Vachellia nilotica subsp. *cupressiformis* – status and conservation approach of an endemic agroforestry tree in Rajasthan

The arid zone of India is the most fragile ecosystem facing extreme droughts, erratic and high-intensity rainfall, seasonal variations in climatic pattern, abundance of solar energy and high evapotranspiration. The arid region is spread over 38.7 m ha, while the semi-arid region accounts for 34% of the total land area. In recent decades, the semi-arid region has expanded by 10%. The newly formed semi-arid region in North India alone accounts for 4% of reduction in rainfall and increased evapotranspiration have led to increased aridity[1]. Under such adverse situations, traditional agroforestry plays an important role in providing food, fodder, fruits, fuel, etc. and also provides security to the local people and animals/livestock during extreme drought conditions. The traditional agroforestry system is a permanent feature of a landscape, where farmers without disturbing the natural tree component, integrate crops, grasses and animals. Especially, under arid regions, a clear-cut demarcation in distribution of agroforestry systems based on rainfall gradient can be seen, for example, khejri (*Prosopis cineraria*)-based agroforestry system performs well under 400 mm rainfall zone; *Ziyphus* sp. – *P. cineraria*-based agroforestry system between 200 and 300 mm rainfall and shrub-based system under less than 150 mm rainfall[2]. Some species are particular and unique to specific zones/areas due to rainfall, soil or other microclimatic factors. Such types of species are not found in other regions and the growth performance of the species is also not assured. One such endemic agroforestry species is *Vachellia nilotica* subsp. *cupressiformis* (J. L. Stewart) Ali and Faruqi (*Acacia nilotica* subsp. *cupressiformis*), a subspecies of *A. nilotica.*

A. nilotica was described by Linnaeus in 1753 and this species was often recognized in one or the other name up to 1920's. Many taxonomists from different countries have taken efforts to study *A. nilotica*. Cooke[3] thrown attention for cypress like growth characteristics of *Vachellia nilotica* subsp. *cupressiformis*. Later in 1940, five varieties were recognized in East Africa[4]. *A. nilotica* is one of the widespread species and is presently divided into nine subspecies based on size, shape, branching pattern, crown shape and pods. One such subspecies is *V. nilotica* subsp. *cupressiformis*, a native tree of India and Pakistan, is distributed in Punjab, Deccan and Gujarat in India. It is locally called ramkanta, ramkati babul, khajuria babul and kabuli kikar, and belongs to family Fabaceae (subfamily: Mimosoideae). More specifically, this tree is distributed in the semi-arid region of Pali Marwar in Rajasthan, India.

V. nilotica subsp. *cupressiformis* has special characteristics features that distinguished from *A. nilotica*. (i) Narrow and cypress-shaped crown, which permits understory crops to utilize sunlight. (ii) Branches making a narrow angle with the stem. (iii) Straight trunk and stem cylindrical (Figure 1). Thus, it fulfils all the criteria of agroforestry such as leguminous tree, fast vertical growth, narrow crown, few branches, straight and clean bole, deep taproot system, high proportion of main stem, loose canopy permitting transmittance of light and less interference with crop and adding nutrients to the soil. Due to these characteristics, it is preferred on agricultural lands. Therefore, in the semi-arid regions of Rajasthan, it is traditionally grown and conserved in the farmers' field. It is intercropped with cluster bean and mung bean during *kharif*; and bajra, wheat and mustard as *rabi* crop depending on rainfall in a particular year. Acacia is also found in the silvipastoral system of wastelands. Tree is lopped for fodder during winter to feed goats and sheep. Wood twigs and branches are used as fuelwood. This species has considerable importance in agroforestry for its ability to fix atmospheric nitrogen and enhance soil fertility. It also provides complementary tree crop interaction. Considering, the distribution of *V. nilotica* subsp. *cupressiformis* in the semi-arid region of Pali Marwar, this study was conducted to know the present status of the species spread over Pali district, Rajasthan.

The survey was carried out in five villages of Pali Marwar region (Nadol, Sonana, Mundara, Latara and Sadra), particularly in the farmer's field during 2017. The Pali region falls under rainfall zone of 400–450 mm between 25.19N lat. and 73.58E long. (260–390 m amsl). In general, May and June are the hottest months (21–48°C), while December and January are the coldest months (0–15°C) of the year. The density of trees is calculated by simply counting their number in a unit area or the number of trees per hectare. The diameter at breast height (DBH; cm) was measured using a measuring tape. The height (m) of tree was measured using an altimeter.

Traditionally, farmers cultivate intercrops without disturbing the tree component. The tree population was scattered over the field. Farmers carry out lopping operation during winter to cater to the needs of livestock for fodder. The preliminary study indicated considerable variation in the population for all morphological parameters. The density of trees/ha ranged from 5.0 ± 1.00 (Latara) to 11.66 ± 4.72 (Nadol). However, Goyal[5] had reported that the density varied from 40 to 50 trees/ha^{-1}; which indicates that the density of the trees has reduced in the

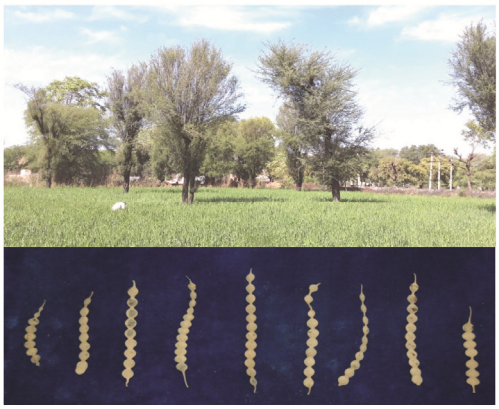

Figure 1. *Vachellia nilotica* subsp. *cupressiformis* in the agroforestry system.

Table 1. Morphological and pod parameters of *Acacia nilotica* subsp. *cupressiformis* in semi-arid Rajasthan, India

	Latitude	Longitude	Density/ha	Height (m)	DBH (cm)	Pod length (cm)	Pod width (cm)	Pod lobe (no.)
Nadol	25.41489°N	73.45953°E	11.66 ± 4.72	11.7 ± 3.34	29.9 ± 1.45	14.13 ± 0.99	1.5 ± 0.09	12.1 ± 1.45
Sonana	25.28491°N	73.51833°E	11.5 ± 2.12	11.0 ± 2.44	31.7 ± 4.26	16.67 ± 1.59	1.45 ± 0.07	10.9 ± 1.52
Mundara	25.19527°N	73.36134°E	11.3 ± 5.85	10.8 ± 1.68	28.2 ± 2.70	13.37 ± 1.50	1.44 ± 0.12	9.7 ± 2.00
Latara	25.14221°N	73.37096°E	5.0 ± 1.00	7.8 ± 1.80	26.5 ± 8.92	11.978 ± 1.51	1.51 ± 0.08	9.5 ± 1.35
Sadra	25.13770°N	73.35659°E	7.33 ± 3.51	6.8 ± 2.27	28.1 ± 7.98	14.31 ± 0.28	1.20 ± 0.02	9.45 ± 0.02

recent past. The conical crown naturally fits in agroforestry system, i.e. more growing space made available to a tree, less competition it faces and the faster it grows.

The clean bole height and diameter play an important role in obtaining quality timber. The height of the tree ranged from 6.8 ± 2.27 m (Sadra) minimum to 11.7 ± 3.34 m (Nadol) maximum. Similarly, DBH recorded a minimum of 26.5 ± 8.92 cm (Latara) and a maximum of 31.7 ± 4.26 cm (Sonana) (Table 1). The height and diameter were found to be considerably high in areas receiving good rainfall. However, the average mean height reported was 5.72 m in the *A. nilotica* provenance of Central India[6], which indicates that *V. nilotica* subsp. *cupressiformis* can perform better in terms of height in semi-arid regions. The exact age of the tree was not identifiable due to several reasons, viz. trees are traditionally grown, less awareness among farmers, and other microclimatic factors. The average height and diameter indicated good site quality.

The maximum pod length was recorded 16.67 ± 1.59 cm (Sonana). Although the pod width did not record any significant differences, the number of pod lobes was recorded maximum in Nadol (12.1 ± 1.45) (Figure 1). Nadol and Sonana performed better in terms of all morphological parameters. Similar type of studies for fruit and pod parameters have been conducted in various provenances of *A. nilotica* ssp. *indica* in the Central and north-western parts of India[7], and in *Acacia tortilis* spp. *radiana* for pod variability in South Morocco[8]. Fruit variation in *Balanites roxbhurghii*[9] and *Manilkara hexandra*[10] has also been reported under arid and semi-arid regions. Wood specific gravity of *V. nilotica* var *cupressiformis* was reported to be 0.74 (ref. 11), which is highest among the arid tree species studied.

Though *V. nilotica* subsp. *cupressiformis* has also been reported from Punjab and Gujarat, in Rajasthan, it is endemic to the semi-arid region. The present study has focused on generating baseline data to know the present status of this species. The study reveals that the density of the trees has reduced in this region, which may be due to increased mechanization for farm activities, mortality and change in cropping pattern and preference for other tree species. Many provenance studies have been carried out for *A. nilotica*, as it is widely distributed in the dry tracts of India[12–14]. Comparatively less importance has been given to the subspecies for carrying out provenance studies or for selection of superior genotypes, which is also equally important as *A. nilotica* for its multifarious utility. Propagation or multiplication using seedlings is absent in this region. There is lack of awareness regarding the conservation of this species. Organized cultivation of this species is also lacking which is essential for its conservation as it is confined to the semiarid regions of Rajasthan. Research must be carried out on the selection of elite trees, multiplication of tree species via seeds or other vegetative means, management practices like pruning and lopping especially to utilize it for timber and fodder. Therefore, it is the need of the hour to focus on conservation and preservation of *V. nilotica* subsp. *cupressiformis*.

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