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Drought management strategies in fruit crops: An overview

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Abstract
Environmental stresses play crucial role in the productivity, survival and reproductive biology of fruit plants as well as crops. Biotic and abiotic stresses, including drought, extreme temperature, scarcity of water, reducing quality of irrigation water and salinity in soil and water are problems which are becoming really acute. Due to their rapid and unpredictable effects, it is becoming very difficult for horticultural scientists and farmers to respond to challenges posed by biotic and biotic stresses. Among these stresses drought stress is considered to be a major threat to sustaining food security under current and more so in future climates. Keeping in mind challenges of drought and quality fruit production in stress prone areas, the present need before researchers and growers is to fight with the challenges posed by drought. There are many approaches like mulching, drip irrigation. Water conservation, use of growth retardants, proper nutrient management, use of antitranspirants and drought tolerant rootstocks through which we can manage these challenges. The use of desirable method under different conditions not only meets the requirement of early and quality production but also provides an alternative approach to mitigate the drought.

Keywords: abiotic stress, drought, fruits, challenges, management

Introduction
Irrigation is critical during plant establishment, which is usually from the first to the third year after planting, depending on the fruit crop. During this period plants have not established an extensive root system and are prone to drought stress. Early in the life of a fruit crop growers work at trying to develop an extensive plant root system and an above ground plant structure to produce fruit on. Lack of water can drastically reduce the time to bearing and increase production costs substantially. Weed control is particularly important in a dry season, because weeds compete with fruit crops for available water. Weeds should be eliminated beneath the fruit crop canopy and the row middles should be kept closely mowed to reduce water loss. In india the potential for a drought during the growing season is a very real probability. The length and severity of droughts vary greatly and cannot be predicted, so planning is critical in order to minimize the effects of a drought. However, the potential for a drought is such that current recommendations for fruit orchards include irrigation as an integral part of fruit production and not as an option. With perennial tree fruit crops it is best to take a proactive position rather than waiting for a drought before taking action. Many orchards are poorly located where water is not readily available. Also, in mature orchards, where fruit trees are relatively deep rooted, installation of an irrigation system during a drought period is impractical and usually not as effective. Water deficiency can lead to reduced shoot length and leaf size. The trunk diameter also does not increase properly. Water stress at bloom time results in reduced fruit set. Drought accentuates the condition of alternate bearing. The lack of moisture also leads to increase in pre-harvest drop and fruit drop later in season, after June drop. Water stress can appreciably restrict size of fruit. Size once lost due to dry weather cannot be recouped even if heavy rains follows thereafter. The practice which decreases water requirement and water lost are effective to increase drought resistance in fruit crops. The World Economic Forum (2009) at Davos published a "Water Initiative" report, which estimated global crop production losses up to 30% by 2025 compared to current yields due to water shortage, if unsustainable use of water for agriculture continues (Zhang 2011) [18]. The use of tolerant rootstocks (Nimbolkar, *et al.,* 2016) [9], polyethylene mulches (Aulakh and Sur 1999) [3], growth retardants like paclobutrazol (Frakulli *et al*., 1999) [4] and antitranspirants are different approaches through which we can mitigate the negative effects of drought.

The paper is an attempt to know about the different management strategies for mitigating drought.

Results and Discussion

Sircelj *et al*. (1999) [15] conducted experiment on 'Elstar' apple cultivar by keeping the plants in stress and control conditions and revealed that different amino acid (proline, glutamine, histidine, arginine, lysine content increased in stress conditions because FAA are known as important constituents of osmoregulation in leaves of many species and their rise during slowly developing stress is correlated with increasing drought tolerance of the plant (Table-1)

Mulching minimises water losses from soil surface as a result of solar radiation and wind action. Lu and Zhao (1998) [6] reported that mulching an apple orchard with straw significantly increased soil moisture by 41 % and adjusted soil temperature compared with control. Aulakh and Sur (1999) [3] observed the effect of different mulches in pomegranate and investigated that polyethylene mulches conserved the higher soil moisture (4.1 %) than control (Table 2)

Spray of antitranspirant chemicals on the tree foliage either reduce the incidence of radiant energy or check losses by physical impedance or through stomatal closure. Kaolin, a radiation reflectant sprayed on pomegranate foliage at 5-8 per cent concentrations effectively reduced transpiration rate (Anon, 1989) [1].

Table 1: Free amino acid contents (nmol/dw) in leaves of control and drought stressed apple cultivar

	Glu	Pro	His	Arg	Lys
E-S	3704	224	147	2081	182
E-C	3148	166	145	1395	146

E-S= Elstar stress, E-C=Elstar control, Glu= Glutamine, Pro= Proline, His= Histidine, Arg= Arginine, Lys= Lysine

Table 2: Effect of mulching on soil temperature, soil moisture, weed population, growth and yield in pomegranate

Treatment	Soil Temperature (°C)	Soil Moisture (%)	Number of weeds	Fruits yield (Number)
Black Polythene	27.06	11.93	19.7	32.6
White Polythene	26.87	11.62	26.4	30.7
Farmyard Manure	23.11	11.17	240.1	27.5
Basooti	22.81	11.01	82.7	26.4
Control (No mulch)	24.28	7.79	112.7	176.3

In a two year study, Masoud (2012) [7] reported that in apricot cv. Hamawy, use of antitranspirants (Green miracle @ 1%) could effectively increase fruit yield, fruit weight, no. of fruits per tree and can also significantly reduce fruit drop (Table 3)

Table 3: Effect of some antitranspirants on the percentage of preharvest fruit dropping, yield and fruit weight (g.) of Hamawy apricot trees during 2010 and 2011 seasons (Masoud, 2012) [7]

Treatment	Pre harvest fruit drop		No. of fruits/tree	
	2010	2011	2010	2011
Control	38.9	40.0	281.0	284.0
Green miracle at 1.0 %.	7.0	7.3	350.0	356.0
Green miracle at 2.0 %.	5.9	6.0	380.0	387.0
Kaolin at 1.0 %	15.0	14.0	330.0	338.0
Kaolin at 2.0 %.	9.2	10.6	355.0	364.0
Vapor guard at 1.0 %.	21.0	20.0	296.0	304.0
Vapor guard at 2.0 %.	18.0	17.5	307.0	318.0
Treatment	Yield/tree		Fruit weight	
	2010	2011	2010	2011
Control	16.6	16.6	59.0	58.5
Green miracle at 1.0 %.	27.3	27.1	78.0	76.0
Green miracle at 2.0 %.	31.5	31.3	82.9	80.8
Kaolin at 1.0 %.	32.2	23.1	70.3	68.2
Kaolin at 2.0 %.	26.3	26.5	74.0	72.9
Vapor guard at 2.0 %.	20.6	21.2	67.0	66.6

Rehman (2010) [14] reported that CCC and PP 333 treatments sprayed at 500 and 1000 ppm gave the highest values of fruit physical and chemical properties on Barrani grapevines as compared with effect of pruning, vapour-guard at 4,6 %, paraffin wax at 8, 10 % (as antitranpirants) (Table 4). The 10 % solution of the antitarnspirant Wilt Purf NCF when applied on peach trees following harvest, water use of the treated trees was reduced by 40 % immediately after application and by 30 % one month after treatment as compared to control (Steinberg *et al*., 1990) [16].

Table 4: Effect of pruning, antitranspirants and growth retardants on mitigating drought effects on yield and fruit quality in Barrani grapevines during 2008 and 2009 seasons

S. No	100 berry weight	Weight (g)		No. of berry/cluster		Yield/Vine (Kg)		Cluster weight (g)		Cluster No./ Vine	
		2008	2009	2008	2009	2008	2009	2008	2009	2008	2009
1	Control	6.42	6.57	261.7	259.9	1.67	1.70	89.63	96.39	1.82	1.61
2	Pruning at 6 canes x 8buds	6.82	7.50	264.0	261.0	1.80	1.95	105.2	103.6	1.97	1.40
5	Vapor guard at 6%	7.76	9.40	378.7	380.8	2.96	3.53	124.0	119.4	1.90	2.29
6	Paraffin wax at 8%	8.41	8.42	278.5	281.6	2.29	2.38	117.4	120.2	2.20	2.21
7	Paclobutrazol at 500ppm	9.06	9.39	398.7	396.9	3.73	3.83	119.9	120.9	2.30	2.25
9	Cycocel at 1000ppm	9.08	9.91	478.8	469.9	4.33	4.38	125.5	126.9	2.29	2.19

Plants having xerophytes characteristics viz. Deeper root system, deciduous in nature, reduced foliage, sunken or covered stomata, waxy coating and hairy leaves etc. minimize the evapotranspiration and make the plants amenable for their cultivation under the moisture stress situations. Fruits like cashew nut, custard apple, ber, aonla have xerophytic characteristics and may be cultivated under moisture stress situations (Pareek and Sharma, 1993; Vashishtha, 1999) [11, 17].

Naor *et al.* (2008) [8] reported that midday stem water potential in *Malus domestica* trees at Ortal decreased with increasing crop load in 1 mm/day, decreased slightly with crop load in the 3 mm/day treatment and was unaffected by crop load in the7mm/day treatment. In contrast, midday stem water potential in trees at Matityahu decreased with increasing crop load at all irrigation rates.

Growth retardants reduce the water requirement of fruit crops thus effectively overcome moisture stress. Paclobutrazol treated plants lost less moisture than those from the control plants. Frakulli *et al*. (1999) [4] reported that olive plants treated with growth retardants paclobutrazol and triapenthenol showed a significant decrease in their daily and total water use and increase drought resistance.

Use of drought resistant cultivars and rootstocks also effectively control moisture stress. Atkinson *et al*. (1998) [2] reported that AR 295/6 and AR 486/1 apple rootstocks have well developed root system and were most tolerant to drought. *P. calleryana* seedling tolerant a wide range of soil texture and soil moisture. D-6 strain is drought tolerant (Lombard and Westwood, 1987). Myrobalan and Mariana plum rootstocks tolerate heavy soils and poor drainage better than peach and apricot rootstocks. Myrobalan rootstock is resistant to drought (Okie, 1987) [10]. Kaynas *et al*. (1997) [5] investigated drought resistance of Granny Smith and Amasya apple cultivars grafted on M9, MM 106 and seedling rootstock and reported that both cultivars were more drought resistant when grafted on M 9 and seedling rootstocks than on MM 106. Prakash *et al*. (2001) [12] reported that Dogridge, Salt Creek and Vitischampini could survive under 100 % moisture stress and there was marginal reduction in net photosynthesis rate.

Conclusion

Drought stress is considered to be a major threat to sustaining food security under current and more so in future climates. Drought ranks foremost among the abiotic constraints for production in fruit crops. There are many approaches like mulching, drip irrigation, water conservation, use of growth retardants, proper nutrient management, use of antitranspirants and drought tolerant rootstocks through which we can manage the negative impacts of drought on fruit crops. The use of desirable method under different conditions not only meets the requirement of early and quality fruit production but also provides an alternative approach to mitigate the drought. Moreover, tolerant rootstocks offer permanent solution to the acute problem of drought.

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