Evaluation of *Pistacia vera* 'Pete I' yield characteristics

C. Allan[1], C.H. Crisosto[1], T. Michailides[2], G.S. Brar[3] and L. Ferguson[1]

[1]Department of Plant Sciences, University of California, Davis, One Shields Avenue, Davis, CA 95616, USA; [2]Kearney Agricultural Research and Extension Center, 9240 South Riverbend Avenue, Parlier, CA 93648, USA; [3]Fresno County Cooperative Extension, 550 E. Shaw Avenue, Suite 210, Fresno, CA 93710, USA.

Abstract

California's 300,000 acre pistachio industry consists of over 90% *Pistacia vera*. Cultivars with different harvest timing would relieve the pressure on processing facilities. A recently identified cultivar, 'Pete I' harvests earlier, but is producing unacceptably high percentages of early season aborted nuts, which abscise, as well as partially filled and blank nuts. Both overload the hullers and float tanks. Field observations suggested insect pressure and/or fungal infestation. In an insect exclusion study, flower buds were both covered by insect-impermeable mesh and left uncovered on the 'Pete I' trees for the season until harvest. The resulting clusters showed no significant difference in the final percentage of aborted nuts between the bagged and unbagged samples. Laboratory plating of early- and mid- season nuts for fungal pathogens detected none beyond background levels. Therefore, high percentages of blanking and partially filled nuts in the 'Pete I' pistachio cultivar were not due to either insect or fungal pressures. Other possibilities are pollen or ovule incompatibility, or self-thinning through embryo abortion.

Keywords: insect exclusion, blanking, botrytis, excessive aborting, nut quality

INTRODUCTION

The pistachio industry continues to grow in California and new cultivars with increased nut size, shell split percentages, and yields are slowly being introduced. One of the new cultivars that have been planted in commercial orchards is 'Pete I'. This pistachio cultivar is patented with the description of a white shell, high split percentage and large nut size (US PP17836 P3). In practice, this cultivar has been shown to have a high percentage of blank and partially filled nuts. The former decreases yields and the latter overloads hullers and float tanks in the processing plant.

This project investigated the potential hypotheses for these problems. The first hypothesis was that early season *Lygus hesperus* and *Calocoris norvegicus* insect damage was producing the early aborted nuts. *Lygus* and *Calocoris* are known pests of California pistachios (Goodell and Bentley, 2003). *Lygus* have piercing sucking mouthparts that damage young pistachio fruits prior to shell hardening. *Calocoris* are a more recently introduced invasive pest that prefer legumes, alfalfa and weeds but can also damage pistachios (Rice and Bentley, 2003).

Another suggested cause of early nut abortion is *Botrytis cinerea*. *Botrytis* is an endemic fungus with the ability to infect the floral structures or enter a fruit through damaged areas. It can remain dormant until susceptible host tissue is available and conditions are suitable for growth (Elmer and Michailides, 2004).

Our objective was to determine if insects or fungi were the cause of early embryo abortion and blank nuts in the 'Pete I' pistachios. The method used for the insects was exclusion studies. The method used to detect fungal pathogens was laboratory studies of early season nut samples on nutrient media to detect the presence of fungal pathogens.

MATERIALS AND METHODS

Insect exclusion

Five 'Pete I' orchards throughout California's San Joaquin Valley between latitudes 36.7

and 35.5°N and longitudes 120.9 and 119°W were selected for sampling. In each site, 10 branches among 4 trees were bagged with insect excluding cages before bud break. These cages were sprayed weekly, alternating between the pyrethroids bifenthrin and β-cyfluthrin. At harvest the bags were removed and the clusters inside were dissected for the percentages of fully set and matured nuts and aborted nuts compared to the nuts from the unbagged clusters. These data were also compared to 'Pete I' grower data (processor grade sheets) from the surrounding orchards to verify our filled split and aborted nut counts of the unbagged clusters were representative of the surrounding orchards.

***Botrytis* plating**

'Pete I' pistachio samples showing early stages of abortion (small nut sizes, necrosis) were selected from six trees in four orchards throughout the San Joaquin Valley of California. The first samples were taken at early nut set April 21, 2014 and the second sample taken 2 months later on June 16, 2014. These samples were brought to the lab and the nuts removed from the peduncle. The fruitlets were dipped in a 10% chlorine solution for 2-3 min and stirred to remove air bubbles. By tree the fruitlets were dried in a laminar flow hood on triple paper towels for 20 min. Ten fruitlets were plated in 90 mm diameter petri plates containing 15 mL of acidified potato dextrose agar. The plates were then incubated at 20°C for 4-5 days and the number of *B. cinerea* colonies developed were recorded.

RESULTS AND DISCUSSION

Insect exclusion

There was no significant difference in the average percentage of filled split nuts between the bagged and unbagged clusters of 'Pete I' trees (Figure 1). The bagged clusters averaged 66.8% filled split nuts versus 68.3% for the unbagged clusters (p-value 0.272 at 95% CI). This result suggests that insect pressure was not causing nut abortion during the season. The percentage of filled nuts with the desirable shell split for 'Pete I' in the four experimental sites based on grower data averaged 56% whereas the same average for the industry standard 'Kerman' cultivar averaged 78.5% (data not shown). Finally, these filled split percentages were consistent with those reported by the growers and managers for the surrounding orchard blocks. These collective data confirm that insect damage was not the cause of the young nut abortion during the season, or the high percentage of blanks at harvest, observed in the 'Pete I' cultivar. However, the bags did appear to decrease the number of nuts per cluster. This could be because the early selection of the bagged floral buds resulted in a more limited selection of final clusters while the unbagged samples were more plentiful and selected on nut presence. There could have also been a shading effect of the bag on the success of the nut setting within the cluster.

***Botrytis* plating**

There was no excessive presence of *Botrytis cinerea* or any other pathogen present in any of the sites with 'Pete I' showing early aborting nuts. This suggests that the early embryo abortion was not due to fungal pathogens.

In the sites 1, 3, and 5 there was no *Botrytis* present on the fruitlets. *Alternaria* was present in all platings and was within expected ranges, based on previous studies. Other fungal spores were identified, but all these fungi are commonly found in pistachio orchards and one would expect to isolate them, and none posing a great risk to the fruit development (Table 1).

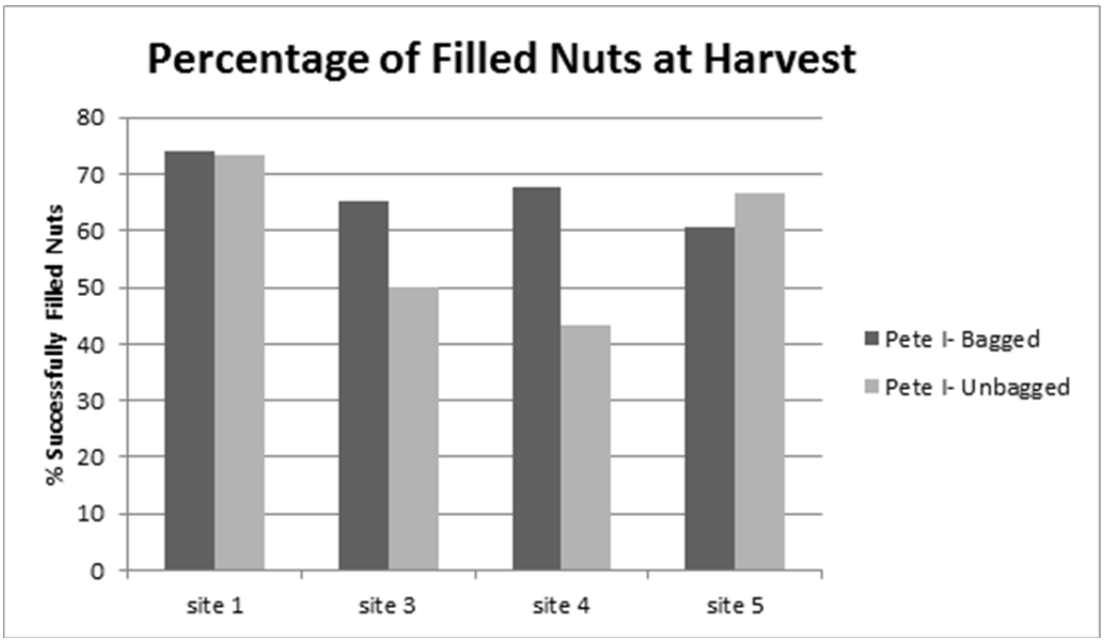

Figure 1. Percentages of filled nuts in bagged and unbagged 'Pete I' samples. 'Kerman' unbagged samples are used as a control reference. There was no significant difference in the percentage of filled split nuts between the bagged and unbagged samples of Pete I nut at the four different sites.

Table 1. Distribution of fungal growth following plating of young fruit after sampling on June 16, 2014.

Site	Percentage of nuts with:
1	20% *Alternaria*; 3% *Penicillium*; 1% *Epicoccum*; 1% *Aspergillus niger*
3	42% *Alternaria*; 10% *Aspergillus niger*; 4% *Fusarium;* 2% *Cladosporium*
4	10% *Alternaria*; 2.5% *Botrytis*; 2.5% *Fusarium*; 2.5% *Aspergillus niger;* 20% *Cladosporium*
5	8% *Alternaria*; 4% *Rhizopus*; 4% *Aspergillus niger*; 2% *Fusarium*

CONCLUSIONS

The pistachio cultivar 'Pete I' is not aborting nuts as a response to either insect or fungal pressures. Another explanation may lie in the physiology of this particular cultivar which sets a large amount of nuts early in the year and not having the carbohydrate stores or photosynthate to maintain the growth of all the fruitlets. This idea is currently being tested through a thinning study. If thinning improves the final yield and split percentage of 'Pete I', further efforts should be made to see if this new cultivar is economically viable in the California pistachio industry. Recent studies using microscopy to identify the root causes of early nut abortion suggest that a lack of an embryotic sac in the inflorescence could lead to blanking and early abortion of the nut is most likely caused by a funicular degeneration that blocks sap flow to the young ovule (Shuraki and Sedgley, 1996). The failure of a growing seed to fill the pericarp is still unclear, however, it is suggested that this partial-fill is most likely caused by a nutrient imbalance or by environmental pressures (Meinke and Sussex, 1979).

ACKNOWLEDGEMENTS

We would like to acknowledge the California Pistachio Research Board for their continued funding and for William Seaman and the 'Pete I' growers for their funding and support. Also thanks to all the growers and managers that have donated their trees for this research.

Literature cited

Elmer, P.A.G., and Michailides, T.M. (2004). Epidemiology of *Botrytis cinerea* in orchard and vine crops. In Botrytis: Biology, Pathology and Control, Y. Elad, B. Williamson, P. Tudzynski, and N. Delen, eds. (Dordrecht, The Netherlands: Kluwer Academic Publishers), p.243–272.

Goodell, P.B., and Bentley, W.J. (2003). Lygus bugs. In Pistachio Production Manual, L.E. Ferguson, ed. (Oakland, USA: Univ. Calif. Div. Agr. Natural Resources).

Meinke, D.W., and Sussex, I.M. (1979). Embryo-lethal mutants of *Arabidopsis thaliana*. A model system for genetic analysis of plant embryo development. Dev. Biol. *72* (*1*), 50–61 http://dx.doi.org/10.1016/0012-1606(79)90097-6. PubMed

Rice, R., and Bentley, W. (2003). Neurocolopus and Calocoris. Pest, Disease and Physiological Disorders Management. Fruitsandnuts.ucdavis.edu/files/73701.pdf.

Shuraki, Y., and Sedgley, M. (1996). Fruit development of *Pistacia vera* (*Anacardiaceae*) in relation to embryo abortion and abnormalities at maturity. Aust. J. Bot. *44* (*1*), 35–45 http://dx.doi.org/10.1071/BT9960035.