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NITROGEN FERTILIZER EFFECT ON BIOMASS PRODUCTION IN *Albizia procera* SEEDLINGS UNDER NURSERY CONDITIONS

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Abstract: An attempt was made to study the effect of nitrogen treatments on biomass production pattern in *Albizia procera* seedlings under nursery conditions. After transplanting and establishment of seedlings, four nitrogen treatments, 0, 20, 40 and 80 kg N/ha were applied in two equal split doses. Comparing all treatments, 40 Kg N/ha was observed to be effective towards biomass production. However, the differences in the variations of morphological parameters were significantly higher in rainy season than in winter or summer. Root biomass was observed always higher as compared to stems or leaves. On seasonal average basis 40 Kg N/ha treatment was observed significantly higher than 20 Kg N/ha, 80 Kg N/ha and control. The nodule biomass was significantly higher in rainy season followed by summer and winter for all the treatments. Higher nitrogen dose *i.e.* 80 Kg N/ha inhibited growth and biomass whereas, 40 Kg N/ha promoted the overall growth and biomass production.
Keywords: *Albizia procera*; biomass; Nodulation; Nitrogen doses; Seasonal behaviour.
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INTRODUCTION

Nitrogen is one of the vital elements for plant growth and development (Zhao *et al.,* 2005) affecting growth behavior and soil fertility (Heumann *et al.,* 2002). Nevertheless, plants cannot directly access di-nitrogen from the atmosphere. However, it is absorb in its available form in the soil through their roots in the form of either ammonium or nitrates ions. The limited bioavailability of nitrogen and the dependence of crop growth on this element have spawned a massive N-based fertilizer industry worldwide (Dobermann, 2007; Westhoff, 2009). In the recent past an increasing prices along with the increasing demand of chemical fertilizers and depleting soil fertility necessitates knowing the suitable doses of nitrogenous fertilizers. Harper (1974) reported that the addition of soil nitrogen is required for the maximization of biomass at initial nursery stages of growth even for some legume species (Zhang *et al.,* 1990, Becker *et al.,* 1991). High concentration of inorganic N in the soil normally inhibits symbiotic nitrogen fixation (Hungria and Vargas, 2000). Uniyal (1997), Mir (2012) in *Dalbergia sissoo;* Kumar (2005) in *Acacia catechu;* Chaukiyal (1994), Kumar (2013), Chaukiyal *et al*. (2013) also observed that higher doses of nitrogen fertilizer generally inhibit the growth and nitrogen fixation activity in *Pongamia pinnata* whereas, lower dose promote the growth, nodulation as well as nitrogen fixation activity. Many woody legumes grow rapidly and serve as renewable sources of fuel, nitrogen rich green manure, high protein forage and other wood products. The genus *Albizia procera* is one amongst and belongs to subfamily Mimoseae of the family Leguminoseae. It is a highly valued multipurpose tree legume and regarded as a potential fodder resource (Stewart and Dunsdon, 2000). This is used in dropsy, pain, rheumatism, convulsions, delirium, and septicaemia (Kirthikar and Basu, 2000) and shown highly potential in soil reclamation process during early phase of mine spoil restoration in dry tropical environment (Singh *et al*., 2004). Keeping view in mind, the present study was an attempt to investigate the N fertilizer effects on the plant biomass, and nodulation behaviour of *A. procera* at seedling stage. The information generated will be helpful in assessing the actual potential of this species for nitrogen assimilation capability and suitable for the various afforestation programmes.

EXPERIMENTAL

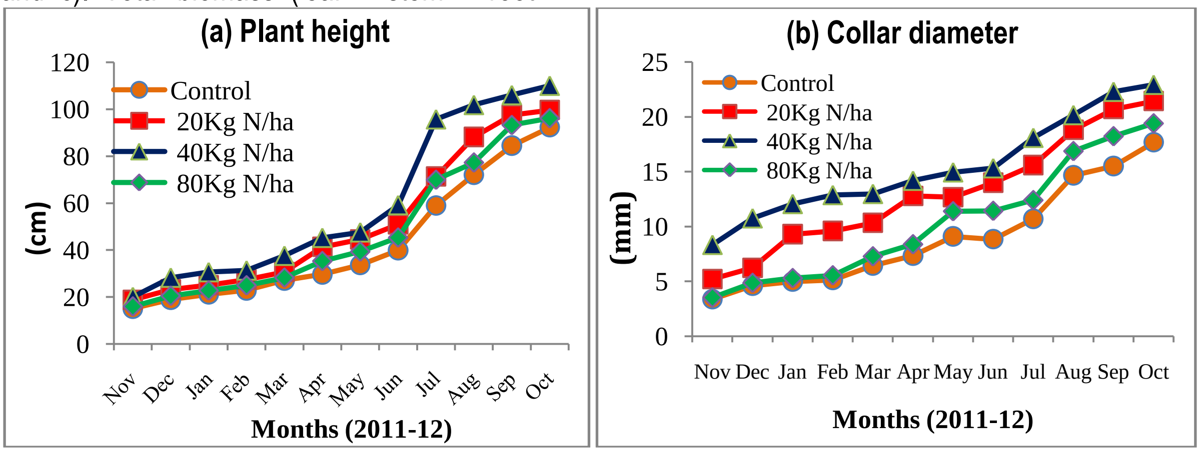
The mature pods of *Albizia procera*, were collected from a selected healthy tree. Pods were sun dried, separated and sown in germination boxes during March, 2011. The mixture of soil, sand and farm yard manure (FYM) in 2:1:1 ratio was mixed and sieved. Five kg of soil was filled in each earthen pot (30 cm diameter). In the month of June single seedlings were transplanted in each pot for better growth. A basal dose of fertilizer *i.e.* potash (K_2O, 58% to 60%) and super phosphate (P_2O_5, 16%) were applied at the rate of 40 kg/ha and 80 kg/ha respectively. After transplanting, four nitrogen (N) treatments were mixed thoroughly at the rate of 20 Kg N/ha, 40 Kg N/ha, 80 Kg N/ha along with one control N-0 (without nitrogen). Two equal split doses of N fertilizer *i.e.* CO $(NH_2)_2$, 46% urea) were applied in an aqueous solution and equal quantity of water was added to control plants (N-0). Plants were irrigated lightly, immediately after nitrogen application so that the nitrogen was uniformly distributed in the soil and easily available to the plants, and to avoid the evaporation and leaching losses. Watering and other cultural practices were carried out as and when required. Morphological observations were recorded at monthly intervals. Average seasonal activity was calculated for winter (November-February), summer (March-June) and rainy (July-October) by pooling the monthly observations. Fresh weights of individual plant parts *i.e.* leave, stems, roots and nodules were recorded immediately and then kept in the oven at 80°C for 72 hours for dry weight. Final dry weight was taken when it lost all arable moisture and weights became constant. The experiment was laid down in a completely randomized design (CRD) with three replicates maintained for each treatment. The data were analyzed using two way ANOVA (Analysis of Variance) technique. Post-hoc tests were used for further data analysis. Means of all treatments were calculated and the differences were tested for significance using the least significant difference (LSD) test at $p = 0.05$.

RESULTS AND DISCUSSION

A continuous increase in the plant height, collar diameter and root length was observed from November, 2011 to October, 2012 in all treatments. The plants treated with nitrogen fertilizers shown higher values for plant height, collar diameter and root length per plant as compared to control (Figure 1a, b and c). Significantly higher plant height, collar diameter and root length per plant were recorded during rainy season as compared to summer and winter. Among all the treatments, 40Kg N/ha showed significantly higher values for plant height, collar diameter and root length. Statistically, seasons, treatments and their interaction (S x T) were significant at 5% level for plant height (Table 1a). For collar diameter, the effect of nitrogen treatments was significant for seasons, treatment and months. However, their interactions (seasons x treatments) were non- significant (Table 1b). Among all treatments, minimum root length was observed in control. However, the differences were not significant from 80 Kg N/ha treatment. Significantly higher values were observed for 40 Kg N/ha in all three seasons. The statistical analysis reveals that seasons, and treatments were significant at 5% level (Table 1c). Among all morphological parameters, number of leaves and nodules per plant increased from the month of March and reached maximum in August, after that it decreased simultaneously. A complete absence of leaves and nodules was observed in the month of February. In all the treatments 40 Kg N/ha showed the best performance throughout the year (Figure 1d and e). Mean of leaf and nodule numbers per plant were significantly different in different seasons. However, maximum (16.56) number of leaves per plant was recorded in rainy season for all the treatments. Further analysis showed that only seasons and treatments were significant at 5% (Table 1d). The maximum (89.25) number of nodules per plant was recorded in rainy season followed by summer and the minimum (6.71) in winter season. On the seasonal basis, control and 80 Kg N/ha were observed equally effective. The difference in nodule number per plant in relation to seasons, treatments and seasons x treatments were significant at 5% level. However, seasons x treatments were non-significant for number of leaves per plant (Table 1d and e). An increase in leaves and nodules dry weight was recorded from March to August followed by a gradual decrease up to the month of December to February and a higher peak was observed in the month of August. Among different treatments maximum leaf and nodules dry weight was recorded in 40 Kg N /ha followed by 20 Kg N/ha and 80 Kg N/ha whereas, minimum in control (Fig. 2a and d). Among all three seasons significantly higher values were recorded in rainy season followed by summer and winter. However, mean nodule dry weight for 40 and 20 Kg N/ha treatments showed equally effective. Statistically, seasons, treatments and their interactions (S x T) were significant at 5% level of significance in respect of leaves and nodules dry weight per plant (Table 2a and d).

An increase in the stem and root dry weight per plant was observed throughout in all the treatments (Figure 2b and c). Mean of stem and root dry weight per plant was significantly different in different seasons. However, among all treatments, 40 Kg N/ha was most effective. An increase in per plant dry biomass was recorded in rainy season as compared to winter and summer respectively. Statistically, seasons, treatments and interaction between seasons x treatments were significant at 5% level in respect of stem and root dry weight (Table 2b and c). Total biomass (leaf + stem + root + nodule) followed the similar pattern as was observed in individual plant parts. With breaking of winter and starting of summer season the dry weight increased sharply. The effect of nitrogen treatments was recorded significantly higher than control plants. However, 40 Kg N/ha showed significantly higher biomass per plant as compared to others (Figure 2e). Statistically, seasons, treatments and interaction between seasons and treatments were significant at 5 % level. Mean total dry biomass was significantly different in different seasons, whereas, significantly higher values were recorded in rainy season as compared to winter or summer (Table 2e). On the monthly analysis basis, total plant dry weight was significant at 5% level for months, treatments and their interaction.

The various growth parameters *i.e.* plant height, collar diameter and root length per plant shown an increasing pattern with plant age and maximum values were observed in rainy season (July-October). Highest values for growth parameters were recorded plants treated with 40 kg N/ha and minimum in the control. The similar type of results was previously reported by Chaukiyal (1994), Chaukiyal *et al.* (2013) and Kumar (2013) in *Pongamia pinnata*. Number of leaves in *A. procera* seedlings was significantly influenced by different treatments and seasons, being a deciduous in nature the leaves were shed during winter season, and on set of spring new leaves flushes comes out.



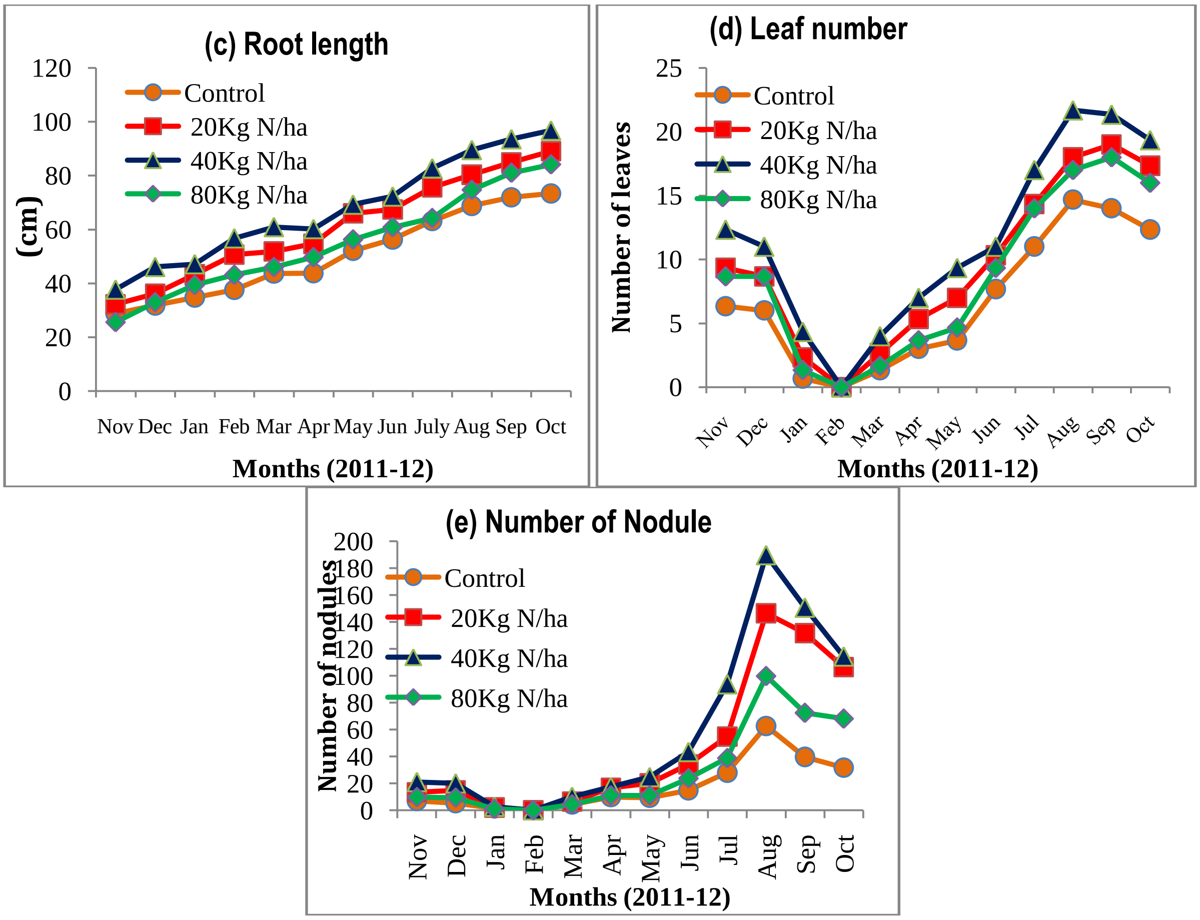
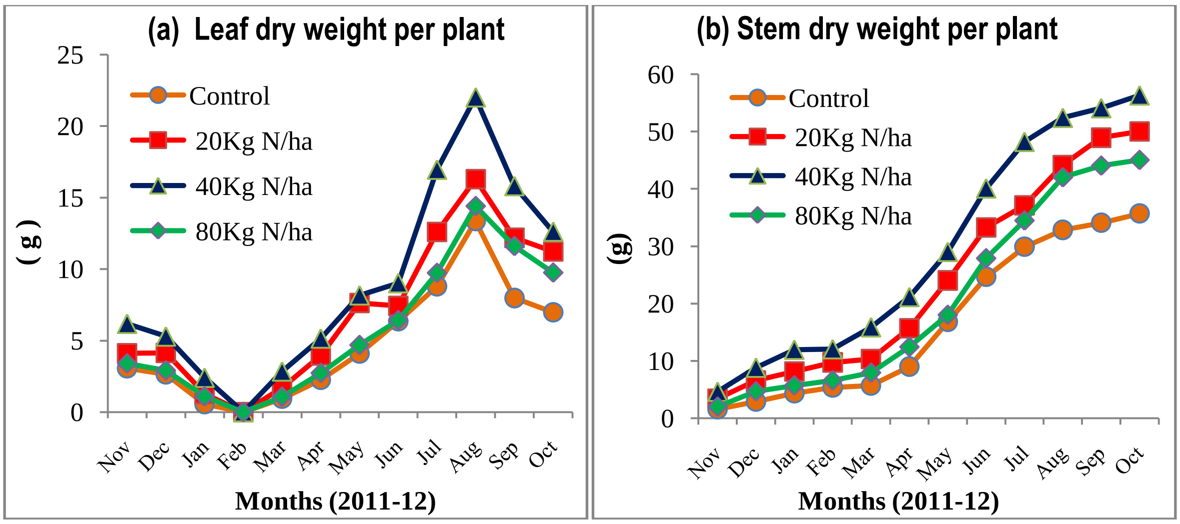


Figure 1. Plant height, Collar diameter, Root length, Number of leaves and Number of nodules per plant in *Albizia procera* seedlings as affected by different Nitrogen treatments



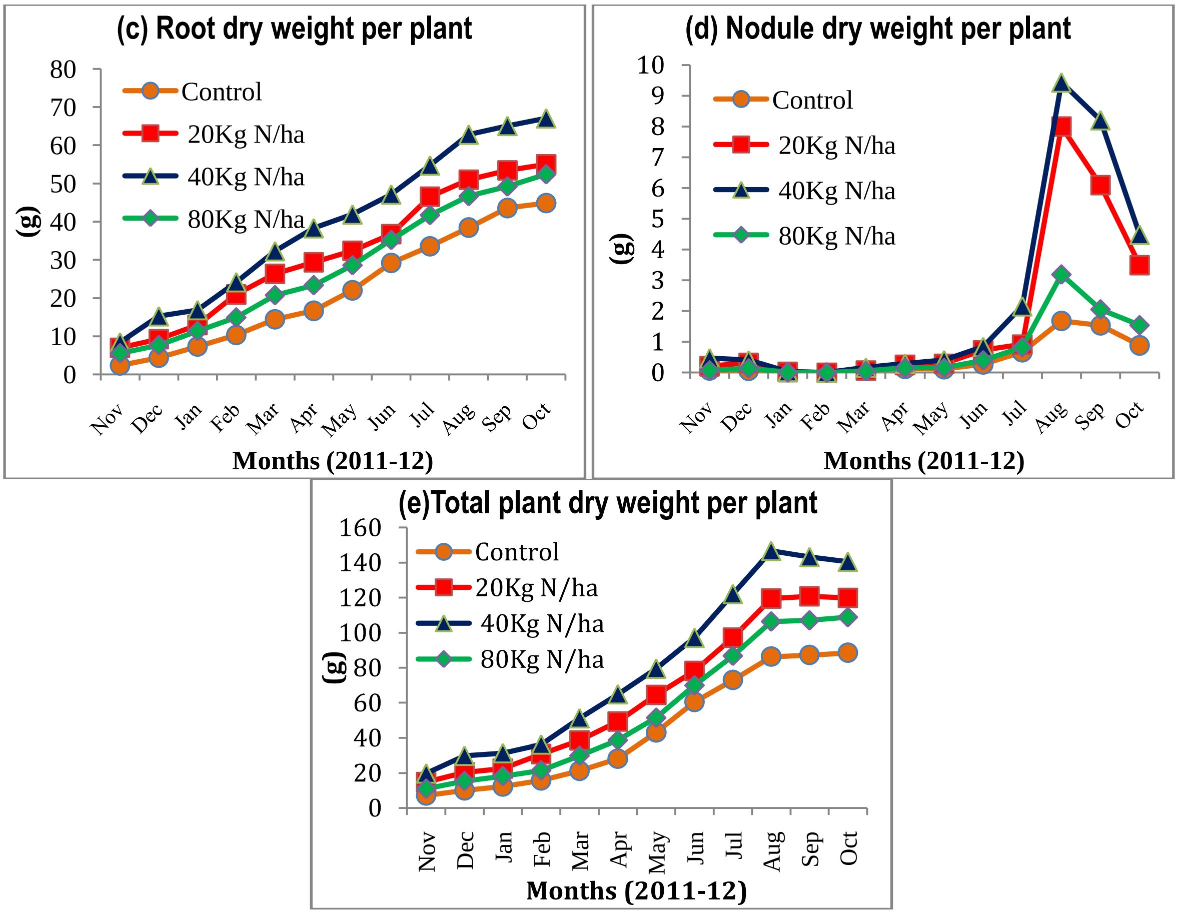


Figure 2. Leaf, Stem, Root, Nodule and Total plant Dry weight per plant in *Albizia procera* seedlings as affected by different Nitrogen treatments

Table 1. Effect of Seasonal variation and Nitrogen treatments on plant physiology in *A. procera* seedlings

(a) Plant Height (cm)				
Treatments/Seasons	**Winter**	**Summer**	**Rainy**	**Mean**
Control	19.35±0.96 a	32.54±1.47 b-d	76.92±3.88 f	42.94±4.38 A
20 Kg N/ha	23.63±0.96 ab	41.84±2.25 de	89.13±3.65 g	51.53±4.88 B
40 Kg N/ha	27.53±1.38 a-c	47.36±2.41 e	103.38±1.86 h	59.42±5.54 C
80 Kg N/ha	20.98±1.02 a	36.98±1.90 c-e	84.08±3.50 fg	47.34±4.72 AB
Mean	22.87±0.70 A	39.68±1.27 B	88.37±2.14 C	
	Seasons	**Treatments**	**Seasons x Treatments**	
Significant	S	S	S	
LSD (5%)	3.27	3.78	6.54	
(b) Collar Diameter (mm)				
Treatments/Seasons	**Winter**	**Summer**	**Rainy**	**Mean**
Control	4.52±0.29	7.93± 0.53	14.63±0.87	9.03±0.79 A
20 Kg N/ha	7.59±0.67	12.44±0.46	19.13±0.88	13.05±0.89 B
40 Kg N/ha	11.00±0.70	14.35±0.78	20.86±0.73	15.40±0.81 C
80 Kg N/ha	4.80±1.28	9.61±0.66	16.71±0.94	10.37±0.91 A
Mean	6.98±0.46 A	11.08±0.47 B	17.83±0.54 C	
	Seasons	**Treatments**	**Seasons x Treatments**	
Significant	S	S	NS	
LSD (5%)	0.95	1.10	1.90	
(c) Root Length (cm)				
Treatments/Seasons	**Winter**	**Summer**	**Rainy**	**Mean**
Control	33.23±1.53	48.95±1.98	69.31±1.67	50.49±2.68 A
20 Kg N/ha	40.55±2.22	59.98±2.38	82.48±1.65	61.00±3.13 B
40 Kg N/ha	46.95±2.38	65.67±1.76	90.64±1.67	67.75±3.22 C
80 Kg N/ha	35.25±2.48	53.18±2.46	76.00±2.51	54.81±3.14 A

Mean	38.99±1.31 A	56.94±1.40 B	79.61±1.48 C	
	Seasons	**Treatments**	**Seasons x Treatments**	
Significant	S	S	NS	
LSD (5%)	2.92	3.38	5.85	
(d) Number of Leaves				
Treatments/Seasons	**Winter**	**Summer**	**Rainy**	**Mean**
Control	3.25±0.94	3.92±0.76	13.00±0.56	6.72±0.87 A
20 Kg N/ha	5.08±1.32	6.33±0.90	17.17±0.63	9.53±1.07 BC
40 Kg N/ha	6.92±1.57	7.83±0.82	19.83±0.65	11.53±1.17 C
80 Kg N/ha	4.67±1.28	4.83±0.90	16.25±0.55	8.58±1.06 AB
Mean	4.98±0.66 A	5.73±0.46 A	16.56±0.46 B	
	Seasons	**Treatments**	**Seasons x Treatments**	
Significant	S	S	NS	
LSD (5%)	1.34	1.55	2.68	
(e) Number of Nodules				
Treatments/Seasons	**Winter**	**Summer**	**Rainy**	**Mean**
Control	3.42±0.88 a	9.50±1.19 a	40.50±4.36 b	17.81±3.12 A
20 Kg N/ha	7.50±2.05 a	19.25±3.10 ab	109.75±11.02 d	45.50±8.59 B
40 Kg N/ha	10.92±3.00 a	28.83±3.80 ab	137.08±11.45 e	57.28±10.39 C
80 Kg N/ha	5.00±1.43 a	12.50±2.83 a	69.67±7.25 c	29.06±5.51 A
Mean	6.71±1.05 A	16.27±1.62 B	89.25±6.93 C	
	Seasons	**Treatments**	**Seasons x Treatments**	
Significant	S	S	S	
LSD (5%)	7.81	9.02	15.61	

Values are Means ± standard errors. Means within a column with the same letter are not significantly different at p≤0.05 using Tukey's HSD Test. S= significant and NS = non significant.

Table 2. Effect of seasonal variation and nitrogen treatments on dry biomass of leaves, stem, root, nodule and total plant of *A. procera* seedlings

(a) Leaves dry weight (g)				
Treatments/Seasons	**Winter**	**Summer**	**Rainy**	**Mean**
Control	1.57±0.46 a	3.41± 0.66 abc	9.29±0.84 de	4.76±0.67 A
20 Kg N/ha	2.38±0.60 ab	5.18±0.83 bc	13.07±0.70 f	6.88 ±0.86 B
40 Kg N/ha	3.47±0.77 abc	6.30±0.81 cd	16.86±1.12 g	8.87±1.10 C
80 Kg N/ha	1.85±0.49 ab	3.73±0.64 abc	11.38±0.67 ef	5.66±0.77 AB
Mean	2.32±0.31 A	4.66±0.39 B	12.65±0.58 C	
	Season	**Treatment**	**Season X Treatment**	
Significant	S	S	S	
LSD (5%)	1.03	1.19	2.06	
(b) Stem dry weight (g)				
Treatments/Seasons	**Winter**	**Summer**	**Rainy**	**Mean**
Control	3.55 ±0.50 a	14.05±2.57 abcd	33.13±0.91 f	16.91±2.26 B
20 Kg N/ha	6.97±0.74 ab	20.81±2.64 de	45.04±1.76 gh	24.27±2.86 A
40 Kg N/ha	9.38±0.94 abc	26.54±2.89 ef	52.75±1.02 h	29.56±3.19 C
80 Kg N/ha	4.76±0.58 a	16.58±2.48 cd	41.41±1.29 g	20.92±2.74 A
Mean	6.16±0.47 A	19.50±1.46 B	43.08±1.20 C	
	Seasons	**Treatments**	**Seasons x Treatments**	
Significant	S	S	S	
LSD (5%)	2.45	2.83	4.90	
c. Root dry weight (g)				
Treatments/Seasons	**Winter**	**Summer**	**Rainy**	**Mean**
Control	6.05±0.93 a	20.55±1.77 cd	40.10±1.57 f	22.23±2.50 A
20 Kg N/ha	12.48±1.65 ab	31.18±1.32 e	51.51±1.16 g	31.72±2.81 C
40 Kg N/ha	16.11±1.73 bc	39.86±1.86 f	62.40±1.55 h	39.46±3.34 D
80 Kg N/ha	9.80±1.16 ab	26.93±1.83 de	47.50±1.42 g	28.08±2.74 B
Mean	11.11±0.87 A	29.63±1.32 B	50.38±1.37 C	
	Seasons	**Treatments**	**Seasons x Treatments**	
Significant	S	S	S	

LSD (5%)	2.13	2.46	4.27	
d. Nodule dry weight (g)				
Treatments/Seasons	**Winter**	**Summer**	**Rainy**	**Mean**
Control	0.04± 0.01 a	0.14±0.03 ab	1.19±0.14 ab	0.46±0.10 A
20 Kg N/ha	0.14±0.04 ab	0.34±0.07 ab	4.63±0.88 c	1.70±0.45 B
40 Kg N/ha	0.23±0.07 ab	0.43±0.08 ab	6.07±0.95 c	2.24±0.55 B
80 Kg N/ha	0.06±0.02 a	0.19±0.06 ab	1.90±0.36 b	0.72±0.19 A
Mean	0.12±0.02 A	0.27±0.03) A	3.45±0.44 B	
	Seasons	**Treatments**	**Seasons x Treatments**	
Significant	S	S	S	
LSD (5%)	0.55	0.64	1.10	
e. Total dry weight (g)				
Treatments/Seasons	**Winter**	**Summer**	**Rainy**	**Mean**
Control	11.21±1.02 a	38.16±4.79 cd	83.71±2.11 f	44.36±5.34) A
20 Kg N/ha	21.97±1.75 ab	57.51±4.61 e	114.25±3.31 g	64.57±6.71 C
40 Kg N/ha	29.18±1.89 bc	73.12±5.22 f	138.08±3.18 h	80.13±7.84 D
80 Kg N/ha	16.47±1.35 ab	47.44±4.68 de	102.19±2.84 g	55.37±6.26 B
Mean	19.71±1.22 A	54.06±3.01 B	109.56±3.20 C	
	Seasons	**Treatments**	**Seasons x Treatments**	
Significant	S	S	S	
LSD (5%)	4.72	5.45	9.44	

Values are Means ± standard errors. Means within a column with the same letter are not significantly different at p≤0.05 using Tukey's HSD Test. S= significant and NS = non significant.

Tewari (1994) also reported similar type of results. Slow growth was recorded in *A. procera* during winter season. Hence physiological and biochemical activities associated with the growth and development phenomenon remained idle. Almost similar type of results were reported in *Myrica* (Sharma *et al*., 2010) in *Pongamia pinnata* (Kumar 2013 and Chaukiyal *et al*., 2013) and in *Phaseolus vulgaris* by Shamseldin and Moawad (2010). Biomass production increased with increasing plant age. In the present study, comparing the different nitrogen doses in individual plant parts, maximum biomass values were recorded in 40 kg N/ha followed by 20 Kg N/ha, 80 Kg N/ha and minimum in control. It indicates that *A. procera* is less responsive to higher nitrogenous fertilizer doses. Several studies showed that a wide variety of plant species are able to take up N compounds especially under N deficient conditions (Schimel and Chapin 1996, Nasholm *et al.,* 1998, Nasholm *et al*., 2000, Hodge *et al.,* 2000, Harrison *et al.,* 2008, Nasholm *et al.,* 2009). Similarly, an adverse effect of nitrogenous fertilizer has already been explained elsewhere in *Dalbergia sissoo* by Uniyal and Pokhriyal (2000); Kumar (2005); Indieka and Odee (2005), in *Pongamia pinnata* by Chaukiyal *et al*. (2013) and in *Triticum aestivum* by Aynehband *et al.* (2012). Fluctuations in below ground biomass production within a growing seasons is a common phenomenon, which have been documented by Shackleton *et al.* (1998) and Synman (2005). Comparing biomass production pattern and its distribution, maximum value was observed in root>stem>leaf in rainy season followed by summer and winter. Similar type of biomass distribution was earlier reported by Thapliyal (2002) in *Albizia lebbeck* and Xu *et al*. (2007) in *Lespedeza* also supports our results. Vasileva *et al.* (2011) reported that the application of mineral nitrogen exerted a stronger influence on the quantity of root mass.

The present study, revealed that on the basis of treatments, maximum nodule number was observed in 40 kg N/ha and it decreased with increasing N fertilizer (80 Kg N/ha) dose. This result is supported by the findings of Indieka and Odee (2005) in *Sesbania sesban* and Hungria *et al.* (2003) in *Phaseolus vulgaris.* In *A. procera,* initiation of fresh nodules take place during harsh, summer conditions, which ultimately slow down the physiological and biochemical activities during this period. These results were supported by the earlier findings of Chaukiyal *et al.* (2000 and 2013). The nodule number start decreasing as the temperature goes down in winters and no nodules were obtained in February as earlier reported by Chauhan (1999) and Thapliyal (2002) in *Albizia lebbeck*. Maximum nodules were produced in rainy season followed by summer and minimum in winter. Almost similar trend was reported earlier in *Albizia lebbeck* (Thapliyal 2002); in *Phaseolus vulgaris* (Shamseldin and Moawad, 2010); in *Dalbergia sissoo* (Singh and Pokhriyal, 2002); in *Sesbamia sesbam* (Indieka and Odee, 2005) and (Vasileva *et al*., 2011).

CONCLUSION

It may be inferred from above results that nitrogen applications were effective in stimulating growth and biomass production in *A. procera* seedlings but higher (80 Kg N/ha) nitrogen doses were not effective and have an inhibitory effect on the growth and biomass production. Therefore, excessive nitrogen fertilizer application should be avoided for nitrogen fixing species such as *Albizia procera* or should be applied in split doses after assessing the requirement of plant to maintain the proper growth and development processes. The seedling growth can be maintained by the adopting suitable agronomic management practices therefore, N requirement can be compensated by employing appropriate fertilizer doses without hampering the biological nitrogen fixation system and any losses through volatilization to the atmosphere and seepages to the ground water at initial stage of growth. Therefore, a demand and supply to be maintained and plants can fully utilize the applied fertilizer doses. The perfection of these techniques will help to increase the productivity depending on the agro-climatic sites of the country. On the basis of these results, it can be concluded that 40 Kg N/ha is the most effective for growth and biomass production in *Albizia procera* under nursery conditions.

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