EFFECTS OF THINNING ON THE INCIDENCE OF DAMAGE AND SEVERITY OF DECAY IN BAGRAS (*EUCALYPTUS DEGLUPTA* BLUME) PLANTATIONS

Emelio O. Anino

Northern Mindanao State Institute of Science and Technology, Philippines

ABSTRACT

Thinning of intermediate and suppressed trees has been implemented on 3- to 4-year-old bagras (E. deglupta) plantations in Surigao del Sur, Philippines. The objective is to remove unwanted competition and to gain some form of revenue by selling the felled trees as banana props. However, the falling trees caused damage to other plantation trees. Bagras is susceptible to heart rot. A study was, therefore, conducted to determine the extent of decay in bagras due to thinning.

Data showed that injured bagras developed extensive decay in the sapwood and heartwood. Six percent of the injured trees died. Retained-trees, which were already exposed to sunlight, developed an average of eight epicormic branches on the lower stems. Thinning methods must, therefore, be improved to reduce sapwood injury and ensuing decay and to prevent the development of unwanted epicormic branches on the commercially useful portion of the stem.

1. INTRODUCTION

In trees, open wounds are avenues for the entry of decay fungi into the heartwood, and it is not until a wound is completely healed that the tree is no longer exposed to infection (Smith 1970). However, some species decay faster so that by the time the wound is healed, the decay fungi have already established or colonized the injured sapwood. Normally, sapwood rot fungi do not infect the heartwood, but they provide venues for the heart rot fungi to penetrate the heartwood causing heart rot or decay of the heartwood. This results in wood volume loss.

Thinning of intermediate and suppressed trees has been implemented on the 3- to 4-year-old bagras plantations in Surigao del Sur, Philippines, to remove the unwanted competition and to gain some form of early revenue by selling the trees as props to banana growers nearby. In the process of thinning, the retained-trees were hit by the felled trees breaking some branches and injuring portions of stem thus exposing the sapwood to the elements. Bagras is susceptible to heartwood decay or heart rot; thus thinning practice predisposes the trees to decay. A study was, therefore, conducted to determine the extent and severity of heart rot in bagras due to thinning.

2. MATERIALS AND METHODS

2.1 Survey of injuries in the 1991 experimental thinning plots

In April 1991 (two months after thinning), a total of 332 injured trees were identified and labelled in the 3- to 4-year-old bagras stands in Surigao del Sur, Philippines. Of these, 200 were uninjured and 132 were injured. The injured trees were evaluated for the number, size (length and width) and location/distance of injuries from the trunk base. Outlines of injured wood were traced with red paint for reference. Diameter-at-breast-height (DBH) and total height (TH) of both injured and uninjured trees were measured. Crown classes were also determined.

In July 1992, both the injured and uninjured sample trees were bored with increment borer to get wood samples for decay examination. The injured trees were bored at the center of one injury point in the stem at/or below breast height. Boring in uninjured control trees was conducted at a point in the stem 1.3 m from the base. Increment cores from each tree were properly collected, labeled and brought to the laboratory for decay examination and measurement. Decay was classified as occurring either at the injured sapwood or at the heartwood.

In February 1995, 3.6 years from initial thinning, increment cores and DBH measurements were taken from 60 injured and 88 uninjured trees for examination.

2.2 Survey of injuries in the 1995 commercially thinned bagras stands

Twelve survey plots previously established by Silviculture researchers in thinned plantations were relocated. In each plot, the number of injured or uninjured trees, number of wounds per tree and average length and width or diameter of wounds was counted. The number of trees with or without swollen knots and number of swollen knots per tree were counted. The length of lower stems of affected trees without knots were measured. Epicormic branches that developed in the stem of the retained-trees were counted.

In logged 12-year- old bagras trees, 20 random swollen knots were opened, and the average diameter and length of decayed wood were measured. The length of decayed knot was determined by extracting increment cores using increment borer positioned at an angle following the slanting orientation of the knot or occluded rotten branch stubs.

3. RESULTS AND DISCUSSION

3.1 DBH and wound size after the 1991 experimental thinning

Table 1 showed that the length of freshly injured sapwood ranged from 1 to 76 cm or an average of 9.66 cm while the width of the wounds ranged from 1 to 5 cm or an average of 1.11 cm. Average wound area was 11 cm^2. The number of wounds per injured tree ranged from 1 to 6. However, only 34 individuals or 26% of the 132 injured sample trees were multiple wounds. The average DBH of injured trees was 11.5 cm while that

of the control trees was 13.64 cm or a difference of 2.14 cm. Injuries were in the form of detached or stripped bark when branches were prematurely broken due to crushing impact of falling thinned out undesirable bagras trees, and when the stem of falling trees hit the stem of standing trees.

3.2 Decay status one year after the experimental thinning

One year after thinning, new bark tissues healed majority of the wounds, but most of the exposed sapwood had decayed. Eight wounded trees died. Table 1 showed that 71% of the injured trees had their exposed sapwood decayed by fungi as manifested by the presence of assorted fungal fruiting bodies on the wounds. The remaining 29% of the injured trees had sound exposed sapwood not damaged by fungi.

The average depth of decayed sapwood was 2.15 mm. Moreover, 56% of the injured trees had heart rot. The average diameter was 1.68 mm which was negligible at the time of survey. As expected, only 26% of the uninjured control trees had heart rot with a very negligible diameter of 0.17 mm.

3.3 DBH and decay status in 3.6 years after the experimental thinning

In February 1995 or 3.6 years after thinning, the average DBH of 60 injured sample trees and 88 uninjured sample trees were 15.73 cm (Table 2) and 19.72 cm, respectively, or a difference of about 3.99 cm in favor of the uninjured ones. However, in the first measurement in 1991, the average DBH of injured trees was already 2.14 cm smaller than the uninjured thus it follows that the former was smaller than the latter in the succeeding years. Nevertheless, if the growth rates were the same for both the injured and uninjured trees, the injured trees should have reached an average DBH of 17.58 cm. Thus, the injured trees were still smaller by 1.85 cm suggesting that there was a possibility that the injured trees grew slower by 9% due to wounding.

Table 2 also showed that the difference in the extent of sap rot and incidence of heart rot from those data in Table 1 did not vary markedly. Sap rot, or the rotten injured sapwood tissues, did not enlarge to become a full-blown heart rot but rather being compartmentalised or confined in a fixed point by the surrounding healthy wood tissues. These also suggest that sap rot did not cause heart rot. This is usually the case because sap rot or sapwood pathogens do not normally attack heartwood, but confined themselves in exposed sapwood or even get killed when new tissues healed-over the wounds. A fungus, *Phellinus noxius*, is the causal agent of heart rot in bagras (Almonicar 1991).

Although the decayed sapwood due to sap rot did not significantly increase in size and depth, still they degrade or lower the quality and usefulness of the affected stems because of the rot. Veneer and lumber recovery would be reduced due to the defects.

Table 1: Status of injured and uninjured bagras trees as of July 1992, one year after thinning.

Injured Trees		**Uninjured Trees**
Original number of injured trees	132	200
Range of injured sapwood length (cm)	1-76	
Average injured sapwood length (cm)	9.66	
Range of injured sapwood width (cm)	1-5	
Average injured sapwood width (cm)	1.11	
Average wound area (cm^2)	11	
Surviving injured trees	124	
Decay Measurement		
Injured Sapwood		
Number of trees with sound injured sapwood (%)	29	
Number of trees with decayed injured sapwood (%)	71	
Average decay depth (mm)	2.15	
Heartwood		
Number of trees with sound heartwood (%)	44	98
Number of trees with decayed heartwood (%)	56	2
Average decay diameter (mm)	1.68	0.17

3.4 Thinning injury in 1995 commercially thinned plantations

From May to June 1995, survey data (Table 3) showed that thinning injuries occurred in all 12 sample plots located in seven bagras plantations ranging from 5 to 12 years old. On the average, 25.7% of all retained-trees in the plots were injured. Each injured tree had an average of 1.9 or 2 injuries on the stem. The average size of the injuries was 122.0 cm^2 with 13.6 cm^2 as the minimum and 478.5 cm^2 as the maximum. The smallest injury size occurred in the 5-year-olds while the maximum size was in the 12-year-olds.

It is therefore expected that 26 out of 100 trees in thinned bagras plantations have an average of 112 cm^2 of decayed wood with a depth or thickness of 1 cm or less (Table 2). This would mean a degrade on the quality of veneer or lumber when the logs containing the injuries are processed into these products. Moreover, survey showed that retained-trees have the tendency to develop an average of eight epicormic branches distributed in the stems when they were directly exposed to sunlight.

3.5 Knot condition of leave-trees

Table 3 showed that 67% of the retained-trees, or 67 out of 100 trees, have decayed knots (stubs of broken branches), averaging 3 per tree. Each tree had 3 knots. Some trees have 4.21-metre long knot-free lower stems and others have 14.29-metre long knot-free lower stems or an average of 10 metres in all knotted trees.

Table 2: DBH and decay measurements from the remaining injured and uninjured bagras as of February 1995 or 3.6 years from thinning.

Data	Stem Condition	
	Injured	*Uninjured*
1. Number of samples	60	88
2. Average DBH (cm)	15.76	19.72
3. Number of trees with sap rot	16 (27%)	6 (7%)
4. Range of sap rot depth (cm)	0.2 – 1.0	0.2 – 0.8
5. Average depth of sap rot (cm)	0.12	0.03
6. Number of trees with heart rot	20 (33%)	4 (4.5%)
7. Range of heart rot diameter (cm)	0.2 – 1.5	0.6 – 0.8
8. Average diameter of heart rot (cm)	0.32	0.04

Sap rot – decay in injured sapwood.
Heart rot – decay in the heartwood.

Table 3: Thinning injury and knot condition data from retained-trees in thinned bagras plantations as of June 1995.

Number of injured trees (%)	26.0
Number of uninjured trees (%)	74.0
Average wound number per injured tree	2.0
Average wound size (cm^2)	112.0
Number of knot-free trees (%)	33.0
Number of knotted trees (%)	67.0
Average number of swollen knots per tree	3.0
Average knot-free stem length (m)	10.0
Average number of epicormic branches per tree	8.0

3.6 Size of decayed knots

In a separate stem samples of logged 12-year-old bagras, 20 swollen knots were sampled for size measurement of decayed wood. Table 4 showed that the average diameter of each decayed knot was 4.2 cm and length was 6.6 cm. Two out of 20 knots were not decayed. Three decayed knots merged with centre rot/heart rot with a depth of 15.7 cm on the average.

The above data suggests that when the retained-trees in thinned bagras stands are logged at 12 years of age, 67% would have the aforementioned stem defects. Only about 10 m of the lower stems of the 67 trees out of 100 would be free from holes due to decayed knots, and 33 trees out of 100 are totally free of knots.

Table 4: Data on diameter and depth of decayed knots in the stem of retained-trees in thinned bagras plantations as of June 1995.

Swollen Knot No.	**Decayed Knot Diameter (cm)**	**Decayed Tissue Length**		**Remarks**
		Knot (cm)	**Knot plus centre rot (cm)**	
1	3.9	0.4	0.0	
2	4.8	5.6	0.0	
3	0.7	-	9.0	*
4	0.0	0.0	0.0	**
5	2.5	7.0	0.0	
6	4.0	8.0	0.0	
7	4.0	5.5	0.0	
8	4.7	8.0	0.0	
9	4.9	-	12.0	*
10	2.8	6.9	0.0	
11	5.0	7.1	0.0	
12	4.4	6.7	0.0	
13	5.3	10.0	0.0	
14	4.1	7.8	0.0	
15	5.5	-	26.0	*
16	5.0	6.3	0.0	
17	0.0	0.0	0.0	**
18	4.6	7.0	0.0	
19	5.0	6.5	0.0	
20	4.3	6.2	0.0	
Average (Mean)	**4.2cm (1.7 inches)**	**6.6cm (2.6 inches)**	**15.7cm (6.2 inches)**	
Standard Error of the Mean	0.28 cm	0.53 cm	9.1 cm	

NOTE: Average decayed knot diameter and length and centre rot radius excluded sound tissue measurements.

* *decayed knot merged with centre rot*

** *no decay*

4. CONCLUSION

The findings demonstrated that the extent of decay in bagras trees due to thinning operation was extensive relative to their end uses. Thinning injury resulted in some decayed sapwood and decayed broken knots, which further developed into heart rot in the main stems. It also triggered the development of several epicormic branches in the formerly clean stems before thinning. These defects would result in substantial losses when the stems are processed into veneer, lumber or pulp and paper products.

5. ACKNOWLEDGEMENT

The author would like to thank the Paper Industries Corporation of the Philippines (PICOP) for giving him the chance to conduct this research.

6. REFERENCES

1. Almonicar, R. S. 1991. *Pest/disease condition in ITPLA for October 1991.* Monthly Report. Forest Research Department, PICOP, Bislig, Surigao del Sur, Philippines (Unpub.).
2. Smith,W.H. 1970. *Tree Pathology: A Short Introduction,* Academic Press, New York. 309 p.