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IRRIGATION AND MULCHING EFFECTS ON LEMON PEEL PROPERTIES

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ABSTRACT : The peel is a natural package that protects the flesh from insect and microbial invasion and limits water loss and gas exchange. Marketing of lemon depends on the peel quality, thus, for the peel to become marketable, it must form and develop with few defects and be resilient enough to maintain its integrity on the tree and during postharvest storage. Moisture regulation is of utmost importance to get aimed fruit quality in lemon. As lemon is challenged with serious problem of fruit cracking which is directly related with peel parameters so timely scheduling of irrigation and moisture conservation needs to be emphasized on priority. To study the impact of moisture regulation, an experiment was laid out in Randomized Block Design comprising of six irrigation treatments with and without mulching at "Punjab Government Progeny Orchard & Nursery, Attari, Amritsar" during the fruiting years 2005 and 2006. Use of black polythene as mulch in combination with frequent irrigation after 3 days influenced the peel parameters the most.

Keywords: *Lemon, black polythene, irrigation, mulching, peel.*

Lemon is principal acid citrus fruit used for culinary and non-culinary purposes throughout the world, primarily for its juice, though the pulp and peel are also used in cooking and baking. Lemon peel is an excellent source of fibre, potassium, magnesium, calcium, folate and beta carotene. Lemon peel contains about 5 to 10 times more vitamins than lemon juice. Lemon peel improves bone health as it contains high amount of calcium and vitamin C. When lemon peel is consumed it prevents various types of cancers, including skin cancer, colon cancer and breast cancer.

The fruit growers face many problems in cultivating lemon crop. One such problem is fruit cracking which is a long lasting problem and directly depends upon the peel parameters. The peel resistance and plasticity, determines the intensity of cracking and the location of the cracks (Knoche and Peschel, 9).It has been assessed that during the phase of cell enlargement, if the peel does not restart its growth, when the pulp expansion takes place, the fruit splits. The texture of peel attains ability to resist the pressure of the expanding juice vesicles. The moisture regulation and conservation creates favourable conditions for continued growth of peel for a longer span, making it sufficiently elastic to keep pace with the internal growth of pulp thereby, resisting pressure to split or crack.

Although a number of factors, both external and internal, are responsible for this malady but the peel parameters such as peel thickness are considered most responsible for the disorder. The soil moisture seemed to be major contributing factor in maintaining the peel quality. The weak peel offers stress on peel when pulp expands (Meng, 11), thus peel strength in terms of thickness is an important parameter. Morgan (12) advocated that sufficient water availability is a crucial factor for healthy citrus production. Peel thickness increases by avoiding the wide variation in soil moisture depletion, applying copious and regular irrigation during fruiting season (Measham, 10) along using some moisture conservation practices. As the fruit splitting is most likely to occur shortly before maturity when rain or irrigation follows a period of drought, thus, reducing the irrigation interval during peak summer period and the use of black polythene as mulch, results in healthy peel that restores appearance and storability (Bisht and Kumar, 2)

MATERIALS AND METHODS

The plant material for investigation was selected from "Punjab Government Progeny Orchard & Nursery, Attari, Amritsar". In the trial, eight year old, uniform and disease free trees of lemon were selected to study the effect of various irrigation and mulching treatments on lemon peel. The experiment was laid out in Randomized Block Design having six treatments replicated thrice during both the experimental years (2005& 2006).

Treatment details

T_1-Irrigation at 10-15 days interval (control)

T_2-Irrigation at 7 days interval

T_3-Irrigation at 3 days interval

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T_4-Irrigation at 10-15 days interval and mulching with black polythene sheet

T_5-Irrigation at 7 days interval and mulching with black polythene sheet

T_6-Irrigation at 3 days interval and mulching with black polythene sheet

The randomly harvested fruits were hand peeled and peel thickness was measured in millimeter with the help of Vernier Caliper. The mean peel thickness was calculated by taking the average of peel from 10 fruits. To determine the moisture content, the fruits were peeled off. The weight of peel was taken and then kept in the oven at 65ºC till a constant dry weight was obtained. The moisture content was expressed as the per cent of fresh weight of the peel of fruit. Chlorophyll 'a' and chlorophyll 'b' from the peel was determined by spectrophotometer (Arnon, 1). The spectrophotometer used was Hitachi U-2880, which is double beam spectrophotometer. The concentration of chlorophyll 'a' and 'b' was calculated by using the following formula :

Chlorophyll 'a' (mg/g of fresh weight)

$$= 12.7\,(A_{663}) - 2.89\,(A_{645}) \times \frac{V}{1000 \times W}$$

Chlorophyll 'b' (mg/g of fresh weight)

$$= 22.9\,(A_{645}) - 4.86\,(A_{663}) \times \frac{V}{1000 \times W}$$

Where, 'A' is the absorbance of chlorophyll extracts at the desired wavelength.

'V' is the final volume of the solution.

'W' is the weight of the sample taken.

Potassium and Calcium content of peel was determined by digesting these samples in di-acid mixture of nitric acid and perchloric acid in the ratio of 3:1. Potassium was estimated by flame photometer as described by Champman and Pratt (3) while Calcium was determined by atomic absorption spectrophotometer.

RESULTS AND DISCUSSION

It can be clearly observed from the data (Table 1 and 2) that the peel thickness increased with every increase in the irrigation intensity and use of mulch during the two respective years of present investigation.The maximum peel thickness *viz.* 2.03 mm during 2005 and 2.06 mm during 2006 was recorded in the fruits of T_6 treatment while it was minimum (1.53 mm and 1.56 mm) in those trees irrigated at 10-15 days interval (control). Josan *et al.* (8) reported increase in peel thickness with increasing number of irrigations in lemon. Increase in peel thickness may be due to favourable change in the microclimate of the trees which were irrigated frequently. Better supply of water results in the prolonged growth of the peel. Decicco *et al*. (4) also reported increase in rind thickness of Navelina orange which was having more total available soil moisture. Mulching has significant effect on rind thickness of oranges (Ghali and Nakhalla, 6) as well as quality of strawberry (Singh *et al.,* 13). It is concluded that small increase in the rind thickness might have increased the resistance to fruit cracking.

Garcia-Luis *et al.* (5) studied the anatomy of the fruit in relation to the propensity of citrus species to split. The conflicting reports quoted by them indicate fruit splitting is a complex phenomenon which may be determined by a combination of factors. In this report, the anatomical characteristics of cultivars prone to splitting and those of cultivars which usually do not split have been compared. The relationship between anatomy of the fruit and splitting was further explored in hybrid Nova, comparing the characteristics of non-split and split fruits and the effect of hormone treatments both on splitting and the anatomy of the fruit. They described that fruit splitting results from the physical pressures of the rapidly expanding juice vesicles on the peel layers. These pressures stretch the albedo layer (mesocarp), whose cells enlarge tangentially during the period of rapid pulp growth while their radial diameter decreases and may lead eventually to peel collapse and cracking. The intensity of the stresses generated by the pressures, together with peel resistance and plasticity, determines the intensity of cracking and the location of the cracks. On theoretical grounds, it may be expected that an increase in peel thickness should increase the mechanical resistance of the peel and reduce splitting.

The moisture content of peel exhibited an increasing trend with increasing irrigation intensity. The highest moisture content of peel in lemon was reported in T_6 where it was recorded as 77.80 and 78.66 per cent respectively during both the trial years. Josan (7) reported increase in moisture content of peel with more irrigation. The increase in moisture content of peel might be due to better supply of water to various fruit parts during active growth period owing to ample availability of water with frequent irrigations. The present results of moisture content of peel and pulp in lemon are in corroboration with the findings of Josan (7). The practice of mulching also resulted in retaining

soil moisture and better water supply resulting in increased moisture content of peel.

The maximum level of chlorophyll 'a' was recorded to the tune of 7.33 mg/100g fresh weight in first year and 7.28 mg/100g fresh weight during the second year with the application of irrigation at 3 days interval coupled with black polythene mulch. During both the years of study, the minimum chlorophyll 'a' content was obtained in control giving values 6.72 and 6.67 mg/100 g fresh weight. The trend for chlorophyll 'b' was also similar during both the evaluation years the highest value of 5.71 and 5.66 mg/100 g fresh weight in T_6 fruits. The content decreased with dryness or decreased irrigation intensity. Chlorophyll content of peel was higher under all irrigation and mulching treatments though it was maximum under treatment T_6 and minimum under control. The lower chlorophyll content of fruits under control was due to early maturation of the fruits in control than under various irrigation and mulching treatments where the maturation was delayed. Tomer and Singh (14) also reported increase in the chlorophyll content of leaves in Pant Lemon-1 when irrigation was done frequently.

The calcium content in peel was highest in fruits of control treatment T_1 viz. irrigation at 10-15 days interval, to the tune of 1.10 per cent during first trial year and 1.11 per cent during second year. The level of calcium content in peel was quite low in T_6 (1.02 per cent and 1.03 per cent). The perusal of the data presented in Table 1 and 2 clearly indicate that the irrigation and mulching treatments failed to produce any significant effect on potassium content of peel as majority of the treatments were statistically at par with each other. The highest value of potassium content of peel to the tune of 0.74 per cent during 2005 and 0.76 per cent during 2006 was recorded with application of irrigation at 3 days interval and mulching with black polythene sheet *viz.* T_6. Tromp (15) also reported similar findings in apple that uptake of potassium increased under increasing water availability so the increase in potassium content of peel as observed in the present investigations may also be because of enhanced uptake of potassium due to increased water supply as

Table 1: Effect of irrigation and mulching on peel characters of lemon fruit during 2005.

Treatment	Peel thickness (mm)	Moisture content of peel (%)	Chlorophyll 'a' (mg/100g fresh weight)	Chlorophyll 'b' (mg/100 g fresh weight)	Calcium content of peel (%)	Potassium content of peel (%)
T_1	1.53	73.53	6.72	5.09	1.10	0.66
T_2	1.73	75.00	6.97	5.30	1.08	0.69
T_3	1.90	76.10	7.19	5.53	1.04	0.70
T_4	1.73	74.85	6.96	5.28	1.09	0.68
T_5	1.86	75.80	7.16	5.45	1.05	0.70
T_6	2.03	77.80	7.33	5.71	1.02	0.74
CD (P=0.05)	0.11	0.30	0.12	0.15	NS	0.03
CV %	3.51	0.23	0.99	1.63	3.86	2.94

Table 2 : Effect of irrigation and mulching on peel characters of lemon fruit during 2006.

Treatment	Peel thickness (mm)	Moisture content of peel (%)	Chlorophyll 'a' (mg/100g fresh weight)	Chlorophyll 'b' (mg/100 g fresh weight)	Calcium content of peel (%)	Potassium content of peel (%)
T_1	1.56	74.66	6.67	5.04	1.11	0.67
T_2	1.76	76.13	6.92	5.22	1.10	0.70
T_3	1.93	77.08	7.10	5.48	1.05	0.72
T_4	1.73	76.07	6.91	5.23	1.11	0.68
T_5	1.90	76.86	7.03	5.36	1.06	0.71
T_6	2.06	78.66	7.28	5.66	1.03	0.76
CD (P=0.05)	0.08	1.37	0.13	0.12	NS	0.04
CV %	2.58	0.99	1.10	1.24	4.36	3.40

compared to control. The low level of calcium in peel may be due to its competitive absorption with potassium. In the present studies, low calcium content in peel could be attributed to less translocation of calcium than potassium.

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