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Review Article

Exogenous Applications of Threshold Potential Tool to Combat Water Scarcity in Banana

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A B S T R A C T

Bananas are consumed as ripe fruit, whereas plantains, which remain starchy even when fully ripe, need cooking for palatability and consumption. Originally crops from humid tropics, they have acclimatized to a broad range of climatic conditions. While bananas have come to occupy the status of a high value, commercial crop, plantains have remained a staple food of many ethnic groups. Irrespective of their commercial status, banana and plantains are referred as 'Poor man's apple'. Origin of Banana is Asia Banana is one of the world's most important horticultural crops cultivated on five continents in about 120 countries. A banana is an edible fruit, botanically a berry, produced by several kinds of large herbaceous flowering plants in the genus Musa. In some countries, bananas used for cooking may be called plantains. Banana, basically a tropical crop, grows well in a temperature range of 15^0C-35^0C with relative humidity of 75-85%. In India this crop is being cultivated in climate ranging from humid tropical to dry mild subtropics through selection of appropriate varieties. A soil that is not too acidic and not too alkaline, rich in organic material with high nitrogen content, adequate phosphorus level and plenty of potash are good for banana.

Keywords

Musa Sp., Tissue culture, Drought, Berry, Food production

Introduction

National Status of Banana Area, Production and Yield

Bananas and plantains are a major staple food and export product in many countries with a worldwide average global banana production with arise from 69 million tonnes in 2000-2002 to 116 million tonnes in 2017-2019, at an approximate value of 31 billion USD. While Banana produced across India accounts for around 32 million metric tons. (FAO, 2020, http://faostat.fao.org). While India ranks first in banana production, contributing about 24% (26.5 Million Metric Tonnes) to the total world banana pool, and covering approximately 7,76,000 Ha of agricultural land. National average productivity is 34.2 MT/Ha. Banana also has the highest production amongst all the fruits in India (33%) (Meer *et al.*, 2019) (Fig. 1 & 2). In India total fruit crops covered 6480 Ha area for 92846 MT production and producers get 14.33 MT/Hectare productivity out of which Banana alone covers 858 ha area and

its production is 29163 MT in year 2018-19. Banana is the fourth-important food ingredient in terms of gross value exceeded only by rice, wheat and milk product. Banana is one of the major and economically important fruit crop of India. Banana occupies 23% area among the total area under crop in India. It is an important crop for small and marginal farmers.

In India, around 20 cultivars viz. Dwarf Cavendish, Robusta, Monthan, Poovan, Nendran, Red Banana, Nyali, Safed Velchi, Basarai, Ardhapuri, Rasthali, Karpurvalli, karthali and Grandnaine etc. mainly Grandnaine is gaining popularity and may soon be the most preferred variety due to its tolerance to biotic stresses and good quality bunches. Fruit develops attractive uniform yellow colour with better self-life and quality than other cultivars. The major banana growing states in India are Assam, Aandhra Pradesh, Bihar, Gujarat, Karnataka, Kerala, Madhya Pradesh, Maharashtra, Tamil Nadu, West Bengal. Uttar Pradesh stands 4th position in banana area and production i.e. 67.40 Ha and 3078.73 MT respectively followed by Gujarat (64.69 Ha; 4185.52 MT), Andhra Pradesh (86.32 Ha; 4143.55 MT) and Tamil Nadu (94.99 Ha; 3640.73 MT) in year 2016-17. While In State Wise Productivity of Banana Uttar Pradesh (45.68 MT/Ha) comes on 5th position after Madhya Pradesh (67.74 MT/Ha), Gujarat (64.70 MT/Ha), Punjab (57.89 MT/Ha), Andhra Pradesh (48.00 MT/Ha). Mainly eastern districts and area are more suitable for Banana production than the western as they cover more area for banana production in 2015-16 (Table-1).

Opportunities and Challenges in the Banana Market

Banana is a leading food crop in terms of production value. With some 15 percent of global production exported, its total trade value stood at some USD 8 billion in 2016, making bananas the largest traded fruit crop in value terms. This note discusses a number of important issues that are shaping developments in global banana markets. A number of banana diseases are affecting banana production around the globe, threatening the livelihoods of local populations and especially income opportunities for smallholder banana farmers. India, by far the largest producer of bananas globally, increased its export volume by 47 percent due to further expansion in the harvested area for traded varieties. While banana production in India primarily targets the domestic market, a growing share of production is exported to the Gulf countries, Malaysia and Nepal. Supply shortages in the Philippines, the main competing exporter, meant that shipments from India could benefit from high demand in the Gulf countries and Southeast Asia. Another supporting factor was the low price of Indian bananas, which reportedly sold at a 50 percent discount to bananas from Ecuador and the Philippines at the Dubai auction. As India ranks first in Banana production, it exports approx 110.87 thousands metric tonnes Banana to different countries and get 38,852.57 lacs income per year (Table 2).

Banana Farming: Traditional vs Tissue Culture

In the past, when bananas were grown as an annual crop, farmers traditionally used sword suckers as planting material. Each mother plant supplied one or two suckers during the planting season from March to May. Inevitably, many important diseases, including viruses and *Fusarium wilt*, were readily transmitted from one crop cycle to the next. In banana farming, suckers generally may be infected with some pathogens and nematodes. Similarly due to the variation in age and size of sucker, crop is not uniform,

harvesting is prolonged and management becomes difficult but about 70% of the farmers are using suckers as planting material while the rest 30% of the farmers are using tissue culture seedlings. Therefore, *in vitro* clonal propagation i.e. tissue culture plants are recommended for planting. They are healthy, disease free, uniform in growth and early yielding.

Water shortage and Banana farming

Water will be one of the biggest challenges for the future of agriculture because Seventy per cent of global water use is for agriculture. Water use is increasing because of the growing global population, and that is leading to scarcity. The crop productivity is subjected to number of stresses and potential yields are seldom achieved with stress. The present challenges like global climate change, water and soil pollution, less water availability, urbanization etc adds up to the situation. These lead to growing interests among scientists on abiotic stress research. Abiotic stress includes drought, heat, flood, salinity, mineral deficiency, toxicity, and chilling or freezing stress. All crops grown under natural environment are subjected to one or the other stress.

A lot of water is used in the production of bananas to irrigate the plantations. With some simple adjustments and small investments in techniques, water use can be reduced. But small growers have a limited knowledge of irrigation while With less energy and water use, yields can be increased. Not all techniques are feasible for small growers, but training about ground water would make this feasible. Due to similar adjustments, less stressed fruit is grown. Stressed fruit has a shorter shelf life. The supply chain profits when less stressed fruit is marketed. It's not always easy to convince growers. The results of one grower who invests or changes his production method are of great importance. If that's positive, more will follow.

Developing technologies to meet the needs of growing populations and increasing demand for fruits, vegetables, and other horticultural products is essential. Environmental stress severely restricts the distribution and productivity of plants [2]; particularly drought is a major abiotic factor that limits crop productivity [3].

Drought stress remains an ever-growing environmental problem that severely limits crop production worldwide and causes important agricultural losses particularly in arid and semi-arid areas [4]. Water stress enforces a serious threat to banana productivity. The consequences of water deficit include its adverse effects on plant phenology, development, assimilate partitioning, carbon assimilation, growth, and plant reproduction processes. Drought induced osmotic stress triggers a wide range of perturbations ranging from growth and water status disruption to the modification of ion transport and uptake systems [5-7].

However, the topic doesn't just concern production companies, but the environment in general and the consequences for drinking water. Also think about climate change.

In many areas, rain patterns have already changed. Another point is the increasing salt water level in coastal areas. The best way to enable growers to adapt is to offer a good price
Climate smart agriculture: Adapt to new circumstances to realize sustainable production methods." The certificate is updated to the changing conditions, and they've also looked at protecting the ecosystem, health of soils and biodiversity. "It doesn't stop at the company's perimeter, we have to use a landscape-wide approach."

Table.1 Area and production of Banana for major producing districts of Uttar Pradesh in 2015-16

DISTRICTS	2015-16	
	Area (Ha)	Production (MT)
GORAKHPUR	18.04	813.67
KUSHI NAGAR	14.39	650.55
FATEHPUR	7.51	354.57
KAUSHAMBI	6.34	300.79
MAHARAJGANJ	5.37	238.74

Source: Horticultural Statistics at a Glance 2017

Table.2 Export of Fresh Bananas from India-Country Wise

COUNTRY	2016-17	
	Qty MT	Rs. Lacs
UNITED ARAB EMIRATES	24368.63	11897.81
IRAN	15838.89	5505.06
SAUDI ARABIA	10280.67	5199.46
OMAN	12937.97	4619.24
KUWAIT	10463	4302.8
NEPAL	27406.09	2691.16
QATAR	3761	2249.54
BAHRAIN	2610.09	1307.23
MALDIVES	1518.51	469.15
IRAQ	593.23	189.4
OTHERS	1093.79	421.72
TOTAL	**110,871.87**	**38,852.57**

Source: APEDA Website

Source: Horticultural Statistics at a Glance 2017

Fig.1 Leading Fruit Producing Countries in the World

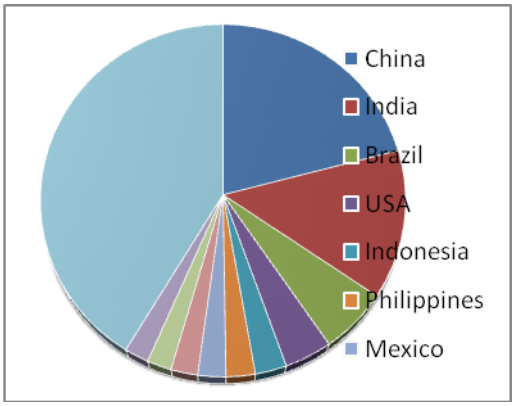
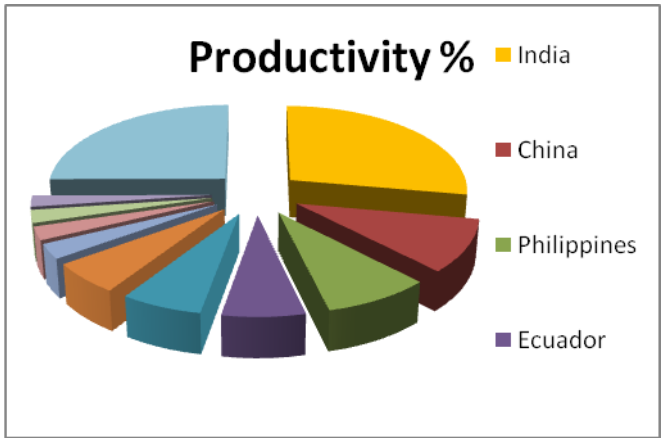


Fig.2 Major Banana Producing Countries in the World



Bananas have high water requirements, however water logging of the soil can result in oxygen starvation of the roots, causing shutdown of the plant (Daniells & Evans 2005). Oxygen deficiency for more than 6 hours results in root tip death, which in turn leads to branching of the roots (Pattison & Lindsay 2006).

No species is highly drought resistant but there is a considerable range of drought tolerance. Very broadly, response to drought is correlated with natural habitat and ranges from natives of non-seasonal climates (Australimusa and Callimusa) being intolerant, to those from extreme monsoonal areas that have severe drought seasons (Rhodochlamys) showing drought evasion by dying down to the corm in dry weather and sprouting again with rain. Members of section Musa tend to show variable tolerance with *M. balbisiana* able to withstand weeks of dry weather while the Australian native species M. acuminata subsp. banksii has a much greater requirement for water (Simmonds 1962).

Periods of drought can lead to a reduction of root growth and root tip death. When sufficient water becomes available and roots recommence growing, it may result in multiple branching giving a 'witches broom' appearance (Goenaga and Irizarry 2000). Plants can tolerate short periods of drought because of their water-filled energy reserves but may only produce small bunches of bananas (Nelson *et al.*, 2006). Lack of water may also result in bunches that don't 'fill' (Mahouachi 2007). Periodic water stress is also associated with 'maturity bronzing' manifested by discolouration of mature bananas and cracking of the skin (Mahouachi 2007)).

Banana is an economically important fruit crop that is cultivated in many tropical and sub-tropical countries. It is a perennial herbaceous monocot, which belongs to the musa genus of the musaceae family. In Malaysia, it is the second most widely cultivated fruit crop with a total production of more than 50,000 metric tonnes. Banana can be consumed both as staple food as well as an export commodity.

Conventionally, bananas are grown from their vegetative suckers. This is because almost all of the banana cultivars are triploid, seedless or seed sterile. However, conventional planting is not the ideal method because planting materials may carry fungal pathogen, viruses, weevils and nematodes. Diseases like panama wilt (*Fusarium oxysporium*), head rot (Erwinia carotovora)

and banana Bunchy Top virus (BTTV) are often found in banana farms propagated using disease-contaminated suckers. Consequently, another alternative method of propagation is adopted through in vitro clonal propagation or tissue culture.

The banana plants need continuous sources of soil moisture for optimum growth. There may be over 40 m3 of "plant water" in a hectare of banana plants in a day and transpiration loss is estimated at 30-60 m3. Any water deficit would thus retard its growth and the effects may sometimes be evident only several months after the drought. The soil moisture deficit stress during vegetative stage of banana causes plant to extend its life cycle, poor bunch formation, lesser number of fingers and small sized fingers. The waters stress during flowering causes poor filling of fingers and unmarketable bunches.

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