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Agrometeorological Aspects of Crop Production in Temperate Kashmir

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In our recent article on forecasting uncertain weather over temperate Kashmir (India) (*Drought Network News*, Vol. 9, No. 1, pp. 12–14), we tried to characterize the crop-growing environments by giving long-term means of various agrometeorological parameters (such as air temperature, relative humidity, precipitation, and hours of bright sunshine). Forecast analysis for changes in temperature and precipitation events indicated an overall reliability of about 50%. Changes in minimum temperature could be forecasted relatively more accurately than changes in maximum temperature. Precipitation events were more uncertain during summer (May to October), which happens to be an important season from the standpoint of crop production.

The present article focuses on the variability of Kashmir weather and its possible impact on summer and winter crops of the region. Historical weather data has been analyzed on a "weekly/monthly mean" basis to depict the ranges between which they might have fluctuated. The analysis is based on calculation of standard deviations. Results of one such analysis are depicted in Figure 1, which shows substantial variability in all weather elements. With the exception of one or two months, the parameters of precipitation and weekly duration of sunshine are quite inconsistent. A similar graph (Figure 2) has been prepared on a weekly mean basis wherein the means of air temperature (maximum and minimum) and weekly totals of precipitation/sunshine hours are depicted. The phenological stages of some important crops have also been worked out.

Figure 2 also shows the "gallery" formed after plotting values of the "mean ± standard deviations." The width of the gallery or path is directly proportional to the fluctuation observed in the past. The wider the path/gallery, the more variable the particular weather element. In the case of air temperature, we observed the width of path to be comparatively narrower for minimum temperatures. From this it can be assumed that changes in maximum temperatures over the growing season are more variable compared to changes in minimum temperatures. Maximum temperatures could become a decisive factor in crop production over temperate Kashmir. But the results of forecast analysis, wherein we had clearly indicated greater reliability in predicting changes in *minimum* temperatures, show that reliably forecasting changes

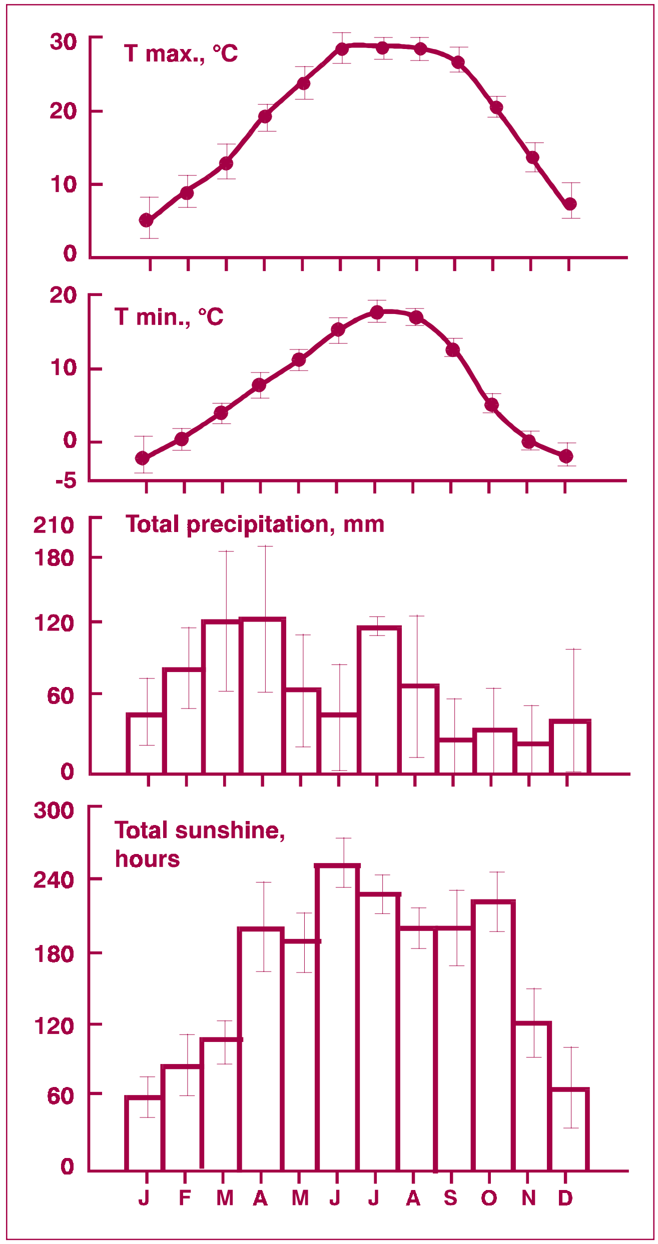

Figure 1. Monthly variability of weather, 1980–96.

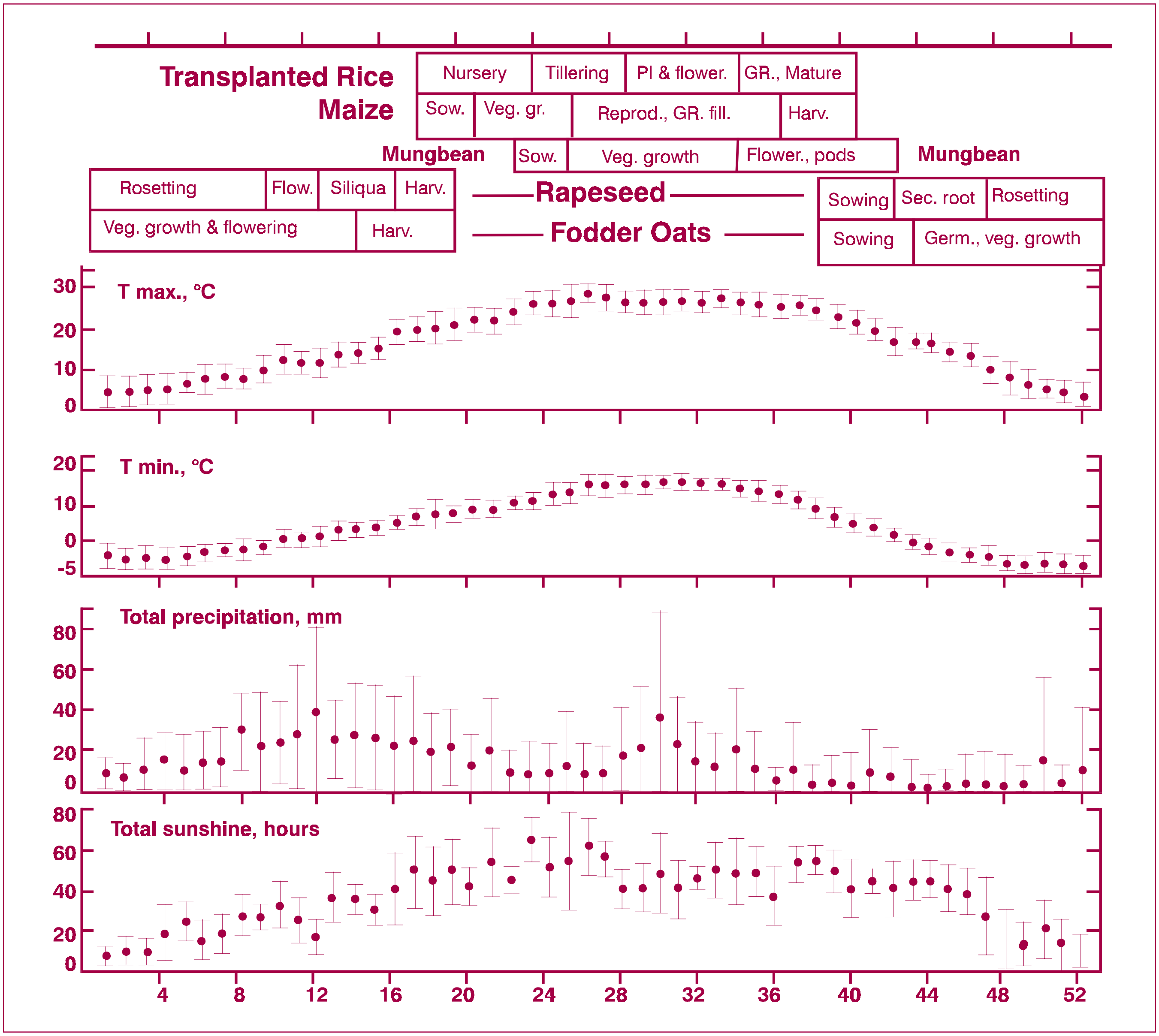

Figure 2. Crop weather relationships under variable conditions, 1980–96.

in *maximum* temperatures is a problem that remains to be tackled. In addition, a lot of fluctuation also exists for the remaining parameters (in particular, precipitation and sunshine hours), as is evident from the width of the gallery (Figure 2).

Active tillering and panicle initiation (PI) are critical crop-growth stages for rice. These stages fall between the 27th and 32nd meteorological weeks (Figure 2). Weather elements during this time period are quite unpredictable and variable and thus are likely to affect rice yields in temperate Kashmir.

Rapeseed and oats are winter season crops (October to May). The optimum seeding time for these crops is between the 38th and 43rd meteorological weeks (i.e., mid-September to the end of October). It is an established fact that winter tolerance of these two crops depends to a large extent on the amount of growth that takes place just before the onset of severe winter weather. Our crop weather calendar (Figure 2) shows a steep fall in mean temperatures from October on. A crop sown during the 38th to 43rd meteorological weeks that has gained sufficient growth will definitely be able to withstand the adversities of forthcoming winters (low-temperature tolerance).

As the winter season advances and spring arrives (March–April), temperatures increase. We observed continuous rains with significant variability (Figure 1). This period coincides with reactivation of winter crops, resulting in vegetative and reproductive growth. Top dressing and intercultural operations are performed. At this point, especially between the 10th and 19th meteorological weeks, rainfall variability adversely affects both vegetative and reproductive growth of the rapeseed crop and, at times, harvesting and threshing operations.

The weather of the region, with all its ramifications, severely limits agricultural choices. Summer crops suffer from uncertainties in temperature and rainfall while winter crops suffer losses due to low temperatures and weather-induced delays in cultural operations. The typical temperate climate of our region gives little opportunity for adjustments through variation in sowing dates. Delayed sowing has resulted in yield reductions of 50%.

Solving climate-related problems requires a lot of research and many developmental efforts in some important areas. The approaches should be interdisciplinary in nature and may encompass some of the following:

- Characterization of climate using historical weather data, and then evolving response farming strategies.
- Establishment of a data base management system for recording, retrieval, and analysis of weather data.
- Probability analysis of various weather elements (such as rainfall and temperature) will provide information to help crops withstand adversity at critical growth stages.
- Preparation of crop-weather calendars incorporating such information as agronomic practices and disease and pest occurrence under normal and late planting conditions. This will also help in forecasting pest/disease outbreaks and taking remedial measures.
- Use of standard models for crop-growth modeling in which both conventional and remotely sensed data can be used.
- Evolvement and strengthening of "Agrometeorological Field Advisory Units" (AMFUs) for advising farmers on their day-to-day agricultural operations.

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