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RESEARCH ARTICLE

PLANT DIVERSITY RECORDED AT KUPPI ARTIFICIAL FOREST PLANTATION IN PAKISTAN

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ABSTRACT

Forests are a substantial source of terrestrial biodiversity; reforestation has the potential to restore biodiversity through managed plantations of native and exotic species. Therefore, the present study was conducted to determine under-storey natural vegetation along with types of planted trees located at Kuppi Artificial Forest Plantation (KAFP). The KAFP comprised of forty-one blocks. The data was collected during summer and winter season in 2010 by Quadrat method from thirteen blocks, those were selected on the basis of plantations types. The planted tree species were *Dalbergia sissoo, Terminalia arjuna, Morus alba, Eucalyptus camaldulensis, Vachellia nilotica, Prosopis cineraria* and *Bombax ceiba*. Quadrat sizes of $10m^2$,$5m^2$ and $1m^2$ were used for surveying trees, shrubs and ground flora like grasses, sedges and forbs respectively. Plant samples were identified by using the Flora of Pakistan present at General Laboratory of Department of Botany, University of Agriculture, Faisalabad. Results indicated that artificial reforestation has the ability to restore important native vegetation. Many wild species of Punjab plains; grasses viz., *Setaria pumila, Panicum antidotale, Dactyloctenium aegyptium, Sporobolus indicus*, herbs viz., *Anagallis arvensis, Verbascum thapsus, Medicago polymorpha, Oxalis corniculata, Euphorbia hirta*, trees such as, *Senegalia modesta, Syzygium cumini, Tamarix aphylla*, shrubs such as, *Volkameria inermis, Withania somnifera, Grewia tenax* and sedges such as, *Bolboschoenus affinis, Cyperus rotundus* were recorded along-with planted trees at KAFP. Ground flora *Cynodon dactylon* and *Desmostachya bipinnata* were dominant. Presence of salt resistant species indicated that soil under study is salt affected. Therefore, the study concludes that reforestation has the ability to restore native vegetation and can be used for the preservation of natural biodiversity.

KEYWORDS

Artificial Forest, Plant Biodiversity, Native Flora in Pakistan.

1. INTRODUCTION

Plant biodiversity plays a significant ecological role in artificial forest plantation ecosystems. Artificial forests affect both biological and physical environments. It can be helpful in moderating climate, improving quality of air by reducing primary and secondary pollutants, purifying air by absorbing substantial amount of carbon dioxide and releasing oxygen into the air, regulating rainfall and flooding water runoff and maintains the sheltering of the wildlife (Dinesen et al., 2001). Moreover, balancing of precipitation rate, structure and texture of soil supporting vegetation and obstruction of some natural catastrophes are also maintained by forests (Milad et al., 2011).

Artificial forests assist the preservation of native flora. These may be helpful to increase the species frequency, density and richness, especially in biodiversity poor sites (El-Keblawy and Ksiksi, 2005). Artificial plantations have also provided suitable habitats to a large number of native, exotic and endangered species lowering their predicted rates of extinction. Therefore, stripping the forest cover may result in a higher mortality rate, migration and eventually loss of endangered species (Barlow et al., 2007). Deforestation or loss of biodiversity was also accompanied by the loss of valuable genetic pool since forests are a significant source of genetic diversity with many rare genetic combinations (Palmberg-Lerche, 2008). The negative impacts of deforestation on socio-economic and political instability of local people were also evident (Porter-Bolland et al., 2008).

Nevertheless, the rate of degradation of biodiversity can be curbed by reforestation at degraded sites and by planting artificial forests at non-forested sites as reported (El-Keblawy and Ksiksi, 2005; Carnus et al., 2006). Reforestation and afforestation were also proved helpful in the improvement of degraded soil structure and texture and restoration of socio-economic benefits for locals (Pal and Sharma, 2001). Therefore, to cope with dreadful consequences of deforestation and to ensure the

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conservation of biodiversity many man-made plantations such as forests at Changa Manga, Gatwala and Kuppi have been established in the past few decades (Javed et al., 2006; Hameed et al., 2011; Naeem et al., 2012). Hence, the present study was conducted at Kuppi Artificial Forest Plantation (KAFP) to document natural vegetation restored under man-made plantations.

2. Materials and Methods

2.1 Selection of site

The study was conducted at Kuppi Artificial Forest Plantation (KAFP) located at Chak No. 363, 367 G.B (Figure 1). covering an area of 365 hectares approximately. The KAFP compartmentalized into forty-one blocks; only thirteen were extensively surveyed. The selection of the blocks understudy was based primarily on the structure of blocks and types of planted trees.

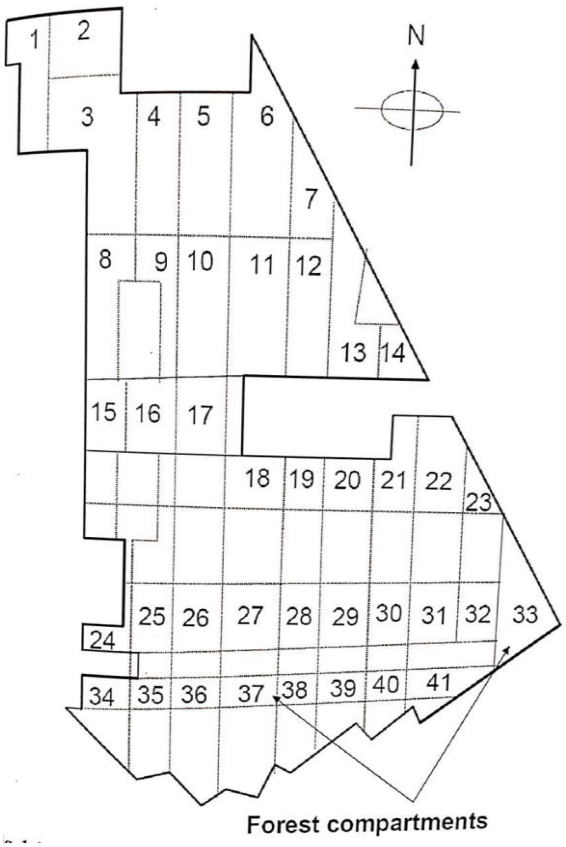

Figure 1: Map of Kuppi Artificial Forest Plantation (KAFP)- Chak No. 363, 367 G.B.

2.2 Data Collection and Methodology

The study was conducted twice during the summer and winter seasons in 2010. Under-storey vegetation was studied using the quadrat method. A total of five quadrats was laid in each block under study; by one in the center and four at corners. Quadrat sizes of $10m^2$,$5m^2$ and $1m^2$ were used for surveying trees, shrubs and ground flora like grasses, sedges, and forbs respectively. All the plant species were identified using Flora of Pakistan found at General Laboratory of Department of Botany, University of Agriculture, Faisalabad. The data was processed by using the Microsoft Excel (ver. 16.35).

3. Results

The survey conducted at thirteen blocks of KAFP (Figure 1) recorded a total of ninety-five species belonging to thirty-eight plant families (Figure 2). Each block comprised of a combination of both native and exotic planted tree species. Major native trees planted were *Dalbergia sissoo*, *Vachellia nilotica* and *Prosopis cineraria*. However, non-native planted trees recorded were *Bombax ceiba, Morus alba* and *Eucalyptus camaldulensis*.

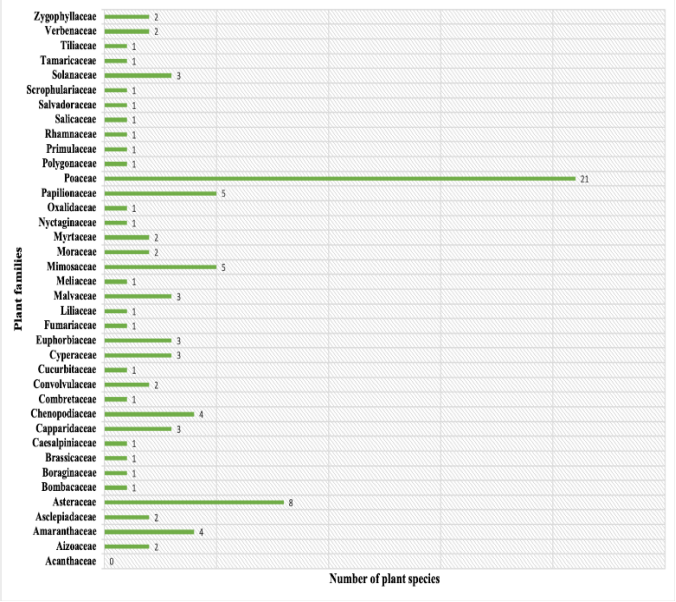

Figure 2: Number of plant species belonging to thirty-eight plant families recorded from Kuppi Artificial Forest Plantation (KAFP)

Native shrubs, climbers, sedges and grasses were also recorded from different families. Percentage of types of surveyed vegetation included in following order herbs > grasses > shrubs > trees > climbers >sedges (Figure 3). The Cyperaceae family was represented by sedges such as *Bolboschoenus affinis, Cyperus rotundus* and *Fimbristylis dichotoma*. Climber *Vicia sativa* from family Papilionaceae was also recorded. The herbs represented the most dominant types of under-storey vegetation. There were about twenty-one herbs emerging during their favorable seasons for growth.

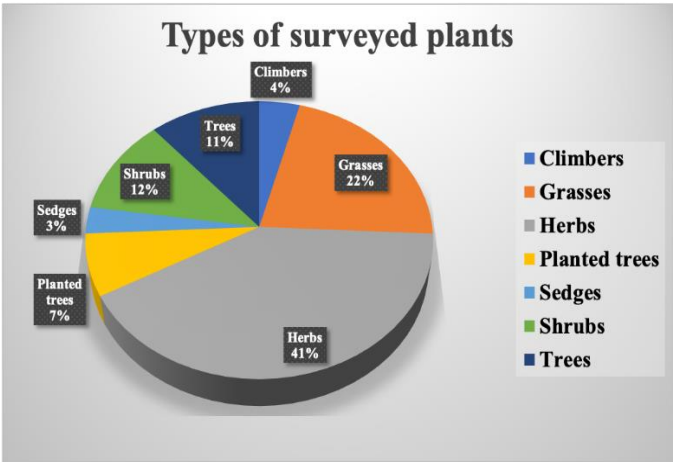

Figure 3: Types of the plant species surveyed at Kuppi Artificial Forest Plantation (KAFP)

The maximum number of important species found were belonging to family Poaceae such as *Setaria pumila, Urochloa ramosa, Sorghum halepense, Bambusa bambos, Saccharum bengalense, Panicum antidotale*. The Asteraceae was the second largest family including species such as *Eclipta prostrata, Conyza bonariensis, Carthamus oxyacantha, Launaea nudicaulis, Sonchus oleraceus, Cichorium intybus* and *Xanthium strumarium*. Other species were the only representative of their families such as *Cordia obliqua* from Boraginaceae, *Parkinsonia aculeata* from Caesalpiniaceae, *Melia azedarach* from Meliaceae, *Asphodelus tenuifolius* from family Liliaceae, *Fumaria indica* from family Fumariaceae, *Boerhavia diffusa* from Nyctaginaceae (Table 1).

Table 1: List of plant species recorded from Kuppi Artificial Forest Plantation (KAFP)

Plant families	Species
Acanthaceae	
Aizoaceae	*Trianthema portulacastrum*[H] L. ('Itsit'), *T. triquetra*[H] Willd. (red spinach)
Amaranthaceae	*Achyranthes aspera*[H] L. ('Puth-kanda'), *Amaranthus viridis*[H] L. (pigweed), *Alternanthera sessilis*[H] (L.) DC. (Rabbit-meat), *Digera muricata*[H] (L.) Mart. (False-Amaranth;'Tandla'),
Asclepiadaceae	*Calotropis procera*[S] (Aiton) W. T. Aiton('Ak'), *Pentatropis spiralis*[C] (Forssk.) Decne. (Ambevel)
Asteraceae	*Carthamus oxyacantha*[H] M. Bieb., *Cichorium intybus*[H] L., *Cirsium arvense*[H] (L.) Scop., *Conyza bonariensis*[H] (L.) Cronquist, *Eclipta prostrata*[H] (L.) L., *Launaea nudicaulis*[H] (L.) Hook.f., *Sonchus oleraceus*[H] L., *Xanthium strumarium*[H] L.
Bombacaceae	*Bombax ceiba*[pT] L. (Silk cotton tree; 'Simbal')
Boraginaceae	*Cordia obliqua*[T] Willd. (Lassora; 'Seloo')
Brassicaceae	*Lepidium didymum*[H] L.
Caesalpiniaceae	*Parkinsonia aculeata*[S] L. (Jerusalem-thorn; 'Walaiti kikar')
Capparidaceae	*Capparis decidua*[S] (Forssk.) Edgew., *Cleome brachycarpa*[H] Vahl ex DC. ('Ponwar'), *Crateva religiosa*[T] G. Forst. (Temple plant; 'Barna')
Chenopodiaceae	*Chenopodium album*[H] L. (lamb's-quarters; 'Bathu'), *Chenopodiastrum murale*[H] (L.) S. Fuentes et al. (nettle-leaf goosefoot), *Salsola baryosma*[S] (Schult) Dandy, *Suaeda vera*[S] Forssk. ex J. F. Gmel (shrubby sea-blite; 'Láani').
Combretaceae	*Terminalia arjuna*[pT] (Roxb. ex DC.) Wight & Arn.(Arjun tree, 'Arjun')
Convolvulaceae	*Convolvulus arvensis*[C] L., *C. prostratus*[H] Forssk.
Cucurbitaceae	*Cucumis maderaspatanus*[C] L.
Cyperaceae	*Cyperus rotundus*[Sd] L., *Bolboschoenus affinis*[Sd] (Roth) Drobov, *Fimbristylis dichotoma*[Sd] (L.) Vahl
Euphorbiaceae	*Euphorbia hirta*[H] L., *E. prostrata*[H] Aiton., *E. royleana*[S] Boiss.
Fumariaceae	*Fumaria indica*[H] (Hausskn.) Pugsley
Liliaceae	*Asphodelus tenuifolius*[H] Cav.
Malvaceae	*Abutilon fruticosum*[H] Guill. & Perr., *Malva parviflora*[H] L., *Malvastrum coromandelianum*[H] (L.) Garcke
Meliaceae	*Melia azedarach*[T] L. (Neem tree, 'Neem')
Mimosaceae	*Leucaena leucocephala*[pT] (Lam.) de Wit, *Prosopis cineraria*[pT] (L.) Druce, *P. glandulosa*[S] Torr., *Senegalia modesta*[T] (Wall.) P. J. H. Hurter (Black brush; 'Phulai'), *Vachellia nilotica*[pT] (L.) P. J. H. Hurter & Mabb. subsp. nilotica (Gum arabic, 'Desi kikar')
Moraceae	*Ficus benghalensis*[T] L., *Morus alba*[pT] L.
Myrtaceae	*Eucalyptus camaldulensis*[pT] Dehnh.(River Red gum; 'Safeda'), *Syzygium cumini*[T] (L.) Skeels (Java plum; Jaman)
Nyctaginaceae	*Boerhavia diffusa*[H] L.
Oxalidaceae	*Oxalis corniculata*[H] L.
Papilionaceae	*Alhagi maurorum*[S] Medik., *Dalbergia sissoo*[pT] Roxb. ex DC. (Indian rosewood; 'Shisham'), *Lathyrus aphaca*[H] L., *Medicago polymorpha*[H] L., Vicia sativa[C] L.
Poaceae	*Aeluropus lagopoides*[G] (L.) Thwaites, *Bambusa bambos*[G] (L.) Voss (Giant bamboo; 'Bans'), *Cynodon dactylon*[G] (L.) Pers., *Dactyloctenium aegyptium*[G] (L.)Willd., *Desmostachya bipinnata*[G] (L.) Stapf, *Dichanthium annulatum*[G] (Forssk.) Stapf, *Digitaria ciliaris*[G] (Retz.) Koeler, *Echinochloa colona*[G] (L.) Link, *Eragrostis minor*[G] Host, *Ochthochloa compressa*[G] (Forssk.) Hilu, *Panicum antidotale*[G] Retz., *Paspalidium flavidum*[G] (Retz.) A. Camus, *Pennisetum pennisetiforme*[G] (Hochst. & Steud.) Wipff, *P. setigerum*[G] (Vahl) Wipff, *Saccharum bengalense*[G] Retz., *Saccharum spontaneum*[G] L., *Setaria pumila*[G] (Poir.) Roem. & Schult.subsp. pumila, *Sorghum halepense*[G] (L.) Pers., *Sporobolus indicus*[G] (L.) R. Br. var. flaccidus[(Roem. & Schult.) Veldkamp, *Urochloa ramosa*[G] (L.) T. Q. Nguyen, *Urochloa reptans*[G] (L.) Stapf
Polygonaceae	*Rumex dentatus*[H] L.
Primulaceae	*Anagallis arvensis*[H] L.
Rhamnaceae	*Ziziphus mauritiana*[T] Lam.
Salicaceae	*Populus×canadensis*[T] Moench
Salvadoraceae	*Salvadora oleoides*[T] Dcne.
Scrophulariaceae	*Verbascum thapsus*[H] L.
Solanaceae	*Nicotiana plumbaginifolia*[H] Viv., *Solanum virginianum*[H] L., *Withania somnifera*[S] (L.) Dunal.
Tamaricaceae	*Tamarix aphylla*[T] (L.) H. Karst.
Tiliaceae	*Grewia tenax*[S] (Forssk.) Fiori
Verbenaceae	*Phyla nodiflora*[H] (L.) Greene, *Volkameria inermis*[S] L.,
Zygophyllaceae	*Fagonia indica*[H] Burm. f., *Peganum harmala*[H] L.

[H]-Herbs, [C]-Climber, [Sd]-Sedges, [G]-Grasses, [S]-Shrubs, [T]-Trees, [pT]-Planted Trees

4. Discussion

Plant biodiversity at KAFP was relatively poor and indicated the typical thorn vegetation of the Punjab plains such as *Millettia pinnata, Phyllanthus emblica, Bombax ceiba, Tamarix aphylla, Senegalia modesta, Prosopis cineraria, Dalbergia sissoo, Cassia fistula, Ziziphus mauritiana, Crateva religiosa, Terminalia arjuna, Vachellia nilotica and Vachellia farnesiana* trees (Maan and Chaudhry, 2001; Arshad et al., 2002; Ali et al., 2012). A few exotic species of Eucalyptus were also recorded from the study site. Though, a native of Australia but is well introduced in Pakistan, such as *Eucalyptus camaldulensis* (Zahid et al., 2010).

The Poaceae family is the representative plant family found frequently across all types of artificial or natural forest plantations established in the Punjab plains (Akbar and Arshad, 2000). During the present study, many kinds of grasses recorded were the indicators of environmental stresses such as salinity and drought, representing semi-arid and salt affected soil conditions (Ashraf et al., 2006). For example, *Aeluropus lagopoides* being a halophyte, is the typical species of soils with excessive salinity (Mohsenzadeh et al., 2006). Likewise, other salt resistant grasses included *Desmostachya bipinnata, Panicum antidotale, Imperata cylindrica, Cynodon dactylon, Sporobolus indicus* and *Pennisetum pennisetiforme* were also recorded at KAFP (Ahmad et al., 2011).

Other grasses recorded such as *Pennisetum setigerum, Cynodon dactylon, Panicum antidotale, Desmostachya bipinnata* and *Pennisetum pennisetiforme* are drought-resistant species, signifying semi-arid climate (Ashraf et al., 2006). Some important tussock grasses such as *Saccharum spontaneum* and *Saccharum bengalense* were also reported (Chaudhry et al., 2001). Moreover, invasive weeds of Punjab plains such as *Echinochloa colona, Eleusine indica, Eragrostis minor, Polypogon monspeliensis, Digitaria ciliaris, Urochloa reptans* and *Urochloa ramosa* were also reported at KAFP (Hussain et al., 2012). Hence, plant survey at KAFP indicated the important natural vegetations those are frequently reported from Punjab plains and being restored along-with exotic and native planted trees. It also highlights the significance of reforestation and afforestation for the rehabilitation of biodiversity at degraded sites.

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