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EFFECT OF LEAF HARVESTING ON REPRODUCTION AND NATURAL POPULATIONS OF INDIAN WILD BANANA *ENSETE SUPERBUM* (ROXB.) CHEESMAN (ZINGIBERALES: MUSACEAE)

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Abstract: *Ensete superbum* (Roxb.) Cheesman an important taxon in India is threatened in Maharashtra. It is sporadically distributed on high altitude slopes and rocky cliffs in the Western Ghats. It is an important medicinal and economic plant utilized by people living in rural areas, while the leaves are also utilized in urban areas. The leaves are harvested for commercial purposes. The effect of leaf harvest on natural population with respect to regeneration of new plantlets was evaluated. The results revealed that, non-scientific leaf harvesting resulted in significantly reduced flowering and fruiting, less number of new plantlets in the population, and population degradation. Therefore, leaf harvesting should be practiced in a controlled manner to maintain the population health of this highly potential species.

Keywords: *Ensete superbum*, leaf harvesting, population health, regeneration.

The genus *Ensete* Bruce ex Horan, belonging to family Musaceae, is distributed in Africa and Asia. It is considered an old and relict genus with few cultivated species. In India, the genus is represented by two species viz.: *Ensete superbum* (Roxb.) Cheesman and *E. glaucum* (Roxb.) Cheesman. *Ensete superbum* is listed as not threatened in India with wild distribution mainly in the Western Ghats (Singh & Karthikeyan 2000) and also known to occur in Assam and Rajasthan states; *E. glaucum* is distributed in northeastern India (Subbaraya et al. 2006; Sarojkumar et al. 2010). Apart from India, the species is also reported from Thailand (Anonymous 2014).

In Maharashtra, *E. superbum* occurs along the Western Ghats and is locally known as 'Rankeli' or 'Kavadar' in Marathi. It grows in rock crevices of vertical slopes and also along the seasonal streams on hill slopes (Sharma



DATA DEFICIENT	LEAST CONCERN	NEAR THREATENED	VULNERABLE	ENDANGERED	CRITICALLY ENDANGERED	EXTINCT IN THE WILD	EXTINCT
DD	LC	NT	VU	EN	CR	EW	EX

Ensete superbum
Indian Wild Banana



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et al. 1996). The species is non stoloniferous, therefore, reproduces by seeds only. The seeds of the species have therapeutic potential and are used to cure diabetes, kidney stone (urinary calculi), leucorrhoea and dysuria (Yesodharan & Sujana, 2007; Sarojkumar et al. 2010). The leaf ash ointment in butter is used against leucoderma (Meena & Yadav 2010). The leaves are harvested and used as dinner plates; stalk of inflorescence are either eaten raw or after boiling in water, young flowers and tender fruits are used as vegetables in northern Western Ghats in Maharashtra (Rahangdale 2008). In Kerala and Karnataka, besides the flowers and fruits, the seeds are collected as a crude medicinal drug (Yesodharan & Sujana 2007; Sarojkumar et al. 2010) and also sold in the international market.

It was observed in Bhimashankar Wildlife Sanctuary that, the tender leaves, inflorescences and fruits are delicacies for the Hanuman Langur *Semnopithecus hypoleucos* ssp. *iulus* and other wild animals. Thus, the primary use by wild animals is heavily supplemented by the harvesting of leaves, inflorescences, fruits and seeds by human beings, which adds to the problem of dwindling populations of this species in the northern Western Ghats. There are no efforts taken in any way to increase or maintain the population of this taxon. In Pune District, it was observed by the authors that the previously existing populations are depleting. The leaves of *E. superbum* are harvested during active growth period of the plants in Pune, Thane, and Raigarh districts for sale on a commercial scale in the form of dinner plates and also for spiritual purposes. Therefore, to find out the reason behind depletion in the health of natural populations, present study was undertaken to evaluate the effect of leaf harvesting on the reproduction and population health in the natural populations of this taxon.

STUDY AREA

The present study was carried out in Pune District. Pune District is situated on the northern Western Ghats of the central western part of Maharashtra and lies between 17°05'–19°02'N & 73°02'–75°01'E. The geographical area of the district is 15,642km² spread over 13 taluks (Fig. 1). Pune District is a part of the subtropical monsoon land and therefore shows significant seasonal variations in temperature and rainfall, which has resulted in its having a rich diversity of flora and fauna, particularly in the western region of the district.

METHODS

Extensive field surveys were carried out during July 2010 to November 2012 to study the populations of



Figure 1. Location map of Pune District and the localities under present study.

Ensete superbum (Roxb.) Cheesman in different parts of Pune District. The study was conducted at five locations of four taluks falling under the study area covering part of northern Western Ghats. The locations were selected on the basis of existing populations of the species and incidences of leaf harvesting. The details of five locations are given in Table 1.

Besides this, ethnobotanical information was also recorded through oral interviews of local herbal practitioners and also through available secondary literatures (Subbaraya et al. 2006; Yesodharan & Sujana 2007; Sarojkumar et al. 2010). Quantitative assessment was done by quadrat method following Michael (1986) by laying the quadrates of 5×5 m². The quadrates were laid down in biased manner wherever the natural populations of *Ensete* were present. The study was conducted by considering following parameters, viz.: mature plants, number of regenerated plantlets, flowering, fruiting, and human interference. The selected locations were visited during July to September to record observations. The data was analyzed statistically by applying ANOVA as per Singh & Chaudhary (1985). The locations studied were considered as treatments while the quadrates laid down at each location as replications for this analysis. The results of ANOVA were tested for significance at P=0.05 and P=0.01 level against the control location, i.e., Pangari, because there was none or very negligible harvesting of leaf, fruits or seeds. The ANOVA is presented in Table 2

and the mean and least significant difference in Table 3.

RESULTS

During the present study, some important observations were recorded: (i) the leaves of *E. superbum* are harvested by local communities during the active growth period of the plants, specifically on the occasion of Shraavan fast (in the month of August-September) for dinner plates and god worship (Images 1–5), (ii) The harvested leaves are sold in the markets of Pune and Mumbai regularly, (iii) In most cases, almost all the leaves are harvested leaving only 1–2 tender leaves on the plant. Other plant parts are also utilized by local people; such as the central core of inflorescence and pseudostem used as salad; flowers and young fruits also used as vegetables; and the seeds used to cure kidney stones and diabetes. Once the central core of inflorescence is harvested the plant dies without reproduction.

The results revealed that, treatment mean squares of mature plants and regenerated plantlets are significant at 1% level, while that of flowering and fruiting was significant at 5% level. This indicates that the locations are significantly variable with respect to these parameters. The replication mean squares are found to be non significant for all three parameters, indicating that there

were no differences among the quadrates laid down for taking observations at all the locations.

The mean values for the parameters studied, viz., number of mature plants, regenerated plantlets and the number of incidences of flowering and fruiting are significantly different as compared to that at the control location for all the locations except Ralegan. At Kelad the incidences of flowering and fruiting were found to be non-significant when compared with that at the control location. Pangari and Ralegan are the locations in the taluk Junnar, where the intensity of harvesting of the *Ensete* products is relatively less. Sinharharh and Lonawala are the most disturbed locations followed by Kelad falling under Velhe Taluk with relatively longer rainy season.

The populations near the Sinharharh and Lonawala were found to be highly disturbed due to excessive leaf harvesting, grazing, as well as exploitation for medicinal purposes. The species population within the disturbed area shows dwarf or stunted growth of mature plants, abortive flowering and fruiting. In these populations a fewer number of young plants were observed.

Table 1. Locations at which the observations are recorded.

	Location	Taluka	Altitude	Geographical coordinates	Forest types
1	Pangari	Junnar	778m	73°51'451"E & 19°17'604"N	Dry deciduous
2	Ralegan	Junnar	792m	73°47'294"E & 19°11'437"N	Dry deciduous
3	Lonawala	Mawal	680m	73°24'148"E & 18°43'172"N	Moist deciduous
4	Sinharharh	Haveli	995m	73°45'807"E & 18°22'085"N	Dry deciduous
5	Kelad	Velhe	661m	73°34'980"E & 18°12'448"N	Moist deciduous

Table 2. Analysis of Variance (ANOVA) for three parameters of natural populations of *Ensete superbum*.

Source	D.F.	Mean squares for characters		
		Mature plants	Regenerated plantlets	Flowering & fruiting
Locations (Treatments)	4	84.17 **	70.07**	6.62*
Quadrates (Replications)	9	14.63	14.28	2.38
Error	36	13.25	11.48	2.43

D.F. = Degrees of freedom; *, ** Represent F test significance at P=0.05 and P=0.01, respectively.



Image 1. *Ensete superbum* - Leaf harvesting

Table 3. The mean values for the locations (Treatments) along with standard error.

	Characters	Mean values for the locations						SEm	LSD (P=0.05)	LSD (P=0.01)
		Pangari#	Ralegan	Sinhagarh	Lonavala	Kelad	Grand mean			
1	Mature plants	15	12.2	9.5**	7.3**	10.4**	10.88	1.03	2.95	3.96
2	Regeneration	7.4	6.8	1.5**	2.6**	3.1**	4.28	0.96	2.75	3.68
3	Flowering fruiting	2.3	1.2	0.4**	0.4**	1.6	1.18	0.44	1.27	1.70

Represents location considered as control. *, ** Represent significance at 5% (P= 0.05) and 1% (P=0.01) probability, respectively when compared with control location (Pangari).

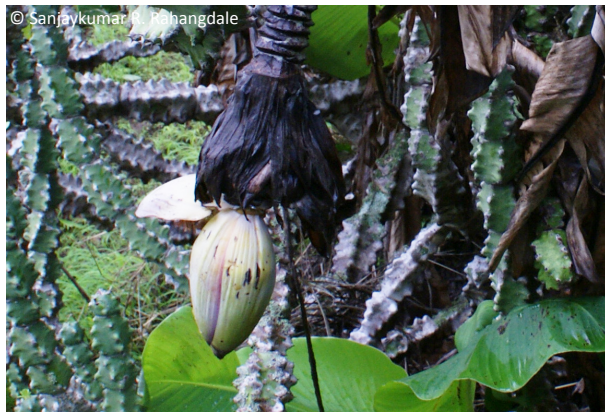


Image 2. Abortive flowering and fruiting of *Ensete superbum* at harvesting site



Image 3. Healthy flower and fruiting of *Ensete superbum* at non-harvesting site



Image 4. Population of *Ensete superbum* seedlings



Image 5. Healthy population of *Ensete superbum*

Undisturbed and healthy populations were recorded at Pangari and Ralegan, having good physical appearance with healthy flowering and fruiting. These populations have a larger number of mature plants and young plantlets (Images 1–5).

DISCUSSION AND CONCLUSIONS

In *E. superbum* the photosynthate from the leaves is stored in the underground corm. This source sink relationship is very crucial for the normal reproductive

cycle in plants. Sufficient photosynthate should be available within the plant to fulfill the need of sink, i.e., the flowers and fruits. A planned study of leaf harvesting and yield in *Ensete ventricosum* (Welw.) Cheesn. revealed that, at least eight leaves should be kept intact for non significant effect on the reproduction and yield (Tsegaye 2007). This means, eight fully expanded leaves are sufficient to fulfill the demand of photosynthate towards maintenance of good reproduction and ultimately the normal population of *Ensete*. Study on the sunflower

showed that, the defoliation near or during flowering stage and intensity of defoliation greatly reduces the yield (Kene & Charjan 1998); while, Barimavandi et al. (2010) reported that, the defoliation of top leaves has significant negative effect on seed yield in maize. This means that, the defoliation affects adversely on the seed yield and ultimately on the reproductive capacity of the plant. In some locations under the present study, as most of the leaves were harvested and the population had less number of young plantlets indicates that the plants do not get sufficient food to complete its reproductive cycle. Based on the present evaluation it is revealed that, the rate of regeneration of young plantlets is affected because of the large quantity of leaf harvesting. The number of regenerated plantlets is found to be less in the disturbed sites, whereas at undisturbed sites the population has a healthy regeneration of plantlets (Fig. 2). Unlike the southern Western Ghats, the plants of *Ensete* become defoliated due to unavailability of rain or water in the northern Western Ghats. Under these conditions the photosynthate is stored in the corms and used for next year's growth. The leaf harvesting affects this amount of stored food material and ultimately results in poor growth in the subsequent season. It is also observed that once the leaves are harvested, especially in the month of September, new leaves are produced, but they do not get sufficient duration to synthesize the food and store it in the corm. Thus the corm may have a deficit of the stored food material. These results indicate that the existing populations of the species may perish in forthcoming years from the locations where heavy and uncontrolled leaf harvesting is practiced.

Therefore, it is recommended that proper harvesting methods should be practiced to maintain healthy growth of the plants and ultimately to sustain the natural population of the species. This could be achieved through the following measures: (i) leaf should be harvested only during the vegetative state of the plants, (ii) at least the top 4–6 leaves should be kept intact on the plant, (iii) harvesting should be practiced with one year gap between successive harvests of the same population, and (iv) planned cultivation should be undertaken along with development of agronomic practices.

The present study revealed that, natural populations of *Ensete superbum* are excessively degraded due to indiscriminate harvesting for medicinal purposes, commercial gains and grazing. The commercial exploitation of this species coupled with habitat destruction is likely to reduce its population, in nature. Hence, adequate management actions including in situ and ex situ conservation measures need to be undertaken

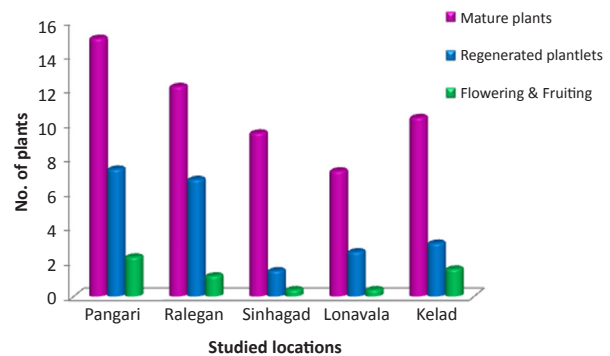


Figure 2. Graphical representation of *Ensete superbum* at different locations.

to harvest this valuable resource sustainably.

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