I. Introduction

During the kharif season (south-west monsoon) in 1967, public attention was focussed on a disease of the Bajra crop, known as 'Ergot', in many parts of India. Although this disease has been known from the times of the Greeks and Romans, it seemed to be a new one so far as the Bajra crops in India were concerned. According to a leaflet issued by the Division of Mycology and Plant Pathology of the Indian Agricultural Research Institute, Delhi in October 1967, this disease appeared for the first time in cultivated varieties of Bajra in certain areas of the Maharashtra State in 1959. With the introduction of Hybrid Bajra No. 1 developed at the Punjab Agricultural University, Ludhiana, the disease spread to many Bajra-growing areas in India and it appeared in epidemic form during the kharif season of 1967 in many parts of the country. The fungal organism which incited this disease has been classified by the Indian Agricultural Research Institute as Claviceps microcephala.

Ergot contains a poisonous alkaloid. According to press reports, at least 20 persons died around Delhi towards the end of the monsoon season of 1967 by eating the infected Bajra. Loss of cattle was also reported in the newspapers. The disease also reduced the crop yield. The need for preventing a recurrence of this epidemic can be realised from the fact that Bajra crop is cultivated over 27 million acres of land in our country and yields annually about 4 million tons of food grain.

II. Meteorological Factors and Their Importance in Ergot Pathology

Butler and Jones⁴ and Walker⁵ have discussed in detail the pathology of the Ergot disease. Although they do not mention about environmental factors specially applicable to India, they have clearly stressed the importance of meteorological factors in ergot-pathology. For instance they have pointed out that the minute conidia which are contained in the sticky yellow fluid known as 'honey-dew', can be carried from infected to healthy plants by swaying of the plants in wind and by splashing rain. Again, according to Butler and Jones,² "the ascospores are extruded under conditions of high humidity of about 76 to 78% saturation of the atmosphere and may either collect at the ostioles in viscid masses for dispersal in splashing rain-drops, or if showers are followed by sunny periods, such conditions would liberate the spores from the perithecia and cause them to be forcibly ejected into the air and so may be carried further afield by the wind to any spikelets that may be open for the reception of pollen."

The importance of wind in the dissemination of the infection will be realised if we recall that during the south-west monsoon season, in the important Bajra-growing areas like Maharashtra and Rajasthan, steep pressure gradients prevail resulting in strong winds. It is interesting to recall in this connection that the Ergot disease first appeared in India in 1959 in Maharashtra.

III. Purpose of the Present Investigation

As far as the writer is aware, no literature is available about the precise meteorological factors which influence at different stages the incidence and development of Ergot under Indian conditions. However, there is no doubt that the Ergot disease was much more widespread and severe in India in 1967 than in 1966. We shall therefore, assume for the sake of simplicity, that the initial conditions relating to the parasite and host-plant were more or less the same, both in 1966 and 1967 and examine how far the meteorological factors would have contributed to the greater incidence and extent of this disease in 1967. This assumption is of course not strictly justified because the sclerotia which fall to the ground during one crop-season may revive before the next crop-season while on ground and generate ascospores which may lead to infection. Ergots are however fortunately not long-lived and do not remain viable on the ground for more than a year.⁶

An investigation of this kind should, strictly speaking, be based on "precision records" as

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⁶ Sunny clear skies in the pre-monsoon season (hot weather period) uninterrupted by unseasonal rain have a sterilising influence on the soil.
suggested by Ramdas. Unfortunately, such records were not available in the present case. Nevertheless the writer has made this preliminary study, making use of whatever information was available about the general atmospheric conditions and about the growth of Bajra crop in Delhi area. This approach is justified in this preliminary investigation as, according to our present knowledge, the fungal organism connected with Ergot, attacks only the flowers of the crop which are exposed to the general atmosphere.

IV. BASIC METEOROLOGICAL OBSERVATIONS AND CROP-WEATHER INFORMATION UTILISED IN THIS STUDY

The Safdarjung Airport and Lodi Road Observatories are less than a mile apart as the crow flies and the meteorological observations recorded at these two sites were utilised in this investigation. The observations at both these sites will be referred to in the rest of this article as "at the meteorological observatory, New Delhi". This observatory is about 5 miles to the east-south-east of the Experimental Research Farm of the Indian Agricultural Research Institute (I.A.R.I.), Delhi where Bajra is cultivated for research purposes. The general atmospheric conditions at the meteorological observatory, New Delhi may be considered to be representative of those at I.A.R.I. except in the cases of rainfall and relative humidity. Even in these two cases, the minor differences would not vitiate the broad conclusions reported in this article.

The India Meteorological Department† have compiled district-wise "Crop-Weather calendars showing the life-history and mean dates of important epochs of growth of crops in the various States. Although no crop weather calendar is available for Delhi State in respect of Bajra, calendars are available for this crop for a few districts in Rajasthan, the nearest district for which it is available being Churu which is only 12 _kilometres (approximately) to the west-south-west of Delhi. These calendars supplemented by the author's discussions at the I.A.R.I. constituted the basic crop-weather information for this study.

V. METEOROLOGICAL CONDITIONS AT NEW DELHI AFTER THE ONSET OF THE SOUTH-WEST MONSOON IN 1967

The monsoon advanced into Delhi on 2nd July 1967 and there were showers daily at

† The "Crop-Weather Calendars" were first prepared by Dr. L. A. Ramdas in 1946.

Delhi between 2nd and 8th July 1967. It was understood during discussions at the I.A.R.I. that Bajra was sown in the Experimental Research Farm at the I.A.R.I. in different plots between 15th and 30th July 1967.

Figure 1 shows (a) the daily values of relative humidity and total cloud amount at 0830 and 1730 IST, (b) rainfall during the 24 hours ending at 0830 IST and (c) the total number of hours of sunshine daily, at the meteorological observatory, New Delhi, during July, August and September 1967. For purposes of comparison, the daily 0830 IST values of relative humidity and total cloud amount and the total number of hours of sunshine daily, in July, August and September 1966 have also been shown in the same diagram. The periods during which the Bajra was sown (July, 15th to 30th) and would have flowered (September 1st-10th) at the I.A.R.I., Delhi in 1967, are also shown pictorially in the diagram.

An examination of this diagram reveals the following:

(a) The morning relative humidity was 85 to 95% between 1st and 10th September 1967. The evening relative humidity which is normally only 45 to 50% over Delhi at this time of the year, was 75 to 90% between 1st and 5th and 60 to 70% between 6th and 10th September.

(b) The total cloud amount was six to eight octa (i.e., the sky was 75 to 100% covered) both morning and evening between 1st and 8th September 1967. Normally the sky over Delhi is covered only about one-third at this time of the year.

(c) The total number of hours of sunshine was only 1 to 5 hours daily between 1st and 7th September 1967. Normally the duration of sunshine at Delhi in September is 7 hours.

(d) There were showers daily between 1st and 6th September 1967. Rainfall was as much as 38 millimetres during the 24 hours ending at 0830 IST on 2nd.

VI. METEOROLOGICAL CONDITIONS AT NEW DELHI AFTER THE ONSET OF THE MONSOON IN 1966, A YEAR OF NO EPIDEMIC OF ERGOT

In 1966, the monsoon advanced into Delhi and the neighbouring areas on 25th to 26th July. The dates of sowing, flowering, etc., of Bajra over Delhi area in 1966 are unfortunately
not available and hence are not specifically discussed here. However, the attention of the reader is invited to the low relative humidity and the little cloud amount even at 0830 IST and the long duration of sunshine during most of the period covering the last ten days of August and the first fortnight of September 1966, in Fig. 1.

VII. PROGRESS OF RAINFALL WEEK BY WEEK IN 1966 AND 1967

Table I shows the rainfall in the different weeks between the 26th week (June 25 to July 1) and the 38th week (September 17-23) in 1966 and 1967 and the normal rainfall during the same period based on the data of a large number of years. The weeks cover the same periods as in the Crop-Weather calendars of the India Meteorological Department. The rainfall of 50% in excess of the normal in the 31st week (30th July to 5th August 1967), of more than 100% in excess of the normal in the successive 3 weeks (32nd, 33rd and 34th) followed by rainfall of nearly 50 to 60% in excess of the normal in the 35th and 37th weeks in 1967 are significant from the point of view of our investigation. It will be noted that the picture of the weekly rainfall in the same period in 1966 is different.

VIII. MEAN HOURLY SURFACE WIND-SPEEDS AT NEW DELHI IN SEPTEMBER 1967 AND 1966

An examination of the mean hourly surface wind-speeds tabulated from the records of the Dines Pressure Tube Anemograph at the meteorological observatory at New Delhi, shows that, in the first half of September 1967 as well as of September 1966, the mean hourly speeds did not exceed 28 kmph at any time nor did they persist even at this speed long enough to suggest the possibility of spreading of infection as an effect of winds.

IX. LARGE-SCALE METEOROLOGICAL SITUATION OVER NORTH-WEST INDIA (INCLUDING DELHI STATE), DURING THE PERIOD OF FLOWERING OF BAJRA IN 1967

The large-scale meteorological situation over north-west India between 1st and 10th September 1967 was interesting. Conditions similar to those at Delhi prevailed over an area of at least 65,000 sq. miles (1,66,400 sq. km.) with Delhi close to its northern border between 1st and 7th September. These conditions shifted progressively west-south-westwards after 7th September. The large-scale weather systems at all levels in the atmosphere between the ground and 16 km. were favourable for sustained wet spell over an extensive area with Delhi almost at its northern fringe, during the normal flowering period of the Bajra. Our analysis thus supports the greater incidence of the Ergot disease in Gurgaon and other areas to the south of Delhi as reported in the Delhi Press.

In contrast to the above, there was nothing striking in the large-scale meteorological situation during the corresponding period in September 1966. From 24th August 1966 to

<table>
<thead>
<tr>
<th>Weeks</th>
<th>1966</th>
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<tr>
<td></td>
<td>Normal Rainfall (Whole mm.)</td>
<td>Actual Rainfall (Whole mm.)</td>
</tr>
<tr>
<td>26 (June 23-July 1)</td>
<td>30</td>
<td>105</td>
</tr>
<tr>
<td>27 (July 2-8)</td>
<td>32</td>
<td>2</td>
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<td>28 (July 9-15)</td>
<td>38</td>
<td>2</td>
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<tr>
<td>29 (July 16-22)</td>
<td>51</td>
<td>2</td>
</tr>
<tr>
<td>30 (July 23-29)</td>
<td>45</td>
<td>72</td>
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<tr>
<td>31 (July 30-Aug. 5)</td>
<td>42</td>
<td>104</td>
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<tr>
<td>32 (Aug. 6-12)</td>
<td>41</td>
<td>92</td>
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<td>33 (Aug. 13-19)</td>
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<td>28</td>
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<td>34 (Aug. 20-26)</td>
<td>34</td>
<td>2</td>
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<tr>
<td>35 (Aug. 27-Sept. 2)</td>
<td>3</td>
<td>0</td>
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<tr>
<td>36 (Sept. 3-9)</td>
<td>30</td>
<td>51</td>
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<tr>
<td>37 (Sept. 10-16)</td>
<td>37</td>
<td>0</td>
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<tr>
<td>38 (Sept. 17-23)</td>
<td>36</td>
<td>17</td>
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N.B.—Figures in italics represent actual rainfall which is equal to or less than half of the normal rainfall. Figures in thick type represent actual rainfall which is equal to or more than twice the normal rainfall.
7th September 1966, no large-scale rain or cloud-producing system affected north-west India (including Delhi State). Consequently during this period, the entire Bajra-growing area in north-west India, experienced very weak monsoon conditions with plenty of sunshine.

X. Concluding Remarks

This preliminary study has brought out the importance of meso- as well as large-scale meteorological factors in the incidence of Ergot disease of Bajra. However, it has to be followed up by a more exhaustive study based on a well-co-ordinated observational cum research.

![Diagram of Ergot of Bajra at Delhi during Kharif 1967 and Meteorological Factors]

FIG. 1. The period of sowing between 15th and 30th July 1967 and the period of flowering between 1st and 10th September 1967 shown pictorially in the bottom portion of the diagram may be specially noted. The stippled portion of the diagram, in September, shows the portion of the flowering period when the duration of sunshine was less than 5 hours in the day, the total cloud amount was more than six octa (more than 75% of the sky covered) and the relative humidity was more than 80%. Compare the conditions in 1967 with those in 1966.
programme drawn up jointly by agro-meteorologists and plant pathologists and carried out over a number of years.

XI. AACKNOWLEGMENT

Dr. L. A. Ramdas, Emeritus Scientist, National Physical Laboratory, Delhi, very kindly went through the manuscript of this article and offered constructive criticisms for which the author is indebted to him. The author had also the benefit of useful discussions with Dr. N. V. Sundaram, Plant-pathologist at the Indian Agricultural Research Institute, New Delhi, for which he would express his sincere thanks. The author is grateful to the Director-General of Observatories, New Delhi, for according permission for using the meteorological data of the observatories at New Delhi and for providing other facilities for this investigation.


ADRENERGIC RECEPTOR(S) AND CALCIUM

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The nature of the adrenergic receptor(s) has been the subject of intense study particularly since Ahlquist's classification of these into α- and β-types. Based on the available data Belleau suggested a model of the α- and β-receptors and the mode of their interaction with catecholamines and related compounds. In a recent paper he has elaborated his earlier ideas to take into account new data.

We wish, herein, to deal with an aspect not emphasised earlier and which appears to us as of considerable importance in the further understanding of the subject. The role of calcium ions in adrenergic activity is well known and Belleau has in fact taken this factor into consideration while elaborating his picture of interaction with the α-receptor. However, he has not discussed its role with regard to the β-activity, though data are not lacking on the importance of calcium ions in β-adrenergic activity. In this context the recent interesting observations of Naylor on the influence of adrenaline and some adrenergic blocking drugs on the 'lipid facilitated transport' of calcium ions deserve careful consideration. Naylor found that lipids extracted from microsomal and mitochondrial fractions of the hearts of rabbit, guinea-pig and other animals facilitated transport of calcium ions from the Ringer's solution into a lipid solvent phase. This transport was inhibited by the addition of pronethalol (I) and propranolol (II), the two typical β-adrenergic blocking agents to the Ringer's solution, whereas it was potentiated by the addition of adrenaline (III) and nor-adrenaline (IV) and not altered by the addition of tyramine (V).

An interpretation of the above data is the following and could lead to interesting correlations. From Naylor's data, it may be inferred that the adrenergic blocking drugs as well as adrenaline and nor-adrenaline are able to bind calcium, whereas tyramine is unable to do so, and this appears more probable as the drugs under study were added to the Ringer's solution containing calcium prior to extraction with the lipid. Under the experimental conditions interaction of the drugs with the lipid as the primary process is unlikely. Further the calcium-pronethalol/propranolol combination is obviously lipid insoluble, thus keeping down the calcium in the aqueous phase in contrast to the calcium-catecholamine combination which is lipid soluble. The capacity of these compounds to bind calcium can be traced to the presence of an alcoholic hydroxyl, which is absent in tyramine. On the other hand, it is likely that the catechol group in adrenaline and nor-adrenaline enables their complexes to link on to appropriate polar functions in the bio-lipids and thus get transported to the lipid phase. The absence of such a functional group in the β-blocking drugs would then explain...