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Weather features associated with abnormal wheat yields of Himachal Pradesh

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सार — हिमाचल प्रदेश में पिछले तीन दशकों में गेहूं की उपज में हुए महत्वपूर्ण परिवर्तनों का पता चला है। एक सांख्यिकी निदर्श के आधार पर इस राज्य में असामान्य उपजों के लिए उत्तरदायी मौसम के कारकों की पहचान के लिए यह अध्ययन किया गया है। इसमें फसल कार्मिकों की तुलना में संवेदनशील अवधियों के दौरान सिनाप्टिक प्रणालियों और मौसम पर चर्चा की गई है।

ABSTRACT. Significant variations in wheat yields over Himachal Pradesh during the last three decades have been reported. A study has been undertaken to identify the weather factors responsible for the abnormal yields over the State, based on a statistical model. The synoptic systems and weather during the sensitive periods of the abnormal years against the physiology of the crop are discussed.

1. Introduction

Wheat is the principal rabi crop of Himachal Pradesh. The wheat yields of the State (Fig. 2) varied from 300 to 1300 kg/ha, during 1951 to 1978. These variations are either due to technology or aberrations in weather. A statistical model has been developed to identify the sensitive weather factors and their periods which affect the wheat yields. The synoptic systems responsible for the weather during the sensitive periods of the abnormal years of wheat yields, during the period of least technological impact, are discussed.

2. Data used and method of analysis

Wheat yield of nine districts namely Mahasur, Sirmur, Mandi, Chamba, Bilaspur, Kinnaur, Kangra, Kulu and Shimla, and daily weather data from the observatories of Shimla, Dalhousie, Dharampur, Mandi, Bilaspur and Buntar besides rainfall of State rain-gauge stations of Himachal Pradesh are used in the analysis. The daily weather data during the wheat crop season (October to April) for the period 1951 to 1967, when the technological impact is least, is considered. The years 52-53, 65-66 and 61-62, 64-65 are the years of abnormal (lowest and highest) yields of the State.

The method is mainly based on multiple linear regression, used by Das *et al.* (1971 a, b) and Appa Rao *et al.* (1977, 1982). The statistical model and the sensitive periods obtained from the analysis are given in Table 1.

3. Discussion of results

3.1. *Sensitive periods and yield estimates*

From Table 1, it is seen that the sensitive periods are, rainfall during 20 to 28 January, 25 October to 2 November and cloud during 8 to 14 December and minimum temperature during 24 February to 1 March. The former three are helpful and latter is harmful to the crop. These cover elongation, sowing, active tillering and flowering phases of the crop respectively.

The fit between reported and estimated yields (by the model Fig. 3) show a fairly close agreement between them.

The model estimated two years yields, outside the analysed sample, within $\pm$ 10% error.

3.2. *Synoptic scale systems and associated weather during the sensitive periods of the crop*

The anomalous weather during the above four sensitive periods are shown in Fig. 1, during the abnormal years which are marked by arrows. Higher and above normal values of rainfall and cloud amounts are congenial for a better yield. Particularly the highest yield of 61-62 is associated with the large values of rainfall during sowing and elongation periods

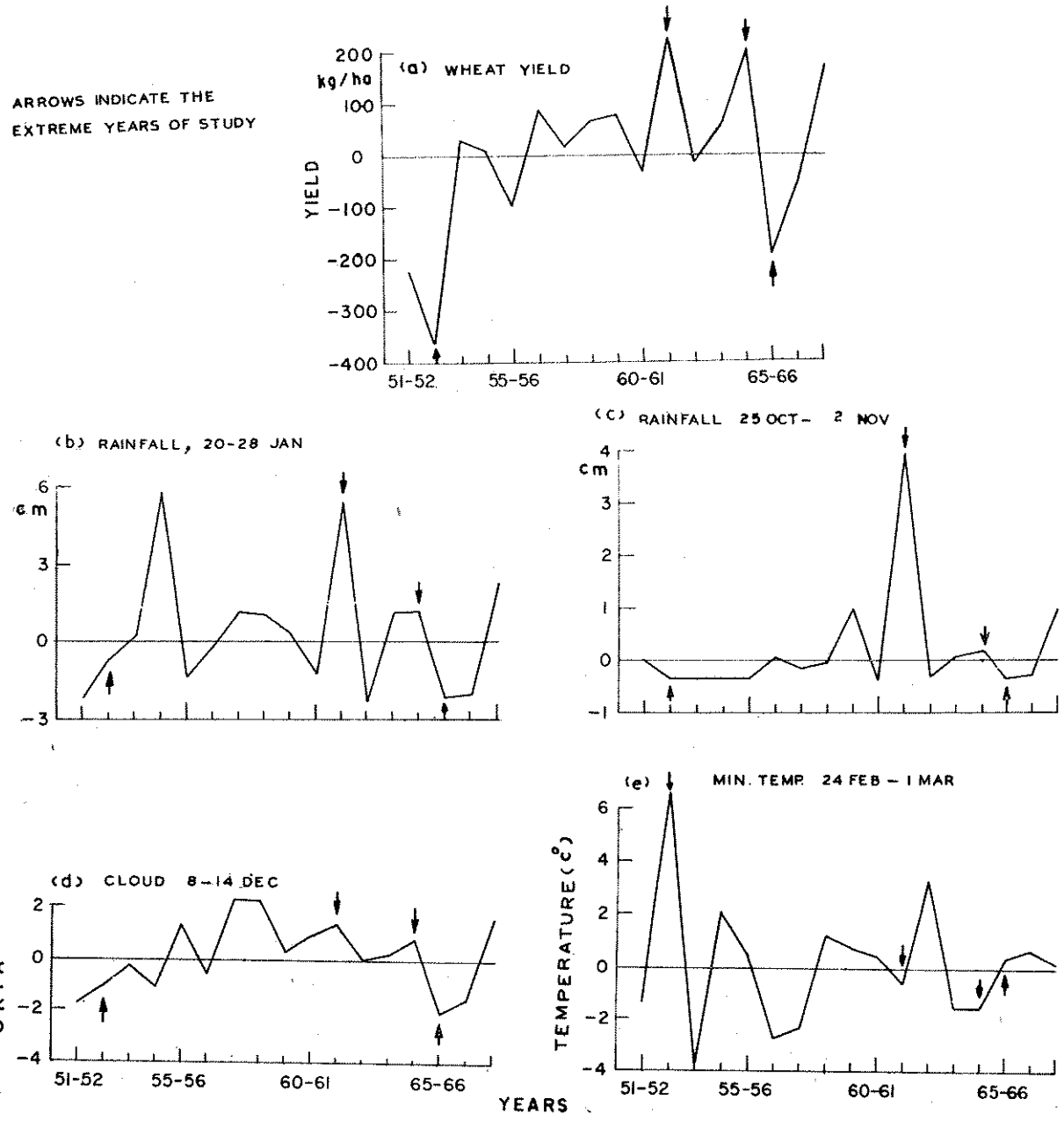

Fig. 1. Anomaly diagrams during the period 1951 to 1967 :

(a) Wheat yields, arrows indicate the extreme years of study
(b) Rainfall during 20 to 28 January
(c) Rainfall during 25 October to 2 November
(d) Cloud during 8 to 14 December
(e) Minimum temperature during 24 February to 1 March

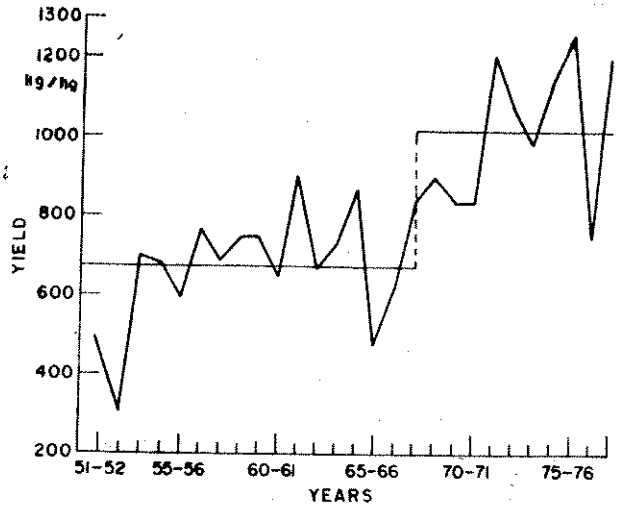

Fig. 2. Average wheat yields of Himachal Pradesh

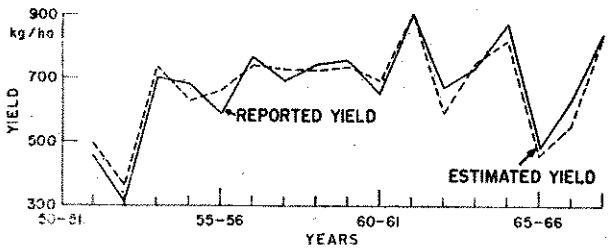

Fig. 3. Reported and estimated (based on regression model) wheat yields of Himachal Pradesh during 1951 to 1967

TABLE 1

Statistical model to forecast wheat yield

Division : Himachal Pradesh, No. of years of data used : 17

Mean (kg/ha)	Standard deviation	Coeff. of variation	Regression equation	Net M.C. C.	Total % variation accounted for
674.0	167.3	21.8	$y=550.5+15.0x_1$ $+41.2x_2$ $+65.6x_3-23.7x_4$ *(2.14) (2.80) (6.0) (5.07)	0.95	89.7

x_1=Rainfall (cm) during 20-28 Jan
x_2=Rainfall (cm) during 25 Oct to 2 Nov
x_3=Average cloud in octas for the period 8-14 Dec
x_4=Mean minimum temperature ° C during 24 Feb to 1 Mar
y =Yield.
*(t-test value for the parameters)

of the crop. Minimum temperatures are harmful during the flowering stage of the crop beyond a certain value and the lowest yield is associated with a steep fall in it during 52-53.

During the active growth of crop, rainfall and cloud over Himachal Pradesh are due to "western disturbances" (Rao and Srinivasan 1969). These are low pressure systems which move over extreme north and produce rainfall and snow over Jammu & Kashmir, Himachal Pradesh, Punjab, Haryana and even east Rajasthan and west Uttar Pradesh. Cold waves and fog occur in the rear of the systems. In case of active disturbances the drop in temperature is rather abrupt and appreciable and sometimes bring ground frost.

The synoptic systems during the four abnormal years are discussed below, based on the weather charts.

25 *October to* 2 *November* — Fair weather prevailed over Himachal Pradesh in '52 and '65 and neighbourhood without any rain. Night temperatures were above normal in '65. In '61, snow and rain occurred over Himachal Pradesh due to passage of a western disturbance over Western Himalayas.

20 *to* 28 *January* — In 1953 excessive rain and snow occurred due to movement of two western disturbances over northern hills of the State. In 1966 the weather was fair without any rain. In 1961 widespread rain and snow reported due to passage of a western disturbance, whereas '65, is associated with fairly widespread rain over the State due to passage of another western disturbance.

8 *to* 14 *December* — In '52, two western disturbances moved over extreme north without weather and in '65, the area was free from any system. Night temperatures were below normal over northwest India in '65. In '61, weather was fair and in '64, it was associated with local rain.

24 *February to* 1 *March* — 1953 and '66, were associated with excessive rain due to movement of western disturbances over northwest India and Western Himalayas respectively. These systems brought a fall of night temperatures below normal. In '62, a western disturbance passed over Punjab and neighbourhood with a good spell of rain over Himachal Pradesh and night temperatures were normal. Weather was fair in '66.

4. Conclusion

Rainfall, cloud and minimum temperatures during sowing, elongation, tillering and flowering stages are the important weather parameters that affect the final wheat yield over Himachal Pradesh. Lowest wheat yields are associated with poor rainfall, low cloud amount and appreciable fall of minimum temperatures over the State. The important weather systems responsible for the differential weather features are the western disturbances.

References

Appa Rao, G., 1983, Estimation of wheat yields over Punjab using district and State models, *Mausam*, **34**, 3, pp. 275-280.

Appa Rao, G., Jaipal, Joseph, L.,Deshpande, S.P. and Mahajan, A.V., 1977, Forecasting the yield of principal crops of India from weather parameters-wheat, India Met. Dep., Pre-publ, Sci. Rep. No. 77/8.

Das, J. C., Mehra, A. K. and Madnani, M. L., 1971(a), Forecasting the yield of principal crops in India on the basis of weather—Paddy/Rice, *Indian J. Met. Geophys.*, **22**, p. 47.

Das, J. C., 1971(b), Forecasting wheat yield in India with the help of weather parameters : Part I—Punjab and Haryana, India Met. Dep. Sci. Rep. No. 140.

Rao, Y.P. and Srinivasan, V., 1969, Forecasting manual Part-III, India Met. Dep., Pune.