Population structure and Regeneration of *Croton scabiosus* Bedd. (Euphorbiaceae) in dry forests of South Eastern Ghats of YSR Kadapa District, Andhra Pradesh, India

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ABSTRACT

Croton scabiosus Bedd. (Euphorbiaceae), an endemic tree of dry forests of South Eastern Ghats, is categorized as a vulnerable tree. For effective conservation of this species studies on its population structure and regeneration are required. The population structure and regeneration of *C. scabiosus* was studied in 11 localities of dry forests of Kadapa district, India, by laying 66 quadrats 5x200m in size. A total of 2571 individual trees with a range of 61-100 individuals in each quadrat were recorded. The majority (81%) of the individuals are in 10-20 cm and 21-30 cm gbh class, followed by 19% of 31-40 cm gbh class. The height class distribution revealed that 74.06% trees are in 2-3 m height class, while 20.78% trees in 4-5 m height class and only 5.14% trees are 6-8 m height. In the regeneration category 8.8% of seedlings and 49.7% saplings were recorded. In addition, *C. scabiosus* is associated with 54 tree species belonging to 39 genera and 21 families. The most commonly associated tree species are; *Acacia caesia*, *A. chundra*, *Cleistanthus collinus, Gardenia gummifera, Mimosa intsia, Ochna obtusa, Strychnus nuxvomica, Pterocarpus santalinus* and *Wrightia tinctoria.* In certain sites *C. scabiosus* formed the dominant lower canopy tree in the elevation range of 155 m-328 m.

Keywords: *Croton scabiosus, Endemic tree, Vulnerable, Dry forests, associated trees, Population structure, Regeneration*

INTRODUCTION

Tropical dry forest accounts for 38.2% of the total forest cover of India [1]. These dry forests not only constitute rich species diversity, generate a variety of natural resources, but also promote livelihood security to local communities [2]. Tropical dry forests occur in climates with seasonal rainfall, with a mean annual rain fall of 250- 2000 mm and Potential Evapo-

transpiration (PET) of >1[3]. The distribution of plants is determined by climatic variables like rain fall, temperature, soil conditions, moisture, nutrient availability and competition between plant species for crown and root space as well as human interference [4]

Croton scabiosus Bedd. (Euphorbiaceae), a small deciduous tree of 4-6 m in height, is endemic to South Eastern Ghats of Andhra Pradesh [5-7]. This species is represented by small populations, with a scattered distribution in dry deciduous forests (Fig. 1,2) of South Eastern Ghats of Andhra Pradesh [8]. It is found in Ananthapuramu, Kadapa and Nellore Districts of South Andhra Pradesh, India. It is listed as vulnerable according to IUCN Red list status [8].The species is medicinally important, as the seeds are used as an antidote for snake bite and scorpion sting by the local people [9]. It has a very attractive silvery to golden foliage, which can be recommended as an ornamental garden plant [10]. Its populations in the natural habitat in Kadapa forests are primarily threatened by forest fires, fungal infection of seeds and poor germination [7]. As this is an endemic and medicinally important species and its populations are small and declining in the native habitats, studies on regeneration and phytosociological information are necessary for its conservation.

2. MATERIALS AND METHODS

Study Area

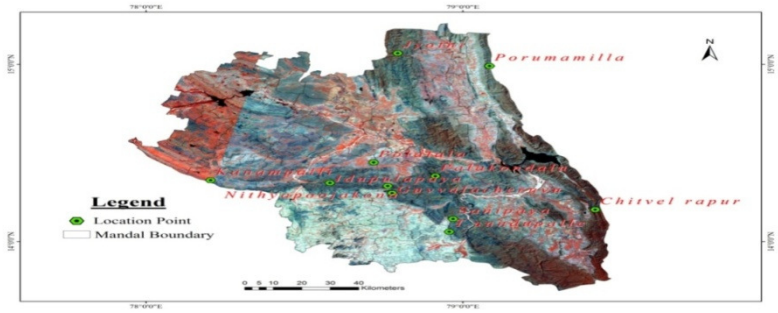
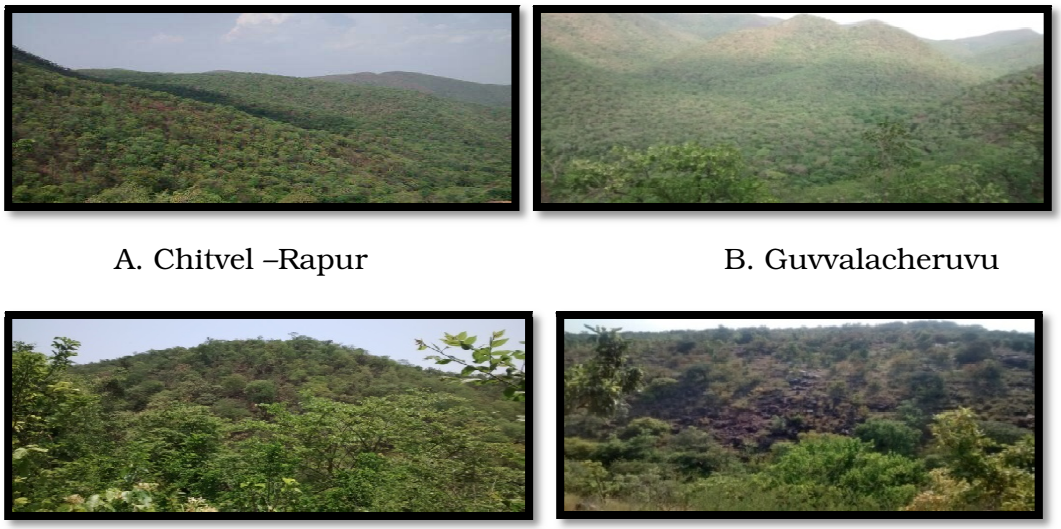


Fig. 1 Location of the study area

YSR Kadapa district is located between $13^0 43^l$ and $15^0 14^l$ North latitude and $77^0 55^l$ and $79^0 29^l$ East longitude. The total geographical area of the district is 15,379 km^2, with the forest area comprising 5,050 km^2, which is 32.87% of the district area. Day temperature reaches maximum 46^0C in May and minimum 31^0C in December in Kadapa district. Average rain fall is 700mm.The present study was undertaken in the dry deciduous forests of Kadapa district in 11 places, namely; Idupulapaya, Palakondalu, Nithya pooja Kona, Porumamilla, Joythi, Kanampalli(Pulivendula), Sundupalli, Sanipaya, Polathala, Guvvalacheruvu,

and Chitvel-Rapur hills. These 11 locations are identified based on forest vegetation of *C. scabiosus* species distribution (Fig. 1 and 2). The study was carried out at each location to assess the density 4.04/0.6 ha^{-1} in totally 6.6 ha population and regeneration status of the tree species. All the study sites consists of dry deciduous forests.



A. Chitvel –Rapur B. Guvvalacheruvu

C. Sundupalli D. Pulivendula

Fig. 2. Dry Forests with high abundance of *Croton scabiosus* in Chitvel-Rapur, Guvvalacheruvu, Sundupalli and Pulivendula forests

Data collection and analysis

The study was carried out in 11 study sites; in each site six belt transects of 5x200 m were laid, which formed 0.6 ha in each area, and 6.6 ha in total field by study area. In each site diameter at breast height (1.37m above ground) and height of all the individuals were recorded in each quadrat. The regeneration was studied by counting all encountered seedlings (<10cm) and saplings (1m height). Population structure of *C. scabiosus* was assessed by frequency histogram by categorizing the density into three gbh (girth at breast height) classes 10-20 cm, 21-30 cm and 31-40 cm. The trees were categorized into three height classes, 2-3 m, 4-5 m and 6-8 m. In all study sites associated trees with *C. scabiosus* were also recorded.

3. RESULTS

A total of 2571 C. *scabiosus* individuals in 6.6 ha area, with a range of 61-100 individuals in 5x200 m quadrat (0.6ha) were recorded. Out of these 226 are seedlings (<10cm height), 1277

are Saplings (1m height) and 1068 are trees (≥10 cm gbh). The number of individuals, seedlings and trees in different forests is shown in Fig. 3 and Table -1.

Table -1 Number of *C.scabiosus* in different forests and their Gbh and Height class

Forest areas	Number of Individuals	Seedlings (<10cm ht)	Saplings 1m ht)	Trees (≥10 cm gbh)	Gbh Class(Cm)			Height Class (m)		
					10-20	21-30	31-40	2-3m	4-5m	6-8m
Chitvel, -Rapur	208	20	58	136	33	65	35	50	54	32
Guvvalacheruvu	269	15	144	110	29	68	23	88	22	-
Idupulapaya	214	28	125	61	21	40	5	55	6	-
Nithyapooja kona	262	33	116	113	32	49	40	86	27	-
Palakondalu	419	16	217	178	69	113	-	163	15	-
Polathala	215	27	114	72	40	35	2	66	6	-
Porumamilla	204	8	130	66	29	35	7	51	15	
Pulivendula	285	10	164	105	47	52	11	103	2	-
Sanipaya	328	37	133	158	15	48	66	96	54	8
Sundupalli	167	32	76	69	18	27	14	33	21	15
Jyothi	-	-	-	-	-	-	-	-	-	-
Total	2571	226	1277	1068	333	532	203	791	222	55

The gbh class distribution showed that 31.2% of 10-20 gbh class, 49.8% of 21-30 gbh class and 19% of 31-40 gbh class (Fig. 4). 10-20 gbh class is represented by 333 trees, out of these highest in Palakondalu (20.72%) and lowest in Sanipaya (4.6%) trees. 21-30 gbh class is represented by 532 trees. Palkondalu forest consists of highest percentage of trees (21.24%) of this group and lowest in Sundupalli (5.1%). 203 trees are in 31-40 gbh class with highest percentage in Sanipaya (32.51%) and lowest in Polatala (0.98%).

The height class distribution revealed that 74.06% trees occur in 2-3 m height class while 20.78% trees 4-5m height class and only 5.14% trees are in 6-8m height class (Fig.5). Trees of 2-3 m height class are highest in Palakondalu (20.60%) and lowest in Sundupalli (4.17%). Trees of 4-5 m height class, highest in Chitvel –Rapur and Sanipaya (24.32%), lowest in Pulivendula (0.90%). Chitvel –Rapur forest is dominated by 6-8 m height class (58.18%).

A total of 54 associated tree species were inventoried that belong to 39 genera and 21 families (Table -2). Fabaceae is the dominant family represented by six species, Moraceae family with four species and Rubiaceae with three species are the other dominant families .The other families are represented by two or one species in different forest areas. *C.scabiosus* in different forest areas is commonly associated with *Acacia chundra, Boswellia serrata, Cassia fistula, Dalbergia lanceolaria, D. latifolia, Diospyrous chloroxylon, D. melanoxylon, Ficus mollis, Ficus*

virens, Gardenia gummifera, G. resinifera, G. latifolia, Grewia hirsuta, G. tiliifolia, Ochna obtusa, Premna tomentosa, P. latifolia, Pterocarpus santalinus, Strychnos nux-vomica, S. potatorum and *Wrightia tinctoria* (Table -3).

Over all Regeneration of *C.scabiosus* is average in all the sites studied. The frequency distribution analysis among the quadrats reveals that seedlings are present in only 35 qudrats (53.03%) out of all the 11 localities studied. The regeneration distribution shows that the saplings are 49.7% and seedlings are 8.8%. Highest regeneration status with regard to seedlings (16.37%) is observed in Sanipaya forest and lowest in Porumamilla (3.54%) and Pulivendula (4.4%) forests. (Fig. 6). With regard to saplings highest percentage (17%) is in Palakondalu forest and lowest in 4.54% forests in Chitvel –Rapur (Fig. 7) .

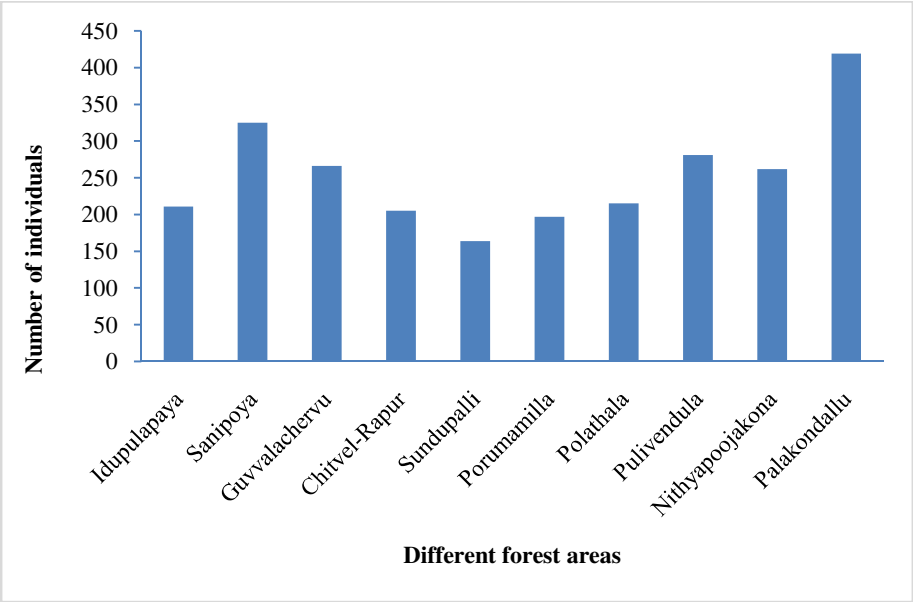


Fig.3 Number of Individuals in *C. scabiosus* in different forests of Kadapa district

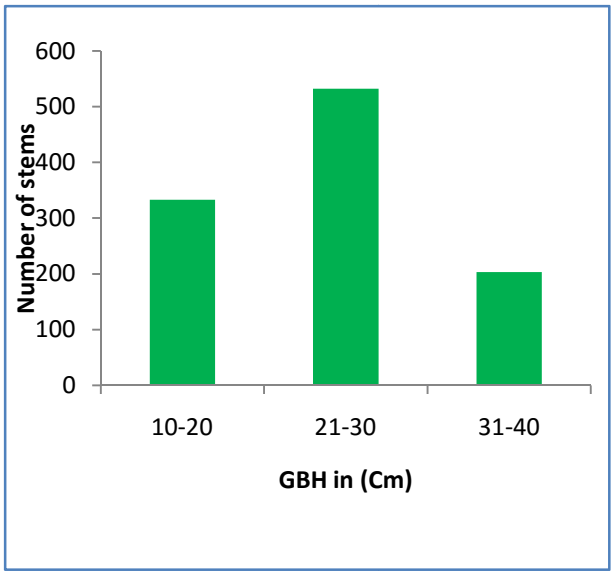


Fig. 4 Number of stems in *C. scabiosus*

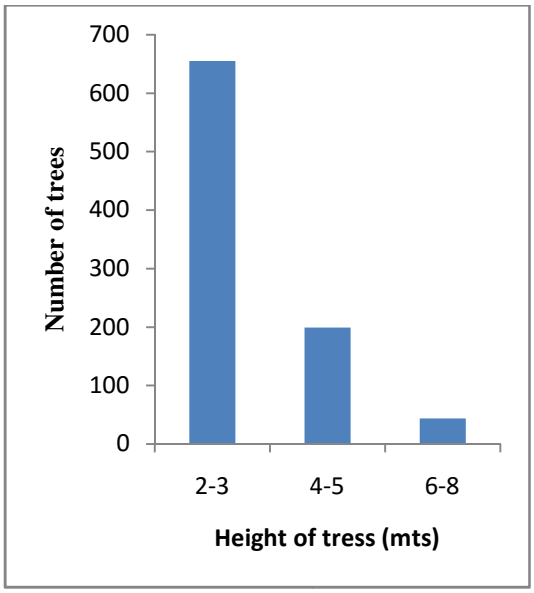


Fig. 5 *C. scabiosus* tree height

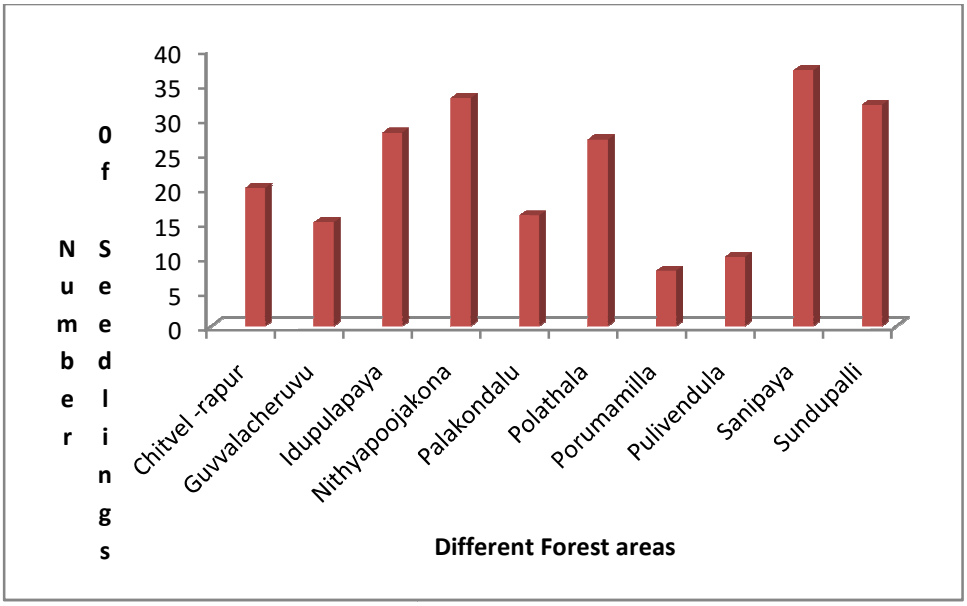


Fig. 6 Number of seedlings in different forest areas

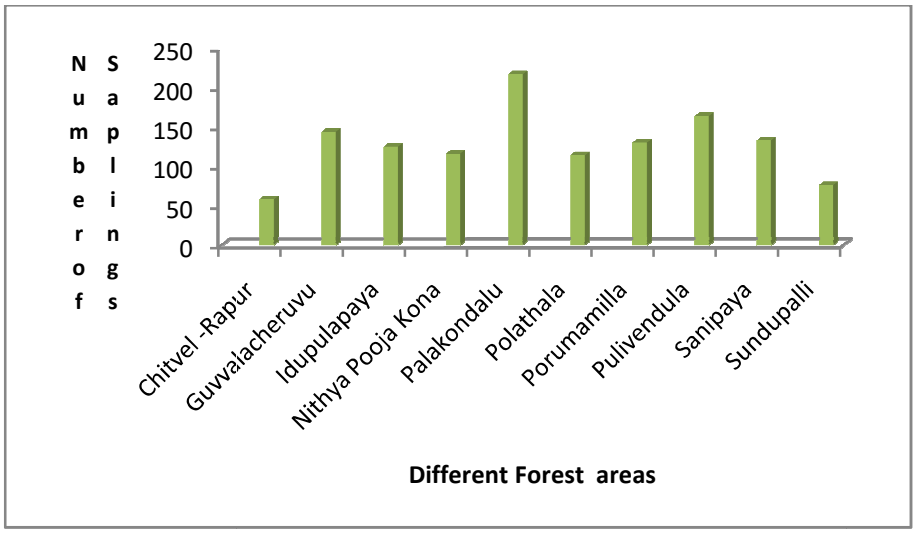


Fig.7 Number of saplings in different forest areas

Table -2 Associated tree species with *C. scabiosus*

SI.No	Tree Species	Family
1	*Acacia caesia* (L.) Willd.	Mimosaceae
2	*Acacia chundra* (Rottler) Willd.	Mimosaceae
3	*Aegle marmelos* (L.) Correa	Rutaceae
4	*Albizia amara* (Roxb.) B.Boivin	Mimosaceae
5	*Anogeissus latifolia* (Roxb. ex DC.)	Combretaceae
6	*Atalantia monophylla* DC.	Rutaceae
7	*Bauhinia racemosa* Lam.	Fabaceae
8	*Boswellia ovalifoliolata* N.P.Balakar. & A.N.Henry	Burseraceae
9	*Boswellia serrata* Roxb.ex Colebr.	Burseraceae
10	*Bridelia montana* (Roxb.) Willd.	Euphorbiaceae
11	*Buchanania axillaris* (Desr.) Ramam.	Anacardiaceae
12	*Cassia fistula* L.	Caesalpiniaceae
13	*Cassine glauca* (Rottb.) Kuntze	Celastraceae
14	*Ceiba pentandra* (L.) Gaertn.	Bombacaceae
15	*Cleistanthus collinus* (Roxb.) Benth.	Euphorbiaceae
16	*Chloroxylon swietiana* DC.	Rutaceae
17	*Cochlospermum religiosum* (L.) Alston	Cochlospermaceae
18	*Commiphora caudata* (Wight & Arn.) Engl.	Burseraceae
19	*Dalbergia lanceolaria* L.f.	Fabaceae
20	*Dalbargia latifolia* Roxb.	Fabaceae
21	*Deccania pubescens* (Roth) Tirveng.	Rubiaceae
22	*Diospyros chloroxylon* Roxb.	Ebenaceae
23	*Diospyros melanoxylon* Roxb.	Ebenaceae
24	*Dolichondrone atrovirens* (Roth) K.Schum.	Bignoniaceae
25	*Erythroxylum monogynum* Roxb.	Erythroxylaceae
26	*Ficus benghalensis* L.	Moraceae
27	*Ficus mollis* Vahl	Moraceae
28	*Ficus religiosa* L.	Moraceae

29	*Ficus virens* Aiton	Moraceae
30	*Gardenia gummifera* L.f.	Rubiaceae
31	*Gardenia resinifera* Roth	Rubiaceae
32	*Grewia flavescens* Juss.	Tiliaceae
33	*Grewia hirsuta* Vahl	Tiliaceae
34	*Grewia tiliifolia* Vahl	Tiliaceae
35	*Hardwickia binata* Roxb.	Caesalpiniaceae
36	*Lannea coromandelica* (Houtt.) Merr.	Rutaceae
37	*Madhuca longifolia* (J.Kong ex L.) J.F.Macbr.	Sapotaceae
38	*Mimosa intsia* L.	Mimosaceae
39	*Naringi crenulata* (Roxb.) Nicolson	Rutaceae
40	*Ochna obtusata* DC.	Ochnaceae
41	*Phyllanthus emblica* L.	Euphorbiaceae
42	*Polyalthia cerasoides* (Roxb.) Bedd.	Annonaceae
43	*Premna latifolia* Roxb.	Verbenaceae
44	*Premna tomentosa* Willd.	Verbenaceae
45	*Pterocarpus santalinus* L.f.	Fabaceae
46	*Radermarchera xylocarpa*(Roxb.)Roxb.ex K. Schum.	Bignoniaceae
47	*Santalum album* L.	Santalaceae
48	*Strychnos nux-vomica* L.	Loganiaceae
49	*Strychnus potatorum* L.	Loganiaceae
50	*Syzigium alternifolium* (Wight) Walp	Myrtaceae
51	*Terminalia bellirica* (Gaertn.) Roxb.	Combretaceae
52	*Terminalia chebula* Retz.	Combretaceae
53	*Terminalia tomentosa* Wight&Arn.	Combretaceae
54	*Wrightia tinctoria* R.Br.	Apocynaceae

Table -3 Associated trees with *C. scabiosus* in different forests of Kadapa district

Forest area	Elevation (in m)	Associated Trees
Chitvel - Rapur	261-510m	*Limonia acidissima, Ficus virens,Mimosa intsia*
Idupulapaya	275m-598m	*Anogeissus latifolia, Dolichondrone atrovirens, Grewia hirsuta, Gardenia resinifera, Hardwikia binata*
Guvvalachervu	467m-519m	*Chloroxylon swietenia, Gardenia gummifera, Gardenia resinifera, Pterocarpus santalinus, Ochna obtusata*
Nithyapooja kona	407m-597m	*Boswellia serrata , Cleistanthus collinus, Cochlospermum religiosum, Pterocarpus santalinus.*
Palakondalu	155m-328m	*Cleistanthus collinus, Gardenia gummifera, Gardenia latifolia, Pterocarpus santalinus, Mimosa intsia, Ochna obtusata, Buchanania axillaris.*
Polathala	215m-368m	*Acacia chundra, Bridelia montana, Diospyros chloroxylon, Dolichondrone atrovirens.*
Porumamilla	478m-592m	*Cassia fistula, Diospyros melanoxylon,*

		Phyllanthus emblica .
Kanam Palli	268m-462m	*Anogeissus latifolia, Gardenia gummifera, Wrightia tinctoria*
Sanipaya	205m-706m	*Anogeissus latifolia, Aegle marmelos, Hardwickia binata* .
Sundupalli	208m-515m	*Anogeissus latifolia, Acacia chundra, Bauhinia racemosa* .
Joythi	392m-635m	*Croton scabiosus* is not found -

Discussion

Population structure of *C. scabiosus* in terms of proportion of seedlings, saplings and adults among the 11 forests varied. The size class distribution of tree has often used to represent to the population structure of forests [11]. The forest was dominated by mostly saplings in all the 11 sites. Individuals of 10-20 gbh class, 21-30 gbh class and 2-3 m height class are more in Palakondalu (21.4%) because soil and climatic conditions are favorable for good growth of trees, and low in Sundupalli may be due to rocky habitat. Highest percentage of 31-40 gbh class is in Sanipaya (27.2%) this may be due good forest soil and favorable climatic conditions. This forest is undisturbed, so trees showed good growth. Lowest in Polathala (0.8%) forest which is a sacred grove with much anthropogenic disturbances. Out of total 1068 trees more individuals of 4-5m height class and 6-8m are recorded in Chitvel -Rapur hills (32.5%) low in Pulivendula (1.2%).The total basal area value is 7.74m^2/ha with a range of 25% - 75% and the average height is 3m.*C. scabiosus* tree height and the calculated basal area showed a marked strong relationship. The total basal area recorded in the present study is 7.74m^2/ha^{-1} and this is within the range of tropical dry forests in other parts of Eastern Ghats 6.6-23.2m^2 ha^{-1},7.792-492.2m^2 h^{-1} [12,13].

The regeneration can be predicted by the structure of their population [14]. Though the number of population of saplings is good the seedling growth is poor. In general regeneration of species is affected by various anthropogenic activities [15, 16] and natural factors such as climatic conditions. The biotic pressures play an important role in forest community dynamics and often regulate the recruitment and survival pattern of seedlings [17].

Highest percentage of seedlings growth occurred in Sanipaya (16.37%) . It may be due to good soil and climatic condition favorable for growth and almost no human interference and the lowest seedling growth on rocky habitats of Pulivendula ghats (4.42%) and Porumamilla (3.53%)

as the hills are rocky and lack of adequate soil for germination of seeds. Though tree population is high in Palakondalu seedling growth is low (7.07%) in this forest. This may be due to recurrent forest fires and anthropogenic disturbances. In all areas seed germination is also affected by fruit and seed infestation and poor viability of seeds. The *C. scabiosus* tree usually occurs in lower canopy and the upper canopy is dominated by *Pterocarpus santalinus, Terminalia alata, Anogeissus latifolia, Gardineia gummifera, G. resinifera, Cleistanthus collinus, Mimosa intsia* and *Wrightia tinctoria*. *C.scabiosus* formed the dominant lower canopy tree in the elevation range of 155-328 m. In Joythi forests which form the bordering area of Kadapa and Kurnool district, *C.scabiosus* trees are not found. This is in conformation of the report of Raju and Pullaiah [18].

Conclusion

The overall population structure of tree species in the study site reveals that contribution of saplings to the population was highest followed by trees and seedlings. The regeneration status of *Croton scabiosus* in various forests of Kadapa district is low. The establishment, survival and growth of seedling is governed by several biotic and abiotic factors. Recurring forest fires and nutrient poor rocky habitat are the main abiotic factors which cause poor regeneration. Flower and fruit predation by beetles and fungal infestation of fruit and seeds, poor germination and anthropogenic disturbances are the important biotic factors for the recruitment and population expansion. Hence proper conservation measures have to be formulated to protect the species, taking into account its medicinal and economic values. Awareness programmes regarding the importance of forests, controlling forest fires and motivating the village people towards sustainable harvesting of forest products may help minimize the pressure on this species.

Acknowledgements

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