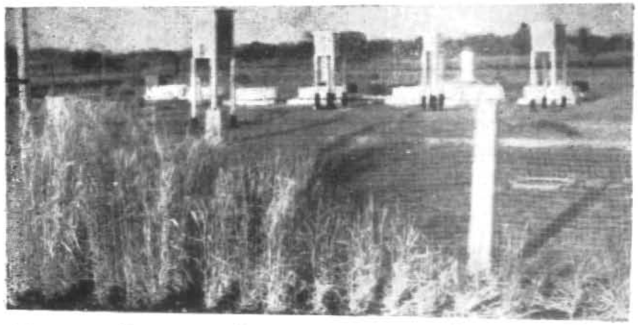

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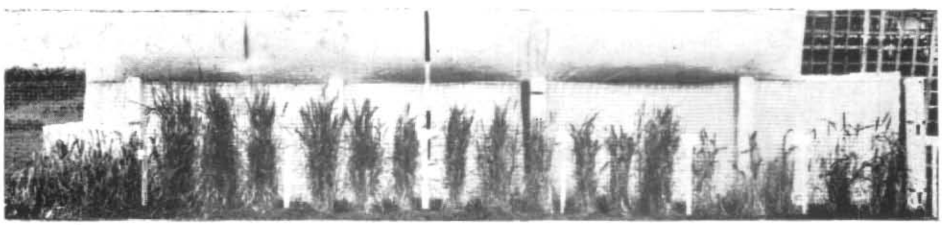

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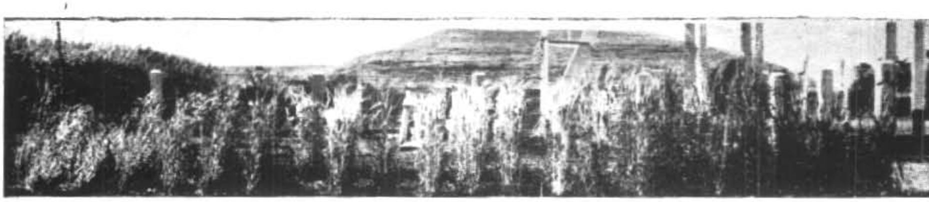

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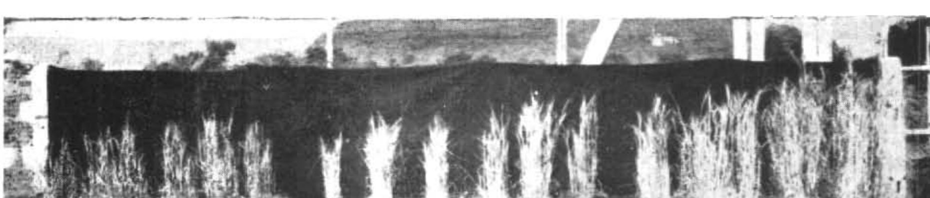

46 11-1-54 | 45 28-12-53 | 44 14-12-53 | 43 30-11-53 | 42 16-11-53 | 41 2-11-53

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Flowering of Wheat in relation to air temperature

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(*Received 20 March 1955*)

1. Introduction

In order to study the effects of air temperature on the flowering of the wheat crop, an experiment was conducted at the Central Agricultural Meteorological Observatory at Poona from 1952-54. The results obtained are presented and discussed in this note.

2. Material and method

A plot was marked out in the Central Agricultural Meteorological Observatory at Poona and prepared into a good seed bed, well manured with well rotten farmyard manure. Seeds of wheat, variety Niphad 4, which is grown extensively in Bombay Deccan, were sown in rows by hand dibbling. The sowings were done once every fortnight beginning with 21 April 1952. On each date of sowing three rows were sown, the rows being 1 ft apart. About 35 plants in each row (4 feet in length) were obtained. The photographic picture on the previous page shows the plants on different dates. Careful watch was maintained from the day after sowing and after the seedlings had come out, frequent light hand-irrigation was given so that deficiency of soil moisture was never allowed to become limiting. The following observations were recorded on the plants.

(*a*) *Height attained by the plants*

After the flag leaf was put forth, height was measured from the ground surface upto the base of the flag leaf of the tallest shoot of each plant. The average of these height values was treated as representing the height attained by the plants, for the particular date of sowing.

(*b*) *Date of flowering*

The date on which the first ear-head was found to have fully emerged was noted down as the date of flowering.

(*c*) *Yield of grain*

Finally, the total yield of grain as well as the total number of tillers for all the plants of each date of sowing was recorded. The yield per tiller was then obtained so as to eliminate the effect of tillering on the yield.

All the above 3 items of observations were made separately for each of the different sowings.

At the Central Agricultural Meteorological Observatory at Poona, a complete and detailed record of all climatic factors are being maintained on a routine basis. These meteorological records were utilised for the purpose of the present investigation.

3. Results and discussions

Table 1 gives the dates of sowing as well as the height attained, the date of flowering and the yield, corresponding to each date of sowing.

It appears from Table 1 that (*a*) from the point of veiw of height attained as well as the yield of grain, the year 1952 was somewhat more favourable than the year 1953, (*b*) there is an indication that broadly speaking, longer vegetative growth period (days from sowing to flowering) is conducive to greater height as well as higher yield of grain and (*c*) the optimum time of sowing from the point of view of yield of grain, is somewhere between October and November, *i.e.*, to say, the traditional period of sowing wheat during October in the Deccan appears to be fully justified.

However, the most striking feature of Table 1 is that under the climatic conditions at Poona, Niphad 4 wheat can flower at any time during the year. In other words, at no time during the year, the climatic factors at Poona are such as to become limiting for the flowering of Niphad 4 wheat.

The extreme variation in the air temperature under which flowering has taken place will be seen from Table 2 which gives the mean daily values, for the period from sowing to flowering of (*a*) maximum temperature, (*b*) minimum temperature, (*c*) average temperature $\left(\frac{\text{maximum} + \text{minimum}}{2}\right)$ and (*d*) the diurnal range of temperature (maximum—minimum).

It will be seen from Table 2 that the variations in the mean daily values, under which flowering has taken place are as follows—

Maximum temperature	= 100·3 to 78·1°F
Minimum temperature	= 74·9 to 47·9°F
Average temperature	= 87·1 to 66·7°F
Diurnal range of temperature	= 38·3 to 9·1°F

It is clear, therefore, that the flowering of Niphad 4 wheat can take place under widely varying temperature conditions.

The correlations between the number of days from the date of sowing to the date of flowering, *i.e.*, the time taken from flowering and (*i*) the maximum, (*ii*) the minimum, (*iii*) the average and (*iv*) the diurnal range of temperature were next worked out. The values obtained are given in Table 3.

There are 53 pairs and for significance at 1 per cent level, the value of correlation co-efficient has to be ·354 (Snedecor 1946). Hence, it is seen that the time required for flowering is very highly correlated with the mean daily minimum temperature, the mean daily average temperature and the mean daily diurnal range of temperature during the vegetative period (sowing to flowering) while no such correlation exists in the case of mean daily maximum temperature. Further, the correlations with the minimum and the average temperatures are negative while that with the diurnal range positive. In other words, greater the minimum and/or the average temperatures, earlier is the flowering, while greater the diurnal range, later the flowering. However, the average temperature and the diurnal range of temperature values are dependent to some extent on the minimum temperature. For, if there is no change in the maximum temperature, a decrease in the minimum temperature will decrease the average temperature but increase the diurnal range and *vice versa*. Figs. 1 and 2 are dot diagrams showing the relationships between the minimum and the average and the minimum and the diurnal range of temperature respectively. In both cases, fairly strong correlation is noticed, positive between minimum and average and negative between minimum and diurnal range. It appears, therefore, that minimum temperature is the important factor in determining the time taken for flowering. This point was further confirmed by working out the partial correlations of the first order. The partial correlations between time taken for flowering (F), the minimum temperature (N), the maximum temperature (X), the average temperature (A) and the diurnal range of temperature (R) are given in Table 4.

For significance at 1 and 5 per cent levels the values have to be ·354 and ·273 respectively (Snedecor 1946). As will be seen from Table 4, all the values under the minimum temperature (N) are not significant even at 5 per cent level. On the other hand, all the partial correlations of rFN on the other three factors are highly significant. In other words, this shows that if the minimum temperature is not operating, the other factors do not show any correlation with the time taken for flowering. This confirms the statement made above that

TABLE 1

Number of sowing	Date of sowing	Date of flowering	Number of days from sowing to flowering	Height attained (cm)	Grain yield per culm (gm)
1	21-4-1952	8-6-1952	48	41·0	Not determined
2	5-5-1952	21-6-1952	47	54·0	,,
3	19-5-1952	30-6-1952	42	46·6	,,
4	2-6-1952	11-7-1952	39	41·0	·49
5	16-6-1952	23-7-1952	37	54·0	·35
6	30-6-1952	10-8-1952	41	46·6	·26
7	14-7-1952	28-8-1952	46	31·5	·24
8	28-7-1952	4-9-1952	38	39·0	·54
9	11-8-1952	22-9-1952	42	49·4	·46
10	25-8-1952	7-10-1952	43	52·6	·38
11	8-9-1952	27-10-1952	50	42·8	·92
12	22-9-1952	20-11-1952	59	65·9	1·44
13	6-10-1952	30-11-1952	55	73·9	1·16
14	20-10-1952	17-12-1952	58	76·6	1·34
15	3-11-1952	30-12-1952	57	79·5	1·23
16	17-11-1952	12-1-1953	56	62·3	·96
17	1-12-1952	25-1-1953	56	81·0	1·09
18	15-12-1952	9-2-1953	56	69·0	·66
19	29-12-1952	21-2-1953	54	51·7	·37
20	12-1-1953	6-3-1953	53	31·4	·02
21	26-1-1953	12-3-1953	45	19·8	·009
22	9-2-1953	27-3-1953	46	24·4	·08
23	23-2-1953	12-4-1953	48	32·0	·03
24	9-3-1953	26-4-1953	48	24·4	·09
25	23-3-1953	6-5-1953	44	24·0	·04
26	6-4-1953	17-5-1953	41	25·0	·11
27	20-4-1953	4-6-1953	45	26·0	·34
28	4-5-1953	14-6-1953	41	34·0	·21
29	18-5-1953	27-6-1953	40	44·0	·44
30	1-6-1953	12-7-1953	41	47·4	·51
31	15-6-1953	25-7-1953	40	47·8	·60
32	29-6-1953	5-8-1953	37	56·6	·63
33	13-7-1953	24-8-1953	42	43·5	·41
34	27-7-1953	9-9-1953	44	46·0	·74
35	10-8-1953	21-9-1953	42	46·9	·55
36	24-8-1953	12-10-1953	49	46·2	·55
37	7-9-1953	26-10-1953	49	51·3	·69
38	21-9-1953	4-11-1953	44	52·3	·73
39	5-10-1953	21-11-1953	47	58·6	·77
40	19-10-1953	8-12-1953	50	56·5	·71
41	2-11-1953	28-12-1953	57	57·1	·71
42	16-11-1953	19-1-1954	64	46·7	·42
43	30-11-1953	28-1-1954	59	39·7	·45
44	14-12-1953	10-2-1954	58	35·2	*
45	28-12-1953	20-2-1954	53	31·7	*
46	11-1-1954	8-3-1954	55	30·1	*

* A severe hailstorm on 16-3-1954 damaged the plants in grain stage and there was no yield of grain

TABLE 1 (*contd*)

Number of sowing	Date of sowing	Date of flowering	Number of days from sowing to flowering	Height attained (cm)	Grain yield per culm (gm)
47	25-1-1954	24-3-1954	58	27·0	†
48	8-2-1954	29-3-1954	49	25·1	†
49	22-2-1954	12-4-1954	49	21·1	†
50	8-3-1954	28-4-1954	50	22·1	Yield not determined
51	22-3-1954	7-5-1954	46	19·0	,,
52	5-4-1954	19-5-1954	44	23·5	,,
53	19-4-1954	29-5-1954	40	24·0	,,

† A severe hailstorm on 16-3-1954, damaged the plants in early vegetative stage and there was no yield of grain

TABLE 2

Number of sowing	Date of sowing	No. of days (sowing to flowering)	Temperature during the period, sowing to flowering, in °F: Mean daily minimum	Mean daily maximum	Mean daily average	Mean daily diurnal range
1	21-4-1952	48	72·78	98·54	85·66	25·76
2	5-5-1952	47	73·08	94·79	83·93	21·71
3	19-5-1952	42	73·23	90·30	81·77	17·07
4	2-6-1952	39	72·52	87·42	79·97	14·90
5	16-6-1952	37	72·15	84·67	78·41	12·52
6	30-6-1952	41	71·37	81·88	76·63	10·51
7	14-7-1952	46	69·01	78·07	73·54	9·05
8	28-7-1952	38	69·99	80·32	75·15	10·33
9	11-8-1952	42	68·18	82·52	75·35	14·33
10	25-8-1952	43	67·91	85·97	76·94	18·06
11	8-9-1952	50	66·07	86·16	76·11	20·09
12	22-9-1952	59	61·39	88·82	75·11	27·43
13	6-10-1952	55	56·85	88·82	72·59	31·47
14	20-10-1952	58	54·27	88·07	71·17	33·80
15	3-11-1952	57	52·63	87·14	69·89	34·51
16	17-11-1952	56	53·42	86·65	70·03	33·23
17	1-12-1952	56	52·61	84·55	68·58	31·95
18	15-12-1952	56	51·31	86·16	68·73	34·85
19	29-12-1952	54	51·54	87·68	69·61	36·14
20	12-1-1953	53	52·51	90·75	71·63	38·24
21	26-1-1953	45	55·67	93·83	74·75	38·16
22	9-2-1953	46	59·79	98·11	78·95	38·33
23	23-2-1953	48	63·58	99·12	81·35	35·54
24	9-3-1953	48	66·03	98·79	82·41	32·76
25	23-3-1953	44	68·34	98·49	83·41	30·15
26	6-4-1953	41	69·67	98·25	83·96	28·58
27	20-4-1953	45	70·62	99·30	84·96	28·68
28	4-5-1953	41	71·49	98·33	84·91	26·85
29	18-5-1953	40	74·90	94·33	84·61	19·43
30	1-6-1953	41	72·10	87·74	79·92	15·65

TABLE 2 (*contd*)

Number of sowing	Date of sowing	No. of days (sowing to flowering)	Temperature during the period, sowing to flowering, in °F: Mean daily minimum	Mean daily maximum	Mean daily average	Mean daily diurnal range
31	15-6-1953	40	71·52	82·58	77·05	11·06
32	29-6-1953	37	71·30	82·10	76·70	10·80
33	13-7-1953	42	71·24	81·74	76·49	10·49
34	27-7-1953	44	70·48	82·09	76·29	11·61
35	10-8-1953	42	69·67	83·33	76·50	13·67
36	24-8-1953	49	68·89	85·53	77·21	16·65
37	7-9-1953	49	67·86	86·68	77·27	18·82
38	21-9-1953	44	67·02	87·81	77·41	20·81
39	5-10-1953	47	62·00	88·44	75·22	26·44
40	19-10-1953	50	56·02	88·09	72·05	32·08
41	2-11-1953	57	49·35	85·43	67·39	37·14
42	16-11-1953	64	48·56	86·02	67·29	37·46
43	30-11-1953	59	47·85	85·64	66·75	37·62
44	14-12-1953	58	50·02	85·79	67·91	35·26
45	28-12-1953	53	53·15	89·14	71·15	35·99
46	11-1-1954	55	53·93	91·33	72·63	37·40
47	25-1-1954	58	57·31	92·35	74·83	35·04
48	8-2-1954	49	57·98	93·88	75·93	35·90
49	22-2-1954	49	60·60	95·34	77·97	34·73
50	8-3-1954	50	66·71	99·19	82·95	32·47
51	22-3-1954	46	67·27	98·43	82·85	31·16
52	5-4-1954	44	70·20	100·29	85·25	30·09
53	19-4-1954	40	74·44	99·80	87·12	25·36

TABLE 3

	Max. temp.	Min. temp.	Av. temp.	Diurnal range of temp.
Number of days from sowing to flowering	—·05	—·84	—·69	+·72

TABLE 4

	N	*X*	*A*	*R*
rFN	—	—·83	—·66	—·64
rFX	+·15	—	+·74	—·71
rFA	+·09	—·87	—	—·71
rFR	+·23	+·87	+·74	—

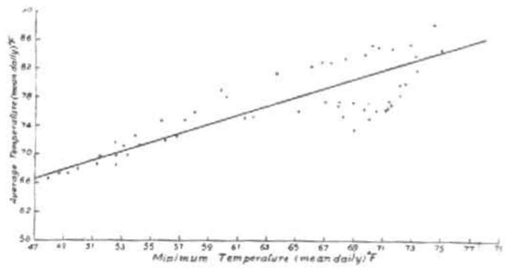

Fig. 1

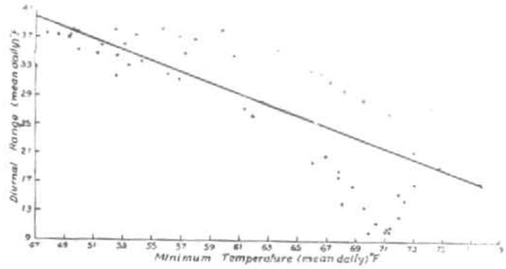

Fig. 2

the minimum temperature is primarily responsible in determining the length of the vegetative phase or the time taken for flowering.

4. Conclusions

It has been shown that in the case of Niphad 4 wheat (*a*) for the purposes of yield of grain in the optimum period of sowing in the Deccan area is somewhere between October and November, which is the local practice, (*b*) the temperature requirements for the flowering are not critical and flowering can take place under widely varying temperature conditions and (*c*) the mean daily values of minimum, average and diurnal range of temperature during the period from sowing to flowering, are strongly correlated with the time taken for flowering, while the maximum temperature does not show any such correlation. Further, the correlations with both the minimum and the average temperatures are negative while that with the diurnal range of temperature is positive.

However, the most important finding is that minimum temperature is primarily responsible in determining the length of the vegetative phase, *i.e.*, the time taken for flowering. Warmer winter nights tend to induce early flowering, while cooler winter nights tend to delay the flowering by prolonging the vegetative period.

Attempts are being made to verify the results in the case of other varieties of the wheat crop.

5. Acknowledgement

The authors are thankful to Shri J.S. Teli of Agricultural Meteorological Division for help in conducting the experiments.

REFERENCE

Snedecor, G. W. 1946 *Statistial Methods*, p. 149, Table 7·3.