DETERMINATION OF THE LENGTH OF THE GROWING SEASON

by R. Vollprecht and D.R. Walker

Divisional Office, Perth

(Manuscript received March, 1956)

Abstract: The average dates of opening and close of the growing season are determined for Perth and Kellerberrin by three methods Each of these methods uses the effective rainfall and the rainfall recorded at the stations, but in two cases the methods are graphical using monthly and daily data, whilst the third method involves statistical analysis by least squares. A tabulation of results shows close agreement between dates by the different methods. It is thus demonstrated that for certain purposes the use of monthly averages gives results in close agreement with those obtained from daily averages.

1. INTRODUCTION

In most of the work done at Perth, the length of the growing season and its opening and closing dates have been obtained from curves based on mean monthly values of rainfall and effective rainfall.

There has been considerable discussion regarding the validity of expressing these results to the nearest tenth of a month when the units used in their determination are whole months.

It is the writers' view that this procedure is legimitate; that the length of the season can be expressed in fractions of a month and that the opening and closing dates can be specified with reasonable accuracy to a tenth of a month.

The purpose of this article is to demonstrate that the results obtained from curves based on mean monthly values of rainfall and effective rainfall, agree very closely with those obtained from curves based on mean daily values, and also with results obtained by statistical analysis.

Two stations, Perth and Kellerberrin, were used in the tests. Although the full data necessary for computing daily effective rainfall, i.e. mean daily temperatures and 9 a.m. relative humidities, were available over a long period for Perth, they were limited to 30 years in the case of Kellerberrin. Likewise rainfall data were available for a 70 year period for Perth but only 45 years for Kellerberrin.

It is held that the close agreement of the dates obtained by the three methods justifies the use of curves based on monthly means where more detailed data are not readily available.

The authors wish to acknowledge the assistance given by Mr. M. Lamond in checking the tabulations and computations used in the statistical determination.

2. DEFINITION OF GROWING SEASON

The growing season is taken to be that portion of the year during which average rainfall exceeds "effective" rainfall (Trumble 1937). It is based on meteorological data only, and takes no account of edaphic factors.

3. DETERMINATION OF "OPENING" AND "CLOSING" DATES

(i) From monthly averages

The first method is that used in the preparation of regional surveys. Mean monthly evaporation (E) figures were estimated from charts issued by the Bureau of Meteorology; and by use of Prescott's formula, $P/E^{0.7} = 0.54$ (Prescott 1949), the mean monthly values of effective rainfall (P) were calculated.

The values of effective rainfall and average rainfall were plotted at the mid point of each month of the year, assuming that the monthly values constitute grouped data of individual daily totals. Smooth curves were then drawn through the plotted values, and the points of intersection taken to represent the beginning and end of the growing season.

Figs. I(a) and I(b) show the curves for Perth and Kellerberrin respectively. The opening dates obtained from

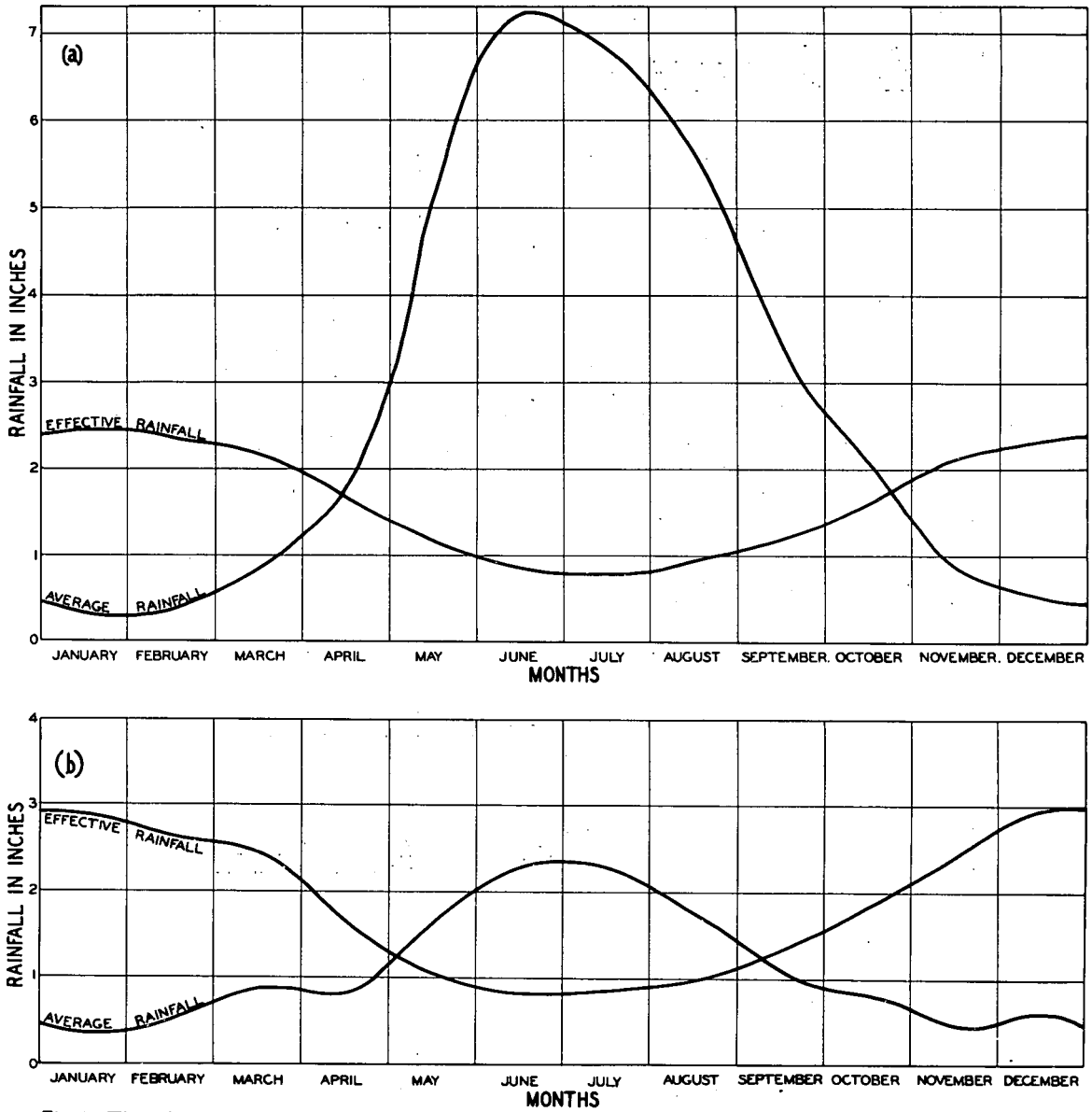
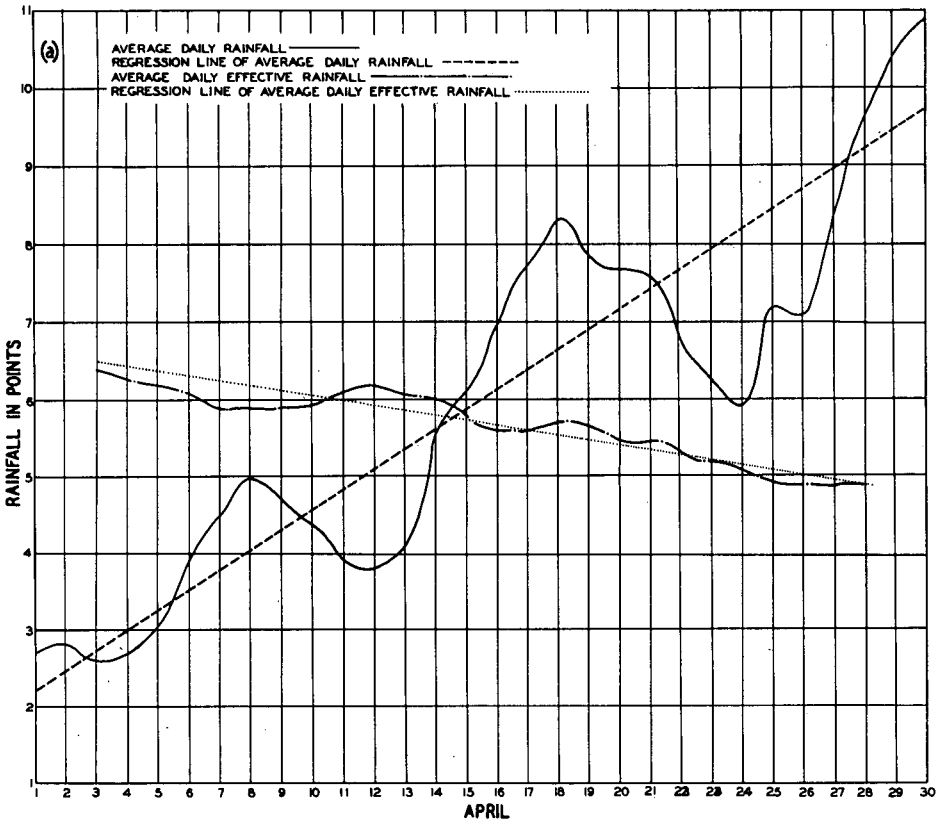


Fig. 1. The distribution of average monthly rainfall and average effective monthly rainfall (a) at Perth (b) at Kellerberrin.



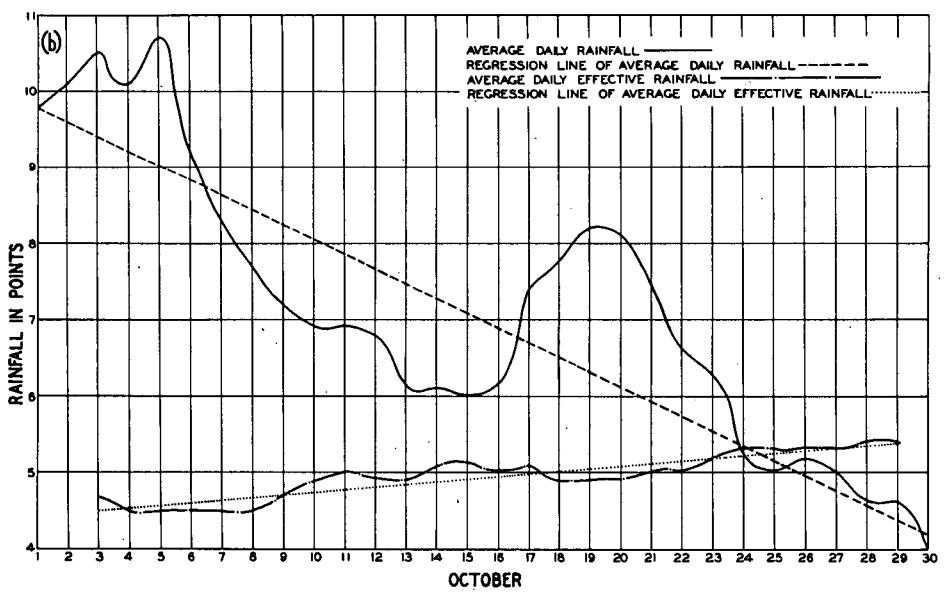


Fig 2. The distribution of average daily rainfall and average effective daily rainfall and the regression lines at Perth (a) for April and (b) for October.

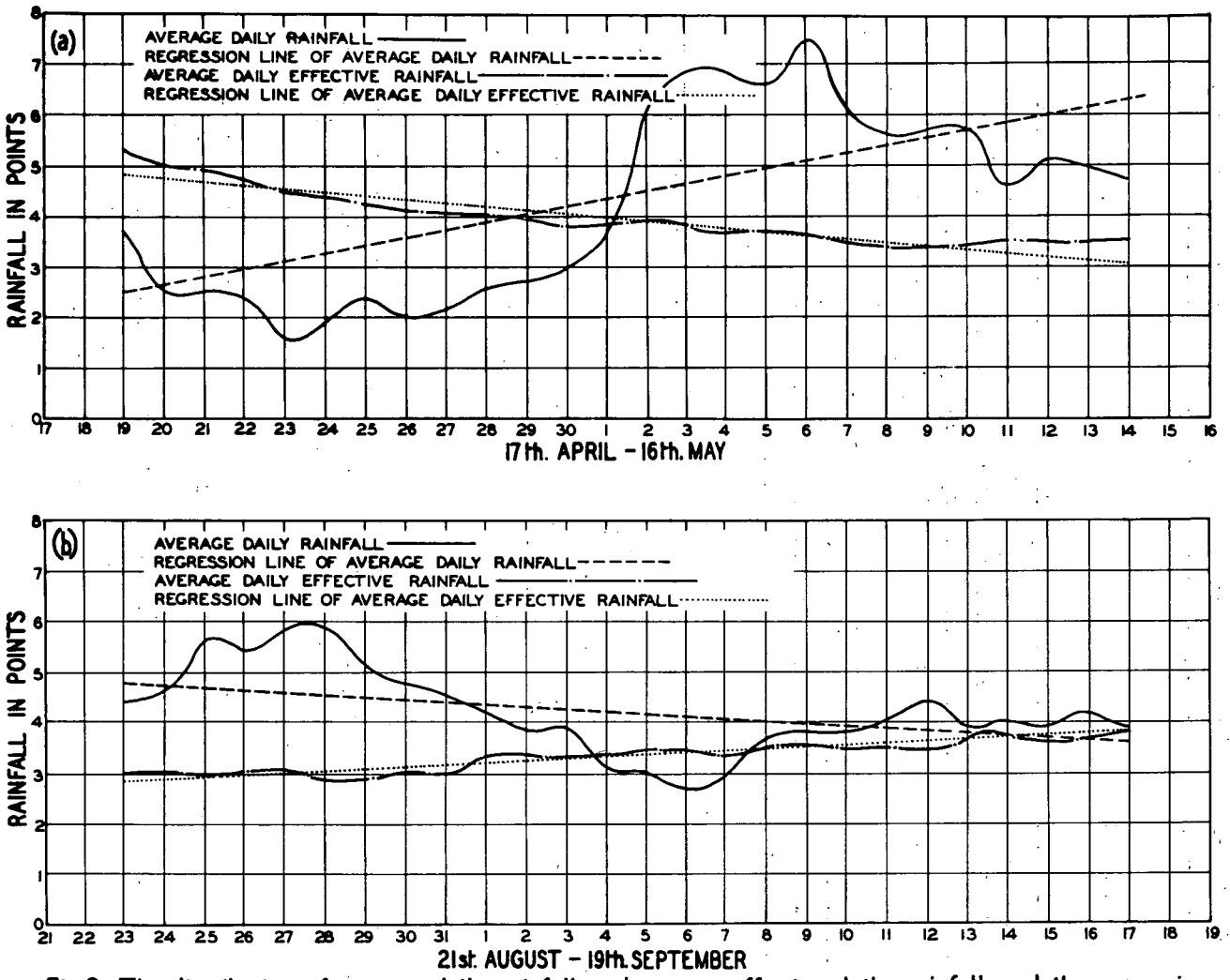


Fig 3. The distribution of average daily rainfall and average effective daily rainfall and the regression lines at Kellerberrin (a) for the period 17th. April – 16th. May and (b) for 21st. August – 19th. September.

them were 14 April for Perth and 2 May for Kellerberrin, and the closing dates 24 October and 8 September respectively.

(ii) From daily averages

To check the accuracy of the results obtained as above it was decided to construct similar curves showing average daily values of rainfall and effective rainfall. These were smoothed by using five day running means. Sections of the curves at the time of the break and close of the season are shown for Perth in Figs. 2(a) and 2(b), and for Kellerberrin in Figs. 3(a) and 3(b). The regression equations for both the average daily rainfall and the average daily effective rainfall were calculated and plotted on these graphs.

The daily rainfall curves were obtained by calculating the average fall for each day of the month, over periods of 70 years and 45 years for Perth and Kellerberrin respectively. The effective rainfall curves were based on daily evaporation, calculated from mean daily saturation deficit (Prescott 1938), which in its turn was computed from mean daily temperature and 9 a.m. relative humidity (Foley 1945). The lengths of these records were 40 years for Perth and 30 years for Kellerberrin.

In the case of Perth the opening date given by the intersection of the curves agrees with that from the intersection of the regression lines, both giving 14 April, but whilst the curves show the closing date as 23 October, the regression lines give 24 October.

There is some discrepancy between the opening dates given by the curves and regression lines in the case of Kellerberrin, these being 29 April and 1 May respectively. It will be seen from Fig. 3(b) that the season closes on 4 September, but re-opens from 7 to 13 September, after which two curves are less than 0.3 points apart.

(iii) By statistical analysis

The method of least squares was applied to the difference between the average daily values of the rainfall and effective rainfall, and the day on which this difference became zero was determined.

If a is the difference between the daily values,

t the day of the month,

the analytic equation of the straight line is of the form

$$a = A + Bt$$

where A and B are constants.

To find the line of best fit the method of least squares was applied, the value of the constants A and B being found from the equations

$$A = \frac{\Sigma t \Sigma(at) - \Sigma a \Sigma t^2}{(\Sigma t)^2 - n\Sigma t^2}$$

$$B = \frac{\Sigma t \Sigma a - n \Sigma(at)}{(\Sigma t)^2 - n \Sigma t^2}$$

where n = number of observations. (Conrad and Pollack 1949).

At the opening date (or the closing date) of the growing season the actual rainfall is equal to the effective rainfall, that is "a" is zero and the equation becomes

$$0 = A + Bt$$

and

$$t = -\frac{\Sigma t \ \Sigma(at) - \Sigma a \ \Sigma t^2}{\Sigma t \ \Sigma a - n \ \Sigma(at)}$$

Substitution of the appropriate values in this equation gave the following results:-

Perth

Opening date - 15 April; closing date - 25 October

Kellerberrin

Opening date - 30 April; closing date - 13 September

4. COMPARISON OF RESULTS

The following table shows results obtained by the different methods:-

Method of Calculation	Opening Date	Closing Date	Length of Season
		PERTH	
Graphical			
1. From monthly averages	14 April	24 October	6 months 10 days
2. From daily averages			
(a) curves	15 April	24 October	6 months 9 days
(b) regression lines	15 April	25 October	6 months 10 days
Statistical Analysis	15 April	25 October	6 months 10 days
		KELLERBERRIN	
Graphical			
1. From monthly averages	2 May	8 September	4 months 6 days
2. From daily averages			
(a) curves	1 May	between 4 and 17 September	4 months 3 days 4 months 16 days
(b) regression lines	29 April	14 September	4 months 15 days
Statistical Analysis	30 April	13 September	4 months 13 days

From this table it can be seen that for Perth, where a long series of records is available there is very close agreement between the results obtained by the three different methods.

From Kellerberrin the agreement is good at the opening of the season. At the end of the season it is difficult to determine which date should be accepted. The first closure is on the 4th, but the season re-opens again on the 8th for a period of 9 days, during which time the average rainfall exceeds the effective rainfall by approximately 1/5th of a point. The average date of closure is therefore somewhere between the 4th and 17th. Possibly when a longer series of observations is available the daily average curves will give a more definite cut.

5. CONCLUSION

It has been demonstrated that for a station where long term averages are available, growing season data obtained from mean monthly values agree very closely with those obtained from mean daily values.

For an inland station with a considerably shorter record the date obtained for the break of season by mean monthly value is within 1/10th of a month of those obtained from mean daily values. For the end of the season, the date obtained by use of mean monthly values lies between the two possible dates obtained from mean daily values.

It is therefore held that for practical purposes growing season data for the South Western Division of Western Australia can be obtained within an accuracy of ± 0.1 months by the use of average monthly values of rainfall and effective rainfall.

REFERENCES

Conrad, V. and Pollack, L.W.	1950	Methods in Climatology. Harvard. p. 86.
Foley, J.C.	1945	A study of Average Hourly Values of Temperature, Relative Humidity and Saturation Deficit in the Australian Region for Records of Capital City Bureaux. Bulletin 35. CMB Melbn. p. 22.

REFERENCES (Contd)

Prescott, J.A.	1938	Indices in Agricultural Climatology. Journ. Aust. Inst. Agric. Sci. 4 pp. 33-40.
Prescott, J.A.	1949	Climatic Expressions and Generalised Climatic Zones in regard to Soil and Vegetation. Special Conference in Agriculture, Australia, 1949, Proc. pp. 27-33, 1951.
Trumble, H.C.	1937	The Climatic Control of Agriculture in South Australia Trans. Roy. Soc. of S. Aust. 61 pp. 41-62.