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Intensification of Fodder Productivity through *Melia dubia* based Silvipastoral System

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Abstract:- A field experiment was conducted under the foot hills of ooty at Forest College and Research Institute, Mettupalayam from 2020 to 2022 to estimate the productivity of fodder and legume grasses combination in the existing plantation of *Melia dubia*. Fodder crops viz., CO (BN) 5 grass, Guinea grass CO (GG) 3, Lucerne (*Medicago sativa*), Hedge lucerne (*Desmanthus virgatus*) and *Stylosanthes* were sown in four year old *Melia* plantation as sole crop and in combination. The soil taxonomically belongs to Irugur soil series (Inceptisol soil order). The soil is sandy loam in texture, neutral in soil reaction with a pH range of 6.6 to 7.3 and free from salinity hazards. The trials were laid out in randomized block design and replicated thrice. Results of this experiment revealed that CO (BN) 5 grass along with Hedge Lucerne were found to be compatible under Melia plantation in terms of fodder yield. In addition, the fodder crops grown as inter crops have a beneficial impact on the growth of tree components nitrogen fixation.

Keywords:- *Silvipasture, Melia, Fodder crops, CO (BN) 5 grass, Hedge Lucerne.*

I. INTRODUCTION

Livestock contribution towards food, nutritional and livelihood security to the rural population all over the world is quite enormous. In India, Livestock plays an important role in Indian economy. About 20.5 million people depend upon livestock for their livelihood. Livestock contributed 16% to the income of small farm households as against an average of 14% for all rural households. Livestock provides livelihood to two-third of rural community. It also provides employment to about 8.8 % of the population in India. India has vast livestock resources. Livestock sector contributes 4.11% GDP and 25.6% of total Agriculture GDP (National Accounts Statistics, 2019). India has the largest livestock population in the world with 536.76 million heads during 2019 showing an increase of 4.8% over previous livestock census. Total number of cattle in 2019 is 193.46 million showing an increase of 1.3% over previous census. India is home to 57.3% of world's buffalo population (ranks first) and 14.7% of world's cattle population (second) (20th Livestock Census Report, 2019). This livestock population is expected to grow at the rate of 0.6% in the future. There is currently a net deficiency of 35.6% green fodder, 10.95% dry fodder and 44% concentrate feed materials in the country (IGFRI Vision, 2050). By 2050, the demand for green and dry feed will be 1012 and 631 million tones, respectively. In the year 2050, with the current rate of expansion in forage supplies, there will be an 18.4% deficit in green fodder and a 13.2% shortfall in dry fodder Adopting region specific silvipastoral and hortipastoral models could help to enhance the availability of forages for livestock substantially.Silvipasture is one of the oldest practices of agroforestry which includes the cultivation of forest tree species with fodder crops along with livestock in farm lands. The main objective of this system is to supply food, fuel, fodder and timber for a farming family and to increase the farm income by achieving higher productivity and profitability.

Tree crop selected for silvipastoral system should have the potential of fixing atmospheric nitrogen into the soil and also supply more leaves as fodder to livestock during off season. Besides trees should have small sized leaves so that trees allow more light for the intercrops / fodder crops. Moreover, the tree crop should not compete with the intercrops for resources. For improved efficiency of a silvipastoral system; there should be minimum competition and maximum complementary effect among the components. The success of a good silvipasture system is determined by the selection of appropriate fodder crops such as fodder grasses and legume mixtures suitable to cultivate under the shade of the trees. All the components involved in the system should have complementary effects, wherein the tree crops provide shade and shelter to the farm animals, the fodder crops supply fodder to the farm animals and in turn the farm animals supply organic manure to the trees involved in the system. Shade trees in agroforestry enhance functional biodiversity, carbon sequestration, soil fertility, drought resistance as well as weed and biological pest control.

Melia dubia, belonging to the family meliaceae, found common in moist deciduous forests of Kerala, Karnataka (Nuthan *et al*., 2009), Tamil Nadu (Parthiban *et al*., 2009) Gujarat (Chauhan *et al*., 2018) and is one of the fast-growing

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tree species (Thakur *et al*., 2019). It is also proven to be one of the most compatible agroforestry tree species amenable with different under storey crops (Mohanty *et al*., 2019) with transient or no allelopathic effect on intercrops (Kumar *et al*., 2017; Parmar *et al*., 2019). *Melia dubia* based agro forestry systems have been reported to be profitable than that of monocropping systems (Jilariya *et al*., 2019). Besides as an important industrial tree species, it also has ecological importance like soil enrichment, afforestation and phyto-remediation (Nuthan *et al*., 2009); medicinal uses (Yasodha *et al*., 2011), fruit pulp as livestock feed (Sukhadiya *et al*., 2019). Hence, to increase the productivity of tree fodders, to reduce the gap between demand and supply of green fodders and to utilize the available land between the tree species, Keeping on this in mind a study was taken up to screen out the suitable shade tolerant fodder crops under Melia plantation.

II. MATERIALS AND METHODS

Field experiments were conducted at foot hills of ooty at Forest College and Research Institute, Mettupalayam from 2020 to 2022 to evaluate shade tolerant fodder crops in *Melia dubia* based silvipastoral system. The slips of fodder grasses *viz.*, CO(BN)5 grass and Guinea grass CO(GG)3 were planted and seeds of leguminous fodders viz., Lucerne (*Medicago sativa*), Hedge Lucerne (*Desmanthus virgatus*) and Stylo (*Stylosanthes scabra*) were sown under four-year-old Melia plantation as per the treatment schedule. The treatment schedule includes CO(BN)5, CO(GG)3, lucerne, hedge Lucerne and stylo as single crop with Melia and CO(BN)5 + lucerne, CO(BN)5 +hedge Lucerne, CO(BN)5 + stylo, CO(GG)3 + Lucerne, CO(GG)3 + hedge lucerne and CO(GG)3 + stylo as combination in 3:1 ratio and one control plot without any intercrops was maintained. The soil was taxonomically belongs to Irugur soil series (Inceptisol soil order). The soil is sandy loam in texture, neutral in soil reaction with a pH range of 6.6 to 7.3 and free from salinity hazards (Table 1). The soil fertility rating revealed that the soil is low in alkaline $KMnO_4$-N (215 kg ha^{-1}) and Olsen- P (9.6 kg ha^{-1}) and medium in Neutral Normal NH_4OAc-K (229 kg ha^{-1}). The lower horizon contains quartz layer, kankar nodules and iron concretion. The soil is highly permeable. The clay mineral is kaolinite type.

The trial was laid out in randomized block design with three replications. The spacing followed in *Melia dubia* plantation was 4m x 4m. CO(BN)5 and CO(GG)3 grasses were planted at a spacing of 50 cm x 50 cm, hedge lucerne was sown at 50 cm x solid row, lucerne was sown at 25 cm x solid row and Stylo was sown at 35 cm x 15 cm. Plot size is 3m x 4 m. The space in between the tree (*Melia*) is utilized for planting intercrops in 6 months. For observing the height of Melia, tree altimeter was used and for recording the GBH, The fodder crops were harvested using sickles 5 cm above the ground leaving the stubbles for re growth and the fodder yield was recorded. The harvesting of fodder crops was done for every 4 months intervals. The green fodder yield was recorded in kg per plot (12 m^2) and then converted to tons per hectare. The sale price of TNAU for grass fodder was Rs. 2500 per ton and leguminous fodder was Rs. 4500 per ton and this was followed for calculating the income of the fodder crops. The recorded data were analyzed statistically by following the procedure given by Panse and Sukhatme (1978) to find out the significance of the treatments.

III. RESULTS AND DISCUSSION

- *Fodder productivity in Melia based silvipastoral system*

Data on the yield and income of fodder crops are presented inTable 1. The analyzed data of fodder yield revealed that there were significant differences among the treatments. During the first year, maximum green fodder yield of 80.8 tons per ha was recorded from CO (BN) 5 grass + hedge lucerne combination which was significantly superior to other fodder crops. Similarly, during the second year the CO (BN) 5 grass +Hedge lucerne combination gave a higher yield of 111.8 tons per ha but was statistically at par with CO (BN) 5 grass + *Stylosanthes* (100 tons per ha). The higher fodder yield in these combinations might be due to the contribution of nitrogen fixation by leguminous fodders viz., hedge Lucerne and stylo and also the fodder yield of both the fodder crops were included in combination. This fodder combination was followed by CO (BN) 5 grass as sole crop during both the years. Similar finding of higher green fodder yield in BN hybrid + legume fodder combination was observed by Thomas *et al.*2021. Even though the fodder yield of CO (BN) 5 grass has higher under Melia based Silvipastoral system, the maximum yield potential of CO (BN) 5 grass was not attained under the system possibly due to the shade of Melia. Similar finding was reported by Singh and Oraon. (2017) who observed that the crop yield under silvipastoral systems was invariably affected by the shade of the trees in tree-crop combination but the resource use efficiency was better under trees than in open condition. However, on a system basis, the productivity of the combination is observed to be more than sole cropping.The fodder yield obtained from Lucerne was significantly very low when compared to other fodder crop which was due to severe weed infestation of Cuscuta during both the years. The weed dodder (*Cuscuta campestris*), the most damaging annual obligate stem parasite causes a serious problem in forage legumes like lucerne (*Medicago sativa* L.) and Egyptian clover (*Trifolium alexandrinum* L.) (Dawson *et al*., 1994).Crop yields can be significantly reduced as it parasitizes and shades out the host plants. Plants infested with field dodder gradually weaken, their lush growth dwindles and they have very small vegetative and generative yield (Fathoulla and Duhoky, 2008).Regarding the income obtained from the fodder crops, CO (BN) 5 grass + Hedge Lucerne.

Combination gave the highest income of Rs.2, 43,400 per ha and Rs. 3, 20,900 per ha during the first and second year respectively which was significantly higher than other fodder crops. The lowest income was obtained from Lucerne sole crop. In an agro forestry system, agricultural crop

production is invariably lower due to competition with trees, but biomass production is adequately compensated due to the overall productivity (tree+crop) which is generally greater than sole agricultural system (Newaj *et al.*, 2003). The reduction in crop yield under agro forestry systems can be attributed to competition for the light, water, nutrients and allelopathic effect *etc*. The competition may be interspecific or intraspecific (Carnell 1990).

- *Effect of fodder crops on growth of Melia dubia*

The growth parameters of *Melia dubia* (main crop) are presented in Table 2. The data revealed that the growth parameters (height and GBH) of Melia were not significantly influenced by the intercrops throughout the study period. However, height as well as GBH was found to be higher with Melia + fodder crops when compared to sole crop of Melia. Better growth performance of *Melia dubia* under silvipastoral system might be due to better nutrient availability through Nitrogen fixation by leguminous fodder crops, lower weed growth, nutrient recycling, and better moisture conservation and higher microbial activity in the soil due to larger organic carbon content obtained from the biomass of the intercrop. This shows that there was a beneficial effect due to the fodder crops on the growth of *Melia dubia*. Similar findings of higher growth performance of Melia with Pasture crops were reported by Prajapati *et al.*, (2020), Thakur *et al.*, (2019) and Jilariya *et al.*, (2019

IV. CONCLUSION

The results obtained from this study revealed that CO (BN) 5 grass along with Hedge Lucerne were efficient shade tolerant fodder crops under *Melia* plantation which contributed higher green fodder yield and income. In addition, the fodder crops grown as inter crops contributed for beneficial impact on the growth of trees. Therefore, based on the observed benefits reported in the present study, Melia based silvipasture model could be adopted profitably by small and marginal farmers without deteriorating soil health and the environment.

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Table 1. Soil Parameters and Chemical Properties of experimental soil

Parameter	Depth (cm)	
	0-15	**15-30**
Soil textural analysis		
Sand (%)	73.03	73.21
Silt (%)	21.22	21.45
Clay (%)	3.17	2.65
Textural class	Sandy loam	Sandy loam
Bulk density (g/cm^3)	1.42	1.41
Particle density (g/cm^3)	1.79	1.74
Porosity (%)	20.76	18.71
Water holding capacity (%)	20.88	20.46
Chemical properties		
Soil reaction (pH)	7.54	Jackson (1973)
Electrical conductivity (dS m^{-1})	0.19	Jackson (1973)
. Organic carbon (%)	0.402	Walkley and Black (1934)
Available nitrogen (kg ha^{-1})	215	Subbiah and Asija (1956)
Available phosphorus (kg ha^{-1})	9.6	Olsen *et al.* (1954)
Available potassium (kg ha^{-1})	229	Stanford and English (1949)

(Mean of two years)

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Table 2: Yield of fodder crops (inter crops) in *Melia* based silvipastoral system at Mettupalayam, Tamil Nadu.

Treatments	Fodder yield (tons ha^{-1})		Income in Rs.		Mean	
	2020	2021	2020	2021	Fodder yield	Income (tons ha^{-1})
T_1 - CO(BN)5 grass	68.50	98.00	171250	245000	83.25	208125
T_2 - GG CO(GG)3	19.30	47.40	48250	118500	33.35	83375
T_3 - Lucerne (L)	2.80	2.40	12600	10800	2.60	11700
T_4 - Hedge lucerne (HL)	20.70	31.30	93150	140850	26.00	117000
T_5 - Stylosanthes (Stylo)	18.90	24.30	85050	109350	21.60	97200
T_6 - CO(BN)5 + Lucerne	53.90	93.60	140350	239600	73.75	189975
T_7 - CO(BN)5 + HL	80.80	111.80	243400	320900	96.30	282150
T_8 - CO(BN)5 + Stylo	57.70	100.00	182050	287800	78.85	234925
T_9 - CO(GG)3 + Lucerne	15.20	31.30	43600	84850	23.25	64225
T_{10} - CO(GG)3 + HL	28.19	47.36	111890	133340	37.79	122615
T_{11} - CO(GG)3 + Stylo	26.10	57.90	103050	169050	42.00	136050
T_{12} - Control (*Melia dubia* alone	0.00	0.00	0.00	0.00	-	-
SEd	3.90	6.41	11994	17957	-	-
CD (p= 0.05)	8.37	13.75	25726	38519	-	-

Note: Sale price of grass fodder = Rs. 2500/ton and sale price of legume fodder = Rs.4500/ton

Table 3: Growth parameters of *Melia dubia* (Main crop) in the Melia based silvipastoral system at Mettupalayam, Tamil Nadu

Treatments	2020		2021		Mean	
	Height (M)	GBH (Cm)	Height (M)	GBH (Cm)	Height (M)	GBH (cm)
T_1 - CO(BN)5 grass	6.38	20.91	6.80	20.46	6.59	20.69
T_2 - GG CO(GG)3	6.27	23.37	6.26	20.78	6.27	22.08
T_3 - Lucerne (L)	6.49	24.67	7.02	23.74	6.76	24.21
T_4 - Hedge lucerne (HL)	6.93	24.30	7.24	22.68	7.09	23.49
T_5 - Stylosanthes (Stylo)	5.61	25.43	6.59	24.27	6.10	24.85
T_6 - CO(BN)5 + Lucerne	6.27	26.56	6.70	20.67	6.49	23.62
T_7 - CO(BN)5 + HL	7.04	28.16	7.88	24.91	7.46	26.54
T_8 - CO(BN)5 + Stylo	6.49	26.93	7.56	24.49	7.03	25.71
T_9 - CO(GG)3 + Lucerne	6.38	29.03	6.59	23.43	6.49	26.23
T_{10} - CO(GG)3 + HL	5.94	28.44	6.69	24.05	6.31	26.23
T_{11} - CO(GG)3 + Stylo	5.94	30.45	6.26	20.78	6.10	25.62
T_{12} - Control (*Melia dubia* alone	6.16	30.71	6.26	18.34	6.21	24.53
SEd	0.63	2.53	0.74	2.21	0.65	2.45
CD (p= 0.05)	NS	NS	NS	NS	NS	NS