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Stress Management in Horticultural Crops

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Management of stress is important practice for successful cultivation of crops and attaining reasonable yields under abiotic stress situations mainly depends on the available adaptation options. The adaptation efforts would enable us to channelize concerted efforts for the holistic development of horticulture sector empowering marginal and small farmers. Majority of the fruit crops are perennial, possess deep root system, and undergo vegetative and reproductive phases during different seasons in a year. The long time horizon of perennial horticulture crops itself is a challenge. The quick adaptation strategies, like switching over to tolerant cultivars and changing planting dates or season, followed in annual crops are not likely in perennial fruit crops. Hence, the choice of fruit crops should be guided by the suitability of a crop species and their varieties in a particular location. The planting and rearrangement of fruit orchards require long-term consideration.

Modification in Cultural Practices

The alterations in cultivation practices help in effective management of abiotic stresses in perennial crops. In mango better tree growth, fruit retention, and fruit size and higher yields are realized under irrigation. The fruit size and yield increased in field-grown mango cv. Hindi with more frequent irrigation. Since the occurrence of water stress immediately after fruit set increases fruit drop, protective irrigation is essential during the fruit development period. Thus, providing irrigation at least during post-fruit set period under water-limiting conditions is very important for realizing sustainable yields. Under water-deficit conditions, production practices that can improve water use efficiency would help in water saving and bringing more area under irrigation. Plastic mulching helps in reducing soil water evaporation and rainwater impact and provides effective weed control and congenial environment for soil microflora. The use of mulching enhances the production and quality of produce under waterlimiting conditions. The production system employing drip irrigation, fertigation, and plastic mulching would help in realizing higher yields. During initial establishment of mango plants in the field, under water scarcity situations, application of 1.25 l of subsoil irrigation per day through pitcher placed one foot below ground and mulching with sugarcane thrash at 1.0 kg basin−1 is suggested for better establishment.

Micro-Irrigation

Systematic irrigation scheduling enhances water productivity largely because of improved efficiency and timing of water applications. Through the precise and direct application of water in root zone through drip irrigation, better crop growth and yield can be realized along with considerable savings in water. Drip irrigation method enables judicious use of available irrigation water in fruit orchards. Overall it saves up to 30–70% irrigation water and also helps in realizing higher yields by 25–80%. Various studies have shown that the adoption of micro-irrigation systems increased yield and productivity of fruit increases by 42.3%. This resulted in improved water use efficiency, and an average irrigation cost has been brought down by 31.9%. Micro sprinkler irrigation not only helps in water saving to the tune Micro sprinkler irrigation not only helps in water saving to the tune of 20 to 30%, but during summer it helps in reducing temperature in the microclimate and increases the humidity, leading to better growth and yield.

Adopting Novel Irrigation Methods

In addition to drip irrigation and mulching, novel irrigation methods, like partial root-zone drying (PRD), could be adapted for production of fruit crops under water scarcity conditions. Partial root-zone drying is an irrigation water application technique alternating from one side of the plant to the other. This system purposefully imposes water stress to the plants at specific growth stages by providing limited amounts of plant's daily water use. The production of ABA hormone and other chemical signals in the drying roots presumably reduces stomatal conductance and leaf growth thereby increasing water use efficiency. In mango orchards where water is a limiting factor, PRD may be the key for a sustainable production. A frequent response of fruit trees to deficit irrigation (DI) is earliness in flowering. This stress-induced flowering is often explained in terms of a lesser resource competition with vegetative growth effectively restrained by water deficit in evergreen and deciduous fruit trees.

Choice of Tolerant Rootstocks

In situations where there is a strong consumer preference for a select cultivar that is susceptible and if alternative tolerant cultivars are not available, the option of using rootstocks for better performance needs to be explored. Rootstocks with better root system, having capacity for enhanced water and nutrient uptake, could be used for grafting commercial cultivars to mine water from deeper soil layers. In grapes, cv. Pinot Noir on "101–14 Mgt" rootstock had higher CO2 assimilation, transpiration rate, and higher water use efficiency than on "3309C". Rootstocks, 110R, 99R, and 1103P, belonging to Vitis berlandieri x Vitis rupestris crosses, show increased water use efficiency. The rootstocks such as Dogridge, Salt Creek, and Vitis champini clone showed tolerance with reduced cytokinin level and increased ABA accumulation at 50% moisture stress compared to irrigated vines. Mango rootstocks exhibited differential response during water stress. The cultivars Starch, Peach, and Kensington required 7–9 days, whereas Mylepelian took 16 days to reach negligible photosynthesis rates during water stress. Thus, availability of different suitable rootstocks enhances the farmers' ability to manage abiotic stresses. Although saline conditions have adverse effects on plant height, number of leaves, leaf area, and stem thicknes, the mono- and polyembryonic mango cultivars display differential tolerance to salinity stress. 18 Abiotic Stress Management in Fruit Crops 408 Studies have demonstrated that the polyembryonic genotypes appear to have greater tolerance to salinity compared to monoembryonic types. The Gomera-1 having ability to restrict uptake and transport of Cl and Na ions from root system to the aboveground parts is identified as tolerant to salinity stress. The tolerant seedlings exhibit physiological tolerance to chloride ion concentrations in leaf tissues. The rootstocks have the ability to either restrict sodium uptake or, once taken up, sequester sodium in vacuole or older leaves. The adverse effects of salinity stress could be successfully alleviated by using tolerant rootstocks. The rootstock Dogridge followed by Salt Creek showed least mortality under saline conditions (8 dS m−1).

Choice of Tolerant Crops

In areas where the crops perennially face water and high temperature stresses, the knowledge should be shared with farmers on fruit crops which would be most suitable. In such circumstances, the selection of appropriate fruit species becomes very important. Many fruit crops are endowed with physiological and morphological adaptations and have capacity to withstand adverse effects of water stress. Ber sheds leaves to avoid extreme water stress during summer. Pomegranate is fairly winter hardy and tolerant to water-deficit and high temperature stresses. It tolerates concentrations up to 40 mM NaCl in irrigation water. Fig has adopted to retain high-bound water in the tissue, by having sunken stomata, thick cuticle, and leaf wax coating. Aonla, being a hardy and drought-tolerant subtropical tree, can be grown well under tropical conditions. In salt-affected lands where cultivation of annual field crops is limited, adopting relatively tolerant crops like ber, aonla, guava, grape, karonda, jamun, and phalsa would help in utilization of such lands for horticulture. These crops could be considered as candidate crops to face the challenges of abiotic stresses under climate change conditions.

Though various adaptation options like cultural practices, advanced irrigation methods, tolerant crops, or varieties and rootstocks are available, the productivity of fruit crops remains low in areas experiencing abiotic stresses. The main reasons are slow pace of adoption by the small and marginal farmers, limited awareness about the potential adverse effects of abiotic stresses, dearth of agro ecological zone-based perspective plans, lack of awareness about the risks associated with horticultural crops, and lack of integrated location-specific modules to overcome abiotic stresses. Therefore, focus is required for developing integrated location-specific and crop-specific adaptation strategies for various abiotic stresses. Dissemination of already available adaptation strategies can be taken up through location-specific monitoring networks and creating awareness among farmers on likely climatic risks. The timely availability of planting material of tolerant cultivars needs to be assured through proper institutional mechanism. The institutional support to provide forecast and early warnings needs to be further strengthened. Robust insurance policies linked to climatic risks of a region, recent weather extremes, and weather forecasts are very much essential. The coping measures need to be further developed with focused research. Multidisciplinary efforts are needed to develop integrated adaptation strategies. There is an immediate necessity to enhance the genetic base through collection of wild and cultivated genotypes having tolerance to abiotic stresses. The identification of traits imparting tolerance to abiotic stresses is an important step in the process of crop improvement and development of tolerant cultivars.