To evaluate the relative efficacy of Alley Species with respect to hedge-row persistence, herbage yield and fuel wood production.

Abstract

Field experiments were conducted at malgawan Research Farm, Janta mahavidyalaya Ajitmal Auraiya during two consecutive kharif seasons of 2021- 22 and 2022-2023 '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 and Sesbania under Agro-forestry system, Leucaena for herbage production is good and it gives more green fodder yield(119.59q/ha) than Sesbania yielded 105.01q/ha, that fulfils fodder requirement and becomes best alternate of fodder during shortage of fodder. Sesbania for fuel wood production are recommended and yielded 42.55q/ha. that higher than Leucaena. 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_0 (No Pruning), the establishment and persistency were better than both the pruning management and P_0 significantly increased the tree height 4.35meter than P_1 & P_2 1.91 &1.96 meter height respectively. The number of branches was significantly higher in Sesbania with no pruning (33.69) over both the pruning management P_1 & P_2 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 Leucaena under treatment P_2(pruning during crop growth and foliage used as forage) than P_1 (pruning during crop growth and foliage added to soil) with N_2 level of fertilizer than N_0 & N_1 fertilizers level respectively in both years mean basis.

Keywords: Alley species, herbage yield, and fuel wood production.

INTRODUCTION

India is an agricultural based country where ≥70% population lives in villages comprising 105 million farm families. 97 m.ha. is under soil degradation as per ICAR vision2023.Nitrogen fixing trees (NFTs) and shrub in agro-forestry system 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(Bahuguna1985) and Debroy1986 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 are 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

UNDER PEER REVIEW

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 envisages 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 as hedge row intercropping or avenue cropping) appears to be an appropriate agro- forestry system. The hedge rows are cutback at planting of annual crops periodically pruned during cropping to prevent shading and to reduce competition with the associated crops. The hedge rows are allowed to 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's 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 pest and aberrant weather conditions. Subabul (Leucaena leucocephalla)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 leucaena and sesbania into the soil acting as green manure, this enhances soil organic matter and nutrient content particularly nitrogen because leucaena and sesbania 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"To evaluate the relative efficacy of alley species with respect to hedge- row persistency, herbage yield and fuel wood production".

Method and Materials:

The experiment were conducted during rainy season of 2022 and 2023 where annual crop was grown in association with Leucaena and sesbania 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 1.72m.mhos and soil organic carbon of 0.32% with 180kg available N, 18.94kg available P_2O_5 and 255.43kg/ha available K respectively.

UNDER PEER REVIEW

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 main plot and fertilizer management in subplot respectively. Treatment was comprised as under

T_1- A_1 +P_0 +N_0 (No pruning and no application of nitrogen in A_1 Sesbania spp.)

T_2-A_1+P_1 +N_1 (P_1- pruning during crop growth and foliage added to soil also fertilized with 45 kg/ha N in alley species Sesbania)

T_3- A_1+P_2+N_2 (P_2- pruning during crop growth and foliage added to soil also fertilized with 90 kg/ha N in alley species Sesbania)

T_4- A_2+P_0+N_0 (No pruning and no application of nitrogen in A_2 alley Leucaena spp.)

T_5- A_2+P_1+N_1 (P_1- pruning during crop growth and foliage added to soil also fertilized with 45 kg/ha N in alley species Leucaena spp)

T6-A_2+P_2+N_2 (P_2- pruning during crop growth and foliage added to soil also fertilized with 90 kg/ha N in alley species Leucaena)

The experiments were tested in single split plot design with 9m×5m plot size and replicated thrice. The alley species sesbania and leucaena were fertilized @ 20kgN +50 kg P_2O_5/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 polybag by sowing of two seed in each bag, after 60-65 days seedlings were used for transplanting. During 2nd and 3rd 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 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 practice adapted as 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_2O_5 and 30kg K_2O/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

UNDER PEER REVIEW

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 Leucaena & sesbania. Next to 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 the 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 favoured by entire cropping seasons in first season over 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 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 Leucaena trees and it is more than the sesbania in both the seasons and also on mean basis.The collar diameter of sesbania trees(26.93cm) was significantly more than the Leucaena in both the seasons and also on mean basis.

Sesbania was having a greater number of branches(32.85) than Leucaena in both the years. Infact, the Leucaena, which is basically in tree group attains more height and persistency while on the other hand, Sesbania basically being a shrub attains less height, more number of branches and more collar diameter. The persistency is very high in Leuceana and Sesbania. The N, P & k content % and P, K uptake q/ha of sesbania trees were more than the leucaena in both the years and on mean basis. The protein content therefore was also more in sesbania.The N uptake q/ha of Sesbania trees was more than the Leucaena 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 sesbania that Leucaena could not supersede Sesbania in N uptake q/ha.

The light interception percent of sesbania trees was more than the percent light interception of Leucaena in both the years and also on mean basis. It was all because of better canopy of Leucaena which does not allow the light to intercept on the ground. The reverse was true with Sesbania in light interception because of its poor canopy.

UNDER PEER REVIEW

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 the years. Under P_0 (No Pruning), the establishment and persistency was better than both the pruning management and P_0 significantly increased the tree height(4.35m) & number of branches(33.69) over both the pruning management system in both season. The variation in collar diameter due to pruning management were not well marked in both the years, however both the pruning mgt. Showed more diameter than treatment P_0 in both the years and pooled basis. Here, it may be inferred that under no pruning conditions, the trees will attain definitely more height than the pruned trees. Further, the trees who have been without topped will gain more diameter than the trees where topping/pruning has not been done. As per established fact, the seed production would also be more under no pruning conditions.

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_2(pruning during crop and foliage used as forage) than P_1 (pruning during crop growth and foliage added to soil) in both the years and also on mean basis. The seed production(8.66q/ha) assessed under no pruning conditionswas found more in second year than first year. The N,P & K contents were found more with P_0 (no pruning)than both the pruning mgt. in both the years and also on mean basis. The variations in crude protein content due to Sesbania and Leucaena alley species were not well marked in both the season and also on mean basis. The Alley species crude protein yield q/ha which was assessed under P_2 (Pruning during crop growth and foliage used as forage) was found more in second season than first year.

Effect of N:

A look at data presented in table 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^1,light interception, LER and ATER affected due to deferent N levels and under N3(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

UNDER PEER REVIEW

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. Leucaena and Sesbania were favoured by the N in their growth, yield and quality aspects.

Conclusion

Present study reveals that out of the two alley species tested viz. Leucaena and Sesbania under Agro-forestry system, Leucaena for herbage production is good and it gives more green fodder yield that fulfils fodder requirement and becomes best alternate of fodder during shortage of fodder and Sesbania for fuel wood production are recommended. Both the alley species be pruned prior to crop sowing and pruned material be added to the soil increases soil fertility as well as Organic carbon content in soil.

UNDER PEER REVIEW

Table 1 :Establishment and Persistency, Tree height in meter and Collar Diameter in cm						
Treatments	**Establishment & Persistency %**		**Tree Height in meter**		**Collar Diameter in cm**	
Alley species	**2021-22**	**2022-23**	**2021-22**	**2022-23**	**2021-22**	**2022-23**
Sesbania (A_1)	98.24	93.24	2.62	3.03	19.60	26.93
Leucaena (A_2)	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
Pruning Management						
No Pruning(P_0)	98.61	94.86	4.35	5.61	14.83	24.21
Pruning (P_1)	98.33	93.31	1.91	1.82	16.33	25.59
Pruning (P_2)	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
N level Kg/ha						
0 (N_0)	97.64	92.92	2.76	2.94	16.48	23.76
45 kg (N_1)	98.75	95.00	2.72	3.15	15.98	24.06
90 kg (N_2)	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 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.**
Alley Species								
A_1	32.85	29.72	105.01	50.98	42.55	33.64	8.45	5.48
A_2	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	-	-	-	-	-	-	-
Pruning Management								
P_0	33.69	-	-	-	-	-	-	8.66
P_1	25.28	31.68	111.62	48.70	35.82	51.45	12.88	-
P_2	24.57	32.04	112.98	49.91	37.12	51.08	12.79	-
Sem±	0.82	-	-	-	-	-	-	-
C.D.at 5%	2.60	-	-	-	-	-	-	-
N level Kg/ha								

UNDER PEER REVIEW

0 (N_1)	28.68	31.27	110.16	44.90	32.38	50.07	12.53	8.54
45 (N_2)	27.46	32.16	112.63	49.24	36.32	51.71	12.93	7.99
90 (N_3)	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 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**	**ATER q/ha/ day**
Alley Species	**N Content**	**P Content**	**K Content**	**N**	**P**	**K**	**Intercrop**	**Sole crop**		
Sesbania (A_1)	2.88	1.18	2.08	3.02	1.23	2.19	33.64	71.79	1.23	0.61
Leucaena (A_2)	2.57	0.15	0.97	3.03	0.18	1.15	68.89	148.98	1.24	0.61
Pruning Management										
P_0	2.74	0.68	1.53	-	-	-	-	-	-	-
P_1	2.70	0.67	1.51	3.01	0.74	1.68	51.45	109.35	1.24	0.61
P_2	2.70	0.66	1.51	3.05	0.74	1.70	51.08	109.55	1.23	0.61
N level Kg/ha										
0 (N_1)	2.68	0.65	1.53	2.95	0.72	1.66	50.05	107.59	1.24	0.61
45 (N_2)	2.71	0.66	1.53	3.05	0.74	1.72	51.71	110.62	1.23	0.61
90 (N_3)	2.74	0.69	1.54	3.12	0.78	1.75	52.02	112.01	1.23	0.61

Table 4: Available N Kg/ha (0 – 22.5 cm) of Experimental field as influenced by different treatments

Treatments	**After experiment during 2021 - 22**	**After Experiment during 2022-23**	**In Kg /ha during 2021 - 22**	**In Kg/ha during 2022-23**
Alley species				
Sesbania (A_1)	0.097	0.105	194	210
Leucaena (A_2)	0.093	0.106	186	212
Pruning Management				
P_0	0.087	0.096	174	192
P_1	0.095	0.102	190	204
P_2	0.092	0.096	184	192
N Level Kg/ha				
0 (N_1)	0.091	0.095	182	190
45 (N_2)	0.096	0.100	192	200
90 (N_3)	0.098	0.104	196	208

UNDER PEER REVIEW

P_0 – No Pruning
P_1 – Pruning during Crop growth and foliage added to soil
P_3 – Pruning during crop growth and foliage used as fora

References:

AOAC.(1970).*Official methods of analysis*. Association of Official Analytical Chemists, Washington,D.C.

Bahuguna, S.(1985). My life my tree message on world forest Day. Patriot, March22.

Dubois,M.,K.A.Gilles,J.K.Hamilton,P.A.RebersandF.Smith,(1986).Colorimetric method for determination of sugar cane related substances. *Analytical Chemistry*28:350-356.

Tangendjaja,B.,J.B.LowryandR.H.B.Wills.(1986). Change sinmimosine, phenol, protein and fibre content of *Leucaenaleucocephala* leaf during growth and development.*Aust.J.Expt.Agri.*26:315-317.

AICRPDA.(1987), All India Coordinated research project for Dry land Agriculture, main center Rajkot, Annual Report. PP.SA-8.

Atta- krah,A.N.(1989). Availability and use of fodder shrubs and trees in tropical Africa Proc. Workshop on Shrubs and tree Fodder for animals IDRC-276e.140-162.

Balasubramaniam, V. And SekayanngeL,(1991). Effect of free legumes in hedgerows on soil fertility changes and crop performance in semi-arid highlands of Rawanda Biological Agriculture & Horticulture,8:17-32.

Chaturvedi,O.P and Jha,A.N. (1994). Production potential Leucaena leucocephala and intercrops grown under different alley management system in mid Indo- Gangetic plains, range managt. & Agroforestry. 15:93 – 103.

FariaMarmol,J. (1994). Evaluation of accessions of*Leucaena*intheverydrytropicalforestofZuliaState, p.p. 192-201.

Bhatia, K.S. and Kanaujia,(2000). Growth Responses of pearl millet and Barley

UNDER PEER REVIEW

to Leucaena leucocephala based Agroforestry system. C.S.A. University of Agriculture and Technology Kanpur. Indian Journal of Agro Forestry2:33-36.

Burman,D and Gill, A.S.(2001). Alley Cropping system for soil resource management. Indian Grassland and fodder Research Institute, Jhansi, Indian Journal of Agroforestry Vol.3 No.2: 108-119.

Gill. A. S.(2002) Leucaena leaves as a source of manureL.R.R. 5:26.

Shukla N.P, Rekib A, Burman D. (2002) Productivity of Sesbania Alley cropping system with sequently cropped Berseem and maize at different moisture regimes and fertilizers. Tropical Agriculrural Research and Extension 5(1-2).

Tudri.S, Y.Ishi,H. Numaguchi and S.Pransanpainch(2002). The effect of cutting interval on the growth of Leucaena and three associated grasses in Thailand. Trop.Grass/36:90-96.

Krishna,B.E. Allolli T.B. (2005). Influence of cropping system and source of Nutrients in Leucaena based alley cropping system on yield and quality of Tomato. Karnataka Journal Agric. Sci.18 (2): 464-468.

Bhatt,R.K.,T.A.Khan,P.S.PathakandA.K.Mishra,(2006).Sustainable for age production under silvipastoral systems in semi arid conditions.

Zaharah A. R. Chintu R, Ziana,Z. Z. Bah A.R & Rashidah Wak (2008). Management of Agroforestry system for enhancing resource use efficiency and crop productivity. Iana Vienna, ISSN 1011-4289.

Beedy, T.; Snapp, S.; Akinnifesi, F.; Sileshi, G. (2010) Impact of Gliricidia sepium intercropping on soil organic matter fractions in a maize-based cropping system.Agric.Ecosyst.Environ.,138,139–146.

N.K.Jat, Arpan Pandey, ShivaDhar. (2010). Influence of Sesbania green manure with or without wheat residues and N fertilization on Maize- Wheat cropping system. Indian Journal of Agronomy.55(4): 253-258.

UNDER PEER REVIEW

Praveen Jakhar, Dhananjay Barman, Madhu Madiganda(2013). Alley cropping system for natural resource conservation in shifting cultivation degraded lands of EasternGhats. In book Natural Resource Conservation; Emerging issues & future challenges(PP 851-855).

Primo, D.C.; Menezes, R.S.C.; Sampaio, E.V.D.S.B.; Garrido, M.D.S.; Junior, J.C.B.D.; Souza, C.S. (2014). Recovery of N appliedas15N-manureor15N Gliricidiabiomass by maize, cotton and cowpea. Nutrition CycleAgroecosystem,100,205–214.

Martins,J.C.R.;Freitas,A.D.S.D.;Menezes,R.S.C.;Sampaio, (2015) Nitrogen symbiotically fixed by cowpea and Gliricidia in traditional and agroforestry systems under semiarid conditions.Pesquisa AgropecuariaBrasileira. 50,178–184.

Silva, A.R.D.; Collier, L.S.; Flores, R.A.; Santos, V.M.D.; Silva, L.L.D.; Oliveira, V.A.; Barbosa, J.M. (2015).Productive Yield of Cowpea and Maize in Single Crop and Mixtures in an Agro-forestry System.Am.Eur.J.Agric.Environ.Sci.15,85–92.

De Oliveira,V.R.; E Silva, P.S.L.; Pontes, F.S.T.; DePaiva, H.N.; Antonio,(2016) R.P.Growth of Arboreal Legum in ous Plants And Maize Yield In Agroforestry Systems. RevistaÁrvore. 40,679–688.

Burman D Adhikari P.P., Hombegowda H.C., Jakhan P. & Madhu M.(2017). Soil erosion and control and carbon sequestration in shifting cultivated degraded highlands of eastern India, Performance of two contour hedge row system. Agro-forestry System 91(4): 757-771.

Moura-Silva,A.G.;Aguiar,A.D.C.F.;Jorge,N.;Agostini-Costa,T.D.S.;Moura,E.G.(2017). Food quantity and quality of cassava acted by legum in ous residues and inorganic nitrogen application in as oilo flow natural fertility of the humid tropics.Bragantia,76,406–415.

Burman D Adhikari P.P., Hombegowda H.C., Jakhan P. & Madhu M (2018). Soil and onsite nutrient conservation potential of aromatic grasses at field

UNDER PEER REVIEW

scaleunder a shifting cultivated degraded catchment in Eastern Ghat India. Int.Journal of Sediment Research. 191-201

Devi,S., Bharadwaj, K. K.,Dahiya,G. and Sharma,M.K.(2020). Assessment of yield and nutrient uptake of wheat in agri-silvi horticulture system under semi arid region of Haryana. Indian Journal of Ecology,47(3),866-868**.**

UNDER PEER REVIEW