EFFECTS OF KAOLIN CLAY PARTICLE FILM ON LEAF TEMPERATURE, NUT TEMPERATURE AND SUNBURN SUSCEPTIBILITY IN WALNUT

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ABSTRACT

Sunburn occurred most frequently on the southwest corner of the tree in indentations in the lower canopy positions where heat tended to be trapped. Continuous light exposure in the 2-3pm (Pacific daylight savings time) period was required for sunburn to develop. Kaolin clay particle film was effective in lowering leaf and nut temperatures but the levels of sunburn observed in this trial would not have justified use of kaolin clay particle film from economics considerations of sunburn prevention alone. Perhaps if the kaolin clay particle film were being used for pest control as well, it may have been economically viable but this was not part of the current study.

PROCEDURES

Kaolin clay particle film was sprayed on Chandler, Howard, Tulare and Vina walnuts. Trees were planted in 1999 at a spacing of 22' by 22'. Applications were made on June 14, June 20, and July 26 at the rate of 50 lbs./200gpa with a Nelson Hardee 6800E spray rig driven at 2.5 mph..

Nut and leaf temperatures were monitored with a handheld infrared thermometer (Raytek MX2- close focus, Fluke Corp., Everett, WA USA 98206) and with thermocouples attached to Campbell Scientific CR10 and CR10X dataloggers (Campbell Scientific, Logan, Utah 84321).

On August 16, 17, 20 and 21st, light incident on individual leaves and nuts was measured with GaAsP photosensors (Hamamatsu, Japan), connected to a datalogger (DL2e, Delta-T Devices Ltd, Cambridge, UK). Instantaneous light level readings were taken every minute.

Overall orchard sunburn was evaluated by assessing the levels of minor, moderate and severe sunburn on the lower one third of the canopy. Sunburn was assessed by counting sunburned nuts (20 trees per variety) on July 22, 2006 in each of the four quadrants separately, northeast, southeast, southwest, and northwest.

RESULTS AND DISCUSSION

Walnuts appear to have a temperature damage threshold for sunburn around 50°C (Fig. 1). Because July 17, 2006 was not hot enough for sunburn to occur naturally, two methods were used to induce damage. Once discoloration of the hull occurred, either by burning the hull with a propane torch or placing it inside of an aluminum reflective chamber, the temperature of the nut climbed above 50°C rapidly and sunburn damage resulted. It is not clear if this effect was due to the physical discoloration leading to increased energy absorption, or due to tissue death and lack of ability to cool the nut physiologically. In either case, once discoloration of the nut occurred, the damage cycle began and the nut rapidly deteriorated.

Kaolin was effective in lowering leaf and nut temperature and preventing sunburn damage in walnut. Fig. 2 shows the temperature of exposed nuts that were either untreated or sprayed with kaolin clay particle film. The temperature of the kaolin treated nuts was only about 2 to 4°C lower than the untreated nuts but his was enough to keep it below the damage threshold of about 50°C. Notice in Fig. 2 that the high sheltered air temperature on July 22, 2006 was about 40°C (104°F) but the untreated nut temperatures reached 51°C (124°F). Lower canopy shaded nut temperatures were at or slightly below ambient temperatures.

Sunburned nuts occurred most frequently in the lower canopy on the southwest corner of the tree where there was an indentation in the canopy where heat was likely trapped. A period of uninterrupted sunlight on the nut for about 1 hour in mid-afternoon was most likely to result in sunburn. Even brief interruptions in the light from a shadow of an adjoining branch passing over the nut were enough to prevent sunburn. This suggests that tree training and pruning could be utilized to minimize the conditions where sunburn is likely to occur. The worst sunburn occurred on trees with southwest facing exposed nuts where the tree in the adjacent row to the west was smaller in stature.

Severely sunburned nuts tended to have an uninterrupted period of direct sunlight hitting them in the 2-3pm period (daylight saving time; Fig. 3a). Nuts that were moderately (Fig. 3b) or mildly sunburned (Fig. 3c) had a similar exposure to severely sunburned nuts but had the sunlight hitting them interrupted by shadows of overhanging branches and/or leaves giving intermittent periods of shade (Fig. 3b). Healthy green nuts generally did not have long periods of uninterrupted PAR during the mid-afternoon period (Fig. 3d). Healthy green nuts from interior canopy positions had limited direct PAR (Fig. 3e) and these are nuts that our previous work has shown are susceptible to becoming shriveled and/or oilless nuts.

The varietal susceptibility to sunburn is shown in Fig. 4. The highest levels of sunburn in both control and particle clay treated trees occurred in Howard followed by Chandler, Tulare and Vina. Howard trees were generally smaller and hence had more chance for the nuts to be in PAR conditions likely to cause sunburn. Sunburn was most common on the southwest quadrant followed by the southeast quadrant. Little sunburn occurred in the northeast or northwest quadrants. This suggests that spray applications should be concentrated on the southwest and to a lesser degree southeast quadrants for maximum benefit.

The levels of sunburn observed in this trial would not likely have led to an economical use of kaolin under these conditions. If the particle clay film were being used for pest control as well as sunburn protection, it may have been economically viable but this was not part of the current study.

Acknowledgements

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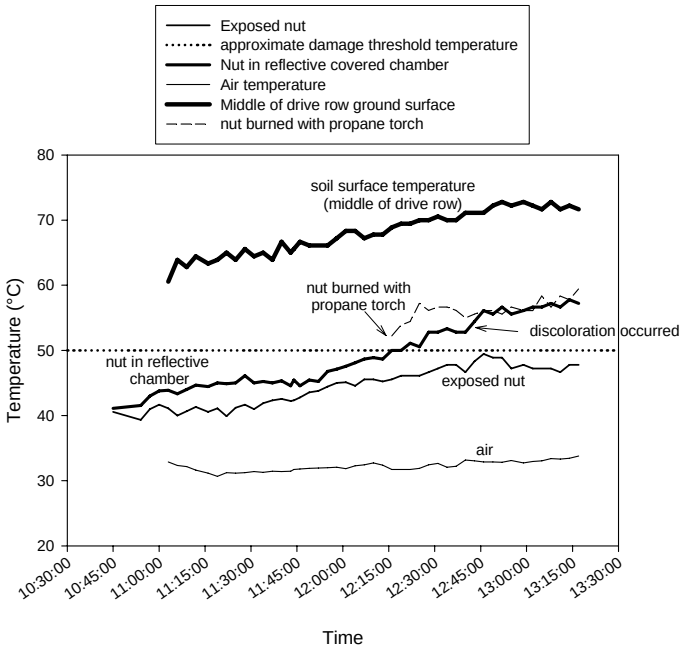

Fig. 1. Temperatures of air, exposed nut, nut in aluminum foil reflective chamber, nut burned with propane torch, and soil surface on July 17, 2006. High air temperature of 33.7°C is equal to 93°F and damage threshold of 50°C is equal to 122°F. Maximum soil surface temperature of 72.8°C is equal to 163°F.

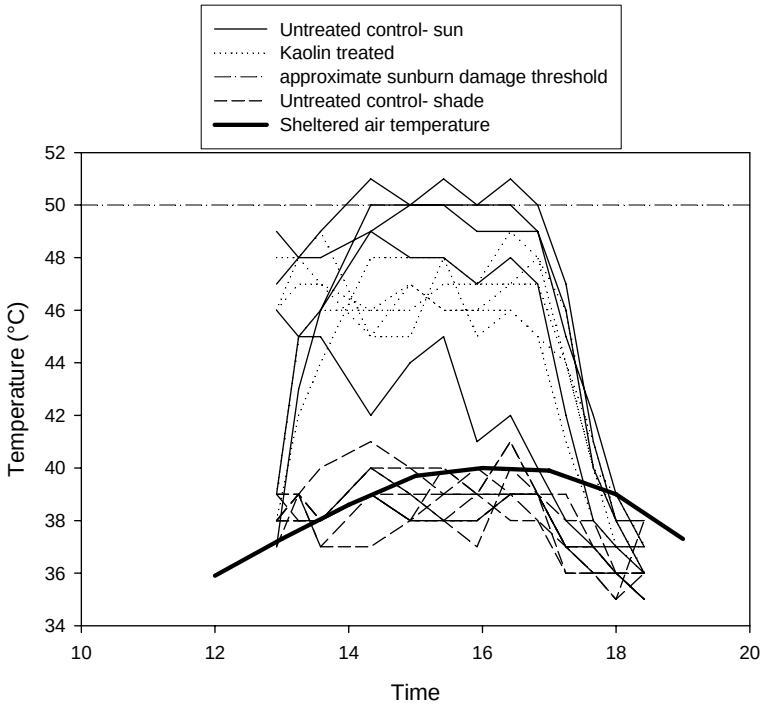

Fig. 2. Surface temperature of sun-exposed nuts, sun-exposed nuts treated with kaolin, and shaded nuts on July 22, 2006. Approximate damage threshold of 50°C is indicated. High air temperature was 104°F.

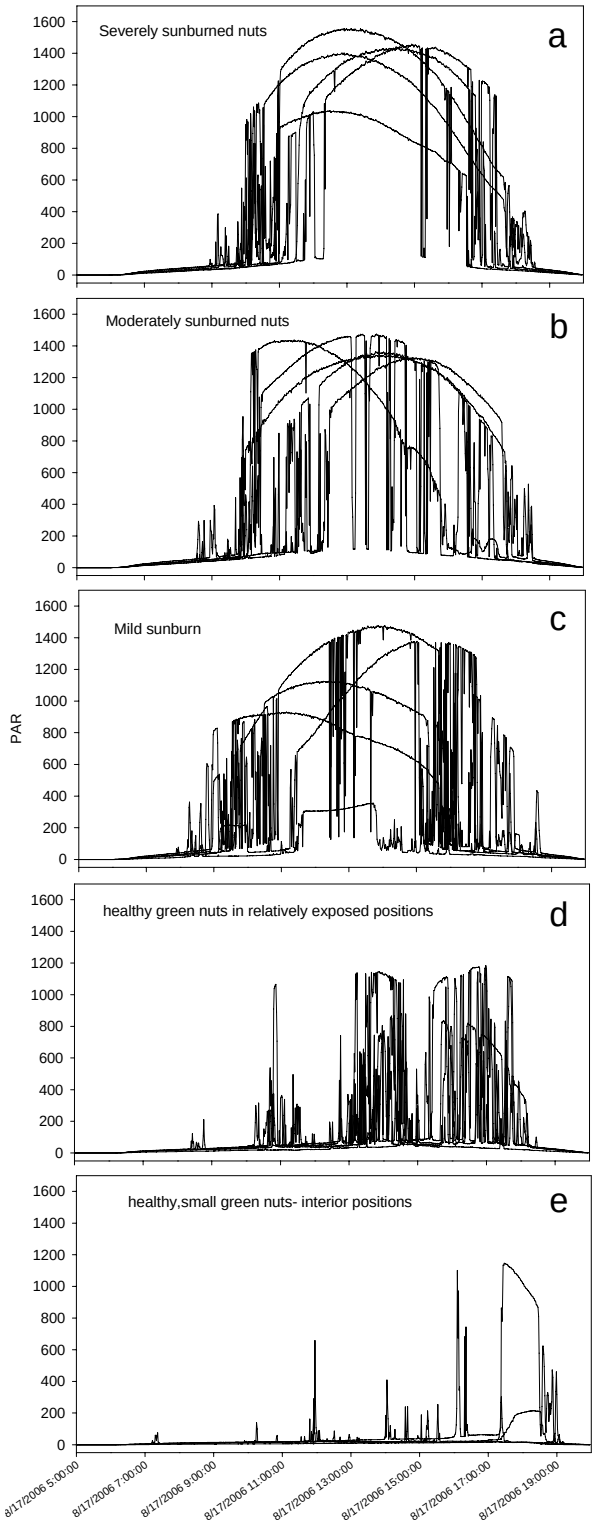

Fig. 3. Photosynthetically active light incident on severely sunburned nuts (a), moderately sunburned nuts (b), mildly sunburned nuts (c), healthy green nuts in relatively exposed positions (d), and healthy small green nuts in interior canopy positions (e). All measurements were on the Vina variety.

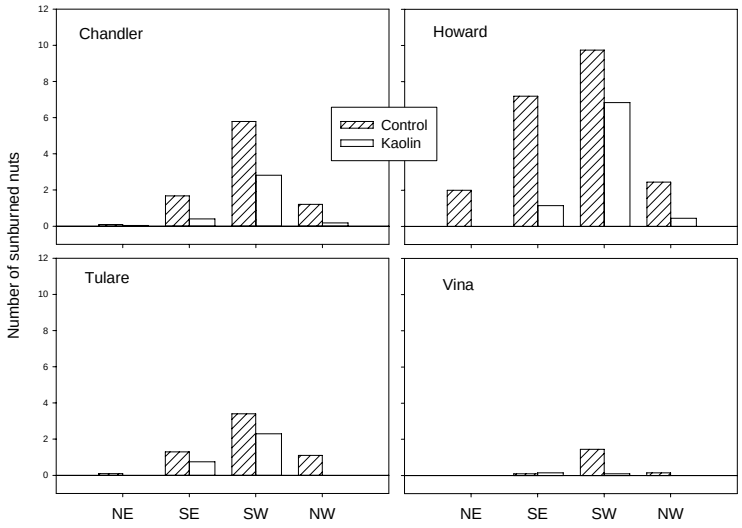

Fig. 4. Number of sunburned nuts per tree by canopy orientation for Chandler, Howard, Tulare and Vina walnuts. Nuts were rated in bottom one third of canopy only but this is where the majority of sunburn occurred.