# IMPLEMENTATION OF CATTS TREATMENT USING BOXED/PALLETIZED PEACHES AND NECTARINES

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Forced hot air combined with a controlled atmosphere consisting of 1% oxygen and 15% carbon dioxide (CATTS) has been previously shown to be an effective quarantine treatment that does not adversely affect stone fruit quality provided that fruit of good initial quality are used for the treatment (Neven et al., 2006; Obenland et al., 2005). For successful implementation by the stone fruit industry in California, however, the treatment must be adaptable to industry practices so that it can be economically viable. Bulk treatment in bins is not favored by the California industry as, without additional handling steps, it would result in some fruit being treated that did not require a quarantine treatment. Another problem is that special enclosures around the packing and treatment areas would be needed to guard against reinfestation following treatment. As a result of these issues, we have worked to adapt the treatment that we have developed using bin treatments into one can handle boxed fruit stacked onto pallets. This treatment format would eliminate the problematic issues and also would fit perfectly into current industry practices. This report presents research to evaluate the effect on insect efficacy and fruit quality of CATTS treatment of nectarines in a large, specially-constructed chamber capable of simultaneously treating two full pallets of fruit.

Commercially-packed nectarines (size 48-50) were repacked into vented single-layer boxes and allowed to warm to 23 °C. A total of 144 boxes for each of the 3 replicate runs per variety were stacked onto one of the pallets inside the chamber while the other pallet was blocked off to lessen the amount of fruit needed. Conditions for the CATTS treatment were as specified in the APHIS treatment manual (T601-1-1) with the exception of the chamber heating rate which was increased from 12 °C/h to 18 °C/h in an attempt to compensate for the lesser degree of airflow present in the large chamber as compared to laboratory conditions. After treatment the fruit were placed into storage at 1 °C for 3 weeks and then ripened prior to quality evaluation. Some of the key quality parameters that were evaluated are shown in Table 1. Negative effects of treatment were noted in all three of the nectarine varieties evaluated with the percentage of marketable fruit being significantly reduced by treatment in Fire Pearl and August Pearl, with an increase in decay being the predominant cause in Fire Pearl. August Pearl and Arctic Pride also both exhibited a large amount of browning around the pit that was easy visible in the white-fleshed fruit. None of the other quality parameters were significantly affected by treatment. There was a substantial amount of variation in the temperatures experienced by different boxes in the pallet stack during the fruit quality experimentation with the fruit cores in the coolest measured box reaching 43 °C over 40 minutes later that the hottest box (Figure 1). Boxes on the outside of the stack tended to heat up faster than those on the inside. These temperature differences were probably due to poor airflow and likely contributed to the loss in fruit quality as longer treatment times were needed to compensate for the uneven heating. The average total treatment duration needed for the large chamber was just over 30 minutes longer than that needed for treating the same fruit on a small scale under laboratory conditions.

In order to evaluate the effectiveness of the system in achieving insect mortality a test was conducted using peaches artificially infested with 4$^{th}$ instar oriental fruit moth larvae. This stage of insect development had been previously determined to be the most tolerant to CATTS treatment (Neven et al., 2006). The treatment protocol was altered for this test to require a final core temperature of 43.5 °C and a hold time at that temperature of 15 minutes based upon prior testing of large chamber heating rates. Three replications, each replication representing a separate treatment of one pallet, were conducted. Twenty-five boxes of infested fruit were randomly interspersed within the pallet stack for each of the replications, with there being in excess of 3,200 larvae per replication. Upon evaluation of the initial replication it was found that there were survivors and that the overall mortality rate was 98.1%. Examination of the treatment temperatures present in the individual infested boxes indicated that all but two boxes reached the desired temperature and hold time. However, since only 2 out of the 24 fruit in each infested box were monitored for temperature during the treatment run it is possible that some of the fruit which had survivors did not receive the required treatment. For replication 2 and 3 a longer hold time at the final core temperature of 45 minutes was used which resulted in 100% mortality.

<u>Summary</u>

- Fruit quality was adversely affected by treatment in the large-scale CATTS chamber, mainly in the form of greater surface injury and browning around the pit.
- Insect efficacy could be achieved with this system but at a treatment level that would likely cause unacceptable quality loss.
- The problems with treatment of stone fruit in a boxed/palletized format appear to be primarily due to the fact that the boxes impede airflow, leading to large temperature differences among fruit at different positions in the pallet.
- Further changes in box and/or chamber design to improved airflow through the boxes are needed for this adaptation of CATTS treatment to be successful.

Neven, L.G., L.M. Rehfield-Ray, and D. Obenland. 2006. Confirmation and efficacy tests against codling moth and oriental fruit moth in peaches and nectarines using combination heat and controlled atmosphere treatments. Journal of Economic Entomology. 99: 1610-1619.

Obenland, D., P. Neipp, B. Mackey, and L. Neven. 2005. Peach and nectarine quality following treatment with high-temperature forced air combined with controlled atmosphere. HortScience. 40: 1425-1430.

Table 1. Nectarine fruit quality following large-scale CATTS treatment. Values are the means from all boxes within the pallet stack.

| Variety | Treatment | Marketable (%)[z] | Decay (%) | Brix | Acidity (%) | Firmness (lbs.)[y] | Internal Browning (%)[x] |
|---|---|---|---|---|---|---|---|
| Fire Pearl | Control | 90.3a | 7.9a | 12.8a | 0.48a | 2.1a | 0.10a |
| | CATTS | 76.4b | 19.1b | 13.4a | 0.39a | 5.2a | 0.17a |
| | | | | | | | |
| August Pearl | Control | 94.9a | 4.1a | 15.0a | 0.24a | 2.2a | 0.5a |
| | CATTS | 87.1b | 8.4a | 15.2a | 0.27a | 3.9b | 11.6b |
| | | | | | | | |
| Arctic Pride | Control | 95.0a | 1.7a | 14.9a | 0.22a | 1.6a | 3.0a |
| | CATTS | 88.6a | 2.0a | 14.9a | 0.22a | 5.0b | 30.9b |

Comparisons of treatments followed by different letters are significantly different ($P \leq 0.05$).
[z]Refers to surface quality only
[y]Measured after 2 days of ripening
[x]Percentage of fruit with unacceptable internal browning

Figure 1. Minutes required to heat probed fruit core temperatures to 43 °C in the individual boxes. View is facing the ends of the boxes with each of the two layers side-by-side (left = rear, right = front). Values represent the means from three experiments with three replicate runs per experiment. The shading indicates if the box heated at a fast (darkest shade), intermediate (lighter shade) or slow (no shading) rate relative to the other boxes. Airflow alternated from one side to the other.

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 160 | | 177 | 148 | | | | | |
| | 151 | | 139 | | 127 | 151 | 151 | |
| | | | | | | | 146 | |
| | 164 | | | | | 145 | | |
| 142 | 165 | | 163 | | 135 | | | 139 |
| | | 160 | | | | 147 | 147 | |
| | 154 | | | | | 153 | | |
| 152 | | | 148 | | | | | |
| 155 | | | | | 142 | | 151 | 143 |
| | | | | | | 146 | | 142 |
| | | | | | | | 151 | |
| | 158 | | | | | 154 | | |
| | | | | | | | | |
| 158 | | | | | 145 | | | 131 |
| | | | 151 | | | 156 | | |
| | | 166 | | | | | 155 | |
| | | | | | | 147 | | |
| 138 | | 161 | 141 | | 142 | 157 | 168 | 134 |