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Response of Economic Tree Species to Extremely Severe Cyclonic Storm- Fani in Selected Coastal Districts of Odisha

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***Abstract*:** The Extremely Severe Cyclonic Storm “Fani' made landfall on 3rd May 2019 near Puri on Odisha coast with maximum sustained surface wind speed of 170-180 kmph gusting to 250 kmph and then passed over Puri, Khurda, Cuttack, Jagatsinghpur, Kendrapara, Jajpur, Bhadrak, Balasore and Mayurbhanj districts of Odisha. Immediately after cyclone, an extensive survey was made in four seriously affected districts such as Puri, Khordha, Cuttack and Jagatsinghpur and 25 economic tree species commonly found in such areas were evaluated to find out their response to cyclone. *Borassus flabellifer* (Palmyra palm) responded strongly exhibiting significantly lower damage followed by *Phoenix sylvestris, Cocos nucifera, Areca catechu,* etc.*Moringa oleifera* (Drumstick) faced significantly higher damage followed by *Acacia mangium, Leucaena leucocephala, Eucalyptus tereticornis,* etc. The overall per cent of plants (tree, sapling, pole & seedling) uprooted, trunk snapped, branch broken, bent and leaf stripped/ dried were 6.57, 3.88, 13.51, 3.41 and 31.56, respectively and their corresponding scores of damage were 6.57, 3.10, 8.11, 1.36 and 6.31, respectively. Damage was significantly higher in tree stage followed by pole, sapling and seedling stage. The total score of damage was 53.01, 33.61, 12.67 and 2.54 in tree, pole, sapling and seedling stage, respectively.

***Keywords*:** Tree, Pole, Sapling, Seedling, Fani, Cyclone, Storm

In the process of global warming and climate change in recent years, the frequency and intensity of tropical cyclones are increasing in some areas. The East Coast of India is one of the six most cyclone-prone areas in the world. Although the North Indian Ocean (the Bay of Bengal and Arabian Sea) generates only about 7% of the World's cyclones (5 to 6 TCs per year) their impact is comparatively high and devastating, especially when they strike the coasts bordering the North Bay of Bengal. In the last century, the Indian subcontinent has experienced 1019 cyclonic disturbances, of which 890 were along the eastern coast and 129 were along the western coast and 260 cyclonic disturbances had their landfall along the Odisha coast. The revisit or recurrence time of a severe storm to the Odisha coast is around four years; for West Bengal coast it is 5 years. As far as cyclones are concerned, the revisit time for the Odisha coast is nearly 2 years which is much shorter than that of the other states indicating that Odisha is the most frequently cyclone affected coastal state in the country (Govt. of Odisha 2019).Cyclones are common features in the coastal areas of Odisha as its location comes within the latitudinal range of cyclones (Mishra, 1999). The Extremely Severe Cyclonic Storm “Fani' made landfall at about 8.30 AM on 3rd May 2019 near Puri (Fig. 1). The maximum sustained surface wind speed of 170-180 kmph gusting to 250 kmph was observed during landfall. After the landfall, the cyclone with nearly same intensity continued for next 06 hours. It passed over Puri, Khordha, Cuttack, Jagatsinghpur, Kendrapara, Jajpur, Bhadrak, Balasore and Mayurbhanj districts of Odisha. Then, it emerged into Gangetic West Bengal as a Severe Cyclonic Storm with wind speed of 90-100 kmph gusting to 115 kmph by early morning of 4th May. The track of Fani is shown in Figure 2-3.

Fani was the strongest cyclone to have passed Odisha since the super cyclone in1999. It is also the first time since 1976 that a cyclone of such intensity blew through India. Under the influence of the cyclone, very heavy rainfall occurred in many parts of the state on 3rd and 4th May, 2019. Nine districts have recorded average rainfall of more than100 mm. The Khordha district recorded highest 187.8 mm rainfall followed by Cuttack-171.1 mm, Jajpur- 143.9 mm and Nayagarh- 141.7 mm. Five more districts have received average rainfall between 50 mm and 100 mm. The objective of the present study was to find out resistant economic tree species for the cyclone affected areas in Odisha like states.

MATERIAL AND METHODS

An investigation was carried out to assess the response of 25 economic tree species to Extremely Severe Cyclonic Storm- *Fani* that occurred on 3rd May 2019 in coast of Odisha (India) with maximum sustained surface wind speed of 170-180 kmph gusting to 250 kmph. The study was carried out in four most affected districts of Odisha state (India) such as

Puri, Khordha, Cuttack and Jagatsinghpur district (Fig. 3). These districts cover about 11,983 km^2 geographical area. These are most populated districts of the state having population 77,11,844 (2011 census) and include the four most important cities of the state such as Bhubaneswar (capital city of Odisha), Puri (most important tourist destination of the state), Cuttack (oldest city of the state) and Paradeep (Port city of Odisha). These are coastal districts are located within 100 km aerial distance from coast of Bay of Bengal. The study area experiences tropical hot and humid climate with annual rainfall about 1500mm.

An extensive inventory was made in these four districts and data was collected within 20 days of cyclone. The important 25 economic tree species which are commonly found in tropics were included in the investigation. Each species was assessed in its 4 stages of growth such as tree, pole, sapling and seedling stage. The mean of total score of damage was compared both stagewise and species wise with split plot design considering 4 stages of growth as main plot units, 25 tree species as sub-plot units and four districts as 4 replications. Since the comparison for species needs more precision, they have been in sub plots, whereas, stages of growth which needs comparatively lesser precision are placed in main plots. For each species 100 plants were selected from each district, hence a total of 10,000 plants were studied. Dead, severely diseased and plants with hollow or decayed trunk were not considered. The species studied are given in Table 1. R software has been used for data analysis.

The observations were recorded on parameters related to extent of damage such as percentage of trees uprooted, trunk snapped, branch broken, trees bent, leaf stripped/dried and rating of species damage (Bhol and Sinha 2006). The percentage of uprooted trees was determined by counting the number of trees in a sampling unit which had been totally uprooted with respect to total number of trees in the sampling unit. The trunk snapped was estimated in case of trees which had lost total crown due to breakage of main bole and expressed in per cent. The branch broken trees was determined by counting the trees in which breakage of branches were roughly more than 50 % of the total branches in eye estimation and expressed in per cent. For calculating the per cent of plants bent, the plants which bent more than 15^0 with respect to vertical axis were considered. The per cent of leaf stripped/dried plants were estimated by taking into consideration the plants in which more than 50% of total leaves approximately in eye estimation were stripped off/ dried. The stages of plant growth such as tree, pole, sapling and seedling stage were determined as per the definition of Khanna (1991).

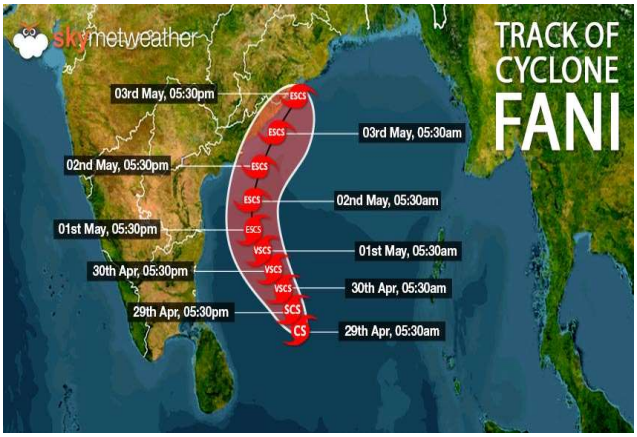

Fig. 1. Extremely severe cyclonic storm - Fani hitting Odisha coast on 3rd May 2019

Fig. 2. Track of Fani on India map

Fig. 3. Track of Fani on affected state Odisha and study area (marked)

Table 1. Damage of tree species by *Fani* and scoring of damage at different stages of plant growth

Growth stage	Per cent of plants damaged					Score of damage (Points)				
	Uprooted	Crown snapped	Branch broken	Plants bent	Leaf stripped/ dried	Uprooted (@ 100 points/ plant)	Crown snapped (@ 80 points/ plant)	Branch broken (@ 60 points/ plant)	Plants bent (@ 40 points/ plant)	Leaf stripped/ dried (@ 20 points/ plant)
1. *Acacia auriculiformis*										
Tree	28	4	30	12	26	28	3.2	18	4.8	5.2
Pole	8	0	26	10	56	8	0	15.6	4	11.2
Sapling	0	0	0	5	54	0	0	0	2	10.8
Seedling	0	0	0	0	6	0	0	0	0	1.2
2. *Acacia mangium*										
Tree	54	2	22	14	8	54	1.6	13.2	5.6	1.6
Pole	36	0	15	11	38	36	0	9	4.4	7.6
Sapling	0	0	0	12	62	0	0	0	4.8	12.4
Seedling	0	0	0	0	12	0	0	0	0	2.4
3. *Aegle marmelos*										
Tree	7	2	24	3	53	7	1.6	14.4	1.2	10.6
Pole	0	0	11	0	64	0	0	6.6	0	12.8
Sapling	0	0	0	0	36	0	0	0	0	7.2
Seedling	0	0	0	0	14	0	0	0	0	2.8
4. *Anacardium occidentale*										
Tree	33	0	48	0	19	33	0	28.8	0	3.8
Pole	12	0	28	20	40	12	0	16.8	8	8
Sapling	0	0	20	0	66	0	0	12	0	13.2
Seedling	0	0	0	0	16	0	0	0	0	3.2
5.*Anogeissus acuminata*										
Tree	12	0	58	6	24	12	0	34.8	2.4	4.8
Pole	0	0	48	0	52	0	0	28.8	0	10.4
Sapling	0	0	20	0	54	0	0	12	0	10.8
Seedling	0	0	0	0	12	0	0	0	0	2.4
6.*Anthocephaluscadamba*										
Tree	36	22	40	2	0	36	17.6	24	0.8	0
Pole	20	12	34	5	29	20	9.6	20.4	2	5.8
Sapling	0	0	0	0	36	0	0	0	0	7.2
Seedling	0	0	0	0	18	0	0	0	0	3.6
7. *Areca catechu*										
Tree	10	4	0	9	62	10	3.2	0	3.6	12.4
Pole	0	0	0	0	27	0	0	0	0	5.4
Sapling	0	0	0	0	0	0	0	0	0	0
Seedling	0	0	0	0	0	0	0	0	0	0
8. *Artocarpus heterophyllus*										
Tree	12	0	32	3	52	12	0	19.2	1.2	10.4
Pole	0	0	22	1	58	0	0	13.2	0.4	11.6
Sapling	0	0	0	0	39	0	0	0	0	7.8
Seedling	0	0	0	0	16	0	0	0	0	3.2

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Table 1. Damage of tree species by *Fani* and scoring of damage at different stages of plant growth

Growth stage	Per cent of plants damaged					Score of damage (Points)				
	Uprooted	Crown snapped	Branch broken	Plants bent	Leaf stripped/ dried	Uprooted (@ 100 points/ plant)	Crown snapped (@ 80 points/ plant)	Branch broken (@ 60 points/ plant)	Plants bent (@ 40 points/ plant)	Leaf stripped/ dried (@ 20 points/ plant)
9.*Azadirachta indica*										
Tree	3	0	12	9	66	3	0	7.2	3.6	13.2
Pole	0	0	4	1	53	0	0	2.4	0.4	10.6
Sapling	0	0	1	0	44	0	0	0.6	0	8.8
Seedling	0	0	0	0	12	0	0	0	0	2.4
10. *Borassus flabellifer*										
Tree	6	2	0	7	39	6	1.6	0	2.8	7.8
Pole	0	0	0	0	12	0	0	0	0	2.4
Sapling	0	0	0	0	0	0	0	0	0	0
Seedling	0	0	0	0	0	0	0	0	0	0
11.*Calophylluminophyllum*										
Tree	4	0	72	1	21	4	0	43.2	0.4	4.2
Pole	0	0	24	0	66	0	0	14.4	0	13.2
Sapling	0	0	10	0	32	0	0	6	0	6.4
Seedling	0	0	0	0	8	0	0	0	0	1.6
12. *Casuarina equisetifolia*										
Tree	26	38	18	8	10	26	30.4	10.8	3.2	2
Pole	18	24	12	6	38	18	19.2	7.2	2.4	7.6
Sapling	0	0	0	2	46	0	0	0	0.8	9.2
Seedling	0	0	0	0	18	0	0	0	0	3.6
13.*Cocos nucifera*										
Tree	9	3	0	10	58	9	2.4	0	4	11.6
Pole	0	0	0	0	24	0	0	0	0	4.8
Sapling	0	0	0	0	0	0	0	0	0	0
Seedling	0	0	0	0	0	0	0	0	0	0
14. *Eucalyptus tereticornis*										
Tree	35	26	24	12	3	35	20.8	14.4	4.8	0.6
Pole	22	11	28	10	29	22	8.8	16.8	4	5.8
Sapling	0	0	0	6	58	0	0	0	2.4	11.6
Seedling	0	0	0	0	14	0	0	0	0	2.8
15. *Leucaena leucocephala*										
Tree	35	28	24	10	3	35	22.4	14.4	4	0.6
Pole	22	11	28	9	30	22	8.8	16.8	3.6	6
Sapling	0	0	0	7	61	0	0	0	2.8	12.2
Seedling	0	0	0	0	15	0	0	0	0	3
16. *Mangifera indica*										
Tree	16	5	48	5	26	16	4	28.8	2	5.2
Pole	0	0	38	3	59	0	0	22.8	1.2	11.8
Sapling	0	0	22	0	78	0	0	13.2	0	15.6
Seedling	0	0	0	0	14	0	0	0	0	2.8

Cont...

Table 1. Damage of tree species by *Fani* and scoring of damage at different stages of plant growth

Growth stage	Per cent of plants damaged					Score of damage (Points)				
	Uprooted	Crown snapped	Branch broken	Plants bent	Leaf stripped/ dried	Uprooted (@ 100 points/ plant)	Crown snapped (@ 80 points/ plant)	Branch broken (@ 60 points/ plant)	Plants bent (@ 40 points/ plant)	Leaf stripped/ dried (@ 20 points/ plant)
17. *Moringa oleifera*										
Tree	12	82	6	0	0	12	65.6	3.6	0	0
Pole	0	54	46	0	0	0	43.2	27.6	0	0
Sapling	0	0	22	16	62	0	0	13.2	6.4	12.4
Seedling	0	0	0	0	54	0	0	0	0	10.8
18. *Phoenix sylvestris*										
Tree	7	3	0	8	45	7	2.4	0	3.2	9
Pole	0	0	0	0	16	0	0	0	0	3.2
Sapling	0	0	0	0	0	0	0	0	0	0
Seedling	0	0	0	0	0	0	0	0	0	0
19. *Pongamia pinnata*										
Tree	3	0	14	9	60	3	0	8.4	3.6	12
Pole	0	0	6	1	53	0	0	3.6	0.4	10.6
Sapling	0	0	1	0	45	0	0	0.6	0	9
Seedling	0	0	0	0	12	0	0	0	0	2.4
20. *Psidium guajava*										
Tree	32	0	16	22	30	32	0	9.6	8.8	6
Pole	0	0	12	0	88	0	0	7.2	0	17.6
Sapling	0	0	8	0	66	0	0	4.8	0	13.2
Seedling	0	0	0	0	12	0	0	0	0	2.4
21. *Samanea saman*										
Tree	32	4	52	11	1	32	3.2	31.2	4.4	0.2
Pole	12	0	48	8	32	12	0	28.8	3.2	6.4
Sapling	0	0	0	2	52	0	0	0	0.8	10.4
Seedling	0	0	0	0	14	0	0	0	0	2.8
22. *Syzygium cumini*										
Tree	13	0	62	8	17	13	0	37.2	3.2	3.4
Pole	0	0	49	0	51	0	0	29.4	0	10.2
Sapling	0	0	26	0	59	0	0	15.6	0	11.8
Seedling	0	0	0	0	14	0	0	0	0	2.8
23. *Tamarindus indica*										
Tree	17	0	12	6	51	17	0	7.2	2.4	10.2
Pole	0	0	6	3	42	0	0	3.6	1.2	8.4
Sapling	0	0	0	0	18	0	0	0	0	3.6
Seedling	0	0	0	0	8	0	0	0	0	1.6
24. *Tectona grandis*										
Tree	31	35	22	8	4	31	28	13.2	3.2	0.8
Pole	19	12	24	7	38	19	9.6	14.4	2.8	7.6
Sapling	0	0	0	5	56	0	0	0	2	11.2
Seedling	0	0	0	0	20	0	0	0	0	4
25.*Terminalia arjuna*										
Tree	15	4	44	8	30	15	3.2	26.4	3.2	6
Pole	0	0	24	0	76	0	0	14.4	0	15.2
Sapling	0	0	8	0	36	0	0	4.8	0	7.2
Seedling	0	0	0	0	8	0	0	0	0	1.6
Average	6.57	3.88	13.51	3.41	31.56	6.57	3.10	8.11	1.36	6.31

Rating of species damage: To compare the damage of different species quantitatively, different parameters of damage were given different scores. The trees uprooted, trunk snapped, branch broken, bent and leaf stripped/dried were scored as 100, 80, 60, 40, 20 points, respectively and rating was calculated by the formula: per cent damage x respective score (Bhol and Sinha 2006).

Ranking of resistant species: The ranking of tree species resistant to cyclone was done in the reverse order of damage score i.e. the species scoring lowest damage was considered as most resistant.

RESULTS AND DISCUSSION

There was a significant difference in response of trees to the Extremely Severe Cyclonic Storm '*Fani*' with regard to damage. There was variation in the extent of damage among different species studied as well as the damage in different stages of growth in the same species (Table 1). Among the 25 species studied at different stages of growth, the average per cent of plants uprooted, trunk snapped, branch broken, bent and leaf stripped/ dried were 6.57, 3.88, 13.51, 3.41 and 31.56, respectively. The average respective score of damage of these parameters were 6.57, 3.10, 8.11, 1.36 and 6.41. *Borassus flabellifer* (Palmyra palm) resisted most exhibiting least damage with a damage score of 18.2 in tree stage and 2.4 in pole stage only with average score of 5.15 (Table 2). *Moringa oleifera* (Drumstick) recorded the highest score of damage (81.2, 70.8, 32.0 and 10.8 in tree, pole, sapling & seedling stage, respectively) with average score of 48.72.The total score of damage was highest in tree stage

Table 2. Total score of damage of different economic tree species by *Fani* at different stages of plant growth

Tree species	Common name	Total score of damage (points) at different stages of growth				
		Tree	Pole	Sapling	Seedling	Mean
1. *Acacia auriculiformis*	Australian wattle	59.20	38.80	12.80	1.20	28.00
2. *Acacia mangium*	Mangium	76.00	57.00	17.20	2.40	38.15
3. *Aegle marmelos*	Bael	34.80	19.40	7.20	2.80	16.05
4. *Anacardium occidentale*	Cashewnut	65.60	44.80	25.20	3.20	34.70
5.*Anogeissus acuminata*	Button tree	54.00	39.20	22.80	2.40	29.60
6.*Anthocephaluscadamba*	Kadam	78.40	57.80	7.20	3.60	36.75
7. *Areca catechu*	Areca nut	29.20	5.40	0.00	0.00	8.65
8. *Artocarpus heterophyllus*	Jack tree	42.80	25.20	7.80	3.20	19.75
9.*Azadirachta indica*	Neem	27.00	13.40	9.40	2.40	13.05
10. *Borassus flabellifer*	Palmyra palm	18.20	2.40	0.00	0.00	5.15
11.*Calophylluminophyllum*	Alexandrian laurel	51.80	27.60	12.40	1.60	23.35
12. *Casuarina equisetifolia*	Casuarina	72.40	54.40	10.00	3.60	35.10
13.*Cocos nucifera*	Coconut	27.00	4.80	0.00	0.00	7.95
14. *Eucalyptus tereticornis*	Blue gum	75.60	57.40	14.00	2.80	37.45
15. *Leucaena leucocephala*	Subabul	76.40	57.20	15.00	3.00	37.90
16. *Mangifera indica*	Mango	56.00	35.80	28.80	2.80	30.85
17. *Moringa oleifera*	Drumstick	81.30	70.80	32.00	10.80	48.72
18. *Phoenix sylvestris*	Sugar palm	21.60	3.20	0.00	0.00	6.20
19. *Pongamia pinnata*	Pongam tree	27.00	14.60	9.60	2.40	13.40
20. *Psidium guajava*	Guava	56.40	24.80	18.00	2.40	25.40
21. *Samanea saman*	Rain tree	71.00	50.40	11.20	2.80	33.85
22. *Syzygium cumini*	Jamun	56.80	39.60	27.40	2.80	31.65
23. *Tamarindus indica*	Tamarind	36.80	13.20	3.60	1.60	13.80
24. *Tectona grandis*	Teak	76.20	53.40	13.20	4.00	36.70
25.*Terminalia arjuna*	Arjun	53.80	29.60	12.00	1.60	24.25
Mean		53.01	33.61	12.67	2.54	25.46

$CD_{(0.05)}$ for species = 0.69
$CD_{(0.05)}$ for stages of growth = 1.24
$CD_{(0.05)}$ for species x stages of growth= 1.39

(53.01) followed by pole stage, sapling stage and seedling stage. The mean total score of damage was 25.46. This means the cyclone *Fani* completely damaged 25.46% of these 25 economic tree species in the study area.

The higher aged plants suffered more than the lower aged plants (Table 3). Trees were more damaged (19.5 %, 10.6% , 27.2% , 7.6% & 28.3% uprooted, crown snapped, branch broken, bent & leaf stripped/dried, respectively) followed by pole and saplings. Seedlings did not face such damage. The corresponding score of damage followed the similar trend (Table 4). The ranking of trees with respect to their resistance to cyclone *Fani* was in the following order: *Borassus flabellifer* ranked top followed by *Phoenix sylvestris, Cocos nucifera, Areca catechu, Azadirachta indica, Pongamia pinnata, Tamarindus indica, Aegle marmelos, Artocarpus heterophyllus, Calophyllum inophyllum, Terminalia arjuna, Psidium guajava, Acacia auriculiformis, Anogeissus acuminate, Tectona grandis, Mangifera indica, Syzygium cumini, Samanea saman, Anacardium occidentale, Casuarina equisetifolia, Anthocephalus cadamba, Eucalyptus tereticornis, Leucaena leucocephala, Acacia mangium* and *Moringa oleifera* (Table 5).

The response of palms was remarkably better to *Fani*, although there was difference in ability among them to resist cyclonic wind. The small crown, clear bole, fibrous stem, massive adventitious root system, etc might help them against strong wing to resist. Further, the species like *Borassus flabellifer* and *Phoenix sylvestris* grow wildly having better anchorage of roots in the site. Duryea and Kampf (2017a) observed broad-leaved and other conifer trees (such as pines) and found palms to be more resistant to winds. Palms grow differently than other trees because they have one terminal bud. If that bud is not damaged, palms may lose all their fronds (leaves) and still survive. Palms in the coastal plain and tropical and subtropical regions are often more resistant to winds. However, individual palm species do vary in their responses to wind.

The high wood density, better geometry of branching passing wind, strong root system, small to moderate height, ability to lose leaves, etc help to resist wind (Bhol and Sinha, 2006; Skatter and Kucera, 2000; Duryea and Kampf, 2017a; Kushla, 2017). In Super Cyclone 1999 in the present area, species like *Azadirachta indica, Pongamia pinnata* and *Emblica officinalis* were also found resistant (Bhol and Sinha, 2006). The vulnerability of some species to cyclonic wind may be primarily because of their fast growth rate and brittleness of stem and branches. Some species have shallow root system and compact crown. Most of these damaged species had also witnessed poor resistance to Super Cyclone 1999 in such area (Bhol and Sinha, 2006). Similar findings have been reported by Calvert (2011), SCPL (2012), Sundarapandian et al (2014), Duryea and Kampf (2017b).

CONCLUSION

The response of palms such as *Borassus flabellifer, Phoenix sylvestris, Cocos nucifera* and *Areca catechu* was significantly higher over other tree species to resist Extremely Severe Cyclonic Storm- *Fani* followed by *Azadirachta indica, Pongamia pinnata* and *Tamarindus*

Table 3. Overall per cent of plants damaged at different stages by *Fani*

Stage of plant	% of plants damaged irrespective of species				
	Uprooted	Trunk snapped	Branch broken	Plants bent	Leaf stripped/ dried
Tree	19.5	10.6	27.2	7.6	28.3
Pole	6.8	5.0	21.3	3.8	42.8
Sapling	0.0	0.0	5.5	2.2	42.4
Seedling	0.0	0.0	0.0	0.0	12.7

Table 4. Overall score of damage at different stages of plant by *Fani*

Stage of plant	Score of damage irrespective of species (points)					
	Uprooted (@ 100 points/ plant)	Crown snapped (@ 80 points/ plant)	Branch broken (@ 60 points/ plant)	Plants bent (@ 40 points/ plant)	Leaf stripped/ dried (@ 20 points/ plant)	Total score of damage in a stage (points)
Tree	19.5	8.4	16.3	3.1	5.7	53.0
Pole	6.8	4.0	12.8	1.5	8.6	33.6
Sapling	0.0	0.0	3.3	0.9	8.5	12.7
Seedling	0.0	0.0	0.0	0.0	2.5	2.5

Table 5. Ranking of economic tree species resisting to extremely severe cyclonic storm-*Fani*

Tree species	Common name	Family	Mean score of damage of all 4 stages of growth (out of 100)	Rank of economic tree species resistant to *Fani*
Borassus flabellifer	Palmyra palm	Arecaceae	5.15^{u}	1
Phoenix sylvestris	Sugar palm	Arecaceae	6.20^{t}	2
Cocos nucifera	Coconut	Arecaceae	7.95^{s}	3
Areca catechu	Areca nut	Arecaceae	8.65^{r}	4
Azadirachta indica	Neem	Meliaceae	13.05^{q}	5
Pongamia pinnata	Pongam tree	Fabaceae	13.40^{pq}	6
Tamarindus indica	Tamarind	Caesalpiniaceae	13.80^{p}	7
Aegle marmelos	Bael	Rutaceae	16.05^{o}	8
Artocarpus heterophyllus	Jack tree	Moraceae	19.75^{n}	9
Calophylluminophyllum	Alexandrian laurel	Clusiaceae	23.35^{m}	10
Terminalia arjuna	Arjun	Combretaceae	24.25^{l}	11
Psidium guajava	Guava	Myrtaceae	25.40^{k}	12
Acacia auriculiformis	Australian wattle	Mimosaceae	28.00^{j}	13
Anogeissus acuminata	Button tree	Combretaceae	29.60^{i}	14
Mangifera indica	Mango	Anacardiaceae	30.85^{h}	15
Syzygium cumini	Jamun	Myrtaceae	31.65^{g}	16
Samanea saman	Rain tree	Mimosaceae	33.85^{f}	17
Anacardium occidentale	Cashew	Anacardiaceae	34.70^{e}	18
Casuarina equisetifolia	Casuarina	Casuarinaceae	35.10^{e}	19
Tectona grandis	Teak	Lamiaceae	36.70^{d}	20
Anthocephaluscadamba	Kadam	Rubiaceae	36.75^{d}	21
Eucalyptus tereticornis	Blue gum	Myrtaceae	37.45^{c}	22
Leucaena leucocephala	Subabul	Mimosaceae	37.90^{bc}	23
Acacia mangium	Mangium	Mimosaceae	38.15^{b}	24
Moringa oleifera	Drumstick	Moringaceae	48.70^{a}	25
CD (p=0.05) for species			0.69	

Values with at least one common letter are not significantly different

indica. On the other hand the most susceptible economic species was *Moringa oleifera* followed by *Acacia mangium, Leucaena leucocephala, Eucalyptus tereticornis, Anthocephalus cadamba* and *Tectona grandis which* should not be grown in commercial scale in such areas. Further, the plants in tree stage were significantly affected by cyclone followed by poles and saplings. Seedlings were found not affected by cyclone.

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