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EFFICACY OF OAT, BERSEEM AND LUCERNE UNDER SUBABUL (*LEUCAENA LEUCOCEPHALA*) AND POPLAR (*POPULUS DELTOIDES*) BASED SILVOPASTORAL SYSTEM

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ABSTRACT

Silvipastoral system is emerged as an important component in climate-smart agriculture, provide a wide range of products and services that can substitute for each other and, in the right circumstances, can be produced synergistically. Intercropping of legumes, cereals and fodder crop is a promising theme in silvi-pastoral system for its potential for increasing and stabilizing yields, reducing grazing pressure, sustaining tree health and increasing self-sufficiency with fodder is in agreement with the principles of agroforestry. The present investigation was carried out at Allahabad, India during the year 2013-14 in order to find the efficacy of fodder crops grown under Subabul and Poplar based silvo-pastoral system. Three fodder crops *viz., Avena sativa L.* (Oat), *Trifolium alexandrinum L.* (Berseem) and *Medicago sativa L.* (Lucerne) were shown under five years old plantation tree species *viz.*, P*opulus deltoides* ,*Leucaena leucocephala* under silvopastoral system and open field condition. The experiment was laid out in 3 x 3 Factorial Randomized Block Design (FRBD) with three replications. Significantly maximum fresh and dry weight of fodder crops per plant and per hectare were recorded under T_0 (open field condition) while higher height was observed under T_1 (Subabul).In open field condition maximum fresh and dry weight and fresh weight per hectare were recorded in Oat followed by Berseem and Lucerne. Under intercrops maximum fodder yield (68.31t / ha) was recorded in treatment T_1C_1 (Oat grown under Subabul) while minimum fodder yield (51.55 t / ha) by T_2C_2 (Lucerne grown under poplar).

INTRODUCTION

An efficient agroforestry system would aim at systematically developing integrated land use systems and practices where the positive interaction between trees and crops are encouraged and maximized. This seeks to achieve a more productive, sustainable and diversified output from the land as compared to the conventional mono-cropping system. The farmers, mainly due to the economic benefits to them have adopted the trend of growing trees around agricultural land. But it will be worthwhile to work out an integrated approach with the help of agricultural and forestry scientists, depending on the suitability of crops and locations. There fore, there is a great need to identify the suitable agricultural, fodder and horticultural crops, which can grow well along with tree plantation with limited solar energy available underneath the trees.

The choice of intercrop is important as the economic returns depend on particular tree species (root system, canopy, allelopathy effect of litter *etc.*) though the choice is also determined by the technical factors like agro-climatic and edaphic conditions. Agroforestry system with judicious mixing of crop, trees and grasses meet all basic requirements of mankind and his livestock. Tree species significantly influenced the grass yield. Grass yield was 22% and 49% greater with Z. mauritiana than Acacia nilotica and Ailanthus excelsa, respectively. This may have been caused by deeper tree root systems that competed less with the grass for nutrients and water. Trees can serve as a pump, absorbing nutrients at some depth and depositing them at the surface (Sharma *et al*., 1990).Subabul (*Leucaena leucocephala)* belongs to the family Leguminosae and sub-family Mimosaceae, it is also known as 'miracle tree' due to its paramount economic importance. Its common name is ipil-ipil (Philippines). It is a fast growing thornless, evergreen leguminous woody perennial. It is a native of southern Mexico (region of Chimps and Yucatan) has been introduced in many countries of the world. It is capable of growing in diversified agro-climatic conditions of tropical region. The soil nutrient *i.e.* carbon, nitrogen, phosphorus and potassium content under tree plantation are higher as compared to open condition (Singh and Lal, 1969). The increase in yield under agri-silviculture system can be attributed to the high amount of nutrients added to the soil through leaf litter of trees (Agarwal and Lahiri, 1980). In India, the poplar is grown commercially by farmers, mainly in the Punjab region. Poplar is a very prominent taxonomical group of tree species in plantation forestry in India. The most common use of poplar is in plywood.

Intercropping of legumes, cereals and fodder crop is a promising theme in silvi-pastoral system for its potential for increasing and stabilizing yields, reducing grazing pressure, sustaining tree health and increasing self-sufficiency with fodder is in agreement with the principles of agroforestry. India carries a huge livestock population consisting of cattle, buffalo, sheep, goat, horses and ponies, mules, donkeys, camels, mithun and Yak in the country is 512.05 million numbers in 2012. India has the largest cattle inventory in the world followed by Brazil and China and accounts 31% of total cattle (FAS/USDA, 2016). Animal performance basically depends on factors that influence animal requirements and feed utilization (Das *et al*,. 2014). Small ruminants, namely, goats and sheep, play a vital role in securing the livelihood of small and marginal farmers and landless laborers. Such animals should not be blamed for the ecological degradation, soil erosion and desertification caused by human activities. Inadequate and seasonal production of fodder is serious drawback of livestock production system in Uttar Pradesh. There is an acute shortage of livestock feeds and fodders in India, and also a large gap between needs and availability, is major challenge to overcome quality and quantity fodders. The feeds and fodders available on community grazing land, on the roadside and in forests during the rainy season should be harvested and utilized during the scarcity period.

There is great opportunity of fodder production system in Uttar Pradesh due to adaptability of silvi-pastoral system under varying range of soil. Poplar and Subabul is fast growing tree getting popularity among the farmers due to its high value utility and fodder value. Silvi-pastoral system is considered as an important tool for acceleration of fodder diversification in India by promoting livestock, food and nutritional security, income and employment generation, poverty alleviation, judicious use of natural resources and ecological management in our country. The extensive system of livestock rearing should be replaced with semi-intensive and intensive systems for commercial milk and meat production. Green fodder play crucial role in dairy management and required for sustainability as well as productivity (Gupta *et al.,* 2007). Fodder and feed are the major inputs in animal production especially in milch animals, which accounts for about 60 to 70 % of total cost of milk production. The milk production can be easily increased by adequate supply of nutritious feed and fodder (Verma *et al., 2016*). There is no scope to increase area under fodder crops. Under such situation, adoption of improved package of practices (Kumar, 2012, Kumar, 2013, Kumar, 2014a and Kumar, 2014b) intensive crop rotation, inclusion of short duration crops in existing rotations of grain, fodder and cash crops and better agronomic practices have great significance. Similarly development and enhancement of bamboo cultivation can promotes economic and environmental growth, mitigates deforestation and illegal logging, prevent soil degradation and restores degraded lands in both village as well as urban area of India (Pathak *et al.*, 2016). Consistent shade environment affects quality and yield of fodder which also causes poor adaptability under silvi-pastoral system. Keeping this view the present study was design to evaluate the performance of different fodder crop as well as to quantify the yield and quality of fodder under poplar and Subabul based silvi-pastoral system in Uttar Pradesh, India.

MATERIALS AND METHODS

The investigation was carried out in central region of Uttar Pradesh during 2013-14 for screening the different fodder crop to find the association between morphological parameter and yield attribute under silvo-pastoral system. The experimental site is at elevation of 98 m above sea level at 28.87º N latitude and 81.15º E longitude. The characteristics of the soil are sandy loam in order to Inceptisol soil. The research area has a sub-tropical climate with extremes of summer and winter. During the summer season, the temperature reaches upto 46-48ºC, while during winter season, especially in the month of Nov. and Jan. temperature drops down to as low as 1-20ºC. During winter, frost and during summer, hot scorching wind are common features. The average rainfall in this area is around 882 mm, during the monsoon *i.e.* June to Sept, with a few occasional light showers and drizzles are seen in the winter also. The data on plant height (cm), dry weight of plants (kg) and fodder yield were recorded. Fodder yield was recorded by multiple harvesting of crops at different intervals and workout on hectare basis (kg/ha). Dry matter yield was determined by drying herbage yield samples of different fodder in a forced drought oven at 70ºC for 24 Hours to constant weight. The experiment was laid out in (3x3) factorial design with three replications. The data collected were subjected to statistical analysis appropriate to the design and significance of different sources of variations was tested by Fisher's and Yate's F-test at probability level of 0.05 (Chandel, 1984).

RESULTS AND DISCUSSION

The results of the experiment have been presented in tables and graphically illustrated through bar-diagrams, wherever required, and discussed in the light of the findings reported by earlier researchers. The observations were recorded under the following parameters.

The analysis of variance revealed significant differences among different treatment combination. A wide range of variations among the different combination of fodder crops and silvi-pastoral system in respect fresh and dry yield of fodder were

Table 1: Plant height (cm) of fodder crops under different agroforestry models at different intervals

	15 DAS				30 DAS			
Agroforestry model (T)	Crops (C) C_1(Oat)	C_2 (Lucerne)	C_3 (Berseem)	Mean (T)	Crops (C) C_1(Oat)	C_2 (Lucerne)	C_3 (Berseem)	Mean (T)
T_0(Open field)	25.64	21.81	23.37	23.61	42.33	35.53	38.7	38.86
T_1(Subabul)	18.96	16.35	17.44	17.58	31.8	27.13	28.93	29.29
T_2(Poplar)	15.31	13.72	14.09	14.38	25.4	22.73	23.47	23.87
Mean (C)	19.97	17.29	18.3		33.18	28.47	30.37	
	F-Test	S. Ed. (±)	C. D. (P=0.05)		F-Test	S. Ed. (±)	C. D. (P=0.05)	
Agroforestry model (T)	S	1.02	2.17		S	0.46	0.98	
Crops (C)	NS	-	-		S	0.46	0.98	

Table2 : Fodder yield per hectare (t ha^{-1}) of fodder crops under different agroforestry models.

Agroforestry model (T)	Crops (C)		
	C_1 (Oat)	C_2 (Lucerne)	C_3 (Berseem)
T_0(Open field)	86.13	77.44	83.23
T_1(Subabul)	68.31	61.80	66.18
T_2(Poplar)	57.71	51.55	54.05
	F-Test	S. Ed. (±)	C. D. (P=0.05)
Agroforestry model (T)	S	0.43	0.91
Crops (C)	S	0.43	0.91
Interaction (T x C)	S	0.74	1.58

recorded. It revealed that yield was mainly contributed by plant height and crops itself. This yield attributes are influenced by morphological characters like height, primary branches and thickness of plant parts.

Plant height (cm)

The plant height as influenced by agroforestry models, fodder crops and their interaction, recorded at 15, 30, 45 and 60DAS is presented in Table 1. Effect of different agroforestry models was significant at 15 DAS, while the effect of crops and interaction between agroforestry models and fodder crops were non-significant. At 30, 45 and 60DAS, plant height was, however, significantly influenced by agroforestry models, fodder crops and their interaction. At 15 DAS, maximum plant height (23.61 cm) was recorded in open field (T_0) followed by 17.58 cm withT1 (Subabul based agroforestry system).T_2 (Poplar based agroforestry system) recorded the minimum (14.38 cm). Fodder crop Oat (C_1) recorded maximum plant height (19.97 cm) followed by 18.30 cm with C_3 (Berseem) and the minimum (17.29 cm) was found with C_2 (Lucerne).

Treatment combination T_0C_1 (fodder crop Oat in open field) recorded maximum plant height (25.64 cm) followed by 23.57and 21.81cm with T_0C_3 (fodder crop Berseem in open field) and T_0C_2 (fodder crop Lucerne in open field) respectively, whereas, the minimum (13.72 cm) was found with T_2C_2 (fodder crop Lucerne under Poplar based agroforestry system). Similar trend was observed at 30,45and 60 DAS. Maximum plant height at 30DAS (38.86 cm) was recorded in T_0 (open field) followed by 29.29 cm withT_1 (Subabul agroforestry model).Poplar based agroforestry system (T_2) recorded the minimum plant height (23.87 cm). C_1 (fodder crop Oat) recorded maximum plant height (33.18 cm) followed by 30.37 cm with Berseem (C_3) while Lucerne (C_2) recorded the minimum (28.47 cm).

Combination ofT_0C_1 (fodder crop Oat in open field) recorded maximum plant height (42.33 cm) followed by 38.70and 35.53cm with T_0C_3 (Berseem in open field) and T_0C_2 (Lucerne in open field) respectively. The minimum (22.73 cm) was recorded with T_2C_2 (Lucerne under Poplar based agroforestry system). T_1C_2 (Lucerne under Subabul agroforestry models), T_2C_2 (Lucerne under Poplar agroforestry models); and T_2C_2 (Lucerne under Poplar agroforestry models), T_2C_3 (Berseem under Poplar agroforestry models) were statistically at par.

The fodder yield per hectare due to agroforestry models, fodder crops and their interaction is presented in Table: 1. The differences in the fodder yield per hectare as influenced by agroforestry models; crops and their interaction were significant and maximum fodder yield (82.27t ha^{-1}) was obtained in open field (T_0) followed by Subabul agroforestry (T_1) model (65.43 t ha^{-1}) while the minimum (54.44 t ha^{-1}) was recorded under Poplar trees (T_2). Fodder crop Oat (C_1) recorded maximum fodder yield (70.72 t ha^{-1}) followed by Berseem (C_3) (67.82 t ha^{-1}) and the minimum (63.59 t ha^{-1}) remained with Lucerne (C_2).

Interacting treatment combination T_0C_1 (fodder crop Oat in open field) recorded maximum fodder yield (86.13 t ha^{-1}) followed by 83.23 t ha^{-1} with T_0C_3 (fodder crop Berseem in open field) and 77.44 t ha^{-1} with To C_2 (fodder crop Lucerne in open field), whereas, the minimum (51.55 t ha^{-1}) was recorded with T_2C_2 (fodder crop Lucerne under Poplar trees).

Dry weight of plants per hectare

The dry weight of plants per hectare under different agroforestry models, fodder crops and their interaction is presented in Table- 3. The differences in the dry weight of plants per hectare as influenced by agroforestry models, crops and their interaction were significant. Plants in open field (T_0) recorded maximum dry weight per hectare (10.36 t ha^{-1}) followed by 8.24 t under Subabul trees (T_1) and the minimum (6.86 t ha^{-1}) remained under Poplar agroforestry model (T_2). C_1 (fodder crop Oat) recorded maximum dry weight of plants per hectare (8.90 t ha^{-1}) followed by C_3 (Berseem) (8.54 t ha^{-1}).The minimum (8.02 t ha^{-1}) was recorded with C_2 (Lucerne).

As a result of interaction, treatment combination T_0C_1 (fodder crop Oat in open field) recorded maximum dry weight of plants per hectare with 10.85 t ha^{-1} followed by T_0C_3 (fodder crop Berseem in open field) with 10.47 t ha^{-1} and 9.77 t ha^{-1}with ToC_2 (fodder crop Lucerne in open field), whereas, the minimum (6.49 t ha^{-1}) was recorded with T_2C_2 (fodder crop Lucerne under Poplar trees).

Dry weight of plants per hectare was commensurate with the fresh weight and of plant and fodder yield. Dry weight of plants per hectare was much higher in open field as compared to Subabul and Poplar agroforestry systems. Higher dry weight of plants per hectare was recorded in Oat than the Lucerne and Berseem crops under Subabul and Poplar trees. This might be due to more competition for sunlight under tree as compared to open condition. Reduction in fodder yield under silvipastoral system is greatly influenced by photosynthetic activity. Moreover, this might be due to addition of nutrients which improved the physical, chemical and biological properties of soil and this leads to improve the root growth and development and thereby uptake of nutrients and water from soil volume resulting in increased yield.

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