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Mortality Status of *Acacia nilotica* (Kikar) Under Different Land Uses in Haryana

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ABSTRACT

Acacia nilotica (Kikar) is a multipurpose tree. In recent years its large scale dying in Haryana has been reported. About 9.2 lakh trees have been reported dead upto 2000 under different land uses. To assess the mortality status of A. nilotica under different land uses in the state, a study was carried out during 2005-2006 covering all agro climatic zones of the state. Monoculture and mixed plantations located in forest along rail line, road, canal, sanctuary and community lands were selected for this study. The study revealed that maximum morality has been recorded in Sultanpur National Park, Gurgaon (36%) plantation and minimum in Hissar Delhi Road, Hissar (14%) plantation. The present study also revealed that no single factor has been accounted for the mortality of kikar plantations but mortality is site specific and its intensity is governed by the dominance of either environmental or miscellaneous factors including physic-chemical properties of soil However, no mortality was observed from mixed plantation located in all land use sites. Maximum mortality was observed from plantations facing acute biotic stresses. To avoid biotic stresses to the plantations, it is advisable to adopt mixed plantations instead of monoculture which can reduce Acacia nilotica mortality at some extent.

Keywords:

Acacia nilotica, biotic stress, Haryana, monoculture, mixed plantation, mortality, rain

INTRODUCTION

Forests of Haryana are mainly distributed in the northeastern and south- western Districts. There are three forest types i.e. Tropical Dry Deciduous in the eastern part, Tropical Moist Deciduous in the Shivaliks region and Tropical Thorn Forests in the western parts of the state. The state has two national parks and eight wild life sanctuaries which is 0.69 % of the total geographical area. The forest cover is 3.61 % and tree cover is 3.19% of the total geographical area of the state. The human population of the state is 25.35 million, of this 65.21% is rural and 34.79 % is urban. Population density is 573 persons per square kilometer. The livestock population is 8.86 million (Anon. 2011). Plantation activity in the state has been taken up extensively from early 1980's under Social Forestry Scheme. Large-scale plantations were carried out under Aravalli Project since 1992. The total forest of plantation covered upto 1999 was 742740 ha, mostly on panchayat lands, along the roads, canals, railway lines, water courses, on the available institutional lands and on the farm lands (Anon, 2001). Species- wise plantation by Forest Department up to 1998 was *Acacia nilotica,* 22.0%; *Eucalyptus species* 21.0%; *Prosopis cineraria,* 15.0%; *Dalbergia sissoo,* 12.0%; *Salvadora spp,* 3.0%; *Populas spp,* 2.0%; *Acacia tortilis,* 2.0%; *Azadirachta indica,* 2.0%; *Magnifera indica,* 2.0%; and other species 19.0%.The forest area are under acute biotic stresses namely grazing, lopping, encroachment, for urbanization and industrialization whose consequences are in the form of rapid soil and

water erosion, loss of biodiversity , reduction in natural regeneration and shrinking of forest cover. Sporadic trees growing under stress die regularly in the natural forests and plantations. In recent years mass scale drying of Kikar (*Acacia nilotica*) has been reported from various parts of the country (Dhiman,2001; Kaushal *et.al.*2001).Sapara, (2000) reported that in Haryana 9.2 lakh trees of Kikar have died in the year 2000 and the severity of drying is prevalent in the north, west and south circles in the state. Study on mortality of kikar was done by Luna *et.al* (2006), Luna and Sharma (2009) whereas Bariyal et al. (2008) and Chandra et al. (2012) have studied various factors of mortality of kikar. The present study was under taken with the objectives to assess ecological status (mortality) of Kikar in pure and mixed stands under different landscapes in selected areas in North, West and South Haryana.

MATERIALS AND METHODS

Five districts *viz*., Ambala, Kaithal, Jind, Hissar and Gurga were selected for studying the phenomenon of Kikar mortality in the State of Haryana in India. The sampling design adopted for this study was two stage stratified sampling. The first stage-sampling unit was a district and in the second stage it was category of planted trees. Planted trees are classified in eight categories: *viz.,* Farm Forestry, Block plantation, Road, Pond, Rail, Canal side plantations, National Parks / Sanctuaries and others. An extensive survey was conducted in all selected zones and three types of stands viz., Sites with healthy trees, sites with partially dead trees and sites with dead trees were selected.

The sample stands were divided into three to five replicate sub-plots (minimum 10 x10m^2), depending upon the size of plantation area. 25-100 trees in each sub-plot were measured for height and diameter at breast height (d.b.h.). Ecological studies were undertaken as per the method described by (Misra 1968). These entire plantations are located in different agro climatic zones of Haryana Comparative study of heavy and least biotic stresses plantations on available sites were also carried out. Several quadrats of standard sizes were laid out in block plantations to determined total tree, healthy tree, dead tree and stump of trees ha^{-1} undergrowth species ha^{-1} were also determined invaded to forest plantations of Kikar in Hisar and Bir Bara Ban Sanctury.

Soil samples from the depth of 0-30 cm. from healthy partially dead and dead trees were collected for physico-chemical analysis of soil as per standard laboratory methodology (Black 1956 and Jackson 1957).

RESULTS AND DISCUSSION

Mortality in kikar planatation

The age of kikar plantations selected for the present study ranged between five years to twenty-seven years (Table 1). Maximum mortality was recorded in the block plantation near Sultanpur National Park in Gurgaon (36%) followed by Saraswati Van Vihar in Kaithal (33%) again a block plantation and minimum was recorded in Hissar Delhi Road, Hissar (14%) in block plantation. However the incidence of mortality was low in block plantation in Jind. No mortality has been recorded in Barwala range of Hissar but the percentage of dead stumps was very high (65%). Deswal et al. (2009) described that mortality of Kikar varied from location to location and was in between 5.0 % to 8.5% in Harayana state.

The environmental factors seemed to be the key factors among the pre-disposing causes which affected the physical attributes (Luna et al. 2006). Rainfall and temperature are two important attributes of climate that directly affect the plant growth. The data of rainfall of Cheeka observatory located in Kaithal district revealed that the area receives an annual rainfall of 766.35 mm (Fig. 1 and 2). During 2001 annual rainfall was 1988.00 mm which was recorded maximum in 10 years i.e since 1995-2005 (Fig.1 and 2) and August month alone contributes 1665 mm rainfall in 2001. Erratic rainfall is being observed in the observatories from where data has been collected with heavy rainfall in the year 2001 causing flood in the state, which resulted in heavy water logging in the plantation areas, and this may have resulted mortality in Shisham and Kikar trees being of successional nature.

Table 1: Selected study sites for assessment of Kikar mortality in monoculture plantations

							Tree Status			
District	**Place**	**Division**	**Category**	**Plantation Year**	**Area (ha.)**	**Trees ha^{-1}**	Dead (%)	Partially Dead (%)	Stumps (%)	Healthy (%)
Hissar	Hissar Delhi Road	Hissar	Block	1980	5	467	67(14.0)	67(14.0)		333(72.0)
Hissar	Barwala	Hissar	Rail track side 1980	1980	2.5	430			280(65.0)	150(35.0)
Jind	jind	Jind	Block	1980	5	520	90(17.2)	nil	100(19.2)	330(63.5)
Kaithal	Sarswati Van Vihar	Saraswati	Block	1978	5	250	73(33.0)	42(17.0)		125(50.0)
Gurgaon	Sultanpur National Park	Gurgaon	Block	1985	5	600	217(36.0)	150(25.0)		233(39.0)
Ambala	Barswar	Ambala	Community Land	1993	10	1001	217(22.0)	300(30.0)	117(11.0)	367(37.0)
Ambala	Narayangarh	Ambala	Block	2000	5	1199	233(19.0)	283(24.0)	233(19.0)	450(38.0)
Ambala	Road Side	Ambala	Community	1995	2.5	965	200(21.0)	216(22.0)	216(22.0)	333(35.0)

Table 2: Growth features of Kikar in selected sites

Site	Habitat	Type of plantation	Age	Area (ha)	Height (m)	Diameter (cm)
Healthy						
Gurgaon	Sultanpur National Park	Block	15 - 20 years	5	12.6	42.2
Kaithal	Saraswati Van Vihar	Block	27 - 28 year	5	13.6	40.6
Ambala	Saha Range Road Side	Strip	15 - 20 years	4	10.2	32.8
Ambala	Range road side	Strip	15 - 20 years	10	11.4	30.4
Ambala	Narayangarh	Block	5 - 6 years	5	5.5	14.6
Jind	Bir Bara Van Sanctuary	Block	15 - 20 years	5	9.8	28.3
Hisar	Delhi road	Block	12 - 15 years	2.5	8.9	26.0
Partially Dead						
Gurgaon	Sultanpur National Park	Block	15 - 20 years	5	11.6	26.6
Kaithal	Saraswati Van Vihar	Block	27 - 28 year	5	9.7	25.1
Ambala	Saha Range Road Side	Strip	15 - 20 years	4	9.2	27.3
Hisar	Delhi road	Block	12 - 15 years	2.5	8.8	21.2
Dead						
Gurgaon	Sultanpur National Park	Block	15 - 20 years	5	6.8	22.6
Kaithal	Saraswati Van Vihar	Block	27 - 28year	5	7.5	24.5
Ambala	Saharange Road Side	Strip	15 - 20 years	4	7.2	22.3
Ambala	Range road side	Strip	15 - 20 years	10	8.2	26.1
Ambala	Narayangarh	Block	5 - 6 years	5	5.5	9.2
Jind	Bir Bara Van Sanctuary	Block	15 - 20 years	5	7. 3	21.1
Hisar	Delhi road	Block	12 - 15 years	2.5	6. 4	17.6

The study of Banyal, et al. (2008) on mortality of kikar and shisham (*Dalbergia sissoo*) in Punjab reported that extreme winter and hot summer seasons, erratic rainfall after long dry spells during active growth season, short rainy season and drastic increase in number of fog days seemed to be primary factors to induce mortality of these species. The similar finding was observed by Kaushik and Bangarwa (2002) and Luna et al. (2006) while studying the kikar mortality in Haryana and Punjab respectively

Soil Physical and chemical properties

Soil has a significant influence on the growth of trees. Kikar prefer well-drained soils with good porosity and avoids clayey soils. Data of physico-chemical properties of the dead, partially dead and healthy sites are presented in Table 3. Clay percentage was somewhat higher at partially dead and dead site as compared to healthy sites. Porosity was higher in healthy sites in comparison to other two sites and bulk density was higher in dead site as compared to partially dead and healthy sites which indicated the heavy texture and compactness of soil of dead site. Biotic

Table 3: Physico-chemical properties of soil under different mortality regimes in kikar plantations

District	Site	Age	Type of Plantation	Categorization	Sand (%)	Silt (%)	Clay (%)	Texture	Porosity (%)	Bulk density (g/cc)	pH	O.C (%)	Av. N (%)	Av. K (%)	Av.P (%)
Guraaon	Sultan pur National Park	15-20 years	Block	Healthy	64	17	19	Loam	40.5	1.25	7.68	1.04	0.023	0.019	0.009
				Partially dead	60	16	24	Clay Loam	37.6	1.35	8.35	0.83	0.017	0.015	0.007
				Dead	60	14	26	Clay Loam	35.1	1.36	8.87	0.75	0.014	0.008	0.006
Hisar	Road side near village	12-15 years	Block	Healthy	82	11	7	Loamy Sand	42. 4	1.20	7.94	0.98	0.019	0.010	0.0019
				Partially dead	77	12	11	Loamy Sand	40.1	1.19	8.33	0.65	0.013	0.008	0.0012
				Dead	70	11	19	Loamy Sand	38.7	1.18	8.93	0.56	0.010	0.005	0.0009
Kaithal	Saraswati Van Vihar Sanctuary	27-28 years	Strip	Healthy	58	18	24	Clay loam	36.5	1.35	7.97	0.99	0.020	0.015	0.0075
				Partially dead	56	17	27	Clay loam	37.4	1.37	8.59	0.78	0.013	0.009	0.0028
				Dead	57	18	25	Clay loam	35.6	1.37	8.97	0.69	0.0095	0.005	0.0019
Ambala	Saha Range Road Side	15-20 years	Strip	Healthy	80	13	7	Silty Loam	41.2	1.22	7.89	1.12	0.021	0.009	0.0017
				Partially dead	70	13	17	Silty Clay Loam	39.5	1.25	8.62	0.89	0.011	0.007	0.0010
				Dead	62	14	24	Clay Loam	36.7	1.35	9.03	0.75	0.0055	0.005	0.0008
Ambala	Ambala Range road side	15-20 years	Block	Healthy	64	7	29	Silty Clay	42.5	1.26	7.94	0.88	0.020	0.010	0.0012
				Partially dead	62	11	27	Clay loam	38.9	1.36	8.33	0.68	0.010	0.008	0.0008
				Dead	65	7	28	Clay loam	37.8	1.36	8.97	0.58	0.0056	0.006	0.0006
Ambala	Narayangarh	5 years	Block	Healthy	48	28	24	Clay loam	36.8	1.35	7.98	1.01	0.025	0.013	0.0016
				Dead	60	18	22	Clay loam	36.0	1.36	8.57	0.88	0.018	0.009	0.0010
Jind	Bir Bara Van Sanctuary	15-20 years	Block	Healthy	49	34	17	Loam	43.2	1.22	8.02	0.68	0.0034	0.010	0.0017
				Dead	44	29	27	Clay loam	38.2	1.35	8.89	0.98	0.019	0.007	0.0009
Hissar	Road side near village	12-15 years	Block	Healthy	52	39	21	Clay loam	37.7	1.36	8.04	0.78	0.0085	0.010	0.0012
				Partially dead	52	21	27	Clay loam	36.8	1.36	8.32	1.02	0.018	0.007	0.0008
				Dead	54	20	26	Clay loam	36.0	1.38	8.96	0.78	0.0091	0.005	0.0006

Table 4: Ecological status of Kikar in mixed plantations in Haryana

District	Place	Division	Range	Category	Plant yr	Area (ha)	Trees/ha	Species	Trees/ha (%)
Hisar	Ambala Road	Hisar	Hisar	Block	2000	1.0	2640	Shisham	17609 (67.0)
								Kikar	640(24)
								Ber	160(6)
								Ailanthus	80(3)
Sirsa	Jodhkan Village	Sirsa	Sirsa	Community	2000	10	1034	*A. nilotica*	667(64)
								A. tortilis	367(36)
Sirsa	NH-10	Sirsa	Sirsa	Block	1986 2001	2.5	2635	Shisham	100(4)
								Shisham Sap.	367(14)
								Eucalyptus	833(32)
								Eucalyptus spp.	533(20)
								Kikar	67(2.5)
								Prosopis	67(2.5)
								Neem	267(10)
								Neem	267(10)
Jind	Kaithal-Jind Road	Jind	Jind	Block	1997	5.0	1403	Siris	134(5)
								Shisham	501(36)
								Kikar	139(10)
								Karanj	557(39)
								Neem	139(10)
Karnal	Karnal Asand Road	Karnal	Peonti	Block	1999 2000	7	2680	Shahtoot	67(5)
								Kikar	520(19)
								Cordia myxa	40(1.5)
								Shisham	600(23)
								Shisham sap	400(15)
								Neem	40(1.5)
								Neem	40(1.5)
								Shahtoot	160(6)
								Eucalyptus	120(4.5)
								Arjun	360(13)
								Ber	400(15)

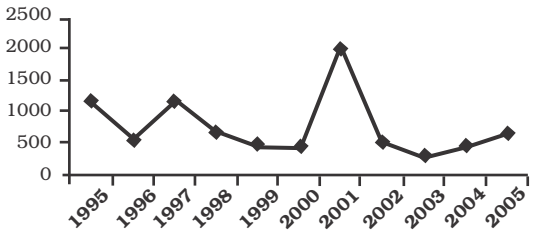

Fig. 1. Annual rainfall at Cheeka observatory located in Kaithal district

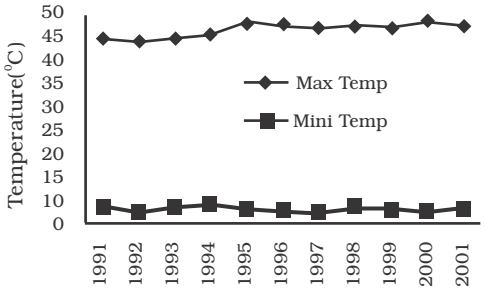

Fig. 2. Maximum and minimum temperature at Cheeka observatory located in Kaithal district

The study of Banyal, et al. (2008) on mortality of kikar and shisham (*Dalbergia sissoo*) in Punjab reported that extreme winter and hot summer seasons, erratic rainfall after long dry spells during active growth season, short rainy season and drastic increase in number of fog days seemed to be primary factors to induce mortality of these species. The similar finding was observed by Kaushik and Bangarwa (2002) and Luna et al. (2006) while studying the kikar mortality in Haryana and Punjab respectively

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sustain in waterlogged or compact soils. Soil pH was alkaline at all the sites (table-3) showing the presence of excessive salts. Soil pH influences development of diseases which is more severe in alkaline than in acidic conditions (Jackson, 1957). Such conditions are not suitable for the survival of Kikar plants (Kaushal and Banyal 2005) though Kikar plants can tolerate higher pH value of 8.5. The low and higher concentration of salts was reported to create hindrance for the uptake of various essential nutrients leading to physiological disorders in plants (Banyal et. al. 2008). Kaushik and Bangarwa (2006) collected the soil samples around healthy and dead trees in Haryana and reported that there was an accumulation of salts in feeding root zone of dead trees compared to healthy trees and as such Kikar trees cannot withstand such high level of salinity and becomes the victim of wilting due to physiological disorders. Therefore preponderance of such conditions advocated the role of pH in drying of Kikar plantations in Haryana. Organic carbon, available nitrogen, potassium and phosphorous was more in healthy sites than partially dead and dead sites (Table 3). Organic carbon directly correlated with the nutrient status of the soil and also improved the other properties of the soil which may help the plant growth while available nitrogen is essential for the growth of the plant and also helps in physiological processes carried out by plants to make plant well adapted to the existing conditions of the environment. In the present study organic carbon and available nitrogen of dead and partially dead sites was less in comparison to healthy site. Banyal et al. (2008) reported the low content of organic carbon and available nitrogen may cause the mortality of Kikar plantations in Punjab and suggested the level of existing organic carbon and available nitrogen may be increased by adding manure and other suitable material to make the condition suitable for the survival of Kikar plantations .

To compare the mortality status in monoculture Kikar with mixed plantations where Kikar is planted one or /either of the species, a study was carried out in the four districts of Haryana viz., Karnal, Jind , Hissar and Sirsa where five mixed plantations selected for this study between the age of 5-20 years. Study revealed that there are no signs of mortality in the mixed plantation (Table 4).

CONCLUSION

The present study revealed that no single factor was found responsible for the mortality of Kikar plantation but mortality is site specific and its intensity is governed by the dominance of either environmental or miscellaneous factors including physico-chemical properties of soil.

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