551·577·2/·3(548)

A study of the relationship between the previous barometric pressure and relative humidity on the daily rainfall at Coimbatore

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(*Received 18 June 1965*)

ABSTRACT. Correlations between rainfall of 10 cents and above and barometric pressure and relative humidity were worked out based on fifteen years' data (1949 to 1963). No significant correlations were noticed during the Dry Weather period (January and February) and the Southwest Monsoon period (June to September).

During the Hot Weather period (March to May) barometric pressure on two days and three days prior to the day of actual rainfall had a positive influence on rainfall at 5 per cent level. If the rain is of the order of 50 cents, the fall in barometric pressure is appreciable. The same was noticeable in the case of relative humidity three days previous to the rainfall. During the Northeast Monsoon period the significance of relative humidity recorded on three and two days before rainfall is at 5 per cent level, while on the previous day the level of significance is at 1 per cent level.

1. Introduction

One of the objectives of artificial rainmaking scheme at Coimbatore is to assess the behaviour of the meteorological factors foreshadowing a precipitation, so that with this knowledge rain can be fairly predicted before its actual occurrence. With this object in view, barometric pressure and relative humidity data were compiled for 15 years (1949 to 1963) from the records of the Agricultural Meteorological Observatory at Coimbatore and statistically examined.

Piston (1941) found that most of the summer showers and all thunderstorms are formed by condensation in vertically ascending currents of fairly high velocity. The winter rains, on the other hand, are due to condensation in cyclonic storms, when the air rises in a long sloping path. Geddes (1930) has described the types of rain as due to direct cooling through expansion and consequent cooling and to a less extent through mixing. Sansom (1955) tried to predict the seasonal rains of Kenya by means of correlation studies. The correlation coefficients, thus arrived, were slightly below 5 per cent level of significance but in the absence of any other forecasting device evolved so far, he has come to the conclusion that even at the present level of their significance, these coefficients would provide an idea of an oncoming rain to farmers, gardeners and others interested in rainfall.

2. Data

(*a*) Rainfall data of 10 cents and above for each of the years 1949 to 1963, both inclusive, have been separately tabulated for the four periods— (1) Dry Weather period (January and February), (2) Hot Weather (March to May), (3) Southwest Monsoon (June to September) and (4) Northeast Monsoon (October to December).

(*b*) The barometric pressure as recorded with Fortin's Barometer and relative humidity as calculated from the readings of the dry and wet bulb thermometers housed in the Stevenson Screen for each of the days of the rainfall have also been noted along with the rainfall data. Similarly the pressure and relative humidity recorded one day, two days, three days and four days previous to the actual day of precipitation, have also been tabulated.

3. Methods

(*a*) Correlations were worked out separately between pressure and rainfall and relative humidity and rainfall for each one of the intervals, namely, one day, two days, three days and four days prior to the recording of rain for each period. These data are given in Table 1.

(*b*) Out of the four periods, only in two, namely, Hot Weather period of March to May and Northeast Monsoon period of October to December, significant correlations were observed. The analyses of variance were worked out both for pressure and relative humidity for the Hot Weather period and for relative humidity alone for the Northeast Monsoon period. These analyses of variance were worked out to assess the influence of barometric pressure and relative humidity on the daily rainfall patterns of above 50 cents and 50 cents and below. The relevant data for the Hot Weather and Northeast Monsoon periods are given in Tables 2 and 3 respectively.

TABLE 1

Correlation between pressure and rainfall and relative humidity and rainfall

Period	Interval before the day of precipitation							
	One day		Two days		Three days		Four days	
	(a)	(b)	(a)	(b)	(a)	(b)	(a)	(b)
Dry Weather ($n=28$)	−0·077	−0·084	−0·083	+0·015	−0·029	+0·149	−0·086	+0·345
Hot Weather ($n=142$)	+0·026	+0·136	+0·203*	+0·105	+0·169*	+0·188*	+0·069	+0·148
Southwest Monsoon ($n=253$)	−0·003	+0·060	−0·006	+0·017	−0·009	−0·037	+0·016	+0·030
Northeast Monsoon ($n=272$)	+0·035	+0·162†	−0·023	+0·126*	−0·005	+0·129*	+0·110	+0·011

(a) — Barometric pressure. (b) — Relative humidity. * — Significant at P=0·05. † — Significant at P=0·01

TABLE 2

Analysis of variance of pressure and relative humidity during the Hot Weather period

Source	Pressure				Relative humidity			
	D.F.	S.S.	M.S.	F.	D.F.	S.S.	M.S.	F.
Rainfall types (a and b)	1	0·019241	0·019241	23·61*	1	1368	1368	44·13*
Intervals within rainfall types (a and b)	8	0·012053	0·001507	1·85	8	9166	1146	36·97*
Occasions of rainfall	141	1·987535	0·014095	17·29*	141	31804	226	7·29*
Residual	559	0·455490	0·000815		559	17588	31	
Total	709	2·474319			709	59926		

Comparison of pressure means for rainfall types

Means	a	b	SED	CD
	28·7872	29·7982	0·0022	0·0043

Conclusion b, a

Comparison of relative humidity means for rainfall types

Means	a	b	SED	CD
	85·53	82·62	0·44	0·86

Conclusion a, b

Comparison of intervals means

For (a)

Means	I_0	I_1	I_2	I_3	I_4	SED	CD
	91·16	86·16	84·67	83·22	82·45	1·12	2·20

Conclusion $I_0, I_1, \overline{I_2, I_3}, I_4$

For (b)

Means	I_0	I_1	I_2	I_3	I_4	SED	CD
	88·73	82·86	82·12	79·06	81·06	0·44	0·80

Conclusion $I_0, \overline{I_1, I_2}, I_4, I_3$.

a — above 50 cents, b — below 50 cents * — Significant at P=0·001,
I_0 — Day of rainfall, I_1 — One day preceding, I_2 — Two days preceding, I_3 — Three days preceding,
I_4 — Four days preceding

TABLE 3

Analysis of variance of relative humidity during the Northeast Monsoon period

Source	D.F.	S.S.	M.S.	F.
Between rainfall types a and b	1	285	285	11·88*
Intervals within rainfall types a and b	8	5417	677	28·21*
Occasions of rainfall	271	38517	142	5·91*
Residual	1079	26326	24	
Total	1359	70545		

Comparison of relative humidity means for rainfall types

Means	a	b	SED	CD
	90·84	91·77	0·27	0·53

Conclusion b, a

Comparison of relative humidity means for intervals

For (a)

Means	I_0	I_1	I_2	I_3	I_4	SED	CD
	95·79	92·56	90·37	90·45	89·68	0·64	1·25

Conclusion I_0 I_1 $\overline{I_3 \ I_2 \ I_4}$

For (b)

Means	I_0	I_1	I_2	I_3	I_4	SED	CD
	93·89	91·40	90·20	89·42	89·31	0·56	1·10

Conclusion I_0 I_1 $\overline{I_2 \ I_3 \ I_4}$

a — above 50 cents b — below 50 cents, * — Significant at $P=0·001$,

I_0 — Day of rainfall, I_1 — One day preceding, I_2 — Two days preceding, I_3 — Three days preceding, I_4 — Four days preceding

4. Discussion

(*i*) The following tentative inferences are drawn from Table 1 —

(*a*) Neither of the weather factors, namely, barometric pressure and relative humidity seems to have any relationship with rainfall during the Dry Weather and Southwest Monsoon periods.

(*b*) In the Hot Weather period, barometric pressure recorded on three days and two days before the actual day of precipitation seems to exert a positive significant influence on the precipitation at the level of 5 per cent. Relative humidity, recorded on three days before the precipitation, has also a positive significant influence at the same level of 5 per cent. During the Northeast Monsoon period relative humidity recorded in one, two and three days prior to rainfall exerts a positive significant influence on rainfall at the level of one per cent for the one day and 5 per cent for two and three days prior to rainfall. In this period barometric pressure appears to have no significant influence on rainfall.

(*c*) Both the pressure and relative humidity on three days prior to rainfall influence the rainfall. This inference supports the view of Geddes (1930). According to Geddes, the relationship between barometric pressure and rainfall during the Hot Weather period is primarily through expansion and consequent cooling. The significant influence of relative humidity in the interval of three days before the actual rainfall is due to not only expansion and consequent cooling but also to a certain extent through mixing of the air containing a high percentage of water vapour with the summer clouds. That is why rainfall with hailstones are received at Coimbatore only during the Hot Weather period.

(*ii*) *Hot Weather period* — An examination of the data in Table 2 will reveal the following tentative inference —

It is evident that a higher precipitation, *i.e.*, above 50 cents, is associated with a higher fall in the barometric pressure and *vice versa*. But the converse is the case in respect of relative humidity in this period. It is also to be noted that the relative humidity three days and four days before the day of precipitation is less than those prevailing on one day and two days previous to the day of actual rainfall.

(*iii*) *Northeast Monsoon period* — A reference to Table 3 brings to light that the relative humidity associated with precipitation of over 50 cents is significantly higher in value than that associated with rainfall of 50 cents and below. This inference is in consonance with the inference drawn in regard to relative humidity for the Hot Weather period. It is also to be noted that there is not much of variation in relative humidity in the periods, four, three and two days before rainfall, but there is a sudden increase in relative humidity on the day previous to rainfall.

5. Summary and conclusion

From this study the following broad inferences are drawn —

(*i*) Both the weather factors, namely, barometric pressure and relative humidity have no significant influence on rainfall in the Dry Weather and Southwest monsoon periods.

(*ii*) In regard to Hot Weather period barometric pressure on two days and three days prior to rainfall has significant positive influence on rainfall. Relative humidity recorded on three days before rainfall also has a significant influence.

(*iii*) As regards Northeast Monsoon period, relative humidity alone exerts a positive significant influence on rainfall. The significance of relative humidity recorded on three and two days before rainfall is at the level of 5 per cent, whereas the relative humidity recorded on the previous day has a significance at the level of 1 per cent.

(*iv*) The fall in barometric pressure seems to be associated with the impending rain in the Hot Weather period. If the rain is of the order of 50 cents, the fall in barometric pressure will be appreciable.

(*v*) In the Northeast Monsoon period variations in relative humidity during the previous three days appear to be associated with the subsequent rainfall.

In conclusion, it may be stated that a study of this nature on the pre-disposing conditions for natural precipitation will be of immense use in a scheme of artificial induction of clouds. Instead of merely depending on the amount and type of clouds on the day of seeding, if a knowledge of the favourable pre-disposing conditions for natural precipitation is also made use of, the selection of a particular day for the artificial induction of clouds will really be on sound basis, thereby increasing the scope for the successful artificial induction of clouds.

6. Acknowledgement

The authors are grateful to the Chairman and members of the Artificial Rainmaking Reviewing Committee for their critical suggestions to improve the text of the paper. Their thanks are also due to all those, associated with the collection of the basic data, made use of in this study.

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