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Investigation of Physiological Disorders and Fruit Quality of Sweet Cherry

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Summary

Physiological disorders (deep suture, fruit cracking, and double fruit), and fruit quality of 'Van' sweet cherry *(Prunus avium* L.*)* cultivar in relation with irrigation, gibberellic acid (GA_3) and nitrogen (urea) were studied. Irrigation treatments were tested as 100 % (full irrigation), 50 % (moderate water stress) and 20 % (severe water stress) replenishment of water depleted from the 100 % replenishment treatment at 90 cm soil profile at ten day intervals. GA_3 and nitrogen were applied to trees during flower bud differentiation period at the doses of 100 mg L^{-1} and 900 mg L^{-1}, respectively. Lowest amount of double fruits were obtained from I_{50}+N+GA_3 application. Deep suture were most seen in the fruits exposed to moderate water stress plus nitrogen application. Fruit cracking was not affected statistically significant by any of the applications. All of the quality attributes of cherry fruits were statistically influenced by all the treatments and weather conditions.

Key words. deep suture – doubling – fruit cracking – gibberellin – nitrogen – *Prunus avium* – water stress

Introduction

Deep suture, fruit cracking and double fruit are major problems which cause crop losses in sweet cherry production. Some sweet cherry cultivars may have up to 80 % abnormal shaped fruits (Southwick et al. 1991). Fruit cracking of sweet cherry due to rain near harvest is a major source of crop loss in the cherry industry. The disorder is characterized by a splitting of the outside layer of the cherry skin called the cuticle (Whiting 2005). Double fruit and deep suture arise in the bud during flower bud formation. Double fruits form when two pistils fuse together during development and grow. In the fruit with deep suture, the pistil margins do not fuse at the base and remain open.

These physiological disorders are the problems caused by climate and by management practices that change the microclimate endured by the sweet cherry tree. Among these practices would be irrigation, fertilization and growth regulators. In addition, in many cases, certain varieties are more predisposed to a specific disorder than others (Usenik et al. 2005). The incidence of deep suture (Stephen and Uyemoto 1999) and double fruit (Beppu et al. 1996) increases when summer temperatures are very high during flower bud differentiation period. Water stress during the summer months (Patten et al. 1989) and post harvest in the previous season (Larson et al. 1988; Johnson et al. 1992; Kader 2002) were reported to increase the development of double fruit in the next season.

Many authors have observed a relationship between these physiological disorders and fertilization (Welensiek 1977; Luckwill 1980; Williams et al. 1987; Beppu and Kataoka 1999). Beppu and Kataoka (1999) also speculated that pistil formation might be related with hormones. Gibberellic acid (GA_3) sprays have been evaluated in many cherry growing regions to reduce the risk of crop loss by making fruit more resistant to cracking (Usenik et al. 2005; Cline and Trought 2007).

Research to determine the differentiation and development of sweet cherry flower buds has shown that floral initiation stars at the of June in Turkey under Aegean conditions. Inside the developing flower buds, pistil primordia, which ultimately develop into fruit, begin to take shape at the end of the August (Engin and Unal 2007). In this study, we report the subsequent effects of irrigation applied between May and September, and gibberellin and nitrogen applied in June and August on fruit crack, double fruit and deep suture formation in 'Van' sweet cherry. We also examine the response of the 'Van' sweet cherry fruits to these treatments.

Material and Methods

The experimental treatments were imposed on a commercial block of 25-year 'Van' cherry *(Prunus avium L.)* trees grafted on 'İdris' *(Prunus malaleb L.),* a common rootstock for sweet cherry in Turkey, located near the Horticulture Experimental Farm of Ege University, 45 m above sea level. The trees were planted at 5x5 m spacing and trained in a typical vase shape. All trees were cultivated the same, such as irrigation, pruning, fertilization, soil management and disease controlling. The soil contained 57 % sand, 22 % silt, and 21 % clay from a 0 to 30 cm depth, and 53 % sand, 21 % silt, and 26 % clay from 30 to 60 cm with 0.11 % total nitrogen and 2.7 % organic matter. Monthly average temperatures and total rainfall during the three years of the study (2003–2005) for the site (Anonymous 2006) are presented in Table 1.

Treatments

Treatments were imposed on five single-tree replications. Three irrigation treatments, differing in rate, were evaluated at ten day intervals. Basins were opened under the each canopy of the trees, and a ditch existed between them to distribute the water among trees. Water applied to each basin was measured using a flow meter connected to an irrigation pipe. Irrigation treatments were tested with 100 (I_{100}), 50 (I_{50}) and 20 % replenishment of water (I_{20}) depleted from 100 % replenishment treatment at 90 cm soil profile. The measured soil moisture level at I_{100} treatment was used to initiate the irrigation of cherry trees during the growing season. I_{50} and I_{20} irrigation regimes were applied at the rates of 50 and 20 %, respectively, of control treatments (I_{100}) on the same day. Soil water content was monitored gravimetrically in each 0.3 m layer down to a depth of 0.90 m for each treatment before each irrigation water application.

Irrigations were commenced on the fourth week of May and ended at the end of September each year. Trees were irrigated 12 times throughout the growing season. The amount for whole growing period for I_{100}, I_{50} and I_{20}, respectively was 1124.3, 562.1 and 224.8 mm in the first year, and 1076.8, 538.4 and 215.3 mm in the second year of the experiment.

The effective root zone of cherry was considered as 0.90 m. For the sweet cherry experiment area, water content at field capacity varied from 18.7 to 20.8 and wilting point varied from 10 to 11.5 % on dry weight basis. The dry soil bulk densities ranged from 1.3 to 1.7 g cm^{-3} throughout the 0.90 m deep profile.

Irrigation water applied during the experimental years was also analyzed (EC: 1220 dS m^{-1}; pH: 7; SAR: 1.09) and classified as C_3S_1. According the EC, PH and SAR values, it can be concluded that the water was suitable for sweet cherry irrigation.

Nitrogen (in the urea form) and gibberellin (GA_3) prepared separately in a tank were sprayed on the trees with a small sprayer at two growth stages (before flower bud differentiation period in June and during the flower bud differentiation period in August) at the doses of 100 and 900 mg L^{-1}, respectively, for a 2-year period (2003 and 2004). The trees were sprayed to run off, using an average of 6.8±0.47 l of solution per tree. Pure water was sprayed on the control trees. Data was obtained in following vegetation periods (2004 and 2005) at harvest time.

Measurements

Total fruits and fruits with cracking, deep suture and doubling on the tagged shoots 1.5 m above ground in each year were counted in June before harvest and the percentage of deep suture and double fruits were determined for each treatment.

Fruit weight was determined by the mean value of the 50 fruits collected. Fruit flesh firmness in these fruits was measured by a hand penetrometer (Effegi, FT 011, Italy) on the shaded part of the fruit over a wide diameter using a cylindrical tip (8 mm) (Karaçali 2002). Values were shown in Newton (N) force. The surface colour of cherry was measured with a Minolta CR-300 colorimeter (Minolta, Osaka, Japan). Measurements were recorded in L* (lightness), +a* (redness), +b* (yellowness) CIE (Commission Internationale de l'Eclairage) colour co-ordinates. hue (h*) values were calculated from a* and b* values using the equations

$(C^* = (a^{*2} + b^{*2})^{1/2};\ h^* = \tan^{-1}(b^* / a^*))$.

Colour attributes were measured at two different points on both sides of randomly chosen ten out of fifty cherries.

Total soluble solid content (%) of the fruits were measured with a refractometer (Atogo, ATC-1, Japan). Titratable acidity was determined with a pH meter (Mettler Toledo MP220, Germany) and expressed as g malic acid per 100 ml juice (Karaçali 2002). 50 fruits were used for these measurements.

Statistical analysis

The experiment was designed as a randomized parcels design with five single tree replications. Data were evaluated with SPSS for Windows (Chicago, USA, v. 13.0,) statistical package program and significance between the means was determined by Duncan's multiple range test.

Table 1. Monthly mean temperature and total rainfall values (2003–2005) (Anonymous 2006).

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
Mean temperature (ºC)												
2003	11.1	4.9	8.6	12.7	21.3	27.2	28.6	28.0	22.5	19.7	13.1	9.5
2004	7.1	8.2	12.2	15.7	20.3	26.5	29.0	27.8	23.8	19.8	13.2	10.7
2005	9.4	7.8	11.6	15.9	21.1	24.9	29.1	–	–	–	–	–
Total rainfall (mm)												
2003	112.6	153.3	12.1	109.7	8.5	0.8	0.0	0.0	0.0	68.5	18.0	95.6
2004	189.1	26.8	12.9	29.6	10.7	1.6	1.8	0.0	0.0	1.6	72.6	45.7
2005	111.4	191.8	71.5	13.8	71.7	40.0	0.3	–	–	–	–	–

Differences within the years and the treatments were tested.

Results

Effects on physiological disorders

Trees were exposed to three different irrigation regimes (severe and moderate water stresses, and full irrigation) with or without additional applications of nitrogen and gibberellin.

Irrigating trees at 50 % of full replenishment level resulted in the lowest amount of double fruits (35.6 %) compared to the other treatments (Table 2). However amongst the all applications, I_{50}+N+GA_3 application provided the highest gain (80 %) in healthy fruits. Both water stress and ample water gave same amount of double fruits. Gibberellin decreased doubling, while nitrogen increased it. Combination of the treatments (I+GA_3+N) provided less double fruits. Statistical analysis showed that doubling was under the influence of application year and treatment type.

Deep suture was most seen in the fruits exposed to moderate water stress plus nitrogen application (22.3 %) (Table 2). I_{20}+GA_3 application caused only 3.6 % fruits with deep suture. N and GA_3 resulted in different responses within each irrigation treatment. For example, N increased the incidence when the plants were exposed to severe or moderate water stress, but caused a decrease in the plants with adequate water. GA_3 decreased it in all the applications. The highest positive effect of gibberellin was obtained from the severely stressed plants (3.6 %). Combinations of the three applications (water+gibberellin+nitrogen) made a big difference in the amount of fruits with deep suture.

Fruit cracking was not affected by any of the applications (Table 2). Tree which received no water resulted in the highest ratio of cracked fruits. Nitrogen, gibberellin, and both generally decreased it. The best application was determined as the full irrigation supplemented with nitrogen.

Effects on fruit quality

All of the quality attributes of cherry fruits were statistically influenced by all the treatments and the yearly weather conditions. Statistical analysis of the fruit weight showed that great differences among the applications did not exist (Table 3). The heaviest and the lightest fruits were obtained from the moderate stress plus GA_3 application (8.91 g) and moderate water stress plus N application (6.75 g), respectively. When irrigation only was considered, moderate irrigation regime resulted in the biggest fruits. Trees under different irrigation schedules responded differently to nitrogen amendment, generally increasing the fruit weight. On the other hand, gibberellin caused an increase irrespective to the irrigation level. Combination of the applications exhibited a general increase in the fruit weight.

The mean values of firmness were lower for the cherries treated with GA_3 and N, except when trees received 50 % water plus N. Applying gibberellin and nitrogen did not change the general course. Water stress provided the hardest fruits overall (Table 3).

Statistical differences were not distinct in total soluble solids, titratable acidity and pH of the fruits (Table 4). The sweetest fruit was from I_{50}+GA_3+N application. Gibberellin or nitrogen did not create a big difference in sweetness. Nitrogen only decreased the TA when applied with moderate water.

Statistical differences for L, a, b and hue angle were found significant among the applications and between the years (Table 5). However, there was not great variability among the treatments for all four. The pattern of variability of a and b was very similar to that of L.

Table 2. Effect of irrigation, nitrogen and gibberellic acid on 'Van' sweet cherry fruit physiological disorders.

Treatment	Double fruit (%)			Deep suture (%)			Cracking (%)		
	2004*	2005*	Mean**	2004^{ns}	2005 ^{ns}	Mean*	2004 ^{ns}	2005**	Mean ^{ns}
I 20	48.7 ab	35.3 ab	42.0 ab	24.8	7.6	16.2 abc	6.4	5.9 bcd	6.1
I 20+N	25.1 bcd	33.3 ab	29.2 bcde	31.8	7.9	19.9 ab	4.5	6.7 bc	5.6
I 20+GA_3	21.6 cd	29.2 bc	25.4 de	0.0	7.1	3.6 c	4.8	5.3 bcde	5.0
I 20+GA_3+N	35.5 abcd	27.7 bc	31.6abcde	4.1	7.6	5.9 ec	3.0	4.4 cdef	3.7
I 50	38.8 abcd	32.3 ab	35.6 abcd	17.6	8.8	13.2 abc	0.0	7.0 b	3.5
I 50+N	43.9 abc	36.4 ab	40.2 abc	36.0	8.5	22.3 a	0.0	5.3 bcde	2.7
I 50+GA_3	29.3 abcd	27.7 bc	28.5 cde	15.8	9.5	12.7 abc	1.9	5.2 bcde	3.5
I 50+GA_3+N	17.3 d	21.7 c	19.5 e	10.4	8.6	9.5 abc	0.0	5.1 bcde	2.6
I 100	47.0 ab	37.1 ab	42.0 ab	25.0	5.6	15.3 abc	0.0	9.6 a	4.8
I 100+N	50.3 a	40.4 a	45.4 a	11.7	6.2	8.9 bc	1.9	2.7 f	2.3
I 100+GA_3	33.5 abcd	32.1 ab	32.8 abcd	8.8	6.3	7.5 bc	4.0	3.4 ef	3.7
I 100+GA_3+N	49.2 ab	31.6 abc	40.4 abc	9.1	6.8	7.9 bc	2.0	3.9 def	2.9
Mean	36.7 a*	32.1 b		16.2 a**	7.5 b		2.4 b**	5.4 a	

^{NS}, *, **, Nonsignificant or significant at P≤0.05, or 0.01, respectively.

Table 3. Effect of irrigation, nitrogen and gibberellic acid on 'Van' sweet cherry fruit weight and firmness.

Treatment	Weight (g)			Firmness (N)		
	2004**	2005*	Mean**	2004**	2005**	Mean**
I 20	7.53 cd[z]	6.69 cd	7.11 de	2.63 a	2.82 a	2.73 a
I 20+N	6.99 ef	7.48 bcd	7.24 de	2.31 def	2.62 b	2.47 bcde
I 20+GA_3	7.74 cdef	7.24 bcd	7.49 cde	2.39 bcdef	2.43 bcd	2.41 cde
I 20+GA_3+N	8.12 bc	8.34 ab	8.23 abc	2.53 abcd	2.41 cd	2.47 bcde
I 50	8.00 cd	7.24 bcd	7.62 bcd	2.29 ef	2.55 bcd	2.42 cde
I 50+N	7.10 def	6.39 d	6.75 e	2.55 abc	2.57 bcd	2.56 bc
I 50+GA_3	8.96 ab	8.85 a	8.91 a	2.22 f	2.47 bcd	2.34 e
I 50+GA_3+N	7.00 def	7.13 cd	7.07 de	2.32 cdef	2.47 bcd	2.40 de
I 100	6.89 f	7.70 abc	7.29 de	2.57 ab	2.60 bc	2.59 b
I 100+N	7.73 cdef	7.32 bcd	7.52 cde	2.46 abcde	2.53 bcd	2.49 bcde
I 100+GA_3	9.55 a	7.14 bcd	8.35 ab	2.49 abcde	2.55 bcd	2.52 bcd
I 100+GA_3+N	7.90 cde	7.50 bcd	7.70 bcd	2.40 abcdef	2.38 d	2.39 de
Mean	7.79 a*	7.42 b		2.43 b**	2.53 a	

NS, *, **, Nonsignificant or significant at P≤0.05, or 0.01, respectively.

Table 4. Effect of irrigation, nitrogen and gibberellic acid on 'Van' sweet cherry fruit quality parameters.

Treatment	TSS (%)			TA (g malic acid 100 ml^{-1})			pH		
	2004**	2005**	Mean**	2004**	2005*	Mean**	2004**	2005**	Mean**
I 20	20.0 d	20.3 ab	20.2 bcd	0.43 e	0.44 d	0.44 d	3.84 a	3.90 abc	3.87 a
I 20+N	20.2 d	20.1 bc	20.1 bcd	0.57 ab	0.50 abcd	0.54 ab	3.70 d	3.89 abc	3.80 bcd
I 20+GA_3	18.9 e	19.3 bcd	19.1 e	0.36 f	0.49 abcd	0.42 d	3.80 ab	3.94 a	3.87 a
I 20+GA_3+N	22.1 ab	19.2 cd	20.6 b	0.56 abc	0.47 bcd	0.52 abc	3.69 d	3.88 abcd	3.79 cd
I 50	21.8 ab	19.0 cde	20.4 bc	0.51 d	0.51 abc	0.51 bc	3.70 d	3.89 abcd	3.80 bcd
I 50+N	22.0 ab	19.3 bcd	20.6 b	0.52 cd	0.45 cd	0.49 c	3.69 d	3.82 de	3.76 de
I 50+GA_3	22.4 a	18.8 de	20.6 b	0.55 abcd	0.53 ab	0.54 ab	3.75 bc	3.85 bcde	3.80 bcd
I 50+GA_3+N	22.6 a	21.6 a	22.1 a	0.50 d	0.49 abcd	0.50 c	3.76 bc	3.91 ab	3.84 ab
I 100	22.2 a	17.9 ef	20.1 bcd	0.54 bcd	0.49 abcd	0.51 bc	3.78 b	3.86 bcde	3.82 bc
I 100+N	20.6 cd	19.3 bcd	19.9 bcd	0.59 a	0.50 abcd	0.55 a	3.69 d	3.83 cde	3.76 de
I 100+GA_3	21.5 abc	17.6 f	19.6 de	0.58 ab	0.52 abc	0.55 a	3.64 e	3.83 cde	3.74 e
I 100+GA_3+N	21.0 bcd	18.5 def	19.8 cde	0.54 abcd	0.54 a	0.54 ab	3.72 cd	3.81 e	3.77 de
Mean	21.3 a**	19.2 b		0.52 a**	0.49 b		3.73 b**	3.87 a	

NS, *, **, Nonsignificant or significant at P≤0.05, or 0.01, respectively.

Discussion

The effect of water availability in the root zone of cherry trees treated with or without gibberellin and nitrogen on fruit disorders and quality was studied. Generally, the frequency of occurrence of deep suture and double fruits in 2004 was higher than 2005. This might have been due to high temperature during flower bud differentiation. In western part of Turkey, flower bud initiation of sweet cherry starts at the end of June (Engin and Unal 2007), followed by floral primordium developing in the order of sepal and petal. Beppu and Kataoka (1999) reported that the buds are most sensitive to high temperatures (above 30 °C) at the beginning of floral differentiation. In this study, temperature increases during this stage, which shows a parallelism with an increase in deep suture and double fruit. The frequency of fruit cracking in 2005 was higher than 2004 because of the rain around the harvest. Doubling under water stress regime was the same as under full irrigation regime. Beppu and Kataoka (1999) stated that high temperature

Table 5. Effect of irrigation, nitrogen and gibberellic acid on 'Van' sweet cherry fruit colour.

Treatment	L* value			a* value		
	2004**	2005*	Mean**	2004*	2005*	Mean**
I 20	41.17 ab	39.66 abc	40.42 a	36.58 ab	32.78 a	34.68 a
I 20+N	37.62 c	38.11 abcd	37.87 bcd	32.46 abc	31.26 abcd	31.86 abcd
I 20+GA_3	42.83 a	36.12 cd	39.48 ab	37.15 a	28.07 bcd	32.61 ab
I 20+GA_3+N	37.40 c	37.22 bcd	37.31 bcd	31.50 bc	30.09 abcd	30.80 bcd
I 50	37.61 c	39.07 abc	38.34 abc	32.05 bc	32.26 abc	32.16 abc
I 50+N	37.72 c	40.78 a	39.25 ab	32.96 abc	33.94 a	33.45 ab
I 50+GA_3	35.63 c	36.69 bcd	36.16 cd	29.58 c	27.78 cd	28.68 c
I 50+GA_3+N	35.99 c	35.36 d	35.67 d	30.49 c	27.23 d	28.86 cd
I 100	36.71 c	40.87 a	38.79 ab	31.12 c	33.16 a	32.14 abc
I 100+N	38.17 bc	39.48 abc	38.83 ab	34.45 abc	31.74 abc	33.10 ab
I 100+GA_3	36.15 c	39.80 ab	37.97 bc	30.71 c	31.93 abc	31.32 abc
I 100+GA_3+N	38.25 bc	39.05 abc	38.65 ab	34.61 abc	32.47 ab	33.54 ab
Mean	37.94^{ns}	38.52		32.81 a**	31.06 b	

Treatment	b* value			Hue Angle		
	2004**	2005*	Mean**	2004**	2005**	Mean**
I 20	17.90 ab	15.12 abc	16.51 a**	26.09 ab	24.73 abc	25.41 a
I 20+N	13.55 c	13.36 abcde	13.46 b	22.45 bcde	23.06 abcd	22.76 ab
I 20+GA_3	20.54 a	10.47 de	15.50 ab	28.92 a	20.40 de	24.66 ab
I 20+GA_3+N	12.89 c	12.10 bcde	12.50 c	22.15 cde	21.86 bcde	22.01 bc
I 50	13.31 bc	14.39 abcd	13.85 ab	22.55 bcde	24.02 abcd	23.29 ab
I 50+N	13.86 bc	16.78 a	15.32 ab	22.76 bcde	26.29 a	24.53 ab
I 50+GA_3	11.06 c	11.08 cde	11.07 c	19.51e	20.81 cde	20.16 c
I 50+GA_3+N	11.61 c	9.45 e	10.53 c	20.83 de	19.02 e	19.93 c
I 100	12.36 c	15.68 ab	14.02 ab	21.63 de	25.22 ab	23.43 ab
I 100+N	14.85 bc	14.20 abcd	14.53 ab	23.31 bcd	23.99 abcd	23.65 ab
I 100+GA_3	14.77 bc	14.46 abcd	14.61 ab	25.68 abc	24.34 abcd	25.01 a
I 100+GA_3+N	15.03 bc	14.39 abcd	14.71 ab	23.47 bcd	23.87 abcd	23.67 ab
Mean	14.31 ^{ns}	13.46		23.28 ^{ns}	23.13	

^{NS}, *, **, Nonsignificant or significant at $P \leq 0.05$, or 0.01, respectively.

rather than lack of water is a critical factor in the formation of double pistils in 'Satonishiki' sweet cherry.

However, trees response to GA_3 or N in terms of doubling varied under different irrigation schedules. When trees were under moderate water stress or full irrigation, N application raised the occurrence. GA_3 response was more in the decreasing direction in all three irrigations. Higher temperatures in the second year of the experiment also played a role in this increase. It has been reported by the works of TUKEY (1954) and JOHNSON et al. (1992) that water stress coupling with warm conditions caused an increase in the occurrence of double pistils in peach and apricot.

Deep suture in the fruits was not directly under the influence of watering. Similar ratios of fruits with deep suture were obtained with water stress and full irrigation, but slight decrease was observed in moderate irrigation. Hot temperatures during July–September in 2003 and 2004 might have caused an increase in this disorder. SOUTHWICK and UYEMOTO (1991) correlated closely the slight increases in average daily temperature in July, August, and September with increased incidence of deep suture in Bing cherries. They also stated that in order to reduce this incidence, regular irrigation is required and water stress during the growing period from late June to early September should be kept to a minimum. In this study, trees that had moderate water showed the lowest amount of fruits with deep suture. SOUTHWICK et al. (1991) stated in their study that due to the effects of varying water supply between April and September, deep suture was the most prevalent fruit abnormality and regional differences existed.

In 2004, trees receiving 50 % water did not have any cracked fruits, however in the second year; the occurrence was spotted due to the rain near harvest. This is expressed as the common problem by TROUGHT (1986). Water stress caused more fruit cracking compared to the other irrigation schemes. Application of nitrogen or gibberellin decreased the occurrence. DEMIRSOY and BILGENER (1998) also stated that gibberellin treatment decreased cracking indices.

The extent to which environmental conditions, management practices or other factors cause yearly differences of fruit quality remains uncertain (CLAYTON et al. 2003). The subsequent effects of the irrigation, gibberellin and nitrogen on the fruit yield and quality components did not result in definitive differences in our study, however there were statistical significances among the applications and within the application year. Water stress made a statistically distinct difference in fruit firmness only. The other components were not greatly influenced by the irrigation treatments. The use of GA_3 increased fruit firmness at harvest, in agreement with the results of CHOI et al. (2002) and KAPPEL and MACDONALD (2002). Fruit weight of 'Van' sweet cherries, in contrast to the findings of DEMIRSOY and BILGENER (1998), but in agreement with those of BASAK et al. (1998), increased with GA_3. When changes between the years respective to the irrigations were considered, gibberellin spray was effective on pH, soluble solids and titratable acidity and not effective on colouring.

Nitrogen application also inflicted different effects on various aspects of the quality depending on the irrigation regime. Its one stable effect was reduction of pH. FILLERON (2004) who studied three cultivars of cherry reported that the qualities of the fruits were not affected by the nitrogen applications. BUSSI et al. (2003) stated that pre-harvest applications of N and K in plum did not influence vegetative growth, yield or average fruit weight, but tended to reduce fruit soluble solids and colouring. Our results show that effect of N on the fruit quality was depended on the water available to the trees. It can also be speculated that the effects were dependent on timing or dosage of nitrogen application.

Conclusion

These results suggest that physiological disorders seen in the sweet cherry fruits were influenced more by irrigation, gibberellin or nitrogen applications compared to the quality components of the fruits. Trees under moderate water stress produce the lowest amount of abnormally shaped fruits without further need for any external application of gibberellin and nitrogen. This also reduces the expense. When summer temperatures are not excessive and trees are supplied with ample water, the chance of obtaining more normal flower and fruit will increase.

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