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Ergonomic evaluation of the preparation of cuttings and minicuttings for eucalyptus seedling production, with the use of scissors

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Abstract. This study was conducted in a nursery for eucalyptus seedling production in a forest Company, located in the southern state of Bahia, Brazil. It aimed to evaluate the ergonomic conditions of the preparation of cuttings and mini-cuttings with scissors for Eucalyptus seedling production to increase well-being, satisfaction and safety and minimizing the occurrence of occupational diseases, also improving the process efficiency and final product quality. Environmental conditions, levels of noise, postures, RSI risk and physical workload were assessed. The environmental conditions complied with the recommended norms, except at certain times of day, when workers should make compensation breaks. The workers that collect minicuttings presented postures classified as normal by OWAS. On the other hand, the posture of workers dealing with cutting preparation requires corrections in a short run. The workers were subjected to moderate RSI risk due to the high degree of repeatability found. The physical workload was classified as mild, with no need for ergonomic interventions.

Keywords: Forestry Ergonomics, Seedling nursery, Occupational diseases.

1. Introduction

The expansion of the Brazilian forestry sector requires improved techniques for forestry operations and activities.

Considering the vegetative propagation of Eucalyptus in Brazil, many changes can be observed, including the cutting technique, implemented on a commercial scale in the late 70s [7]. Currently, the minicutting technique has been adopted in most medium and large forest companies in Brazil. This cutting and minicutting technique in Eucalyptus seedlings requires a reasonable number of employees for the preparation of cuttings.

According Alfenas [2], the cuttings must be 8 to 12 cm long and contain a pair of leaves, which are divided across the middle. Similarly, the minicuttings must be 4 to 8 cm long and contain one or more pairs of leaves, split half to one third of its length.

The activity is closely linked to the use of scissors as a work tool. Inappropriate models are often used for such activity. They can be dangerous and, directly and indirectly, jeopardize the quality of the final product. Trained workers produce on average 3500 cuttings during their work day. Considering that each cutting and minicutting needs some treatment, the number of times the blades of the scissors are activated is higher than the value mentioned above.

The preparation of cuttings and mini-cuttings may pose high risk of developing Repetitive Strain Injury and Work Related Musculoskeletal Disorders (RSI / WMSDs), due to the high frequency of repetitive movements.

Using ergonomics concepts and tools, it is possible, in fact, to mitigate the direct and indirect damage on the well-being and health of workers and thus

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enhance operational efficiency, through the ergonomic adaptation to human beings and the rearrangement of the system, through the analysis and reconfiguration of jobs.

The present study aimed to evaluate the ergonomic conditions of the preparation of cuttings and minicuttings with the use of scissors for the production of Eucalyptus seedlings, targeting the well-being, satisfaction and safety at workplace.

2. Materials and methods

2.1. Location and data collection

The study was conducted in a nursery for the production of seedlings of eucalyptus in the southern state of Bahia - Brazil. Samples were collected between January and February 2011.

2.2. Evaluating the ergonomic conditions of the preparation of cuttings and minicuttings with the use of scissors for the production of Eucalyptus seedling

2.2.1 Structure and functioning of the preparation of cuttings

A study was conducted at workplaces, aiming to:

- Identify the types of activities developed in the production of eucalyptus cuttings and minicuttings;
- Identify the stages of the process of minicutting and cutting production to achieve eucalyptus seedlings;
- Check the equipment used and evaluate their use.

2.2.2 Analysis of the environmental conditions

2.2.2.1 Thermal environment

The WBGT (Wet Bulb Globe Thermometer) index meter, called MONITOR HEAT STRESS - TGD 300 was used to evaluate the thermal conditions at workplace. It was installed in the location where the task for the preparation of cuttings and mini-cuttings is carried out. Data were collected at 5-min intervals during the workday.

2.2.2.2 Lighting

It was employed the Testo 540 lux meter to determine light intensity at workplaces, which is required to investigate the compliance of the values found with those recommended by Brazilian law, with accuracy of ± 3%. The device was positioned horizontally at workplace and the illuminance values obtained were compared with those of the NBR-5413/92 norm [1].

2.2.2.3 Noise

A Wed007 dosimeter and the dBLexd management software system were used for better evaluation during workday. The results were compared with those at the table of tolerance to continuous or intermittent noise, according to the NR 15 standard [4]

2.2.3. Analysis of postures

The analysis of postures of workers was performed through the OWAS (Owaka Working Posture Analysing System) [10], which was developed by Finnish researchers during the 70's. As database, it uses photos showing the postures adopted by workers during the performance of their activity for further analysis and classification, according to standard tables of postures associated to indexes and classified according to how long workers remain in that position.

2.2 4 Assessment of RSI/WMSD risk

The RSI/WMSD risk was assessed through the Couto [5] check-list methodology, which is a simplified assessment of the risk of tenosynovitis and upper limb musculoskeletal disorders related to work activities. The methodology consists of a weighted analysis of situations related to physical overload; force with hands, posture at each workstation, tools, repetitiveness and work organization. Risk-free situation corresponds to one point each, while those that offer risk correspond to a zero score.

Footage, photographs and on-site observation of working activities were carried out for data collection. The working activities were classified according to total points. Values above 22 points mean very low risk of RSI; between 19 and 22, low-risk, between 15 and 18, moderate risk, between 11 and 14, high risk, below 11 points, very high risk.

2.2.5 Physical workload assessment

The physical workload required to perform the activity was assessed by surveying heart rate during the workday. Data collection and analysis were carried out through the Garmin Forerunner 305 system. The equipment contains a digital wrist receiver, elastic strap and a transmitter with electrodes. The data were collected by the transmitter, attached to the chest by the strap, and transmitted to the receiver at preset time intervals. The data achieved were analyzed by a

software system provided by the Garmin Forerunner 305 manufacturer.

Following the methodology proposed by Apud [3], the cardiovascular load at work, corresponding to the percentage of heart rate during work, in relation to the maximum usable, by equation 1 is:

$$CCV = \frac{FCT - FCR}{FCM - FCR} \times 100 \quad \text{Eq. 1}$$

Where;
CCV= cardiovascular load in%;
FCT = working heart rate in%;
FCM = maximum heart rate (220 - age);
FCR = resting heart rate.

3. Results and Discussion

3.1. Structure and Functioning of cutting preparation

The first stage of the work carried out in the nursery occurs in the Clonal Garden, where the minicuttings can be found, namely, the eucalyptus saplings from superior trees, obtained from shoots of the parent tree. The material is packaged in plastic tubes, filled with organic substrate (primarily composed of rice husk, eucalyptus and vermiculite) that can ensure adequate nutritional conditions for the development of plants.

Rooting occurs in greenhouse, where the buds picked from ministumps remain for 15 to 20 days. Then, the material passes through a seven-day shading stage. Next, the seedlings are taken to the selection area, where those that do not have the quality desired are excluded.

Then, they remain for 30 days at the growth stage, and 20 days at the stage of acclimatization, which allows further maturing of the plants. This is the last stage before the seedlings are shipped to planting in the field.

3.2. Analysis of the environmental conditions

3.2.1. Thermal Environment

According to the Norm NR 15[4]., the limit of tolerance for heat exposure is 30 °C for one hour of continuous work, which is classified as mild. The WBGT index values recorded were within the standards established by the norm, indicating no thermal overload. However, it does not mean that the environment is thermally comfortable.

According to the American Society of Heating Refrigerating and Air Conditioning Engineers ASHRAE [8], thermal comfort is a state of mind that reflects satisfaction with the thermal environment surrounding people. Thus, even if the evaluation of the thermal environment is in accordance with the regulations, some employees reported to be uncomfortable with room temperature.

The employees mainly complained about high temperature at workplace, due to the climate in the region. According to Laville [9], during physical work in the heat, it is observed that muscle strength declines, yield declines and brain activity changes, causing the disruption of sensorimotor coordination. The frequency of errors and accidents tends to increase as the level of monitoring decreases, mainly from 30 °C. The analysis of the values reported for part of the workday reveals that the temperature has reached levels close to the maximum allowed. At some hours of the day, the temperature reached 31°C.

Thus, workers are recommended to adopt measures such as frequent breaks to cool the body, reduced working hours, frequent intake of liquids, among others [6].

3.2.2 Lighting

Data were collected in mini-gardens at times when workers were not using luminets (50%) and at times when they used them during workday.

The values found for the situations mentioned were, respectively (31230 and 14129 lux). The analysis of these figures demonstrated that these values are required for very special visual tasks, operations, among others. It is possible to infer that the location of analysis itself has some effect, since it is an open area that receives plenty of natural light. However, considering the results for the period that employees used the luminet, the results were mainly classified as tasks with normal visual requirements, average machinery work and offices. The activities performed in the study were classified as of satisfactory level, according to the NBR 5413 [1].

3.2.3 Noise

The average noise level recorded was 67.74 dB (A), a value below the limit recommended by Brazilian standards, which set a limit considering that above 85 dB and 115 dB (A), workers should use hearing protection, as prescribed by the Regulatory Norm NR-15 [1].

Considering the environment and the results analyzed, the employees were not obliged to use hearing protection.

This value lower than the recommended may be related to the type and location of the activity performed, without any machinery nearby. It can be understood, therefore, that, at the cutting stage, noise levels were higher because workers were very close to the machine that fills the tubes with substrate.

3.3. Analysis of postures

The usual positions of workers during the performance of collecting and cutting activities are analyzed according to standard postures.

The postures adopted in the production of cuttings and mini-cuttings are classified according to duration, mostly in Class 1: normal posture. This classification requires some care, unless in exceptional cases, while the other posture, less observed, refers to Class 3: a posture that deserves attention in the short term.

3.4. Assessment of RSI/WMSD risk

Pain and musculoskeletal discomfort are symptoms arising from the occupational characteristics of the activity and can harm the musculoskeletal system of individuals.

Risk assessment of the personnel involved in the production of eucalyptus cuttings and mini-cuttings is illustrated below, in Table 1. The stages of cutting, first selection or toilet, and second selection or shipping were evaluated.

Table 1

Classification of *RSI/WMSD* risks, according to the activity performed

Activity	**Score**	**Classification**
Collection	16	Moderate risk
Cutting	16	Moderate risk
First selection	15	Moderate risk
Second Selection	15	Moderate risk

Considering the results presented above, it can be said that, since they are within the range of 15 to 18 points, the workers involved in the production of eucalyptus cuttings and mini-cuttings were subject to moderate risks of presenting diseases such as RSI/WMSD in the future. According to the check-list methodology of Couto [5], one of the alarming points is that the manual effort detected is repeated more than eight times per minute.

3.5. Evaluation of physical workload

The results achieved were related to the employees that carry out collecting and cutting activities, who are aged 34 years, on average. The oldest is 48 years old and the youngest, 21. It can be noticed that the working activity does not require great physical effort, since the cardiovascular load for workers handling the equipment is 6.56%, a value below the limit recommended by Apud [3], which is 40%. The average heart rate during the working day was 85 bpm, a value below the threshold heart rate. The activity was classified as mild and, in this case, it was not necessary to determine more breaks from work during the activity, since the existing pauses are long enough for workers to recover their energy.

4. Conclusion

The ergonomic conditions found in the preparation of cuttings and mini-cuttings with scissors in the production of seedlings of Eucalyptus are described below:

1) The environmental conditions were in line with the values recommended by the norms, except the thermal environment, since during the hottest hours of the day, workers should make breaks for compensation.
2) The workers that collect minicuttings had their postures classified as normal by OWAS [10], while those who performed cuttings adopted postures that require short-term corrections.
3) The workers were at risk of presenting moderate RSI/WMSDs due to the high degree of repeatability found.
4) The physical workload was classified as mild, and there was no need for ergonomic interventions.
5) According to the perceptions of workers, the scissors presented appropriate weight, size and workability.

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