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LABORATORY BASED EVALUATION OF 1-METHYL CYCLOPROPENE (1-MCP): WITH FIVE SOUTH AFRICAN COMMERCIAL EXPORT AVOCADO CULTIVARS

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ABSTRACT

In the past, the firmness of South African export avocados was maintained by reducing the storage temperature during transport. More recently, controlled atmosphere (CA) has been added to further reduce ripening during storage. This certainly improved the chances of landing a hard fruit in Europe, but certain physiological and monetary concerns remain. During the 2000 and 2001 seasons, we evaluated the effectiveness of 1-methyl cyclopropene (1-MCP), an ethylene inhibitor on avocados, at the ARC-ITSC laboratory in Nelspruit, South Africa. The trials were done with all the major export cultivars and covered aspects such as storage potential, respiration rate and fruit quality upon ripening. The results were extremely positive and the manufacturer (Rohm & Haas, USA) has obtained registration (SmartFresh™) on avocados in South Africa. Static container trials followed during the 2002 season, the results of which are published in a second paper.

Key Words: Avocado, Hass, Fuerte, Pinkerton, Ryan, Edranol, 1- methyl cyclopropene, 1-MCP, Smartfresh

INTRODUCTION

During the 2000 and 2001 seasons, we have been evaluating the effectiveness of 1-methyl cyclopropene (1-MCP), an ethylene inhibitor formulated to block the cellular receptor sites for this hormone. During 2000, trials were conducted with all the major export cultivars in order to establish the efficacy of 1-MCP in terms of the inhibition of ripening. The positive results warranted further research and the study was continued during the 2001 season. The most important aim of the 2001 trials was to compare the ripening inhibition efficacy of 1-MCP with that of controlled atmosphere (CA) storage.

MATERIAL AND METHODS

Fruit from five different avocado cultivars, namely, Pinkerton, Hass, Edranol, Fuerte and Ryan, were obtained from a packinghouse in the Burgershall area of the Mpumalanga Province of South Africa. 1-MCP was administered in 3 concentrations, namely, 0, 225, 500 and 1000 ppb for 12 hours at respectively 5ºC and 10ºC. After administering the 1-MCP, the avocados were stored at 6ºC for 25 days. Hereafter, the fruit were ripened on the shelf at the prevailing room temperature. Densimeter readings were taken at the time of evaluation to ensure that the fruit were cut within similar firmness ranges. Fruit ripening was expressed as the mean number of days until the 'ready to eat stage' was reached and a longitudinal ripening profile was composed. The following recordings were made upon ripening: Black cold damage was scored and expressed as the percentage of skin surface that showed this chilling injury symptom. Dusky browning was scored and expressed as the percentage of skin surface that showed the symptom. Lenticel damage was scored and expressed as the percentage of skin surface exhibiting injured lenticels. Anthracnose was scored and expressed as the percentage of the skin surface of each fruit that showed symptoms of infection. Greypulp was scored and expressed as the percentage of the pulp volume of each fruit that showed symptoms. Vascular browning was scored and expressed as the percentage of the pulp volume of each fruit that showed symptoms. Stem-end-rot was scored and expressed as the percentage of the pulp volume of each fruit that showed symptoms.

In the 'Edranol' trial, a controlled atmosphere (CA) at 6% O_2: 4% CO_2 treatment was compared to fruit treated with 500 ppb 1-MCP. The fruit were stored at 5ºC and 10ºC and the respiration rate determined. In the case of the RA treatments, this was done with 8 fruit throughout the storage period. As CA storage had to be uninterrupted, the respiration rates of the CA treatments were only determined on day 25 when CA storage was terminated and on day 30 when all the fruit were removed from cold storage. Upon ripening, the fruit were evaluated using the set of quality parameters mentioned above.

RESULTS AND DISCUSSION

The mean number of days required for ripening at ambient is displayed in Figure 1. From the results it is clear that 1-MCP lengthened the ripening period of all cultivars. In the case of 'Fuerte' and 'Hass', the period from removal out of cold storage until ripe, was effectively doubled. With 'Edranol' and 'Pinkerton' it was tripled while in 'Ryan' the shelf life period was lengthened by four to six times.

No major difference in ripening rate was observed between the 5ºC or 10ºC applications. It would therefore be possible to apply the compound at the storage temperature at which the fruit are exported. In South Africa, this temperature is usually between the two temperatures used in the present study.

The incidence of greypulp is shown in Figure 2. The 5ºC 1-MCP treated 'Pinkerton', 'Edranol' and 'Ryan' fruit developed significantly less greypulp than the control. This was also true for Edranol fruit treated at 10ºC. Greypulp appears during the ripening of cool stored fruit, it is an indication of over-maturity and controlled through export maturity regulations formulated by the South African Avocado Growers Association (SAAGA) and enforced by the Perishable Product Export Control Board (PPECB). 1-MCP may possibly have a role to play in reducing the incidence of grey-pulp. However, the epidemiology of the disorder is such that a number of season's commercial statistics is required to substantiate this claim.

In the cases of 'Ryan', 'Edranol' and 'Fuerte', the incidence of anthracnose and stem end rot (Figures 3 and 4) was significantly higher in 1-MCP treated than in control fruit. This is to be expected,

as it is a well known fact that in avocados, the lengthening of the storage period, such is also attained by the use of colder temperatures, CA, MA or 1-MCP, increases the incidence of pathological disorders upon ripening.

The epidemiology of pulp spot, black cold injury, dusky browning and lenticel damage is usually difficult to interpret and the present study was no exception (data not shown). The incidence of the disorders was found to be low and the results did not indicate 1-MCP to significantly influence the manifestation of the symptoms.

The respiration rates of the Edranol fruit stored under CA are shown in Figures 5 and 6. From the graphs it is clear that 1-MCP suppressed the respiration rate of the fruit to a far greater extent than did CA at storage temperatures of both 5^{o}C and 10^{o}C.

CONCLUSIONS

The results were extremely positive and 1-MCP has considerable potential to contribute towards a reduction in the incidence of 'soft landings' of South African avocados exported to Europe. The manufacturer (Rohm & Haas, USA) has subsequently registered the powder formulation of the product in South Africa. During 2002, a tablet formulation of 1-MCP, SmartFresh^{TM}, was tested under semi-commercial conditions on 'Fuerte' and 'Hass' at the Westfalia packhouse near Tzaneen in the Limpopo Province of South Africa (Lemmer *et al.,* 2003).

REFERENCE

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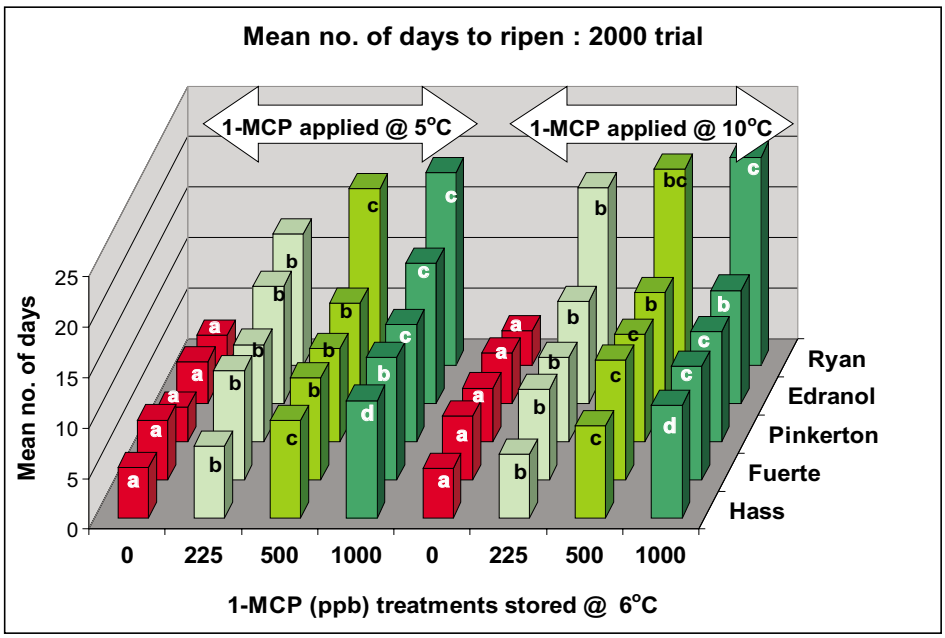

Figure 1: Mean number of days required to ripen the fruit of 5 different avocado cultivars under ambient conditions. The fruit were treated with different concentrations of 1-MCP (0, 225, 500 and 1000 ppb) applied at two temperatures (5°C and 10°C), before being stored at 6°C for 30 days. Bars marked with the same symbol are not significantly different. The statistics apply separately for each cultivar do not allow for statistical comparison between cultivars (Student t-test, P>0.05).

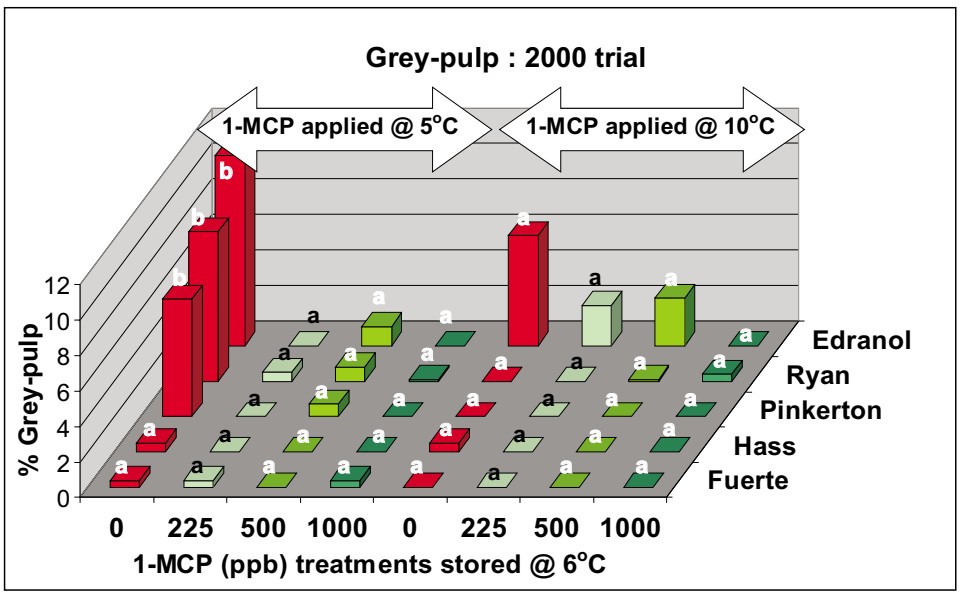

Figure 2: Percentage grey-pulp recorded in 5 different avocado cultivars, after ripening at ambient conditions. The fruit were treated with different concentrations of 1-MCP (0, 225, 500 and 1000 ppb) applied at two temperatures (5°C and 10°C) , before being stored at 6°C for 30 days. Bars marked with the same symbol are not significantly different. The statistics apply separately for each cultivar do not allow for statistical comparison between cultivars (Student t-test, P>0.05).

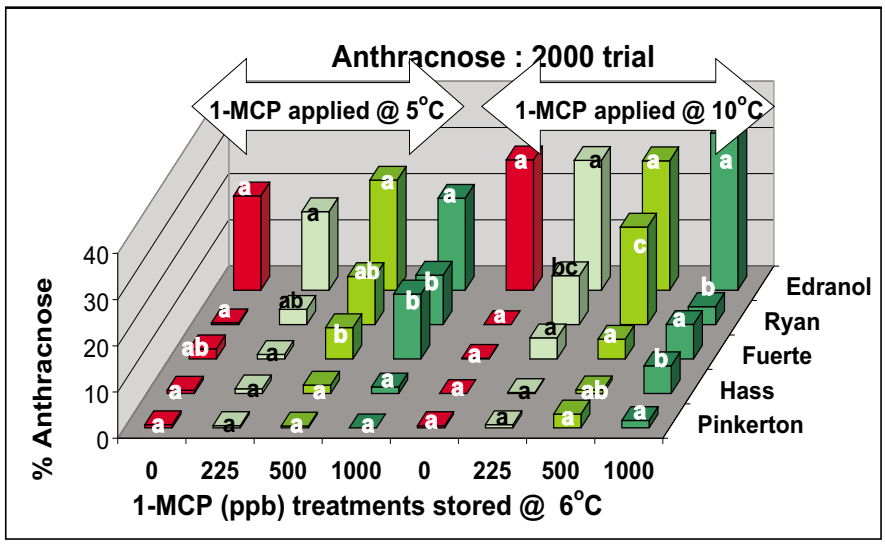

Figure 3: Percentage anthracnose recorded in 5 different avocado cultivars, after ripening at ambient conditions. The fruit were treated with different concentrations of 1-MCP (0, 225, 500 and 1000 ppb) applied at two temperatures (5°C and 10°C), before being stored at 6°C for 30 days. Bars marked with the same symbol are not significantly different. The statistics apply separately for each cultivar do not allow for statistical comparison between cultivars (Student t-test, P>0.05).

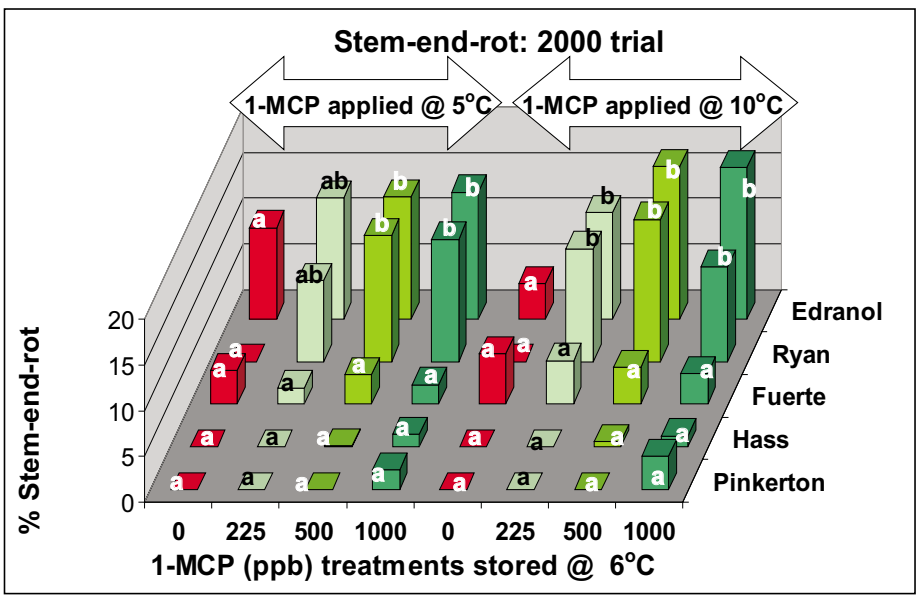

Figure 4: Percentage stem-end-rot recorded in 5 different avocado cultivars, after ripening at ambient conditions. The fruit were treated with different concentrations of 1-MCP (0, 225, 500 and 1000 ppb) applied at two temperatures (5°C and 10°C) , before being stored at 6°C for 30 days. Bars marked with the same symbol are not significantly different. The statistics apply separately for each cultivar do not allow for statistical comparison between cultivars (Student t-test, P>0.05).

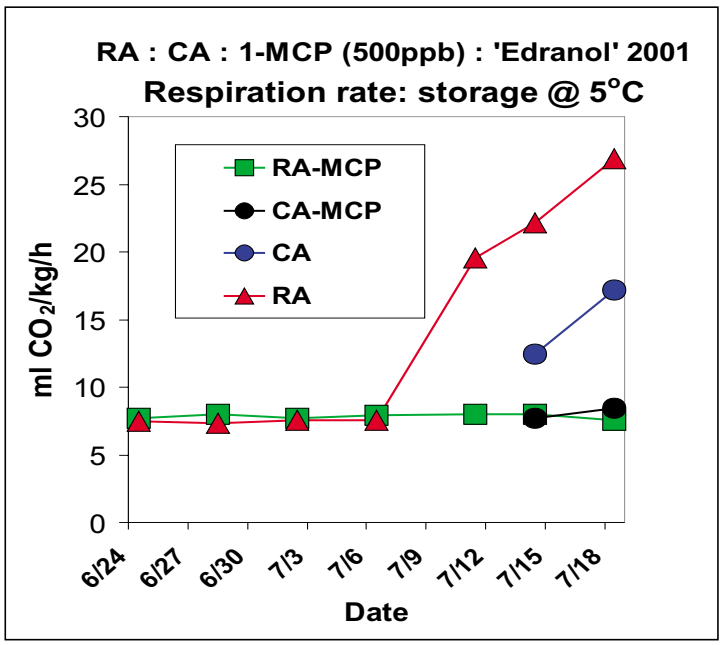

Figure 5: The respiration rate of control and 1-MCP treated 'Edranol' fruit stored under RA and CA conditions at 5°C.

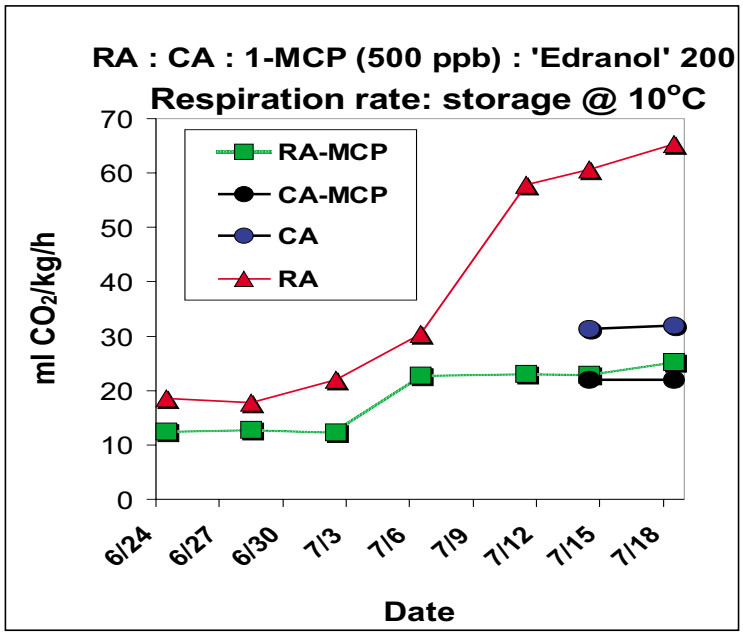

Figure 6: The respiration rate of control and 1-MCP treated 'Edranol' fruit stored under RA and CA conditions at 10°C.