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Would Kaolin Particle Film Avoid Sunburn in " *Ardestani* " Pomegranate

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ABSTRACT

In this study we aimed to reduce pomegranate losses because of sunlight injury in khorasan razavi province, Iran. Midday temperatures in summer may rise above 45˚C in this area causing sunburn damage to the fruits, which may object losses of up to 28% of the total yield. Processed kaolin (Khorasan Kaoline Co.) Sprayed over the whole canopy and fruits four times at 12 – 16 days intervals from early July to early September. All applications done at 6% of kaolin suspension. The resulting white coating significantly reduced fruit surface temperatures mean from 35.44˚C in control to 29.3˚C. Sunburn damage of fruits decreased from 22.35 % in control to 15.30 % in the kaolin treated fruits. Beside the total reduction in sunburn injury of fruits, kaolin reduced the severity of sunburn. Sunburned fruits in kaolin treated trees had lower intensity of injury in comparison to control, significantly.

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INTRODUCTION

The pomegranate (*Punica granatum* L.), an ornamental plant which has been popular among Mediterranean peoples for centuries., which is native to Iran and the Himalayas, produces delicious and edible fruits, and belongs to the Punicaceae family [10]. Pomegranates (*Punica granatum* L.) widely cultivated in the warmest areas of the Mediterranean basin, southern Asia and Middle East where summer air temperatures normally rise above 40◦C. This tree species is well adapted to marginal lands and arid soils. Pomegranates sold as whole fruits, but exposure of the fruit to intensive sunlight can cause sunburn damage in the form of large black spots on the fruit skin, which deliver the fruit unmarketable. Pomegranates are especially sensitive to sun because they are terminal-bearing plants, with thin branches that bend with the increase in fruit weight as the season progresses [9].

Several approaches could be taken to reduce sunburn instance in fruits. Cultivation of plant cultivars with higher leaf surface and better shading over the fruits, or those with more resistant fruits to sunburn is one way to avoid sunlight damage. Fertilization and irrigation regimes that increase vegetative growth and development which improve protection of the fruits from direct sunlight exposure is another solution to sunburn which is limited to available water and fertilization costs. We can shelter trees and fruits from sunlight direct exposure, with screens and shades. This way is too expensive and will be good only for high value fruits [9,5,6,11].

Materials drew up to have paint-like properties like kaolin, aluminum silicate and whitewash have been successfully used to reduce sunburn and sunlight injury for decades. The conditions that cause solar injury include high air temperature and solar radiation (UV 195–400 nm; PAR 400–700 nm; IR >700 nm) [7].

Critical fruit surface temperatures for sunlight injury occurrence reported by different studies. 38 °C for walnut, 50°C for muskmelons, 42°C for raspberry, 40°C for tomatoes, 46–49°C for browning and 52°C for necrosis of apple skin [8,13,7,2,6]. In the present paper we report on our results on sunburn reduction in pomegranates.

The application of a kaolin particle film reduces fruit temperature with tools of evaporative cooling and fewer direct sunlight happening on fruit surface. Decreases in fruit surface temperature can be correlated to the amount of kaolin residue on the fruit surface [7]. A 5 to 10 °C decrease in midday fruit surface temperatures by a kaolin based particle film was reduced almost 100% in some studies and had no effect in others, while the

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general trend was around a 50% decrease in sunlight impelled fruit damages which are varied by location and cultivar [8].

MATERIALS AND METHODS

To test kaolin impact on fruit sunburn of pomegranate fruits, an experiment conducted on a commercial orchard in khorasan razavi province, Iran. Two concentrations (zero and 6%) of processed Kaolin particle film sprayed on *Ardestani* cultivar of pomegranate as a liquid suspension, which evaporates, leaving powdery film on the surfaces of leaves, stems and fruits.

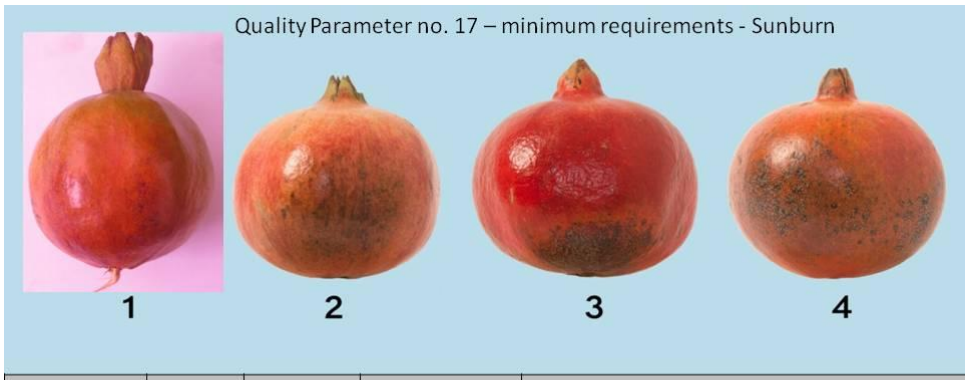
Treatments arranged in a randomized block design with 3 replications. Conventional spray equipment used to gain good coverage to increase efficacy. Kaolin suspension sprayed over the whole canopy and fruits four times at 14 – 20 days intervals from early July to mid September. To keep powder film thickness on plant organs steady.

Number of sunburned fruits was collected during harvest period and ratio of injured fruits by sun to total fruit number of the tree reported as sunburn percentage. Marketable fruit number was calculated using following formula:

Marketable fruit number = Total fruit number of the tree – sunburned fruit number – fruits infected with pests – cracked and damaged fruits

To examine sunburn severity of damaged fruits, an standard quality parameter of pomegranate was used [4]. In this quality standard sunburn damage of pomegranate was classified in four groups, I: very slightly have sunburn injury, II: sunburned slightly and a little color change in some injured parts of fruit. III: sunburn injury is greater and color change of peel from red to brown spread in fruit surface, IV: more than half of fruit surface affected by sunburn injury. While two first classes are acceptable, class III and IV are out graded and have not minimal costumer acceptance (Figure 1).

JMP 10.0th edition was used for all statistical analysis at probability level of 1 %.



Extra Class Cat. "Extra"	Class I Cat.I	Class II Cat.II	Out of Grade Non conforme	Notes
-	1	2	3,4	Sunburn is a skin defect. In sever cases it might cause an arils color defect. In such case it should be rejected.

Fig. 1: Standard Quality parameter for sunburn in pomegranate, according to [4]. Fruits are graded in 4 groups, two acceptable classes and two out of grade classes.

RESULTS AND DISCUSSION

Table 1, shows significant effects of kaolin treatments on fruit temperature, sunburn injury and marketable fruit number. Kaolin treatments yielded a larger percentage of good quality fruit than the controls. Since marketable fruits from the control treatment accounted for 26.32% of the yield, the kaolin treatment resulted in a 39% increase of marketable fruits (65.04%).

Kaolin treatment significantly decreased sun made injuries on fruit around 7 % of total yield (from 22.35 % in control to 15.30 % in the kaolin treated fruits) which improve total income of farmers (Table.1).

Table 1: Effect of different kaolin treatment on sunburn, fruit temperature and marketable fruit number.

		Sunburn (Fruit number)	Sunburn (% of total fruit)	Fruit Temp. (C)	Marketable Fruit number
Kaolin	0%	19.22 ^{a}	22.28 ^{a}	35.45 ^{a}	22.78 ^{a}
	6%	13.22 ^{b}	15.3 ^{b}	29.3 ^{b}	56.12 ^{b}
L.S.D : 2.97684 , means with different letter in same column are significantly differ at α : 0.01.					

The kaolin coating significantly reduced fruit surface temperatures mean from 35.44˚C in control to 29.3˚C in 6 % of kaolin treatment. Either, this decline could be one major reason that sunburn has lower quantities in kaolin sprayed fruits (Figure 2). In the other hand as it believed that kaolin significantly decrease fruit exposure to UV radiation [7], it could be also important to reduce fruit sunburn. Results of our study on effectiveness of kaolin particle film coating in fruit temperature and sunburn reduction, is similar to those gained in trials and commercial use of different kaolin based formulations on apple [7,13,5], pomegranate [9], tomato [2], walnut [1] pear [12,3] and grape [11].

To understand the sunburn injury severity, total sunburned fruits of both control and 6 percent kaolin treatment classified in 4 groups. Analysis of data showed that sunburn occurrence in kaolin treated fruits, were significantly lower than control treatment (Table 2).

Table 2: Effect of different kaolin treatment on sunburn severity.

		Sunburn Severity classification			
		Class I	Class II	Class III	Class IV
Kaolin	0%	2.3122	10.3289	41.7344	45.61
	6%	30.3711	58.2456	9.9422	1.4344
L.S.D : 2.14479 , α : 0.05					

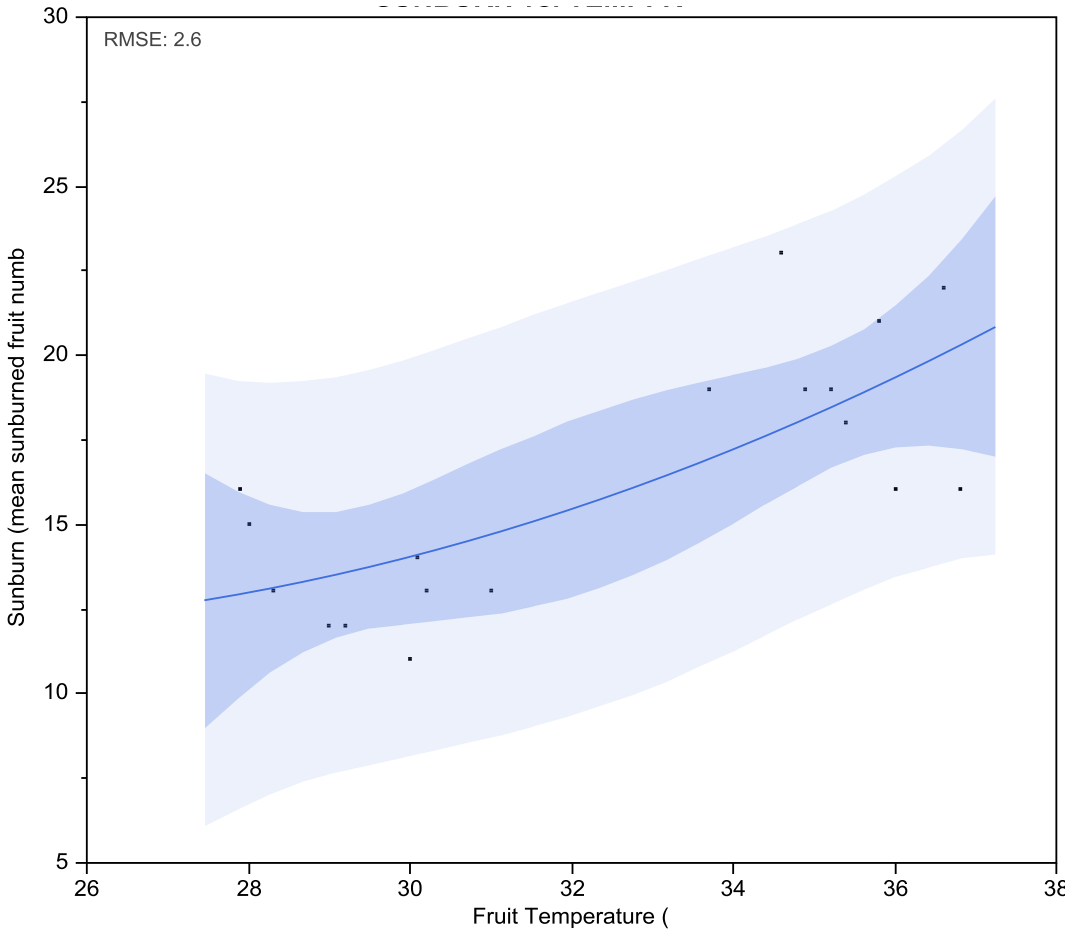


Fig. 2: Fruit temperature and sunburn relationship in *ardestani* pomegranate. ■ mean number of sunburned fruits, Line of Fit, the area around fit line are the confidence of fit and confidence of prediction at 95% confidence. as much as fruit temperature reduces, sunburn injury does.

In table 2, percentage of sunburned fruits in each class for both treatments showed that 6 percent kaolin treatment successfully reduced severity of sun injuries in *ardestani* pomegranate.

Many different reasons could result in fruit damage. Pests, unsuitable irrigation which cause fruit cracking and white seeds, direct sunlight and high temperatures that make fruits burned and different tools and methods applied to lower them to have more profitable. Expensive methods are not recommended. Finding a solution to some of these troublemaking reasons would be more satisfactory.

Kaolin based products like Surround and so many that used around the world in agriculture seems to be the best known solution because of its reported physiological benefits for plant. Higher net photosynthesis because

of lower temperature, better radiation and water use efficiency [8]. it also have some problems, like its residuals on fruit after harvesting that could be easily disappear with a simple cleaning prior to packaging and we think it is not a major problem.

The biggest problem in kaolin application come to those fruits like pomegranate that have a special skin surface that make kaolin powder residues unstable and so increases spray replications. Solvents and surfactants are applicable but it is important to use some safe products which would not harm human and environment.

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