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Management of Drought and Salt Stresses in Banana

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Indian agriculture is still heavily dependent on the monsoons. Almost 53% of its gross cropped area is rainfed. When rainfall is low, areas irrigated through canals, tanks, watersheds and groundwater are affected and also reservoir and groundwater levels dip. Mostly, only about 35-40% of the area is under assured irrigation.

Banana planting in India is generally done based on water availability, rainfall and suitable time for flowering and bunch development. The planting is done based on the monsoon and availability of water in the canal irrigated area. The irrigation practice in different parts of the country is based on traditional field experience and generally it is empirical in nature. Irrigation is done at intervals of 4-10 days and it depends on the month, season and soil type. During the active monsoon period, no irrigation is needed while during summer, frequent irrigation at 3-5 days interval is required. Occasional supplementary irrigation may be required for crops during the break periods of the monsoon season with prolonged dry spells, when the evaporating surfaces receive excessive heat due to advective conditions.

A mature Dwarf Cavendish banana plant could consume 25 liters of water on a clear day, 18 liters on a partly cloudy day and 9.5 liters on an overcast day. Banana plant can take easily 30% available water from the soil at field capacity. At 60% depletion of available water, wilting may occur, therefore banana plants need continuous soil moisture for optimum growth. Any water deficit would thus retard its growth and its effects may sometimes be evident only several months after the drought. If there is a shift in rainfall pattern, there must be a change in cultivation system and adaptation. Factors that operate against extension of banana cultivation are: areas with long dry season, irrigation water with more salts, saline and sodic soil of cultivable land, frost occurrence, cool winters, hot winds in summers and stormy or cyclonic winds.

Effects of soil moisture deficit stress in banana

General external symptoms

Reduction in rate of leaf emergence, loss of turgor in cigar leaves, drooping of leaves (Fig. 1), premature senescence, yellowing and drying of young leaves, choking of bunch

Fig. 1: Soil moisture deficit stress effect

Fig. 2: Choking of bunch throw

emergence (Fig. 2) and reduction in size of pseudostem due to loss of water. Sometimes, combined effect of soil moisture deficit and high temperature stress also occurs in the plant, which damages the plant more than the stress when occur in isolation. In severe stress condition, the plant may topple down due to weakness of pseudostem.

Critical stages of plant growth to soil moisture stress in banana

- Occurrence of soil moisture deficit stress at 3rd month after planting may not affect the bunch size, but it delays the shooting by 15-20 days.
- Befalling soil moisture deficit stress in Grand Naine at 5th month after planting may result in development of malformed bunches (Fig. 3) and reduction in number of hands and fingers.
- Soil moisture deficit stress taking place at the time of flowering to first one month after flowering may affect the normal fruit development, *i.e.*, it reduces fruit length and girth resulting in reduction in bunch weight to the tune of 42% in susceptible banana (cv. Robusta).

Fig. 3: Malformed bunch

Mitigation of soil moisture deficit stress

In banana cultivation, possibility of arising soil moisture deficit stress is more, because it has to be grown for minimum of one year and has to pass through all the seasons of the year. Therefore, due attention must be given towards maintenance of optimum soil moisture during critical stages of banana plant growth and any lapse may reflect in the yield. The practices to be followed in banana cultivation to tackle the befalling soil moisture deficit stress are as follows:

General agronomic practices

- Planting of suckers in pits (planting of sucker in 1.5 ft depth), so that the growing roots go deeply to extract the soil moisture.
- Installation of drip system to deliver optimum water in the root zone saves 25-30% water. Application of optimum quantity of water through drip at different growth stage is provided in the table.
- Mulching the area between banana plants with dead banana leaves or black polyethylene sheets to reduce water evaporation.

Irrigation at critical growth stages

Regular irrigation to maintain optimum soil moisture (80-90% of available soil moisture) during 5th and 6th months after planting, which coincides with floral primordial

Table 1. Drip irrigation schedule for banana

Crop growth stage	Duration (weeks)	Quantity of water (liter /plant)
After planting / Ratoon	1-4	4-6
Juvenile phase	5-9	8-10
Critical growth stage	10-19	12
Flower bud differentiation stage	20-32	16-20
Shooting stage	33-37	20 and above*
Bunch development stage	38-50	20 and above*

* Depending on the weather condition

initiation and development and also during flowering to first one month after flowering. This practice may increase the chances to get normal bunch emergence and fruit development.

Drought tolerant banana cultivars

In the areas of nonavailability of sufficient water for regular irrigation, relatively drought tolerant cultivars *viz.*, Saba, Monthan, Karpuravalli and Poovan can be grown rather than Cavendish clones like Grand Naine and Robusta.

Priming of banana plants with biochemicals

In a situation of ensuing drought due to nonavailability of irrigation water, the plants may be primed with 0.1 mM Acetyl Salicylic Acid (ASA) (18 mg/liter water) + 100 ppm Butylated Hydroxy Toluene (BHT) (100 mg/liter) + 0.75% KNO_3 (7.5 g/liter) as foliar spray @ 250 ml / plant, after irrigation. The effect may last for about a month by providing tolerance to the plants under water-deficit condition and more yield (Fig. 4). The foliar spray is important when the plant is expected to face a drought situation in its critical growth stages.

Fig. 4: Bunch emergence in plants treated with drought alleviation chemicals

Maintenance of optimum number of leaves

There is a general belief that retaining more number of leaves at flowering stage may give big bunch. When unlimited water supply situation exists, maintenance of more leaves is not harm. In limited water supply condition, maintaining of only 6-10 top leaves at flowering leads to normal fruit development without affecting fruit quality (Fig. 5). This reduces the water loss through transpiration and cut leaves can be used to cover the soil surface as mulching agent. Also, maintaining an optimum number of leaves promotes light penetration to the lower leaves, reduces water loss through transpiration and arrests spread of leaf spot disease causing pathogen.

No de-leafing at flowering

Retaining only 6 leaves at flowering

Fig. 5: Normal bunch development in de-leafed plants of Rasthali at flowering

Bunch spray

After completion of flowering and opening of all hands and de-naveling of male bud, application of 2% potassium sulphate as bunch spray and second spray after 30 days of first spray increases finger length and girth and bunch weight up to 1.5 kg (Fig. 6). Since plants have sufficient moisture during this stage, it hastens the fruit development (both length and girth). Besides, the fruits get good glossy appearance and fetch good market price.

Fig. 6: Potassium sulphate sprayed bunch at maturity

By adopting the above said measures at the time of limited water supply for irrigation in banana plantation, crops can be saved without big loss to get profitable yield.

Effects of salts in banana growth and yield

In India, 6.73 million ha of land is affected by salinity and alkalinity problem, 25% of groundwater used for irrigation is either saline or brackish and 11.7 million ha is likely to be affected by salinity and alkalinity by 2025. Salt-affected soil problems are old, but their magnitude and intensity have been increasing due to large-scale efforts to bring additional areas under irrigation in recent decades. The problems have been further invigorated by development of irrigation systems without adequate provision for drainage. Traditional banana growing areas, especially in command areas, are becoming more saline due to secondary salinization, *i.e.*, due to regular flood irrigation and poor drainage.

Bananas are generally sensitive to salt stress, especially the cultivars like Nendran and Robusta are very sensitive. The salt stress leads to poor plant growth and yield.

Symptoms of salt stress

- Necrosis of young and older leaf margins (Fig. 7).
- Loss of green leaf area, decreased leaf emergence rate and reduction of plant height and girth of pseudostem.
- Delay in flowering by 60-75 days.
- Reduction in number of hands and fingers.
- Reduction in fruit size (both length and girth).

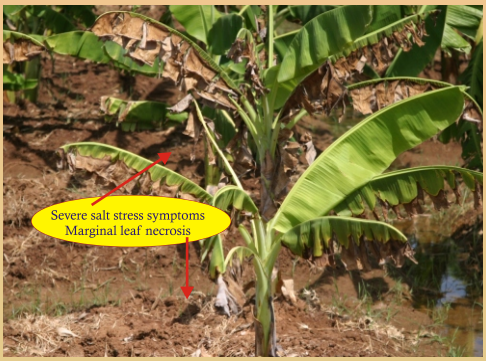

Fig. 7: Salt stressed plants with symptoms

Mitigation of salt stress

Banana can be grown only in soils with moderate salt condition, Hence testing of soil and water quality of the field for suitability to grow banana is very important.

- Salt tolerant banana cultivars like Saba (Fig. 8), Monthan and Karpuravalli can be grown in fields with pH 8.1-8.5 and ECe 4-5 dSm^{-1}.
- Since the plant experiences the salt stress from the beginning of growth, foliar spray of ASA (0.1 mM) combined with BHT (100 ppm) at monthly intervals reduces the adverse salt injury, increases the growth of the plants and also yield of banana.


Fig. 8: Saba, a salt tolerant genotype

- Poovan and NeyPoovan can be grown with appropriate foliar spray at monthly interval till maturity of the bunch. Nendran, Red Banana and Robusta are not recommended for cultivation in the salt affected soils.

By adopting the above said improved management techniques in a meticulous manner, banana farmers are assured of getting higher yield and more profit in the problem soils.

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