

Tackling of heat stress to sustain crop productivity



**CENTRE FOR WATER RESOURCES
DEVELOPMENT AND MANAGEMENT
(KSCSTE-CWRDM)**

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Climate change is drastically affecting sustainable crop production globally. Extreme weather events, especially temperature and rainfall fluctuations, are threatening the cultivation of field crops in many regions of the world, endangering food security. High temperature is one of the most recurrent forms of abiotic stresses and recently there were few reports on high temperature recorded than the normal in few parts of Kerala. In this regard, CWRDM has carried out an analysis for understanding the temperature trend and found that it is showing an increasing trend and the mean annual temperature increased by 0.650 C and the IMD data for the months of January and February, 2023 showed higher anomaly of 1.60 C for Alappuzha and out of 14 districts, 7 districts showed an increase in the temperature for the last two months.

In addition to this, temperature for March, April, and May 2023 were also predicted using SARIMA model. Results showed that the predicted temperature for March and April 2023 is slightly higher, while the predicted temperature for May 2023 is slightly lower than the reference temperature (Long term average). However, all the predicted values fall within the confidence intervals, indicating that there is still some uncertainty in the forecasts. Overall, the analysis showed that a clear trend of increasing temperatures was found across all months. This trend indicates that temperatures are likely to continue rising in the future. This information suggests that we should be prepared for even warmer temperatures in the coming months and years.

Drought condition using SPEI, NDVI and EVI drought index

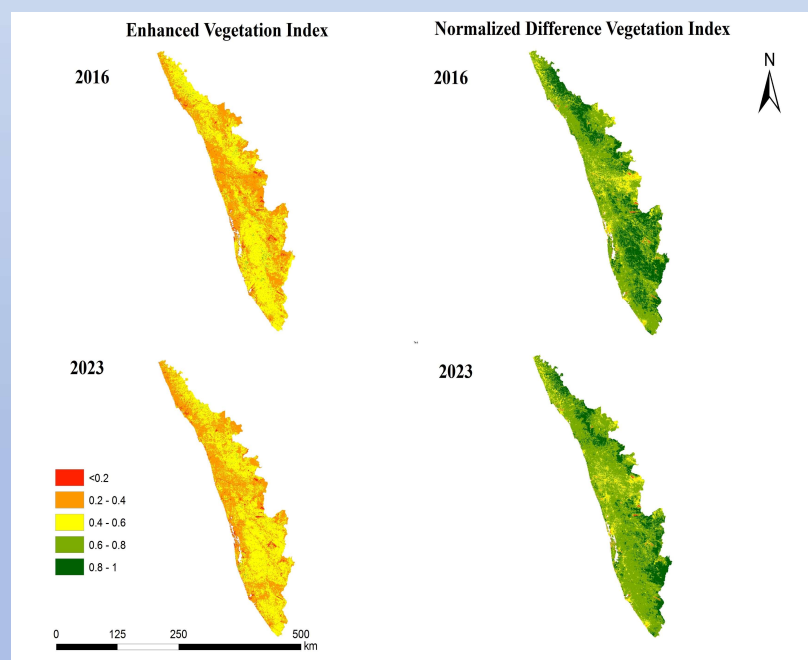
By considering the above points, CWRDM attempted to predict the drought conditions for Kozhikode district using different indices such as Standard Precipitation Evapotranspiration Index (SPEI), Normalized Difference Vegetation Index (NDVI) and enhanced vegetation index (EVI).

The forecasted results showed that there is a possibility of mild to moderate drought conditions (Table). The point forecast for SPEI in March is -0.225, which is below the normal range of -1 to 1, indicating the presence of drought conditions. The lower and upper bounds of 95% prediction interval (-0.362 to -0.088) also suggest that the area may experience mild to moderate drought conditions during this period.

Table : Forecasted SPEI for Kozhikode using ARIMA model

	Point Forecast	Lo 95	Hi 95	
Mar 2023	-0.23	-0.36	-0.09	Mild to moderate drought conditions
Apr2023	-0.27	-0.46	-0.08	
May2023	-0.14	-0.35	0.08	

The forecast for SPEI in May is -0.139, which is close to 0, indicating that the area may experience normal conditions during this period, which seems to be positive. Low NDVI and EVI values indicate moisture-stressed vegetation and higher values indicate a higher density of green vegetation. NDVI and EVI results are compared for 2016 drought year with that of 2023. The results showed that some of the regions of Kerala, showed stressed vegetation and which will result in lower crop productivity.



Overall, based on the forecasted SPEI values and prediction intervals, EVI and NDVI, it can be concluded that the area may experience mild to moderate drought conditions in March and April, normal to mild drought conditions in May.

Effect on crop production

CWRDM experiments and modelling studies showed that for every 10 C rise in temperature, results in 6 to 14 % yield loss in crops such as paddy, amaranthus, cowpea. A sudden rise in temperature leads to enhanced grain maturity with significant reduction in the yield of crops. The increase in night-time temperature increases respiratory losses. Thus, creating an imbalance between source and sink and decrease in net photosynthesis. As a result of reduction in the grain formation period along with loss of carbohydrates in enhanced respiration under higher maximum and minimum temperatures. Proper grain development cannot take place, leading to shrivelling of grains and consequent reduced crop yields. High temperature can have a significant impact on spices and plantation crops, including: Reduced yield and quality: High temperature can reduce crop yield by affecting flower and fruit development, pollination, and seed production. It can also reduce the quality of the crops by affecting the colour, taste, and nutritional content of the produce. Overall, high temperature can have a complex and far-reaching impact on crops, affecting both yield and quality. It is important to implement strategies to mitigate the impact of high temperature, such as irrigation management, shade management, and crop selection.

Management Strategies

The following strategies should be adopted for protection of crops from heat stress.

- CWRDM studies showed that foliar spraying of 0.5 % of Muriate of Potash (KCl) + 0.5 % DAP will be effective to manage the stress and sustain the crop production.
- Mulching of coconut basin with coir pith, coconut husks, green leaves, dried leaves, organic wastes and dried coconut leaves during the fag end of north east monsoon resulted in sustaining the soil moisture and it is also advised that farmers now also can opt for mulching, by which irrigation intervals can be extended.

- Foliar spray of antitranspirants such as Kaolin and Lime are found to be responsive in Kerala conditions since they act as reflectant and protect the crop.
- Results from CWRDM experiments showed that application of organic manures, and use of biofertilizers such as Pink Pigmented Facultative Methnaotrops (PPFM), Pseudomonas, Azospirillum and Rhizobacteria for reducing the water stress of the plants.
- Reduction of irrigation water demand by proper planning viz., irrigation scheduling with deficit irrigation, early sowing of variety, uniform way of planting in group approach, laser land levelling, mulching etc. Switching to less water demanding crops as well as drought tolerant varieties.
- Use of kitchen/ domestic wastewater for irrigation, using proper filtration systems, where ever feasible can be attempted
- CWRDM results suggest that adoption of micro irrigation (Drip, sprinkler and Wick irrigation) resulted in improvement of water use efficiency of crops by 32.0 to 41.0 % than conventional irrigation and yield improvement was also noticed in different crops.

Few of the general suggestions are

- Provide light irrigation to the crop as maintaining adequate soil moisture is crucial to minimize heat stress. Providing water during early morning or evening is desirable to avoid evaporation losses or minimise losses due to high wind speed during day time.
- Time of sowing of the crops should be adjusted in such way that growth stages most sensitive to high temperature do not coincide with the period of heat stress.
- Fertilizers should not be applied to the crop during a high temperature unless there is adequate availability of moisture, otherwise they can have a detrimental effect on the crops.

- Use of crop residue and mulch application should be practiced to improve moisture status of the soil.
- Realign crop calendar and cropping pattern with the changing pattern of rainfall and other climatic parameters.
- The farmers are advised to follow these suggestions to sustain the crop productivity and also to mitigate the negative impacts of high temperature

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