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PERFORMANCE EVALUATION OF MEDICINAL AND AROMATIC PLANTS IN HORTI-MEDICINAL AGROFORESTRY SYSTEM UNDER ARID REGIONS OF ANDHRA PRADESH

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ABSTRACT

A field experiment was conducted for evaluation of medicinal and aromatic plants in horti-medicinal agroforestry system under semi-arid regions of Andhra Pradesh during *kharif,*2021 and 2022 at AICRPDA, Agricultural Research Station, Ananthapur. The treatments consist of four main plots (Trees) of size 72X 36 m *viz.,* Simarouba, Custard apple, Jamun and Amla and three sub plots (Medicinal plants) of size 36 X 4 m *viz.,* Aswagandha, Senna, Nannari and Velvet bean. The experiment was conducted in split plot design with three replications. During 2021, Amla trees, recorded an average fruit yield of 8.0 kg per tree and Jamun fruit yield was 8 kg per tree. During 2022, Amla trees recorded an average fruit yield of 9.3 kg per tree, jamun average fruit yield was 7.1 kg per tree and custard apple average fruit yield was 0.7 kg per tree. The present study findings showed that, in semi-arid regions of Andhra Pradesh, all of the tested medicinal plants performed better when grown as sole crops as compared to different tree-based intercropping systems. Sub plot treatments *viz.,* medicinal plants intercropped in custard apple performed well (Mean leaf yield of Aswagandha was 1547 kg ha^{-1} , Aswagandha root dry weight was 87 kg ha^{-1} ; Senna leaf dry weight was 1674 kg ha^{-1} and velvet bean seed yield was 293 kg ha^{-1})compared to other trees.

Key words: Horti-medicinal agro forestry, Semi- arid regions, Yield and yield attributes

INTRODUCTION

Agriculture in the Scarce Rainfall zone of Andhra Pradesh is largely rainfed and highly susceptible to erratic monsoon patterns, prolonged dry spells and frequent droughts. These regions are characterized by low and uneven rainfall, high evapo-transpiration, and poor soil moisture retention, resulting in unstable crop yields, land degradation, and reduced farm incomes under conventional monocropping systems (Upadhyaya *et al.,*2021).Agroforestry is a land use option that increased livelihood security and reduced vulnerability to climate and environmental change. Arid regions like Ananthapur and Sri Sathyasai districts of Andhra Pradesh are characterized by low and uneven distribution of rainfall coupled with high evapo-transpiration losses, and frequent moisture stress, which limits the productivity,quality and

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sustainability of the conventional cropping systems. Dryland Horticulture offers a transformative approach to horticulture in arid and semi-arid regions addressing the challenges of water scarcity, poor soil and climate variability (Prakash Patil and Vani, 2025). Continuous dependence on field crops under dryland conditions has resulted in unstable yields, declining soil health, and increased vulnerability of farm livelihoods to climate variability. In this context, diversification of land-use systems through climate-resilient and resource-efficient approaches is essential for ensuring sustainable agricultural production in these fragile ecosystems.Horti-medicinal agroforestry systems, which integrate drought-tolerant horticultural species with medicinal and aromatic plants (MAPs), offer a promising alternative for semi-arid environments. Medicinal and aromatic plants such as Aswagandha, Senna, Nannari and Velvet bean are well adapted to moisture-limited conditions and possess high economic value, low input requirements, and growing demand from pharmaceutical, cosmetic and herbal industries. Their inclusion as intercrops or understory components in horticultural plantations enhances land productivity, improves resource-use efficiency and provides diversified income opportunities to small and marginal farmers. Agroforestry reduces dependence on external inputs, mitigates climate risks, and fosters ecological resilience. Scaling such sustainable models through research and adoption is critical for ensuring agricultural productivity, environmental conservation, and food security for future generations (Asha Ram *et al.,* 2025).Evaluation

Table 1. Package of practices followed for different medicinal plants

S.No.	Common Name	Seed Rate	Spacing	Fertiliser dose
	Horticulture/ tree plants (Main plots)			
1	Simarouba (*Simarouba glauca* DC.)	277 grafts ha^{-1}	6X6 m	60N +40P + 40K g/plant
2	Custard apple (*Annona squamosa* L.)	277 grafts ha^{-1}	6X6 m	250N+125P +125K g/plant
3	Jamun (*Syzygium cumini* L.)	277 grafts ha^{-1}	6X6 m	500N +250P+250K g/plant
4	Amla (*Phyllanthus emblica* L.)	277 grafts ha^{-1}	6X6 m	500N +250P+250K g/plant
	Medicinal plants (Sub plots)			
1	Aswagandha (*Withania somnifera)*	10 (kg ha^{-1})	30 x 10 cm	20N +30 P +20K Kg ha^{-1}
2	Senna (*Senna alexandria)*	10 (kg ha^{-1})	45 x 30 cm	40N +40 P +20K Kg ha^{-1}
3	Nannari (*Decalepis hamiltonii)*	12500 seedlings	45 x 45 cm	40N +50 P +40K Kg ha^{-1}
4	Velvetbean (*Mucuna pruriens)*	30 (kg ha^{-1})	60 x 60 cm	20N +40 P +20K

of performance of suitable medicinal and aromatic plants under horti-medicinal agroforestry systems is therefore crucial to identify compatible crop combinations that ensure optimum growth, yield and economic returns without adversely affecting the main horticultural component. Consequently, there is a growing need for resilient and sustainable land-use strategies that can withstand climatic and resource constraints. Since, many medicinal plant species prefer to grow under forest cover, agro-forestry offers a convenient strategy for their cultivation as well as conservation (Rao *et al*., 2004). Such systems also contribute to soil health improvement, microclimate moderation and long-term ecological sustainability. Hence, the present investigation aims to evaluate the performance of selected medicinal plants in horti-medicinal agroforestry systems under the dryland tracts of Andhra Pradesh, with a view to develop a climate-resilient and economically viable farming models.

MATERIAL AND METHODS

Field experiment was conducted during *kharif*, 2021 and 2022 at dryland farm of Agricultural Research Station, Ananthapur of ANGR Agricultural University of Andhra Pradesh, which is geographically situated in between 14.41^{0}N latitudes and 77.40^0 longitude and at an altitude of 350 m. above MSL.The treatments consist of four main plots (Trees) of size 72X 36 m *i.e.* Simarouba, Custard apple, Jamun and Amla and three sub plots (Medicinal plants) of size 36 X 4 m *i.e.* Aswagandha, Senna, Nannari and Velvet bean.The present experiment was conducted in split plot design with three replications.The package of practices followed for medicinal plants were furnished in Table 1.

Simarouba, Custard apple, Jamun and Amla were planted in 2010,with a spacing of 6x6 m in different blocks and which were 10 years old. The medicinal plants were sown as intercrop in between the rows of Simarouba, Custard apple, Jamun and Amla and also as sole crop. The soil is near neutral in soil reaction, low in organic carbon and nitrogen and high in phosphorous and potassium content. The experimental site comes under Class-VI as per land capability classification. An amount of 832 ,759 mm rainfall was received in 40, 41 rainy days during crop growing season of 2021 and 2022, respectively.

RESULTS AND DISCUSSION

Among the agroforestry trees higher stem girth was recorded with Jamun (61.5 cm), which was followed by Simarouba (58.5 cm). During 2021, out of 32 Amla trees, 19 trees came to fruiting (59%) and average fruit yield was 8.0 kg per tree. Similarly, 8 Jamun fruits came to fruiting and average fruit yield was 8 kg per tree. During 2022, out of 32 Amla trees, 19 trees came to fruiting (59%) and average fruit yield was 9.3 kg per tree.Out of 67 Jamun trees, 11 Jamun trees came to fruiting and average fruit yield was 7.1 kg per tree.Out of 80 Custard apple trees 75 trees came to fruiting and yielded 55 kg and average fruit yield was 0.7 kg per tree.The 6 years data (2010 to 2016) indicated that, the maximum yield was achieved by *Anacardium occidentale* with Proso millet followed by *Mangifera indica* with Finger millet (Dalvi *et al.,*2020).

Pooled mean data of two years (2021 and 2022) in the Aswagandha based horti-medicinal agroforestry system revealed that sole Aswagandha produced higher leaf dry matter (2378 kg ha^{-1}) and root dry matter (242 kg ha^{-1}) compared to intercropped systems (Table 2). Among the tree-based combinations, Aswagandha intercropped with custard apple produced comparatively higher biomass than other intercrops, indicating relatively lower competition effects. The reduction in biomass

Table 2. Performance of Ashwagandha under different agro-forestry systems

Treat-ments	Cropping System	2021		2022		Mean	
		Leaf dry wt.	Root dry wt.	Leaf dry wt.	Root dry wt.	Leaf dry wt.	Root dry wt.
		(Kg ha^{-1})					
T1	Sole Aswagandha	3075	65	1680	420	2378	242
T2	Simarouba+ Aswagandha	2258	445	374	89	1316	67
T3	Custard apple + Aswagandha	2564	53	530	112	1547	82
T4	Jamun + Aswagandha	1896	40	340	82	1118	61
T5	Amla + Aswagandha	2450	44	392	102	1421	73

Table 3. Performance of senna under different agro- forestry systems

Treatments	2021	2022	Mean
	Leaf dry wt. (kg ha^{-1})		
T1 Sole Senna	2675	2837	2756
T2 Simarouba+ Senna	2016	840	1428
T3 Custard apple + Senna	2359	989	1674
T4 Jamun + Senna	1848	656	1252
T5 Amla + Senna	2184	967	1575

Table 4. Performance of nannari under different agro-forestry systems

Treatments		2021	2022
		Root dry wt. (g plant^{-1})	
T1	Sole Nannari		916
T2	Simarouba + Nannari	No root yield was	15
T3	Custard apple + Nannari	recoded as crop was	18
T4	Jamun + Nannari	planted in 2021 only	21
T5	Amla + Nannari		33

Table 5. Performance of velvet bean under different agro-forestry systems

Treatments		2021	2022	Mean
		Seed yield (kg ha^{-1})		
T1	Sole Velvet bean	502	465	484
T2	Simarouba+ Velvetbean	335	176	256
T3	Custard apple + Velvet bean	370	215	293
T4	Jamun + Velvet bean	305	188	247
T5	Amla + Velvet bean	327	208	268

under tree-based systems could be attributed to competition for light, moisture, and nutrients. Supporting these findings, Kumar *et al.,* (2010) reported lower alkaloid content in Aswagandha grown under an amla-based cropping system compared to sole cropping, suggesting that tree interactions can influence both yield and quality parameters.In the Senna based horti-medicinal agroforestry system, sole cropping resulted in the highest leaf dry weight (2756 kg ha^{-1}), followed by Senna intercropped with custard apple (1674 kg ha^{-1}) (Table 3). The reduced leaf biomass under intercropping systems may be due to partial shading and below-ground competition imposed by tree components, which are known to affect photosynthetic efficiency and biomass accumulation in understory medicinal crops.

In the Nannari based system, root yield was not recorded during the first year (2021) as the crop was newly established. However, during the second year (2022), sole Nannari recorded the highest dry root yield (916 g $plant^{-1}$), followed by Nannari intercropped with Amla (33 g $plant^{-1}$) (Table 4). The substantial reduction in root yield under intercropping systems highlights the sensitivity of Nannari to competitive stress, particularly during root development stages.

Similarly, in the Velvet bean based horti-medicinal agroforestry system, the highest seed yield was recorded under sole cropping (484 kg ha^{-1}), followed by Velvet bean intercropped with custard apple (293 kg ha^{-1}) (Table 5). Lower yields in intercropped treatments may be attributed to reduced resource availability and altered microclimatic conditions under tree canopies.Overall, the results indicate that while sole cropping of medicinal plants maximized biomass and yield, certain tree-crop combinations, particularly with custard apple, showed relatively better compatibility. These findings emphasize the need for careful selection of tree species and spatial arrangements to minimize competition and enhance productivity in horti-medicinal agroforestry systems.

CONCLUSION

The study revealed that sole cropping of medicinal plants resulted in higher biomass and yield compared to intercropping in horti-medicinal agroforestry systems, due to reduced competition for resources. Among the tree components, Jamun showed better vegetative growth, while Amla and Jamun recorded satisfactory fruit yields. Among intercropping treatments, medicinal crops associated with Custard apple performed relatively better than other tree combinations, indicating higher compatibility. Overall, the results emphasize that careful selection of tree–crop combinations is essential to minimize competition and enhance productivity in horti-medicinal agroforestry systems.

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