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**POTTING MEDIA, TRANSPLANTS AND
YIELDS IN THE PRODUCTION OF
GLASSHOUSE TOMATOES**

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1. INTRODUCTION

It is usual for the production of different glasshouse vegetables to split up the total growth period into two distinct phases: the first in which plants are raised in pots or blocks and the second in which transplants are planted out into their final positions to reach maturity. This system is based upon the 2 factors that during the propagation period over a longer time space is saved, thus resulting in decreased production costs.

For raising plants special potting media are required. These media were the subject of investigations carried out with tomatoes, the most important glasshouse crop in The Netherlands. The study was undertaken with the variety Moneymaker

- a. to determine differences in transplants as related to potting composts used by growers;
- b. to find out what compost properties induced the differences under a.;
- c. to estimate the dependence of yields on transplants from various potting-compost qualities.

2. USE AND PREPARATION OF POTTING MEDIA

For raising tomato plants in The Netherlands plants are normally propagated in soil blocks and for these the most important ingredient is peat.

From a review of literature concerning potting media it is concluded that research led to a simplification of these media by decreasing the number of bulky ingredients. Most of the published work on this field is concerned primarily with materials and additional fertilizers, but there is a lack of literature on the chemical and physical analyses of potting media in relation to plant growth. Consequently little information is available regarding the desired chemical and physical properties of propagating soils.

3. EXPERIMENTAL METHODS IN PROPAGATION TRIALS

Propagation of tomato plants was carried out with soil blocks in the usual way except that pots were placed on rush-mats to eliminate the influence of the border soil. Seedlings were transferred to soil blocks in a young stage without pricking-out.

After the propagation period, plants were cut off just below the cotyledons and scored for fresh weight, stem height, number of leaves at least 3 cm long, stage of development of the inflorescence and dry matter. The stage of inflorescence development was determined by microscopic examination and ranged between 0 = external flower initiation not visible, and 10 = anthesis of the first flower.

Soil analyses included the determinations according to the Proefstation voor de Groenten- en Fruitteelt onder Glas at Naaldwijk (39), pF curves (82) and particle fractionation of organic matter based on a wet-sieving technique (40, 60).

Plant analysis was confined to the nitrogen content in the dry matter of the shoot (56, 57).

Experimental designs and mathematical treatments of the data were taken from different publications in this field (23, 33, 42, 53, 67, 101).

4. FIRST INVESTIGATION ON POTTING COMPOSTS OF GROWERS' HOLDINGS

The experiment was carried out in 1960 on 56 samples taken from composts which were going to be used by growers mainly in the Westland for raising tomato plants. Inquiries among the growers in question gave information about bulky materials and proportions. The data in table 1 indicate a wide variation in the composition of the potting composts, especially since ingredients which were seldom used or used in negligible quantities, are not recorded in this table. The complexity of the mixtures is also shown in the results of the soil analyses (table 2) and in the diversity in moisture and air retention (table 3).

The data from the propagation test with the collected samples are given in figure 1 and illustrate a distinctly different growth between the groups of tomato plants. The yields were used for a classification for compost quality (table 4). Based on these weights only 30% of the tested composts were considered good, the remaining 70% ranging from inadequate to totally unsuitable.

Statistical analyses of the relations between plant growth and the properties of the composts showed that fresh weight was influenced by N-water and organic-matter content. The regression equation was:

$$\text{fresh weight (g/pl)} = 8,6 \log N\text{-water} - 0,06 \text{ org. matter (\%)} - 1,6 \quad (n = 53).$$

The multiple correlation coefficient was 0,87, the partial correlation coefficient for fresh weight and logN-water was +0,85 and that for fresh weight and organic-matter content -0,44.

The effect of the organic-matter content on the fresh weight is an indirect effect of N-water. The explanation of this phenomenon lies in the fact that the N-water is in terms of mg N per 100 g dry soil. Since there is a negative correlation

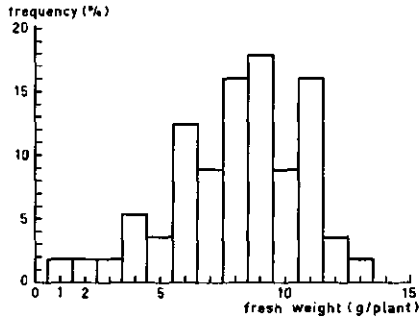


FIG. 1. Histogram for fresh weight of young tomato plants in the 56 potting composts of table 1.

between content of organic matter and bulk density, a given N-water means a reduction of the amount of water-soluble nitrogen per pot when the organic-matter content increases. To avoid this complication the amount of water-soluble nitrogen was expressed on the basis of volume and called the *N-value*, i.e. mg N per 100 ml soil.

The *N-value* was calculated from bulk density and *N-water*. Bulk density was given by:

$$D_b(\text{g/ml}) = 3,1 \text{ org. matter } (\%)^{-0,61} \quad (r = -0,93; n = 56)$$

This equation (figure 2) was derived from data on the pF curves and also held for the soil blocks.

Determining the correlation of fresh weight on log*N-value* and the content of organic matter, the partial correlation coefficient for fresh weight and organic-matter content was +0,14. Consequently plant growth was not related to the content of organic matter. The relation between fresh weight and *N-value* could be represented by the equation:

$$\text{fresh weight (g/pl)} = 8,8 \log N\text{-value} - 0,2 \quad (r = +0,86; n = 53).$$

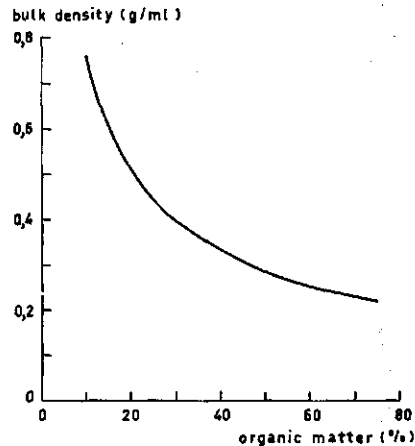


FIG. 2. The relation of bulk density of new soil blocks to organic-matter content for the 56 potting composts of table 1.

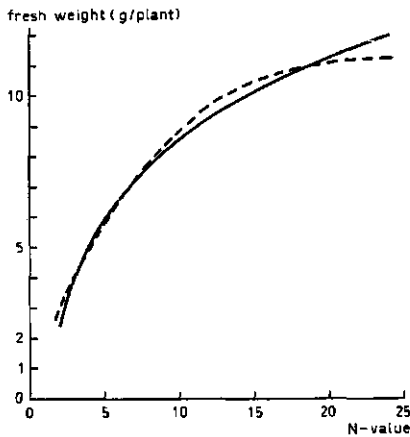


FIG. 3. Relationship between fresh weight and N-value for 53 potting composts of table 1. Continuous line = logarithmic curve; broken line = free hand curve.

This curve in figure 3 is characterized by the absence of an optimum and therefore not acceptable from a biological standpoint. For control's sake the free hand curve is drawn, which curve represented 73% of the total sum of squares.

As can be seen from figure 3 the amount of water-soluble nitrogen in the compost was an important factor for growing young tomato plants. In view of the free hand curve and a frequency table for N-value (table 5) under the given conditions only 12% of the investigated potting composts had received an optimal nitrogen supply.

Fresh weight was also controlled by the air filled pore content at $pF = 1,0$. The equation for the regression of fresh weight on $\log N$ -value and air content at $pF = 1,0$ was:

$$\text{fresh weight (g/pl)} = 8,4 \log N\text{-value} + 0,30 \text{ air content (\%)} - 0,9.$$

The analysis of variance is given in table 6. The sum of squares for the regression on $\log N$ -value took up 78% of the total sum of squares and that for the regression on air content 5%. Calculations were based on the data of 45 potting composts; the rest of the samples was not representative of the whole because of deviations in sampling or measurement.

The relation between fresh weight and air content at $pF = 1,0$ for the mean of N-value (= 9) is drawn in figure 4. Assuming that the air content at $pF = 1,0$ of

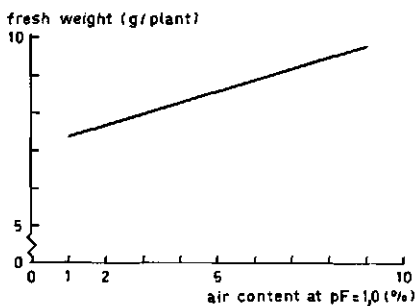


FIG. 4. Influence of air filled pore content at $pF = 1,0$ upon fresh weight for the average N-value in 45 potting composts of figure 3.

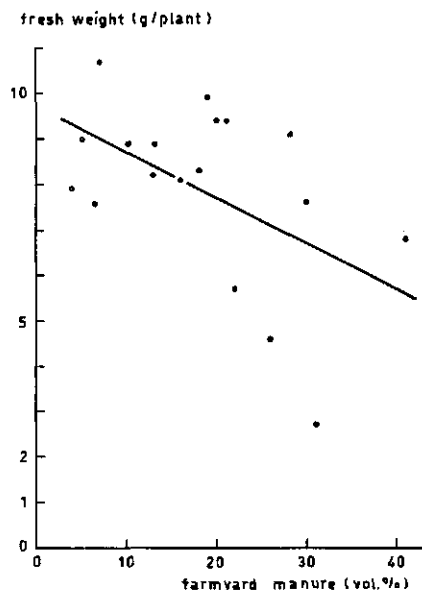


FIG. 5. The effect of farmyard manure in potting composts on the fresh weight after corrections for N-value and air content at $pF = 1,0$.

a potting compost must be at least 6%, no more than 18% of the 45 composts had a correct physical condition (table 7). Growth and air content were not related if N-value < 6 , thus indicating the dominant effect of small amounts of available nitrogen.

An attempt to get information about the quality of the different peats failed completely.

The relation between fresh weight and the quantity of farmyard manure in the potting compost, after corrections for N-value and air content, could be represented by the equation (figure 5):

$$\text{fresh weight (g/pl)} = -0,1 \text{ farmyard manure (\%)} + 9,7 \quad (r = -0,52; n = 18).$$

This indicates that addition of farmyard manure to a potting compost should be avoided.

5. SECOND INVESTIGATION ON POTTING COMPOSTS OF GROWERS' HOLDINGS

Previous investigations in 1960 gave evidence of widely varying compositions, soil conditions and qualities of potting composts in the Westland. To check these results, at the end of 1960 samples were taken from 94 composts in the 'Kring', i.e. the eastern part of the South Holland glasshouse district. These composts were going to be used by growers to raise tomato plants for crops

in heated glasshouses in 1961. Since a total number of 100 samples was desired for statistical reasons, 6 samples of mixtures in an experimental stage were added to the growers' composts.

Compositions of the Kring composts in respect of bulky materials, according to growers' statements, are given in table 8. The data show that composition was as different as in the Westland composts. Compared with the latter, the Kring propagating soils contained more wood-litter (of pine -forests), but lower amounts of gyttja-like dredgings, peat moss and sand.

Results of soil analyses by methods used at Naaldwijk (table 9) show that also different soil properties varied widely. The same applies to particle-size distribution of organic matter, given in table 10. As would be expected from the separate data, the organic fraction $> 1000\mu$ was negatively correlated with the fraction $< 75\mu$ and the regression equation was:

$$\text{org. fraction} > 1000\mu (\%) = -0,83 \text{ org. fraction} < 75\mu (\%) + 50,7 \quad (r = -0,90; n = 100).$$

Fresh weights of young tomato plants after a propagation trial are presented in figure 6 indicating that the range of variation was very large. A classification for the quality of the growers' potting composts is given in table 11 showing that only 19% of these were suitable for raising tomato plants.

There were high correlations between fresh weight and stem height, number of leaves > 3 cm, stage of 1st inflorescence or dry matter. The relative equations, drawn in figure 7, were as follows (units per plant and $n = 100$):

$$\text{dry matter (g)} = 0,072 \text{ fresh weight (g)} + 0,05 \quad (r = +0,97)$$

$$\text{stem height (cm)} = 0,74 \text{ fresh weight (g)} + 4,6 \quad (r = +0,97)$$

$$\text{leaves} > 3 \text{ cm (number)} = 4,01 \log \text{ fresh weight (g)} + 5,3 \quad (r = +0,95)$$

$$\text{stage of 1st inflor. (0-10)} = 2,09 \text{ fresh weight (g)}^{0,53} \quad (r = +0,93).$$

Fresh weight was influenced by the N-water and the organic-matter content. The equation was:

$$\text{fresh weight (g/pl)} = 5,8 \log \text{N-water} - 0,054 \text{ org. matter (\%)} + 1,1$$

The multiple correlation coefficient was 0,82, the partial correlation coefficient for fresh weight and \log N-water $+0,82$, that for fresh weight and organic-matter content $-0,40$ and $n = 100$.

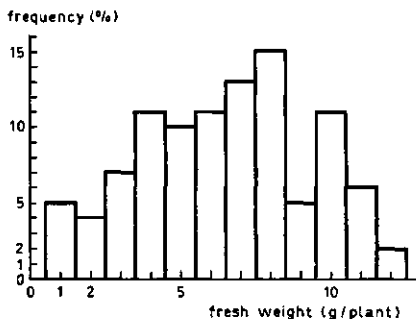


FIG. 6. Histogram for fresh weight of young tomato plants in the 100 potting composts of table 9.

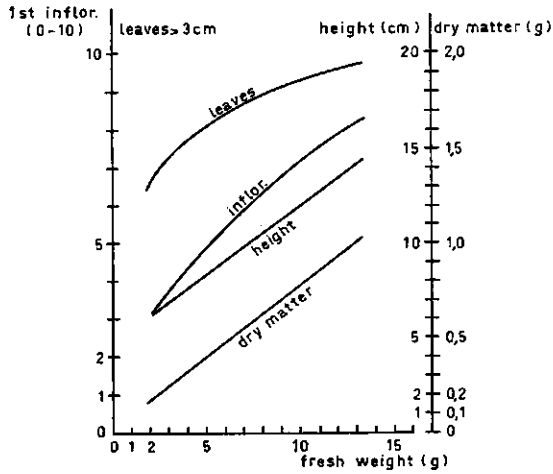


FIG. 7. Regression of dry matter, stem height, stage of 1st inflorescence and number of leaves > 3 cm on fresh weight of young plants in the 100 potting composts of table 9, units per plant.

As in the preceding investigation the N-water was converted into the N-value, also by means of the regression equation for bulk density and organic-matter content. In a correlation analysis of fresh weight, logN-value and the content of organic matter, the partial correlation coefficient for fresh weight and logN-value was +0,84, that for fresh weight and organic-matter content -0,02. The last datum indicates that the content of organic matter did not affect plant growth.

In addition to the N-value, growth was influenced by the content of the organic fraction > 1000 μ . The regression equation for fresh weight, logN-value and the organic fraction > 1000 μ was:

$$\text{fresh weight (g/pl)} = 5,6 \log N\text{-value} + 0,11 \text{ org. fraction (\%)} - 0,3$$

It can be concluded from table 12 that 70% of the total sum of squares for fresh weight was due to the regression on logN-value and 6% to the regression on the organic fraction > 1000 μ ; the residual mean square could not be explained by other soil properties measured in this study.

The curve for the regression of fresh weight on logN-value for the mean of the organic fraction > 1000 μ (23%) and the free hand curve for the relation between fresh weight and N-value, which reduced the total sum of squares by 75%, are represented in figure 8. The data given in this figure show that the greatest influence of the N-value occurred below 10, and that according to the free hand curve the maximum for growth was at 26. The free hand curve is less reliable at N-values above the optimum.

The frequency table for the N-value (table 13) shows that 14% of the growers' composts in the Kring had a sufficient quantity of plant available nitrogen, while 82% of the composts were deficient in this element.

The regression equation for fresh weight and organic fraction > 1000 μ for the mean of logN-value (0,830) is drawn in figure 9. Growth of the young

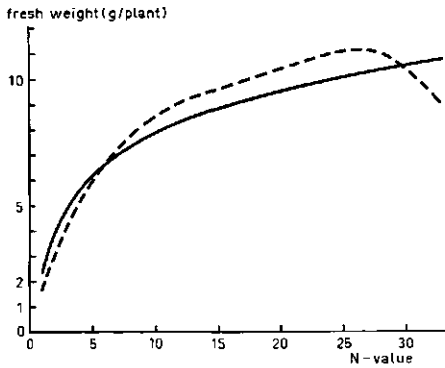


FIG. 8. Relationship between N-value and fresh weight of young plants in the 100 potting composts of table 9. Continuous line = logarithmic curve for the average organic fraction $> 1000\mu$; broken line = free hand curve.

tomato plants increased when organic material in the potting compost was of a coarser grade.

Table 14 gives the distribution of the organic fraction $> 1000\mu$ for the Kring composts. It is to be supposed that the content of this fraction should be at least 30% of the total organic matter, therefore only 7% of the investigated composts had a correct physical condition.

Arranging the N-values in classes, it appeared that the content of organic fraction $> 1000\mu$ did not affect growth if the N-value was below 8. A statistical analysis in order to characterize different organic materials by the determination of the organic fraction $> 1000\mu$ gave inconclusive results.

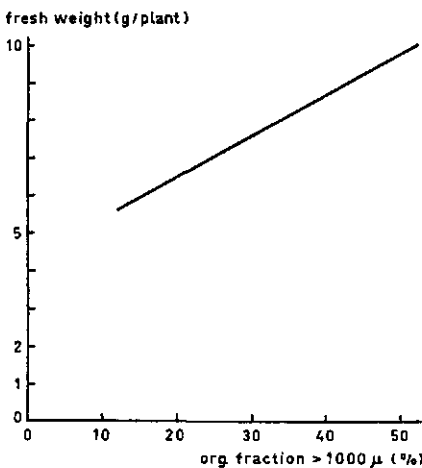


FIG. 9. The relation of fresh weight to the organic fraction $> 1000\mu$ for the average N-value in 100 potting composts of table 9.

6. NITROGEN AND THE STRUCTURE OF POTTING COMPOSTS

Investigations on growers' potting composts have shown that the 2 curves for fresh weight and the N-value were almost identical below N-value = 10 and that growth was maximal at an N-value of approximately 25. However, the optimum N-value was not distinctly exceeded in these investigations. In order to obtain more information about the effect of higher amounts of available nitrogen in composts, an experiment was carried out with different levels of sand and nitrogen using nitrolime as a source.

In this experiment, fresh weight of young tomato plants was correlated with the N-water ($r = +0,66$; $n = 20$) and with the N-value (figure 10), which curve reduced the total sum of squares by 79%. Growth reached its highest rate at N-value = 35.

The shift in the optimum with respect to the investigations on growers' potting composts should be attributed to the differences in fresh weight and the allied nitrogen requirement. Although N-value = 50 was attained, no decrease in growth could be detected.

Nitrogen content of dry matter of shoots ranged between 1,66% and 4,32% N. This content was correlated with the N-water ($r = +0,72$; $n = 20$), whereas the regression with the N-value was given by:

$$N\text{-shoot (\%)} = -0,0014 N\text{-value}^2 + 0,15 N\text{-value} - 0,15 \quad (R = 0,92; n = 20).$$

It is concluded that, for fresh weight and the N-content of the shoot, N-value was a better index to the availability of nitrogen in potting composts than N-water. Since N-value in the present experiments was calculated from both N-water and bulk density, it was found desirable to do future work on a direct determination of N-value in composts by a core sampling method.

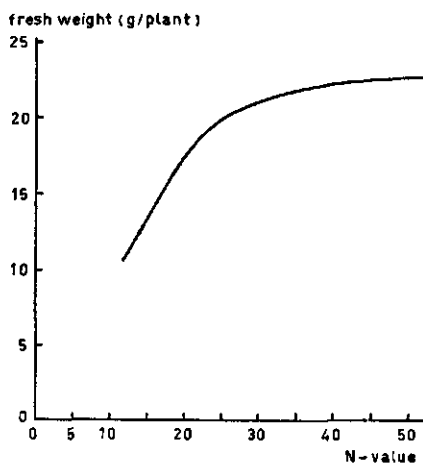


FIG. 10. The effect of N-value on fresh weight in an experiment with different rates of application of sand and nitrogen.

In the last experiment, added nitrogen appeared to be completely removed by extraction with the water used for the determination of N-water. The relationship between the amount of added nitrogenous fertilizer and the N-value is somewhat complicated by compaction. Soils containing a high percentage of organic matter are more or less compressible, therefore compaction influences the amount of food per pot. Optimal nitrogen condition, however, was approaching an N-value = 35 and growth was almost constant when $35 < \text{N-value} < 50$. So the optimal amount of nitrogen may be fixed at 350 mg N per l or 350 g per cubic meter provided that the nutrient value of bulky materials is very low. In this case compaction was found to be of little importance.

In general the optimal nitrogen dressing in potting composts (N_d) for raising tomato plants in soil blocks can be derived from the formula:

$$N_d \text{ (mg N / l)} = 10 [35 - \text{N-value}]$$

Variation in natural nutrient value of bulky materials and in nitrogen requirement in response to plant size explain the different data from the literature concerning optimal doses of nitrogen fertilizer (see table 15).

In the initial investigations on growers' potting composts, air filled pore content and in the second the organic fraction $> 1000\mu$ were important factors in plant growth. Unfortunately, both analytical tests were not applied to the same samples. Although the relationship between the two analyses could not be calculated in the present work, correlation may be probable. The higher air content at $pF = 1,0$ therefore would be attributed to the coarser grades of organic materials. For convenience, determination of this organic fraction $> 1000\mu$ is preferable because of its speed for the measurement of the physical condition of potting composts.

It is of interest to note that wood peats from the same source varied in organic fraction $> 1000\mu$ according to treatment. Further investigations are needed to determine the way to obtain the best quality peat for composts.

7. THE EFFECT OF TRANSPLANTS ON YIELDS

In preceding trials with composts the dimensions of the young tomato plant were a measure for the quality of the propagating soil. A stronger growth of the plant was considered as an indication of a better compost quality. This assumption is only correct if the final yield of the crop is dependent upon the condition of the planting material, so that heavier young plants produce larger yields. In addition, with tomatoes not only a high production is required but earliness is also of importance because of the price variation (figure 11).

A survey of the literature concerning the relationship between propagation conditions and yields from tomatoes, proved that the propagation of the young plant definitely influences the time of cropping and the weight of harvest. Quan-

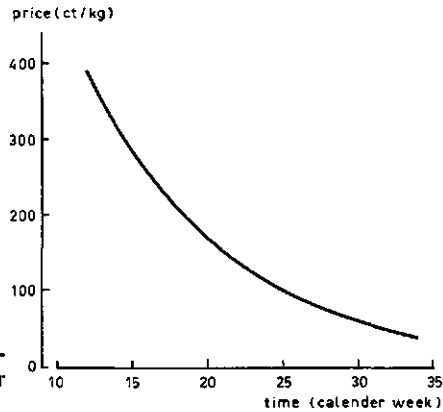


FIG. 11. Seasonal variation of price for tomatoes in the Netherlands, average for 1961–1965 over all auctions.

titative equations between the properties of young plants and yields, however, are not to be found in the literature. To meet this gap, the investigations sub 9, 10 and 11 were carried out.

8. METHODS OF THE EXPERIMENTS WITH CROPS OF TOMATOES

For each experiment a series of young plants was made, mainly differing in the potting media used. The potting-compost mixtures consisted of two components in different ratios by volume. The first component was a potting compost which in former experiments had proved to give excellent results. The second component was a fine, clay-containing peat with poor physical properties without added fertilizers.

After the propagation, a sample of plants was taken from each group in order to determine the properties of the young plants, which have been referred to in chapter 3. The remainder was planted out in its final position. During the growing period observations were made on the crop and the yields were measured.

9. TRANSPLANTS FOR A MEDIUM EARLY CROP, GROWN IN A HEATED GLASSHOUSE (EXPERIMENT I)

Tomatoes were sown on November 21st and December 5th 1960 and then propagated in mixtures with 100, 75, 50, 25 or 0% of good potting compost.

The results of the propagation are given in table 16. The fresh weight of the plants was higher with a better quality of the substrate and with an earlier sowing date. The slight increase in fresh weight with more than 50% good compost must be ascribed to the low plant weight and the consequent low nutrient requirement of the young plant. The interaction potting-compost mixture \times sowing date points to the fact that, if larger plants must be made, the quality of the potting soil is a factor of increasing importance.

When compared with the fresh weight, the rest of the plant properties showed a similar trend. The relations between fresh weight and other properties are stated in table 17. In general correlation coefficients were greater than $+0,90$, figures therefore considerably above the levels of significance at $P = 0,01$. Since the lines should have passed through the origin of abscissa and ordinate, several regressions are in fact curvilinear, which is indicated by relatively high constants.

After planting out, the crop showed large variations in growth as demonstrated in the data of table 18. A heavier plant flowered earlier and produced a higher

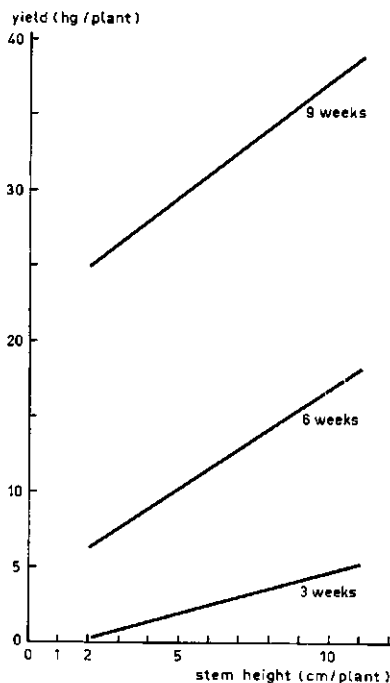


FIG. 12. Experiment I. The relation of yield in 3, 6 and 9 weeks to the stem height of the young plant at planting-out time.

crop. It was noteworthy that heavier plants also gave a better first truss: a larger number of flowers and a higher standard of setting. In view of these facts it was inevitable that better plants were 10 days earlier in production.

The yields of fresh fruits are given in table 19. After 3 weeks of cropping a better potting medium and an earlier sowing date gave a higher yield; over all treatments maximum gain in yield was 5 hg per plant. The same trend was observed for the yields over 6 and 9 weeks, the greatest differences having increased to 12 hg per plant.

The relations between the properties of the young plants and yields in the mentioned periods are given in table 20. With an increased cropping time, the correlation coefficients decreased due to other effects which influenced the growth of the plants during the culture. Apart from this, the relations were highly correlated. The regression coefficients reached the highest figures after 9 weeks, but particularly increased from 3 to 6 weeks. This points to the fact that the effect of the young plants particularly found expression during the first 6 weeks of the harvest.

The length of the stem during planting time was by far the best criterion for the later yields. The concerning regressions are given in figure 12. From this figure it can be seen that the poorest young plants subsequently gave a higher rate of fruit production. In order to explain this phenomenon, it must be remembered that the growth of the poorly growing plants was retarded. As the climatical conditions improved after planting out (longer days and higher light intensities), the plants, initially retarded in their growth, had a more favourable environment during the fruiting stage.

10. TRANSPLANTS FOR A NORMAL CROP, GROWN IN AN UNHEATED GLASSHOUSE (EXPERIMENT II)

Tomato plants were propagated in February and March 1962 using mixtures containing 100, 40 or 10% good potting compost. These treatments were combined with two soil block sizes: 8 × 8 cm and 10 × 10 cm.

In table 21 results of the propagation show that the fresh weight of the young plant increased with a higher percentage of good potting composts in the mixture. A larger soil block also stimulated growth, but this effect was less than that of the propagating-soil quality. The other properties of the young plants gave the same indications.

The interaction mixture × pot size was only significant in regard to the fresh weight and the dry matter. This interaction means that the improvement of substrate quality finds more expression by using a larger soil block, whereas the reverse is also true of course.

After plotting the fresh weight against the quantity of good potting compost

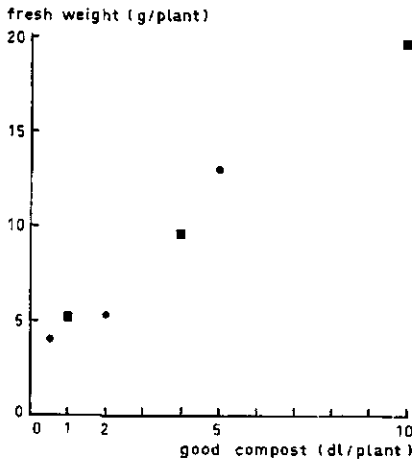


FIG. 13. Experiment II. Fresh weight of the young plant as related to the amount of available good potting compost in the mixture.
 ● = soil block 8 × 8 cm;
 ■ = soil block 10 × 10 cm.

per plant (figure 13) growth appeared to be influenced particularly by the quantity of good component and to a much smaller degree by that of the poor one.

Linear relations between fresh weight of the young plant and other properties are represented in table 22. Correlations were very high, although in some equations high constants indicate a curvilinear response.

After planting out, observations of the crop were made and summarized in table 23. From these data it may be concluded that the number of leaves before the 1st inflorescence was not effected by treatments. A heavier plant flowered earlier, reached a greater height at a fixed date, but did not always give an earlier initial harvesting date.

It was found in all sections of the experiment that yield increased with a better mixture quality and with a larger size of the soil blocks (table 24). After 4 weeks harvest the greatest difference amounted to 5 hg per plant and after 7 weeks this difference had increased to 8 hg per plant. After 9 weeks harvest the difference between the treatments had only changed a little.

The relations between plant properties and yields are given in table 25. The correlation coefficients greatly exceed the 1-per cent level indicating strong positive correlations. In addition, the correlation coefficients varied so slightly that it made no difference which plant property was used to make an estimate of the yields. Prolongation of the harvest period diminished the correlation coefficients as in the preceding experiment.

The course of the regression coefficients clearly demonstrates that the transplants influenced the yields during the first 7 weeks of harvesting.

11. TRANSPLANTS FOR A LATE CROP, GROWN IN AN UNHEATED GLASSHOUSE (EXPERIMENT III)

The treatments in this experiment consisted of 4 mixtures with resp. 100, 40, 25 or 0% good potting compost. As usual in these experiments, the soil blocks were placed on rush-mats. The soil blocks of another treatment with a potting medium of 100% good compost were placed on the soil of the propagating house. As plants normally root into this soil, this experiment was done to find out whether the damage resulting from breaking the roots during planting out, would reduce growth and yield. The propagation took place in the months of April and May 1961, which was late for a normal culture in an unheated glasshouse.

The results of this propagation are mentioned in table 26. It appears that plants from the soil blocks on rush-mats had a much lower fresh weight than those on the glasshouse soil. In the latter case rooting in the glasshouse soil was possible and so these plants suffered less during a period of sharp, sunny weather in which an adequate water supply failed to meet the demands made by the plants. A lower fresh weight was linked with a lower percentage good potting compost in those plants in soil blocks on rush-mats.

The other measured properties of the young plants showed the same picture and the correlations of these on fresh weight were accordingly very high (table 27). Just as in the preceding experiment there are high constants due to curvilinearity.

In table 28 the observations are given which were taken on the crop after planting out. The plants on rush-mats flowered earlier when the potting compost was of a better quality. With the best quality propagating soil positioning of the pots had no influence on the date of flowering despite the fact that in one case the transplants were much larger. Though heavier plants did not always flower earlier, they had a better first truss (more flowers and a relatively better fruitset), were taller and had an initial harvest earlier in the season.

The data concerning the yields in 3, 6 and 13 weeks in table 29 show that, generally, a better quality potting-compost mixture is coupled with a higher yield. The greatest difference in yield amounted to 9 hg per plant after 6 weeks harvesting. The maximum difference was somewhat smaller after 13 weeks owing to a diminished growth of the crop from those plants that were propagated in soil blocks on the ground.

The relationships between plant properties and yields were very close (table 30). In this experiment, as in the preceding one, the correlation coefficients were lower when the length of the yield period increased. The correlations between the development of the 1st or 2nd truss and the yield in 3 weeks gave a slightly curvilinear graph, while this curvilinearity decreased with a longer harvesting period. This explains the relative improvement of the correlation coefficients in these cases.

From the changes in regression coefficients for corresponding equations, it

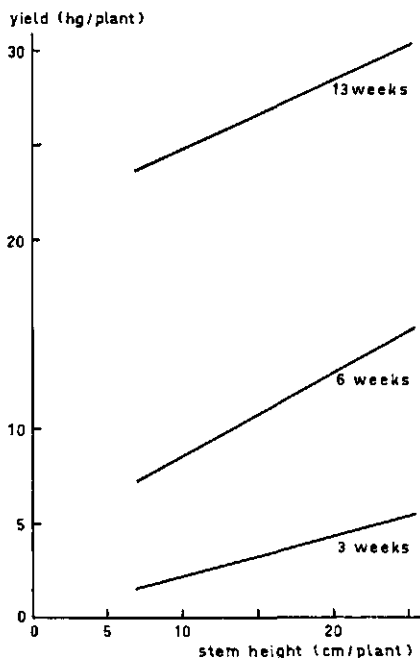


FIG. 14. Experiment III. The relation of yield in 3, 6 and 13 weeks to the stem height of the young plant at planting-out time.

may be concluded, that the influence of the quality of the plant on the yields was maximal after 6 weeks of harvesting.

The relation between the yield and the length of the stem at planting-out time is given in figure 14, which shows that there were only slight differences in the rate of fruit production. This was due to equable climatical conditions during the cultivation.

The results of this experiment gave no indication that root break during planting out caused a reduction in the growth of the final crop.

12. GENERAL DISCUSSION ABOUT TRANSPLANTS FOR TOMATO CULTURE

The relationships between fresh weight and other properties of the young plants, obtained from the various experiments, are summarized in figures 15 to 18.

The regressions of dry matter on fresh weight are given in figure 15. The dry matter *content* changed in two ways: within experiments it was negatively correlated with growth, and between experiments the dry matter *content* increased when the propagation was delayed from winter to summer.

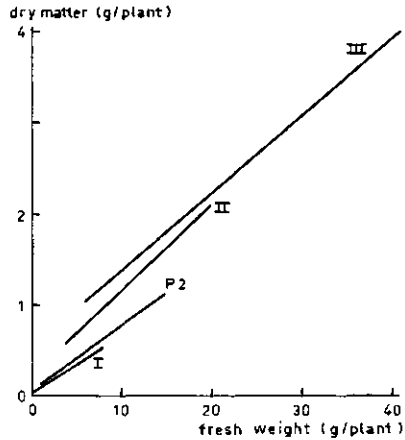


FIG. 15. Relation of dry matter to fresh weight for young plants in different trials. P2 = investigation on 100 potting composts (table 9); I, II, III = at the end of the propagation period in respective experiments.

In figure 16 the relations between stem height and fresh weight are given. Normally the length was relatively smaller when the plants were heavier. Also it is obvious that the plants were relatively shorter when their propagation had been delayed in the season. The difference between I en P₂ must be ascribed to the fact that a lower air temperature causes a slowing down in elongation of the stem.

The number of leaves at least 3 cm long was relatively smaller with heavier plants (figure 17), pointing to the fact the size of the leaf of a young tomato plant increases stem upward. The leaf size rather than the initiation of the leaves was reduced by a lower temperature and a poorer illumination.

The stage of the development of the first inflorescence as related to fresh

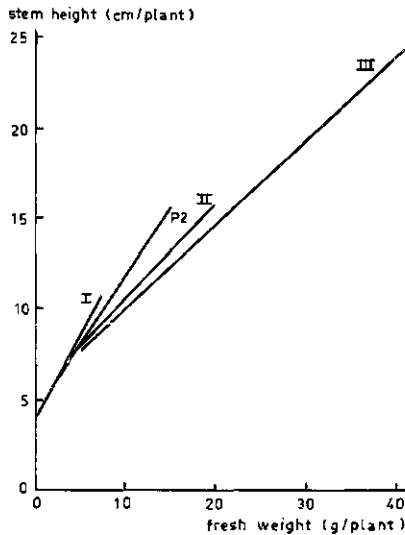


FIG. 16. Relation of stem height to fresh weight for the plants of figure 15.

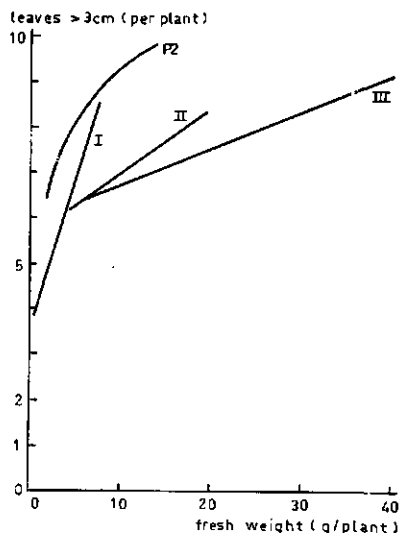


FIG. 17. Relation of number of leaves at least 3 cm long to fresh weight for the plants of figure 15.

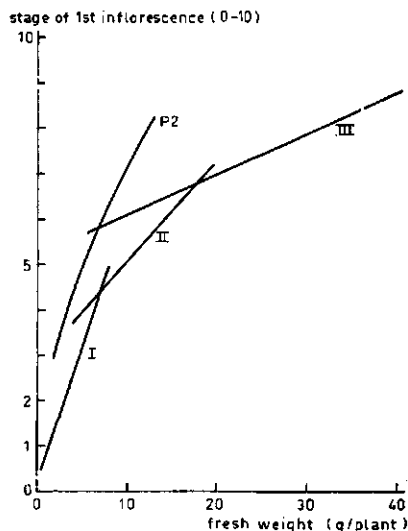


FIG. 18. Relation of stage of 1st inflorescence to fresh weight for the plants of figure 15.

weight is given in figure 18. It was concluded from the lines that the truss development was relatively stimulated by more light and by a lower temperature.

Comparing the relations between the plant properties it was supposed that soil conditions did not influence the typical morphological properties of the young tomato plant, but that these arose on account of changes in climatical conditions.

Experiments I to III were carried out under different conditions so that the levels of young plants and yields varied from trial to trial. In order to make the results comparable, the means for plant properties and yields were calculated as percentages of the maxima. These data were used for the calculations of linear regressions of relative yields in 3 or 6 weeks on relative transplant properties. The results were as follows:

property	cor. coef.		regr. coef.		constant	
	3 weeks	6 weeks	3 weeks	6 weeks	3 weeks	6 weeks
fresh weight	+0,94	+0,89	0,75	0,53	+ 24	+ 48
stem height	+0,97	+0,96	1,06	0,77	- 8	+ 24
leaves > 3 cm	+0,90	+0,85	1,21	0,84	- 33	+ 9
1st inflor.	+0,76	+0,69	0,65	0,44	+ 18	+ 46

$r_{0,01} = +0,50; n = 21$

From this it appears that the best estimation of the yields was obtained from the stem height of the young plant.

The correlation coefficients for the relations between yield and fresh weight were somewhat decreased, owing to the fact that the relations were actually slightly curvilinear. With the number of leaves > 3 cm and the stage of development of the 1st inflorescence it was obvious that the effect per experiment was not completely eliminated by the transformations.

From literature it has been calculated that the regression of yield on stem height of the young plant was less accurate than that on the fresh weight when temperature and varieties were experimental factors in the propagation. The fresh weight probably is more satisfactory for a general criterion because of its connection with the leaf area. It is supposed that the relationship between transplant and yield is determined, in fact, by the leaf area of the young plant as a factor influencing the potential assimilation capacity and thus the rate of growth of the plant after planting out.

Further investigations are desirable, in which the truss development also should be taken into account. In such experiments the development of the inflorescence has to be an independent variable with respect to the other plant properties.

The investigations on potting composts of growers' holdings and the culture experiments indicate that the holdings with tomatoes under glass must have a considerable variation in production. This is affirmed in figure 19, in which the produce of a number of holdings in the Westland is plotted in comparison with the corresponding date of planting out. In addition some production figures were known from holdings of which potting media were used in the second investigation. These data in table 31 indicate that, as a rule, a better quality propagating soil tends to correspond with a heavier early yield.

Consequently, it was justified to set up a calculation, also with the aid of government statistics, concerning the financial consequences of potting-compost quality for the whole of tomato culture in The Netherlands. It appeared that as a result of the poor quality propagating soils the decrease in potential in the period 1960–1965 must be estimated at about 20 million guilders a year. It shows clearly that only the best potting media are suitable for raising young tomato plants.

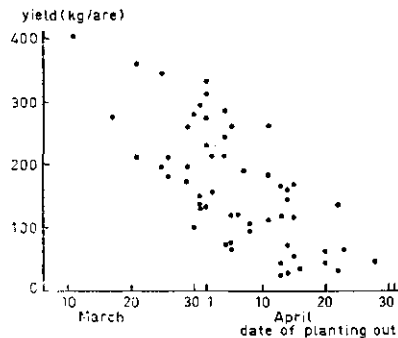


FIG. 19. Yield till 15th July as related to date of planting out for tomatoes in unheated glass-houses on 57 holdings in the Westland in 1960. Redrawn from (3).

SUMMARY

Samples of potting composts for raising tomatoes on holdings in the South Holland glasshouse district were collected in 1960 and 1961.

In propagation experiments with soil blocks, fresh weight of young tomato plants were found to vary widely. Some $\frac{3}{4}$ out of the investigated composts were not suitable for raising plants.

Soil analyses proved that under the given conditions many composts had an insufficient amount of plant available nitrogen, measured by means of N-value which is defined as mg water soluble N per 100 ml soil. Further investigations on composts for raising tomato plants in soil blocks showed that the relation between the optimal nitrogen dressing (N_a in mg N per l, or g N per m³) and N-value is given by:

$$N_a = 10 [35 - N\text{-value}].$$

Plant growth in the growers' potting composts was also influenced by soil physical condition measured as the air filled pore content at pF = 1,0 or as the organic fraction > 1000 μ in % of the total organic matter. The respective content should be at least 6% or 30%.

Experiments with series of transplants from different compost qualities showed that heavier plants made a better crop and produced a higher early and total yield. Overall stem height and fresh weight of the transplants were most accurate for predicting yields by means of regression equations, while the number of leaves at least 3 cm long and the stage of development of the first inflorescence were less accurate.

It is supposed that in the Netherlands the variation in yields of glasshouse tomatoes is partly due to poor potting composts for propagation; the decrease in potential during 1960-1965 is estimated at about 20 million guilders a year.

ACKNOWLEDGEMENTS

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TABLES 1-31

TABLE 1. Composition of 56 potting composts from growers' holdings mainly in the Westland.

bulky ingredients	number of samples, per cent of total	parts, per cent by volume		
		minimum	maximum	mean
gyttja-like dredgings	18	14	66	41
young sphagnum peat	14	15	100	35
farmyard manure	36	4	41	18
peat moss	25	8	35	17
wood peat	54	18	90	49
sand	45	1	30	12
commercial composts	32			100

TABLE 2. Soil analyses of the 56 potting composts from table 1.

description	minimum	mode	maximum
organic matter (%)	10	33	76
CaCO ₃ (%)	0	0,4	9,0
pH-water*	3,3	6,0	7,2
Fe (p.p.m. in extract)	0,6	0,8	16,0
Al (p.p.m. in extract)	0	0,5	6,8
NaCl (mg NaCl per 100 g dry soil)	22	60	273
soluble salts (% in extract)	0,16	0,8	2,22
N-water (mg N per 100 g dry soil)	4	25	127
P-water (mg P ₂ O ₅ per 100 g dry soil)	2	35	> 40
K-water (mg K ₂ O per 100 g dry soil)	16	50	280
MgO (p.p.m. in extract)	139	300	>400
Mn (p.p.m. in extract)	0,3	6	36

* 1 sample with pH = 3,3
 1 sample with pH = 4,8
 remaining samples 5,3 < pH < 7,2

TABLE 3. Percentage of moisture and air content by volume at different pF values for 56 potting composts (table 1).

phase	pF	minimum	mode	maximum
moisture	0,4	68,9	83	89,3
	1,0	65,4	78	85,2
	1,5	48,8	64	72,3
	2,0	37,6	47	58,8
	4,2	10,0	19	29,2
	6,0	2,1	3	4,3
air	1,0	0	5	19,6
	1,5	10,8	19	32,4
	2,0	23,2	36	48,4

TABLE 4. Classification for quality of 56 potting composts with 18 commercial composts from table 1.

compost quality	fresh weight in g per plant	frequency in per cent of total	
		56 potting composts	18 commercial composts
very poor	0 - 3	5	0
poor	4 - 6	22	33
inadequate	7 - 9	43	45
good	10 -13	30	22

TABLE 5. Frequency distribution for the water-soluble soil nitrogen of 55 composts belonging to table 1.

N-value	< 6	6 - < 12	12 - < 18	18 - < 24	24 - < 30
frequency (%)	22	44	22	9	3

TABLE 6. Analysis of variance for the multiple regression of fresh weight on logN-value and air content at $pF = 1,0$ for 45 composts belonging to table 1.

	SS	DF	MS	F	P
total	280	44			
regression on logN-value	218	1	218	188	<0,01
regression on air content	13	1	13	11	<0,01
residual (beyond control)	49	42	1,2		
experimental error			0,2		

TABLE 7. Frequency distribution for the air filled pore content at $pF = 1,0$ of 45 composts from table 1.

air content at $pF = 1,0$ as percent by volume	< 2	2 - < 4	4 - < 6	6 - < 8	8 - < 10
frequency (%)	16	22	44	16	2

TABLE 8. Composition of 94 potting composts from growers' holdings in the Kring.

bulky ingredients	number of samples, per cent of total	parts, per cent by volume		
		minimum	maximum	mean
gyttja-like dredgings	10	10	65	37
young sphagnum peat	16	10	40	20
wood-litter	16	11	50	26
farmyard manure	41	5	50	14
peat moss	5	10	50	21
wood peat	60	20	100	63
sand	31	2	20	8
commercial composts	31			100

TABLE 9. Soil analyses of 100 composts including those of table 8.

description	minimum	mode	maximum
organic matter (%)	5	45	78
CaCO ₃ (%)	0,1	0,5	8,8
pH-water	4,7	6,3	7,5
Fe (p.p.m. in extract)	0,3	1	19
Al (p.p.m. in extract)	0	0,5	14
NaCl (mg NaCl per 100 g dry soil)	7	30	848
soluble salts (% in extract)	0,11	0,6	2,69
N-water (mg N per 100 g dry soil)	2	15	145
P-water (mg P ₂ O ₅ per 100 g dry soil)	0,9	15	76
K-water (mg K ₂ O per 100 g dry soil)	5	50	580
MgO (p.p.m. in extract)	97	450	866
Mn (p.p.m. in extract)	1,8	7	39

TABLE 10. Size distribution of organic particles after a wet-sieving technique in the 100 composts of table 9.

size range of organic fraction (μ)	content in per cent by weight of total organic matter		
	minimum	mode	maximum
< 75	7,0	32	48,6
75 - < 100	1,6	4	8,0
100 - < 200	5,6	13	17,2
200 - < 300	4,8	9	13,1
300 - < 500	5,9	9	11,3
500 - < 1000	6,6	9	17,8
> 1000	11,6	22	52,0

TABLE 11. Classification for quality of the Kring potting composts.

compost quality	fresh weight in g per plant	frequency in per cent of total	
		94 potting composts	29 commercial composts
very poor	0 - 3	16	14
poor	4 - 6	32	28
inadequate	7 - 9	33	34
good	10 - 12	19	24

TABLE 12. Analysis of variance for the multiple regression of fresh weight on logN-value and organic fraction > 1000 μ for the 100 composts of table 9.

	SS	DF	MS	F	P
total	895	99			
regression on logN-value	628	1	628	285	< 0,01
regression on org. fraction	53	1	53	24	< 0,01
residual (beyond control)	214	97	2,2		
experimental error			0,3		

TABLE 13. Frequency distribution for the water-soluble soil nitrogen of 94 potting composts in the Kring.

N-value frequency (%)	<6	6—<12	12—<18	18—<24	24—<30	30—<36
	44	29	9	11	3	4

TABLE 14. Frequency distribution for the organic fraction > 1000 μ of 94 potting composts in the Kring.

organic fraction > 1000 μ (%) frequency (%)	<15	15—<20	20—<25	25—<30	30—<35	> 35
	6	29	39	19	6	1

TABLE 15. Optimal amounts of nitrogen added to composts for raising tomato plants. Data from the literature.

author	medium	mg N/l	fertilizer
BAUMANN (16)	young moss peat	350	nitrolime
BROWNING (24)	peat	300—600	dried blood
FÖLSTER (43)	Einheitserde	100—200	nitrolime
LEPIKSAAR (78)	refuse compost	0	
PENNINGSFELD (84)	young moss peat	300	NPK-compound
ROORDA VAN EYSINGA (92)	moss peat	100—200	urea

TABLE 16. Experiment I. Results of the trial on raising plants, average per plant.

treatment		fresh weight (g)	dry matter (g)	stem height (cm)	number of leaves > 3 cm	stage of inflorescence (0—10)
% good compost in mixture	sowing- date					
100	21st Nov.	7,6	0,49	11,1	8,3	4,0
75		7,7	0,52	10,5	8,5	4,8
50		6,9	0,48	9,5	8,1	5,7
25		2,9	0,28	6,7	6,4	2,5
0		0,6	0,07	3,1	3,7	0,7
100	5th Dec.	2,0	0,11	7,1	5,1	1,4
75		2,0	0,11	7,0	5,0	1,5
50		1,7	0,10	6,4	4,9	1,4
25		1,7	0,09	6,5	4,8	1,4
0		0,2	0,02	1,9	2,2	0,2

TABLE 17. Experiment I. Relation between fresh weight (X) in g per plant and other properties of young tomato plants (Y).

dependent variable Y (units per plant)	sowing-date	correlation coefficient	regression coefficient	constant
dry matter (g)	21st Nov.	+0,99	0,059	+0,06
	5th Dec.	+0,99	0,052	+0,01
	both	+0,98	0,066	+0,01
stem height (cm)	21st Nov.	+0,98	1,02	+2,9
	5th Dec.	+0,99	2,91	+1,3
	both	+0,91	0,93	+3,9
number of leaves > 3 cm	21st Nov.	+0,96	0,59	+4,0
	5th Dec.	+0,96	1,55	+2,0
	both	+0,95	0,67	+3,5
stage of inflorescence (0-10)	21st Nov.	+0,89	0,56	+0,6
	5th Dec.	+0,91	0,73	+0,1
	both	+0,94	0,60	+0,3

$n = 20; r_{0,01} = +0,516$

$n = 40; r_{0,01} = +0,366$

TABLE 18. Experiment I. Flowering-date of 1st inflorescence, distribution of number of flowers in 1st inflorescence on 26th April, plant height on 26th April and date of first picking, average per plant.

treatment		flowering-date 1st inflor. (March)	number of flowers in 1st inflor.			plant height (cm)	date of first picking (May)	
% good compost in mixture	sowing-date		total	completely set abs. % of total	partly set			
100	21st Nov.	1	10,7	8,3	78	0,6	184	4
75		1	10,1	7,5	74	0,4	183	4
50		1	9,8	7,0	71	0,6	182	3
25		5	9,8	7,0	71	0,4	177	9
0		13	8,5	4,2	49	0,6	158	13
100	5th Dec.	7	8,9	6,4	72	0,2	176	9
75		7	9,3	6,7	72	0,2	173	11
50		7	8,8	6,0	68	0,2	170	9
25		8	9,1	5,2	68	0,2	172	10
0		16	8,3	5,0	60	0,4	149	14

TABLE 19. Experiment I. Yields of ripe fruit during different weeks of picking, average per plant.

treatment		yield (hg)		
% good compost in mixture	sowing-date	3 weeks	6 weeks	9 weeks
100	21st Nov.	5,6	18,1	38,3
75		4,8	16,9	38,0
50		4,4	16,0	35,6
25		2,8	13,8	34,3
0		0,8	6,6	24,8
100	5th Dec.	3,1	12,7	32,7
75		3,2	13,6	33,6
50		2,7	13,5	32,5
25		2,7	11,9	31,7
0		0,2	6,5	25,5

TABLE 20. Experiment I. Linear regression of yields on properties of the plants at planting-out time.

properties (units per plant)	period of picking	yield (hg per plant)		
		correlation coefficient	regression coefficient	constant
fresh weight (g)	3 weeks	+0,90	0,51	+ 1,4
dry matter (g)		+0,85	7,10	+ 1,4
stem height (cm)		+0,99	0,56	- 0,8
number of leaves > 3 cm		+0,93	0,73	- 1,1
stage of inflorescence (0-10)		+0,84	0,75	+ 1,3
fresh weight (g)	6 weeks	+0,85	1,18	+ 8,9
dry matter (g)		+0,82	16,69	+ 9,1
stem height (cm)		+0,97	1,33	+ 3,6
number of leaves > 3 cm		+0,91	1,76	+ 2,8
stage of inflorescence (0-10)		+0,81	1,78	+ 8,7
fresh weight (g)	9 weeks	+0,84	1,36	+28,1
dry matter (g)		+0,81	19,34	+28,2
stem height (cm)		+0,96	1,54	+21,8
number of leaves > 3 cm		+0,91	2,04	+21,0
stage of inflorescence (0-10)		+0,80	2,04	+27,8

$r_{0,01} = +0,716$

TABLE 21. Experiment II. Results of the trial on raising plants, average per plant.

treatment		fresh weight (g)	dry matter (g)	stem height (cm)	number of leaves > 3 cm	stage of inflorescence (0-10)	
% good compost in mixture	size of soil block					1st inflor.	2nd inflor.
100	8 × 8 cm	13,0	1,56	13,0	7,7	6,3	2,1
40		5,3	0,73	8,2	6,4	4,2	0,7
10		4,0	0,55	6,8	5,8	3,5	0,5
100	10 × 10 cm	19,6	2,06	15,0	8,3	6,5	2,6
40		9,5	1,14	10,1	7,3	5,5	1,4
10		5,2	0,66	7,7	6,3	3,6	0,6

TABLE 22. Experiment II. Relation between fresh weight of young plants (X) in g per plant and other properties (Y).

dependent variable Y (units per plant)	correlation coefficient	regression coefficient	constant
dry matter (g)	+0,99	0,094	+0,23
stem height (cm)	+0,94	0,54	+5,1
number of leaves > 3 cm	+0,92	0,14	+5,6
stage of 1st inflorescence (0-10)	+0,85	0,22	+2,9
stage of 2nd inflorescence (0-10)	+0,96	0,14	+0,0
$r_{0,01} = +0,423$			

TABLE 23. Experiment II. Number of leaves before the 1st inflorescence, date of flowering of the 1st inflorescence, plant height on 24th May and date of first picking, average per plant.

treatment		number of leaves before 1st inflorescence	flowering-date 1st inflor.	plant height (cm)	date of first picking (July)
% good compost in mixture	size of soil block				
100	8 × 8 cm	5,7	22-4	142	5
40		6,8	30-4	127	7
10		6,5	5-5	117	8
100	10 × 10 cm	5,7	21-4	155	5
40		6,1	23-4	140	6
10		6,0	3-5	127	8

TABLE 24. Experiment II. Yields of ripe fruit during different weeks of picking, average per plant.

treatment		yield (hg)		
%good compost in mixture	size of soil block	4 weeks	7 weeks	9 weeks
100	8 × 8 cm	6,1	15,5	22,0
40		3,5	11,8	19,0
10		2,8	10,0	17,7
100	10 × 10 cm	7,5	18,2	25,2
40		5,0	15,0	22,5
10		3,3	11,2	18,3

TABLE 25. Experiment II. Linear regression of yields on properties of the plants at planting out time

properties (units per plant)	period of picking	yield (hg per plant)		
		correlation coefficient	regression coefficient	constant
fresh weight (g)	4 weeks	+0,99	0,30	+ 1,8
dry matter (g)		+0,99	3,07	+ 1,2
stem height (cm)		+0,99	0,56	- 1,0
number of leaves > 3 cm		+0,99	1,99	- 9,2
stage of 1st inflorescence (0-10)		+0,97	1,34	- 1,9
stage of 2nd inflorescence (0-10)		+0,99	2,08	+ 1,9
fresh weight (g)	7 weeks	+0,97	0,51	+ 8,8
dry matter (g)		+0,98	5,41	+ 7,8
stem height (cm)		+0,97	0,93	+ 4,1
number of leaves > 3 cm		+0,99	3,42	-10,2
stage of 1st inflorescence (0-10)		+0,96	2,28	+ 2,3
stage of 2nd inflorescence (0-10)		+0,97	3,47	+ 9,0
fresh weight (g)	9 weeks	+0,95	0,46	+16,4
dry matter (g)		+0,96	4,70	+15,5
stem height (cm)		+0,94	0,85	+12,2
number of leaves > 3 cm		+0,97	3,12	- 1,0
stage of 1st inflorescence (0-10)		+0,94	2,08	+10,5
stage of 2nd inflorescence (0-10)		+0,94	3,15	+16,6

$r_{0,01} = +0,882$

TABLE 26. Experiment III. Results of the trial on raising plants, average per plant.

treatment		fresh weight (g)	dry matter (g)	stem height (cm)	number of leaves > 3 cm	stage of inflorescence (0-10)	
% good compost in mixture	position of soil block					1st inflor.	2nd inflor.
100	on the ground	41,3	3,88	25,3	9,3	8,5	4,9
100	on a rush-mat	20,5	2,55	15,2	7,8	7,8	4,0
40	on a rush-mat	12,7	1,75	12,3	7,0	6,9	2,4
25	on a rush-mat	8,8	1,26	9,0	6,8	5,9	1,7
10	on a rush-mat	5,5	0,77	6,8	5,8	4,5	0,9

TABLE 27. Experiment III. Relation between fresh weight of young plants (X) in g per plant and other properties (Y).

dependent variable Y (units per plant)	correlation coefficient	regression coefficient	constant
dry matter (g)	+0,99	0,083	+0,56
stem height (cm)	+0,98	0,475	+5,2
number of leaves > 3 cm	+0,92	0,081	+5,9
stage of 1st inflorescence (0-10)	+0,81	0,086	+5,2
stage of 2nd inflorescence (0-10)	+0,85	0,095	+1,1

$r_{0,01} = +0,462$

TABLE 28. Experiment III. Flowering-date of 1st inflorescence, distribution of number of flowers in 1st inflorescence on 6th July, plant height on 20th July and date of first picking, average per plant.

treatment		flowering-date 1st inflor.	number of flowers in 1st inflor.				plant height (cm)	date of first picking (August)
% good compost in mixture	position of soil block		total	completely set		partly set		
				abs.	% of total			
100	on the ground	29-5	8,7	6,5	75	0,3	150	1
100	on a rush-mat	29-5	8,1	5,5	68	0,4	145	2
40	on a rush-mat	2-6	8,3	5,6	67	0,3	137	3
25	on a rush-mat	6-6	7,9	5,4	68	0,2	132	6
10	on a rush-mat	9-6	7,5	4,9	65	0,1	128	9

TABLE 29. Experiment III. Yields of ripe fruit during different weeks of picking, average per plant.

treatment		yield (hg)		
% good compost in mixture	position of soil block	3 weeks	6 weeks	13 weeks
100	on the ground	5,3	14,6	29,2
100	on a rush-mat	3,7	12,1	28,8
40	on a rush-mat	2,5	9,9	26,1
25	on a rush-mat	2,2	8,2	23,2
10	on a rush-mat	1,4	5,9	23,0

TABLE 30. Experiment III. Linear regression of yields on properties of the plants at planting-out time.

properties (units per plant)	period of picking	yield (hg per plant)		
		correlation coefficient	regression coefficient	constant
fresh weight (g)	3 weeks	+0,91	0,10	+ 1,2
dry matter (g)		+0,95	1,24	+ 0,5
stem height (cm)		+0,94	0,21	+ 0,1
number of leaves > 3 cm		+0,92	1,16	- 5,6
stage of 1st inflorescence (0-10)		+0,87	0,91	- 3,1
stage of 2nd inflorescence (0-10)		+0,90	0,89	+ 0,5
fresh weight (g)	6 weeks	+0,87	0,20	+ 6,6
dry matter (g)		+0,93	2,58	+ 4,9
stem height (cm)		+0,92	0,44	+ 4,1
number of leaves > 3 cm		+0,92	2,43	- 7,8
stage of 1st inflorescence (0-10)		+0,93	2,05	- 3,6
stage of 2nd inflorescence (0-10)		+0,93	1,93	+ 4,7
fresh weight (g)	13 weeks	+0,73	0,16	+23,1
dry matter (g)		+0,80	2,14	+21,7
stem height (cm)		+0,78	0,36	+21,1
number of leaves > 3 cm		+0,76	1,97	+11,5
stage of 1st inflorescence (0-10)		+0,82	1,75	+14,3
stage of 2nd inflorescence (0-10)		+0,84	1,69	+21,3

$r_{0,01} = +0,642$

TABLE 31. Yields on several growers' holdings in the Kring from which samples were collected for the second investigation on potting composts.

growers' holding	date of sowing	fresh weight of young tomato plant in propagation test (g per plant)	yield of ripe fruit on 25-4-1961 (hg per plant)
a	10th November	2,9	1,6
b	end of October	3,0	0,3
c	beginning of November	5,5	1,6
d	beginning of October	9,5	3,3
e	10th November	11,5	3,0

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