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APPLICATIONS OF QUALITY CONTROL TO LIQUID FEEDING SYSTEMS AND TESTING OF PEAT SOIL IN GLASSHOUSE

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The importance of peat as a growing medium for glasshouse crops is well known. It is a standard medium to which all nutrients must be added and has excellent water holding capacity. Tomatoes are often grown in 15-20 cm of peat (shallow trough method) and considerable quantities of water and liquid feed are applied during the growing season, especially at times when there is a heavy demand because of good light conditions. It is easy, therefore, to underfeed or overfeed plants, especially since the depth of peat is so small and this could affect yield adversely. In addition, nutrition affects fruit quality so it is also important to ensure that all plants get the same amount of feed in order to maintain uniform high quality. Overfeeding plants also raises costs. The whole operation of feeding, watering and soil testing is similar to a production line in any manufacturing industry and lends itself readily to quality control methods.

Quantity of feed and irrigation water

The quantities of feed and irrigation water required by plants vary considerably with light conditions. Transpiration rates follow solar radiation levels closely and it is probably that demand for nutrients follows a similar pattern. The data in figure 1 show fluctuations in soil conductivity (SC, µmhos/10) levels, measured at weekly intervals, for spring crop tomatoes grown in peat. The plants in the experiment were fed and watered at different rates depending on day length and weather conditions. It is obvious from the large fluctuations in SC obtained that some more objective control is required. This has been achieved for irrigation by the use of a solarimeter, however, good objective methods for estimating amounts of feed required are not yet available and soil analytical data is the main index. It is possible, therefore, that the fluctuations observed in figure 1 would have been much less had the plants been fed and watered using objective control.

Checking dilutes

Diluters should be checked every time that feeding is being carried out to ensure that they are working properly. Growers with a central diluting plant will probably have an SC meter built into the system and the readings should be checked daily. In the case of the smaller type of diluters the setting on the head is often difficult to adjust. SC values for stock solutions of commercially available feeding mixtures at various dilution rates are given in table 1. The SC value for the diluting water is added to the figure in the table and the results written in the bracketed space. In this way, growers can make a modified version of the table for their own use thus ensuring quality control of the feed. If the reading is not correct then more or less diluting water can be used as required. The SC test, therefore, serves to check that the stock solution has been correctly prepared and that the diluter is operating correctly. The practice of adding the SC of the diluting water to the figures in table 1 gives a good approximation of the correct SC for the diluted feed provided the SC of the diluting water is not too high < 80 (table 2).

Most instruction sheets supplied with diluters recommend that the rate of water flow into the diluter should be checked each time feeding is carried out. This is to ensure that the correct amount of feed is applied if a timing method is used. For example, a mains flow rate of 1580 L/hr gives a flow rate from the diluter of 1188 L/hr and a mains rate of 2500 L/hr gives a diluter rate of 1443 L/hr (table 3). If feeding, therefore, is carried out for 1 hour the amount of feed applied could vary if the flow rate is not checked. The diluter, however, reduces the effect of different flow rates, i. e. a difference in mains flow rate of 920 L/hr (2500-1580) is reduced to 255 L/hr (1443-1188) by the diluter. The rate of dilution was independent of the flow rate of water into the diluter in the case of the two diluters that were tested. The necessity of checking flow rate is very important when plants are being irrigated and the diluter bypassed. Differences in flow rates from the mains are not now "reduced" by the diluter and using a time basis to measure quantities could be very erroneous if flow rates are not checked. It should be pointed out that much of this data will not apply if a grower has his own water supply and pumping system since only very slight variations in flow rates would be expected. A survey of water supplies used by growers carried out in 1969, showed that about 30% of Irish growers obtained their supply from mains. Fluctuations in flow rates for mains water at Kinsealy at different times of the day and different days of the week, are presented in table 4. Flow rates varied considerably on Mondays.

These data indicate, therefore, that measuring flow rates should ensure more uniform feeding and irrigation.

Control of feeding systems

Plants in glasshouses are usually fed by hose, low level sprayline or trickle systems. As already mentioned, if feeding or irrigation is being done by hose, the quantities applied can be measured reasonably accurately provided flow rates are known. In the case of trickle a bottle is usually placed under one drip and the quantity applied is measured in this way. This, however, assumes that each drip is delivering at the same rate. While it is impractical to measure the delivery rate from each trickle, it is desirable to make spot measurements to find how well the system is working. The results (table 5) show the delivery rates from two trickle systems (one adjustable) and a sprayline system. Each system was checked at the middle (three adjacent nozzles) and both ends (three adjacent nozzles). Delivery rates varied most in the trickle system. Delivery rates were lower in the centre for the non-adjustable trickle system and the sprayline system. Rate of delivery from spraylines was measured by placing a polythene cowl over the nozzle and collecting the water in a flat container. In the case of adjustable trickle system, nozzles should be inspected daily and spot delivery checks taken.

Soil analysis

If feeding andirrigation has been carried out correctly, only routine soil analysis should be necessary. In general, results for pH, K and SC are sufficient. Occasionally, results may be required urgently which necessitates doing the analysis on a wet sample. Accurate results can be obtained provided the operator realises the need for extra care when filling the measuring container with wet peat (table 6). Sieving the wet sample also poses problems.

Sampling plans and calculation of standard deviations are of great importance during the base fertilisation of peat in bulk. The bulk sample can be subsampled thoroughly and the subsamples analysed. The standard deviation can be calculated rapidly by the range method. This gives an indication of the mixing method and allows different methods to be compared.

At times it may also be necessary to obtain soil analytical results of a desired precision and a problem arises concerning the number of samples which should be analysed to get a result within the desired limits. This may be important when buying fertilised peat in bulk in order to determine if the required amount of fertiliser, e. g. NPK, has been added to the peat. If the mixing methods are good, it is simple to estimate the amount since the results for each subsample tested will be about the same. However, if results from different subsamples vary a lot, indicating bad mixing, then it is more difficult to obtain an average figure and equation I must be used to obtain the number of samples to be analysed in order to get the true fertiliser content within certain limits.

$$\text{I} \text{------} \quad n = \left(\frac{ks}{e}\right)^2$$

n= number of samples required
s= standard deviation
e= desired precision
k= 1. 95 for 95% assurance

A large number of replicate samples can be taken and the standard deviation calculated for any or all of the factors to be measured, e. g. pH, K, SC. The figure for the desired precision (e) is entered in the equation and the number of samples to be analysed to obtain results of a desired precision calculated.

Analytical service

Some of the above tests can be done readily by the grower himself, e.g. SC measurements of feeds and soils. However, it is also important to have a rapid analytical service to assist the grower and carry out some of the more difficult tests. Using quality control methods, it is possible, therefore, to feed and irrigate soils more uniformly, ensure uniform base fertilisation of peat and obtain produce which will be of uniform quality. More rigid control of feeding methods should result in economy and saving in relation to cost of feed.

Summary

Glasshouse crops are often grown in shallow depths of peat. Careful control of base fertilisation, liquid feeding and irrigation is essential for top quality. This "industrial process" lends itself readily to quality control methods.

The solarimeter gives an index of the amount of irrigation required, but water flow rates from the supply mains are important since quantities of feed and water applied are often measured on a time basis. Diluters and stock solutions can be checked by comparing specific conductivity (SC) readings on feed with figures in a table.

Delivery rates from hose, low level sprayline and trickle systems should also be tested frequently and indications are that the sprayline system gives the least amount of variation from region to region along its length.

Soils should be analysed on a routine basis for pH, K and SC. Special attention must be given to uniformity of base dressing in peat and proper sampling methods enable different mixing techniques to be compared.

Much of the testing can be done by the grower himself, however, it is also important to have a good back-up analytical service.

Zusammenfassung

Gewächshauskulturen werden oft auf Torfschichten von geringer Mächtigkeit gezogen. Sorgfältige Durchführung von Grunddüngung, flüssiger Nachdüngung und Bewässerung sind für die Erzeugung bester Qualität unbedingt erforderlich. Regelmässige vorzunehmende Kontrollen bieten hierbei eine Möglichkeit zur Qualitätssicherung.

Der Solarimeter liefert zwar ein Mass für die erforderliche Höhe der Bewässerung, aber es ist wichtig, die Zuflussgeschwindigkeit zu kennen, da Dünger- und Wassermengen sehr oft auf Zeitbasis gemessen werden. Verdünnungsmittel und Stammlösungen können überwacht werden, indem man die ermittelte spezifische Leitfähigkeit der Düngerlösung mit Tabellenwerten vergleicht.

Die Durchflussgeschwindigkeit der Bewässerungsschläuche, am Boden verleger Sprühschläuche und von Tröpfchenbewässerungssystemen sollte ebenfalls häufig überprüft werden. Es ist bekannt, dass der Sprühschlauch von Abschnitt zu Abschnitt auf der ganzen Länge die geringsten Abweichungen aufweist.

Böden sollten routinemässig auf pH, K und spezifische Leitfähigkeit untersucht werden. In Torf ist der gleichmässigen Ausbringung der Grunddüngung besondere Beachtung zu schenken. Bei richtiger Probeentnahme kann man verschiedene Mischtechniken vergleichen.

Viele dieser Prüfungen können von Gärtner selbst durchgeführt werden, ein guter "Analysen-Service" ist aber trotzdem wichtig.

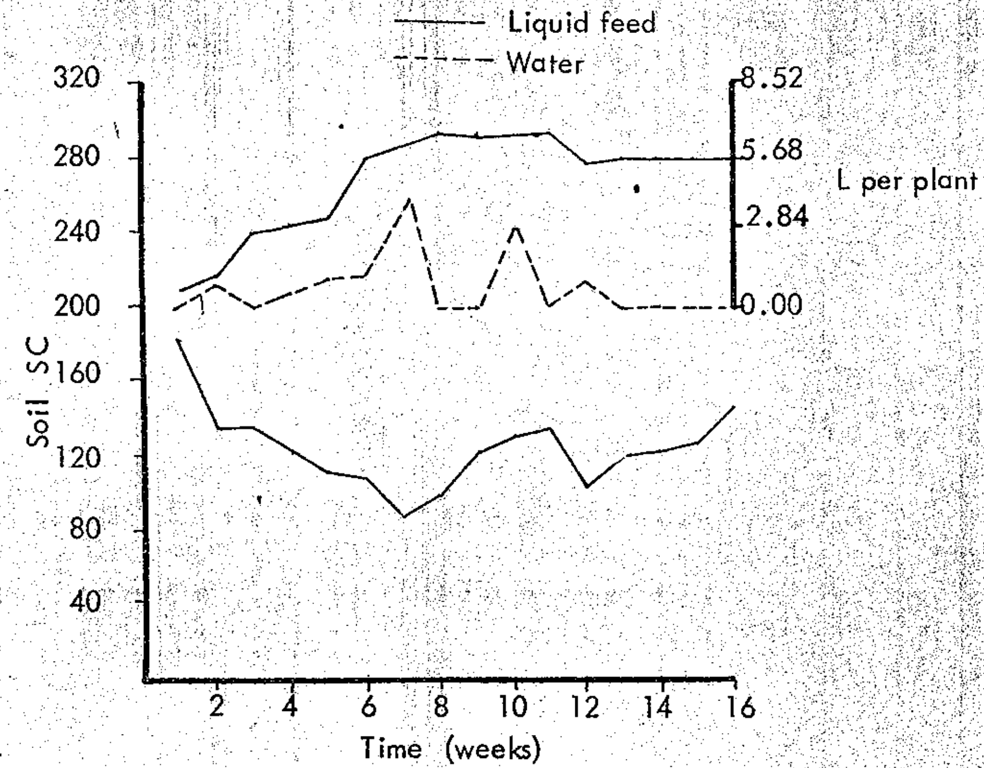

Figure 1 - Fluctuation in soil SC readings.

Table 1 - SC of stock solutions at various dilutions in distilled water.

Stock solution	Dilution rate $\frac{1}{100}$	$\frac{1}{150}$	$\frac{1}{200}$
681 g KNO_3 + 0 g) 141 g) urea 454 g)	180 ( )	122 ( )	94 ( )
Product x No. 1	152 ( )	105 ( )	78 ( )
2	128 ( )	87 ( )	67 ( )
3	115 ( )	78 ( )	59 ( )
4	80 ( )	55 ( )	42 ( )
5	138 ( )	95 ( )	72 ( )
6	211 ( )	149 ( )	114 ( )
7	34 ( )	25 ( )	17 ( )

Table 2 - SC of stock solution diluted 1 in 150 with distilled water and with four other water supplies.

SC of water supply	SC of feed by addition	SC of feed obtained in practice
14	137 (123 + 14)	141
25	148 (123 + 25)	146
40	163 (123 + 40)	158
82	205 (123 + 82)	195
0 (dist. water)	-	123

Table 3 - Change in SC of feed coming from diluter (fixed setting) fed with water at different flow rates.

Flow rate at tap l/hr	SC of feed coming from diluter at fixed setting	Flow rate EX diluter l/hr
1580	170	1188
1810	170	1277
2040	170	1342
2270	170	1360
2500	170	1443

Table 4 - Flow rate (l/hr) for Kinsealy water mains supply at four different times on three different days.

Time of day	Day		
	Monday	Wednesday	Friday
10. 00 hr	2520	2690	2620
12. 00 hr	2620	2520	2690
14. 00 hr	1940	2585	2520
16. 00 hr	1940	2340	2485

Table 5 - Delivery rates (ml/min) from different feeding systems measured at both ends[1] and in the centre[1].

Location	Feeding system		
	Trickle[2]	Sprayline[3]	Trickle[3]
End 1	10. 5	530	10. 8
Centre	8. 1	500	9. 1
End 2	9. 3	517	8. 3

1) figures are means for three drips or nozzles
2) non-adjustable trickle
3) low level sprayline
4) adjustable trickle

Table 6 - Mean analytical figures for 50 glasshouse soils before and after drying.

	Before drying[a]	After drying[b]	SD	t test
pH [c]	6. 390	6. 434	±0. 016	*
K (ppm)	301	302	±2. 04	NS
SC	96	95	±0. 53	NS

a) moisture contents varied between 3. 7 and 73. 2%
b) air-dried at 15°C for 12 to 24 hr
c) pH values for advisory purposes are normally read to one decimal place