EFFECT OF BEET VINASSE ON RADISH SEEDLING EMERGENCE AND FRESH WEIGHT PRODUCTION

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Abstract

The effect of the application of a concentrated beet vinasse (with P added) as organic fertilizer (ca. 4 and 9 t ha^{-1}) on radish seedling emergence and fresh matter production was studied in a glasshouse. In general, neither dose of vinasse interfered with radish emergence in three different soils of SW Andalusia (1^{st} horizon) used as substrates. Furthermore, both treatments with vinasse occasioned higher yearly fresh matter production of radish than those occasioned by two parallel inorganic fertilizer treatments that added similar amounts of N, P_2O_5 and K_2O. Despite its high salt content (ca. 2% Na and Cl), concentrated vinasse may be a good organic fertilizer when properly used.

1. Introduction

Beet vinasses are beet molasses that are almost completely biochemically desugarized, distilled and sometimes concentrated. The use of vinasses as fertilizer is being studied at present in many countries (Debruck & Lewicki, 1985; López et al., 1990), although information is still scarce. Besides a high N content, vinasses possess a large amount of salts (Cabrera et al., 1987) which, in theory, could be harmful for germination and seedling growth of plants less tolerant to salt. However, moderate doses of vinasse (3-5 t ha^{-1}) do not contribute excessive amounts of salts when applied to soils. If the seeds of some plants tolerate the presence of a certain amount of salt, the vinasse could even be applied at a higher dose. The high level of N in vinasse (ca. 3%) and the presence of Ca in soils could be beneficial factors in this respect.

The present paper deals with the effect of one normal and one high dose of a concentrated beet vinasse on radish seedling emergence and fresh matter production in pot trials, using soils with various high, but different, levels of $CaCO_3$.

2. Materials and methods

The experiment was performed using pots with a capacity of 4 litres (ca. 6.1 kg of dry soil, d=1.5 g cm^{-3}) and the first horizon of three representative soils of SW Andalusia as substrates: one sandy soil (pH 8.2; $CaCO_3$ 7%), one red sandy clay loam soil (pH 7.7; $CaCO_3$ 15%) and one light yellowish-brown sandy clay loam soil (pH

7.8; $CaCO_3$ 30%), hereafter referred to as sandy, red and calcareous soils respectively. A concentrated vinasse from the Sociedad Azucarera Ibérica (Seville) was used as organic fertilizer. Table 1 shows the analyses of vinasse.

Doses of vinasse of 5 g/pot (ca. 4000 kg ha^{-1}, 30 cm depth: 0.162 g N, 0.097 g P_2O_5 and 0.206 g K_2O per pot) and 12.5 g/pot (ca. 9000 kg ha^{-1}, 30 cm depth: 0.405 g N, 0.24 g P_2O_5 and 0.515 g K_2O per pot) were used. Every year, the vinasse was thoroughly mixed with the soil of each pot one month before sowing. The same amounts of N and P_2O_5, and about the same amount of K_2O, were also applied to each pot every year, as inorganic compounds. In this case, 1/3 of the N was added at sowing as 46% N urea (0.054 and 0.135 g N/pot) and 2/3 one month after sowing as NH_4NO_3 (0.108 and 0.270 g N/pot). Phosphorus and K were added at sowing as superphosphate aqueous solution (0.094 and 0.235 g P_2O_5/pot) and K_2SO_4 (0.162 and 0.405 g K_2O/pot), respectively.

A complete randomized block design with 5 replicates per treatment was set up. Radish (cv. DATIL ROJO) was sown yearly in the pots (5 plants per pot) and seedling emergence controlled. Data for emergence correspond to the first year only because of the similarity of the results obtained in the three years. Two months after sowing plants were removed and the fresh weight was determined (roots and above-ground part). Throughout the experiment, temperatures during the 12-hour day (maximum photon flux density of ca. 500 uE m^{-2} s^{-1}) ranged from 20-25° C and during the 12-hour night from 15-20° C. Student's t-test was used to test differences between paired means.

3. Results

Table 2 shows the influence of treatments on radish seedling emergence. Results indicate that when vinasse is applied in the red soil at a very high dose, the emergence of radish is comparatively more reduced than in the sandy and calcareous soils (where it is practically unaffected). However, even with this vast application of vinasse, percentages of radish emergence are always about 60% (three years) in the red soil. Thus, it can be inferred from the results (table 2) that, when applied before sowing, the presence of vinasse in soils at normal, or even moderately high levels, does not interfere with emergence of radish, at least in substrates well supplied with Ca.

Tables 3 and 4 show the influence of treatments on fresh matter production of radish (aerial part and roots). Except in some cases, the presence of vinasse occasions higher fresh matter production of both fractions than those occasioned by the corresponding inorganic fertilizer treatments. In relation to the corresponding inorganic fertilizer treatments, the vinasse tends to increase root weight more than that of the aerial part, in all three soils, although some exceptions exist.

It can be seen from table 3 that, in general, the higher increases of fresh matter production (aerial part) are occasioned by the low dose of vinasse in the red soil (a normal dose from an agricultural point of view), whereas the tendency is just the contrary when the high dose is applied to this same soil. The high dose of vinasse seems to be more beneficial in the sandy soil than in the other two soils. When roots are considered, the positive effect of the high dose of vinasse is only observed in the calcareous soil. These results seem to show that moderate, agricultural doses of vinasse may be beneficial for radish in many soils. High doses of vinasse seem to be beneficial to plants only in highly calcareous soils.

4. Discussion

The above results show that the use of vinasse as organic fertilizer is a promising way of recycling this agro-industrial organic waste, thus corroborating results of previous works, in which the same beet vinasse was used (López et al., 1990; López et al., 1992). The main constraint that could be pointed out is based on the previously mentioned high salt content of vinasse, which could increase the Na and Cl levels of many plants.

First analysis of radish (sandy soil, 1st year, data not shown) have shown that the high dose of vinasse certainly occasions a high concentration of Na in the aerial part (2.02 ± 0.44 %), higher than that obtained using the high dose of inorganic treatment (1.08 ± 0.20 %). However biomass production of radish is not affected (Tab. 3 and 4).

In general, first analyses of radish (aerial part, sandy soil) seem to indicate that the presence of vinasse does not lead to an unbalanced plant nutrition. The only nutrient showing a lower concentration as a result of vinasse treatment compared to inorganic fertilizer treatment is Ca (3.44 ± 0.60 % and 5.64 ± 0.65 % for low doses of vinasse and inorganic fertilizer respectively; 3,58 ± 0,60 % and 4.65 ± 0.40 % for high doses of vinasse and inorganic fertilizer, respectively). The high dose of the inorganic fertilizer also gives raise to a higher N content (4.48 ± 0.59 % in the inorganic treatment, 3.38 ± 0.40 % in vinasse), which is not observed when lower, agricultural doses of both fertilizers are applied. On the contrary, vinasse tends to cause slightly higher P, K and Mn contents, especially at the high rate of application (0.43 ± 0.03 % in vinasse, 0.36 ± 0.06 % in the inorganic treatment for P; 4.22 ± 0.63 % in vinasse, 3.54 ± 0.22 % in the inorganic treatment for K; 134 ± 15 ppm in vinasse, 100 ± 10 ppm in the inorganic treatment for Mn).

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Table 1. Analyses of the concentrated vinasse.

Dry matter (%, w/w)	54	pH	5	K (%, w/w)	3.5
Total O.M. (%, w/w)	40	C/N	3.8	Ca (%, w/w)	0.3
Oxid. O.M. (%, w/w)	22	N (%, w/w)	3.3	Mg (%, w/w)	1.0
Density (g cm^{-3})	1.3	P (%, w/w)	0.02	Cl, Na (%, w/w)	2.0

Table 2. Percentages of radish seedling emergence.

Treatment		Sandy soil	Red soil	Calc. soil
Low dose	Inorganic	90.7 a	62.7 a	62.7 a
	Vinasse	85.3 a	54.7 a	72.0 a
High dose	Inorganic	85.3 a	81.3 a	77.3 a
	Vinasse	81.3 a	55.0 b	70.0 a

Paired means followed by the same letter in the same column do not differ significantly (P<0.05).

Table 3. Mean values (g) of fresh wheight per plant of aerial part of radish. LD = Low dose; HD = High dose.

Treatment	year	Sandy 1º	Sandy 2º	Sandy 3º	Red 1º	Red 2º	Red 3º	Calcareous 1º	Calcareous 2º	Calcareous 3º
LD	Inor.	3.58a	3.00a	3.12a	5.12a	5.14a	5.12a	3.52a	4.98a	4.98a
	Vinas.	4.78b	3.68a	6.62b	7.26b	10.12b	8.12b	4.74b	4.78a	6.10b
HD	Inor.	7.18a	4.18a	4.12a	9.24a	9.54a	6.89a	6.00a	6.70a	7.38a
	Vinas.	8.68a	6.54b	6.16b	8.38a	9.14a	9.02a	6.76a	8.22b	10.38b

Paired means followed by the same letter in the same column do not differ significantly (P<0.05).

Table 4. Mean values (g) of fresh wheight per plant of roots of radish.
LD = Low dose; HD = High dose.

Treatment	year	Sandy 1º	Sandy 2º	Sandy 3º	Red 1º	Red 2º	Red 3º	Calcareous 1º	Calcareous 2º	Calcareous 3º
LD	Inor.	2.66a	3.56a	1.34a	3.30a	5.42a	4.18a	2.74a	7.66b	3.68a
	Vinas.	4.20b	5.24b	4.88b	6.44b	7.82b	10.46b	4.68b	5.10a	4.68a
HD	Inor.	5.50a	7.68a	1.94a	5.40a	9.78b	6.33a	2.86a	5.72a	4.98a
	Vinas.	4.82a	7.64a	4.36b	7.00b	7.00a	6.98a	5.33b	9.20b	10.98b

Paired means followed by the same letter in the same column do not differ significantly (P<0.05).