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PJBS

ISSN 1028-8880

Pakistan Journal of Biological Sciences

ANSInet
Asian Network for Scientific Information
308 Lasani Town, Sargodha Road, Faisalabad - Pakistan

Pakistan Journal of Biological Sciences 10 (10): 1755-1758, 2007
ISSN 1028-8880

Investigating of Residual Tree Damage During Ground-Based Skidding

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Abstract: The study aims assessed the damages caused by skidding compared with the damages reported in other logging and skidding studies. Skidding had been conducted using cable skidders. After finishing the skidding operations, a field survey was done to collect data of all residual trees (species, DBH, height) and of tree wounds (size class, location and intensity of damage). Two types of damages were recorded: scarring and root damage. Results show that approximately 80% of the residual trees were damaged and that 52% of the residual trees have been affected by at least one new damage.

Key words: Iran, logging damage, skidding, scarring, temperate forest, residual tree damage

INTRODUCTION

Each harvesting system can cause distinct damage to remaining crop trees during skidding operation. Residual trees are damaged by felling trees and by winching and skidding trees to a log landing. The majority of residual stand damage is located along skid trails where the most harvesting activity occurs.

Wounding can cause stem deformity and decay and significantly effect final crop volume and value. Stern decays are the major cause of low-quality wood. The amount of decay development is related to the length of time since injury, the size of wound, the tree species, the location of wound on the tree and the tree's vigor. Past research has shown that crosscut saw and hose logging averaged about skidder operations up to 40% and mechanical harvesting systems from 5 to 80%. Clatterbuck (2006) indicate more than 43% of the trees damaged or destroyed by harvesting operation. Less severe damage such as bark removal that exposes sapwood also is frequent. Sapwood wounds pose no immediate threat to the tree but increase the likelihood of attack by insects or diseases (Smith *et al*., 1994). Kari and Han-Sup (2002) indicate that there are species-specific differences in the amount and severity of damage incurred by a tree during harvesting. Damage along skid trails did not appear to be strongly associated with the number of skidder passes or with skid trail width. No significant difference was observed in the number of trees (all species or commercial) damaged per unit length or in the number of severely damaged trees per unit length along primary and secondary skid trails (Jackson *et al*., 2002).

Techniques of damage reducing include the implementation of directional felling and vine cutting to reduce residual canopy and tree bole damage, skidding practices that reduce residual damage along skid trails and in logging gaps. Directional felling reduced road and trail densities, use of straight skid trails and temporary rub trees also protect residual trees (Han-Sup and Loren, 2000).

This study assesses damages caused by ground-based skidding in a temperate forest in north of Iran.

The main objectives are to quantify the extent of damage incurred following ground-based skidding in a temperate forest in north of Iran, to compare the observed damage levels to those of other studies with similar skidding system.

MATERIALS AND METHODS

Study site: The study area; Tarbiat Modares University Forestry Experiment Station- located in a temperate forest in North of Iran, between 36^ 31' 56"N and 36^ 32' 11"N latitudes and 51^ 47' 49".E and 51^ 47' 56" longitudes.

The Research area is covered by *Faguse orientalis* and *Carpinus betulus* stands. The canopy cover has been estimated as 0.8; The average diameter 29.72 cm; The average height 22.94 m and The stand density has been measured as 170 trees ha^{-1}. After skidding of 1500 m^3 timbers in the harvested compartment in September 2006 study has been done immediately.

A skid trail of 4 m wide; 400 m length; running parallel south-north slope has been selected for the experiment.

Experimental design: To assess the damages to residual trees. A 100% survey has been conducted in the skid trail after ground-based skidding system. All damaged trees

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greater than 10 cm DBH and within 4 m of the centerline of the skid trail have been labeled and the type of damage has been defined. Tow types of damage were recorded: Scarring and root damage. For scarring damage, the tree DBH, scar length, width and height from ground level were measured. A scar was defined as removal of the bark and cambial layer, exposing the sapwood. Scar area was determined based on rectangles. Scar length and width was measured to the nearest centimeter; these measurements always were rounded to provide conservative estimates of scar size. The distance of each damaged tree from the centerline of a skid trail was also recorded. Any visual scarring or severing of the root system was defined as root damage.

For every tree of the residual stand the number of damages, separated into old and new wounds, was determined. For every single damage the location on the stem, the wound size and the intensity were described. The division of wounds in damage categories (Table 1) permits an assessment of risk for infections by fungi. With an increase of damage category the probability of an infection also increases.

If the bark gets squeezed, the tree would only rarely be infected by fungi but an infection and the following decay mostly occur when the wood is visible.

Table 1: Description of damage categories (DC 1-4)

Categories	DC1	DC2	DC3	DC4
Location of damage	>1 m	0.3 -1 m	Stump	Root
Size of damage	<10 cm^2	10-50 cm^2	51-200 cm^2	>200 cm^2
Intensity of damage	Bark damaged	Bark squeezed	Wood visible, not damaged	Wood visible, damaged

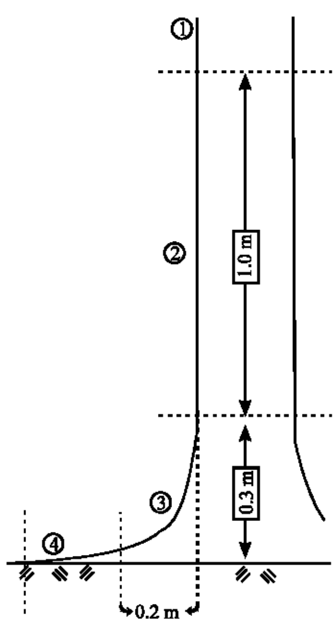

Fig. 1: Division of stem in the four damage-location

The probability, that wound rot fungi appear as a result of real wood injury (DC 4), raises by 40 to 50% compared with damage category 3.

The highest risk for decay is given for trees with injuries in the area of the felling cut and the root collar (Fig. 1). Damages on superficial roots and above the root collar (> 0.3 m) get less often infected by wood-destroying fungi (Limbeck-Lilienau, 2003).

RESULTS AND DISCUSSION

The species of study trees with exposed sapwood wounds is summarized in Table 2. Some logging wounds are not visible immediately after logging. For example, some trees were bumped with logs during winching or skidding but the bark was not removed. Scarring damage can be more serious than other types of wounding because,

Although it may not affect tree diameter growth, it can decrease future log value. Roots were scraped in repeated passes of equipment and dragged logs. Skidder-blading to level the trail surface often severed root systems. The amount of decay development is related to the length of time since injury, the size of wound, the tree species, the location of wound on the tree and the tree's vigor.

Results show that approximately 80% of the trees' incidents of new damage are caused by skidding. Han and D. Kellogg, (2000) reported in the cut-to-length system, the harvester caused more wounding (70%) to crop trees than did the forwarder (30%).

The amount of scarring in stump was 11, 40% in 3-1 m, 8% in higher than 1 m and 41% in root. Fifty nine percent of the scarring was on the bole. Han-Sup and Loren, (2000) reported ground-based systems created more severe root damage and scarring from this systems was significantly lower on the bole than for any other logging system. Scar height has a significant effect on the extent of decay; frequency of infection and amount of decay decreased as wound height increased (Han-Sup and Loren, 2000). The amount of scarring for lower than 10 cm^{2}was 4 and 14% in 10-50 cm^2, 40% in 51-200 cm^2 and 42% in higher than 200 cm^2 (Fig. 2). Limbeck-Lilienau, (2003) reported that in summer 47% off all damages were bigger than 50 cm^2.

Table 2: Percentage of sample trees with open exposed sapwood wounds due to skidding

Species	*Acer cappadocicum*	*Carpinus betulus*	*Faguse orientalis*	*Parotia ersica*
Percentage of damage	7%	9%	58%	26%

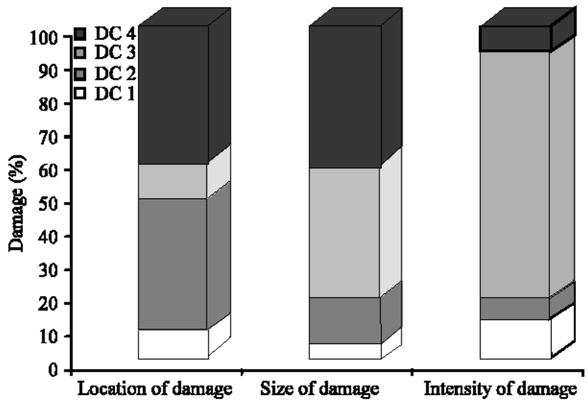

Fig. 2: Percentage of damage categories

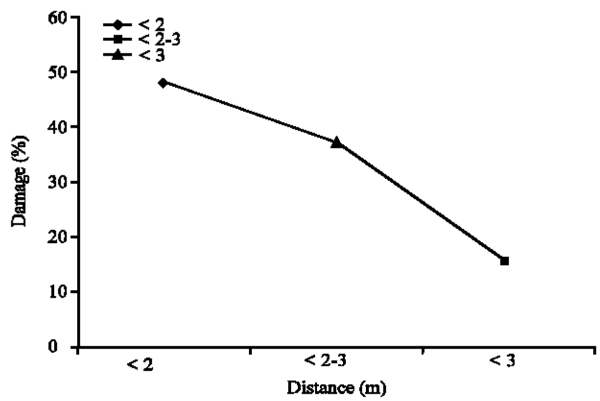

Fig. 3: Percentage of damage from the distance of the skid trails

Fjeld and Granhus (1996) the average area of bark or fibre damage was 79 and 105 cm^2 for small (dbh- 10 cm) and large trees (dbh>10 cm), respectively. Only 12% of the injured trees had damages located on the root system.

The most common kinds of damage included wood visible but not damaged, the amount of bark damaged was 11%, bark squeezed 7%, wood visible 74% and wood damaged 8%. Limbeck-Lilienau, (2003) reported damage category 3 (wood visible, not destroyed) more wounds were found in winter than in summer (64% compared to 59%).

Damaged trees were highly concentrated near skid trails. The greatest damage occurred within 2 m from the centerline of the skid trails (Fig. 3). Han-Sup and Loren (2000) reported the greatest damage occurred within the first 10 ft from the centerline of the skid trails or the skyline. Froese and Han-Sup (2002) reported highest total scarring damage (73.7%) occurred within 15 feet of the nearest skid trail centerline.

CONCLUSIONS

Logging damage resulting in exposed sapwood is a key factor in lower butt-log quality. These wounds provide a source of entry for insects and diseases and also are a source of ring shakes and cracks. Residual-tree damage from skidding may cause a decline in bole quality and subsequent loss of tree value. Reduction of butt log grade and the loss of potential tree value are prime considerations with long-term effects in the future stand.

Assessing the condition of residual trees immediately after skidding is a necessity in predicting future stand potentials. The damage estimated from this study was similar to other studies. The amount of scarring in bole was higher than stump and root. Damage varies by distance from skid trail as well as height above the ground.

The following are some suggestions to reduce logging damage:

- Plan and lay out skid trails and log landings carefully for the most efficient access with minimum disturbance to the residual stand and turning of the log load.
- Protect crop trees from skidding wounds by leaving some poles or small saw log trees near crop trees to serve as bumper trees.
- Remove forks and large branches from felled trees before winching or skidding.
- Cut stumps low. High stumps on a skid trail force the tractor to one side, wounding the trees next to the trail.
- Use old skid trails which are usually level, to minimize skidder blading and eliminate root injury. High stumps also are not common on old trails.

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