

## Original Research Article

### Evaluation of the relative efficacy of Alley Species with respect to hedge-row persistence, herbage yield and fuel wood production in central part of U.P, India

#### Abstract

Field experiments were conducted at Malgawan Research Farm, Janta Mahavidyalaya Ajitmal Auraiya during two consecutive kharif seasons of 2022 and 2023 to evaluate the relative efficacy of Alley species with respect to hedge-row persistence, herbage yield and fuel wood production. Out of the two alley species tested viz. *Leucaena leucocephalla* and *Sesbania sesban* under Agro-forestry system, *L. Leucocephalla* for herbage production is good and it gives more herbage yield(119.59q/ha) than *S.sesbane* yielded 105.01q/ha, that fulfils fodder requirement and becomes best alternate of fodder during shortage of fodder. *S.sesban* for fuel wood production are recommended and yielded 42.55q/ha. It is higher than , *L. Leucocephalla*. Both the alley species be pruned prior to crop sowing in both the consecutive seasons and pruned material be added to the soil, increases soil fertility as well as organic carbon content in soil. Under P<sub>0</sub> (No Pruning), the establishment and persistency were better than both the pruning management and P<sub>0</sub> significantly increased the tree height 4.35meter than P<sub>1</sub> & P<sub>2</sub> 1.91 &1.96 meter height respectively. The number of branches was significantly higher in *S.sesban* with no pruning (33.69) over both the pruning management P<sub>1</sub> & P<sub>2</sub> system in both seasons. The Relative growth rate kg/ha/day, fresh yield of pruning q/ha, dry matter yield of pruning q/ha, fuel wood production q/ha, leaf fodder production q/ha and N, P & K uptake q/ha were found more with *L. Leucocephalla* under treatment P<sub>2</sub>(pruning during crop growth and foliage used as forage) than P<sub>1</sub> (pruning during crop growth and foliage added to soil) with N<sub>2</sub> level of fertilizer than N<sub>0</sub> & N<sub>1</sub> fertilizers level respectively in both years mean basis.

Keywords: Alley species, herbage yield, and fuel wood & Relative Efficiency.

#### INTRODUCTION

India is an agricultural based country where over 70% of the population lives in villages, comprising 105 million farm families. According to ICAR's vision 2023, 97 m.ha. are under soil degradation. Nitrogen fixing trees (NFTs) and shrubs in agro-forestry systems are capable of fixing about 50–100 kg N/ha/year. Similarly, the area under forest which are the main source of timber and fuel wood dwindling around 17% of the country's land area against the national requirement of around 33% under forest cover (Bahuguna 1985) and Debroy 1986 are however, of the opinion that the productive and effective forest area in the country is much less than the reported figure.

Unfortunately forage and fuel wood is however still considered as low priority products. Moreover, due to the increasing pressure on arable lands for growing food fibre and cash crop to meet the rising needs of human populations, there is no scope for diverting cultivated land for forage or fuel wood production. Alternatively forage and fuel resources have to be developed on marginal and sub marginal lands spreads over 175 m.ha. in arid and semi arid areas. These areas are characterised with erratic monsoon behaviour & soil fertility and moisture are the most important factors limiting crop production. Under these conditions, it is envisaged growing of arable crops/grasses along with suitable tree species simultaneously on the same piece of land provides better land utilization and ensures stable production.

Of the different systems of Agro-forestry "Alley Cropping" (also called hedge row intercropping or avenue cropping) appears to be an appropriate agro-forestry system. The hedgerows are cut back at the planting of annual crops and periodically pruned during cropping to prevent shading and to reduce competition with the associated crops. The hedgerows can grow freely to cover the land when there are no crops (King et al 1984). Trees/shrubs used to form hedge rows should be multipurpose and nitrogen-fixing which could enrich the soil besides providing the pruning for forage green manures. The other desirable characteristics are easily established, wider adaptability, fast growth rate, coppicing habit, quick regeneration after pruning tolerance to disease and pests and aberrant weather conditions. Subabul (*Leucaena leucocephala*) and Shevari (*Sesbania sesbane*) are important multipurpose trees with wide adaptability and potentiality for utilization as alley component in alley cropping system. The regular pruning of hedge row is crucial to reduce competition between trees and crops for sunlight, water and nutrient frequently. The biomass incorporated pruned biomass from *L.leucocephala* and *S.sesbane* into the soil acting as green manure, this enhances soil organic matter and nutrient content particularly nitrogen because *L.leucocephala* and *S.sesbane* are leguminous trees capable of fixing of atmospheric nitrogen, which reduces the need for synthetic nitrogen contributed by these trees.

It is in this context that the present investigation entitled "Evaluation of the relative efficacy of alley species with respect to hedge- row persistency, herbage yield and fuel wood production in Central U.P".

## Method and Materials:

### Description of study Area:

The experiment was conducted during rainy season of 2022 and 2023 where annual crop was grown in association with *L. Leucocephalla* and *S.sesban* at Janta Mahavidyalaya Malgawan Agricultural research farm Ajitmal, Auraiya. The sub humid climate of the area features hot summer, dry winds and humid monsoon season with an average annual rainfall ranges 600-700 mm is usually received from July to Sept. with few showers during winters. The soil at the test site was sandy loam in texture, Ph 7.8, Electrical conductivity of 1.72m.mhos and soil organic carbon of 0.32% with 180kg available N, 18.94kg available P<sub>2</sub>O<sub>5</sub> and 255.43kg/ha available K respectively.

### Experimental Design and Treatment arrangement

In this trial the treatment comprising 2 Alley species, three levels of pruning and three levels of fertility were tested in a split-plot design, keeping Alley species and pruning management in the main plot and fertilizer management in the subplot respectively. Treatment was comprised under

T<sub>1</sub>- A<sub>1</sub>+P<sub>0</sub>+N<sub>0</sub> (No pruning and no application of nitrogen in A<sub>1</sub> *S.sesban* .)

T<sub>2</sub>-A<sub>1</sub>+P<sub>1</sub>+N<sub>1</sub> (P<sub>1</sub>- pruning during crop growth and foliage added to soil also fertilized with 45 kg/ha N in alley species *S.sesban* )

T<sub>3</sub>- A<sub>1</sub>+P<sub>2</sub>+N<sub>2</sub> (P<sub>2</sub>- pruning during crop growth and foliage added to soil also fertilized with 90 kg/ha N in alley species *S.sesban* )

T<sub>4</sub>- A<sub>2</sub>+P<sub>0</sub>+N<sub>0</sub> (No pruning and no application of nitrogen in A<sub>2</sub> alley *L. Leucocephalla* .)

T<sub>5</sub>- A<sub>2</sub>+P<sub>1</sub>+N<sub>1</sub> (P<sub>1</sub>- pruning during crop growth and foliage added to soil also fertilized with 45 kg/ha N in alley species *L. Leucocephalla* spp)

T<sub>6</sub>-A<sub>2</sub>+P<sub>2</sub>+N<sub>2</sub> (P<sub>2</sub>- pruning during crop growth and foliage added to soil also fertilized with 90 kg/ha N in alley species *L. Leucocephalla* )

The experiments were tested in a single split plot design with a 9m×5m plot size and replicated thrice. The alley species sesbania and Leucaena were fertilized @ 20kgN +50 kg P<sub>2</sub>O<sub>5</sub>/ha and no fertilizer was applied to the alley spp. in the subsequent years of the experiment, The alley species seedlings were raised in a poly bag by sowing of two seed in each bag, after 60-65 days seedlings were used for transplanting. During 2<sup>nd</sup> and 3<sup>rd</sup> years of the investigation leaves of lopping of the alley spp. were used as a source of green manure for sorghum. The leaf mass was uniformly mixed into the soil at the time of final tillage operations, 15 days before the sowing of experimental crop. Sesbania and leucaena were established through planted in paired rows on either side of the plots in pits of 40×40×40 cm size maintaining an inter and intra row distance of 75 cm and 50 cm respectively. The crop and alley spp. are irrigated time to time when ever needed, weed management practices were adapted as one mechanical weeding and applied Atrazine @ 0.75 kg ai/ha in 600 liters of water as preemergence.

The Hedgerows of Alley species were pruned during July coinciding with the sowing of sorghum. Leaves are separated from the twigs and component wise weight recorded, the leaves were used for soil application or as forage as per the treatment. Sowing of fodder sorghum was done behind the plough 25cm row apart using a seed rate of 40 kg/ha respectively among the both alley species. Sorghum was fertilized at the rate of 40 kg P<sub>2</sub>O<sub>5</sub> and 30kg K<sub>2</sub>O/ha. Nitrogen as per treatment was applied in the form of Urea.

The observations were recorded of Alley species are germination count, plant height, Collar diameter of the main shoot, number of branches, RGR, Fresh yield of pruning's, Dry matter yield of pruning, Fuel wood and leaf fodder production. Seed production from Alley species and Uptake studies respectively.

### **Result and Discussion:**

The result of experiments have been obtained were considered of practical importance and therefore have been discussed in detail along with the repercussions of weather parameters on growth and development, green forage yield and quality of produce, uptake and production of nutrients for the tree crops *L. Leucocephalla* & *S.sesban* . Next to the genetic constitution environment is the foster factor, which decides the growth and development and failure and success of any crop under field conditions. As is apparent from the result, the weather conditions, on the whole proved quite conducive at the time of seedling in both seasons by having sufficient relative humidity, bright sunshine, mean average temperature and evaporation during both the experimental seasons. The data indicates that the effect of seasons on alley species, comparatively favored by entire cropping seasons in the first season over the second season. Hence it may be asserted that the variations in yield data are not due to season but are due to the treatment effects.

Alley species study depicted in table(No.1&2) reveals that the variation in establishment and persistency(95.46%), tree height(3.14meter), RGR(33.91 kg/ha/day), Fresh yield of pruning(119.59q/ha.), leaf fodder production(68.89q/ha), dry leaf fodder production(17.22q/ha), seed production(11.85q/ha) and crude protein yield were recorded with alley species *L. Leucocephalla* trees and it is more than the *S.sesban* in both the seasons and also on a mean basis. The collar diameter of *S.sesban* trees (26.93cm) was significantly more than the *L. Leucocephalla* in both seasons and also on a mean basis. Similar results reported by **(N.K. et al 2010)**.

*S.sesban* had a greater number of branches (32.85) than *L. Leucocephalla* in both years. In fact, the *L. Leucocephalla* , which is basically in the tree group attains more height and persistency while on the other hand, *S.sesban* a shrub attains less height, more number of branches and more collar diameter. The persistency is very high in *L. Leucocephalla* and *S.sesban* both (table no.1). Table No.3 data reveals that the N, P & k content % and P, K uptake q/ha of s *S.sesban* trees were more than the *L. Leucocephalla* in both the years and on a mean basis. The protein content therefore was also more in

*S.sesban*. The N uptake q/ha of *S.sesban* trees was more than the *L. Leucocephalla* on pooled basis. Here it may be argued that though the foliage production was more in *Leucaena* but the N content was so high in *S.sesban* that *L. Leucocephalla* could not supersede *S.sesban* in N uptake q/ha.

The light interception percent of *Sesbania* trees was more than the percent light interception of *L. Leucocephalla* in both the years and also on a mean basis. It was all because of better canopy of *L. Leucocephalla* which does not allow the light to intercept on the ground. The reverse was true with *S.sesban* in light interception because of its poor canopy. Similar finding recorded by **Bhatia et al (2000)**

### **Effect of Pruning Management:**

Under reference further reveals that the Sorghum crop with both the pruning management had significant variations with most of the characters mentioned earlier, while establishment and persistency due to pruning management were not well marked in both years. Under P<sub>0</sub> (No Pruning), the establishment and persistency were better than both the pruning management and P<sub>0</sub> significantly increased the tree height (4.35m) & The number of branches(33.69) over both the pruning management system in both season. The variation in collar diameter due to pruning management was not well marked in both the years, however both the pruning mgt. Showed more diameter than treatment P<sub>0</sub> in both the years and pooled basis. Here, it may be inferred that under no pruning conditions, the trees will attain more height than the pruned trees. Further, the trees that have been without topped will gain more diameter than the trees where topping/pruning has not been done. As per fact, the seed production would also be higher under no pruning conditions.

Table No.2 data reveals that the Relative growth rate (32.04 kg/ha/day), fresh yield of pruning (112.98q/ha), dry matter yield of pruning (49.91q/ha), fuel wood production (37.12q/ha), leaf fodder production (51.08q/ha) and N,P & K uptake(3.05,0.74 &1.70 q/ha) were found more with treatment P<sub>2</sub>(pruning during crop and foliage used as forage) than P<sub>1</sub> (pruning during crop growth and foliage added to soil) in both the years and also on a mean basis. The seed (production 8.66q/ha) assessed under no pruning conditions was found more in second year than first year. The N, P & K contents were found more with P<sub>0</sub> (no pruning) than both the pruning mgt. in both the years and also on a mean basis. The variations in crude protein content due to *S.sesban* and *L. Leucocephalla* alley species were not well marked in both the season and also on a mean basis. The Alley species crude protein yield q/ha which was assessed under P<sub>2</sub> (Pruning during crop growth and foliage used as forage) was found more in second season than first year. The Pruning management enhanced soil fertility and organic carbon content, with specific regimes favouring growth and nutrient uptake. These findings offer sustainable solutions for fodder shortages and soil health also intensification of planting and contributes Biodiversity conservation and environmental benefits. Results are supported by **Bathia et al (2000) & Devi.S. et al (2020)**

### **Effect of N:**

A look at data presented in table No.1,2 &3 reveals that the variations in germination count, establishment and persistency, tree height (3.16m), collar dia (25.01cm), number of branches, relative growth rate (32.68kg/ha/day), fresh yield of pruning's (114.10q/ha), dry matter yield of pruning's (50.25q/ha), fuel wood production (37.20q/ha), green leaf fodder production (52.02q/ha), dry leaf fodder production (13.05q/ha) and seed production (9.47q/ha) from alley species N,P and K content and its uptake qha<sup>1</sup>, light interception, LER and ATER affected due to deferent N levels and under N<sub>3</sub> (90kg/ha) treatment were recorded higher yield of all parameters in both the seasons. It is an established fact that N in general promotes the vegetative growth of the entire flora may be the herb, shrub and trees. This vegetative growth creates a proper sheet for photosynthetic activity of the plants which in turn, augments the entire process related to development, yield and quality. This is the reason that both the alley species viz. *L. Leucocephalla* and *S.sesban* were favoured by the N in their growth, yield and quality aspects. Similar findings recorded by **Silva et al (2015)**.

### **Conclusion**

In the present situation of the country especially in central part of U.P. whereas population density increases day by day and cultivated area converted into rehabilitation area. As a result, forest area also decreases day by day. Under such condition to maintain food grain production without minimize the forest area, Agro-forestry is proved to be the best option for our present needs. The present study compares the performance of the two alley species i.e., *L.leucocephalla* and *S.sesban* in an Agro-forestry system in two consecutive kharif season, focusing on herbage production, *L.leucocephalla* yielded 119.59q/ha while *S.sesban* excelled 105.01q/ha..Therefore, present study revealed that *L.leucocephalla* fulfils fodder requirement and becomes the best alternative of fodder during shortage of fodder and *S.sesban* fulfils the fuel wood requirement. Both the alley species be pruned prior to crop sowing and pruned material be added to the soil to enhance soil fertility and organic carbon content of soil that favour growth and nutrient uptake.

**Table No.1**

<b>Establishment and Persistency, Tree height in meter and Collar Diameter in cm</b>
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Treatments	Establishment & Persistency %		Tree Height in meter		Collar Diameter in cm	
	2021-22	2022-23	2021-22	2022-23	2021-22	2022-23
Alley species						
Sesbania (A <sub>1</sub> )	98.24	93.24	2.62	3.03	19.60	26.93
Leucaena (A <sub>2</sub> )	98.80	95.46	2.85	3.14	12.69	21.62
Sem±	0.469	0.843	0.060	0.110	0.629	0.551
C.D. at 5%	NS	NS	0.190	NS	1.985	1.739
<b>Pruning Management</b>						
No Pruning(P <sub>0</sub> )	98.61	94.86	4.35	5.61	14.83	24.21
Pruning (P <sub>1</sub> )	98.33	93.31	1.91	1.82	16.33	25.59
Pruning (P <sub>2</sub> )	98.61	93.89	1.96	1.83	17.28	23.03
Sem±	0.574	1.033	0.73	0.135	0.771	0.675
C.D.at 5%	NS	NS	0.233	0.428	NS	NS
<b>N level Kg/ha</b>						
0 (N <sub>0</sub> )	97.64	92.92	2.76	2.94	16.48	23.76
45 kg (N <sub>1</sub> )	98.75	95.00	2.72	3.15	15.98	24.06
90 kg (N <sub>2</sub> )	99.17	95.14	2.73	3.16	15.99	25.01
Sem±	0.663	0.919	0.053	0.083	0.447	0.388
C.D.at 5%	NS	NS	NS	NS	NS	NS

**Table No.2**

**Relative growth rate, Fresh yield of pruning & Dry matter yield q/ha of pruning's, Fuel wood production,**

**Leaf fodder production, Dry leaf fodder production and seed production of Alley species q/ha as influenced by treatments**

Treatments	No. of branches/Tree	Crop growth rate(RGR)Kg/ha/Day	Fresh yield q/ha	Drymatter yield of prunning	Fuel wood production q/ ha	Leaf fodder production q/ha	Dry leaf fodder pro.q/ha	Seed production from alley spp.
<b>Alley Species</b>								
A <sub>1</sub>	32.85	29.72	105.01	50.98	42.55	33.64	8.45	5.48
A <sub>2</sub>	22.85	33.91	119.59	47.41	30.39	68.89	17.22	11.85
Sem±	0.67	-	-	-	-	-	-	-
C.D.at 5%	2.12	-	-	-	-	-	-	-
<b>Pruning Management</b>								
P <sub>0</sub>	33.69	-	-	-	-	-	-	8.66
P <sub>1</sub>	25.28	31.68	111.62	48.70	35.82	51.45	12.88	-
P <sub>2</sub>	24.57	32.04	112.98	49.91	37.12	51.08	12.79	-
Sem±	0.82	-	-	-	-	-	-	-
C.D.at 5%	2.60	-	-	-	-	-	-	-
<b>N level Kg/ha</b>								
0 (N <sub>1</sub> )	28.68	31.27	110.16	44.90	32.38	50.07	12.53	8.54
45 (N <sub>2</sub> )	27.46	32.16	112.63	49.24	36.32	51.71	12.93	7.99
90 (N <sub>3</sub> )	27.40	32.68	114.10	50.25	37.21	52.02	13.05	9.47
Sem±	0.66	-	-	-	-	-	-	-
C.D.at 5%	NS	-	-	-	-	-	-	-

**Table No.3 N,P& K Content, N,P & K Uptake and Green fodder yield q/ha of Sesbania and Leucaena as influenced by Various treatments.**

Treatments	Obtain Content from all pruned material of Alley Species			N, P & K uptake in q/ha			Green Forage yield in q/ha		LER	ATE R q/ha/day
Alley Species	N Content	P Content	K Content	N	P	K	Intercrop	Sole crop		
Sesbania (A <sub>1</sub> )	2.88	1.18	2.08	3.02	1.23	2.19	33.64	71.79	1.23	0.61
Leucaena (A <sub>2</sub> )	2.57	0.15	0.97	3.03	0.18	1.15	68.89	148.98	1.24	0.61
<b>Pruning Management</b>										
P <sub>0</sub>	2.74	0.68	1.53	-	-	-	-	-	-	-
P <sub>1</sub>	2.70	0.67	1.51	3.01	0.74	1.68	51.45	109.35	1.24	0.61
P <sub>2</sub>	2.70	0.66	1.51	3.05	0.74	1.70	51.08	109.55	1.23	0.61
<b>N level Kg/ha</b>										
0 (N <sub>1</sub> )	2.68	0.65	1.53	2.95	0.72	1.66	50.05	107.59	1.24	0.61
45 (N <sub>2</sub> )	2.71	0.66	1.53	3.05	0.74	1.72	51.71	110.62	1.23	0.61
90 (N <sub>3</sub> )	2.74	0.69	1.54	3.12	0.78	1.75	52.02	112.01	1.23	0.61

**Table No.4**

**Available N Kg/ha (0 – 22.5 cm) of Experimental field as influenced by different treatments**

<b>Treatments</b>	<b>After experiment during 2021 - 22</b>	<b>After Experiment during 2022-23</b>	<b>In Kg /ha during 2021 - 22</b>	<b>In Kg/ha during 2022-23</b>
<b>Alley species</b>				
Sesbania (A <sub>1</sub> )	0.097	0.105	194	210
Leucaena (A <sub>2</sub> )	0.093	0.106	186	212
<b>Pruning Management</b>				
P <sub>0</sub>	0.087	0.096	174	192
P <sub>1</sub>	0.095	0.102	190	204
P <sub>2</sub>	0.092	0.096	184	192
<b>N Level Kg/ha</b>				
0 (N <sub>1</sub> )	0.091	0.095	182	190
45 (N <sub>2</sub> )	0.096	0.100	192	200
90 (N <sub>3</sub> )	0.098	0.104	196	208

P<sub>0</sub> – No Pruning

P<sub>1</sub> – Pruning during Crop growth and foliage added to soil

P<sub>3</sub> – Pruning during crop growth and foliage used as for a

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