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Performance of Arbi (*Colocasia esculenta*) under *Eucalyptus tereticornis*-based Agroforestry System in Plains of Chhattisgarh

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ABSTRACT: The experiment was carried out at Herbal Garden of Indira Gandhi Krishi Vishwavidyalaya, Raipur (C.G.) during July 2019 to March 2020. The objectives of experiment were, to study the effect of Eucalyptus (*Eucalyptus tereticornis*) on growth and yield behaviour of two varieties of Arbi (*Colocasia esculenta*) and to study the growth behaviour of Eucalyptus tree under Agroforestry System. For this study, the suitable experimental design was laid out on Factorial Randomize Block Design (RBD) with 2 varieties (Indira Arbi-I and Arbi CG–II). Wherein two Treatments and five Replications were carried out on the field. The treatments were used T_1 (RDF), & T_2 (no fertilizer). Important challenges faced during experiment were reduced rate of transpiration, higher relative humidity under the tree canopy and effective utilization of PAR to achieve sufficient production of photosynthate throughout the growth stages of under storey crops. The analyzed results showed that the RDF application gave greatest yield (corm weight per plant, number of cormel per plant, cormel diameter, fresh & dry weight). The fresh yield of colocasia obtained from eucalyptus-based agroforestry system with use of fertilizer is 118.66 qha^{-1} and without fertilizer 103.12 qha^{-1} which reduced, by 12.06 % with statistically significant variation. In case of variety fresh yield Indira Arbi-I (114.286 qha^{-1}) was obtained higher as compared to fresh yield of Arbi CG-II (108.19 qha^{-1}). The height of *Eucalyptus tereticornis* was 21.58 m ± 2.84 before sowing of colocasia crop which increased by 0.69 m with MAI of 1.06 m while diameter at breast height of *Eucalyptus tereticornis* was 25.75 cm ± 1.91 before sowing of colocasia crop which increased by 0.67 cm with MAI 1.25 cm of twelve month of growth period.

Keywords: Agroforestry system, Intercropping, Alley cropping, Arbi (*Colocasia esculenta)*, Eucalyptus *(Eucalyptus tereticornis)*.

INTRODUCTION

Agroforestry is an integrated land-use system approach (Aryal *et al*., 2019), different from the sum of its two major components, *viz.*, agriculture and forestry (Nair *et al*., 2021). It is a land management system that involves deliberate retention, introduction, or incorporation of trees or other woody perennials in crop or animal production fields to benefit from the resultant ecological and economic interactions (Nair, 1992). The specific advantages of this system can be environmental, social and economic (Wato and Amara 2020). Due to overexploitation, unscientific collection, and illegal export, the genetic resources of valuable crops are getting exhausted very fast. The crops are being cultivated along with the trees under agroforestry systems to overcome this situation (Elevitch *et al*., 2018).

Agroforestry is very important tool for successful management of resources and to satisfy humen needs, and maintaining or enhancing the quality of environment and conserving natural resources. Wide-spread utilization of Agroforestry concept and techniques offers great potential for helping to reduce critical shortage of fuel wood and contributing to sustainable farming systems. Agroforestry occupies 25.32 million hectares (mha) or 8.2% of the total geographical area in India (Dhyani and Handa 2013) and its area is expected to increase after the implementation and adoption of National Agroforestry Policy, 2014.

Intercropping is a beneficial system of crop production aimed at maximizing production and profits over space and time (Machado, 2009; Manjunath *et al.*, 2018). Intercropping is a system that focuses on better exploitation of sunlight, effective utilization of nutrients and water, risk reduction and higher exploration of the growth factors from the environment (Awal *et al.*, 2006; Gao *et al.*, 2009; Mobasser *et al.*, 2014; Ajibola and Kolawole 2019).

Eucalyptus' is one of the most planted woody tree species in world. Eucalyptus belongs to family Myrtacea, native to Australia, and adopted to many different habitats. It is fast growing and easy to care. Eucalyptus is perennial and evergreen tree, which is widely utilized in the 'Agroforestry' program (Raj *et al.,* 2016). The wood of Eucalyptus is resistant to termites as well as dry rot so its wood is known for durability and considered valuable timber for construction purposes. The trees are also used as windbreak and shelterbelts in the farm. The tree has also put for extracting several important wood products such as tans, essential oils, resins etc.

Colocasia is originated in South Central Asia, probably in India or Malaysia. It is cultivated mainly in developing countries, rarely on large plantation but cultivated in small farms with little technology. Colocasia is herbaceous plant, having height up to 2 m and have underground tuber. Root system of colocasia is fibrous and shallow. Colocasia is also a good source of riboflavin, thiamine, iron, P & Zn and a very good source of, vitamin B3, vitamin B6, vitamin C, copper, potassium and manganese etc. (Quach, 2003).

Das *et al.* (2011) reported the intercropping of turmeric, ginger and arbi developed under six-year-old Emblica orchards showing a distance of 6m was conducted during 2007-2010. Economic analysis of the B: C ratio structures showed that the maximum value of *Emblica officinalis* + *Curcuma longa'* was (6.29) accompanied by *"Emblica officinalis* + *Zingiber officinale'* (3.44) and '*Emblica officinally*- Colocasia esculenta' (3.20).

Puiatti *et al.* (2015) studied intercropping of taro and sunhemp and observed that production of classes of rhizomes of taro and chemical changes in the soil. The cuttings after 105 Days after Sowing gave less mass production of primary and secondary rhizomes number per plant of large and commercial cormels as compared to the control. Pruning at canopy height at 135 and 165 DAS provided the maximum amounts of fresh and dry mass of sunnhemp, organic carbon and nutrients. At 165 DAS, the contribution of N to the soil by sunnhemp cutting reached 308 Mg /ha and by sunnhemp pruning was 202 kg /ha The intercrop of sunnhemp with taro is viable, with management of the intercropping indicated up to 105 DAS of sunnhemp.

MATERIAL AND METHODS

The experiment was carried out at Raipur, which is located in the South- Eastern part of Chhattisgarh. With 21°.23′39.77″N latitude and 81°.69′44.30″E longitude and having an altitude of 295m above mean sea level.

The Experiment was started in month of July 2019 and crop was finally harvested in March 2020. The experiment was laid out in a Factorial Randomized Block Design with two varieties and two treatments. Eucalyptus trees were spaced at 6m × 6m, In between the eucalyptus trees, two variety- V_1 (Indira Arbi-I) & V_2 (Arbi CG-II) of colocasia was intercropped at spacing 50cm × 30cm. Fertilizer were added in three split doses, as a basal dose half of the nitrogen (N) & potassium (K) and full phosphorus were applied in the field. After that remaining nitrogen and potassium fertilizer is applied in two split. One fourth is applied in 30 DAS and again one fourth is applied in 60 DAS. Crop was irrigated immediately after the sowing to obtain better germination. Afterward irrigation was given as per requirement according to field moisture and seasonal rains.

The soil of experimental field was black clayey soil which belongs to the order Vertisols and it is locally known as Kanhar. The soil of experimental site was very rich in organic carbon and other nutrient because of the addition of litter in the soil every year.

Statistical analysis. The data of all parameters of Colocasia collected precisely was tabulated, computed and statistical analysis done by using word-excel spreadsheet a open factorial randomize block design. The growth parameters data of eucalyptus height and DBH were summarized with standard deviation and presented

Microclimatic observations. The Microclimatic observation were recorded every fifteen days interval, by using Digital Hygrometer and Digital Thermometer are used respectively at three different timings in *i.e.* Morning, Noon and Evening hours in each plot of colocasia crop.

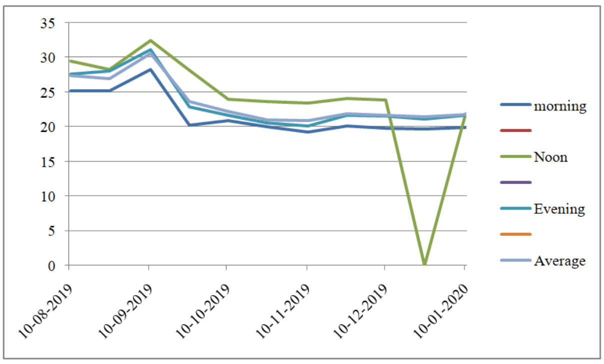

Fig. 1. Micro-climatic feature Temperature in AFS.

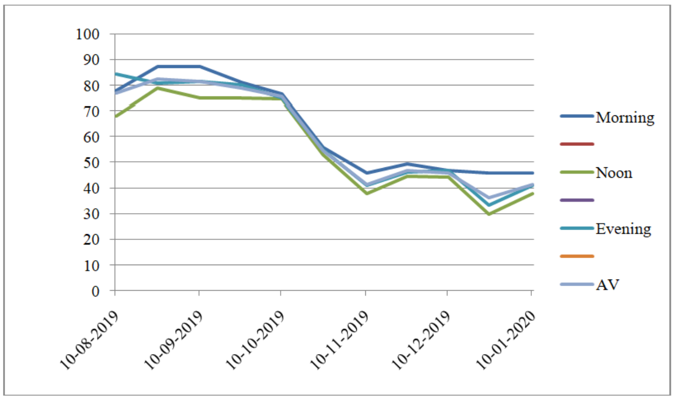

Fig. 2. Micro-climatic feature Relative humidity in AFS.

RESULTS AND DISCUSSION

Yield parameters of Colocasia. As per the data given in Table 1 reveals that yield parameters such as corm length (cm), corm wt. per plant (gm), no. of cormel per plant, cormel length (cm), cormel diameter (cm) and cormel wt. per plant (gm) affected non significantly by source of fertilizer treatment. Analysis of variance by source of variety revealed that corm length (cm), corm wt. per plant (gm), no. of cormel per plant, cormel length (cm), cormel diameter (cm) and cormel wt. per plant (gm) show no significant effect. Analysis of variance of source Tr × Va interaction showed non-significant effect for all yield parameters. Desta and Merga (2020) also reported similar result as non-significant variation among taro varieties concerning corm length, corm diameter and no. of cormel per plant. This variation could be attributed to the inherent variation of taro varieties in response to specific environmental conditions.

Fresh weight. of Colocasia Corm. As per the data given in Table 2 reveals that the fresh yield of tuber showed statistically significant where the maximum yield of colocasia tuber was recorded 118.66 q ha^{-1} in T_1(RDF) and minimum yield of 104.35 q ha^{-1} in T_2 (No fertilizer). In case of variety Maximum fresh weight of colocasia tubers was found in Indira Arbi-I (114.82 q ha^{-1}) and minimum in Arbi-CG-II (108.19 qha^{-1}). In T × V interaction maximum yield was observed in T-1 × V-1 (121.81 q/ha) interaction and minimum T-2 × V-2 (100.88 q/ha).

Dry weight. of Coloasia Corm. As per the data given in Table 2 reveals that the dry yield of colocasia tuber showed statistically non-significant where the maximum dry weight of colocasia tuber was recorded 29.92 q ha^{-1} in T_1 (RDF) and minimum yield 22.943q ha^{-1} in T_2 (zero fertilizer). In case of variety, Maximum dry weight of colocasia tubers was found 27.62 qha^{-1} in V-1 (Indira Arbi-I) & minimum 25.24 qha^{-1} in V-2 (Arbi-CG-II). In T × V interaction maximum yield was observed in T-1 ×V-1 (32.22 q/ha) interaction and minimum in T-2 × V-2 (22.87 q/ha) interaction. It might be due to fact, that it increased the vegetative growth period which leads longer growth duration and ensuring higher tuber yield and different genetic makeup of different varieties, Similar findings are reported by Muhammad *et al.* (2015); Akther *et al.* (2016). Suminarti *et al.* (2016) also reported that tuber yield per hectare was significantly influenced by fertilizer application. Similarily, Sen *et al.* (2007) also reported highest stolon yield in swamp taro with organic (25%) and inorganic (75%) source of nitrogen combination. An analysis on artificial shade on Taro (*Colocasia esculenta*) was performed by Gondium *et al.* (2018) and the results were the shading strength of 18%, over the entire cycle or in some of cycle tested, provides a high expansion of the development and growth of the crops.

Fig. 3. Colocasia corm after harvesting of (a) Indira Arbi-1 (b) Arbi-CG-2.

Tree growth parameters: The height (m) of *Eucalyptus tereticornis* was 21.58 m ± 2.84 before sowing of colocasia crop which increased by 0.69 m with MAI of 1.06m while diameter at breast height (cm) of *Eucalyptus tereticornis* was 25.75 cm ± 1.91 before sowing of colocasia crop which increased by 0.67 cm with MAI 1.25 cm of twelve month of growth

Table 1: Yield parameters of Colocasia Corm under Eucalyptus-based AFS.

	Corm length (cm)	Corm diameter (cm)	Corm weight per plant (gm)	No. of cormel per plant	Cormel length (cm)	Cormel diameter (cm)	Cormel weight per plant
Treatment							
T1	5.14	2.33	54.24	3.04	2.90	1.90	25.69
T2	5.24	2.42	49.48	2.89	3.17	1.89	26.00
SEm±	0.18	0.07	4.32	0.09	0.16	0.07	1.06
SEd±	0.25	0.09	6.11	0.13	0.23	0.11	1.49
CD (5%)	NS	0.21	NS	NS	NS	NS	NS
Variety							
V1	5.06	2.48	55.58	3.30	2.90	1.91	24.99
V2	5.32	2.27	48.14	2.63	3.17	1.89	26.70
SEm±	0.18	0.07	4.32	0.09	0.16	0.07	1.06
SEd±	0.25	0.09	6.11	0.13	0.23	0.11	1.49
CD (5%)	NS	0.21	NS	0.28	NS	NS	NS
Interaction of Tr × Va							
T1 × V1	5.08	2.51	56.88	3.40	2.81	1.95	25.18
T1 ×V2	5.20	2.15	42.08	2.68	2.99	1.85	26.20
T2 × V1	5.04	2.46	54.28	3.20	3.00	1.86	24.80
T2 × V2	5.44	2.39	54.20	2.58	3.34	1.93	27.20
SEm±	0.25	0.10	6.12	0.13	0.23	0.11	1.49
SEd±	0.35	0.15	8.65	0.18	0.33	0.15	2.11
CD (5%)	NS	NS	NS	NS	NS	NS	NS

Table 2: Yield (q/ha) of Colocasia tuber under Eucalyptus-based AFS.

Treatment	Fresh Wt. q/ha	Dry Wt. q/ha
T1	118.66	29.92
T2	104.35	22.943
SEm±	3.02	1.85
CD (5%)	9.51	5.84
Variety		
V1	114.82	27.62
V2	108.19	25.243
SEm±	3.02	1.85
CD (5%)	NS	NS
Interaction of Tr × Va		
T1 × V1	121.81	32.22
T1 × V2	115.504	27.62
T2 × V1	107.824	23.02
T2 × V2	100.876	22.87
SEm±	4.77	2.62
CD (5%)	NS	NS

Fig. 4. A View of Experiment field (Colocasia crop under Eucalyptus-based Agroforestry system).

Fig. 5. Growth of Colocasia crop under Eucalyptus-based AFS during measurement.

CONCLUSIONS

The result revealed that highest yield was obtained 118.66 qha^{-1} in fertilizer treatment and lowest 104.12 qha^{-1} in T_2 where no fertilizer was used, which was reduced by 12.06% with statistically significant variation. In case of variety Indira Arbi-I produced better yield 114.286 q ha^{-1} as compare to Arbi-CG-II which produced 108.1qha^{-1} with non significant variation. The crop registered better growth and yield performance in T_1 (RDF) treatment, while variations under established Eucalyptus plantations was found, the cultivation of colocasia as cover crop showed better growth & yield performance, while the farmer can get extra income on harvesting of Eucalyptus. Thus Eucalyptus + Colocasia farming was found beneficial in economical point of view. Overall, in this experiment colocasia crop showed better results for variety Indira Arbi-I thus it can be acceptable for cultivation as cover crop under AFS to generate Income.

FUTURE SCOPE

Further intensive research work about intercropping management practices with different fertilizer doses under different tree species will be required. Also, the study of microclimatic as well as bio-parameters under the intercropping land utilization program required for more effective recommendation of intercropping management practices.

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Conflict of Interest. None.

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