Susceptibility of Bamboo species in India to the attack of powder post beetle, *Dinoderus minutus* and prophylactic and curative measures for their management

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TIMBER UTILISATION IN INDIA

Annual Requirement of timber- 64 million cu.m

Supply – 43 million cu.m (12 m cu.m from natural forests+31 m cu.m from forestry and other sources).

Demand for fuel wood- 201 million tonnes

Supply- 95 m tonnes.(17 m tonnes from forests +72 m tonnes from farm forestry & other sources).

Woody species in India – 4000 – Still timber deficient country. High prices of conventionally preferred species like Teak, Sal, Deodar, Rosewood, Red sanders etc.

HOW TO BRIDGE THE GAP?

- **Import of wood**
  - **Import is not a long term remedy**

  US$ 1028 million every year at present (FAO, 2000)

- **Utilize short rotation plantation species**
- **Utilize fast growing Bamboo to substitute conventional timber - Desirable solution**

- India is rich in hardwoods which are used for construction, manufacture of furniture and wood composites like plywood and blockboard

- National endeavour is to conserve the material resources of the country to achieve the most economic utilization.

- Bamboo is used as substitute for timber from trees, but the life span of the products are very less due to biodeterioration. Currently the treatments are not mandatory and hence the durability is very low.

Bamboos is the most important non timber resource

Worldwide there are more than 1,250 species under 75 genera of bamboo (Subramaniam, 1998)

In India - 124 indigenous and exotic species, under 23 genera, found natural or under cultivation (Naithani, 1993).

COMMERCIALLY IMPORTANT SPECIES

- ***Bambusa bamboos***
- ***Bambusa nutans***
- ***Bambusa tulda***
- ***Bambusa balcooa***
- ***Dendrocalamus brandisii***
- ***D. giganteus***
- ***D. hamiltonii***
- ***D. stocksii***
- ***D. asper***
- ***D. strictus***
- ***Guadua angustifolia***

BAMBUSA NUTANS

BAMBUSA TULDA

DENDROCALAMUS ASPER

•800 insect species on bamboo have been recorded from Asian countries (Wang *et al.*, 1998) .

•272 species of herbivorous insects occurring on different species of bamboo in India is check listed - Remadevi *et al.* (2011).

•Applications - building materials, scaffolding, mats, fencing, handicrafts, toys, musical instruments. Also used for food and fuel.

50 post harvest pest species of Cerambycidae, Bostrychidae and Lyctidae reported on bamboo (Singh and Bhandhari 1988).

•**Freshly felled bamboo culms are prone to damage from insect borers, which turns them to a powdery mass**

•**Raja Muthukrishnan *et al.* (2009) enlisted 65 species of insects occurring on bamboos under storage**

•**The common beetles are *Dinoderus brevis* Horn., *D. ocellaris* Steph. and *D. minutus* Fab. (Coleoptera: Bostrychidae)- *ghoon* borers (Beeson, 1941; Sen Sarma, 1977).**

•*Dinoderus minutus* Fab. (Coleoptera: Bostrychidae).
Stebbing (1910) reported attack on bamboo.
Beeson (1941) life history and control measures.

•The seasonal variations of starch content and its relation to beetle borer- *D. minutus* and *Minthea rugicollis* infestation (Joseph, 1958).

• Insects that cause damage to felled culms and finished products are probably the most common and serious pests for the Asian bamboo industry (Wang *et al*.1998).

• The damage usually results in the loss of materials in a period of 8-10 months (Thapa *et al*., 1992).

•This pest beetle is often encountered in the United States and Europe through importation of bamboo and rattan furniture (De Angelis 1995).

The stunning fact

Bamboo is naturally nondurable on account of its susceptibility to borers and termites and fungal attack

WOOD DETERIORATING INSECTS IN BAMBOO

Structures, Products & Furniture

Bostrychids *(Dinoderus minutus)*

Lyctids *(Lyctus africanus)*

Termites *(Odontotermes sp)*

powder-post beetles in India

Dinoderus minutus

***Minthea rugicollis* (Walker)**

***Lyctus africanus* (Lesne)**

Larva of *L. africanus*

Adult *L. africanus*

Dinoderus minutus

Bamboo in storages

Powder post beetles !

Major pests of harvested bamboo stocked in timber yards and manufacturers' premises

Lyctid and Bostrychids reduce the bamboo wood to flour-like powder

Protection of bamboos under storage conditions has been studied by few workers.

- **Beeson (1941), Hocking (1942) and Gardner (1945) immersion of bamboo culms in a 50:50 mixture of creosote and fuel oil for a varying period of 2 to 48 hours.**

- **Roonwal and Chatterjee (1951) - spraying stacked bamboos with 0.33% BHC in Kerosene oil as prophylactics**

- **Control of post harvest insect pests of bamboos received little attention in Asian countries (Wang *et al*. 1998).**

- **Some preventive and control measures using various insecticides and wood preservatives have been developed in china, India, Japan and Philippines (Singh and Tewari 1979; 1981 Nair *et al*. 1983; Xu 1983; Liu and Xu 1985; Zhou 1985; Kumar *et al*. 1985; Thapa *et al*. 1992; Garcia *et al*. 1997).**

SYNTHETIC PYRETHROIDS USED IN WOOD/BAMBOO PROTECTION

- PERMETHRIN
- CYPERMETHRIN
- DELTAMETHRIN
- FENVALERATE
- BIFENTHRIN

APPLICATION METHODS

- COATING
- SPRAYING
- BRUSHING
- DIPPING
- SOAKING

•**Thiamethoxam is a systemic insecticide to prevent *D. minutus* infestation (Yamamota 1996; Mason *et al*. 2000).**

Menandro 2008 reported thiamethoxam 10µg ml-1 may have anti –oviposition or ant-feeding effects on *D. minutus* on *B. vulgaris* .

Fumigating in closed chambers or storehouses with sulphuryl fluoride at a rate of 30 to 50 g/m^3 for 24 hours (Li Yanwen *et al*., 1996; Chen Zhilin *et al*., 1999, 2000).

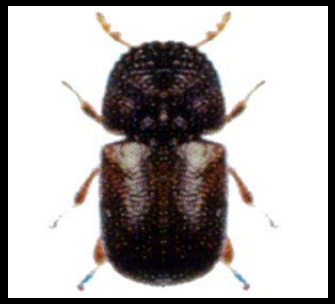
Sulthoni (1990) reported treating dried bamboo splits by immersing them in diesel oil as a simple and cheap method of bamboo preservation.

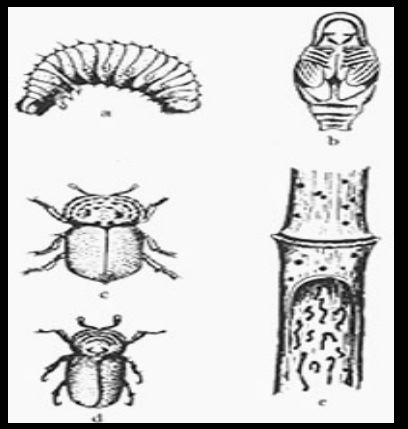
Varma *et al*. (1988) tested the effectiveness of commercial formulations of insecticides against *D. minutus*, and concluded that BHC and the two pyrethroids cypermethrin and permethrin were effective

The beetle *Dinoderus minutus*. belongs to the family Bostrychidae

The adult beetles is blackish brown in color, cylindrical in shape and about 2.5-3.5 mm long. The entry into the bamboo- cuts ends or the inner wall of the inter node made accessible by splits in the septum.

Stage	Developmental period
Egg	3-7 days
Larva	4 weeks
Pupa	8 days
Beetle	Few weeks





MATERIALS AND METHODS

Culture of *Dinoderus minutus*

The different species of bamboos collected from plantations/ bamboo depots were cut into small pieces (5 cms – 30 cms), dried to 20-30% moisture content and provided to adult *Dinoderus* released into mesh boxes/ glass bottles/ cages.

Also tapioca chips cut into 5mm thickness and dried in sun shade were used for rearing the beetles. The dried chips were kept inside culture bottles and adult *Dinoderus minutus* were released on them.

CULTURING USING TAPIOCA CHIPS

MATERIALS AND METHODS

- ***Species tested- D. stocksii , D. strictus, B. balcooa* and *B. pallida.***
- **Prophylactic treatments**

By using different types of oils - Eucalyptus oil, Camphor oil, Clove oil, Cedar oil, Castor oil, Turpentine oil, Honge oil, Olive oil, Neem oil and Peppermint oil and combinations – neem and pongam

- Use of bark and leaf extracts of *Cleistanthus collinus and Prosopis juliflora*
- **Curative methods**
- **Fumigants** - Phosphine gas

Botanicals

1% and 2% bark and leaf extracts of *C. collinus*

4-6% of *C. collinus* complex (1: 3: 4 - extract, Copper and chromium)

4-6% *Prosopis juliflora* extract (1: 3: 4 - extract, Copper and chromium) complex

Treatments

a. Dip treatment

The chemical/ extract was taken in plastic vessels and different sizes were dipped for 24hrs and were taken out and kept for drying.

Standard followed- I.S. 401-1982

b. Pressure treatment

Bamboo pieces measuring 5cm from different positions were treated by pressure impregnation (15 minutes vacuum followed by 50 lbs./sq. inch air pressure for 30 minutes).

Larval inoculation method

On the cut ends of the specimens (5 cm in length) 5 holes of 2-3mm diameter and 5mm depth were made and with the help of fine brush, early stage larvae of *Dinoderus minutus* were inoculated.

Adult release method

5 cm long bamboo stakes from different parts of the bamboo culms (Bottom, middle and top portion) were treated and kept inside aerated mesh boxes.
10 adult *D. minutus* were liberated on the stakes in each box.

Monthly observation upto 6months was made on powder formation. Powder obtained was collected and weighed. Number of adults emerged from each treatment was recorded.

Fumigation

Generation of phosphine gas

Phosphine gas was generated by placing a pellet of Aluminium phosphide tablet in a gas burette placed in a solution of 5% sulphuric acid in a 1L beaker.

For dosing, the required volume of gas was drawn from the gas burette using a gas-tight syringe, and injected in to desiccators through the self sealing septum fitted in the desiccators which were used as test chambers for exposing the life stages of insects.

•**Phosphine gas at different dosages (0.5, 1.0, and 1.5 mg/L) was tested against adult borers and their immature stages by *in vitro* testing.**

Adults and different stages of larvae were used for the study.

•**Phosphine fumigation was carried out in 2.85 L desiccators for an exposure period of 96 hours**

Natural durability

Natural durability of four species, *Bambusa pallida, B. balcooa, Dendrocalamus strictus* and *D. stocksii* . *D. stocksii* and *D. strictus* were more susceptible followed by *B. balcooa* and *B. pallida.*

The top portion was more susceptible to attack

The mean number of progeny emerged from each of the batch of bamboo within 6months was 32.5, 43.0, 44.5 and 45.5 for *B. balcooa, B .pallida, D. stocksii* and *D. strictus* respectively.

Natural durability test against borers (adult

Bamboo species	Bottom	Middle	Top	Mean
B. balcooa	6.0750	5.5500	7.9500	6.5250 a
B. pallida	6.2000	5.3250	8.2500	6.5917 a
D. stocksii	7.4500	6.9750	9.1250	7.8500 b
D. strictus	7.5750	7.0500	8.9250	7.8500 b
Grand mean	6.8250 b	6.2250 a	8.5625 c	

Natural durability test against borers (larval release)

Bamboo species	Bottom	Middle	Top	Mean
B. balcooa	6.6500	6.1000	9.1250	7.2917 b
B. pallida	6.4750	5.8750	8.1000	6.8167 a
D. stocksii	8.2750	7.1500	9.4750	8.3000 d
D. strictus	7.5000	6.8000	8.9500	7.7500 c
Grand mean	7.2250 b	6.4812 a	8.9125 c	

The study showed that the extracts (leaf and bark) at 1 and 2% were not effective in protecting the different species of bamboos from borer attack.

However the powder formation was lesser than in control and the adult emerged from the treated batches were also lesser than in the control.

But higher concentrations like 4 and 6% were very effective in protecting the bamboos from borer attack.

Results and Discussion

The treatment with 1% and 2% bark extracts of *C. collinus* was not effective though the powder formation was lesser than control. There was highly significant variation with respect to Bamboo and position.

Table 1 Adult release assay -Efficacy of 1% bark extract of *C. collinus* against powder formation in four bamboo species

Bamboo species	Bottom	Middle	Top	Dip method	Pressure method
B. balcooa	3.4000	3.0250	2.7750	3.0917	3.0417
B. pallida	2.8875	2.5000	2.4375	2.8333	2.3833
D. stocksii	2.5125	2.6000	2.0625	2.6417	2.1417
D. strictus	2.5625	1.9375	1.9750	1.7583	2.5583
Grand mean	2.8406	2.5156	2.3125	2.5813	2.5313

Table 2 Larva release assay- Efficacy of 1% bark extract of *C. collinus* on powder formation in four bamboo species.

Bamboo species	Bottom	Middle	Top	Dip method	Pressure method
B. balcooa	1.6375	1.6125	0.9875	1.3417	1.4833
B. pallida	1.6375	1.4625	1.4000	1.6500	1.3500
D. stocksii	1.7125	1.8125	1.8250	1.7333	1.8333
D. strictus	1.7000	1.6875	1.7750	1.6917	1.7500
Grand mean	1.6719	1.6438	1.4969	1.6042	1.6042

Table 3. Adult release assay- Efficacy of 2% bark extract of C. collinus on powder formation in four bamboo species in four bamboo species

Bamboo species	Bottom	Middle	Top	Dip method	Pressure method
B. balcooa	1.7250	1.7750	1.4875	1.5167	1.8083
B. pallida	1.6625.	1.6375	1.3625	1. 7917	1.3167
D. stocksii	2.0875	2.3000	2.2625	2.2250	2.2083
D. strictus	2.5375	2.8000	2.8750	2.9333	2.5417
Grand mean	2.0031	2.1281	1.9969	2.1167	1.9688

Table 4. Larva release assay- Efficacy 2% bark extract of C. collinus on powder formation in four bamboo species

Bamboo species	Bottom	Middle	Top	Dip method	Pressure method
B. balcooa	1.0250	1.1000	0.9500	1.0417	1.0083
B. pallida	0.7000	0.9000	0.9625	0.9833	0.7250
D. stocksii	1.1125	1.0875	1.0250	0.9917	1.1583
D. strictus	1.1000	0.9875	1.0750	1.0000	1.1083
Grand mean	0.9844	1.0188a	1.0031	1.0042	1.0000

The results of the treatments of 1% and 2% leaf extract of *C. collinus* revealed that they are not effective in stopping the *Dinoderus* attack.

Table 5. Adult release assay – Efficacy of 1% leaf extract of C. collinus

Bamboo species	Bottom	Middle	Top	Dip method	Pressure method
B. balcooa	3.2375	3.2750	3.5250	3.5167	3.1750
B. pallida	3.1625	2.6500	3.4875	3.2250	2.9750
D. stocksii	2.8250	2.8500	3.0500	2.9417	2.8750
D. strictus	2.7375	3.1750	3.5250	3.3000	2.9917
Grand mean	2.9906 a	2.9875 a	3.3969 b	3.2458	3.0042

Table 6.Larva release assay- Efficacy of 1% leaf extract of C. collinus

Bamboo species	Bottom	Middle	Top	Dip method	Pressure method
B. balcooa	1.7125	1.9875	2.4750	2.0917	2.0250
B. pallida	1.9500	1.8250	2.2625	2.1833	1.8417
D. stocksii	2.0625	2.0625	2.4125	2.2417	2.1167
D. strictus	2.0250	1.8875	2.1750	2.0167	2.0417
Grand mean	1.9375	1.9406	2.3313	2.1333	2.0063

Table 7 Adult release assay- Efficacy of 2%leaf extract of C. collinus

Bamboo species	Bottom	Middle	Top	Dip method	Pressure method
B. balcooa	2.3125	2.1000	1.4250	2.1917	1.7000
B. pallida	2.0375	1.9125	2.1375	2.1000	1.9583
D. stocksii	1.7375	1.8000	1.7625	1.8417	1.6917
D. strictus	2.2125	2.6500	2.4125	2.4750	2.3750
Grand mean	2.0750	2.1156	1.9344	2.1521	1.9313

Table 8 Larva release assay- Efficacy of 2% leaf extract of C. collinus

Bamboo species	Bottom	Middle	Top	Dip method	Pressure method
B. Balcooa	1.6000	1.4375	1.5125	1.5750	1.4583
B. pallida	1.4375	1.5000	1.6750	1.5833	1.4917
D. stocksii	3.0000	1.7500	1.6625	1.7417	2.5333
D. strictus	1.4500	1.6625	1.5625	1.5000	1.6167
Grand mean	1.8719	1.5875	1.6031	1.6000	1.7750

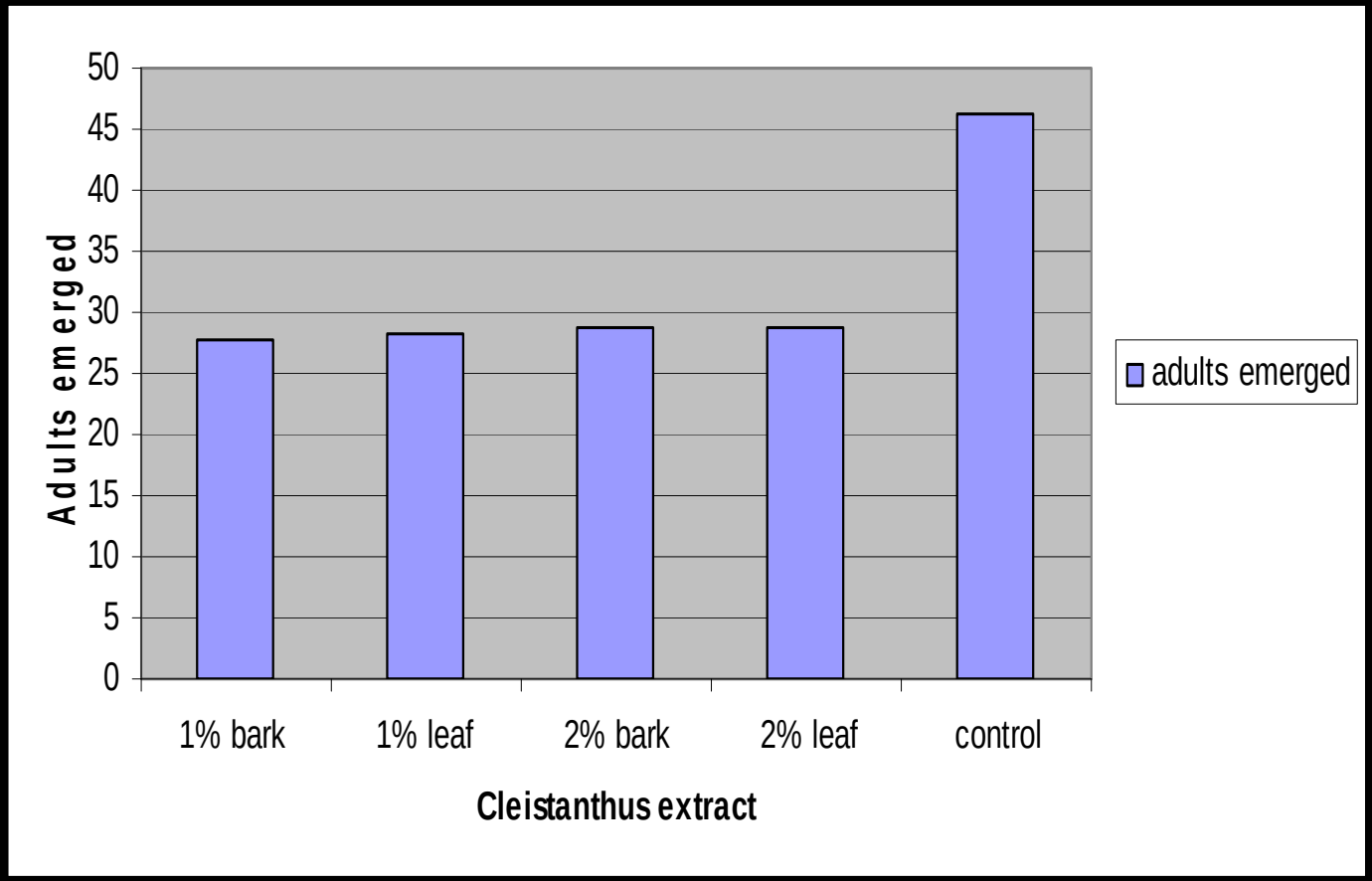



Bamboo pieces treated with 4% bark and leaf extract of *C. collinus* and 6% of *C. collinus* complex and *P. juliflora* complex- were very effective and there was no powder formation even after six months

Effect of Plant extracts- Powder formation

% of extracts	Bottom	Middle	Top
1% bark	2.25625	2.0797	1.9047
2% bark	1.49375	1.57345	1.5
1% leaf	2.46405	2.46405	2.8641
2%leaf	1.97345	1.85155	1.76875
4% bark / leaf	0	0	0
6% *C. collinus* complex	0	0	0
6% *Prosopis juliflora* complex	0	0	0

% of extracts	Dip treatment	Pressure treatment
1% bark	2.09275	2.08023
2% bark	1.56045	1.52241
1% leaf	2.68955	2.5974
2%leaf	1.87605	1.86459
4% bark / leaf	0	0
6% *C. collinus* complex	0	0
6% *Prosopis juliflora* complex	0	0



Adult emergence in treated batches

Efficacy of Neem based formulations

D. asper, D. stocksii, D. strictus **and** ***Bambusa nutans*** **was cut into bottom, middle and top pieces and treated with a formulation of Neem and Pongam formulation (neem seed oil 10% + Pongam seed oil 10%, Solvent 80 %).**

Both pressure and dip treatment were given. There was no powder formation.

Efficacy of oils for control of bamboo borer

To control *Dinoderus* borer different types of oils were used without diluting and not making different concentrations. For this study both larva and adult *Dinoderus minutus* was used.

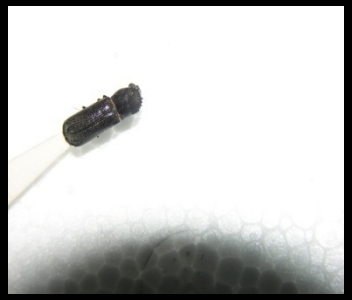
The result revealed that all the oils were useful in controlling formation of powder upto one year.

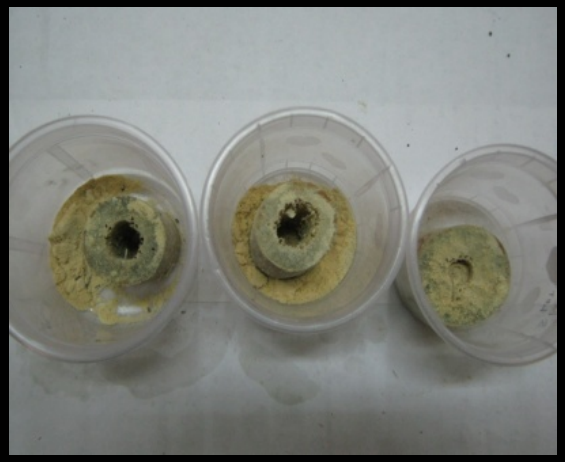
Phosphine fumigation for control of bamboo borer

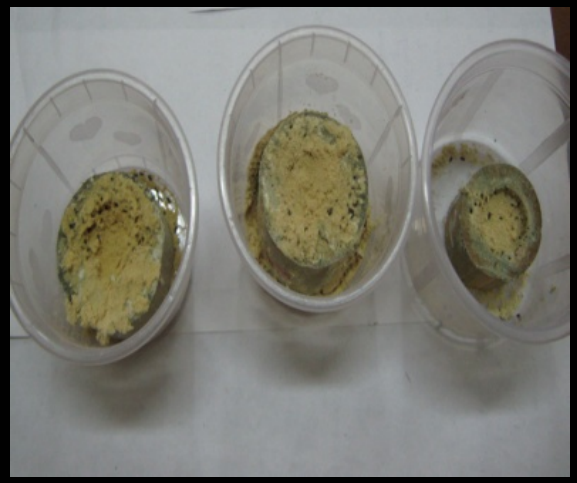
To protect bamboo from the borer attack, phosphine gas at different dosages (0.5, 1.0, and 1.5 mg/L) was tested against adult borers and their immature stages by *in vitro* testing.

Post-fumigation studies indicated that all the three dosages of phosphine caused 100% kill of all life stages of *D. minutus*.

Botanical Treatment (1 and 2% C. collinus)against Dinoderus Borer infestation







4 and 6% extracts effective against the borer


Thank you