ORIGINAL RESEARCH PAPER

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THE STABILIZED DUNES: A PILOT STUDY ON THE EFFECT OF ACACIA TORTILIS ON GROUND VEGETATION, FROM THAR DESERT, INDIA

KEY WORDS: Acacia tortilis, Bikaner, Rajasthan, sand dune stabilization, Thar desert.

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ABSTRACT

In modern days, sand dune stabilization works are very common in desert areas globally. The purpose is multifaceted; developmental needs, soil moisture conservation works, and prevention of desert spread being the main among them. In the Indian state of Rajasthan, the same works have been ongoing for a long in the Thar desert, primarily by the forest department. This study was aimed as a non replicated administrative study, which has reflected on the possible correlation between the stabilization work by afforestation and gradual loss of native shrub species of desert ecosystem as found from the pilot sites. The preliminary findings of this study were then verified against previous research and findings in other arid regions of the world. Simple counting of standing tree and shrub species was done from 1 sq. m. sample plots of both forest department plantation sites and non-forest land areas. It was found that area with matured grown Acacia tortilis has less ground coverage than other areas. Arid ecosystem has unique survival adaptations, the fast growth of an introduced foreign species impacting the native ground cover can be due to multiple ecological reasons. A much broader replicated study is necessary to ascertain this fact and thereby take necessary measures for preserving both the desert ecosystem and enhance the sand stabilization works.

Introduction:

The Great Indian desert or the Thar desert is the 9th largest hot desert in the world, and it occupies nearly 12% of the total geographical area of India (Arora et al 2010). In India, more than 60% of the desert area is in Rajasthan state, where the major desert districts are Barmer, Bikaner, Jaisalmer, and Jodhpur (Sen, 2021; Charan, & Sharma, 2016). Surprisingly when compared to other deserts of the world, the Thar desert is the most populated one; while in other deserts the density is 3 to 9 person per kilometre square, in Thar desert, it's approximately 84 people per kilometre square (Gehlot, & Jakher, 2015; Charan, & Singh, 2018). The Great Indian Desert has been also reported for playing a major role in global climate, mainly concerning monsoon (Santra, & Chakraborty, 2011). The desert zone understandably witnesses low rainfall and associated drought regularly (Poonia, & Rao, 2013).

For a long time the Thar desert was more or less away from mainstream media, however, it came under the spotlight in 1951 in the first five-year plan document which stated that "recent topographic surveys show that the desert of Rajasthan has been spreading outwards in a great convex arch through Ferozepur, Patiala, and Agra towards Aligarh and Kasganj at the rate of about half a mile per year for the past fifty years and is encroaching upon 50 sq miles of fertile land every year" (Dhir, 2003). Thereby, the first time requirement of sand dune stabilization, through a large-scale afforestation programme was conceptualized by the Indian government. Kumar et al in a study made in 1993 had shown that the stabilization work had succeeded whereby no major shifts in dunes were found from 1973 to 1986 in the Bikaner district part of Thar desert. Thus, showcasing the success of the afforestation efforts.

At present time, Japanese International Cooperation Agency (JICA) has provided a loan to Rajasthan state, through the Government of India. The loan is targeted at 15 districts of Rajasthan and involves various field activities, with the main focus on afforestation. The scheme is called Rajasthan Forestry and Biodiversity Project (RFBP). During the posting of the authors in Bikaner (one of the districts under RFBP), phase II of the scheme was ongoing for a total period of 8 years, from 2011-12 to 2019-20. Under the scheme, afforestation was targeted in 590 villages (of 10 desert and 5 non-desert districts).

As stated before, in the desert area, sand storms are still a regular occurrence; whereby, sand dunes were shifting at large scales. Presently the dunes have stabilized both naturally and artificially by plantation activities. The sand dune stabilization has also enhanced the soil moisture content and growth in vegetation cover. However; one major reported drawback of growing foreign species in desert ecosystem is that they are inhibiting the growth of native desert vegetation species (Bhardwaj, & Gupta, 2014). The matter of foreign trees arises with respect to Acacia tortilis, (more commonly known as Israeli babool in India), which is native to African and Middle Eastern arid ecosystems. It is well adapted to extreme climatic conditions (Anderson, & Krzywinski, 2007) The species is the most economically viable one from an agroforestry perspective, as it comes with a cost-benefit ratio of 29% per hectare (Tewari, & Singh, 2006).

It was found to be a regular practice in the desert zone to plant this species on a massive scale, as there is more survival in comparison to the native species like Prosopis cineraria (the state tree of Rajasthan) / Tecomela undulata (state flower of Rajasthan) in the arid zone, other than the cost-effectiveness and less maintenance required. The desert zone plantations are non-rain fed, i.e. repeat watering over the year is required for the survival of the saplings. On this front also, A. tortilis was hardier than other species. Details of plantation/ afforestation activity in the author's division in Bikaner are listed in table 1.

Table 1: Plantation has been done under Rajasthan Forestry and Biodiversity Project phase II till the authors' tenure.

Year	Afforestation done (ha)	Saplings planted (total of native and foreign varieties)
2011-12	339	169500
2012-13	5	2500
2013-14	590.33	331600
2014-15	1706.33	1008850
2015-16	2018.66	1036500
2016-17	2748	1465350
Total	7407.32	4014300 (4 million 14 thousand & 3 hundred

A total of 19193 ha plantation was done all over the state of Rajasthan in the financial year 2015-16 and a total of 26407 ha

in the financial year 2016-17. These data thereby indicates the extent of massive plantation undertaken in Rajasthan. Sand dune stabilization works glimpse is shown in figure 1.

Figure 1: Sand dune stabilization works in Thar Desert

Sand dune stabilization work via afforestation in the Thar Desert

A stabilized sand dune of Thar Desert, a new plantation site

A stabilized sand dune of Thar Desert, an old plantation site

The status of forest and shrub cover in the Bikaner district is given in table 2.

Table 2: Status of forest cover in Bikaner [13]

Very dense forest (sq km)	Moderately dense forest (sq km)	Open forest (sq km)	Total forest area (sq km)	% of geographical area	Scrub (sq km)
0.88	28.06	250.77	279.71	0.92	49.86

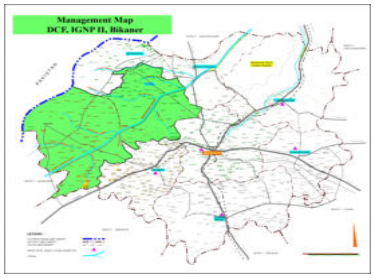
In this study, the authors have tried to find correlation between the massive afforestation activity and the loss of native ground covers.

Materials and methods:

Study site:

IGNP (Indira Gandhi Nahar Project) II, Bikaner division is one of the three territorial forest divisions of the Bikaner district. It was created in October 1987 for the purpose of plantation & sand dune stabilization of the Bikaner part of Thar desert adjoining the IGNP canal, up to the international border. The division has a total area of 40764.580 ha (Figure 2). This division is one of the three forest divisions of the Bikaner district. Bikaner is the fourth largest district of India, thereby for better administrative management, the district has been divided into 3 forest divisions.

Figure 2: The study area of IGNP II, Bikaner division



Sampling:

For the purpose of the study, 12 samplings each were covered from the New plantation site (2-3 yrs old), Old plantation site (10-15 yrs old), and non-forest area (Figure 3). The non-forest areas are area having naturally grown native tree and shrub species, outside the plantation sites of Forest Department. From the 1 sq, m plot laid, counting of major tree and shrub species was done. The non-forest area was specifically targeted for shrub land to understand the effect of the absence of big trees and compare it with the tree area of forest plantations. A simple statistical correlation- regression analysis was done to relate the increase in the number of A. tortilis plantation against the decrease in the number of the native tree and shrub species.

Figure 3a: Old plantation sampling sites in the Thar Desert

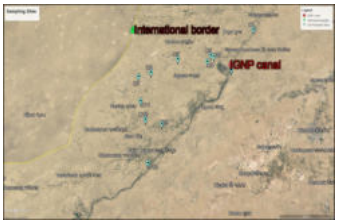


Figure 3b: New plantation sampling sites in the Thar Desert

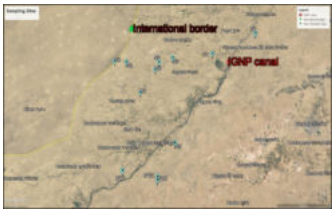
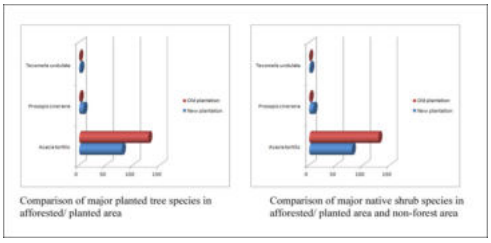


Figure 3c: Non forest sampling sites in the Thar Desert

Result and discussion

As the study was conducted from available field data, and without any special funding support, basic analysis to deliberate the possible impact of planted species on ground vegetation has been done. From the data, it can be seen that in the planted species, the growth of A. tortilis is more than P. cineraria and T. undulata, as reported in old plantation sites (figure 4a). However, the naturally occurring native shrub species growth is more in non-forest areas than the afforestation/ plantation sites (figure 4b). Also, inside the afforestation/ plantation sites, the growth was found to be less in old sites than in the newer sites. This finding raises the query about the growth inhibitory effect of A. tortilis on ground vegetations.

Figure 4: Comparison of major planted tree species in afforested/ planted area and comparison of major native shrub species in afforested/ planted area and non-forest area



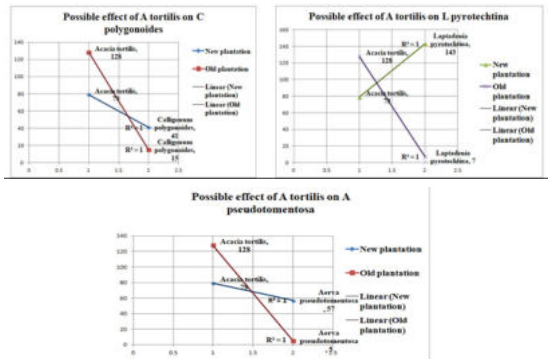
The possible influence of woody species on undercover can be either negative or positive, which also in turn depends on the climate, location, and species concerned (Abdallah, & Chaieb, 2013).

Kahi et al (2009) in a study established the fact that A. tortilis exerts a negative impact on the growth of ground vegetation under their canopies. It was stated by Nakafeero et al (2007) that the leaves of A. tortilis contain phenolic and alkaloid compounds, which had inhibitory effects on seed germination. A tortilis also exhibits autoallelopathy, which is proven by its inhibitory effect on other agricultural crops in absence of other fungi and bacteria (Noumi, & Chaieb, 2011).

Similarly in this study also there was a positive correlation between an increase in the number of A. tortilis with the decrease in the number of native shrub species in planted/ afforestation areas (figure 5). The comparison has been done with three major shrub species found in the area, which are C. polygonoides, L. pyrotechtina, and A. pseudotomentosa. The x axis represents the increase in number of A. tortilis and the y axis denotes the number of shrub species.

Thereby the preliminary findings by the authors were found to be much prominent and regular side effects of planting A. tortilis species. The planting is necessary for the immediate requirements of sand dune stabilization associated with the climatic hardy characteristic of the species. However, in long run, the massive planting of the species has unarguably caused damage to the desert ecosystem by inhibiting the natural growth of arid zone vegetation.

Figure 5: Correlation between the growth of A. tortilis and C. polygonoides/ L. pyrotechtina/ A. pseudotomentosa



Conclusion:

The subject of discussion has been widely researched before in other parts of the globe, however no such previous work was carried out in India before. This basic study has first time validated and reported a similar occurrence of an inhibitory effect of A. tortilis on natural arid zone vegetation in the Thar desert. It can be safely said the introducing economically viable foreign species to desert system has brought short term gain in form of sand dune stabilization; however, the long term damage done to the desert eco system is more significant, as the native vegetation growth has been widely impacted. This study has thereby provided major insight to the authors being in the forestry sector as to the future course of afforestation activities. In the era of post 2020 Global Biodiversity Framework, retaining ecosystem characteristic is a must for mitigating climate change.

This study though needs a massive repeat study in other parts of the Thar desert in Rajasthan state to conclusively establish the need of changing the trend of A. tortilis based sand dune stabilization works. Sand dune stabilization vis-à-vis climate change is a genuine urgency, judicious planning of preserving ecosystem while supplanting new vegetation therefore is the priority to save the desert ecosystem and mitigate the adverse climatic affects both.

Declaration of Interest: The Authors state there are no competing interests to declare.

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