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Testing potting mixes with addition of dried blood, blood and bone and bentonite

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Abstract

The effectiveness of dried blood and blood and bone as a slow release fertilizer and the nutrient storage capacity of bentonite was investigated. Results of four different soil mixes, each with four different crops (lettuce, tomatoes, white cabbage, red cabbage) were analysed. The influence of the soil mixes on germination rates, plant yield and the attraction of sciarid flies and whiteflies was recorded. The samples without dried blood/blood and bone achieved the best results in all investigations except the whitefly attraction. Compared with the effect of dried blood/blood and bone, only a slight influence of bentonite on plant growth and health could be detected.

Key words: Potting mixes, dried blood, blood, bone, bentonite, sciarid fly, whitefly

Introduction

In their native state, many soils have a low nutrient status and are deficient in one or more plant essential nutrients, especially in nitrogen. Fertilizer use is therefore an important aspect of land management. Organic fertilizers such as blood and bone and dried blood provide a slow release source of nitrogen to plants due to mineralization processes. Their addition to a soil is considered to have in general beneficial effects on soil, plant growth and plant health (Handreck, 1985, 1993). Blood and bone (5-8% N, 5-8 % P) and dried blood (13- 15% N), being by-products of the meat industry (McLaren and Cameron, 1996), are widely used in the home garden, but are no longer supplied to the pastoral market due to the BSE issue that has evolved in Europe over the past couple of years. Furthermore, there is a need to reduce the loss of nitrate due to leaching which can be accomplished by adding components that adsorb nitrate.

The School of Horticulture at Seven Oaks has been using bentonite in order to reduce N-leaching and dried blood/ blood and bone as a fertilizer for potting mixes for several years. But the critisism of the use of blood and bone as a fertilizer and the suspicion that it may cause pest infestations triggered the question whether its use should be continued.

This paper reports the results of a trial which investigated the effect of dried blood/ blood and bone and bentonite on germination rates, plant yields and the attraction of sciarid flies and whiteflies.

Materials and methods

Four different batches of potting mixes were made up for investigation: (a) standard mix + 250g dried blood, 250g blood and bone, 125g bentonite; (b) standard mix + 250g dried blood, 250g blood and bone; (c) Standard mix + 125g bentonite and (d) standard mix. The standard mix was composed of 60 litres compost, 20 litres sand, 20 litres composted bark, 300g gypsum, 200g kelp powder.

Planter bags (size 3/4) were filled with the various mixes (80 bags per batch). 20 bags of each batch were sown with one seed each of lettuce, tomato, white cabbage and red cabbage. The bags were kept in a heated greenhouse and irrigated with equal portions of water. The germination rate was determined after no more seeds germinated for a period of six subsequent days. Sticky, yellow cardbord traps (10 x 10.5cm) were placed in the centre of each treatment of 20 bags during the third week of the trial in order to monitor sciarid flies [Diptera: Sciaridae] and whiteflies (*Trialeurodes vaporariorum*). The cards were placed in the morning and removed and counted in the evening. After three weeks all plants were placed outside and continued to be grown under equal conditions. 36 days after sowing, the complete plants (with roots) were harvested and cleaned. The fresh weight of each plant was measured. The whole plants were dried at 105 ^{o}C for 24 hours and their dry weight determined.

In the two samples with dried blood and blood and bone only one red cabbage germinated altogether. Therefore, red cabbage was only considered regarding the germination rate.

Results and discussion

Germination rate: Using chi-square test, a significant dependence between the two variables, potting mix and crop was detected. Therefore, an analysis of variance could not be carried out. Table 1 show that the germination rate for lettuce and tomatoes was similar for the mixes with/ without blood and bone. The germination concerning the white and red cabbage was strongly affected by the presence of blood and bone. Only 13 seeds out of 80 germinated in the samples with blood and bone compared with a total number of 80 germinated seeds out of 80 in the samples without blood and bone.

Concerning the germination rate, hardly any difference in the mixes with/without bentonite was detectable. In the mixes with bentonite 113 seeds out of 160 germinated compared with 107 out of 160 in the mixes without bentonite. The use of bentonite does not seem to affect the germination rate.

Table 1. Germination rate (percentage) under different treatments

Crop	SM+BB +DB+BN	SM+BB +DB	SM+BN	SM
Lettuce	80(16)	50(10)	95(19)	90(18)
Tomatoes	85(17)	80(16)	80(16)	75(15)
White cabbage	20(4)	40(8)	100(20)	100(20)
Red cabbage	5(1)	0(0)	100(20)	100(20)
Mean	47.50	42.50	93.75	91.25

SM=standard soil mix, BB=blood and bone, DB=dried blood, BN=bentonite. Nnumber of germinated seeds is given parantheses

Fresh and dry weight: To analyse the dependence of the fresh and dry weights on the make-up of the potting mix, one-way ANOVA was carried out for lettuce and white cabbage. Concerning the lettuce and white cabbage, the differences between the fresh weights of the plants grown in the treatments with and without dried blood/blood and bone were significant. The plants in both samples without these compounds performed better than the plants in the other two samples. There were also significant differences detectable in the mixes concerning the dry weights of lettuce and white cabbage. The plants grown in the samples without dried blood and blood and bone had a significantly higher mean weight than the plants grown in the samples with blood and bone and dried blood. Table 2 and 3 show the same trend concerning the fresh and dry weights of tomatoes. There are possible reasons for the low fresh and dry weights with dried blood and blood and bone; there could have been effects caused by dried blood/blood and bone that inhibited nutrient uptake or released toxic substances, causing the plants to perform worse than the plants in the samples without blood and bone.

Table 2. Mean fresh weight of plants (g) under different treatments

Crop	SM+BB +DB+BN	SM+BB +DB	SM+BN	SM
Lettuce	4.249^{a}	4.858^{a}	18.296^{b}	16.356^{b}
Tomatoes	0.819	1.936	9.319	9.069
White cabbage	3.210^{a}	5.921^{a}	16.784^{b}	14.028^{b}

^{a,b} Results followed by different letters were significantly different ($P < 0.05$)

Table 3. Mean dry weight of plants (g) under different treatments

Crop	SM+BB +DB+BN	SM+BB +DB	SM+BN	SM
Lettuce	0.255^{a}	0.308^{a}	1.239^{b}	1.214^{b}
Tomatoes	0.071	0.266	1.025	1.020
White cabbage	0.320^{a}	0.567^{a}	1.974^{b}	1.567^{b}

^{a,b} Results followed by different letters were significantly different ($P < 0.05$)

There is no significant difference detectable in the fresh weights of the two crops (lettuce and white cabbage) regarding the treatments with/ without bentonite. However, Table 2 and 3 show for all the three crops that the presence of bentonite seems to have a certain effect on the treatments without dried blood and blood and bone; the treatments with bentonite have on average a higher fresh and dry weight than the treatments without bentonite. It can be assumed that bentonite reduced the leaching of nutrients. Therefore, more nutrients have been available for plant uptake.

The addition of bentonite had an opposite effect when used with dried blood and blood and bone: the plants in the treatments with bentonite had on average a lower fresh and dry weight than the plants in the treatments without bentonite. Bentonite seems to enhance the inhibiting/toxic effects caused by dried blood/ blood and bone resulting in the plants performing worse than the plants in all other samples.

Dry/ fresh weight ratio: Concerning the lettuce and white cabbage, significant differences between the treatments with/ without dried blood/blood and bone were detected. Table 4 shows an overall trend for the treatments without dried blood and blood and bone towards having a higher ratio dry/ fresh weight and therefore a lower content of water. Therefore, a higher content of water could not be the reason for the high fresh weights of the plants grown in the mixes without blood and bone. Due to a failing F_{max} test, no analysis of variance could be carried out for the ratio dry/ fresh weight of tomatoes. The ratios of tomatoes show nevertheless in general the same tendency as the ratios of lettuce and white cabbage. For some inexplicable reasons, the sample with dried blood, blood and bone and without bentonite had a much higher ratio dry/ fresh weight than all other samples and is therefore not consistent with the pattern.

Table 4. Dry/ fresh weight ratio of plants in different potting mixes

Crop	SM+BB +DB+BN	SM+BB +DB	SM+BN	SM
Lettuce	0.0591^{a}	0.0599^{a}	0.0670^{ab}	0.0747^{b}
Tomatoes	0.0887	0.1500	0.1100	0.1119
White cabbage	0.1075^{ab}	0.0968^{a}	0.1157^{b}	0.1112^{ab}

^{a,b} Results followed by different letters were significantly different ($P < 0.05$)

Table 5. Numbers of sciarid flies [Diptera: Sciaridae] on yellow card traps

Crop	SM+BB +DB+BN	SM+BB +DB	SM+BN	SM
Lettuce	405	380	40	9
Tomatoes	429	493	12	15
White cabbage	367	196	34	17
Totals	1201	1069	86	41

Sciarid flies: Chi-square test on the data in Table 5 revealed that the potting mix and crop are significantly dependent concerning the infestation with sciarid flies. Therefore, an analysis of variance could not be carried out. However, Table 5 shows considerable differences between the treatments with/ without dried blood and blood and bone concerning the number of sciarid flies. The data strongly indicates that the flies have been mainly attracted by the soil mixture and less by the plant itself: there were more flies on the samples with blood and bone.

White flies: The chi-square test of the data in Table 6 suggests independence for the potting mix and crop concerning the infestation with whiteflies. The analysis with two-way ANOVA revealed that there is no evidence for an effect of either plant or mix on the number of whiteflies in the traps.

The experimental data show a low number of whiteflies compared to sciarid flies. This is partly due to the fact, that the total number of whiteflies observed during the experiment was lower. Furthermore, the moving habit of the flies influenced the proportion caught in the traps. While the adults of sciarid flies spend much time moving around plants and on soil surfaces, the adults of the whiteflies are used to make short flies when foliage is disturbed, preventing them from being caught in the traps (Chapman, 1998).

Table 6. Effect of potting mixes and additions of dried blood, blood and bone and bentonite on the numbers of whiteflies (*Trialeurodes vaporariorum*) on yellow card traps

Crop	SM+BB +DB+BN	SM+BB +DB	SM+BN	SM
Lettuce	9	10	6	6
Tomatoes	5	3	6	2
White cabbage	13	6	5	11
Totals	27	19	17	19

Dried blood and blood and bone did not meet the expectations concerning their beneficial effects on plant growth and plant health. Their addition to a soil even had a considerable negative effect on the number of germinated seeds and the resulting plant yields. The presence of dried blood/blood and bone in a soil had also a strong attracting effect on sciarid flies, but no effect on whitefly attraction could be found. The use of bentonite achieved a slight increase in the germination rate, the plant yield and the number of attracted sciarid flies.

Further trials are required to examine whether dried blood or blood and bone or both were responsible for the inhibiting/poisoning effect of the corresponding samples on plant growth and the attraction of sciarid flies. Investigations to confirm the observed effects of bentonite on plant growth and its interaction with dried blood and blood and bone might be worthwhile.

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