MANUAL TRANSPORTATION WITHIN THE PLOT AND PHYSICAL DAMAGES TO BANANAS

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ABSTRACT: The manual transportation of banana bunches within plots provokes physical damages to fruits compromising their quality. To assess the influence of the distance banana bunches travel on the shoulders of harvesters within the plot, on the incidence of physical damages present on the peel of fruits of the Nanicão cultivar, two experiments were carried out in the Vale do Ribeira region (SP), in sites with slope < 1%. Each experiment divided the plot in different distance bands, two of which were included in this study: one located far away from the collection roads (30-50 m and 80-100 m distance bands) and another in an intermediate position (70-80 m and 130-150 m distance bands). For each distance band, six banana bunches of 36 mm gauged fruits were randomly sampled. Four banana hands were cut from the middle region of each bunch and ten fruits were assessed per hand, totaling 240 fruits per treatment. Bunches were harvested at the same maturity degree and those served as control were not transported. A total of 1440 fruits was assessed in the two experiments. The physical damages on the fruit surface were graded on a scale with 6 divisions: 0-0.25 cm^2; 0.25-0.5 cm^2; 0.5-1.0 cm^2; 1.0-1.5 cm^2; 1.5-2.0 cm^2; 2.0-2.5 cm^2. The bunches transported on the shoulders of harvesters on distances over 70 m suffered increased ($P < 0.01$) damaged area. Most damages presented areas up to 0.5 cm^2.
Key words: *Musa cavendish*, harvesting bananas, post-harvest, mechanical damages

TRANSPORTE MANUAL NO INTERIOR DO TALHÃO E DANOS FÍSICOS EM BANANAS

RESUMO: O transporte manual de cachos de banana no interior do talhão provoca danos físicos aos frutos que comprometem sua qualidade. Este trabalho objetivou avaliar a influência da distância percorrida pelo cacho de banana no ombro do carregador, no interior do talhão, na incidência de danos físicos na superfície de frutos do cultivar Nanicão. Foram conduzidos dois experimentos na Região do Vale do Ribeira – SP. Os experimentos foram realizados em terreno plano (declividade 0-1%). Em cada experimento dividiu-se o talhão em duas faixas de distâncias distintas: uma situada mais distante do carreador e uma intermediária. No 1° experimento, as faixas de distância foram 30-50 m e 80-100 m, e no 2°, foram 70-80 m e 130-150 m. Para cada faixa de distância foram amostrados, aleatoriamente, seis cachos de banana com frutos de calibre 36 mm. De cada cacho retiraram-se quatro pencas da região mediana para a avaliação de 10 frutos por penca, totalizando 240 frutos por tratamento, somando-se ao final dos dois experimentos 1440 frutos avaliados. Para testemunha, colheram-se cachos no mesmo grau de maturação e não se efetuou o transporte dos mesmos. A avaliação dos danos físicos na superfície dos frutos foi feita através de uma escala com 6 divisões de área: 0-0,25 cm^2; 0,25-0,5 cm^2; 0,5-1,0 cm^2; 1,0-1,5 cm^2; 1,5-2,0 cm^2; 2,0-2,5 cm^2. Os cachos transportados no ombro do operador por distâncias maiores que 70 m, sofreram um aumento ($P < 0,01$) na área lesionada nos frutos. A maioria das lesões apresentou área de até 0,5 cm^2.
Palavras-chave: *Musa cavendish*, colheita de banana, pós-colheita, danos mecânicos

INTRODUCTION

Cultivation of banana suffers considerable losses in Brazil, up to 40% of the total production, mostly during the harvest/transport steps (Brasil, 1993). Inappropriate infrastructure and carelessness in the handling of fruits during harvest and post-harvest operations are the main factors that lead to these high loss rates and to a visual appearance denoting low fruit quality (Alves, 1984). This poor appearance, essentially dark stains on the surface of the fruit peel, is caused mainly by physical damages, such as abrasions, cuts and crushes, mechanical injuries or mechanical damages. These damages occur both in large and small areas of the fruit and are related to handling and to the presence of slopes in the fields (Thompson & Burden, 1996).

Aked et al. (2000) expose the need to obtain more information on the magnitude of the losses, the level of damages occurring during harvesting and the situations in which they take place. These authors also propose studies to assess these impacts and their effects on banana shelf life.

Physical damages that occur during the various production steps – harvesting, transportation, processing and storage – can have different origins. Losses in bananas may have mechanical, physiological and microbiological origins and to obtain better quality fruits with longer shelf life, it is necessary to exert a better control of the processes (Olorunda, 2000). During harvest, for instance, the kind of ground and slope, the distance between the banana tree and the bunch collection roads and the way bunches are transported within the plot, may determine the occurrence and severity of physical damages on fruit surface. During vehicle transportation, within the plot and after processing, the main variables involved in the incidence of physical damages are transportation distance, the state of the roads and trucks, and packaging. During processing and storage, handling, temperature and relative humidity (RH) are the most determinant factors for the final quality.

Independently of the cultivar, fruits are harvested manually, usually by one or two harvesters, according to plant height and bunch weight. As for the Nanicão cultivar, two harvesters are needed: one bears the bunch on his shoulders padded with foam rubber, while the other cuts the bunch stalk off the plant. Bunches are then transported on the shoulder until the nearest collection road, where they wait for transportation to the packing shed. When only one harvester is involved, he performs all activities within the plot (Alves & Oliveira, 1997; Manica, 1997). Souza (2000) compared conventional transportation system (vehicular) with the use of a cableway system, in the Vale do Ribeira region, and showed that the latter causes less physical damages to fruits. During transportation within the plot, even though a foam pad helps absorbing the impacts between the bunch and the shoulder of the harvester, fruits undergo compression and acceleration, as a result of the distance and ground irregularity, that end up causing crushes and abrasions to fruit surface and pulp.

Plot planning must be such as to allow cleaning operations, cultural and phytosanitary management, in order to make harvesting easier. Plot size should not exceed 50 m wide, to save time and reduce the number of harvesters when transporting bunches to the collection roads (Bleinroth, 1984). Bunches should not be transported on the shoulders of the harvester for more than 60 m (Alves & Oliveira 1999). These authors comment that collection roads should separate plots every 50 m. Decreasing the plot width reduces not only the time and number of harvesters, but also damages provoked by the transportation of these bunches within the plot.

The present work seeks to verify the influence of the distance bunches travel on the incidence of the physical damages on fruit surface.

MATERIAL AND METHODS

Experiments were carried out in the Vale do Ribeira region, in the municipality of Sete Barras, SP, Brazil (24º38’ S; 47º55’ W) with banana bunches of the Nanicão cultivar (*Musa*, AAA, subgroup Cavendish), in a plantation located next to the Ribeira de Iguape river banks, in plots of 0%-1% slope, from October 2001 to January 2002. Fruit gauge was 37.01 ± 1.84 mm, which represents the 36 mm gauge, according to the standards of CEAGESP (1998).

Two distance bands were studied in Exp. 1: 30-50 m and 80-100 m, from the closest collection road. For each band (treatment) six banana bunches (replicates) were randomly sampled. For each bunch, the four central hands were separated out of the 7 to 12 hands per bunch and out of each hand, ten fruits were selected, totaling 240 fruits per treatment.

Although the methodology proposed by the CEAGESP (1998) only considers two levels of damaged areas: up to 0.5 cm^2 (light damage) and between 0.5 and 1.5 cm^2 (severe damage), the physical damages were assessed visually with a gauge presenting a 1 to 6 scale for damaged area (Figure 1).

Harvesters transported bunches within the plot as usual. For each distance band, bunches were transported on the shoulders of carriers, with a small protection of foam rubber between their shoulders and the bunch, until the nearest collection road. After transportation, bunches were sorted in hands, and the four central hands were placed on a surface covered with bubble plastic, to avoid any possible new damages to the fruits. The first assessment took place 30 minutes after bunches had been cut, still inside the plot. This time is necessary for the damaged region to darken, allowing a better visualization of the damage.

To assess the latent or imperceptible damages on “green” fruits, hands with 12 to 15 fruits each were care-

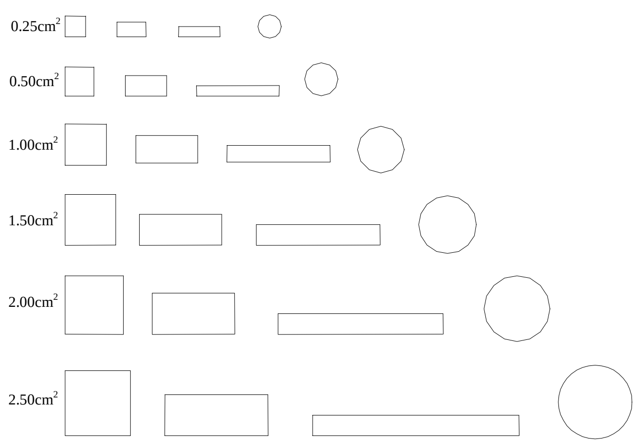

Figure 1 - Gauge used to assess the incidence of damages on the banana peel surface.

fully packaged in “torito” boxes with bottom and walls covered with bubble plastic, also used to separate the hands. They were then transported by trucks to the controlled ripening rooms, circa 300 km from the experimental site, where they stayed for three days under the following conditions : 17 ± 1°C, 90 – 95% RH and 1000 mL L^{-1} ethylene as indicated by Rocha (1984), Sommer & Arpaia (1992), and Manica (1997). After 12 and 24 hours, rooms were opened for 30 minutes to remove the CO_2 and then ethylene was re-injected. The fruits stayed under these conditions until peel coloration degree 4 to 5, according to Wills et al. (1982) and CEAGESP(1998).

For Exp. 2, the methodology was similar, except for the distance bands of the transported bunches, which were 70-80 m and 130-150 m. This experiment assessed not only physical damages caused by manual transportation, but also damages that occured before harvesting and transportation, during the pre-harvesting phase. This experiment did not submit the fruits to controlled ripening, fruits were only assessed, at ripeness degree 1. All data were submitted to analysis of variance and means were compared by the test of Tukey, using the Statistical Program SAS (1996).

RESULTS AND DISCUSSION

For Exp. 1, bunches transported for a longer distance differed ($P < 0.01$) from those not transported (Figure 2). The mean damaged area per fruit increased with transportation on the shoulders of harvesters for longer distances. The increase of these damages may have been caused by the increase in fruit exposure time to contact forces produced between bunches and the support surface.

The difference between the mean damaged area of the ripe and “green” fruits was 0.6 cm^2 for the bunches not transported; 0.65 cm^2 for bunches transported 30-50 m; and 0.96 cm^2 for bunches transported 80-100 m. This may be explained by a major occurrence of latent damages when fruits are transported for longer distances within the plot. The assessment performed on ripe fruits indicated that the plastic protections that enveloped banana hands moved, which caused more contact among the fruits, and between fruits and box walls.

Comparing these results to the program for banana classification proposed by CEAGESP (1998), for the mean area damaged per fruit, shows that if fruits were classified within the plot, they would have shown damaged areas characterizing light injuries, that is, areas smaller than 0.5 cm^2, whereas, if they were classified at their distribution point, when ripe, they would have shown severe injuries, that is, mean damaged area superior to 0.5 cm^2.

For Exp. 2 the bunches transported on the shoulders of harvesters for longer distances also presented major damaged areas on fruit surface, as compared to those not transported (Figure 3). Furthermore, Figure 3 shows the mean damaged area present on fruits in the pre-harvesting period, that is, damages resulting from contact of the fruits with the leaves, with the device used to support banana trees, with some cutting tools and/or among fruits. Although they presented damages with smaller mean areas per fruit as compared to those of the post-harvest period, the sum of these areas would have placed these fruits into a lower classification category, since the mean damaged areas exceeded 0.5 cm^2.

Plots in which bunches travel maximum distances of 50 m are thus preferable to obtain better quality fruits (Figures 2 and 3). These results agree with Bleinroth (1984), who proposed 50 m-wide plots, and with Alves & Oliveira (1999), who proposed transporting bunches for a maximum of 60 m. It is also important to promote a change in the bunch transportation system within the plot, to diminish damages and facilitate the task of the harvester. These changes can come through helping devices for manual transportation, or even creating semi-mechanical systems.

Damages occurring to the fruits not only affect their appearance, but may also reduce their shelf life.

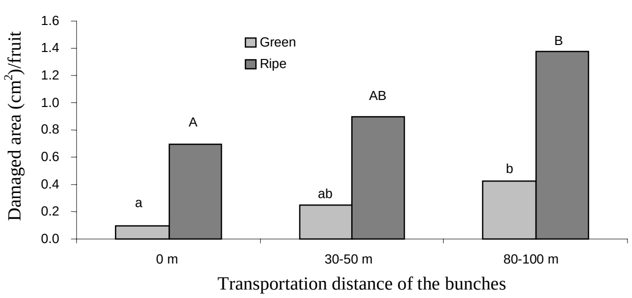

Figure 2 - Damaged area per fruit after bunch transport within the plot. Assessment performed immediately after fruit transport (“green” bananas) and after ripening (ripe bananas), Exp. 1. The same letters on top of the bars of the same gray intensity mean no difference ($P < 0.01$).

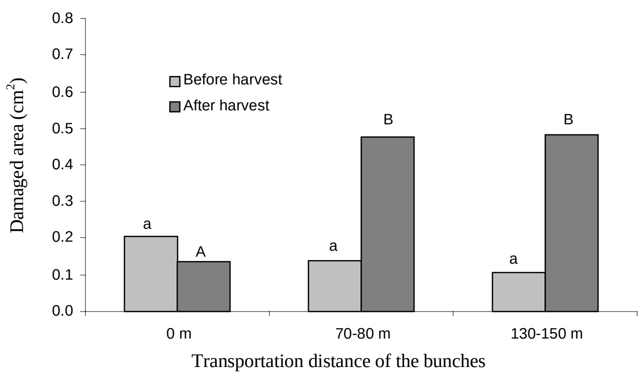

Figure 3 - Damaged area per fruit, due to damages present before harvest and after the bunch was transported within the plot, Exp. 2. The same letter on top of the bars of the same gray intensity mean no difference ($P < 0.01$).

Santana Lladó & Marrero Domínguez (1998) showed that 'Nanica' bananas that had suffered 1 to 4 cm^2 abrasions presented a major production of ethylene, immediately after abrasion, than intact bananas. This result suggests that the ripening period is anticipated when fruits suffer abrasions on their peel.

Analyzing the occurrence of the different damage sizes in both experiments it can be seen that the smaller the lesion area, the higher its occurrence on fruits, independently of the transportation distance (Figures 4 and 5). Of the total damages that occurred for the distance bands assessed in Exp. 1, 60% to 77% of the damages presented areas smaller than 0.25 cm^2; Exp. 2 had similar results, since the damages with area up to 0.25 cm^2 represented 58% to 68% of the total damages to fruits. The larger damages took only place in fruits transported for longer distances (Figures 4 and 5).

Fruits not transported present more damages of areas up to 0.25 cm^2 ($P < 0.01$) than the fruits transported within the plot (Figure 5). In addition, fruits not transported did not present damages of areas larger than 1.5 cm^2, differently from those transported for more than 80 m. Those transported for distances over 80 m presented circa 15% of damages greater than 0.5 cm^2, characterized as severe injuries by the CEAGESP (1998).

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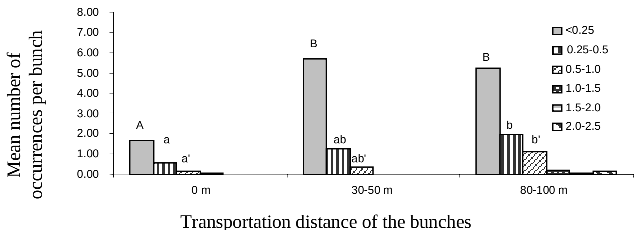

Figure 4 - Number of damages per hand and lesion sizes as a function of the transportation distance of the bunch within the plot, Exp. 1. The same letter on top of the bars of the same gray intensity mean no difference ($P < 0.01$).

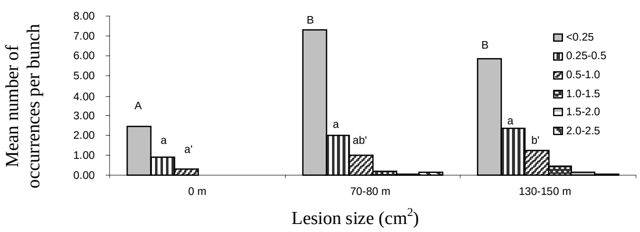

Figure 5 - Number of damages per hand and of lesion size as a function of the transportation distance of the bunch within the plot, Exp. 2. The same letters on top of the bars of the same gray intensity mean no difference ($P < 0.01$).

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