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# Respiration of Whole Fruit and Seed of Avocado at Various Stages of Development[1]

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**ABSTRACT. 'Fuerte' avocado fruits at all development stages show a similar climacteric pattern; however, with development, the post-harvest pre-climacteric becomes progressively shorter. The respiration rate of seeds is higher in young than in mature fruits when determined separately from that of the whole fruit. It is concluded that the contribution of seed respiration to whole fruit respiration decreases with development over the growth season.**

As the climacteric pattern of respiration is considered to be related directly to the ripening processes in mature avocado fruits, it was of interest to determine whether a climacteric was present at the immature stages of fruit development, and whether a parallel softening of the fruit would take place.

For some fruits harvested at early stages of development a climacteric pattern of respiration and symptoms of ripening have been found. For example, in immature cantaloupe McGlasson and Pratt (5) and in tomato Lyons and Pratt (4), found that when fruit were treated with ethylene or when endogenous ethylene was present at threshold value respiration and symptoms of ripening occurred. Wang and Hansen (7) report that softening of immature 'Anjou' pears could occur without development of the climacteric respiration pattern. These fruits, however, ripen either on the plant or after harvest, while avocado fruit does not ripen when still attached to the tree (1). Thus, it is of great interest to study the behavior of young avocado fruits. Also, because the respiration of the seed during development has not been reported, this aspect was included in the study.

## Materials and Methods

The experiments were carried out during a 3-year period with the cv. Fuerte at various stages of development, ranging from young fruit (about 60 g wt) harvested in June, to mature fruit harvested during the normal harvest season, from November to March. The seasonal results were basically similar, therefore only data for the 1968-69 season are presented. At each examination date, 3-5 replicates were tested. Either a large or several small fruits, with a total wt of 230 g, were placed in 2-liter glass containers. The total wt of the seeds in each container was about 200 g. Respiration rate of fruit and seed was determined by the method of Biale and Shepherd (2), and Biale (1).

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*Table 1.* General characteristics of the fruit used in experiments.

| | Harvest date 1968-69 | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | June | July | August | September | November | December | January | February | March |
| Avg wt of fruit (g) | 61 | 165 | 225 | 227 | 227 | 236 | 234 | 235 | 260 |
| Avg wt of seed (g) | 8 | 18 | 38 | – | – | 46 | – | – | – |
| Avg oil content of fruit (%) | 1.3 | 1.7 | 6.5 | 7.2 | 11.5 | 14.9 | 16.2 | 19.0 | 21.7 |

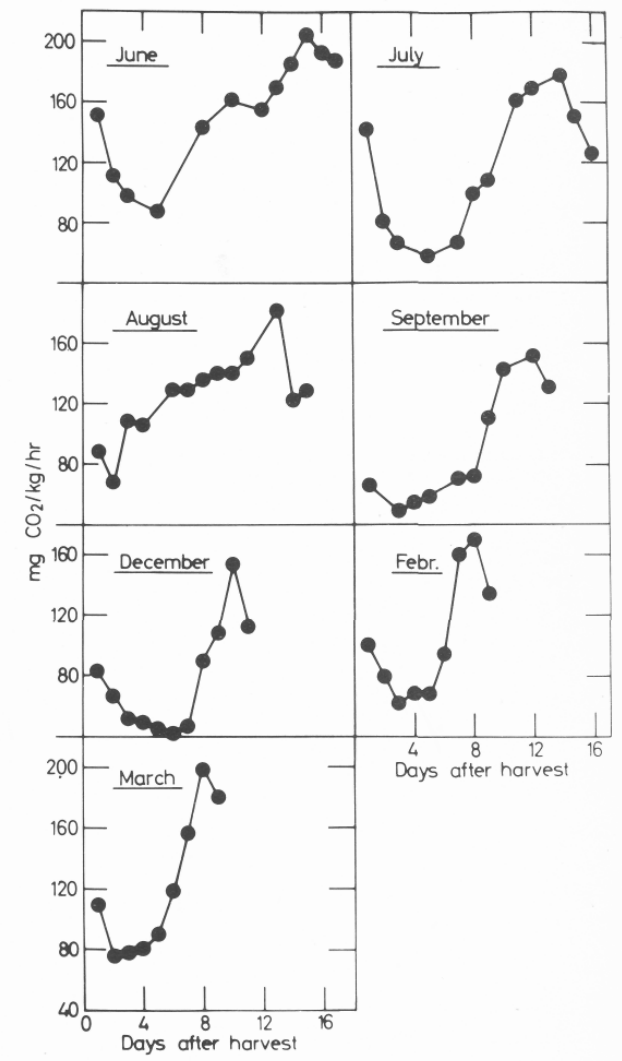


*Fig. 1.* Respiration rate of fruit at various stages of development.

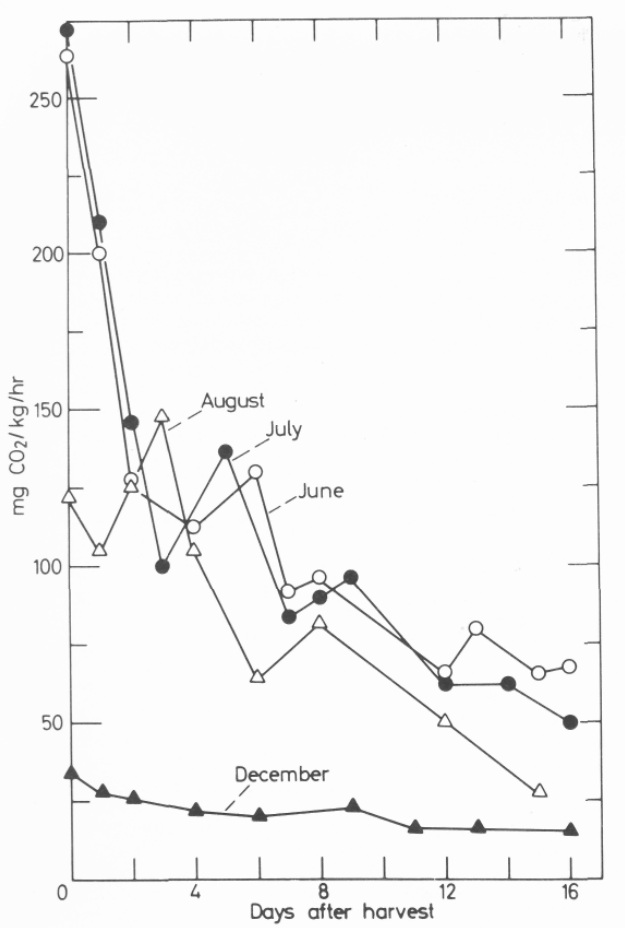


*Fig. 2.* Respiration of seeds separated from avocado fruit at various stages of development.

## Results and Discussion

**RESPIRATION OF FRUITS.** Fruits at all stages of development showed a similar climacteric respiration pattern; however, as development progressed, the climacteric peak appeared earlier. In fruits harvested in June, August, December and March, the climacteric peak appeared after 15, 13, 10 and 8 days respectively (Fig. 1). A

shortening of the period from harvest until the appearance of the climacteric peak has been reported previously in mature avocado fruit, during the commercial harvesting season (3). Maximal respiration rates for fruits at various stages of development measured in the present study were in the range 160 - 200 mg $CO_2$/kg/hr.

Initial respiration rates on the day of harvest declined as development progressed, ranging from 140 - 150 mg$CO_2$/kg/hr to 70 - 100 mg $CO_2$/kg/hr (Fig. 1). High respiration rates in fruit at early developmental stages were observed by Todd et al. (6) in 'Hass'.

The beginning of fruit softening is discernible at all stages of development 1 - 2 days after the climacteric peak. It is noteworthy that the activity of pectolytic enzymes at early stages of fruit development was similar to that in mature fruits, during ripening and softening (submitted for publication). Nevertheless, all of the changes, the processes occurring in young fruit during softening cannot be considered strictly as normal ripening. This is apparent in the lack of full taste in the fruit as well as in the low oil content. Such fruit have no edible qualities.

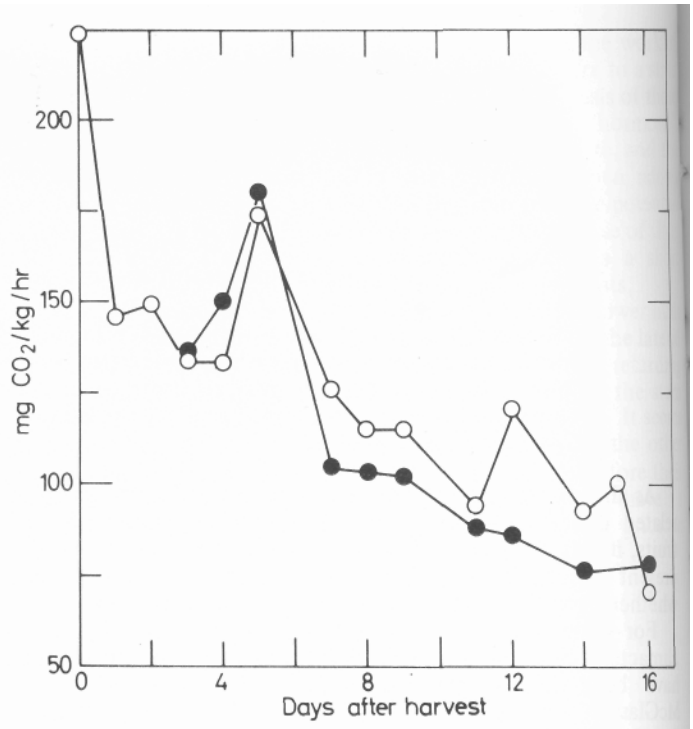


*Fig. 3.* Respiration rate of seeds separated from fruits at different intervals after harvest. ○ Seeds separated at the day of harvest. ● Seeds separated 4 days after picking.

**RESPIRATION OF SEEDS**. The respiration of seeds separated from fruit decreased during storage, following harvest. The respiration rate of seed from immature fruits (June to August) declined rapidly, while in mature fruit it was low and decreased at a moderate rate (Fig. 2). Ben-Yehoshua[2] found similar values in seeds separated from mature 'Hass' fruits. The respiration rate of seeds the 1st day after harvest, separated from fruits harvested in June and July, was 250-270 mg $CO_2$/kg/hr; in August, about 120 mg $CO_2$/kg/hr; and December about 30 mg $CO_2$/kg/hr (Fig. 2). Tests were conducted to find out if high seed respiration rate immediately after separation was not a result of the separation act per se. It was found that the respiration pattern of seeds separated from fruit on harvest day was similar to that of seeds separated several days later (Fig. 3).

The ratio between respiration rates of fruits and seeds changed during fruit development. The contribution of seed respiration to that of the whole fruit is higher in young fruit harvested in June, than in mature fruit harvested in December (Fig. 4).

[2]Ben-Yehoshua, S. 1961. Induction of the ripening process in avocado fruit. Ph.D. Thesis, University of California, Los Angeles.

We conclude that respiration pattern and rates are basically similar in avocado fruit at various stages of development; softening of the fruit occurs shortly after the climacteric peak. The contribution of seed respiration to whole fruit respiration changes with fruit development.

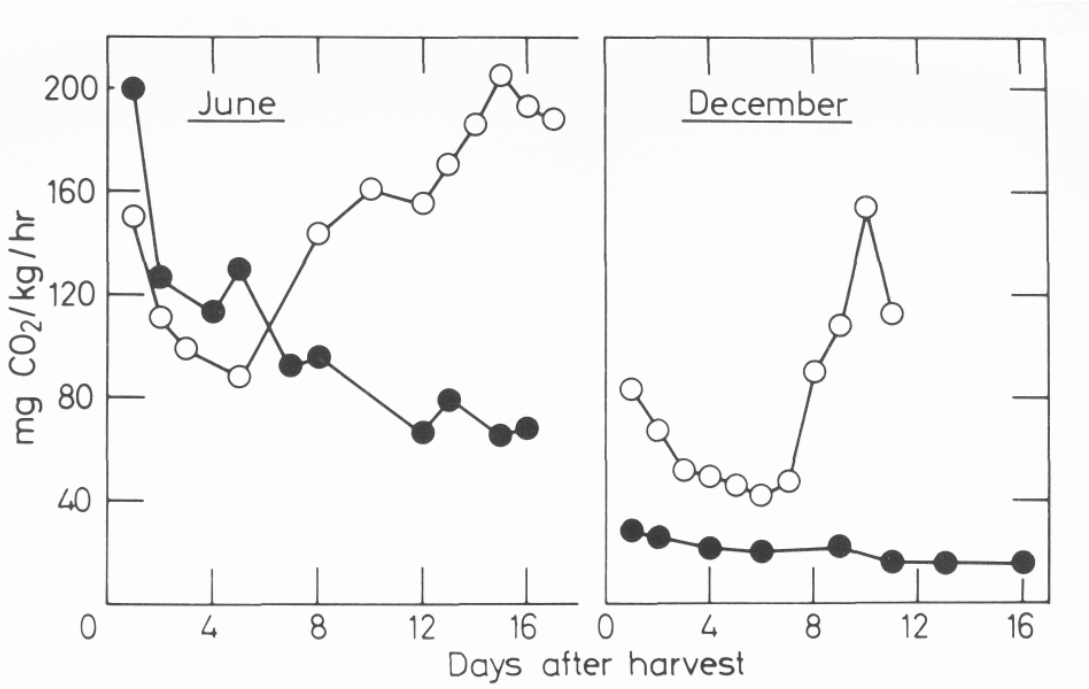


*Fig. 4.* Respiration rate of the whole fruit and of the seed at 2 stages of fruit development. ○ Respiration rate of the whole fruit. ● Respiration rate of the seed.

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