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Crop yields as influenced by agricultural droughts – A water balance approach

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सार — इस लेख में 1981 तथा 1982 के दौरान विभिन्न बरानी खेती की फसलों के विभिन्न बढ़वार अवस्थाओं में कृषि अनावृष्टि के आकलन का एक प्रयास किया गया है। यह आकलन ए.ई./पी.ई. के आवश्यक ईष्टतम साप्ताहिक मानों से विचलन पर आधारित है। ए.ई./पी.ई. के मान खाता प्रणाली द्वारा दैनिक जल संतुलन की संगणना के माध्यम से प्राप्त किए गए। अध्ययन से पता चला है कि रायपुर परिस्थितियों के अन्तर्गत सोयाबीन की फसल अपेक्षाकृत बेहतर हुई।

ABSTRACT. In this paper an attempt has been made to assess the agricultural drought at various growth stages of different dry farming crops during 1981 and 1982 based on the deviation of weekly values of AE/PE from the optimal required values of the same. The values of AE/PE were obtained through the computation of daily water balance by the book-keeping procedure. The study revealed that soybean crop performed better under Raipur conditions.

1. Introduction

In dryland agriculture drought or water stress at different growth stages is one of the major constraints. For assessing the suitability of different crops in a given region a knowledge of the occurrence of water stress and the corresponding yield level is of paramount importance.

For assessing the agricultural drought Sastri *et al.* (1981) proposed a new method of agricultural drought classification but it was for the season as a whole. In this paper an attempt is made to assess the effect of agricultural droughts at different growth stages on the yield of 5 different crops based on the experiments conducted at Zonal Agricultural Research Station, Raipur during the kharif seasons of 1981 and 1982.

For assessing the agricultural drought, the ratio of AE/PE was reported to be the best suitable index (Subrahmanyam *et al.* 1964, 1969; Ramana Rao *et al.* 1979; Sastri *et al.* 1980; Reddy 1983) and the same is considered in this study also.

2. Materials and methodology

The experiment was conducted during the kharif season of 1981 and 1982 with 5 crops, *viz.*, rice, kodo, blackgram, soybean and groundnut with the agronomical practices as per the recommendation.

The daily values of potential evapotranspiration were computed by Penman's (1948) equation and the AE/PE values were worked out by the water balance technique of Thornthwaite and Mather (1955). The optimal required values of AE/PE during seedling, vegetative, reproduction and maturity stages of dryland crops in general were given as 0.25, 0.50, 0.75 and 0.25 respectively by Ramana Rao *et al.* (1979). In this study the values were considered based on the knowledge of water requirement of the crops.

3. Results and discussion

The duration of different growth stages of the crops and the optimal required values of AE/PE are shown in Table 1. The weekly rainfall distribution in both years of study period is shown in Table 2. The agricultural drought pattern for the 5 crops chosen during the two years is shown in Fig. 1.

Rice crop under upland conditions experienced drought during most of the growing period with a slightly higher intensity during 1982, thus reducing the grain yield from 10.15 q/ha in 1981 to 8.75 q/ha during 1982.

Soybean, on the other hand, experienced drought during seedling and vegetative stages in 1982 and only during vegetative stage in 1981. This resulted in a decrease of yield from 14.32 q/ha to 12.62 q/ha in 1982. In case of groundnut with slightly higher water requirement same was the trend, *i.e.*, drought occurred during beginning of vegetative and reproductive stages in 1981 and during seedling stage besides the two stages in 1982. The yields during 1981 and 1982 were 14.00 q/ha and 13.54 q/ha respectively.

The situation was different in case of blackgram. During 1981 water stress occurred in vegetative stage with a yield level of 5.67 q/ha while in 1982 water stress occurred in seedling stage with a yield level of 4.72 q/ha. This infers that water stress at seedling stage is more destructive than during other stages.

In case of kodomillets, drought occurred during the beginning of the vegetative stage, however, with more

TABLE 1

Optimum requirement of index of moisture adequacy "IMA" of different crops in different growth stages

Crops	Variety	Seedling stage		Vegetative stage		Reproductive stage		Maturity stage	
		Period (week)	AE/PE (%)	Period (week)	AE/PE	Period (week)	AE/PE	Period (week)	AE/PE
Rice	JR-16-15-1-1(Purva)	3	75	5	100	4	100	2	50
Soybean	JS 72-44 (Gaurav)	3	50	5	75	4	50	3	50
Blackgram	Type-9	2	50	4	60	4	50	2	40
Groundnut	Jyoti	3	50	5	75	5	75	3	50
Kodomillet	Dindori-2	3	30	5	50	5	50	3	30

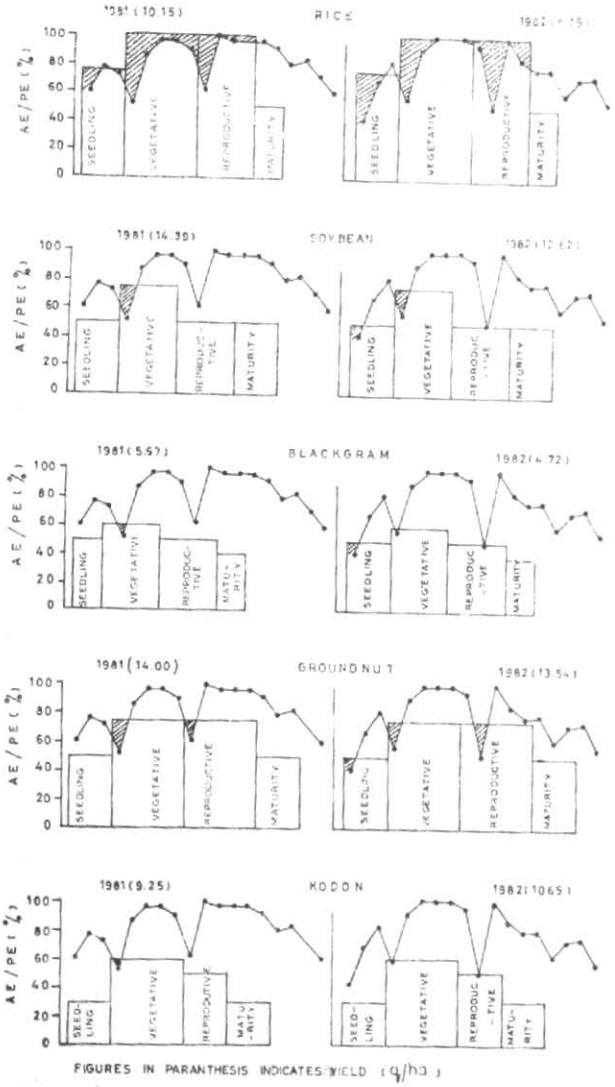

Fig. 1. Agricultural drought pattern for 5 crops

intensity in 1981 (more deviation from the optimal value) as compared to 1982, thus recorded higher yields in 1982.

4. Conclusion

It was observed in this study that with water balance analysis the effect of drought during different crop stages can well be analysed. Grain yield production is affected when drought occurred during any of the first three stages and had a cumulative effect if drought occurred in two or more stages.

TABLE 2

Weekly rainfall distribution and open pan evaporation during 1981 and 1982

Standard Met. week	Beginning date	1981		1982	
		Rainfall (mm)	Open pan evap. (mm/day)	Rainfall (mm)	Open pan evap. (mm/day)
23	4 Jun	12.8	13.9	0	13.7
24	11 ,,	4.0	11.7	72.8	9.9
25	18 ,,	102.4	9.3	10.6	7.5
26	25 ,,	13.8	3.7	34.0	7.3
27	2 Jul	53.4	5.6	0.0	9.6
28	9 ,,	61.2	4.3	36.2	7.9
29	16 ,,	27.0	4.0	53.9	4.8
30	23 ,,	82.7	4.2	23.3	5.4
31	30 ,,	105.6	3.9	51.5	4.1
32	6 Aug	183.0	3.9	240.1	3.8
33	13 ,,	47.6	4.6	82.1	3.5
34	20 ,,	87.0	4.6	73.5	3.5
35	27 ,,	93.2	4.7	39.3	2.4
36	3 Sep	54.8	4.4	12.4	3.6
37	10 ,,	29.0	3.7	45.4	3.7
38	17 ,,	84.0	4.0	0.8	4.9
39	24 ,,	73.4	3.7	16.2	4.3
40	1 Oct	0.0	4.0	0.0	4.3

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References

Penman, H.L., 1948, Natural evaporation from open water, bare soil and grasses, *Proc. Roy. Soc. London, Ser. A* (**193**), pp. 120-145.

Ramana Rao, B.V., Biradar, B.R., Surpur, S.S., Gopinatha Rao, M. and Satyanarayana, T., 1979, 'A study on water availability to the crops grown under rainfed conditions in different soils at Bijapur', *Mausam*, **30**, 4, pp. 469-472.

Reddy, S.J., 1983, 'Agroclimatic classification of semi-arid tropic III: Characterisation of variables relevent to crop production potential, *Agric. Met.*, **30**, pp. 269-292.

Sastri, A.S.R.A.S., Rama Krishna, Y.S. and Ramana Rao, B.V., 1981, 'A new method of classifying agricultural drought', *Arch. Met. Geophys. and and Bio-clim.* **29**, 3, pp. 293-297.

Subrahmanyam, V.P., Subba Rao, B. and Subramaniam, A.R., 1964, 'Moisture adequacy in relation to the distribution of few crops in India', Proc. IASH (IUGG) Assembly, Berkeley (California), 1963, pp. 462-467.

Thorthwaite, C.W. and Mather, J.R., 1955, The water balance, Drexel Inst. Tech., New Jersey, **8**, 1, pp. 1-104.

Yao, A.Y.M., 1969, 'The R index for plant water requirement, *Agric. Met.*, **6**, 4, pp. 259-273.