of natural pesticides (Caplan, 1992). Investigations into biological control are being done on whiteflies. A small wasp called *Encarsia formosa* Gahan has proven to be a natural enemy of the greenhouse whitefly, *Trialeurodes vaporariorum* Westwood. However, in the investigations of *E. formosa* in the control of sweetpotato whitefly, the results were disappointing. Sweetpotato whitefly is not a preferred host of *E. formosa* which means that *E. formosa* does not reproduce well on sweetpotato whitefly. Research conducted in Israel has shown that a small, black lady beetle, *Delphastus pusillus* LeConte, has been successful in controlling both *T. vaporariorum* and sweetppotato whitefly on flowering potted plants. However, further investigations are still needed (McHugh, 1991).

Dr Lance Osborne of the University of Florida has also isolated a fungus, *Paecilomyces fumosoroseus,* that safely kills sweetpotato whitefly. Here too extensive testing is still needed before it can be available as a commercial product, but Osborne found it to be 99% effective in killing sweetpotato whitefly in all stages of development (McHugh,1991). Another alternative in the greenhouse would be to plant African marigold (*Tagetes minuta* L.) as it is considered to ward off whitefly. It is suspected that the strong smell of marigold is the cause of the repellent action on whiteflies (Caplan, 1992).

Garlic was selected to be used in this trial as a natural insecticide, on the basis of research done by Hori (1996). Garlic and onion oils were used against the aphid, *Myzus persicae* Sulzer, to investigate the effect on feeding and settling inhibition. The investigations were done with an assay system consisting of EMIF (electronic measurement of insect feeding behavior), no - choice-, choice tests and a toxicity test. In the no - choice tests, aphids rarely settled on the sealing film which covered the diet containing garlic oil and most of them died. In the choice test, both oils strongly prevented the aphids from settling. In the toxicity test, both oils indicated toxicity, and the toxicity of garlic oil was higher than that of onion oil.

1. 4. 3 Homoeopathy as an alternative

Another alternative would be to use homoeopathic preparations as natural insecticides. Homoeopathy is an alternative, holistic medical practice discovered by a German physician, Dr Samuel Hahnemann, during the early 1800's. The term homoeopathy is derived from the Greek words "homoes" and "pathos" meaning "similar suffering'" (Dancu, 1996). In order to understand homoeopathy, knowledge of the Law of Similars is essential, as this is the basic concept of homoeopathy. The original Hahnemannian homoeopathic Law states: "Similia similibus curentur", which translates as "let likes be treated by likes" (Rawson, 1972). Even before Hahnemann's time, Hippocrates recognised the Law of Similars and stated, "when a natural substance is given to a healthy individual, symptoms will arise; when that same substance is ingested by someone that is ill with similar symptoms, it acts as a curative" (Dancu, 1996). For example, if Belladonna (Deadly Nightshade) were to be taken in its natural form, symptoms such as high restless fever, thirst, irritability, a hot burning skin, and a burning sore throat and ear would be provoked.

However, when Belladonna is taken in its homoeopathic form, it is curative for a person with similar symptoms, who is restless, has a high fever, is thirsty, burning hot, irritable, with an acute inflammatory sore throat or ear infection (Smith, 1982).

Homoeopathic remedies are prepared by a process of serial dilution and succussion (vigorous shaking) (Fig. 7). The potencies and strength of a remedy relate directly to the degree of serial dilution, that is, the higher the dilution of the mother tincture, the greater the power of the remedy to act. Homoeopathic dilutions are most commonly prepared according to either a decimal or centesimal potency. The decimal or 'x' potencies are prepared by diluting 1 drop of substance to 9 drops of alcohol or water (1:9). The centesimal or 'c' potencies are prepared by diluting 1 drop of substance to 99 drops of alcohol or water (1:99). The centesimal dilutions seem to be favoured by homoeopaths as higher dilutions are available, i.e., CM or 100,000c which have a stronger and longer-lasting effect than the lower dilutions (Dancu, 1996).

Isopathy, a therapy used by homoeopaths, is very similar to homoeopathy excepting instead of using a remedy that is like (similar) to the disease, a remedy that is the same as the disease is used; “iso” meaning “same” (Gaier, 1991). Thus in this trial, sweetpotato whitefly was chosen as the remedy against an invasion by sweetpotato whitefly. An example of this type of treatment would be to give a person suffering from diphtheria the homoeopathic remedy Diptherinum.

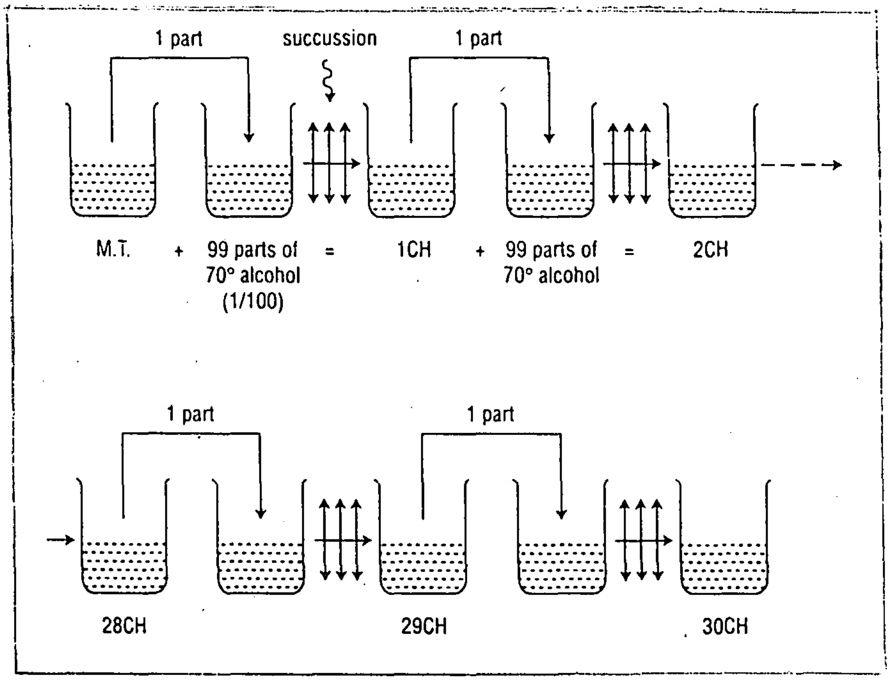

Figure 7 - The process of serial dilution (Gaier, 1991)

1.5. Homoeopathy and Botany

1. 5. 1 Homoeopathy and plant growth

The stimulus for much of the work on the effect of homoeopathic potencies on the growth of plants was provided by Kolisco, who conducted various research between 1923-1959 (cited by Kayne, 1991). He performed numerous experiments to demonstrate the effect of homoeopathic dilutions, mostly on wheat seeds, finding that growth was promoted by 'lower' dilutions, inhibited with higher dilutions and finally stimulated at even 'higher' dilutions (Kayne, 1991).

Betti *et al.* (1994) carried out two experiments (1991/2 and 1992/3) where homoeopathic potencies of Arsenicum album were tested for their effect on seed germination. A randomized trial was conducted, using a wide range of decimal potencies of homoeopathic preparations of Arsenicum album and a control. The results showed that the effects of the 25x, 40x and 45x potencies of Arsenicum album were significantly different to the control. Parametric statistical tests showed that the differences between the treatment groups could not be explained as a mere effect of intrinsic seed variability.

In a further study, Betti *et al.* (1997) performed a blind laboratory experiment in order to show the effect of using Arsenicum album 45x on wheat seedlings poisoned with a material dose of Arsenicum album. It was found that there was a positive effect that was limited to the stem length, which showed significant recovery increasing with treatment time, whereas root length was not affected by the homoeopathic treatment.

Pongratz *et al.* (1993) revived an experiment performed by Kolisko (1924), which studied the influence of three decimal potencies of silver nitrate on the growth of wheat seedlings in the presence of toxic levels of silver nitrate. The potencies used were 24x, 25x and 26x. A significant difference between the effects of the homoeopathic preparations and the control was demonstrated. The length of the stalk was significantly greater in the group treated with silver nitrate 24x than that of the control.

Pelikan and Unger (1971) provided statistically significant evidence that potentised substances do have an effect on plant growth in their experiment on the effect of potentised silver nitrate on the growth of seedlings. The experiment involved a series of 40 growth trials that were repeated six times, using a range of potencies from 8x to 19x. Each series exhibited the same type of curve, a three part growth curve rising from potencies 8x to 14x, falling to 16x and then rising again.

1. 5. 2 Homoeopathy and plant fungi

Bernard (1912) found that low concentrations of homoeopathic preparations of manganese had a stimulatory effect on the development and formation of conidia of *Aspergillus niger* in culture (Scofield, 1984).

Khanna and Chandra (1978) performed both *in vitro* and *in vivo* evaluation of some homoeopathic remedies in the treatment of *Pestalotia mangiferae,* the causal agent of mango fruit rot. The remedies used in the study were Arsenicum album, Kali iodatum, Lycopodium clavatum, Phosphorus, Thuja occidentalis, Asvagandh, Blatta orientalis, Zincum sulphuricum, Filix mas and Kalium muriaticum. Fungitoxicity of the remedies was determined in terms of the inhibition of spore germination of the causal fungus. Each remedy was tested in potencies of 1-200 which were prepared in sterile distilled water. Each replicates was replicated tree times. The results showed that Phosphorus 50, Lycopodium clavatum 190, Asvandh 100, Arsenicum album Potencies 1, 89 and 90 and Zincum sulphuricum Potencies 1 and 2 completely inhibited the spore germination. These remedies were then screened for their efficacy in treating the fruit rot, both preventatively and curatively. It was demonstrated that Lycopodium clavatum Potency 190 was the most effective remedy in both types of treatment, reducing the percentage fruit infection as well as percentage rot.

This remedy was shown not to have caused any change in amino acid, amide, organic acid, sugar and Vitamin C content of the fruit. It was recommended for the treatment of mango fruit rot caused by *P. mangiferae.*

McIvor (1980), cited by Kayne (1991), reported success in treating fruit trees isopathically using homoeopathic dilutions of *Taphrina deformans*, the fungus causing peach leaf curl. A fine hole was drilled into the tree trunk about six inches above ground level and a 6CH potency was injected under pressure.

In research conducted by Brammer (1994), the effect of a homoeopathic preparation of *Perenospora parasitica* (downy mildew) in the treatment of *P. parasitica* on cabbages (using the principle of isopathy) was studied. Her results showed that the 'lower' potencies (15CH and 9CH) always stimulated the disease, whilst the 15CH and 30CH potencies lowered the disease incidence when applied over a short time. This suggests that "higher" potencies decreased the disease incidence when compared to the "lower" potencies.

1. 5. 3 Homoeopathy and plant viruses

Various workers have tested the effect of homoeopathic remedies in controlling or preventing virus infections in plants. Verma *et al.* (1969) tested a variety of homoeopathic remedies, selected from those used in human medicine for the treatment of diseases whose symptoms are suspected to be caused by viruses, against the symptoms caused by tobacco mosaic virus (TMV) in local lesion and systemic hosts. A variety of homoeopathic remedies were claimed to have an inhibitory effect on virus multiplication rate and local lesion production. Singh and Gupta (1985) found that homoeopathic remedies can inhibit plant viruses in local and systemic infections, increase resistance of plants if applied before infection, and increase the incubation period, thus slowing the rate of reproduction of the plant viruses, which slows down an epidemic.

In a study by Webb (1997), a "higher" potency (200CH) as well as several "lower" potencies (6CH, 12CH and 30CH) were used in the homoeopathic control of Tobacco Mosaic virus. The results showed that the "lower" potencies (6CH, 12CH and 30CH) all had a stimulatory effect on the disease. However the 200CH provided some control of the virus on a prophylactic basis.

No references were found in the literature on the subject of homoeopathy and insect control.

Chapter Two

The Trial

2. 1 Aim

The aim of the trial was to investigate the relative effectiveness of a homoeopathic preparation of sweetpotato whitefly, as compared to an agrochemical and a natural insecticide, namely Lannate® (methomyl) and garlic extract, respectively, in the control of sweetpotato whitefly invasion of tomato plants. Two parameters of efficiency were measured, namely, the number of sweetpotato whitefly present and the dry weight of the plants.

2. 2 Trial design

A randomised block design was used in this trial (Fig. 8). There are several distinct advantages of using this type of experimental design. The plots (individual trays) are compact and contain a sufficient number of individual seedlings to obtain a good normal distribution. This ensures that the size of the trial remains manageable and can include a statistically representative number of repetitions. In addition, the use of seedlings as host plants reduces the duration of the experiments, thus allowing a greater number of trials to be conducted in any one growing season (Brophy and Laing, 1992).

Block 1		Block 2		Block 3		Block 4	
Control	-plot 1	200CH	-plot 8	Lannate	-plot 15	30CH	-plot 22
Lannate	-plot 2	1M	-plot 9	200CH	-plot 16	Garlic	-plot 23
Garlic	-plot 3	30CH	-plot 10	control	-plot 17	9CH	-plot 24
1M	-plot 4	9CH	-plot 11	30CH	-plot 18	control	-plot 25
200CH	-plot 5	Garlic	-plot 12	9CH	-plot 19	1M	-plot 26
30CH	-plot 6	Lannate	-plot 13	1M	-plot 20	200CH	-plot 27
9CH	-plot 7	control	-plot 14	Garlic	-plot 21	Lannate	-plot 28

Block 5		Block 6		Block 7		Block 8	
30CH	-plot 29	Lannate	-plot 36	9CH	-plot 43	200CH	-plot 50
Lannate	-plot 30	1M	-plot 37	Lannate	-plot 44	30CH	-plot 51
9CH	-plot 31	200CH	-plot 38	30CH	-plot 45	Garlic	-plot 52
Garlic	-plot 32	control	-plot 39	1M	-plot 46	9CH	-plot 53
1M	-plot 33	30CH	-plot 40	200CH	-plot 47	control	-plot 54
Control	-plot 34	9CH	-plot 41	Garlic	-plot 48	Lannate	-plot 55
200CH	-plot 35	Garlic	-plot 42	control	-plot 49	1M	-plot 56

Figure 8 - Diagram of an example of a randomised block design. Note that each treatment appears once in each block, and that the order is randomised within each block.

This experiment consisted of one trial containing seven treatments repeated in eight blocks (eight replicates). The seven treatments used were 9CH, 30CH, 200CH and 1M potencies of a homoeopathic preparation of sweetpotato whitefly, as well as one agrochemical and one natural insecticide, namely Lannate® and a garlic extract, respectively. The seventh treatment was distilled water (non-potentised), so that it could be established if the least effective treatment provided any means of control at all. There were therefore 56 trays in the trial, containing six seedlings each. Computerised randomisation (Appendix C) of the trays was performed and the trays numbered accordingly, in order to eliminate subjectivity and interplot interference.

2. 3 Materials

Tomato seeds obtained from the Plant Pathology Department of the University of Natal, were first planted into 24 cell seedling trays. A composted pine bark seedling mix was used, (Gromed Organics). Two seeds were planted into each cell to ensure 100% seed germination. These seedling trays were then left in the greenhouse belonging to the Plant Pathology Department of the University of Natal for a period of four weeks, where an automatic irrigation system ensured watering of the seeds twice daily. After the four- week period, the seedlings were transplanted into six pack trays so that each cell contained one seedling only. Fifty - six, six pack trays were used in the trial, adding up to a total of 336 tomato plants.

The seedlings were already being invaded by sweetpotato whitefly that were already present in the greenhouse. However, to ensure that the population of sweetpotato whitefly was great enough, more sweetpotato whitefly were introduced, which were caught with the use of plastic bags, from invaded plants on Mark Laing's property.

The seven treatments used to spray the tomato plants were:

- Lannate® (methomyl) obtained from Grovida Horticultural Products c. c. (Durban).
* Garlic extract donated by the Plant Pathology Department of the University of Natal.
* Homoeopathic preparations of sweetpotato whitefly in four different potencies, i.e., 9CH, 30CH, 200CH (donated by Pharma Natura) and 1M (bought from Natura).
* Distilled water

The treatments were sprayed onto the plant foliage by means of seven high pressure sprays (Efekto Polyspray 2), supplied by the Plant Pathology Department of the University of Natal.

Yellow sticky traps, obtained from AgriBiol (Cape Town)[1] were used to catch the sweetpotato whitefly so that the whitefly could be counted. Two steel droppers were placed on either side of each row of trays and fishing line tied between the droppers. One Yellow sticky trap per tray was then numbered and set up by pegging them from the fishing line, to hang down vertically amongst the top plant foliage (Fig. 9). The sweetpotato whitefly count was done by means of a hand magnifying lens.

[1] AgriBiol
P.O. Box 16388, Vlaeberg 8018
012 4618097

2.4 Methods

2.4.1 Remedy preparation

The collected sweetpotato whitefly were prepared to a 3CH potency at the Technikon Natal homoeopharmaceutical laboratory. This was done according to the method used in the homoeopathic remedy preparation of *Apis mellifica* L. (honey bee) as is laid out in the German Homoeopathic Pharmacopoeia (1985) (Appendix 2). The 3CH was then couriered to Pharma Natura (homoeopharmaceutical laboratory) where the remedy was prepared according to Method 4b (Appendix 3) as is laid out in the German Homoeopathic Pharmacopoeia (1985) to one potency below the required potencies used in the trial (i.e., 8CH, 29CH and 199CH).

The 1M potency was prepared by Natura (homoeopharmaceutical laboratory), from an 8CH potency of sweetpotato whitefly, as this was the lowest potency available.

The 8CH, 29CH and 199CH potencies were then prepared to one potency above the given potencies by the researcher in 150ml amber bottles. A dilution of 1% was used; i.e., 0,8ml potentised substance to 79,2ml of alcohol was used to make up an amount of 80ml of the required potency, which was then successed 10 times.

The final preparations were then prepared from the 9CH, 30CH, 200CH and 1M potency levels into the one litre, high pressure sprays. A ratio of 1: 99 was used, i.e., 1part (5ml) of potentised substance to 99 parts (495ml) of distilled water. Distilled water was used instead of alcohol because alcohol has an adverse effect on plant cell metabolism, leading to cell destruction (Jackson, 1991). Thus the final preparations used were all dilutions of a 1% level.

Figure 9 - Photograph showing the yellow sticky traps

The final garlic extract preparation was prepared according to a ratio of 1 part (50ml) of garlic extract to 10 parts (500ml) of distilled water.

Lannate® was used at the registered rate, diluting 2ml of Lannate® in 500ml of distilled water. A fume cupboard was used when preparing the Lannate® as a precaution and protective clothing, i.e., gloves and a face mask, were always worn during the preparation process, as well as the spraying of the plants.

2. 4. 2 The Trial

Table 1: Flowchart of method followed:

The tomato seeds were planted into 24 cell trays

↓

The trays were then placed into the greenhouse and left for a period of four weeks to grow

↓

The four week old seedlings were then transplanted into six pack trays

↓

All the six pack trays were numbered according to the computerised randomisation and laid out accordingly

↓

Sweetpotato whiteflies caught from Mark Laing's property were introduced to the tomato seedlings

↓

The tomato seedlings were left for another week, so that the sweetpotato whitefly population could be established and settled

↓

The seven treatments were prepared into separate high pressure sprays, using the Plant Pathology Department's laboratory, every Monday

↓

The seedlings were then sprayed once a week with the seven treatments after 13h15, once the automatic irrigation system had completed its last irrigation cycle

↓

The plants were removed according to the computerised randomisation numbering and each group of plants sprayed with the particular treatment separately, as not to interfere with the different treatments

↓

On the first day of the trial, the plants were sprayed with the seven treatments but a sweetpotato whitefly count was not taken

↓

The yellow sticky traps were then set up

↓

A sweetpotato whitefly count was then taken on Thursday of the same week, and from then on, twice weekly (every Monday and Thursday), until twelve counts had been made

↓

After six and a half weeks the seedlings were harvested, by cutting them with secateurs at ground level (Fig. 10) and placed into numbered brown paper packets

↓

The packets were then placed into an oven at 100 °C for 48 hours to dry

↓

The dried plants were then weighed

↓

The insect counts (in the form of total count and AUCCC) and the dry weights were statistically analysed by analysis of variance (ANOVA), using the program Statsgraphics

Figure 10 - Photograph of the process of cutting the stems of the plant at ground level

2. 5 Results

2. 5. 1 Results of the trial

The biweekly counts were processed by the use of a transformation process, the area under the cumulative count curve, AUCCC. This computer program integrates the multiple counts into a single figure which reflects the insect counts over the total counting period.

TABLE 2: SUMMARY OF THE RESULTS

Treat-ment	Cumula-tive count	Rank	Mean AUCCC	Rank	Dry weight(g)	Rank
Garlic	9289	3	3933.25	3	11.25	1
Lannate®	7413	1	3127.13	1	10	5
Control	9704	6	4109	6	9.63	7
1M	9353	4	3960.75	4	9.88	6
200CH	9534	5	4097.38	5	10.5	3
30CH	9739	7	4130.75	7	10.75	2
9CH	8936	2	3829.13	2	10.38	4

AUCCC:	F-Ratio = 0.630	P = 0.7055	Not significant
Dry weight:	F-Ratio = 0.490	P = 0.8122	Not significant

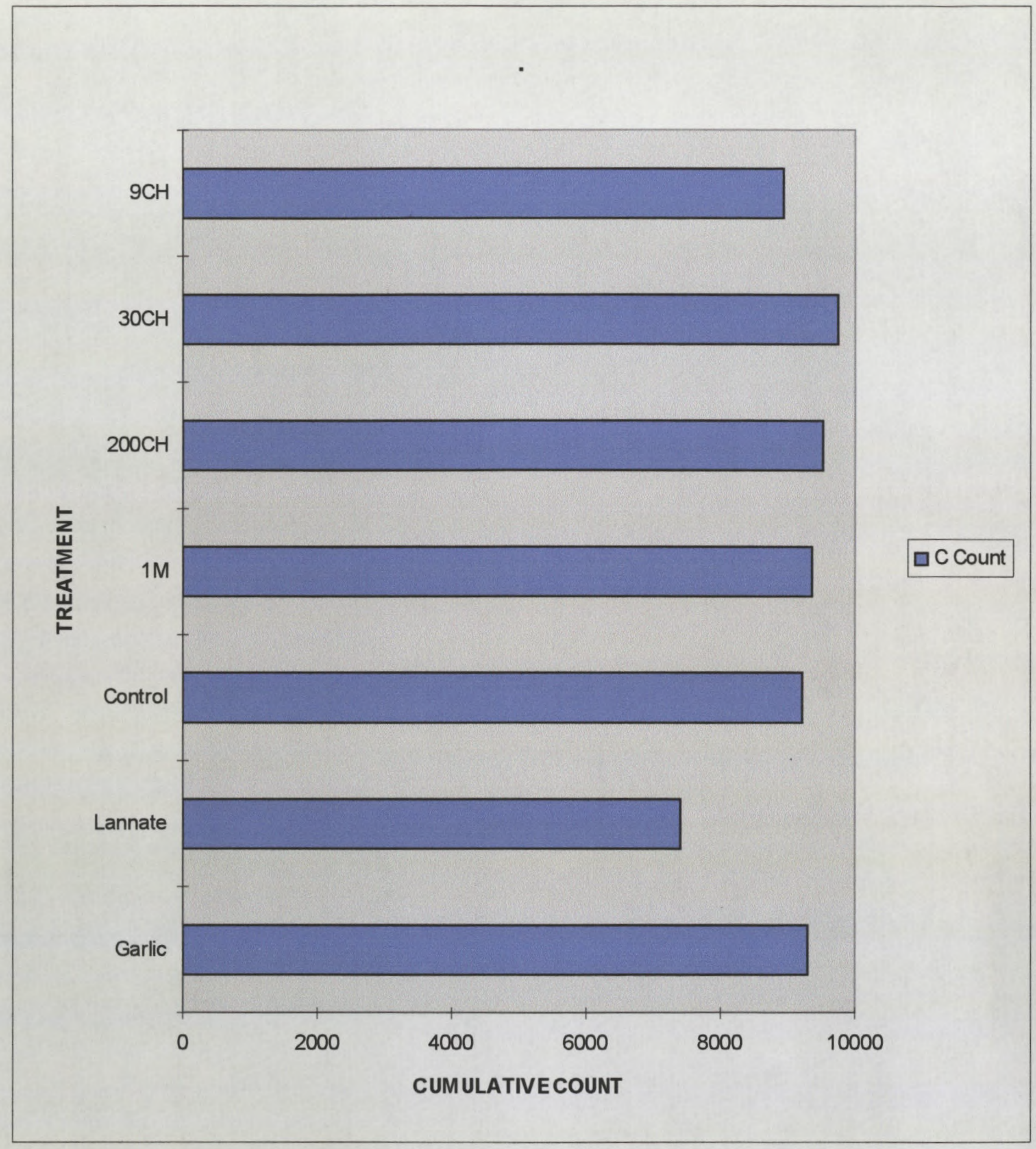

Figure 11: Histogram of the total cumulative counts of whiteflies per treatment

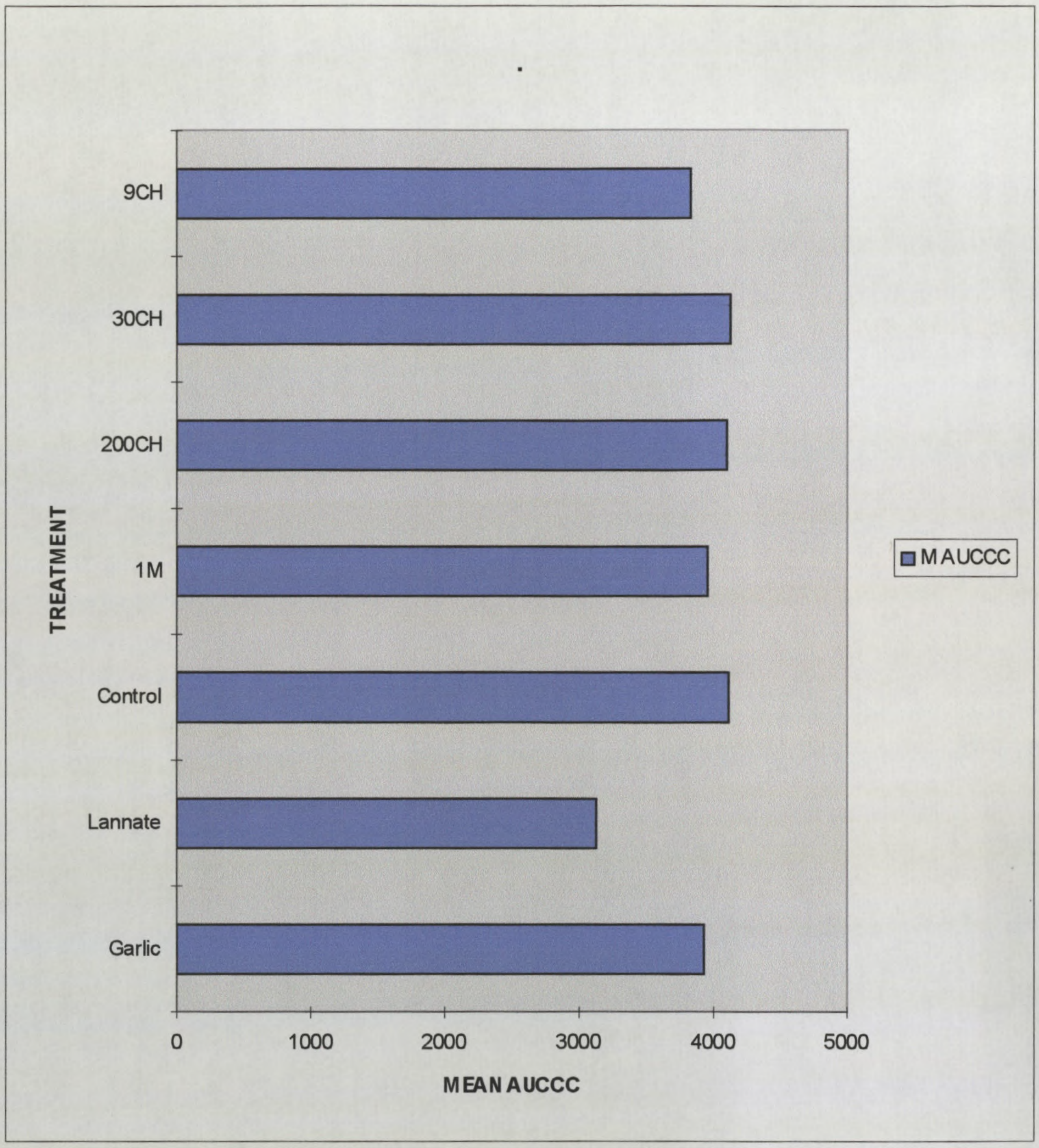

Figure 12: Histogram of the mean AUCCC per treatment

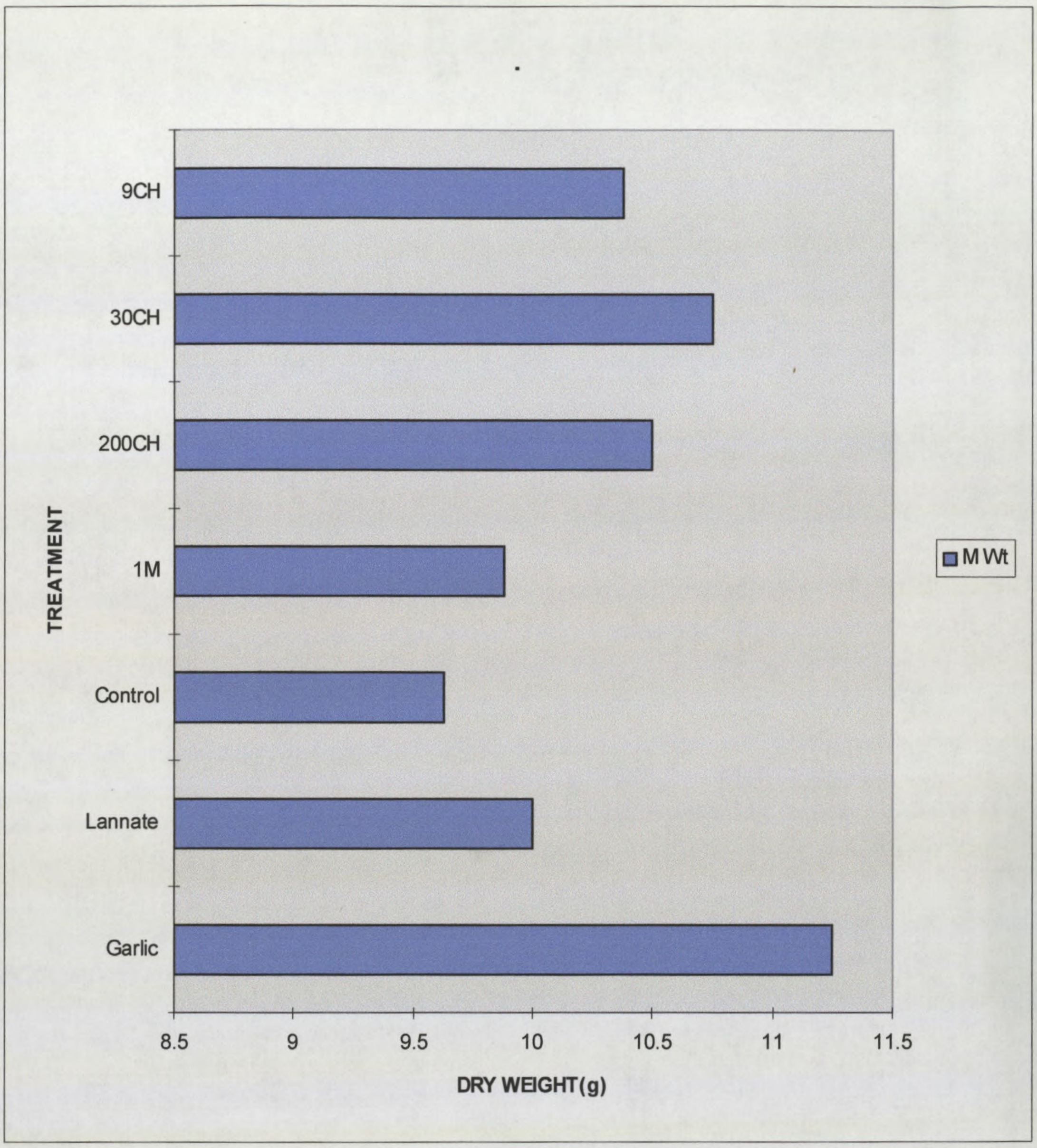

Figure 13: Histogram of the mean dry weights of the plants

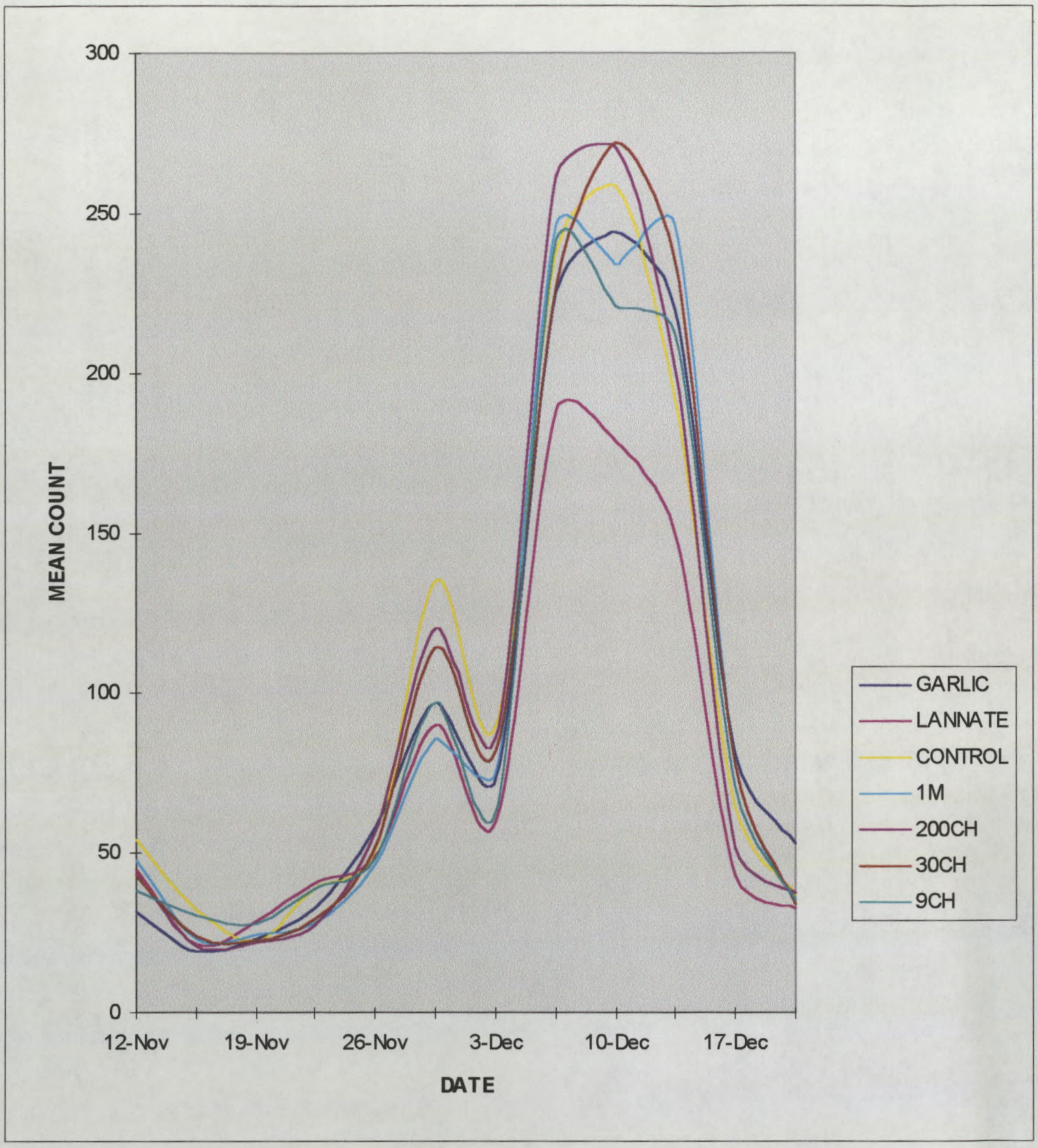

Figure 14: Mean counts of whiteflies, per date, for each treatment

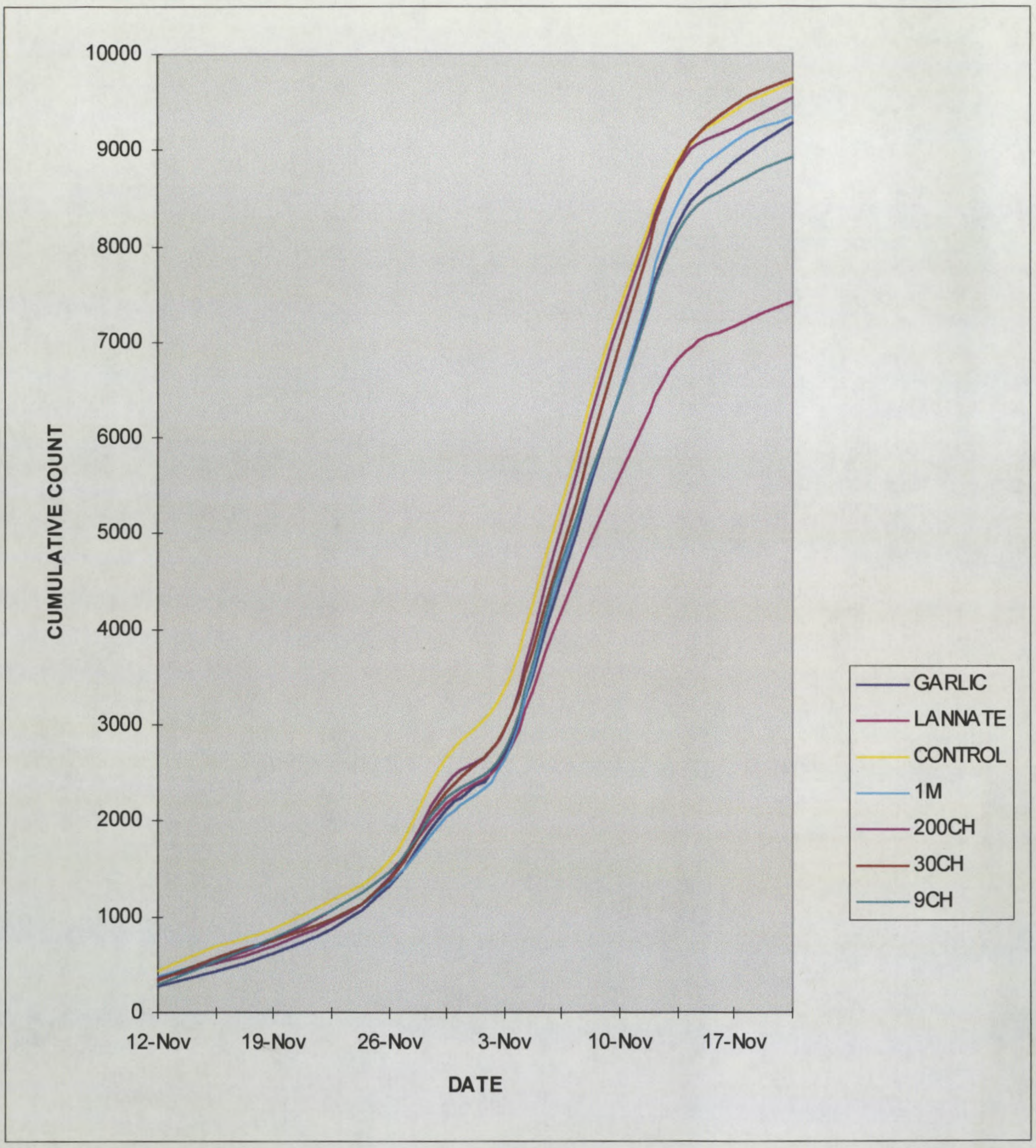

Figure 15: Cumulative counts of whiteflies, per date, for each treatment

2.6 Discussions and recommendations

It was expected that the results of this trial would be that the Lannate® would be the most effective control in the invasion of sweetpotato whitefly. It was expected that the higher potencies of the homoeopathic preparations from sweetpotato whitefly (200CH and 1M) would provide a more effective means of control of sweetpotato whitefly than the lower potencies (9CH and 30CH). Lastly, it was expected that the garlic extract would provide some means of control of sweetpotato whitefly.

However, the results of the trial showed that there was no significant difference between any of the treatments in the control of sweetpotato whitefly. Although there appeared to be a trend that the Lannate® counts were slightly lower than the counts of the other treatments, this was not statistically significant. The conclusion was that either the trial design was incorrect and cages should have been placed around each tray to control interplot interference, or the tested population of sweetpotato whiteflies had developed resistance towards the carbamate group of pesticides.

The homoeopathic preparations of sweetpotato whitefly used in this trial, did not control the invasion of sweetpotato whitefly effectively. The possible explanations would be: firstly, the trial design was incorrect and that cages were needed around each tray in order to measure the fixed population of whiteflies in each cage. Secondly, isopathy may not work in any form as an insecticide. However, this does not exclude the homoeopathic practice as an alternative to agrochemical methods. Other substances prepared homoeopathically may be effective. Remedies such as Staphysagria, a remedy that has proven to be susceptible to insect bites, may prove to be more appropriate. It may be better to use a remedy that will "treat" the plant, thereby helping the plant to become stronger, and thus able to fight against the invasion of sweetpotato whitefly instead of aiming the remedy at the insect.

The application frequency of the dose is another area of consideration. The "lower" homoeopathic potencies tend to have a shorter duration of action, and are generally repeated frequently, whilst the "higher" potencies have a longer duration of action and are therefore repeated less often. In homoeopathic practice the higher potencies, i.e., 1M, are given as a single dose and only repeated after a long period, if necessary. In this trial, the 1M potency was repeated once a week which may have affected the action of the remedy. In further investigations the repeated application of the treatment must be done according to the potency. For example, if a low potency is being used, then the application should be done once or twice daily. If a high potency is being used, a single application should be applied and then after a wait of at least three weeks, the situation should be reassessed to see if another application is needed.

As some of the homoeopathic preparation steps in making up a remedy are done by hand, human error is possible and incorrect methods may have been used, thus invalidating the remedies.

As homoeopathic remedies are very sensitive to environmental factors, the use of these remedies in the agricultural field situation needs to be assessed carefully. The remedies are exposed to direct sunlight if sprayed onto the plant foliage (plant foliage is exposed to direct sunlight) which may destroy the action of the remedy. In the agricultural practice many different chemicals are used which may also effect homoeopathic remedies. Thus further studies could be done on the viability of the use of homoeopathic remedies in the agricultural field.

As the natural insecticide of garlic extract was also ineffective in the control of sweetpotato whitefly invasion, other substances and permecultural methods should be considered. The use of Marigold extract as an insecticide could be investigated.

In terms of the dry weight of the plants, a significant block effect was evident, indicating that the position of the trays affected the growth of the plant. It is thought that the trays on the proximities dried out faster than the inner trays which then affected the growth of the plants.

Although this trial did not produce significant results, one must remember that it was novel research and therefore is just a beginning. Many improvements could be made and new ideas added. As Ulman (1991) stated, “the implications of homoeopathic research suggests that we live in a world not of dwindling but increasing resources, if we can only learn to apply them in an optimal manner. The implications of homoeopathic medicine are truly significant and cry out for more research and replication of past research. Considering how much potential value resides in the field of homoeopathy, it would be a crime not to investigate it. Homoeopathy is a gold mine waiting for prospectors”.

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Appendices

Appendix 1: Summary of the results

Treatment	Repetition	AUCCC	Weight
Garlic (1)	1	2430.5	12
Garlic (1)	2	3738.5	10
Garlic (1)	3	4606	11
Garlic (1)	4	2973.5	10
Garlic (1)	5	2834.5	15
Garlic (1)	6	3021.5	9
Garlic (1)	7	4546	15
Garlic (1)	8	7315.5	8
Lannate® (2)	1	2900	11
Lannate® (2)	2	4667.5	11
Lannate® (2)	3	3337	10
Lannate® (2)	4	2807	10
Lannate® (2)	5	2568.5	13
Lannate® (2)	6	2824.5	11
Lannate® (2)	7	2787.5	6
Lannate® (2)	8	3125	8
Control (3)	1	4588	8
Control (3)	2	4709	8
Control (3)	3	1668	13
Control (3)	4	6304	8
Control (3)	5	4317.5	13
Control (3)	6	3804	10
Control (3)	7	4117	9
Control (3)	8	3364.5	7

Treatment	Repitition	AUCCC	Weight
1M (4)	1	2863	9
1M (4)	2	4867.5	13
1M (4)	3	3535	9
1M (4)	4	4355	7
1M (4)	5	3053	7
1M (4)	6	5453	15
1M (4)	7	3169.5	6
1M(4)	8	4390	7
200CH (5)	1	3949	13
200CH (5)	2	5259	13
200CH (5)	3	2599.5	8
200CH (5)	4	2624.5	11
200CH (5)	5	4480.5	10
200CH (5)	6	6916.5	11
200CH (5)	7	3425	7
200CH (5)	8	3525	11
30CH (6)	1	3057	12
30CH (6)	2	3644	11
30CH (6)	3	7787.5	11
30CH (6)	4	3670.5	13
30CH (6)	5	3888.5	11
30CH (6)	6	3858	7
30CH (6)	7	2225.5	12
30CH (6)	8	4915	9
9CH (7)	1	4335.5	12
9CH (7)	2	3516	9
9CH (7)	3	4156.5	10
9CH (7)	4	4183	13
9CH (7)	5	3346.5	13
9CH (7)	6	3500.5	10
9CH (7)	7	3419.5	7
9CH (7)	8	4175.5	9

Appendix 2: The homoeopathic preparation of *Apis mellifica* (German Homoeopathic Pharmacopoeia, 1985)

Apis

Live honey bees *Apis mellifica* L.

DESCRIPTION
The body of a honey bee is 15 mm long, black, with a silky sheen, and covered with foxy red hairs with a touch of grey. The broad tibiae are without spines. The posterior margins of the segments and legs are brown, with gradual transition to yellowy red. The claws are two-membered, the maxillary palps single-membered. On the hind legs are baskets or scoops invested with bristles. The wings have 3 complete cubital cells, with the radial cell twice as long as it is wide; the 3 cells on the lower margin and the 3 middle cells are closed. A duct connects the barbed sting with the poison sac.

PREPARATIONS

MANUFACTURE
Place 1 part of live animals in a suitable bottle and kill by adding 1 part of ethanol; add one part of ethanol 30 per cent and mince. Add 8 parts of ethanol 62 per cent and leave to stand for 14 days, shaking three times daily. Filter but do not express. Use Method 4b to produce the 2nd and third decimal dilutions with ethanol 62 per cent and subsequent dilutions with ethanol 43 per cent.

CHARACTERISTICS
The mother tincture is initially pale yellow and later dark in colour; the odour is faintly suggestive of beeswax.

IDENTIFICATION
A. To 1 ml of the mother tincture add 10 ml of water. The mixture fluoresces pale blue under ultra-violet light (365 nm).
B. Chromatography. Use thin-layer chromatography in a layer of silica gel GF_{254} *R*.

Test solution: The mother tincture.

Control solution: Dissolve 10 mg of quinine hydrochloride *RN*, 10 mg of menthol *R* and 10 mg of salicylic acid *R* in 10 ml of methanol *R*.
Apply separately 50 µl of the test solution and 10 µl of the control solution. The mobile phase is a mixture of 70 parts by volume of *n*-propyl alcohol and 30 parts by volume of water. Allow the solvent front to rise 10 cm above the line of application. Following evaporation of the mobile phase, evaluate the chromatograms under ultra-violet light (254 nm).
The brilliant blue quinine hydrochloride spot is visible in the lower third of the chromatogram of the control solution and the brilliant blue salicylic acid spot at the transitions from the middle to the upper third.
The chromatogram of the test solution has a bluish grey spot between those standards.
Spray the chromatograms with anisaldehyde solution *R*, heat to 110 - 115 °C for about 10 minutes and evaluate in daylight within 10 minutes.

Appendix 3: Method 4b, a generalised homoeopathic remedy preparation protocol (German Homoeopathic Pharmacopoeia, 1985)

Method 4b: Mother tinctures and liquid dilutions

Method 4b is for mother tinctures manufactured according to the maceration or percolation methods described in the TINKTUREN (tinctures) Monograph in the Pharmacopoeia using 1 part of animals, parts of animals or animal secretions and 10 parts of ethanol in suitable concentration. If adjustment to a given value is necessary, the required amount of ethanol in the concentration prescribed or used for manufacture is calculated according to Formula (1). The calculated amount of ethanol is combined with the filtrate. The mixture is left to stand for at least five days at a temperature not exceeding 20 °C, after which it is filtered if required.

Potentization
The mother tincture is equivalent to the 1st decimal dilution (Ø = 1x).

The 2nd decimal dilution (2x) is made with
1 part of the mother tincture and
9 parts of ethanol of the same concentration.

the 3rd decimal dilution (3x) with
1 part of the 2nd decimal dilution and
9 parts of ethanol of the same concentration.
Ethanol 43 per cent is used for subsequent dilutions from the 4th decimal upwards; the method is the same as for the 3rd decimal dilution.

The 1st centesimal dilution (1c) is made with
10 parts of the mother tincture and
90 parts of ethanol of the same concentration.

the 2nd centesimal dilution (2c) with
1 part of the 1st centesimal dilution and
99 parts of ethanol 43 per cent.
Subsequent dilutions are produced in the same way as the 2nd centesimal dilution.

Appendix 4: Layout of the computerised randomisation block trial design

TITLE:	ANGELA
EXPERIMENTAL SITE:	UNP
DATE:	NOV 1998
TREATMENTS:	7
REPLICATIONS:	8

PLOT NO.	TREATMENT	NAME
1	4	CH9
2	2	LANNATE
3	7	M1
4	3	GARLIC
5	5	CH30
6	6	CH200
7	1	CONTROL
8	6	CH200
9	7	M1
10	4	CH9
11	3	GARLIC
12	5	CH30
13	1	CONTROL
14	2	LANNATE

(CONT)

PLOT NO.	TREATMENT	NAME
15	5	CH30
16	3	GARLIC
17	4	CH9
18	2	LANNATE
19	6	CH200
20	1	CONTROL
21	7	M1
22	5	CH30
23	3	GARLIC
24	6	CH200
25	2	LANNATE
26	1	CONTROL
27	7	M1
28	4	CH9

TREATMENTS	NAME	PLOTS			
1	CONTROL	7	13	20	26
2	LANNATE	2	14	18	25
3	GARLIC	4	11	16	23
4	CH9	1	10	17	28
5	CH30	5	12	15	22
6	CH200	6	8	19	24
7	M1	3	9	21	27

(CONT)

PLOT NO.	TREATMENT	NAME
29	6	CH200
30	1	CONTROL
31	5	CH30
32	4	CH9
33	3	GARLIC
34	7	M1
35	2	LANNATE
36	6	CH200
37	4	CH9
38	3	GARLIC
39	5	CH30
40	1	CONTROL
41	2	LANNATE
42	7	M1
43	3	GARLIC
44	5	CH30
45	2	LANNATE
46	7	M1
47	4	CH9
48	6	CH200
49	1	CONTROL

(CONT)

PLOT NO.	TREATMENT	NAME
50	3	GARLIC
51	4	CH9
52	1	CONTROL
53	7	M1
54	5	CH30
55	6	CH200
56	2	LANNATE

TREATMENTS	NAME	PLOTS			
1	CONTROL	30	40	49	52
2	LANNATE	35	41	45	56
3	GARLIC	33	38	43	50
4	CH9	32	37	47	51
5	CH30	31	39	44	54
6	CH200	29	36	48	55
7	M1	34	42	46	53