EFFECT OF FLOOD IN WESTERN MAHARASHTRA ON PRODUCTION AND PROFITABILITY OF SUGARCANE

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Long term effects of climate change like heavy precipitation, heat waves, and intense droughts always affect agricultural sector and agriculture related livelihood seriously. During July-August of 2019, when the unprecedented and extreme rainfall received in Western Maharashtra lead to severe water logging and flash floods in the Kolhapur, Sangli and Satara districts of the region that also damaged thousands of hectares of cultivated area. Farmers faced economic losses due to various kinds of crop damages. Sugarcane is the major cash crop grown in these districts in *kharif* season along with paddy, soybean, groundnut etc. This article is intended to showcase the adverse impacts of climate change and its repercussions on agriculture by highlighting the case of 'early arrowing' in sugarcane.

Maharashtra state is the second largest producer of Sugarcane in India after Uttar Pradesh and the state produces nearly 72.64 million tonnes of sugarcane from 9.02 lakh hectares area (DA&FW, 2018). Kolhapur, Sangli and Satara districts cultivate more than 30 percent of the total sugarcane grown in Maharashtra

and contribute significantly to the sugarcane production of the state.

SUGARCANE CROP DAMAGE IN THE FLOOD AFFECTED AREA OF WESTERN MAHARASHTRA

The unprecedented rainfall here caused complete rotting of sugarcane crops which were approximately six-month-old or younger. Initially, the continued water logging caused wilt and stunted leaves and further, with the infection of a quick spreading fungus the sugarcane leaves damaged completely. In addition, the yield of mature sugarcane crops dropped sharply due to early arrowing. Flowering in sugarcane crop is referred as 'arrowing' as the inflorescence or tassel of sugarcane is an open-branched panicle that looks like an arrow. When a sugarcane plant enters into the reproductive phase before normal flowering time, the phenomenon is called early flowering (Hunsigi, 2012). It was anticipated that sugarcane crop physiology might have significantly changed due to flood and as a consequence, early arrowing was observed here. Nearly 70-80 percent of the standing sugarcane crop was severely affected by the early arrowing disorder after the flood in western Maharashtra.

FLOWERING IN SUGARCANE CROP AND YIELD ATTRIBUTES

The pattern of flowering in sugarcane largely depends on the interactions of cultivar and environmental factors such as day length, temperature and planting season. For example, some sugarcane varieties can flower copiously in their natural environment but, may flower frugally when introduced to other new regions. Floral development in sugarcane is initiated by shortening day length. However, cool night temperatures, high day temperature and lack of soil moisture also interfere with flower initiation. Flower initiation causes the apical meristem to switch over from vegetative to reproductive development, which causes stalk elongation to cease and consequently affect the yield. Further, flowering restricts crop growth as it terminates the production of phytomeres (shoot segment of sugarcane that includes the internode and leaf along with the lower and upper nodes) at the apex of the main axis, leading to the poor utilization of intercepted radiation in terms of biomass accumulation. Other yield and quality attributes which get affected by early flowering include sucrose quality of cane juice, loss of apical dominance, enhanced auxiliary bud activity, proliferation of side shoot, and increase in the fiber content. Also, flowering response in sugarcane crop is affected by many other factors from varietal selection to post-harvest practices and even varying levels of available soil nutrients and microbial diversity.

CAUSES OF EARLY ARROWING IN SUGARCANE

Early Arrowing due to Water Logging: Early arrowing in sugarcane was observed across the Western Maharashtra after the floods. It has been observed that sugarcane crop growing along feeder canals and other areas with high moisture entered into early reproductive phase with more flowers setting than any other areas. On the other hand, flowering was less in poorly irrigated parts of the fields. Generally, most consistent and heaviest flowering occurs in the low land area which has lateritic subsoil. Well drained basalt soils have less flowering while gravelly or sandy soils usually flower least. It is widely admitted that these variations can be directly attributed to soil moisture status. Sugarcane growing in soils with a perched water table flower highest followed by soils with a good moisture-holding capacity whereas, in soils with inadequate moisture-holding capacity the crop flower least.

Early arrowing in sugarcane negatively affects the yield parameters and so leads to economic losses to the farmers. Besides, pithiness developed in the crop after flowering reduced the cane weight. Furthermore, occurrence of flower stocks in early growth stage of sugarcane crop decreased the tonnage of sugarcane.

Other Causes of Early Arrowing in Sugarcane: Besides high moisture level, early flowering in sugarcane can happen due to apparent flowering behaviour of different varieties, imbalanced land use pattern and improper trash management practices, age of standing crop, seasonal and regional variation, photoperiod, planting time and weather. Weather is one of the most important determining factors for the early flowering in sugarcane. For example, heavy rainfall in August and September favours early flowering. Higher rainfall and higher frequency of rainy days was one of the reasons of early flowering in Western Maharashtra during the *Kharif* season of 2019.

PREVENTIVE MEASURES AND REMEDIES FOR EARLY ARROWING IN SUGARCANE

A study conducted by Shanmugavadivu and Rao (2010) have found that removing leaf spindle once during the induction period reduces flowering intensity and delays the flowering. It is generally done in the first week of August. Generally, measures to avoid early arrowing in sugarcane include provision of balanced nutrients by avoiding water logging conditions and providing suitable soil environment. Application of recommended doses of nitrogen supplemented with phosphorous reduces early flowering. As nitrogen is a major element responsible for enhancing vegetative growth high level of nitrogen prolongs the vegetative growth and may suppress early flowering in sugarcane.

High levels of supplied potassium improved flower emergence, flowering, and the number of viable seeds per tassel in sugarcane crop (Brunkhors, 2001). As farmers mostly burn trashes of the sugarcane crop after harvest, ratoon crops also accumulate potassium from the burnt ash (a potassium source) (Govindasamy, et al 2015). Hence, instead of burning sugarcane trashes after harvest it can be composted. Application of composted trashes improves soil microbial diversity, soil carbon and nutrient elements in soil.

Early flowering in sugarcane can be controlled genetically through breeding programmes using suitable genotype and also through biotechnological transformation. Additionally, timely planting and crop rotation helps in reducing early flowering in sugarcane. Crop rotation/growing of crops in 3 years rotation in the sequence of sugarcane plant -> sugarcane ratoon -> legumes/groundnut or application of green manures and green leaf manures too help to improve microbial structure, function and nutrient dynamics in soil.

CONCLUSION

The changes in temperature, precipitation and seasonal variation due to climate change are vigorously affecting the cropping systems. Hence, for some crops such as sugarcane use of conventional breeding and marker assisted breeding can be promoted to attain desirable crop traits to deal with the ill effects of climate change. With rapid development of genetic technology early arrowing of sugarcane may be delayed which would enable this cash crop to deal with future climatic aggressions such as heavy rains and floods. Micro level field and crop nutrient management by the farmers will also reduce the damages due to an early arrowing of sugarcane.

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