

This Week's Citation Classic

Radford P J. Growth analysis formulae—their use and abuse.
Crop Sci. 7:171-5, 1967. [Grassland Research Institute,
Hurley, Berkshire, England]

The necessary and sufficient assumptions for the derivation of commonly used growth analysis formulae are presented. A distinction is made between traditional, time-averaged parameters of plant growth, and instantaneous, time-dependent measures which require fewer assumptions for their use. [The *SCI*[®] indicates that this paper has been cited over 135 times since 1967.]

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"This paper was my very first contribution to the scientific literature and therefore my first and most probably last *Citation Classic*. Its genesis reflects my personal conviction that the most fruitful marriage between biology and mathematics must arise naturally from the needs of the former and the ability of the latter to meet these needs rather than the imposition of 'useful' mathematical techniques upon 'handy' data sets.

"Whilst working as a very junior consultant biometrician at the Grassland Research Institute (GRI) it was my pleasure to advise M.J. Robson on the mathematical aspects of the quantitative analysis of plant growth, but it was not until the visit of Dale Smith of the University of Wisconsin that I realised the need to publish an integrated overview of the derivation of growth analysis formulae. As one of the consulting editors of *Crop Science*, he invited me to write an authoritative and yet simple explanation of these techniques, which had been applied widely, yet often wrongly, in the UK and Australia, before these errors together with the

verities spread to the US. The timing of publication must have been optimal, resulting in a deluge of over 500 reprint requests from the four corners of the world, greatly enhancing my daughter's stamp collection.

"The reason why this paper has been so frequently cited is because it brought together an array of formulae from a dispersed literature and presented them as a system of interrelated equations based on assumptions which should not be considered in isolation (anyway, one reference is always better than a legion of references). It also pointed the way to a more dynamic view of plant growth which would require fewer but probably more acceptable assumptions. This theme was to have been developed further, with examples, in a subsequent paper, but in 1968 I was directed to divert my attention to the construction of simulation models of biological and agricultural systems—I have never looked back!

"Reprint requests still trickle in and I wonder how anyone can survive on 12-year-old offerings, but my pride compels me to meet the need. Recently, on one or two occasions at international conferences I have been asked, 'Are you *the* Radford of Growth Analysis Formulae?' and I feel something of a fool for having no new revelation to offer in that field. Not to worry! Perhaps one day I will be famous as one of the creators of GEMBASE,¹ which would be a pity because I'm trying to give that up this year! Such is the life of a biometrician: grass, sheep, soils, reservoirs, salmon, PCBs, seals, water quality, ecosystems, etc., etc.

"In conclusion, I must pay tribute to all those who did so much to encourage and help the novice author attempting to make his mark in the scientific literature, especially L.C. Chapas, Robson, G.J.A. Ryle, E.K. Woodford (GRI), and Smith."

1. **Radford P J.** Some aspects of an estuarine ecosystem model—GEMBASE. (Jørgensen S E, ed.)
State-of-the-art in ecological modelling. Oxford: Pergamon, 1979. p. 301-22.