Management And Conservation Of Biodiversity Through Soil Seed Bank In Moist Tropics Of India

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Abstract: Maintenance of biodiversity at landscape level comprising of various ecosystem ranging from agro-ecosystem, plantation, grassland and natural forest is very crucial for the human kind. Human and most animals are almost totally dependent on plants, directly or indirectly, as a source of energy. The vegetation of different ecosystems depends upon the availability of viable seed bank in the soil which insights proper management and restoration of different ecosystems. Soil seed bank is presence of viable seeds and propagules in the soil which was done by seedling emergence method. Total sixty one plant species comprising of 26 families were recorded through germination process in all four different ecosystems- agro-ecosystem, plantation, grassland and natural forest soils. Of the total 61 species thirty one were annuals and thirty were perennials. Herbs and grasses were dominant in all ecosystem types. Grassland and natural forest constitute maximum biodiversity in form of soil seed bank and agro-ecosystem harbored minimal diversity. Conservation and management of biodiversity through soil seed bank have became prime attention for long-term sustainability of various ecosystems. This study therefore, gives basic idea about management of biodiversity through soil seed bank of different ecosystems of moist tropics of eastern Uttar Pradesh, India.

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Introduction

Biodiversity has attracted world attention because of the growing awareness of its importance on the one hand and the anticipated massive depletion on the other (MEA, 2005). Biodiversity being as different types of variables of all living organisms, it makes the structure of varieties of ecosystems and habitats that support essential living resources, including wildlife, fisheries and forests. It fulfill basic human and animal needs in form of food, shelter, fuel wood, paper, medicine, timber, fodder and also gives economic profit to human being (Singh,1999). Biodiversity also has recreational, cultural, spiritual and aesthetic values. Having been destroyed much of the global biodiversity (in all its scalar dimensions – sub-specific, species, ecosystems and landscapes), conservation and sustainable management of biodiversity have become important for the humans and for the nature (Ramakrishnan, 2009). Human plays a tremendous role in wildlife and plant species extinction. Habitat loss, degradation, and fragmentation are the leading factors that cause wildlife extinction and altogether biodiversity loss (Myers, 2003). The diversity of plant life is an essential underpinning of most of our terrestrial ecosystems (Yavari & Shahgolzari, 2010). Plant community plays an important role in sustainable management by maintaining biodiversity and conserving the environment (Farooque & Saxena, 1999; Singh, 2002). The degradation of tropical forest and destruction of habitats due to anthropogenic activities are the major causes of decline in the global biodiversity (Singh, 1999; Kumar et al., 2006). Therefore, in many areas the reconstruction of a disturbed ecosystem is being taken up on a priority basis, both for biodiversity conservation and for maintaining landscape productivity (Solbrig, 1991). Species maintenance and conservation through soil seed bank has invited new dimension of species conservation and maintenance of species diversity.

Seed bank is the collection of viable seeds present on or within soil and associated litter at any given time and represents the stock of regenerative potential (Simpson et al., 1989). Seeds may be large or small, persistent or transient, but they are always spatially and temporally variable (Bai et al., 2010). Seeds play evolutionary and ecological roles in linking past and present population to future plant populations next to community structure and dynamics in a given habitat (Thompson & Grime, 1979; Leck et al., 1989). Soil seed bank plays an important role in plant diversity restoration, conservation and management (Wisheu & Keddy, 1991; Li et al., 2011). Viable seed availability is an important factor for conservation of biodiversity of different ecosystems - agro-ecosystem, plantation, grassland, natural forest and wetland etc. It gives size, composition, structure and dynamics of present, past

and future vegetation of different ecosystems. Seed bank studies can provide important information on restoration and management of different ecosystems (Katherina et al., 2009).

The study area falls under moist tropics where many studies centered on floristic composition and regeneration (Chauhan et al., 2009), vegetation analysis (Pandey & Shukla, 2003; Tripathi & Shukla 2007; Shukla, 2009), community structure and pattern (Gupta & Shukla, 1991; Pandey & Shukla, 1999; Pandey & Shukla, 2001,) and documentation of medicinal plants (Singh & Ali, 1989; Singh et al., 1997; Poonam & Singh, 2009), but study on soil seed bank of various ecosystems in response to conservation and management of different plant diversity were lacking. Therefore, this study focused to analyze soil seed bank of different ecosystems agro-ecosystem, plantation, grassland and natural forest in wake of biodiversity management in moist tropics of Terai region of eastern Uttar Pradesh, India.

Study area

The study sites were stretched over on two districts (Gorakhpur and Mahrajganj) of eastern Uttar Pradesh, India ($26^0$13' N to $27^0$29' N longitude $83^0$05 E and $83^0$56' E latitude). The area represents moist climate with an average annual rainfall of about 1550 mm and temperature fluctuates with an average of maximum 36^0C and minimum 21^0C. The soil is alluvium and yellowish brown in color with neutral pH and sandy loam texture. Four study sites (agro-ecosystem, plantation, grassland and natural forest) were selected for detailed evaluation. The forest belongs to moist deciduous types (Champion & Seth, 1968; Pandey & Shukla, 2003). This region is under Terai bhabhar and biogeographically it is subdivision of upper gangetic plain. The area is characterized with mosaic of landscapes nurturing grassland, plantations, natural patches, sanctuaries, agricultural practices and settlement of local communities with substantial human and livestock population.

Methodology

The soil sampling was done twice in a year (once in rainy season and other in winter season) during June 2007 to December 2009. Permanent plots were marked in each ecosystem. Random soil samples were collected in replicate from each plot of different ecosystems. The weighed soil sample was taken by excavating soil monolith of 20 x 20 cm area with 0-10 cm, 10-20 cm and 20-30 cm depth. Soil samples were collected in well marked polythene bags and brought to the botanical garden of Department of Botany, Banaras Hindu University, Varanasi for detailed evaluation. Each weighed soil sample was transferred into flat shallow earthen pots filled up to about 1 cm below its brim. Regular water was poured in these earthen pots to make favorable moisture content. A set of control earthen pots were also placed in botanical garden with local soil sample which were autoclaved at 200^0C for local seed rain so that the seedling which were germinated in these control sets were subtracted from the respective seeds germinated. Seedling emergence method was followed for soil seed bank analysis (Ter Heerdt et al., 1996). At every 15 days interval, the seedlings were identified and counted; those which were not identified were transplanted into other new earthen pots to allow them growing till their flowering stage for clear identification. The herbarium specimens were deposited in Department of Botany, Banaras Hindu University, Varanasi. Regular observation was carried out till completion of one annual cycle. The maximum seeds were germinated in rainy season and minimum in winter season.

Results and Discussions:

Sixty one plant species were germinated and identified from four ecosystems of the soil seed bank (Table 1). Each species of soil seed bank has been given with its botanical and vernacular name, family, habit and life-form. Annuals were essentially more germinated than perennials. Five species (Blumea lacera, Commelina benghalensis, Cynodon dactylon, Cyperus kyllingia and Euphorbia hirta) were common to all ecosystems. Ageratum conyzoides, Cyperus rotundus, Dicanthium annulatum, Digitaria ciliaris and Parthenium hysterophorus were found in agro-ecosystem, plantation and grassland ecosytems. Achyranthes aspera, Alternenthera sessilis, Cassia occidentalis and Saccharaum spontaneum were only confined in plantation and grassland where as Anagallis arvensis was present in agro-ecosystem and grassland ecosystems. Clerodendron infortunatun, Desmodium gangeticum, Mazus pumilus, Murdannia nudiflora, Oldenlandia affinis, Scoparia dulcis and Terminalia arjuna were found in both types of forest, plantation and natural forest. Centella asiatica was found in grassland and natural forest. Amaranthus viridis, Ammania baccifera, Boerhavia diffusa, Brachiara ramose, Chenopodium album, Echinochloa colona, Eragrotis unioloides, Ludwigia parviflora, Melilotus alba, Phalaris minor, Solanum nigrum were exclusively confined to agro-ecosystem. Similarly, Biophytum sensitivum, Blepharis repens, Bonnaya brachiata, Chrysopogon aciculatus, Desmodium triflorum, Echinochloa crus-galli, Eleusine indica, Eragrotis tenella, Evolvulus nummularis, Fimbristylis schoenoides, Imperata cylindrical were restricted to grassland. Physalis minima was exclusively confined to plantation. Aerva lanata, Andrographis paniculata, Butea parviflora, Cassia fistula, Clitoria ternatea, Cordia dichotma, Dalbergia sisso, Ficus religosa,

Gloriosa superba, Ipomea aquatica, Rauvolfia serpentine, Streblus asper, Tamarindus indica and Tinospora cordiflolia were confined to natural forest only.

Sixty one recorded species were corresponding to twenty six different families. Most dominant families were Poaceae (14 species) and Fabaceae (9 species) followed by Amaranthaceae (4 species); Scrophulariaceae, Asteraceae, Cyperaceae with 3 species each; Acanthaceae, Commelinaceae, Convolvulaceae, Moraceae and Solanaceae with 2 species each; Lythraceae, Primulaceae, Oxaladiaceae, Nyctaginaceae, Apiaceae, Chenopodiaceae, Verbenaceae, Boraginaceae, Euphorbiaceae, Liliaceae, Ongraceae, Rubiaceae, Apocynaceae, Combretaceae and Menispermiaceae having one species each (Figure 1). Shukla (2009) has shown sixty six, seventy three and thirty six families in above-ground vegetation of grassland, forest and old-fields respectively.

Out of total 61 germinated species, 26 species were herbs, 14 grasses, 7 trees, 6 climbers, 4 shrubs, 3 sedges and one forb. Maximum number of species was found in grassland and natural forest each with 28 species where as plantation has 23 species and agro-ecosystem with 22 species (Fig. 2). Agro-ecosystem had twelve herbs, seven grasses, two sedges and one forb; grassland had thirteen herbs, ten grasses, one shrub, three sedges and one forb; and plantation had ten herbs, five grasses, one tree, one climber, three shrubs, two sedge and one forb while natural forest had eight herbs, two grasses, seven trees, six climbers, four shrubs, one sedge and one forb. Herbs and grasses were exclusively found in agro-ecosystem and grassland while trees and climbers were confined mainly to the forest. The rainy season is mainly favorable for the germination of herbaceous and grasses. These plants which were found in soil seed bank showed both temporal and spatial variation.

Study of species diversity pertaining in soil seed bank helped in restoration and conservation of threatened and rare plant diversity in general and medicinal plants used in various diseases for human being in particular in this area. This study insights in situ conservation of not only soil seed bank but also vegetations including layers of herbs, shrubs, climbers and woody plants in range of ecosystems varying from agro-ecosystem, plantation, \grassland and natural forest; it also insights proper management of weeds in agro-ecosystem. Restoration of forest through seed bank could be substantially addressed through proper management and minimizing human disturbance in form of removal of trees for timber, fuel wood, medicinal use, fodder, controlled grazing and limited surface biomass and litter removal could improve soil seed quantum. The biodiversity has been increasingly threatened by the environmental crisis and phases of mass extinction of species (Myers & Knoll, 2001; Singh, 2002). With these substantial facts the management of biodiversity at landscape levels should be our goal, to achieve the twin objectives of preservation and sustainable use of natural habitats/resources. There are convincing scientific, economic and socio-ecological reasons for giving priority to conservation of major centers of plant diversity throughout the world especially as this will very often also lead to the conservation of much threatened animal, plants and micro-organisms diversity as well (Secretariat CBD, 2009). An integrated approach demands satisfying basic human needs in an equitable manner and sustaining and indeed promoting social, cultural and biological diversity, along with the maintenance of the ecological integrity of the system for long-term sustainability of the ecosystems (Ramakrishnan, 1992; Swift et al., 1996).

Soil seed banks play an imperative role in conservation of biodiversity in the natural environment of many ecosystems. Soil seed banks not only reflect history of plant species but also they are determinant of plant communities and have potential to regenerate the new plant diversity or vegetation after any anthropogenic and natural disasters. They also partially reflect history of plant species. The rapid re-vegetation of sites disturbed by wildfire, catastrophic weather, agricultural operations, and timber harvesting is largely due to the soil seed bank. Soil seed bank is commonly known as weed seed bank in agro-ecosystem that reflects weed biodiversity. Farmers in many parts of the world utilize biodiversity as a management tool (Swift et al., 1996). So management of weeds through weed seed bank has become necessary.

In relation to conservation and maintenance of existing biodiversity, there are two highly juxtaposed views concerning the importance of plantation forests (Manhas et al., 2011). One group proclaims that monocultures, augmented by plantations, are of low value for the maintenance of biological diversity because of the simple forest structure (Hill, 1979; Hunter, 1990; Shahabuddin & Rao, 2010). The second group, however, states that plantations have the potential of increasing the biological diversity through successional development of the under storey vegetation and establishment of middle canopy (Krishnasawimy et al., 1954; Parrotta et al., 1997; Carnevale & Montagnini, 2001). Plantations differ from natural forest ecosystems in a number of characteristics, but there is increasing interest in the potential for plantations to serve as nurse crops for establishing the native forest species (Harrington & Ewel, 1997), so it has become necessary to study the role of soil seed bank in plantation.

Grazing is a land use pattern covering approximately 3300 million ha (more than 25%) of the global land

surface which makes it the largest and most extensive land use of the planet (Asner et al., 2004). Grassland mitigates the risks of wildfires, valuation and implementation of mechanisms for payment of environment services, possibly similar to those already in use in some forest land uses (Pagiola et al., 2002), may potentially contribute to the economic sustainability and future conservation of grassland and their multifunctional role (Bugalho & Abreu, 2009). Intensity of grazing in the Terai region is substantially high and subsequent removal of aerial part bearig seed is especially high therefore, the management and restoration of the species present in grassland through soil seed bank has become imperative.

Tropics in general and tropical forest in particular are most species diverse terrestrial ecosystem on planet earth (Reddy & Ugle, 2008) and are distinguished from all other terrestrial ecosystems with a very high diversity in many levels (Reddy & Ugle, 2008). Forests contain roughly 90% of the world terrestrial biodiversity (Living Planet Report, 2010). Tropical forests cover only 7% of the earth's land surface but harbor more than half of the world's species (Singh et al., 2005). However, these species are disappearing at an estimated annual rate of 0.8-2.0% (May & Stumpf, 2000). India constitutes both dry and moist tropical forest (Champion & Seth, 1968), in India of the 86% of the tropical forest area, 54% is dry deciduous, 37% moist deciduous and rest is wet evergreen or semi evergreen (Kaul & Sharma 1971). This moist region has very rich floral diversity and ecological characteristics (Ansari et al., 2006). These moist forests are under threat not only because of anthropogenic pressure (Poonam & Singh, 2009), but also from introduction of nonnative species (Raghubanshi et al., 2005). Seed bank can have only potential to regenerate earlier during successional stage as pioneer plant species; this means that persistent soil seed bank can not contribute to the regeneration of the desired typical forest species (Esmailzadeh et al., 2011). Hence, such forest needs to be conserved and managed not only by study of soil seed bank but also to ban human interference and should be prevented from natural disasters.

Table 1: Species in Soil Seed Bank in Different Ecosystems of Moist Tropics of Uttar Pradesh (2007-2009) (A-Agro-ecosystem, P-Plantation, G-Grassland, N-Natural Forest)

Botanical name	Family	Vernacular Name	Habit	Ecosystem	Life-form
Achyranthes aspera Linn.	Amaranthaceae	Chirchira	Herb	P, G	Perennial
Aerva lanata Linn.	Amaranthaceae	Chaya	Herb	N	Perennial
Ageratum conyzoides Linn.	Asteraceae	Gandh	Herb	A, P, G	Annual
Alternenthera sessilis Br.	Amaranthaceae	Saranchi	Herb	P, G	Perennial
Amaranthus viridis Linn.	Amaranthaceae	Jangali tarai ka sag	Herb	A	Perennial
Ammania baccifera Linn.	Lythraceae	Banmirich	Herb	A	Annual
Anagallis arvensis Linn.	Primulaceae	Armal	Herb	A, G	Annual
Andrographis paniculata Nees	Acanthaceae	Kalmeghi	Herb	N	Annual
Biophytum sensitivum DC.	Oxalidaceae	Vipreetlajja	Herb	G	Perennial
Blepharis repens (Vehl) Roth	Acanthaceae	-	Herb	G	Annual
Blumea lacera DC.	Asteraceae	Kukuraundha	Herb	A, P, G, N	Perennial
Boerhavia diffusa Linn.	Nyctaginaceae	Purnava	Herb	A	Perennial
Bonnaya brachiata Link & Otto	Scrophulariaceae	-	Herb	G	Annual
Brachiaria ramose Linn.	Poaceae	Likhbans	Grass	A	Annual
Butea parviflora Roxb.	Fabaceae	-	Climber	N	Perennial
Cassia fistula Linn.	Fabaceae	Amaltas	Tree	N	Perennial
Cassia occidentalis Linn.	Fabaceae	Bada Chakwad	Shrub	P, G	Annual
Centella asiatica (Linn.) Urban	Apiaceae	Mandukparni, Brahim-buti	Herb	G, N	Annual
Chenopodium album Linn.	Chenopodiaceae	Bathua sag	Herb	A	Annual
Chrysopogon aciculatus Trin.	Poaceae	-	Grass	G	Annual
Clerodendron infortunatum Gaertn.	Verbenaceae	Bhat, Bhatwas	Shrub	P, N	Perennial
Clitoria ternatea Linn.	Fabaceae	Gokarni	Climber	N	Perennial
Commelina benghalensis Wall.	Commelinaceae	Kanchara	Herb	A, P, G, N	Annual
Cordia dichotoma Linn.	Boraginaceae	Lasora	Tree	N	Perennial
Cynodon dactylon Pers.	Poaceae	Doob, Ghas	Grass	A, P, G, N	Perennial
Cyperus kylligia Endl.	Cyperaceae	Motha	Sedge	A, P, G, N	Perennial
Cyperus rotundus Linn.	Cyperaceae	Motha	Sedge	A, P, G	Annual
Dalbergia sisso Roxb.	Fabaceae	Shisham, Sisso	Tree	N	Perennial
Desmodium gangeticum DC.	Fabaceae	Salpan	Shrub	P, N	Perennial
Desmodium triflorum DC.	Fabaceae	Tikuli	Herb	G	Annual
Dichanthium annulatum Forsk.	Poaceae	Janeva	Grass	A, P, G	Perennial
Digitaria ciliaris Pers.	Poaceae	Chipbanso	Grass	A, P, G	Annual

Echinochloa colona Linn. Link	Poaceae	Dhunia, Sama	Grass	A	Annual
Echinochloa crus-galli Beauv.	Poaceae	-	Grass	G	Annual
Eleusine indica Gaertn.	Poaceae	Malankuri	Grass	G	Annual
Eragrostis tenella R. & S.	Poaceae	Jugebans	Grass	G	Annual
Eragrotis unioloides Nees	Poaceae	-	Grass	A	Annual
Euphorbia hirta Linn.	Euphorbiaceae	Dudhi	Forb	A, P, G, N	Annual
Evolvulus nummularis Linn.	Convolvulaceae	Bichhmalia	Herb	G	Perennial
Ficus religosa Linn.	Moraceae	Peepal	Tree	N	Perennial
Fimbristylis schoenoides Vahl	Cyperaceae	-	Sedge	G	Annual
Gloriosa superba Linn.	Liliaceae	Karihari	Climber	N	Perennial
Imperata cylindrical (Linn.) Raeuschel.	Poaceae	Sirhu, Dachela	Grass	G	Perennial
Ipomea aquatica Forsk.	Convolvulaceae	Karmi ka sag, Karvan	Climber	N	Perennial
Ludwigia parviflora Roxb.	Onagraceae	Lwangi Jhar	Herb	A	Annual
Mazus pumilus Burm. f.	Scrophulariaceae	-	Climber	P, N	Perennial
Melilotus alba Lamk.	Fabaceae	Banmethi	Herb	A	Annual
Murdannia nudiflora Linn.	Commelinaceae	Kansura	Herb	P, N	Annual
Oldenlandia affinis DC.	Rubiaceae	Chirval	Herb	P, N	Perennial
Oplismenus burmannii Beauv.	Poaceae	Chitrbanso	Grass	P, G, N	Annual
Parthenium hysterophorus Linn.	Asteraceae	Gajarghas	Herb	A, P, G	Annual
Phalaris minor Retz.	Poaceae	Gehun ke mama	Grass	A	Annual
Physalis minima Linn.	Solanaceae	Banmakoi	Herb	P	Annual
Rauvolfia serpentine Benth.	Apocynaceae	Sarpagandha	Shrub	N	Perennial
Saccharum spontaneum Linn.	Poaceae	Kass	Grass	P,G	Annual
Scoparia dulcis Linn.	Scrophulariaceae	Mithi patti	Herb	P, N	Annual
Solanum nigrum Linn.	Solanaceae	Makoicha	Herb	A	Perennial
Streblus asper Lour.	Moraceae	Sihor	Tree	N	Perennial
Tamarindus indica Linn.	Fabaceae	Imli	Tree	N	Perennial
Terminalia arjuna W & A	Combretaceae	Arjun	Tree	P, N	Perennial
Tinospora cordifolia Mirers	Menispermiaceae	Gurich	Climber	N	Perennial

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Figure 1: No. of Species in Soil Seed Bank of Different Families of Different Ecosystems.

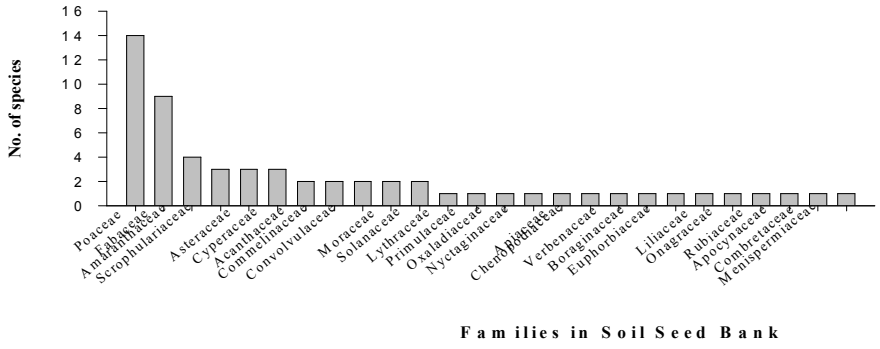
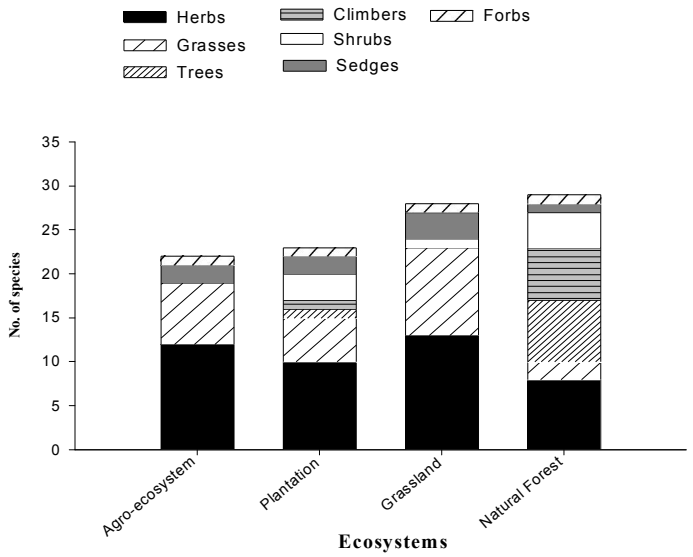


Figure 2: No. of Plant Species of Different Habits in Soil Seed Bank in Different Ecosystems



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