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The Relationship between Irrigated Pasture Production and Radiation

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Regression analyses showed that the best relationship between solar radiation and pasture production of an irrigated trial cut on a fortnightly basis over 9 years was $P = AR1^{B}R2^{C}$ where P was the pasture production and $R1$ and $R2$ the radiation during the cutting period and in the previous cutting period.

Introduction

As systems analysis grow more popular in the study of agricultural processes there will be a need to examine the relationships between climatic factors and the production of crops and pasture. Aslyng (1974) has shown quite high correlations (0.97) between the growth of irrigated ryegrass in lysimeters and solar radiation. However this investigation covered only the period May 1 to October 15 1968 and was done on a monoculture. To investigate the relationship between solar radiation and the growth of a pasture over a long period the production records of an irrigated rate-of-growth trial was used.

Experimental

The pasture experiment from which growth data was obtained was one of a New Zealand series of rate of growth trials, conducted at the Winchmore Irrigation Research Station. Details of the method of pasture measurement are given in Radcliffe (1974) and extended information on the trial is given in Rickard and Radcliffe (1976), yield data were not treated in the manner described by Radcliffe (1974, p 339) under the heading »Calculation of yield data.«

The experiment was carried out on permanent pasture under irrigation; the main species in the pasture were perennial ryegrass *(Lolium perenne L.)* and white clover *(Trifolium Repens L.)* with some cocksfoot *(Dactylis glomerata L.)* brown top *(Agrostis tenuis Sibth)* and *Bromus mollis*. The presence of the clovers guaranteed that an adequate supply of nitrogen was available to the pasture.

The soil type was a Lismore silt loam a typical profile of which consists of 30-35 cm greyish-brown silt loam on thick beds of greywacke and sand. Growth recorded in winter was excluded for the purpose of relating radiation to pasture production; cutting intervals were mainly 14 days, though occasionally intervals were 2-3 days longer. Although leaf area indices were not measured the work of Brougham (1956) has shown that pastures cut to 2.5 cm (as was the case in this trial) leaf area indices would be about 3.0 before and 1.7 after cutting.

The pasture was irrigated when 50% of the available moisture in the top 10 cm had been used – this would be adequate to maintain a low level of plant moisture stress (Rickard 1972); fertility status was maintained by annual applications of 250 kg/ha superphosphate. Radiation was measured with a Fuess Actinograph which records total solar radiation. Fig. 1 shows the relationship between mean solar

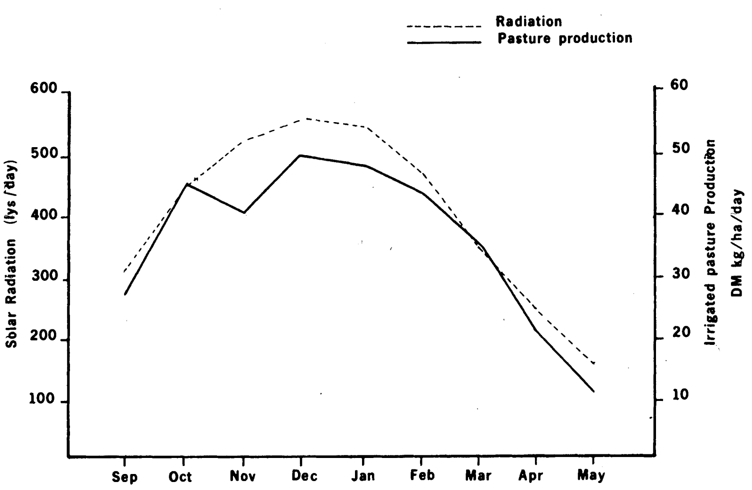

Fig. 1. Relationship between Solar Radiation (ly/day) and irrigated pasture production (kg/ha/day).

Radiation and irrigated pasture production for the September to May period, 1966/67 to 1974/75.

For each year from 1966/67 to 1974/75 regression analyses were carried out between the drymatter production of the pasture during each cutting period (kg ha^{-1} day^{-1}) and the mean radiation received either in the current or the previous cutting period (ly/day^{-1}), the models investigated were: –

1) Linear regression of pasture production on radiation received during the cutting period.
2) Linear regression of pasture production on radiation received during the previous cutting period.
3) As in 1) and 2) but using logarithmic transformations.
4) Multilinear regression of pasture yield on radiation during the cutting period and during the previous cutting period.
5) As in 4) but using logarithmic transformations.
6) Quadratic regressions of dry matter yields on radiation.

Results

The highest correlations were obtained by the multiple regression of pasture production on radiation in the previous and current cutting period, logarithmically transformed. These results are summarised in

Table 1–Multiple Regression of Dry Matter on Radiations previous and current cutting period – Log Transformation

Year	A	B	C	r^2
1966-67	0.016	0.633	0.640	0.80***
1967-68	0.001	0.096	1.656	0.63***
1968-69	0.008	–0.018	1.395	0.82***
1969-70	0.036	0.490	0.685	0.71***
1970-71	0.054	0.542	0.527	0.78***
1971-72	0.027	1.656	0.499	0.75***
1972-73	0.038	0.823	0.330	0.62***
1973-74	1.961	0.007	0.476	0.36*
1974-75	0.001	1.275	0.548	0.67***

* Significant at 5%, ** 1%, *** 0.1%.

The equation is $P = A\ R1^B R2^C$

Where P = pasture production (kg $ha^{-1} day^{-1}$)
$R1$ = radiation during cutting period (ly/day^{-1})
$R2$ = radiation during previous cutting period

A study of this Table shows that there is no systematic pattern in the regression coefficients which would lead to an equation which could be used with confidence in predicting irrigated pasture production. In some cases the variability accounted for by the regression model is not high, falling in one case to 36%.

It would seem that the results obtained on a single species by Aslyng (1974) cannot be extended to a pasture and that any predictive model for irrigated pasture production will have to include other climatic factors as well as radiation.

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