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DETERMINATION OF WOOD PROTECTION BY SEASONING AND CLOVE OIL APPLICATION AGAINST *ODONTOTERMES OBESUS* RAMB. (TERMITIDAE: ISOPTERA)

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ABSTRACT

In order to prevent subterranean termites' attack, seasoning and clove oil application was performed on sap- and heart-woods of *Ficus religiosa* (L.). The exposure of termites was done in soil pits. Seasoning was conducted under sun for 5-60 days and in oven at 60, 80 and 100ºC for 10 and 15 days. Three concentrations of clove oil in acetone (10, 15 and 20%) were evaluated by three methods of application (surface, dipping and vacuum pressure). Results showed that unseasoned sap- and heart-woods of *F. religiosa* suffered a weight loss of 51.4 and 45.9% after 25 days of exposure to termites. Seasoning of dry-wood under the sun and in oven explained a weight loss of 13.1 and 11.9% (after 60 days) and 8.8 and 8.9% (at 100ºC for 15 days) in sap and heart woods, respectively. Oil application on unseasoned sap- and heart-woods registered a weight loss of 6.9 and 6.6%, respectively, in the vacuum pressure methods at 20% concentrations. Surface and dipping methods were not effective as high weight loss was observed in these methods of oil application. The discussion based on comparison with previous studies on application of temperature and oil for protection of wood from termites' attack.

Keywords: Clove oil, dipping, Ficus, *Odontotermes obesus*, seasoning, vacuum pressure, wood

INTRODUCTION

The trees in Genus Ficus such as *Ficus religiosa*, *F. exasperate* and many others have been reported as medicinal plants (Kunwar and Bussmann, 2006; Ahmed *et al*., 2012). In spite of fast growing and spreading nature of *F. religiosa* (peepal), its wood has not been used as firewood except for sacrificial fires (Simoons, 1998). The information on insects attacking *Ficus* tree is little known. *Ocinara varians* Walker (Bombycidae: Lepidoptera) is considered as an important pest of *F. microcarpa*. In addition to this, termite fauna attacking *Ficus* spp. are also not fully understood. However, Scheffrahn *et al*. (2009) has reported *F. elastica* as outdoor host of West Indian drywood termite, *Cryptotermes brevis* (Walker) (Kalotermitidae: Isoptera). Leaf powder of *Shinus molle* L. (Anacardiaceae) and *F*. vasta Forssk applied to plants recorded the lowest effects on termite damage protection, consequently, there was low plant population at harvest (Ibrahim and Demisse, 2013). The woods of *F. religiosa* were damaged by termites, *Coptotermes heimi* Wasmann (Rhinotermitidae: Isoptera) and *Microcerototermes championi* (Synder) (Termitidae: Isoptera) (Manzoor *et al*., 2010; Aihetasham and Iqbal, 2012).

Among various methods of preventing wood from the termite attack, lessening of moisture content of wood (seasoning) to a point when it is not palatable to termites and heat treatment/thermal application have been evaluated for the purpose (Hill, 2006; Roszaini *et al*., 2013).

The effect of wood preservative (Koski, 2008) and seasoning is measured by mass loss of wood upon feeding by termites, and this mass loss may be different for sap-wood and heart-wood (Esteves and Helena, 2009). It is also not clear whether wood preservative should be applied on seasoned or unseasoned wood. Furthermore, keeping in view toxicity of synthetic wood preservative to the environment, natural products such as essential oils are of considerable importance (Arango *et al*., 2004; Verma *et al*., 2009).

Clove oil is extracted from buds of clove (*Eugenia caryophyllata* L., Myrtaceae) and has vast applications in the field of medicine as it has some medicinal properties,

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however, its insecticide properties against insects of stored products have been reported (Kim *et al.*, 2003). Eugenol present in clove oil has been reported as termiticide (Koul *et al*., 2008). Based on recent report on the effect of plant oils as alternative to insecticide and other wood preservatives (Shiberu *et al*., 2013), present studies were conducted to investigate the effect of wood-seasoning and clove oil application on sap- and heart-wood protection of *F. religiosa* against *Odontotermes obesus* (Ramb.) (Isoptera: Termiticide).

MATERIALS AND METHODS

The exposure of *F. reliogiosa* wood after seasoning and oil application was demonstrated in Entomological Field Research Laboratories at Post-graduate Agriculture Research Station, University of Agriculture, Faisalabad, in Completely Randomized Design with three replication of each treatment. This exposure of *F. reliogiosa* wood to termite was done in soil pits having dimensions 60×60×75 cm^3 with concrete floor but leaving a narrow border to prevent the entry of rats in the pits. Peg woods were also installed inside these pits to attract termites. Blocks of sap- and heart-woods of *F. religiosa* were purchased from a local timber market and were cut into small pieces of size 13×5×2 cm^3.

After treatment application, these wooden blocks were placed inside the soil pits and exposed to termite attack for 5, 10, 15, 20 and 25 days. Weight loss was determined after ensuring same moisture contents of wood before and after each interval by determining equilibrium moisture contents of wood.

Seasoning

Seasoning of wood was done by sun drying and thermal treatment in an oven. Wooden stakes were placed under sun in a suitable glass covered chamber for a period of 5, 10, 15, 20, 30, 45 and 60 days. In case of thermal treatment in oven, wooden stakes were exposed to 60, 80 and 100°C for 10 and 15 days.

Oil application

Surface application

For surface application, three concentrations (10, 15 and 20%) of clove oil in acetone were applied with a paint brush on the surface of wooden stakes to run off point.

Dipping method

Wooden stakes were placed in the above mentioned three oil concentrations overnight and then these were keptinside the pits.

Vacuumed pressure application

For applying oil concentrations with pressure (50 k pa), a special apparatus was assembled. The apparatus consisted of a glass chamber, vacuum pump and a rotary pump. Oil solutions and wooden stakes were placed in a chamber. Vacuum pump was then used to create vacuum in chamber.

All wooden stakes thus prepared were exposed to termites in soil pits, for a period of the maximum mass loss in the preliminary experiment, in a similar fashion as described above. In case of control treatment for oil application, only acetone was used.

Mathematical calculations

At next step, weight of termite attacked wooden stakes was calculated and then %weight loss was calculated as:

$$\%\text{weight loss} = \frac{W2 - W3}{W2} * 100$$

W_3 = weight after termite attack

Weight Percent Gain (WPG) of oil experiments was calculated with following formula:

$$\%\text{weight percent gain} = \frac{W1 - W2}{W1} * 100$$

W_1 = weight before oil application,

W_2 = weight after oil application

Statistical analysis

Difference of means weight loss in various treatments was determined by analysis of variance (KruskalWallies test) using $p<0.05$ level of probability.

RESULTS

Weight loss by termites in unseasoned sap- and heart-woods of *F. religiosa*

Percent weight loss of both sap- and heart-woods increased with the number of days. Maximum percent loss was observed after an exposure interval of 25 days. The percent weight losses of sap- and heart-woods after 25 days were 51.4 and 45.9%, respectively. Statistically sap-wood lost 3% to 4% more weight than heart-wood (Fig. 1).

Fig. 1
Comparison of % weight loss of sap- and heart-woods of *Ficus religiosa* due to termite attack.

Impact of sun drying of *Ficus religiosa* woods for different time intervals on weight losses by termites

Mean percent weight loss of sap-wood indicated that the minimum weight loss by termites (13.1%) was observed when sap-wood samples were sun dried for 60 days. On the contrary, maximum weight loss was recorded in control treatment (47.5%). Weight losses at all intervals of sun drying were significantly different from each other. Mean percent weight loss of heart-wood indicated that the minimum weight loss (11.9%) was recorded when heart-wood samples were sun dried for 60 days; whereas, maximum weight loss (46.3%) was observed in control treatment (Table 1).

Impact of oven dying of *Ficus religiosa* woods for different time intervals on weight losses by termites

The minimum weigh loss in sap-wood due to termite attack (8.8%) was observed in oven drying for 15 days at 100°C while the maximum weight loss (59.7%) was observed in control treatment. Similar trend was observed in case of heart-wood (Table 2).

Impact of clove oil application on weight losses of wood stakes of *Ficus religiosa*

Table 3 shows a comparison of weight losses of sap-wood of *F. reliogiosa* in three methods of application. Three concentrations applied by three methods had significant difference for weight losses by termites. The highest concentration (20%) recorded minimum weight losses by termites in surface (25.7%), dipping (18.1%) and pressure application (6.9%) methods. Pressure application method performed better at all evaluated concentrations of olive oil. Maximum weight loss was observed in control treatment (51.6-56.8%) (Table 3).Weight loss after oil application by three methods presented similar picture when heart-woods were material for such comparison (Table 4).

DISCUSSION

The results of present studies have shown that sap-wood was more vulnerable to termite attack and seasoning and later clove oil application reduced weight loss in woods of *F. religiosa*. The extent of weight loss was different in sap- and heart-woods of *F. religiosa*. Sap-wood was 3-4% more susceptible than heart-wood. Mustafa (2011) confirmed that sap-wood was more susceptible to termite attack than heart-wood. Arango *et al.* (2004) and Verma *et al*. (2009) supported our results of difference of weight loss in sap- and heart-wood. High moisture in sap-wood may one of reasons of this difference. Gautam and Henderson (2011) found that there was positive relationship between moisture contents of wood and subterranean termite attack.

Seasoning to reduce moisture contents also resulted in less weight loss by termites. These results coincide with

Table 1

Comparison of treatment means (±S.E.) for weight losses in sun dried sap- and heart-woods of *Ficus religiosa.*

Treatments	Weight loss (%)	
	Sap-wood	Heart-wood
Control	47.5 ± 1.4a	46.3 ± 1.7a
5 days	43.9 ± 0.7b	41.5 ± 0.3b
10 days	38.0 ± 0.6c	35.3 ± 0.7c
15 days	33.1 ± 1.1d	29.8 ± 0.5d
20 days	27.9 ± 0.1e	25.2 ± 0.2e
30 days	22.6 ± 1.7f	19.8 ± 0.5f
45 days	16.5 ± 0.6g	14.7 ± 0.6g
60 days	13.1 ± 0.8h	11.9 ± 1.0h
CV	2.9	2.4

Means with same letter in a column are not significantly different from each other. CV = critical value

Table 2

Comparison of treatment mean (±S.E.)for weight losses in oven-dried sap- and heart-woods of *Ficus religiosa*.

Treatments	Weight loss (%)	
	Sap-wood	Heart-wood
Control	59.7 ± 4.2a	50.7 ± 2.0a
60 °C 10 d	42.2 ± 0.6b	38.2 ± 0.3b
60 °C 15 d	35.5 ± 0.3c	32.9 ± 0.2c
80 °C 10 d	27.1 ± 1.0d	25.9 ± 1.4d
80 °C 15 d	20.6 ± 0.7e	19.4 ± 0.5e
100 °C 10 d	14.2 ± 0.2f	12.4 ± 0.5f
100 °C 15 d	8.8 ± 0.3g	8.8 ± 0.4g
Critical value	5.1	2.90

Means with same letters in a column are not significantly different from each other.

Table 3
Comparison of treatment means (±S.E.) for weight losses of sap-wood of *Ficus religiosa* after surface application, dipping and pressure application of clove oil.

Treatments	Surface application	Dipping	Pressure application
Control	56.8± 2.7a	51.6 ± 1.9a	51.7 ± 1.8a
10%	41.3 ± 0.1b	34.4 ± 1.5b	22.2 ± 1.7b
15%	36.2 ± 0.2c	27.1 ± 1.4c	18.8 ± 1.9c
20%	25.7 ± 0.3d	18.1 ± 1.1d	6.9± 1.2d
CV	2.3	2.4	4.2

Means with same letters in a column are not significantly different from each other.

Table 4
Comparison of treatment means of heart-wood (±S.E.) for weight losses of *Ficus religiosa* after surface application, dipping and pressure application of clove oil.

Treatments	Surface application	Dipping	Pressure application
Control	49.9± 1.4a	48.1 ± 2.0a	47.7 ± 1.2a
10%	38.2± 1.7b	30.6 ± 2.5b	18.8 ± 1.7b
15%	29.9 ± 2.3c	23.9 ± 3.0c	16.1 ± 2.8b
20%	24.4± 1.5d	15.2 ± 1.7d	6.6± 2.3c
CV	4.7	4.5	5.1

Means with same letters in a column are not significantly different from each another.

Matsumura *et al.* (1999) who reported that high temperature on pine-wood reduced termite damage. Boonstra and Tjeerdsma (2006) and Esteves and Helena (2009) reported that heat treatment not only reduced termites damage but also improved wood stability and durability against biodegradation. Heat treatment to reduce subterranean termites damage to various woods has been reported by Manzoor *et al*. (2010) and Aihetasham and Iqbal (2012).

Earlier studies for the use of pressure application of wood preservatives have yielded similar conclusion that vacuum pressure application of oils and other preservatives are the best to reduce biodegradability of wood (Unsal *et al.,*2009*;* Manalo and Acda, 2009) because oil replaces moisture from wood (Koski, 2008). The property of clove oil as termiticide has been reported by Zhu *et al.* (2001) and Park and Shin (2005). In these studies, method of application was in soil rather than on the wood stakes directly.

There is need to further investigate the wood preservation techniques which are environmental friendly and reliable. The different temperatures for oven drying or solar kiln can be exploited to reduce wood damage to termites. Oil application through enhanced vacuum pressure application to make oil penetration deeper in wood can also be future line of action in this regard.

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