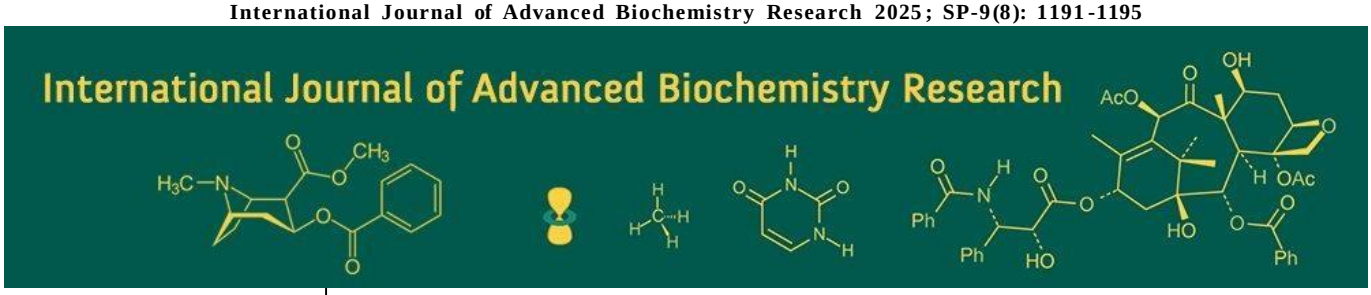

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Effect of inorganic & organic fertilizers on the growth & yield of garlic (*Allium sativum* L.) under chironji (*Buchanania lanzan* Spreng.) based agroforestry system

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Abstract
Aim: To evaluate the effects of inorganic and organic fertilizer on the growth (plant height, number of leaves, leaf length) yield (bulb weight, bulb diameter, yield per plot, yield per ha) and economics (cost of cultivation, cost of treatments, B: C ratio).
Study Design: The study was conducted over a period of 7 months and included two plots one under open condition while the other under Chironji based Agroforestry System.
Place and Duration of Study: The study was conducted at the Research and Nursery of the College of Forestry, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj during the period of October to April 2024-25.
Methodology: In both the sites RBD (Randomized Block Design) was followed, consisting of 12 treatments and 3 replication, with a net plot area of ($3m*3m=9m^2$) and a net experimental area of ($36m*9m=324m^2$) each. Comparisons were made on the basis of treatments as well as under open & Chironji based Agroforestry System.
Results: Treatment T10 (50% RDF+25% Neem Cake+ 25% Vermicompost) showed the best results in growth and yield in both Open and Under Chironji based Agroforestry System, closely followed by the treatment T1 (100%RDF). Although results under open condition were higher in every case, with time the overall income will be higher under Chironji based Agroforestry System.
Conclusion: The study highlights the effects of combining inorganic fertilizer with organic fertilizer for a more sustainable, efficient, economically productive outcomes. The treatments used in the study doesn't solely depends on shifting towards organic fertilizer nor does it depends completely on chemical fertilizers but combines them both for the preservation of the ecosystem as well as reducing the dependency on chemical fertilizer.

Keywords: Agroforestry, chironji, inorganic fertilizers, organic fertilizers, organic carbon, soil electrical conductivity, FYM, vermicompost, neemcake

Introduction

Agroforestry is a dynamic, ecologically oriented strategy for managing natural resources that integrates trees and other woody perennials into farms and rangeland to diversify output and maintain it for greater social, economic and environmental advantages. Agroforestry is described as a mix of land-use systems that incorporates trees and shrubs on farmland and rural landscapes, whether or not they have animals (National Agroforestry Policy, 2014). The major objective of agroforestry is to optimize production and economic returns per unit area while respecting the principle of sustainable development. In order to attain this objective, certain agroforestry modules have been evolved and standardized, combining optimum land use system with tree-agriculture-livestock production system to give maximum economic returns, simultaneously or sequentially. However, the models have to be designed in such a manner so as to make them technologically feasible, ecologically sustainable, economically viable, and socially acceptable (www.researchgate.net).

Chironji *Buchanania lanzan Spreng* commonly known as "Cuddapah almond", "Char" or "Chironji" is a valuable tree species found in a mixed dry deciduous forest throughout the greater part of India excluding eastern Himalayan forest and arid regions of north India. The species is native to India. It is widely distributed in the state of Madhya Pradesh,

Chhattisgarh, Jharkhand, Southeast Uttar Pradesh and parts of Gujarat, Rajasthan, Odisha, Andhra Pradesh, Karnataka and Maharashtra. This species is not under commercial cultivation or plantation therefore, information on its cultivation practices and commercial utilization are rarely available. However, it has tremendous potential to uplift the socio economic status of the native dwellers if cultivated properly. Despite it being a highly valuable NTFP species, its commercial plantation have not been established therefore, its market is hasn't been channelized yet. 7 species of *Buchanania* have been reported in India of which two *B. lanzan* (Syn. *B. latifolia*) and B. axillaries (Syn. *angustifolia*) produce edible fruits. *B. lanceolata* is an endangered species. Among these *species Buchanania lanzan Spreng* is most important and widely distributed species in India. This species was first described by Mr. Hamilton, a forester in 1798 in Burma and the genus *Buchanania* was named after him. It was originated in the Indian sub-continent, and is found in India, Burma, Nepal and few other countries (Chauhan *et al*, 2017) [10]. *Buchanania lanzan* is a socioeconomically important underutilized life support and tropical medicinal species for the tribal population of North, West and Central India. But due to over exploitation and indiscriminate harvesting (looping and cutting) considerable reduction in the population of *Buchanania lanzan* has been recorded in the recent past, leading to severe threats of its extinction, which needs urgent attention towards conservation efforts (Kumar *et al.*, 2013) & (Chauhan *et al.*, 2017) [10, 17] (www.phytojprnal.com). *Buchanania lanzan* thrives in a drier region, which makes it a good dryland tree that can be used for wasteland development and also agroforestry components. The proper choice of the understudy crop and tree species will have significant impact on success of the Agri-silviculture system.

Garlic *Allium sativum* is easy to grow and can be grown year-round in mild climates. While sexual propagation of garlic is possible, nearly all of the garlic in cultivation is propagated asexually by planting individual cloves in the ground. India ranks second in area and production of garlic in the world. In India, average productivity of garlic is 5.27 tons ha^{-1}, cultivated over 2.62 lakh hectares and producing 14.24 lakh MT. It is widely used as spice and has higher nutritional value than other crops of onion family. Besides nutritive values, it is included in Indian system of medicines (Ayurvedic, Unani and Siddha) as a carminative and gastric stimulant to help digestion and absorption of food. The flowers develop numerous egg-shaped bulbils, which have an important function in the propagation of the plant. Garlic plants can be grown closely together, leaving enough space for the bulbs to mature, and are easily grown in containers of sufficient depth. Garlic does well in loose, dry, well-drained soils in sunny locations. Garlic plants prefer to grow in a soil with a high organic material content, but are capable of growing in a wide range of soil conditions and pH levels.

Materials and Methods

The field experiment entitled" Effect of Inorganic and Organic fertilizers on the growth and yield of Garlic (*Allium sativum* L.) Under Chironji (*Buchanania lanzan* Spreng.) based Agroforestry system." was conducted at the Research and Nursery of the College of Forestry, Sam Higginbottom University of Agriculture, Technology & Sciences, Prayagraj during the period of October to April 2024-25. In the experiment local variety of garlic was taken by adopting Randomized Block design with twelve treatments viz., T_0-Absolute Control, T_1-RDF (100% NPK), T_2-100% FYM, T_3-100% Neem Cake, T_4-100% Vermicompost, T_5-75% RDF + 25% FYM, T_6-75% RDF + 25% Neem Cake, T_7-75% RDF + 25% Vermicompost, T_8-50% RDF + 25% FYM + 25% Neem Cake, T_9-50% RDF + 25% FYM + 25% Vermicompost, T_{10}-50% RDF + 25% Neem Cake + 25% Vermicompost, T_{11}-25% RDF +25% FYM + 25% Neem Cake + 25% Vermicompost. The soil was Sandy loam in texture, with soil pH of 7 under Open and 6.7 under Chironji, organic carbon 0.28% under Open and 0.38% under Chironji, soil EC of 0.12 dS/m under Open and 0.16 dS/m under Chironji, N of 248 Kg/ha under Open and 231 Kg/ha, P_2O_5 of 17 Kg/ha under Open and 22 Kg/ha under Chironji, K_2O of 170 Kg/ha under open and 189 Kg/ha under Chironji (KVK, Allahabad, 2025). The garlic was planted at a spacing of 15cm×30cm in 3m×3m plots. The organic manures were applied 5 days before sowing. The inorganic chemical fertilizers were applied as per the above treatments, were applied through urea, single superphosphate and muriate of potash. Growth parameters were recorded 30, 60, 90 and 120 days after sowing (DAS).

Notation	Treatment Combinations
T_0	Absolute Control
T_1	RDF (100% NPK)
T_2	100% FYM
T_3	100% Neem Cake
T_4	100% Vermicompost
T_5	75% RDF + 25% FYM
T_6	75% RDF + 25% Neem Cake
T_7	75% RDF + 25% Vermicompost
T_8	50% RDF + 25% FYM + 25% Neem Cake
T_9	50% RDF + 25% FYM + 25% Vermicompost
T_{10}	50% RDF + 25% Neem Cake + 25% Vermicompost
T_{11}	25% RDF +25% FYM + 25% Neem Cake + 25% Vermicompost

Results and Discussion

The pre harvest data on the plant height (PH), number of leaves (NL), leaf length (LL) are presented on table 1 under open and under Chironji based Agroforestry System which revealed that there were significant differences between organic and combination of inorganic and organic fertilizers on the growth parameters. At 120 DAS treatment T_{10} (50% RDF +25% NC + 25% VC) showed the best results in both the experimental sites where a maximum plant height of (59.37cm under open and 50.93cm under Chironji based Agroforestry System), maximum no. of leaves of (10.13 under open and 8.66 under Chironji based Agroforestry System), maximum leaf length of (64.47cm under open and 60.27cm under Chironji based Agroforestry System) was observed, closely followed by T_1 (RDF [100%NPK]). While T_0 (Absolute Control) performed the lowest in the three parameters in both the sites.

Table 1: Effects of inorganic and organic fertilizer on the growth of garlic

Sr. No.	Treatments	Open Condition			Agroforestry System		
		PH (cm) 120DAS	NL 120DAS	LL (cm) 120DAS	PH (cm) 120 DAS	NL 120DAS	LL (cm) 120DAS
T_0	Absolute Control	37	5.2	49.67	36.13	6.06	46.93
T_1	RDF (100%NPK)	53.5	8.46	63.27	48.5	8.46	59.07
T_2	100% FYM	39.07	5.93	50.47	37.37	6.23	50.6
T_3	100% Neem Cake	42.47	5.86	52.53	40.03	6.8	52.6
T_4	100% Vermicompost	41.13	6.1	51.53	38.83	6.56	51.93
T_5	75% RDF + 25% FYM	46.8	7.06	56.87	44.03	7.43	54.87
T_6	75% RDF + 25% NC	53.37	7.73	60.07	47	8.26	58.47
T_7	75% RDF + 25% VC	48.4	6.66	58.17	45.1	7.7	55.63
T_8	50% RDF + 25% FYM +25% NC	45.3	6.63	54.8	42.97	7.26	53.93
T_9	50% RDF + 25% FYM + 25% VC	43.47	6.46	53.6	41.27	7.06	53.47
T_{10}	50% RDF +25% NC + 25% VC	59.37	10.13	64.47	50.93	8.66	60.27
T_{11}	25%RDF + 25%FYM + NC + 25%VC	50.1	6.8	59.1	46.3	7.9	56.33
S.E d (+)		2.28	0.64	2.411	0.33	0.24	1.629
C.D at 5%		4.72	1.33	5.033	0.68	0.49	3.401

The post-harvest data on the survival percentage (SP), bulb diameter (BD), bulb weight (BW), bulb yield per plot (BYP), bulb yield per hectare (BYH) are presented on table 2 under open and under Chironji based Agroforestry System which revealed that there were significant differences between different treatments. T_{10} showed the highest survival percentage of (91.8% under open and 89.5% under Chironji based Agroforestry System), maximum bulb diameter of (4.63cm under open and 4.33cm under Chironji based Agroforestry System), maximum bulb weight of (27.3g under open and 25.6g under Chironji based Agroforestry System), maximum bulb yield per plot of (4.89kg under open and 4.7kg under Chironji based agroforestry System), maximum bulb yield per hectare of (5.43t under open and 5.2t under Chironji based agroforestry System).

Table 2: Effects of inorganic and organic fertilizer on the yield of garlic

Sr. No.	Treatments	Open Condition					Agroforestry System				
		SP (%)	BD (cm)	BW (g)	BYP (Kg)	BYH (t)	SP (%)	BD (cm)	BW (g)	BYP (Kg)	BYH (t)
T_0	Absolute Control	76.5	2.93	16.76	2.49	2.77	74.5	2.5	14.26	2.18	2.42
T_1	RDF (100%NPK)	88.8	4.5	26.1	4.53	5.02	86.8	4.23	25.2	4.47	4.97
T_2	100% FYM	77.1	3.1	17.43	2.59	2.87	74.3	2.66	15.3	2.35	2.62
T_3	100% Neem Cake	79.3	3.43	20.5	3.19	3.54	78	2.9	17.03	2.70	3
T_4	100% Vermicompost	78.1	3.23	18.73	2.84	3.16	76	2.8	16	2.50	2.77
T_5	75% RDF + 25% FYM	84.3	3.93	23.13	3.80	4.22	82.1	3.5	21.66	3.65	4.05
T_6	75% RDF + 25% NC	87.6	4.43	25.23	4.31	4.79	85.5	4.13	24.3	4.26	4.73
T_7	75% RDF + 25% VC	85.5	4.1	23.76	3.96	4.39	83.3	3.73	22.93	3.92	4.35
T_8	50% RDF + 25% FYM +25% NC	82.6	3.73	22.56	3.65	4.05	80.8	3.3	19.63	3.24	3.60
T_9	50% RDF + 25% FYM + 25% VC	80.5	3.53	21.63	3.42	3.80	79.1	3.06	18.16	2.92	3.24
T_{10}	50% RDF +25% NC + 25% VC	91.8	4.63	27.33	4.89	5.43	89.5	4.33	25.6	4.70	5.2
T_{11}	25%RDF + 25%FYM + NC + 25%VC	86.6	4.2	24.36	4.12	4.57	84.6	3.9	23.56	4.08	4.53
S.E d (+)		-	0.09	0.72	0.12	0.13	-	0.10	0.49	0.09	0.11
C.D at 5%		-	0.20	1.48	0.25	0.27	-	0.20	1.01	0.19	0.22

Conclusion

Based on the field experiment, it may be concluded that after comparing the different parameters of both Open and under Chironji Based Agroforestry System, among the 12 treatments, treatment T_{10} (50% NPK + 25% Neem Cake + 25% Vermicompost) gave better results and recorded the highest plant height, number of leaves, longest leaf, highest bulb diameter, highest bulb weight, highest yield per plot, highest yield per hectare.

It may also be concluded that based on the field work, comparison was made between when cultivation in Open Condition and under Chironji based Agroforestry System and is found that garlic in Open Condition gave better results than garlic under Chironji trees. Currently, Chironji trees are young and the income from trees is zero. The agroforestry is expected to give higher income than open condition in long term after 3-4 years when the trees start yielding fruits Chironji edible kernels fetch about ₹ 600-2000/- per kilogram in Indian market. Benefit Cost ratio of Chironji based Agroforestry system will increase when it starts fruiting thus making it more profitable than monoculture. It is recommended that further research should be continues in this model to prove that Chironji based Agroforestry will give higher income to farmers.

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