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Importance of Vegetation and Soil Seed Banks in Forest Managment

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ABSTRACT

Soil seed banks are reserve of viable seeds present on the surface and in the soil. They are indicators of the past and present plant population in a community. Seed banks are essential for maintaining life and growth in plant communities and are defined as a build up of viable but ungerminated seeds in or on the soil.

Topical dry deciduous forests of Sagar (Ramna) are under constant threat due to over exploitation for various socio-cultural reasons and increasing growth of pharmaceutical industries. Further, the other disturbances due to overgrazing, frequent fires etc. are also exerting constant pressure on the vegetation.

Soil seed banks are very important for plants regeneration, soil seed banks present on the surface in soil, soil seed banks indicate post and present plant populations and plant community seed banks are essential for growth, life maintaining and regeneration. Soil seed banks have a greater role to play in maintaining ecological and genetic diversity in population and communities. Many studies have documented the role of seed banks in vegetation structure and dynamics. Distubance play of major role in regeneration and maintenance of species diversity and the major sources and selective forces in succession and population characteristics.

Soil seed banks play an important role in the composition of different plant communities and thus in their conservation. Composition of seed banks depends on the production and composition of the present and past plant communities as well as on the longevity of the seed of each species under existing conditions. If there is a disturbance in the plant community. Seed banks may intervene in re-establishing the original community. Seedlings and sapling of plants play a useful role in forest egeneration, presence of high density of seedling and saplings plant species showed good regeneration.

The present work is aimed to study the existing soil seed banks of tropical dry deciduous forest of Sagar at Ramna to compare the soil seeds banks populations with the existing composition of forest vegetation.

KEY WORDS: Soil seed bank, Tropical dry deciduous forest, Regeneration, Community.

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INTRODUCTION

Seed banks are essential for maintaining life and growth in vegetation and are defined as a build up of viable but ungerminated seeds in or on the soil'. Seed banks exit because of natural selection for plant species that can withstand harsh condition and germination of optimal ones (Hytt, 1999). The presence of seed banks in soil allows a plant species to maximize its chance for survival, creating benefits for the population. Seeds stores in the seed banks can withstand harsh condition over many year allowing the plants species to be propagated after initial seeds dispersal.

Seed banks play an important role in maintaining ecological and genetic diversity in population and communities. A number of studies have documented the role of seed banks in vegetation structure and dynamics. Disturbance play a major role in regeneration and are the mayor sources and selective force in evolution, succession and population characteristics.

The development of soil seed bank in any plant community depends upon the kind of species existing at present and during early part. Seed with orthodox storage physiology remain stored for a long period of time.

Important of soil seed banks in maintaining ecological diversity has been emphasized by a number of workers (Tempelton and Levin, 1979; Thompson and Grime, 1979; Venable, 1989).

Tropical dry deciduous forest of Sagar are under constant threat due to over exploitation for various socio-cultural reasons and increasing growth of pharmaceutical industries. Further, the other disturbance due to overgrazing, frequent fires are also exerting constant pressure on the vegetation (Fig. 1). The present paper deals with the composition of soil seed banks of a dry deciduous forest of Ramna. Details of the study site has been described by Thakur and Hare (2010).

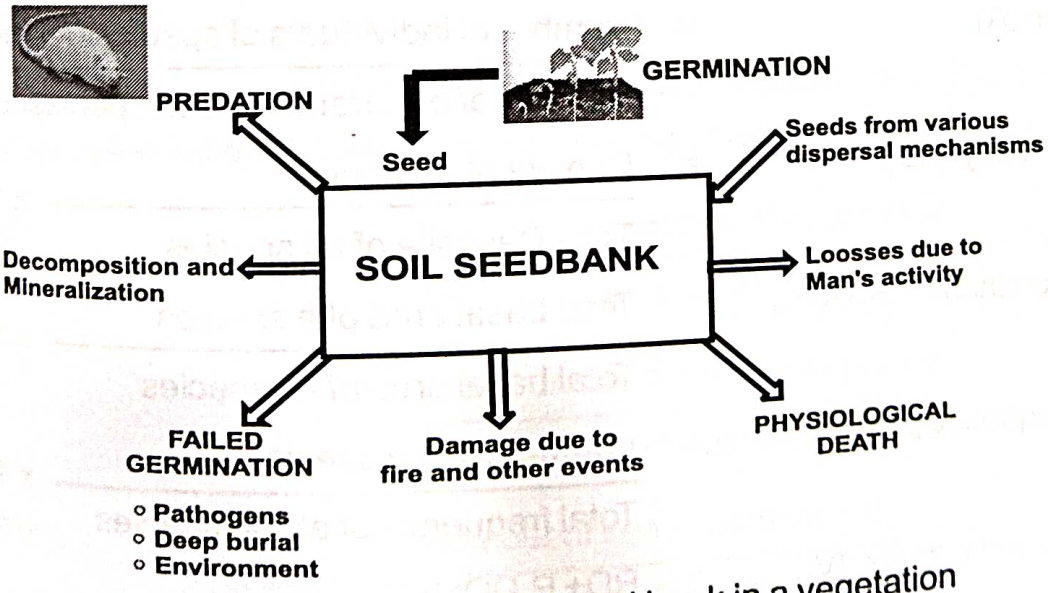

Fig. 1: Factor affecting soil seed bank in a vegetation

MATERIALS AND METHODS

The present study was carried out in tropical dry deciduous forests of Sa district. The climate of the area is typically monsoonic with clearly defined summer, W and rainy seasons. Mean annual rainfall is 1230 mm of which about 80-90% is rec during rainy season maximum (45°C) and minimum (6°C) temperature have been reco during the month of June and December respectively.

Sampling for soil seed banks was done at the site selected on the basis of dis disturbances.

Vegetation

After surveying the study area representative site, Ramna was selected. At stu site Quadrats of 10 x 10m size were randomly placed for the analysis of tree layer. Shru layer was analysed laying quadrats of 5 5m and herb layer by 1m x 1m number of seedlin and saplings of tree species were also recorded.

Data Analysis

The data were quantitatively analysed for frequency, density, abundance and bas area (Curtis and McIntosh, 1950). The sum of all above relative values index was summe up at Importance Value Index (IVI). On the basis of IVI, dominant, co-dominant and mai associate species were recognized (Mueller-Dombois and Ellenberg, 1974). Following formulae were used for the above analysis:

$$\text{Frequency (F) \%} = \frac{\text{Number of quadrats of occurance}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Density (D)} = \frac{\text{Number number of individual of species}}{\text{Total number of quadrats studied}}$$

$$\text{Abundance (A)} = \frac{\text{Number of individuals of speciesin all quadrats}}{\text{Number of quadrats in which speciesoccured}}$$

$$\text{Relative Density (RD)} = \frac{\text{Density of a species}}{\text{Total Desnsity of all species}} \times 100$$

$$\text{Relative Dominance (R.Dom)} = \frac{\text{Total basal area of a species}}{\text{Total basal area of all species}} \times 100$$

$$\text{Relative frequency (R.F)} = \frac{\text{Frequency of a species}}{\text{Total frequency of all the species}} \times 100$$

$$\text{Importance value Index (IVI)} = \text{RD+ R.DOM+RF}$$

Nature of vegetation

Five frequency classes were made on the basis of per cent frequency values of each species following Raunkiaer (1934).

Frequency Percent (%)	Frequency classes
0-20	A
21-40	B
41-60	C
61-80	D
81-100	E

Seed Analysis

Similar to the vegetation analysis, soil seed banks of Ramna forest were analysed for the structure and composition of different seed methods in rainy, winter and summer season employed are basically those of (Spray and Grime, 1977), Kropac (1966), Major and Pyott (1966) and Roberts (1969). Soil samples of 10x10cm size were collected from two different soil layers (0-5 cm and 5-10 cm depths) with in the site, four microhabitats viz., trunk influenced area, canopy area, inter canopy area were selected. These microhabitates were selected to evaluate variation in population dynamics of soil seed banks (Khare, 2005; Khare and Khare, 2006, 2011, 2012). Total thirty two soil samples were collected in after removing leaves, twigs and stones, and numbered for each microhabitat.

Soil samples were washed and passed through different mesh soil sieves to separate different sized seeds. Seeds were classified species wise and their numbers were recorded for analysis. Identification of seeds was done from seeds of native flora and other references.

Considering the seeds of a species similar to as in vegetation analysis, the following attributes for the soil seed banks were analyzed using under mentioned formulae

$$\text{Frequency (F)} = \frac{\text{Number of quadrats of occurance}}{\text{Total number of quadrats studied}} \times 100$$

$$\text{Density (D)} = \frac{\text{Total number of seeds of species}}{\text{Total number of quadrats studied}}$$

$$\text{\% Germination} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds}} \times 100$$

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STUDY AREA

Present study was carried out in forest occurring in Sagar district. Total geographical area of the district is approximately 10,25259km, which lies in the center of north-mid region of India.

Study site - Ramna

This site situated 51 Kilometers from Sagar on Garhakota-Patharia road. It lies at 23°50'N latitude and 79°09'E longitude. Hills rise to a height of 426 meters. Due to less biotic interference. forest is thick with mixed teak vegetation. Dominant tree species are Tectona grandis and Butea monosperma. Shrubs are Carissa spinarum and Lantana camara. Herbs consist of Cassia tora and Sida spinosa. Main geological formation of the site is basalt that supports silty clay loam.

RESULTS AND DISCUSSION

Vegetation

The site as per value of IVI was dominated by Tectona grandis and Butea monosperma (Table 1). Co-dominant species of the site were Terminalia arjuna and Cassia fistula. Composition of tree vegetation was heterogeneous and most of the species showing contagious distribution.

Shrub layer was dominated by Carissia spinarum. Other common species of the site were Lantana camara and Zizyphus oenoplia (Table 2).

In the herb layer dominant species was Cassia tora (Table 3). While Sida spinosa, Achyranthus aspera and Tridax procumbens were co-dominant species.

Maximum importance value index of species indicates its dominance and ecological success, its good power of regeneration and greater ecological amplitude. In the study area, most of the species belonging to tree, shrub and herb layers in general showed contagious distribution that is commonest pattern in nature (Fig.1). The trend of distribution pattern depends on physico-chemical nature of environment as well as on the biological peculiarities of organisms themselves. Trend of distribution in general was as follows-

Contagious > random > regular

Soil Seed Bank Analysis

Total seeds of twenty five plant species were recorded from the site. Out of these 13 were trees, 3 of shrubs and 9 of herbs respectively. Terminalia tomentosa also have

100% frequency under all microhabitats. In lower soil layer, Tectona grandis showed maximum frequency in all microhabitats (Table 4).

Maximum seed density in upper soil layer (0-5 cm) was shown by Terminalia tomentosa (675 m-2) under trunk influenced area. In lower layer (5-10cm) Lagerstroemia parviflora showed maximum seed density (550 m-2) in open area. While Tectona grandis stands next to highest density in canopy area. It is evident from the data that upper soil layer had higher seed density as compared to lower soil layer.

In lower soil layer seed germination was found as 100% in Leucaena Leucocephala under Inter canopy area. Structure and composition of different forest tree species total soil seed bank (0-10 cm) varied from season to season and in- different microhabitats. Over all the soil seed banks were dominated by Tectona grandis and Terminalia tomentosa. Other species showed little contribution to seed banks (Fig.3).

Frequency distribution of seeds of shrub species in upper layer showed dominance of Lantana camara with 100% frequency in different microhabitats. Lantana camara showed 100% seed germination in upper soil layer under open area in 10 to 15 days. Cassia tora also showed 100% frequency in different microhabitats. Species wise result of seed analysis showed maximum density (850 m-2) of Cassia tora in upper soil layer in intercanopy area.

A number of herbaceous species have been found to show 100% seed germination in upper layer (0-5 cm) in 10 to 15 days. On the basis of above result the upper layer showed maximum seed germination than the lower layer. Total soil seed bank (0-10 cm) composition showed heterogeneous nature (Fig. 2).

However, result showed that the number of tree species at the sites and the presence of seeds of the same species in soil seed bank is variable and at times the species in seed bank was not found similarly the trend of occurrence of species found in the vegetation and their absence in soil seed bank was also found for shrubs and herbs very poor representation of species in soil seed bank at the site may be attributed to the intense washing of the seeds due to runoff as the soil was very thin at this site.

At the study site harbors highest number of tree species both in vegetation and soil seed banks. It is interesting to note that soil seed banks were poor in having different species as compared to the vegetation at the site.

Seasonal variation in the number of plant species in soil seed banks at all the form study site were not much (Table 5).

CONCLUSION

The forest site Ramna occur on varying rock formation and soil and vegetation are continuously affected by varying intensity of biotic influences. Different ecological attributes like frequency, density, abundance, importance value index (IVI), nature of vegetation and distribution pattern in Ramna forest communities were analysed.

On the basis of IVI, Butea monosperma was found as the dominating species in Ramna communities. Terminalia tomentosa and Acacia fistula were the co- dominant species. Contagious patterns of distribution are the most common pattern exhibited by tree, shrub and herbs layers. However, some species showed random distribution. Heterogeneous structure of vegetation is very common characters but present data showed homogeneous structure (Fig. 2). Similar to the vegetation analysis, soil seed banks of the selected site were analysed for their structure and composition.

Over all, seeds of tree, shrubs and herbs are found in mostly trunk influences, inter canopy and open area at upper layer (0-5 cm). Further, the distribution of these species in all the microhabitats indicate their general distribution.

Heterogeneous nature of seed bank composition was observed at the study sites (Fig. 3). In general heterogeneity is found as the common character of natural seed banks. Seed banks are likely to play an important role in forest regeneration only after a disturbance (i.e. tree fall gap formation, logging, conversion to other land uses) creates favorable condition for germination of dormant seeds (Garwood, 1983). There was a weak correspondence between species composition in the vegetation and among the emerging seedlings from the seed banks.

Results of the present study suggest that the composition of soil seed banks and the vegetation vary to a great extent as soil seed banks showed less species diversity than the above ground vegetation. Further, the studies pertaining to the similarities between the seed banks and vegetation composition clearly indicate differences on account of indices, structure and composition in coming days. Therefore, there is a need to conserve the species in soil seed banks by mitigating the fire, grazing and other biotic influences.

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Table 1: Composition of forest tree vegetation at Ramna

S. No.	Name of plant species	Frequency %	Density (plants ha^{-1})	Abundance	A/F Ratio	Basal area (m^2)	Relative Dominance	Relative Density	Relative frequency	Importance Value Index (IVI)
1.	*Tectona grandis*	100	375	3.75	0.037	3.40552	20.30	22.72	15.38	58.4
2.	*Butea monosperma*	50	225	4.5	0.09	5.77551	34.43	13.63	7.69	55.75
3.	*Terminalia arjuna*	75	125	1.66	0.022	3.95704	23.59	7.57	11.53	42.69
4.	*Cassia fistula*	100	250	2.5	0.025	0.10438	.6222	15.15	15.38	31.15
5.	*Mitragyna parvifolia*	50	150	3	0.06	1.35033	8.05	9.09	7.69	24.83
6.	*Gardenia latitolia*	50	200	4	0.08	0.46433	2.76	12.12	7.69	22.57
7.	*Aegle marmelos*	50	50	1	0.02	0.31532	1.87	3.03	7.69	12.59
8.	*Miliusa tomentosa*	25	75	3	0.12	0.53137	3.16	4.54	3.84	11.54
9.	*Bridelia retusa*	50	50	1	0.02	0.13161	.7846	3.03	7.69	11.50
10.	*Anogeissus pendula*	25	50	2	0.08	0.1787	1.06	3.03	3.84	7.93
11.	*Terminalia tomentosa*	25	25	1	0.04	0.32611	1.94	1.51	3.84	7.29
12.	*Eleodendron glaucum*	25	50	2	0.08	0.01437	.0856	3.03	3.84	6.95
13.	*Mahuca indica*	25	25	1	0.04	0.21944	1.30	1.51	3.84	6.65

Table 2: Composition of shrub vegetation at Ramna

S. No.	Name of plant species	Frequency %	Density (plants ha^{-1})	Abundance	A/F Ratio	Relative Dominance	Relative Density	Relative frequency	Importance Value Index (IVI)
1.	*Carissa spinarum*	100	575	5.75	30.057	55.89	62.16	36.36	154.41
2.	*Lantana camara*	100	200	2	0.02	41.46	21.62	36.36	99.44
3.	*Zizyphus oenoplia*	75	150	2	0.02	2.64	16.21	27.27	46.12

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Table 3: Composition of herb layer at Ramna

S. No.	Name of plant species	Frequency %	Density (plants m^{-2})	Abundance	A/F Ratio	Relative Dominance	Relative Density	Relative frequency	Importance Value Index (IVI)
1.	*Cassia tora*	100	11.25	11.25	0.112	2301	42.05	14.81	79.87
2.	*Sida spinosa*	100	3.75	3.75	0.03	14.64	14.01	14.81	43.46
3.	*Sida veronicae folia*	100	2.5	2.5	0.025	12.13	9.34	14.81	36.28
4.	*Achyranthes aspera*	75	2.25	3	0.04	11.71	8.41	11.11	31.23
5.	*Tridax procumbens*	75	1.75	2.33	0.03	13.38	6.54	11.11	31.03
6.	*Euphorbia hirta*	75	1.5	2	0.026	7.53	5.60	11.11	24.24
7.	*Xanthium strumarium*	50	1.5	3	0.06	7.53	5.60	7.40	20.53
8.	*Cassia pumila*	50	1.25	2.5	0.05	5.85	4.67	7.40	17.92
9.	*Biophytum sensitivum*	50	1	2	0.04	4.18	3.73	7.40	15.31

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Table 4: Frequency, density and germination of seeds in upper soil layer (0-5 cm) and lower soil layer (5-10 cm) in different microhabitats at Ramna

S. No.	Name of species	Trunk influenced area			Canopy area			Inter canopy area			Open area		
		% Frequency	Density m^{-2}	% Germination	% Frequency	Density m^{-2}	% Germination	% Frequency	Density m^{-2}	% Germination	% Frequency	Density m^{-2}	% Germination
1.	*Anogeissus pendula*	- (-)	- (-)	- (-)	- (25)	- (50)	- (50)	50 (25)	150 (50)	33.33 (50)	50 (50)	75 (50)	33.33 (50)
2.	*Lagerstroemia parviflora*	50 (25)	325 (75)	00 (00)	50 (25)	100 (75)	00 (00)	25 (25)	25 (25)	00 (00)	25 (25)	100 (550)	00 (00)
3.	*Lannea coromandelica*	50 (25)	50 (25)	00 (00)	- (25)	- (50)	- (00)	25 (25)	75 (50)	66.66 (50)	- (-)	- (-)	- (-)
4.	*Leucaena leucocephala*	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	25 (-)	25 (-)	100 (00)	- (-)	- (-)	- (-)
5.	*Mitrogyna parvifolia*	75 (25)	150 (100)	00 (00)	50 (25)	125 (100)	00 (00)	75 (25)	125 (75)	00 (00)	25 (25)	125 (25)	00 (00)
6.	*Schleichera oleosa*	25 (-)	25 (-)	00(-)	25 (-)	25 (-)	00 (-)	-(25)	- (25)	- (00)	- (-)	- (-)	- (-)
7.	*Terminalia tomentosa*	100 (50)	675 (50)	00 (00)	100 (25)	50 (50)	12.5 (00)	100 (25)	650 (50)	23.07 (00)	100 (75)	450 (125)	5.55 (00)
8.	*Tectona grandis*	25 (100)	25(400)	00 (12.50)	25 (100)	600 (500)	00 (15)	25 (100)	25 (400)	00 (18.75)	50 (100)	100(400)	00 (25)
9.	*Lantana camara*	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	25 (-)	25 (-)	100 (-)
10.	*Alysicarpus monilifer*	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	25 (-)	25 (-)	100 (-)	- (-)	- (-)	- (-)
11.	*Cassia tora*	75 (75)	250 (500)	70 (50)	100 (75)	750 (675)	3.66 (37.03)	100 (50)	850 (775)	29.41 (29.03)	100 (100)	225 (300)	44.44 (25)
12.	*Dioscorea bulbifera*	25 (-)	25 (-)	100 (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)	25 (-)	25 (-)	100 (-)
13.	*Eragrostis tenella*	50 (-)	75(-)	100 (-)	25 (-)	50 (-)	50 (-)	25 (25)	25 (25)	100 (100)	- (-)	- (-)	- (-)
14.	*Martynia diandra*	25 (-)	25 (-)	00 (-)	25 (-)	25 (-)	50 (-)	25 (-)	25 (-)	00(-)	25 (-)	25 (-)	00 (-)
15.	*Xanthium strumarium*	25(-)	25(-)	100 (-)	25 (-)	25 (-)	100 (-)	- (-)	- (-)	- (-)	- (-)	- (-)	- (-)

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Table 5: Frequency, density and germination of seeds in upper soil layer (0-10 cm) in different microhabitats at Ramna.

S. No.	Name of species	Trunk influenced area			Canopy area			Inter canopy area			Open area		
		% Frequency	Density m^{-2}	% Germination	% Frequency	Density m^{-2}	% Germination	% Frequency	Density m^{-1}	% Germination	% Frequency	Density m^{-1}	% Germination
1.	*Anogeissus pendula*	-	-	-	25	50	50	75	200	83.33	100	125	83.33
2.	*Lagerstroemia parviflora*	75	400	00	75	175	00	50	50	00	50	650	00
3.	*Lannea coromandelica*	75	75	00	25	50	00	50	125	116.66	-	-	-
4.	*Leucaena leucocephala*	-	-	-	-	-	-	25	25	100	-	-	-
5.	*Mitrogyna parvifolia*	125	250	00	75	225	00	125	200	00	50	150	00
6.	*Schleichera oleosa*	25	25	00	25	25	00	25	25	00	-	-	-
7.	*Terminalia tomentosa*	150	725	00	125	100	12.5	125	700	23.07	175	575	5.55
8.	*Tectona grandis*	125	425	(12.50	125	1100	15	125	425	18.75	150	500	25
9.	*Lantana camara*	-	-	-	-	-	-	-	-	-	25	25	100
10.	*Alysicarpus monilifer*	-	-	-	-	-	-	25	25	100	-	-	-
11.	*Cassia tora*	150	750	125	175	1425	40.69	150	1625	58.44	200	525	69.44
12.	*Dioscorea bulbifera*	25	25	100	-	-	-	-	-	-	25	25	100
13.	*Eragrostis tenella*	50	75	100	25	50	50	50	50	200	-	-	-
14.	*Martynia diandra*	25	25	00	25	25	50	25	25	00	25	25	00
15.	*Xanthium strumarium*	25	25	100	25	25	100	-	-	-	-	-	-

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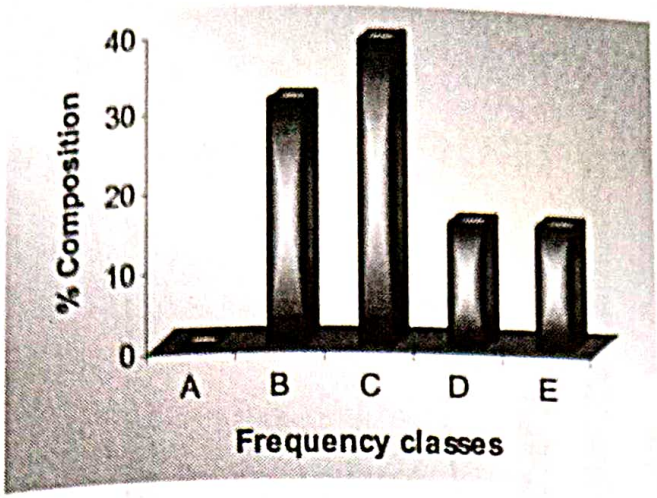
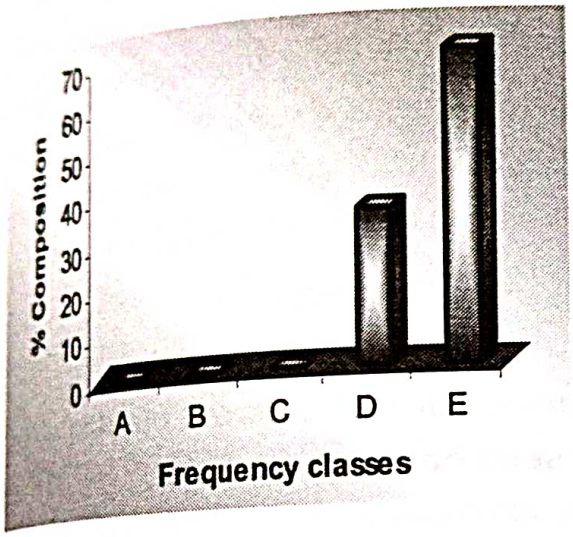
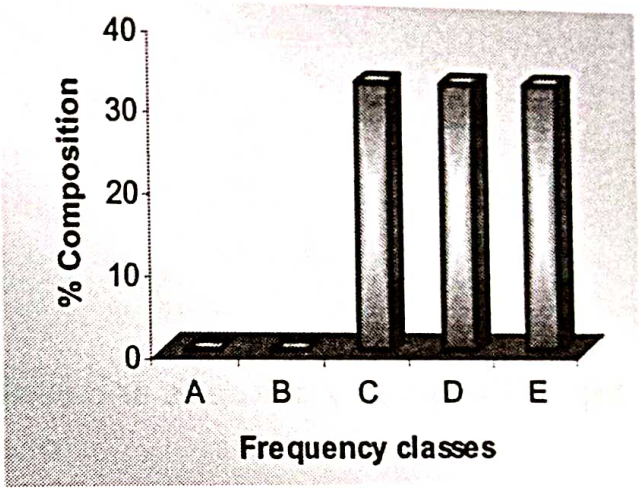


Tree



Shrub



Herb

Fig. 2: Frequency diagram of different communities at Ramna

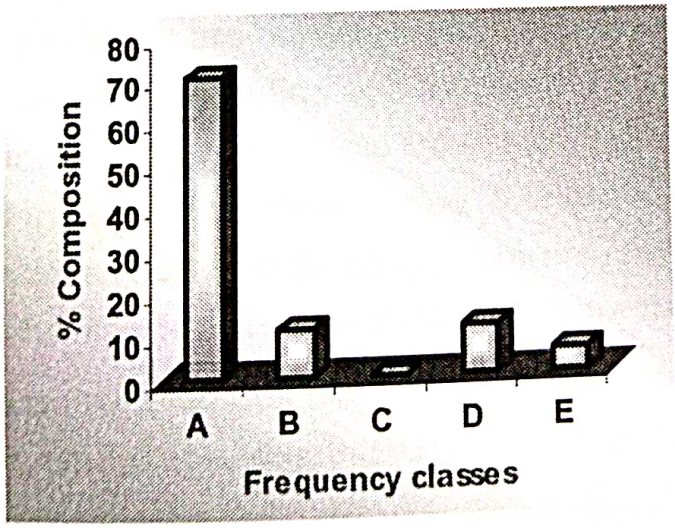


Fig. 3: Frequency diagram of soil seeds banks at Ramna

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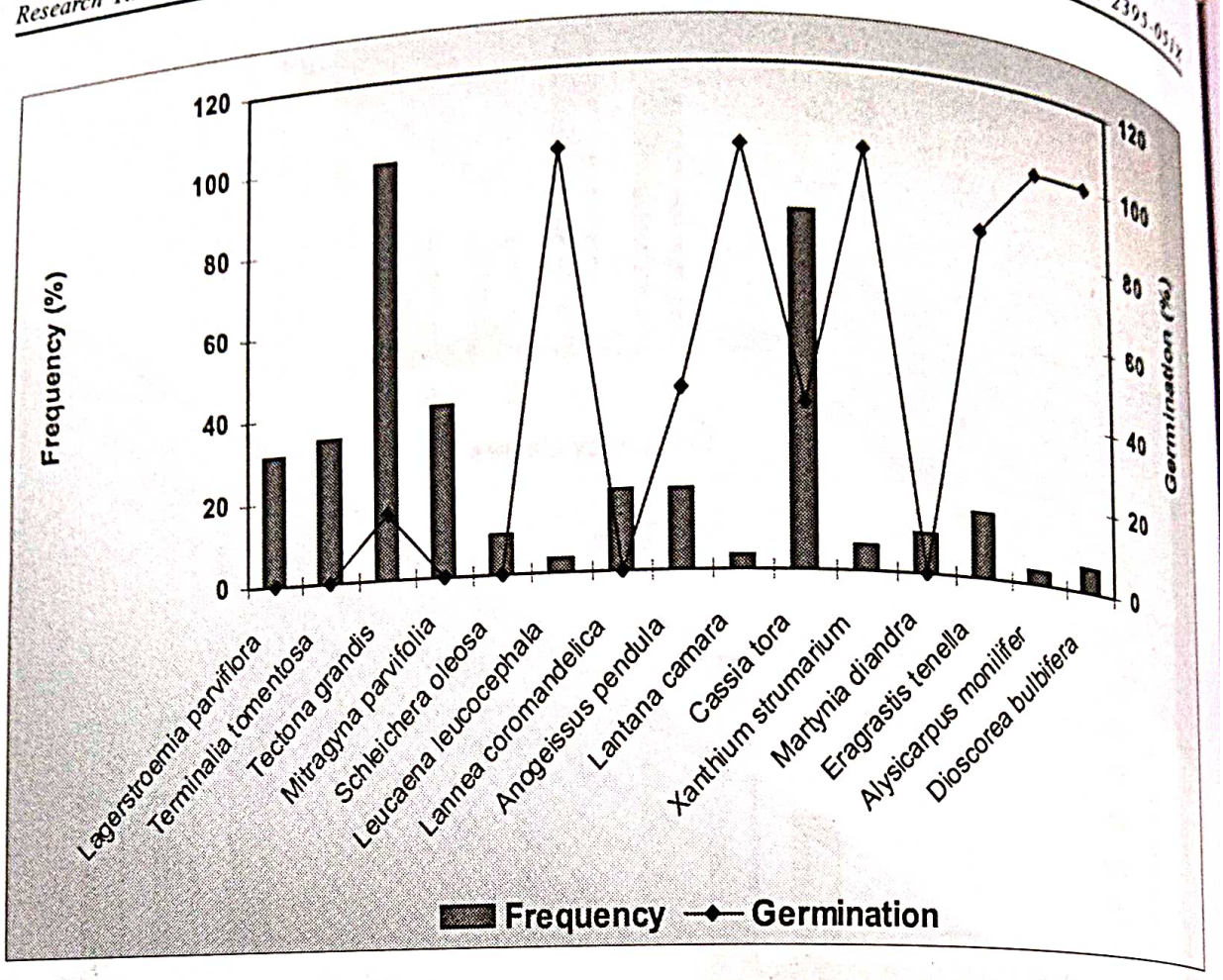

Fig. 4: Frequency of seeds and seed germination of different plant species of soil seed bank.