BIOLOGIA PLANTARUM (PRAHA)

23 (4) : 311–314, 1981

BRIEF COMMUNICATION

An Easy Estimation of Tomato Root Parameters Based on Calcium Absorption

R. S. Sachan and R. B. Sharma

Department of Soil Science, Govind Ballabh Pant University of Agriculture and Technology, Pantnagar 263145 (Nainital), India

Abstract. Using tomato as a test plant Ca absorption by the plant and characteristics of root growth in the nutrient solution has been reported. It has been shown that the amount of calcium present in the tomato shoot serves as a good index of the rate of root growth in the solution as well as in the soil. The flux of Ca, P and K into the roots of field grown tomatoes have been calculated based on such estimations of root parameters.

Quantitative estimations of the root parameters in the soil system are often needed by the ecologists, crop scientists and foresters. The field techniques presently used for estimating the root parameters involve collection of soil-root cores, separation of roots from the soil by tedious method of root washing, removal of dead plant tissues and the roots of foreign plants and time consuming procedure of measurement using Newman's mathematical formula (Newman 1966). In spite of such a tedious and time consuming procedure, the values obtained are hardly reproducible due to the complexities of a growing root system because of its simultaneous generation and degeneration and activation and deactivation cycles, always in operation during the growth of a plant. Furthermore, conventional field techniques do not take into account the length and surface area contributed by the root hairs which are invariably present in the soil grown plants. The method suggested here takes advantage of the fact that in a moist soil, due to its high calcium buffering capacity (Russell 1961), mass flow transports to the root surface several times more Ca than the roots can actively absorb (Bar-Yosef and Kafkafi 1970). This results in a very high concentration of Ca around the root and therefore Ca uptake per unit root parameter always remains at its maximum and constant. Therefore, Ca uptake by the plant could serve as an index of the amount of total roots developed during the growth of the plant. This constant uptake could easily

Received May 20, 1980; accepted October 10, 1980

TABLE 1
Tomato root parameters and Ca content in shoots*

Days after transferring to nutrient solution	Root parameter per plant Length [m]	Surface area [m²]	Fresh weight [g]	Dry weight [g]	Cumulative shoot Ca content [g]
7	7.46	0.0047	0.9060	0.0257	0.0070
14	37.63	0.0236	4.5720	0.1215	0.0385
21	103.32	0.0649	12.5540	0.2930	0.0800
28	301.30	0.1894	36.6100	0.9510	0.2303
35	662.04	0.4161	80.4420	2.5289	0.6798

* The measurements were made after pooling 5 plants together but results are expressed on per plant basis.

be determined at identical Ca concentrations in the solution culture. MARSCHNER and RICHTER (1973) and ROBARDS *et al.* (1973) have reported that Ca absorption takes place by younger roots only. The presence of adequate Ca around the growing root apices has been reported to be essential (MARSCHNER and RICHTER 1973), otherwise the root growth stops and results in the blackening of root tips. Hence the selection of Ca absorption as an index of total root growth that has taken place within a specified period of time is further justified. The behaviour of other elements such as P and K has been known to differ in this respect and thus cannot be used for this purpose.

Seedlings of tomato, *Lycopersicum esculentum* MILL., (cv. Eurocross B) were raised in nutrient enriched peat. Fifteen-day old seedlings were transferred to the nutrient solution having high Ca concentration (5 meq l^{-1}) in 80 l capacity pots. This Ca concentration was selected because at optimum level of plant growth the uptake per unit root length increased up to this level when concentrations of 2.5, 5, 7.5 and 10 meq l^{-1} were used. After one week of seedling transfer to the nutrient solution 5 plants were harvested randomly at weekly intervals for 5 weeks. The root parameters *viz.* fresh matter, dry matter, length (NEWMAN 1966) and surface area and Ca content of the shoot were measured (Table 1). Since the plant growth in the nutrient solution was quite uniform, the measurements were made by pooling all the 5 plants together. The results were expressed, however, on per plant basis.

The amount of Ca absorbed had very high and significant (at $P = 0.01$) correlation with the various root parameters. The following regression equations were obtained:

$$Y = -18.92 + 1.016x_1 \quad (r = 0.9924^{**}) \qquad 1$$
$$Y = -18.92 + 0.161x_2 \quad (r = 0.9924^{**}) \qquad 2$$
$$Y = -18.92 + 8.367x_3 \quad (r = 0.9924^{**}) \qquad 3$$
$$Y = -2.02 + 266.786x_4 \quad (r = 0.9990^{**}) \qquad 4$$

(** significant at $P = 0.01$)

where Y is the amount of Ca absorbed ($g \times 10^{-3}$) and x_1, x_2, x_3 and x_4 stand for length [m], surface area [$m^2 \times 10^{-4}$], fresh weight [g] and dry weight [g] of roots, respectively. There was very high correlation (significant at $P = 0.01$) amongst the various root parameters also. Root length, being

TABLE 2
Cumulative content in shoot and net influx into the roots of Ca, P and K in field grown tomato

Days after trans-planting	Cumulative content [g] Ca	P	K	Equivalent root length* [m]	Net influx [$\mu g\ m^{-1}d^{-1}$] Ca	P	K
28	0.2258	0.0228	0.1707	240.8	–	–	–
35	0.6835	0.0685	0.5499	691.3	153.0	15.3	126.8
49	2.3335	0.3051	2.2148	2315.3	87.7	12.6	88.5
56	4.1020	0.4874	3.2627	4056.0	81.4	8.4	48.2

* Calculated from regression Eq. 1.

the most convenient expression for nutrient uptake studies, could easily be worked out from Eq. 1. As the root hairs are also formed in the soil system, these in directly calculated root length values may not be the same as observed by physical measurements which do not account for root hairs. However, since Ca absorption by the plant is the result of participation of the total root system formed including the root hairs, active and inactive roots that are physically present at a particular time and those that have degenerated, the Ca uptake can be equated with the root length that has contributed to its uptake at one time or another. These indirectly calculated root length values which are equated with the amount of Ca absorbed may be designated as "equivalent root length". The same root length will also participate in the absorption of other nutrients and therefore, influx of these nutrients can also be calculated.

The "equivalent root length" values for soil grown tomato plants were thus estimated from the amount of Ca absorbed using Eq. 1. These estimated values of root length were then used for calculating the Ca, P and K influx into the roots of tomato in the soil system (Table 2) by the following relationship given by BREWSTER and TINKER (1972).

$$\text{Flux per meter of root} = \frac{(U_2 - U_1)(\ln L_2 - \ln L_1)}{(t_2 - t_1)(L_2 - L_1)},$$

where U is the nutrient content of the shoot, L is the root length and t is the plant age. The subscripts refer to successive harvests. These influx values at different stages of the growth of the tomato decrease with time which conforms to the flux pattern and magnitude reported for corn by MENGEL and BARBER (1974) under field conditions and for cucumber by SACHAN and SHARMA (1980). Thus the indirect method presented herein for estimating root parameters is simple, precise and much less time consuming than the conventional field techniques.

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BOOK REVIEW

Chararas, C.: Écophysiologie des Insectes Parasites des Forets. — Édité par l'auteur, Paris 1979. 297 pp., 123 figs., 11 tables.

Constantin Chararas, Research Director of CNRS in Paris, a scientist long employed at the Institut National Agronomique, has an outstanding reputation among all entomologists studying bionomy, ecology and physiology of forest pests, in particular beetles of the families *Scolytidae*, *Cerambicidae*, *Curculinoidae etc.* He has advocated a new approach to the research of forest pest for more than 25 years, after he had demonstrated the complexity of the relationship between bark beetles and their host plants (the role of primary attractants and plant osmotic pressures). His experience has already been summarized in the book "Étude biologique des *Scolytidae* des Conifères" published in 1962. The present book Ecophysiology of Insect Forest Pests is a comprehensive treatise based both on available literary data and his own results gathered for 30 years of his research career.

The first part of the book briefly describes the forest insects from an ecologic point of view and with emphasis on economic importance, their adaptations to various climatic conditions, and their distribution and harmful activities to the host plants. It also discusses factors, such as the primary plant attractants, which influence plant infestation.

The second part elucidates the mechanism of infestation in more detail, primarily by distinguishing between primary plant attractants and other compounds released in the forest community due to the action of insects and other interactions between the community organisms. The paragraphs on the luring activity of the terpenic compounds for xylophagous insects reflect author's experience in this field of research, which has undergone tremendous development in recent years. The significance of secondary attractants and pheromones for the spreading of several important pests is well documented.

The third part of the book deals with nourishment and digestive enzymes of insects, various types of food ingestions, and the role of taste receptors and stimuli. Importance of the composition of plant communities for the development of insect populations from the point of view of their proper nourishment is emphasized. Examination of the oxidase activity is an original contribution to this branch of research. The role of microorganisms for the digestive processes in insects is also elucidated.

The conclusive chapter is devoted to considerations on the relationships between the development of host plants and their insect pests.

In summary, the book Ecophysiology of Insect Forest Pests by C. Chararas well combines the results of modern research with the aspects of practical pest control.

V. Novák (*Jíloviště-Strnady*)