# Acta Horticulturae

Number 150
June 1984

*Technical communications of ISHS*
*International Society for Horticultural Science*

## Nitrogen dynamics in bark composts as dependent on production methods II. Pot trials with ryegrass and spray carnations

K. Teicher
R. Gutser
P. Fisher

Barcelona, Spain
28 Aug. - 2 Sept. 1983

# NITROGEN DYNAMICS IN BARK COMPOSTS AS DEPENDENT ON PRODUCTION METHODS

## II. Pot trials with ryegrass and spray carnations

K. Teicher
Bayer.Hauptversuchsanstalt f.Landwirtschaft

R. Gutser
Institute for Plant Nutrition

Technical University Munich
8050 Freising-Weihenstephan
BRD

P. Fischer
Institute for Soil Science and Plant Nutrition
Fachhochschule Weihenstephan
8050 Freising-Weihenstephan
BRD

Abstract

In pot trials with ryegrass and spray carnations, the effect of different production methods of bark composts (long - and short - term fermentation) on N-dynamics was tested. In mixtures of peat/bark composts (40/60 vol.%), long-term composts and peat substrate showed higher yields and N-uptake on base of same amounts of soluble nutrients - base fertilizing with N, P and K corresponding to substrate analysis - than short-term composts (3 cuts of ryegrass). Liquid feeding to each cut (0.6 g N/pot for $4^{th}$- $6^{th}$ cut) decreased these differences, nevertheless two short-term composts gave lower effects.

After 11 months the decomposition of organic matter in bark composts was 7 - 30 %.

Spray carnations were tested with three different rates of liquid feeding as supplement to the same base fertilizing (N, P, K). Fresh weight increased with rising liquid feeding. The differences in yield between bark composts decreased with increasing intensity of liquid feeding. Therefore difficulties in N-dynamics of bark composts will partly be corrected by high rates of liquid feeding.

## 1. Introduction

Sphagnum peat is a stable substrate poor in nutrients, so that lacking nutrients for optimal growth of cultivated plants have to be supplied in mineral form. All nutrients then stay in a largely mobile form and thus are plant available. Bark composts however, sometimes give problems with respect to availability of fertilizer nitrogen (e. g. Zöttl, 1981 and others). In incubation trials, Gutser et al. (1984) could demonstrate that the fermentation procedure, especially turnover time, has a marked influence on N dynamics (N-fixation and release) of bark composts. Long-term composts showed a more balanced and thus predictable N turnover than short-term composts. The following investigation was done to study how production methods for composts affect plant growth, and if a continuous N nutrition of cultivated plants in all compost varieties can be achieved by additional regular liquid feeding (N) which is common use in intensive horticulture.

## 2. Material and methods

These problems were studied in two pot trials with ryegrass (Mitscherlich pots) and spray carnations (containers).

Bark composts

8 composts (4 long-term (LC), 3 short-term (SC) fermented bark composts and one from a depot (DC)) were tested. Nutrient contents are shown in table 1 (exact physical and chemical analytical data and production procedures v. Gutser et al., 1984).

TABLE 1 - NUTRIENT CONTENTS IN BARK COMPOSTS (mg/l)

| | LC | | | | DC | | SC | |
|---|---|---|---|---|---|---|---|---|
| | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| $N_{min}$ (0.025 N $CaCl_2$) | 15 | 205 | 250 | 240 | 15 | 270 | 540 | 70 |
| $P_2O_5$ (CAL) | 40 | 55 | 50 | 140 | 45 | 280 | 90 | 65 |
| $K_2C$ (CAL) | 345 | 400 | 400 | 500 | 205 | 705 | 350 | 415 |

Bark composts were used in mixtures with sphagnum peat (60/40 vol. %) and compared with sphagnum peat alone (sphagnum peat : 2.5 g $CaCO_3$/l - trace elements as single substrate 75 mg Flory 10/l, otherwise half the amount). Particle size of all composts was $<$ 20 mm.

Experiments with ryegrass (Lolium perenne)

Mitscherlich pots ( 5 l vol.)

part 1: N-depletion without liquid feeding
($1^{st}$ - $3^{rd}$ cut, 7 Apr - 6 Jul 82
uniform base fertilizing (NPK) with compensation ($NH_4NO_3$, $Ca(H_2PO_4)_2$, $K_2SO_4$) of substrate contents up to 260 mg N, 180 mg $P_2O_5$ and 305 mg $K_2O$/l
to $2^{nd}$ cut: 120 mg $K_2O$ as KCl/l

part 2: utilization of N by ryegrass after uniform liquid feeding with N ($4^{th}$ - $6^{th}$ cut, 6 Jul - 28 Sept 82
dressing per cut: 100 mg N + 150 mg $K_2O$/l

Watering: with deionized water - 70 to 90 % of maximum waterholding capacity according to plant growth

Replications: 5

Experiment with spray carnations (Dianthus caryophyllus)

Effect of varying intensities of liquid feeding on yield and quality

Container (5 l), 3 plants/pot, Variety: Sam's Pride
Duration of experiment: 15 Apr - 11 Oct 82
Fertilizing: Base fertilizing was given on the same level as in the experiments with ryegrass.

Rates of liquid fertilizing (sum, mg/l substrate):

1: 620 N, 415 $P_2O_5$, 580 $K_2O$
2: 870 N, 580 $P_2O_5$, 810 $K_2O$
3: 1115 N, 750 $P_2O_5$, 1045 $K_2O$

This liquid feeding was applied weekly from 7 May - 17 Oct 82 in 20 single doses with Flory salts

Evaluation: yield (fresh-weight) of 2 flowering-periods (number of flowers, marketable incl. garland quality)
Main harvest with determination of total shoot weight

Watering: tap water

Replications: 3

## 3. Results

Ryegrass - mineral N - release by composts

On basis of equal supply of easily soluble mineral N ($N_{min}$ = 260 mg/l substrate), long-term composts showed a clearly better effect of N (yield, N-removal) than short-term composts or the bark compost from a depot (table 2).

TABLE 2 - POT TRIAL WITH BARK COMPOSTS TO RYE GRASS YIELDS (g DRY MATTER/POT) AND N-UPTAKE (mg/POT)

| COMPOSTS | YIELD | N-UPTAKE |
|---|---|---|
| I. N-DEPLETION | (3 CUTS) | |
| peat | 33.4 | 1o21 |
| LC 2 | 32.1 | 923 |
| LC 3 | 27.8 | 9o1 |
| LC 4 | 37.3 | 1o75 |
| LC 5 | 37.8 | 11o2 |
| DC 6 | 22.7 | 568 |
| SC 7 | 20.o | 581 |
| SC 8 | 26.2 | 752 |
| SC 9 | 18.1 | 442 |
| II. WITH UNIFORM LIQUID FEEDING: | 1oo mg N/L · CUT | ($4^{TH}$ - $6^{TH}$ CUT) |
| peat | 42.5 | 978 |
| LC 2 | 41.2 | 937 |
| LC 3 | 41.3 | 857 |
| LC 4 | 41.6 | 912 |
| LC 5 | 45.5 | 963 |
| DC 6 | 32.6 | 762 |
| SC 7 | 43.2 | 1o14 |
| SC 8 | 29.3 | 79o |
| SC 9 | 27.3 | 745 |
| LSD 5 % | 2.5 | 6o |

Highest yields and N removals were achieved with composts LC 5 and LC 4, both long-term-fermented barks with 1.0 respectivly 1.4 g N added for rotting/l. Second best was peat (TKS = peat (culture) substrate). Among short-term composts, SC 8 yielded the best result (fermented for 1 week with 0.9 g N/l, then left 6 months in plastic bags) with a clear lead. The higher availability of N in long-term composts resp. TKS as compared to short-term composts is due to the 1st and 2nd cut (fig. 1). In the 3rd cut the N-supply of all samples was largely depleted.

Ryegrass: Effect of liquid feeding (N)

With the exception of compost SC 8, N dressing applied to every cut (4th - 6 th cut), resulted in a marked rise of yields and also of N removals in variants with short-term composts resp. the depot compost as compared to the first experiment (table 1, fig. 1). Compost SC 7 achieved best yields of long-term composts resp. of TKS and also showed highest N removals (mineralization of N in poultry manure - v. preparation of composts in Gutser et al., 1984). The poor performance of compost SC 8 and 9 (yields!) was striking as well as of depot-bark compost DC 6 in all of 3 cuts (fig. 1). Taking in account the results from incubation trials, this can't be fully explained by the special N-dynamics of the former two composts. Possibly, besides fixation of fertilizer N, a high heavy metal supply from short-term composts, especially Mn and Zn was the reason for this unsatisfying plant growth (table 3).

TABLE 3 - HEAVY METAL CONTENTS IN PLANT (mg/kg DRY MATTER)

| COMPOSTS | 2ND CUT | | | 5TH CUT | | | PH ($CACL_2$) | |
|---|---|---|---|---|---|---|---|---|
| | Mn | Cu | Zn | Mn | Cu | Zn | START (COMPOSTS) | FINISH (MIXTURES) |
| peat | 185 | 12 | 68 | 37 | 6 | 85 | 5.5 | 3.9 |
| LC 2 | 125 | 6 | 62 | 273 | 6 | 92 | 6.9 | 5.0 |
| LC 3 | 385 | 9 | 95 | 240 | 8 | 107 | 7.0 | 5.9 |
| LC 4 | 728 | 8 | 68 | 808 | 5 | 100 | 6.3 | 4.7 |
| LC 5 | 433 | 8 | 70 | 583 | 5 | 90 | 5.9 | 4.9 |
| DC 6 | 62 | 6 | 72 | 93 | 7 | 85 | 7.1 | 6.8 |
| SC 7 | 257 | 14 | 318 | 1140 | 10 | 196 | 5.2 | 5.5 |
| SC 8 | 1090 | 17 | 192 | 1075 | 14 | 258 | 7.6 | 7.5 |
| SC 9 | 2300 | 16 | 236 | 600 | 13 | 384 | 7.2 | 6.3 |

Concentrations of 1000 - 2000 mg Mn or 200 - 400 mg Zn/kg D.M. certainly must have had some effects on plant metabolism. During the whole vegetation period, however, there was no deficiency symptom, induced by Zn or Mn, to be observed (v. Scharpf, 1981). Neither EDTA - nor $MgSO_4$ - soluble Zn and Mn-values give a satisfactory explanation for these heavy metal contents of the plants.

Spray carnations: Experiment with varying rates of liquid feeding (N)

With only few exceptions, increasing fertilizer rates applied to the growing plants resulted in significant increase of fresh weight yield of carnations (sum of 1st and 2nd flowering period (fig. 2) - experimental error was generally high (only 3 replications).

On the low feeding level, long-term composts except LC 3 and especially TKS achieved higher carnation yields than the depot-bark compost and the short-term composts SC 8 and 9; the altogether good yield performance of SC 7 was striking. Middle and high rates of liquid feeding caused converging results in all composts.

Bark compost did alter the quality of the crop only little; differences were generally within the experimental error. Medium and in part also higher rates of liquid feeding resulted in most cases in a slight increase of numbers of flowers and buds of the 1st and 2nd flowering period (marketable incl. garland quality). Table 4 shows as simplification only the means of flowers- and bud numbers resp. flower stalks from the 3 fertilizer rates.

TABLE 4 - POT TRIAL WITH BARK COMPOSTS TO SPRAY CARNATIONS
NUMBERS OF STALKS RESP. FLOWERS + BUDS (SUM OF 1st + 2nd + GARLAND QUALITY/POT)
(AVERAGE OF 3 LEVELS OF LIQUID FEEDING)

| composts | stalks | flowers + buds |
|---|---|---|
| peat | 45 | 344 |
| LC 2 | 45 | 354 |
| LC 3 | 44 | 326 |
| LC 4 | 44 | 334 |
| LC 5 | 43 | 323 |
| DC 6 | 43 | 316 |
| SC 7 | 44 | 329 |
| SC 8 | 42 | 306 |
| SC 9 | 44 | 313 |
| LSD 5 % | 4 | 30 |

Differences were generally small; short-term composts SC 8, 9 and depot-bark compost had slightly lower bud- and flower-numbers than the others (not statistically significant); numbers of flower stalks varied only little between 42 and 45.

Losses by decomposition in different composts

In pot trials with ryegrass losses of matter in the various composts were computed after arithmetical elimination of the peat portion (table 5).

TABLE 5 - DECOMPOSITION OF BARK COMPOSTS IN POT TRIAL WITH RYE GRASS (SHARE OF PEAT IS MATHEMATICAL ELIMINATED)

Decomposition time: 7 Apr - 28 Sep 1982 = trial with rye grass (10 - 30°C)
28 Sep 1982 - 28 Feb 1983 = without plants (-5°C - + 15°C)

| COMPOSTS | LOSS OF DRY MATTER % | PH ($CACL_2$) 1 OCT 82 | BARK/PEAT MIXTURES VOL.WEIGHT (G DRY MATTER/L) 7 APR 82 | 1 OCT 82 |
|---|---|---|---|---|
| peat | 5 | 3.9 | 85 | 80 |
| LC 2 | 20 | 5.0 | 193 | 230 |
| LC 3 | 18 | 5.9 | 178 | 200 |
| LC 4 | 7 | 4.7 | 182 | 196 |
| LC 5 | 8 | 4.9 | 178 | 168 |
| DC 6 | 30 | 6.8 | 241 | 226 |
| SC 7 | 26 | 5.5 | 156 | 168 |
| SC 8 | 25 | 7.5 | 144 | 151 |
| SC 9 | 27 | 6.3 | 140 | 144 |

Inspite of high experimental variation (about 10 - 15 %), it can be deducted from these results, that long-term composts, especially LC 4 and LC 5, have a higher microbial stability than short-term composts or the depot-bark compost. Higher decomposition-rates imply a portion of biologically attackable matter and thus fixation of N, if C/N ratio in this organic part is > 20. PH-values should have only little influence on the amount of losses by decomposition, at least above 5.0. Volume-weight was hardly affected during this 6-months-trial; evidently all composts have stable coarse fractions which prevent sagging and thus a decrease of number of coarse pores.

## 4. Discussion

In pot trials with ryegrass, it could be clearly demonstrated that composting methods, especially length of fermentation time with its differing effects on N dynamics, do influence plant growth as well as N-uptake. Long-term fermented barks as well as peat substrate showed a good and even supply of added nitrogen fertilizer. The poor plant yield on short-term fermented bark composts was mainly due to biological N fixation of $NH_4$ and $NO_3$ which has also been the case in incubation trials for N turnover studies. Usually higher losses of organic matter in these composts give a good explanation for the increased N fixation in comparison with other products, especially sphagnum peat. According to this, determination of easily decomposable organic matter should be an essential criterion for the assessment of N turnover in different bark composts. An appropriate method is currently being developed. By continuous liquid fertilizing with N, differences between the test composts with regard to yield and N-removals by plant could be compensated partly (ryegrass) or nearly fully (spray carnations). Liquid fertilizing in the trial with ryegrass was suboptimal (100 mg N/l, 5 l pot), so that some short-time composts and depot-bark compost reacted with noticeably lower yields also under these culture conditions. High (4350 mg N/pot) up to very high (5575 mg N/pot) amounts of liquid feeding for carnations resulted in largely equal yields with only small differences in the marketalbe product;

some long-term composts showed best results already with the middle N supply; i. e., the very high N-rate meant over-supply, yet without effects on yield and quality.

From these experiments it may be deduced that the balanced N turnover of long-term fermented barks, without major N fixation or N mineralization, facilitates an optimal N nutrition of horticultural plants. Dressing prescriptions for the various plants therefore should be similar to peat substrate.

Short-term composted barks require a continuous high N liquid feeding, the level of which still has to be the question of further tests. Unsatisfying results with rye grass on short-term composts were partly explained by high heavy metal contents (Zn, Mn) which could not be expected from the preliminary analysis of the substrates (EDTA- and $MgSO_4$-extraction). It is known that especially conifer barks have high concentrations of among others Mn and Zn (up to 800 mg Mn resp. 160 mg Zn/kg bark - D. M., acc. to Keilen, 1977); strong heat or steam treatment e. g. in a compost reactor could possibly increase availability of heavy metals similar to steaming of soils and substrates; by post-rotting of short-term fermented bark, availability of Mn clearly decreases (unpublished results). There was no correlation between pH of compost and mobility of heavy metals.

## References


Gutser, R., Teicher, K., and Fischer, P., 1984: Nitrogen dynamics in bark composts dependent on production methods. I.Model trials. Acta Horticulturae, z. Zt. im Druck

Keilen, 1977: zit. in Archut, E., 1981: Rindenhumus - kein Ersatz, sondern vollwertiges Substrat. Gb. + Gw. 81: 618-621.

Scharpf, H.C., 1981: Manganüberschuß und Eisenmangel in Rindensubstraten. Taspo, Sh.1981: Rindenprodukte für den Gartenbau. Thalacker Verlag Hamburg, 76S., 12-18.

Zöttl, H.W., 1981: Bestimmung und Beseitigung der Stickstoffimmobilisierung im Rindenhumus. Taspo, Sh.1981: Rindenprodukte für den Gartenbau. Thalacker Verlag Hamburg, 76S., 7-11.

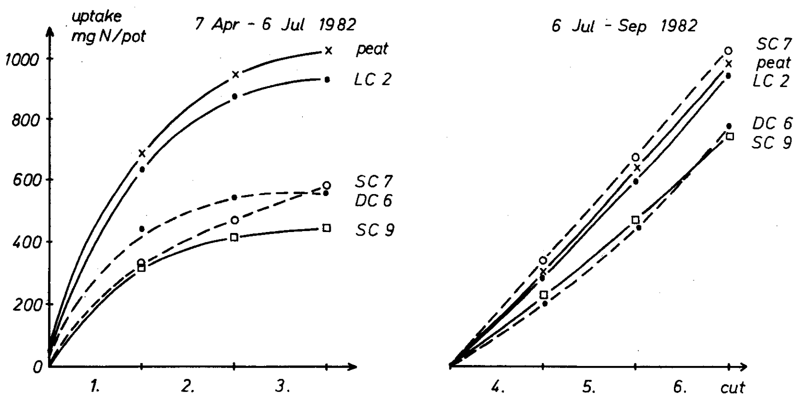


*Fig.1 – N-dynamic of bark substrates, composted with different methods peat/bark = 40/60 (Vol. %)*

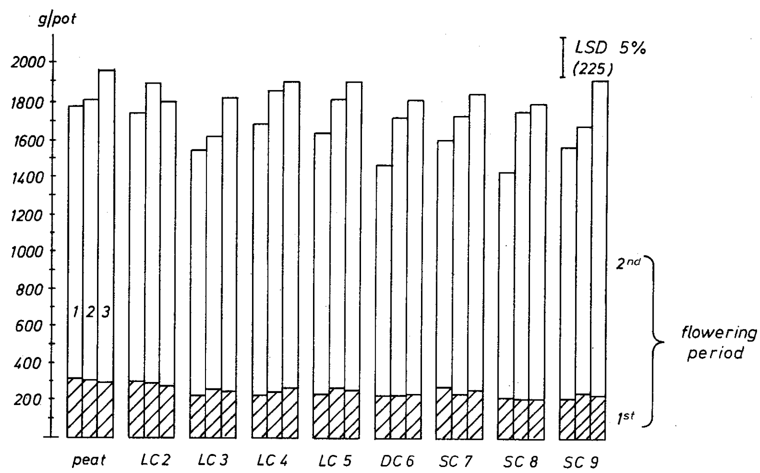


*Fig. 2 - Pot trial with bark composts to carnation - Effect of liquid feeding (1 = 620 ; 2 = 870 ; 3 = 1115 mg N/l) on yield (g fresh weight/pot)*