Project No. 2

Crop weather relation studies in *Kharif* Bajra

Objectives:

- To study the effect of weekly weather variables on crop yield
- Develop Crop yield prediction models using historical weather data and yield

Results:

1996

Crop and meteorological data were collected in a multi-date sown bajra crop. The data included observations on crop phonological stage occurrence, periodical dry matter accumulation and leaf area development as well as computations of growing degree days for both individual phenological stages and for crop growth period as a whole.

1997

Observations on variations in phenophase-wise meteorological parameters and moisture availability index were made during the course of the experiment. No ergot disease was noticed even under conditions of very late sowing during the month of August. This was ascribed to low relative humidity conditions during the early period of crop growth. At that juncture, no further data were available.

1998

The data collected from experimental records of the AICRP for Pearl millet for the period 1988 to 1994 and of the AICRP on Agrometeorology for the period 1995-1998 with respect to date of sowing, flowering-time and crop yield, and corresponding weather data of Regional Research Station, Bijapur were analyzed for correlation coefficients between agrometeorological variables in different weeks after sowing and the bajra grain yield (Table 2.1) and inferences were made.

The final yield was adversely influenced by higher moisture availability during 2-3 WAS, but favorably by higher maximum temperature during 3-4 WAS, while rainfall during 9 WAS and later was favorable for higher yield.

Table 2.1 Correlation coefficient between agrometeorological variables in crop growth period and final grain yield of bajra

WAS	Rainfall	Max. Temp.	Min. Temp.	MAI
1	0.0	-0.35	-0.46	0.10
2	-0.36	0.17	-0.39	-0.49
3	-0.30	0.52*	-0.40	-0.50 *
4	0.17	0.49	-0.36	0.06
5	0.11	0.23	-0.35	0.43
6	-0.43	-0.11	-0.33	-0.30
7	-0.31	-0.22	-0.32	-0.22
8	0.12	-0.19	-0.12	0.22
9	0.68*	-0.26	0.19	0.12
10	0.33	-0.21	0.22	0.39
11	0.44	-0.66*	0.18	0.56*
12	0.54*	-0.70*	0.22	0.53*

1999

The conditions indicated by the analysis of 1998 were tested by tabulating the temporal profiles of various meteorological conditions under different growing environments. Similar profiles were noticed in relation to the final grain yield. Higher grain yield was obtained in growing environments with higher maximum temperature during 2-4 WAS and higher rainfall during 9-11 WAS. The condition that lower moisture availability during 2-3 WAS also was satisfied. Thus the results of 1998 were vindicated.

2000

The dry matter partitioning components of *Kharif* Bajra were analyzed as response to the agrometeorological variations, particularly the soil moisture. The earliest sown crop experienced extreme moisture stress (Soil moisture < 10%) during the earhead emergence period, which drastically reduced the partitioning of dry matter to earhead, and its development could not be revived even with sufficient moisture conditions later on. On the other hand, favorable moisture conditions (>15%) during the earhead emergence period enhanced the contribution to earhead considerably, as in case of crop sown one month later. Occurrence of mild stress later on did not affect the partitioning factor, whereas favorable soil moisture conditions only boosted the yield, even in case of late sown crop.

2001

In an extreme condition of delayed onset of monsoon, the Bajra crop could be sown only in the month of August, which is at least a fortnight beyond the recommended sowing window. Yet, the crop provided high yield. Normally, bajra sown in August yields only about 20 to 30 per cent of the crop sown in June. However, this year, the yield of crop sown in August was comparable to that of the crop sown in June in other years. The results of the report of 1998 were recollected and the present situation was analyzed keeping that in view. It had been reported then that higher maximum temperature during 3-4 WAS favored higher bajra yield. Comparison of maximum temperature of June-July 2000, August-September of both 2000 and 2001 was graphically made on weekly basis (Fig 2.1), and it was noticed that the maximum temperature of August was indeed higher in 2001 by about two degrees, and it was also on par with that of June in 2000. This supported the earlier results, and also initiated agronomic inferences practices based on agrometeorological results.

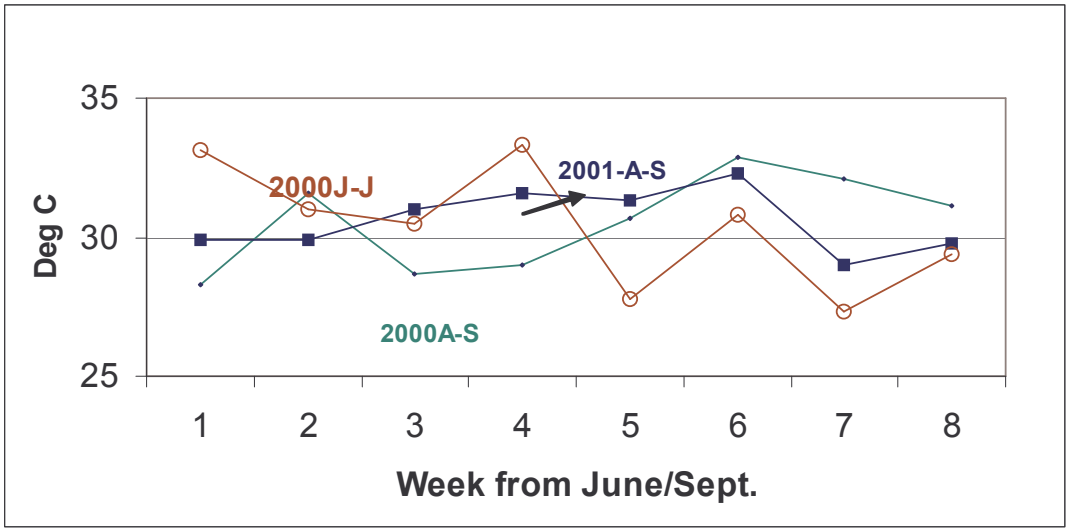

Fig 2.1 Maximum temperature profiles during bajra seasons of 2000 and 2001

2002

Yield prediction models for two diverse Bajra genotypes

Yield data of ten years from the experiments of AICRP on Pearl Millet and AICRP on Agrometeorology were considered for analysis. Correlation and regression analysis were performed between the yield of bajra genotypes Cv. MH-179 (a hybrid) and Cv. WC-C75 (variety) and their corresponding meteorological conditions during different weeks after sowing. Variables with significant associations were selected for stepwise regression analysis individually for the two cultivars.

The models developed are presented hereunder.

1) MH-179:

$Y = -8430.75 + 327.9\ MaxT(3) - 8.90\ RF(6,7)$ …….$R^2 = 0.72$

2) WC-C75:

$Y = -2912.15 + 126.34\ MaxT(3) - 2.09\ RF(2) + 4.65\ RF(9,10)$ …….$R^2 = 0.69$

The numbers in the parentheses indicate the week after sowing.

These models clearly indicate the differential response of cultivars to the prevailing weather conditions.

It is once again clear that, whichever is the cultivar, the maximum temperature during 3rd and 4th weeks after sowing is an important variable for yield determination,. Also, the other parameter, which determines the yield, is rainfall. The timing of sensitivity is different for the two genotypes, which may have to do more with whether the genotype is of short duration or long duration.

2003

For the third successive year, the Station received poor rainfall till July. The sowing of bajra crop could be performed only on Aug 7, 2003. This provided an opportunity for reiterating the hypothesis of this Scientist that in case of delayed onset of monsoon, the crop would yield higher even if sown in the month of August.

Through a series of graphical presentations (Fig 2. 2 - Fig 2.5) covering the data of six years of experimentation, this Scientist proposed and proved that:

- The yield of bajra was very much dependent on maximum temperature during the third and fourth weeks after sowing
- Maximum temperature higher than 31 C during this period was highly favorable
- Highest yield of bajra is recorded in growing environments of maximum temperature greater than 31 C in both third and fourth weeks after sowing. If temperature is above 31 C in only one of the weeks (3rd or 4th), the yield levels are moderate. The yield levels are poor if maximum temperature is less than 31 C in both the weeks concerned.
- In years of low rainfall during June and July, the maximum temperature remained high in the month of August
- Therefore, in such years the grain yield of bajra becomes higher than normal under delayed sown conditions
- In view of higher temperature, and low relative humidity, the ergot disease does not come into play.
- The results finally paved way for a recommendation to the farming community as given below.
- In the eventuality of failure of rainfall till the recommended time of sowing, bajra sowing can be taken up till the first fortnight of August.

2004

Seven years' data (1998-2004) of yield and weather variables during the crop growing season have been analysed for development of multiple regression yield prediction model for the recommended and popular Bajra genotype ICTP-8203. The resultant correlation coefficients are presented in Table 2.2 and the developed model is as presented in Table 2.3. It is now clear that higher maximum temperature during the 3rd week after sowing is very important to get high yield in all varieties of Bajra. The other model parameters vary from one genotype to another.

Table 2.2 Correlation coefficients between *Kharif* Bajra yield and meteorological variables during crop growing period

Para meter	WAS											
	1	2	3	4	5	6	7	8	9	10	11	12
MAXT	0.37	-0.03	**0.46**	0.33	0.15	-0.50	-0.28	0.10	**-0.48**	-0.23	0.22	-0.18
MINT	0.08	-0.07	-0.01	0.17	0.24	0.28	0.15	0.31	0.03	0.08	0.22	0.28
VP1	-0.10	0.11	0.24	0.46	0.24	0.11	-0.08	0.25	-0.09	0.11	0.10	0.20
VP2	-0.11	-0.14	0.16	0.24	0.09	0.20	0.11	0.27	0.04	0.19	-0.02	0.16
RH1	-0.23	-0.16	0.01	0.06	0.09	0.09	0.07	0.28	0.32	0.18	0.09	0.30
RH2	-0.20	-0.03	0.00	0.05	0.05	0.28	0.24	0.34	0.28	0.21	-0.13	0.22
TR	0.18	0.00	0.26	0.17	0.04	-0.45	-0.33	-0.10	-0.42	-0.31	0.02	-0.38
CBSS	0.21	-0.02	0.26	0.27	0.37	-0.23	-0.25	-0.26	-0.08	-0.24	0.04	-0.29
RF	-0.31	-0.11	0.14	0.28	0.28	-0.18	-0.17	-0.33	-0.17	-0.25	-0.23	-0.02
CC1	-0.04	0.06	-0.18	-0.11	0.16	0.47	0.41	0.49	0.47	0.44	0.17	0.37
CC2	-0.19	-0.06	-0.08	-0.13	0.18	0.50	0.49	**0.62**	**0.63**	0.49	0.30	0.59
EVP	0.29	0.09	0.28	0.33	0.09	-0.23	0.03	0.28	-0.39	-0.20	0.45	-0.06
GDD	0.22	-0.01	0.22	0.28	0.20	-0.20	-0.20	0.18	-0.36	-0.23	0.26	0.11

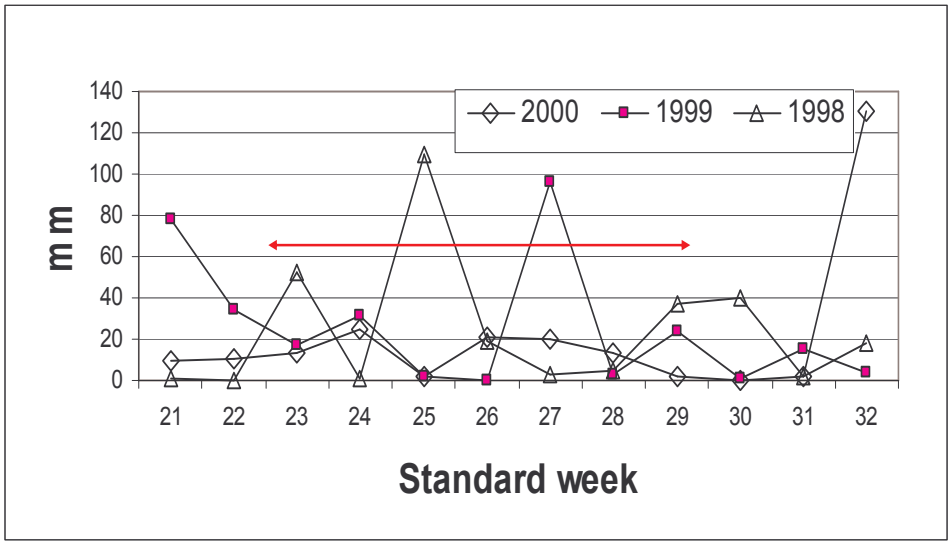

Fig 2.2 Weekly Rainfall during years with good rainfall in June and July

Good Rainfall during June-July (Fig 2.2) results in drop in Maximum Temperature during August (Fig 2.3)

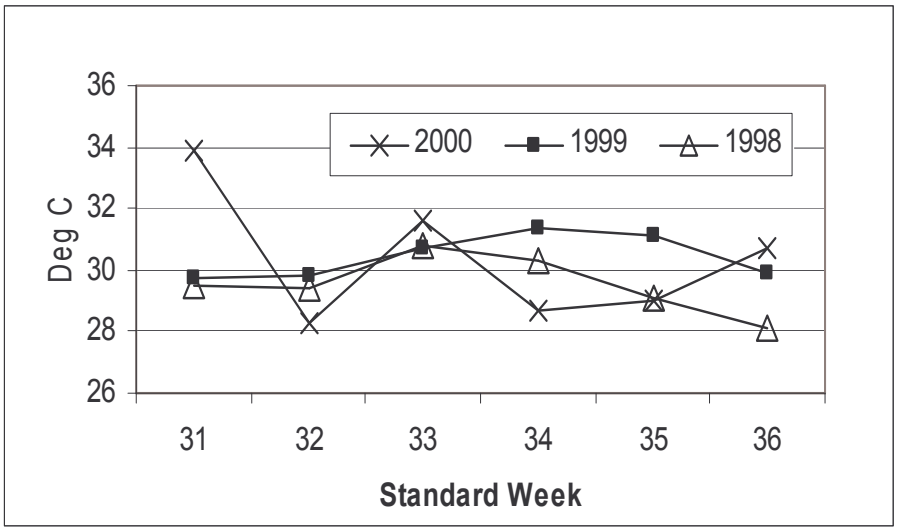

Fig 2.3 Temperature during August in years of good rainfall in June and July

Table 2.3 Yield of bajra sown in August during years of good rainfall in June and July

Year	1998	1999	2000
Yield (Kg/ha)	216	347	205

- Temperature less than 31Deg C in 3-4 WAS, caused by high rainfall in June and July resulted in low yield

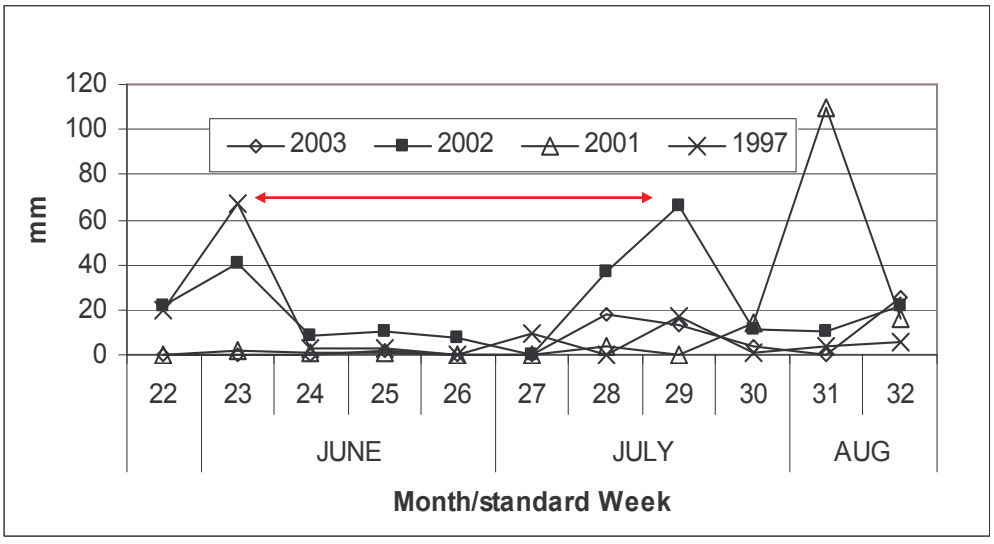

Fig 2.4 Years with Poor rainfall in June and July

- Poor rainfall during June-July (Fig 2.4) resulted in drop in tmaximum temperature during August (Fig 2.5)

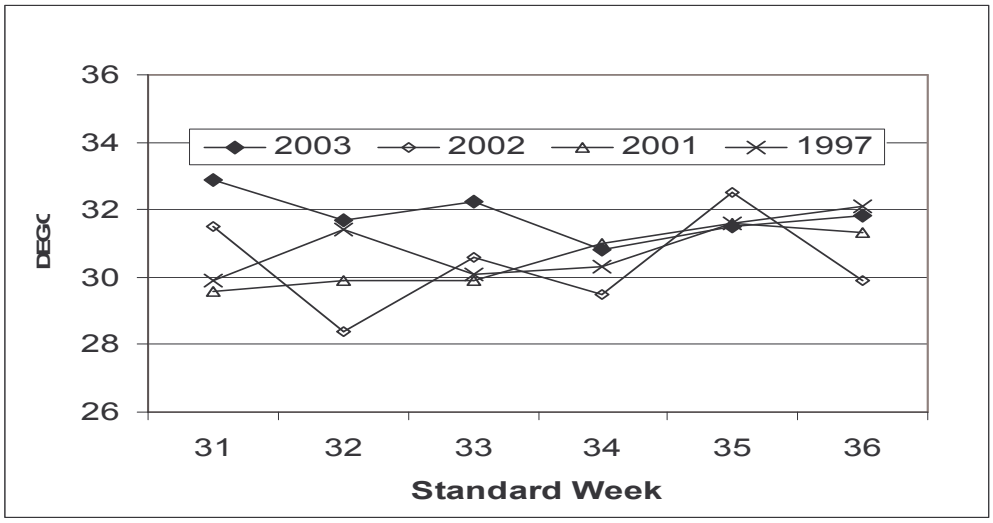

Fig 2.5 Temperature during August in years of poor rainfall in June and July

Table 2.4 Yield of bajra sown in August during years of poor rainfall in June and July

Year	1997	2001	2002	2003
Yield (Kg/ha)	646	1037	768	1002

- Temperature more than 31Deg C in 3-4 WAS, caused by poor rainfall in June and July resulted in high yield of bajra (at least 60% of June sown crop in normal year)

Table 2.5. Yield Model for Bajra Genotype ICTP-8203

Cultivar	Model	R^2
ICTP-8203	Y= 47.4 TX3 - 110.6 TX6 + 233.7 CC2(8) + 236.0 CC2(9) + 207.4	0.66

[TX3= Maximum Temperature in WAS-3; TX6= Maximum Temperature in WAS-6; CC2(8)= Afternoon cloud cover in WAS-8; CC2(9)= Afternoon cloud cover in WAS-9]

Thus the results of the experimentation on crop weather relations of *Kharif* Bajra provided outputs such as i) Development of yield models on genotype basis as well as in combination, ii) Identifying higher maximum temperature (>31 C) during 3rd and 4th weeks after sowing as the most critical parameter for obtaining higher bajra yield and iii) Evolving a contingency package of practice for delayed sowing of bajra in years of poor rainfall during June and July.