A study on water availability to the crops grown under rainfed conditions in different soils at Bijapur

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(Received 4 February 1978)

ABSTRACT. The soil moisture available in the red sandy soils, red loams, medium black soils and deep black soils at Bijapur was estimated using a simple climatic water balance model. As the ratio of actual evapotranspiration to the potential evapotranspiration gives the rate at which water is supplied compared to the demand for water, the values of the ratio A_E/P_E with 40, 60 and 80 per cent probabilities in different soils were presented. The planting schedules for short, medium and long duration crops were worked out and the chances of sowing the crops of different durations during the optimum sowing periods were given.

1. Introduction

Bijapur district is located in the semi-arid tracts of Karnataka State and the agricultural production depends upon the distribution of rainfall during the southwest and northeast monsoon seasons. The important soil types found in this region are red sandy soils, red loams, medium black soils and deep black soils. Studies on the distribution of rainfall at Bijapur were made by Ramana Rao *et al.* (1975a, 1975b, 1977). Srinivasamurty (1973) studied the water availability periods at Bijapur assuming that the water holding capacity of the soil as 300 mm. In addition to the information on the distribution of rainfall it will be extremely useful if information on water availability in soils of different types is also known for planning in agriculture. Therefore, the present paper deals with the water availability in the form of soil moisture in red sandy soils, red loams, medium and deep black soils in Bijapur district.

2. Material and Methods

The daily rainfall data recorded at Bijapur during the years 1921 to 1970 were obtained from the Deputy Director General of Observatories (Climatology and Geophysics), Meteorological Office, Pune. The weekly totals of rainfall were computed from the month of April to December considering that each month will be consisting of four weekly periods only as shown below.

The mean monthly values of potential evapotranspiration worked out by Rao *et al.* (1971) using modified Penman's formula were considered and the corresponding weekly values of potential

Months	Weekly period	Dates
April to December	1	1-8
	2	9-15
	3	16-23
	4	24-30 or 31

evapotranspiration were calculated. The average monthly rainfall observed during the years 1921 to 1970 and the mean monthly values of potential evapotranspiration are given in Table 1.

A_E/P_E values have been computed using the Thornthwaite and Mather (1955) model assuming a linear relationship between available soil moisture and A_E/P_E ratio. In this analysis it was assumed that (*i*) the available soil moisture storage in the beginning of the month of April is zero during all the years; (*ii*) run-off and deep drainage will take place only after the soil gets saturated and (*iii*) only the normal P_E values were used for all the years (as the basic meteorological data for the corresponding years are not available for computing P_E values). The water balance model used in the present study does not take into account (*i*) fallow and cropped situations, (*ii*) stages of crop growth and (*iii*) variations in the evaporative demand.

The rainfall received during the week was added to the soil moisture storage at the end of the previous week to get the accumulated soil moisture.
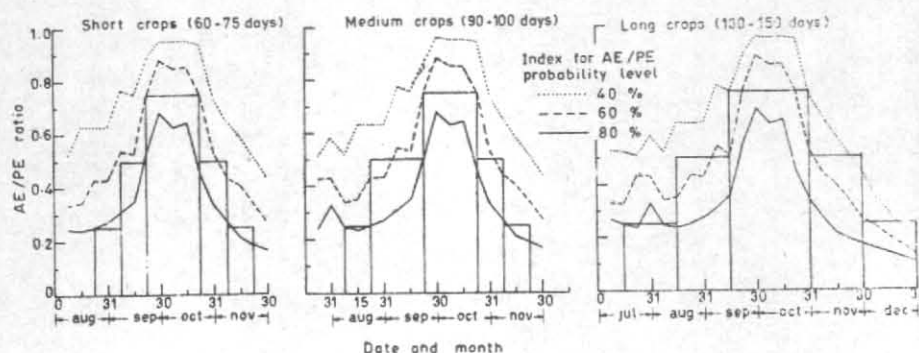
Fig. 1. Fitting of long, medium and short duration crops with 100 mm water capacity for 3 levels of A_E/P_E probabilities at Bijapur

The excess water after the soil moisture reaches field capacity was allowed to go as run-off. The actual evapotranspiration was subtracted from the accumulated soil moisture to get the soil moisture storage at the end of the week.

The water holding capacities of the different soils were taken as shown below after conducting field trials:

Red sandy soil	100 mm
Red loams	150 mm
Medium black soil	200 mm
Deep black soil	250 mm

As the ratio A_E/P_E represents the rate at which water is supplied compared to the demand for water, it can be used as an index of water availability as suggested by Virmani (1975) and Srinivasamurty (1976). Therefore, the values of A_E/P_E with 40, 60 and 80 per cent probabilities were estimated during different weekly periods in the case of different soils considered. The A_E/P_E requirements during seedling, vegetative, reproductive, physiological maturity and harvest maturity were considered as 0.25, 0.50, 0.75, 0.50 and 0.25 respectively. Accordingly, the planting schedules for short duration (60 to 75 days), medium duration (90 to 100 days) and long duration crops (130 to 150 days) were worked out in case of red sandy soils, red loams, medium black soils and deep black soils as shown in Figs. 1-4.

Ramana Rao *et al.* (1978), in their study on occurrence of optimum sowing rains in Bangalore district considered that a period with one week on either side of the sowing date as the optimum sowing period and the rainfall of at least 20 mm received in one or two consecutive days as sowing rain. Accordingly, the probabilities of getting sowing rains at least once in respect of red sandy soils, red loams, medium black soils and deep black soils during the optimum sowing periods were found and given in Table 2.

3. Results and discussion

Red sandy soils

From Fig. 1, it can be seen that the peak period of water availability occurs from the last week of

TABLE 1

Mean monthly rainfall and potential evapotranspiration at Bijapur

	Mean monthly				
	Rainfall	Potential evapotra-spiration		Rainfall	Potential evapotran-spiration
	(cm)	(cm)		(cm)	(cm)
Jan	0.42	10.87	Jul	7.28	13.74
Feb	0.29	12.29	Aug	7.30	13.46
Mar	0.66	16.54	Sep	14.50	12.44
Apr	2.21	18.03	Oct	8.78	12.31
May	3.92	19.74	Nov	2.76	10.23
Jun	7.81	15.65	Dec	0.66	9.65

TABLE 2

Probabilities of getting sowing rains at least once during the optimum sowing periods for long, medium and short duration crops in different soils at Bijapur

Soil type	Duration of crop growth	Optimum sowing period	Percentage probability of getting sowing rains at least once
Red sandy soils	Long	9-23 July	54
Red loams and medium black soils	Medium	1-15 Aug	38
	Short	16-30 Aug	44
	Medium or short	1-30 Aug	68
Deep black soils	Long	16-30 July	54
	Medium	9-23 Aug	52
	Short	24 Aug-8 Sep	60
	Medium or short	9 Aug-8 Sep	82

September to the third week of October. Therefore, the sowing of crops has to be adjusted such that the reproductive stage of crop growth coincides with
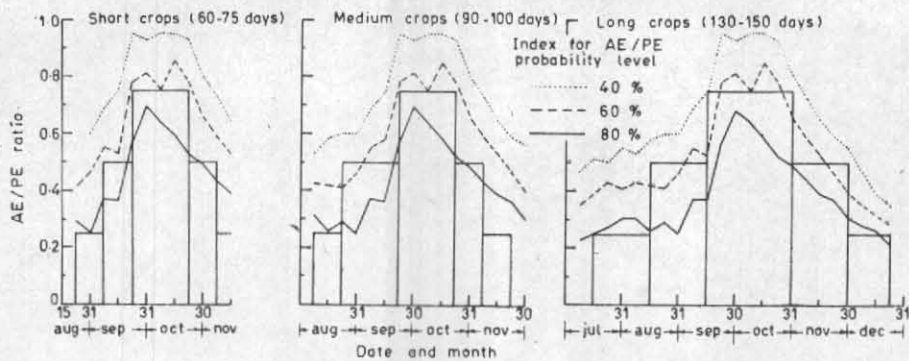
Fig. 2.   Fitting of long, medium and short duration crops with 150 mm water storage capacity for 3 levels of AE/PE probabilities at Bijapur
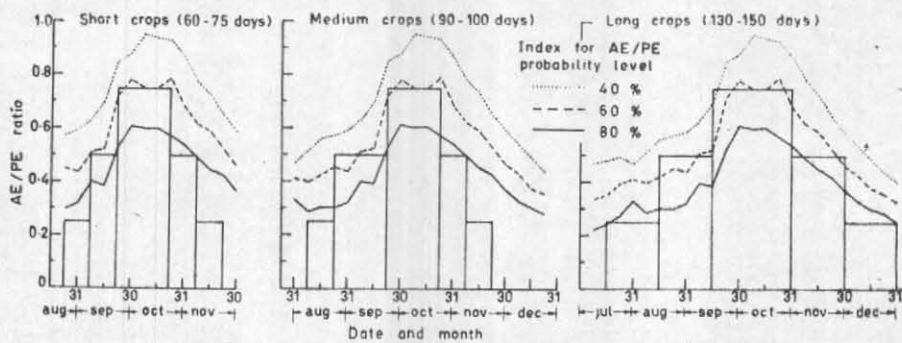

Fig. 3.   Fitting of long, medium and short duration crops with 200 mm water storage capacity for 3 levels of AE/PE probabilities at Bijapur

this period for getting better yield. If sowings are done as per the schedules shown in Fig. 1, short duration crops can have fair yield in 3 out of 5 years and medium duration crops can have fair yield in 3 out of 5 years with some supplimental irrigation during the vegetative stage of crop growth. Long duration crops can have fair yield in only 2 out of 5 years. From Table 2, it can be seen that the probabilities of getting sowing rains for long, medium and short duration crops are 54, 38 and 44 per cent respectively. The probability of getting sowing rains either for medium or short duration crops is 68 per cent. Therefore, the farmers have to adjust the duration of crop depending upon the date of receipt of sowing rains. The farmers usually grow kharif jowar, ground nut, and bajra as long and medium duration crops. The yield per acre can be increased by growing short duration crops like black gram or green gram during the years when the long and medium duration crops cannot be sown in time. Intercropping of deep rooted crops like castor or pigeon pea with the main crop has to be tried for safe economic returns.

Red loams

From Fig. 2, it can be seen that the short duration crops can have fair yield in 3 out of 5 years and medium duration can have fair yield in 3 out of 5 years with some supplimental irrigation during the

vegetative phase of crop growth. Long duration crops can have fair yield in 2 out of 5 years. The probabilities of getting sowing rains for long, medium and short duration crops are 54, 38 and 44 per cent respectively. The probability of getting sowing rains either for medium or short duration crops is 68 per cent, *i.e.,* in 7 out of 10 years. The farmers usually grow kharif jowar, bajra and ground nut as long and medium duration crops. Therefore, it is better to grow short duration crops like green gram and black gram whenever sowing of long and medium duration crops is not possible. As in the case of red sandy soils, intercropping of deep rooted crops like castor or pigeon pea with the main crop has to be tried for safe economic returns.

Medium black soils

From Fig. 3, it can be seen that the short duration crops can have fair yield in 3 out of 5 years and medium duration crops can have fair yield in 3 out of 5 years with some supplimentary irrigation during the early vegetative growth period. Long duration crops can have fair yield only in 2 out of 5 years. The probabilities of getting sowing rains at least once for long, medium and short duration crops are 54, 38 and 44 per cent respectively. The probability of getting sowing rains either for medium or short duration crops is 68 per cent. The farmers
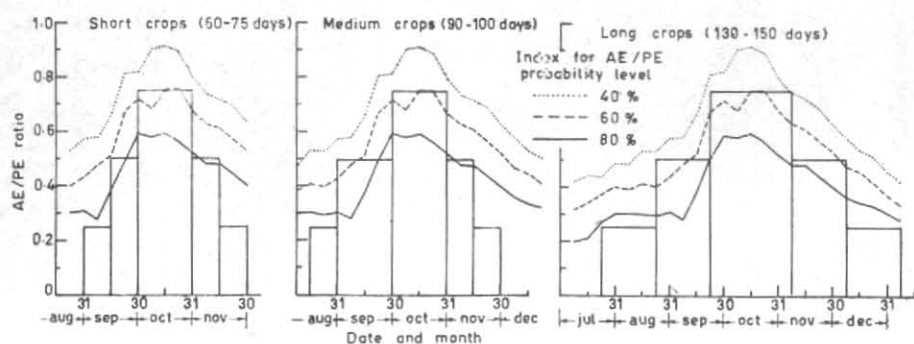
Fig. 4.   Fitting of long, medium and short duration crops with 250 mm water storage capacity
for 3 levels of   *AE/PE* probabilities at Bijapur

usually grow rabi jowar, safflower and gram during rabi season under conserved moisture conditions leaving the land fallow during the southwest monsoon season. The yield of rabi crops is very less as the crops will experience moisture stress during flowering and reproductive stages in most of the years. Therefore, there is need to investigate whether a two-tier cropping system with kharif crops of medium and short duration and mixed cropping of rabi crops like safflower or gram will be helpful in increasing the production per unit area in the medium black soils.

Deep black soils

From Fig. 4, it can be seen that the short and medium duration crops can have reasonable yield in 3 out of 5 years and long duration crops can have fair yield in 2 out of 5 years. The probabilities of getting sowing rains for long, medium and short duration crops are 54, 52 and 60 per cent respectively. The probability of getting sowing rains at least once either for medium or short duration crops is 82 per cent. The farmers usually grow rabi jowar, cotton and wheat in deep black soils under conserved moisture conditions. Therefore, the possibility of mixed cropping of kharif and rabi crops such that the kharif crop will be harvested when the rabi crop is about to enter its vegetative stage has to be examined in order to increase the production in these moisture retentive soils.

4. Conclusions

In general, one can expect reasonable yield of medium and short duration kharif crops in 3 out of 5 years in all the types of soils at Bijapur. Long duration crops can have fair yield only in 2 out of 5 years. The chances of getting sowing rains for long, medium and short duration crops during the optimum sowing period are very less and, therefore, there is need to adjust the duration depending upon the date of receipt of sowing rains. The farmers usually grow rabi crops in black soils leaving the land fallow during the southwest monsoon season. Therefore, there is need to evolve suitable mixed cropping system with intercropping of rabi crops in between the rows of medium and short duration kharif crops such that the kharif crops can be harvested when the rabi crop enters its vegetative phase in the moisture retentive soils for increasing production

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