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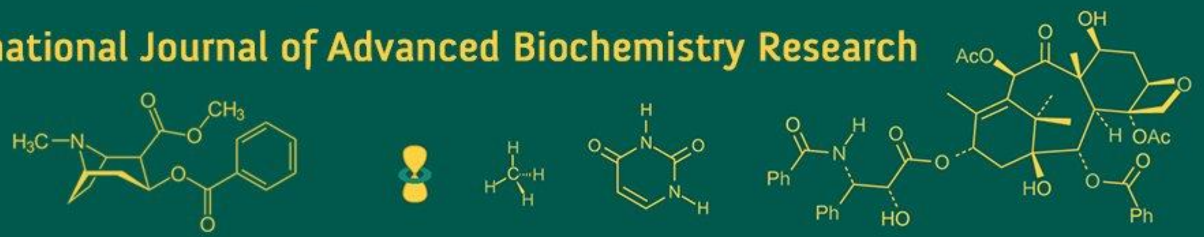

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Effect of integrated nutrient management on the growth and yield of onion (*Allium cepa.*) under chironji (*Buchanania lanzan*) based Agroforestry system

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Abstract
The experiment was carried out at Department of Silviculture and Agroforestry, College of Forestry, SHUATS, Prayagraj during the month of October, 2023 to March, 2024. To evaluate the " Effect of integrated nutrient management on the growth and yield of onion (*Allium cepa*) under Chironji (*Buchanania lanzan*) based Agroforestry System in Prayagraj Condition" The experiment was laid out in RBD (Randomized Block Design) comprising of 16 treatments *viz.*, T_1 RDF (100%), T_2 FYM (100%), T_3 Vermicompost(100%), T_4 Bone meal (100%), T_5 Poultry manure (100%), T_6 75% RDF + 25% FYM, T_7 75% RDF + 25% Vermicompost, T_8 75% RDF + 25% Bonemeal, T_9 75% RDF + 25% Poultry Manure, T_{10} 50% RDF + 25% FYM + 25% Vermicompost, T_{11} 50% RDF + 25% FYM + 25% Bonemeal, T_{12} 50% RDF + 25% FYM + 25% Poultry Manure, T_{13} 50% RDF + 25% Vermicompost+ 25% Bonemeal, T_{14} 50% RDF + 25% Vermicompost+ 25% Poultry Manure, T_{15} 50% RDF + 25% Bonemeal+ 25% Poultry Manure , $T_{1}6$ 20% RDF +20% FYM + 20% Vermicompost+ 20% Bonemeal+ 20% Poultry Manure, with three replications open condition and Chironji based Agroforestry system. The treatment in each replication will be allotted randomly. The study revealed that the treatment T_9: 75% RDF + 25% Poultry Manure gave higher growth parameter and yield parameter such as: Plant height, no. of leaves, Leaf Length and plant yield in open condition to compare the Chironji based Agroforestry system.

Keywords: Integrated nutrient management, onion, chironji, agroforestry system, RBD, poultry manure, FYM, Vermicompost, Bonemeal, growth and yield parameter

Introduction

Forests are one of the most vital natural resources, providing ecological stability, biodiversity conservation, and a wide range of ecosystem services such as air purification, soil and water conservation, and climate regulation (FAO, 2020) [6]. They are also a source of numerous products including timber, fruits, fodder, medicinal plants, gums, and resins, which support both rural livelihoods and national economies (Tewari, 1995; CSIR, 1986) [17, 2]. In India, forests and trees have been deeply integrated into cultural, social, and spiritual life since ancient times. Traditional systems of land management often combined agriculture with trees and livestock, laying the foundation for what is today known as agroforestry (Nair, 1993) [13].

Agroforestry, a sustainable land-use practice that integrates trees and shrubs with crops and/or livestock, enhances soil fertility, reduces erosion, improves water use efficiency, and promotes biodiversity (Jose, 2009) [11]. By mimicking natural ecosystems, agroforestry systems not only sustain agricultural productivity but also provide resilience against climate change (Kumar & Nair, 2011) [12]. India, with its diverse agro-climatic regions and long history of tree-crop interactions, holds immense potential for agroforestry in addressing food security, livelihood enhancement, and environmental sustainability. However, in the process of agricultural intensification, monoculture practices have largely replaced traditional agroforestry systems, leading to reduced ecological balance and overexploitation of natural resources (Dhyani *et al*., 2013) [4].

Among the important species associated with agroforestry and forest ecosystems, Chironji (*Buchanania lanzan* Spreng.) is a multipurpose tree valued for its edible kernels, oil, fodder, fuelwood, tannin-rich bark, and gum. The kernels, often used as a substitute for almonds, hold significant nutritional and economic importance for rural and tribal communities in central India (Janick & Paull, 2006) [10]. Despite its socio-economic value, natural regeneration of Chironji is poor due to premature harvesting and site degradation, raising concerns about its sustainable utilization and conservation (Troup, 1986) [19].

Similarly, onion (*Allium cepa* L.) is one of the most widely cultivated vegetable crops, second only to tomato in global importance (FAO, 2012) [5]. Known as the “queen of the kitchen” (Selvaraj, 1976) [15], onion is consumed worldwide in multiple forms fresh, dried, or processed and contributes significantly to the agricultural economy of India, which is the second largest onion producer globally (Dhaker *et al*., 2017) [3]. In addition to its culinary value, onion is recognized for its medicinal properties and high export potential through dehydrated products (Hazra *et al*., 2021) [8]. However, onion production is highly sensitive to climatic and photoperiodic conditions, and faces challenges such as post-harvest losses, price fluctuations, and inadequate storage facilities (Brewster, 1990) [1].

Given the ecological and economic significance of multipurpose tree species like Chironji and horticultural crops like onion, it becomes essential to explore their integration within sustainable agroforestry systems. Such an approach can provide diversified products, improve rural livelihoods, conserve biodiversity, and strengthen resilience against environmental stresses. The present study is therefore aimed at evaluating the role and potential of these species in agroforestry and agricultural systems, with particular emphasis on their ecological, economic, and cultural importance in India.

Materials and Methods

The field experiment entitled “Effect of Integrated Nutrient Management on the Growth and Yield of Onion (*Allium cepa* L.) under Chironji (*Buchanania lanzan* Spreng.) Based Agroforestry System under Prayagraj Agro-climatic Conditions” was conducted during Rabi season 2024-25 at the Research and Nursery, College of Forestry, Sam Higginbottom University of Agriculture, Technology and Sciences (SHUATS), Prayagraj, Uttar Pradesh, India. The experimental site lies in a subtropical climate with extremely hot summers (46-48 °C) and cold winters (4-5 °C). Relative humidity ranges from 20-94%, and the average annual rainfall is 1013.4 mm. Meteorological data on temperature, rainfall, and relative humidity during the crop season (October 2024-March 2025) were recorded at the Meteorological Observatory, SHUATS.

The soil of the experimental field was sandy loam in texture with pre-sowing properties under open and Chironji shade conditions, respectively, viz., pH 6.91 and 6.6 (Jackson, 1958), EC 0.11 and 0.17 dS m^{-1} (Wilcox, 1950) [21], organic carbon 0.23 and 0.31% (Walkley and Black, 1947) [20], available N 234 and 231 kg ha^{-1} (Subbiah and Asija, 1956) [16], available P 30 and 19 kg ha^{-1} (Olsen *et al*., 1954) [14], and available K 164 and 187 kg ha^{-1} (Tooth and Prince, 1949) [18]. Post-harvest soil analysis was carried out using the same methods. The experiment was laid out in a Randomized Block Design (RBD) with 16 treatments and 3 replications under both open and Chironji-based agroforestry systems. Each plot measured 2 × 2 m with 0.25 m bunds and irrigation channels. Onion seedlings (45-50 days old, raised in nursery beds using soil, FYM, and vermicompost mixture) were transplanted at 10 cm × 15 cm spacing in open field and 10 cm × 30 cm spacing under Chironji (7 × 3 m spacing). The treatments included: T_1 - 100% RDF (NPK), T_2 - 100% FYM, T_3 - 100% Vermicompost, T_4 - 100% Bonemeal, T_5 - 100% Poultry manure, T_6 - 75% RDF + 25% FYM, T_7 - 75% RDF + 25% Vermicompost, T_8 - 75% RDF + 25% Bonemeal, T_9 - 75% RDF + 25% Poultry manure, T_{10} - 50% RDF + 25% FYM + 25% Vermicompost, T_{11} - 50% RDF + 25% FYM + 25% Bonemeal, T_{12} - 50% RDF + 25% FYM + 25% Poultry manure, T_{13} - 50% RDF + 25% Vermicompost + 25% Bonemeal, T_{14} - 50% RDF + 25% Vermicompost + 25% Poultry manure, T_{15} - 50% RDF + 25% Bonemeal + 25% Poultry manure, and $T_1$6 - 20% RDF + 20% FYM + 20% Vermicompost + 20% Bonemeal + 20% Poultry manure. Fertilizers were applied through urea, single superphosphate, and muriate of potash as per treatment combinations. Organic manures were applied 5 days before transplanting.

Cultural operations such as irrigation, weeding, and plant protection were carried out uniformly. A total of six irrigations were applied during the crop cycle at critical growth stages. Weeding was performed manually at 20, 40, 60, and 80 days after transplanting. Harvesting was done when 70-80% of the onion tops bent down and bulbs developed a papery outer skin. Observations on growth parameters included Chironji tree height, onion plant height (30, 60, and 90 DAS), number of leaves, leaf length, and survival percentage. Yield attributes recorded were bulb weight per plant, bulb weight per plot, and yield per hectare. Economic analysis was carried out to estimate cost of cultivation, gross return, net return, and benefit-cost ratio for each treatment. The recorded data were subjected to statistical analysis following the Analysis of Variance (ANOVA) technique for RBD as suggested by Fisher (1960). Treatment means were compared using critical difference (CD) at 5% probability level.

Results and Discussion

The pre harvest data on the plant height (PH), number of leaves (NL), leaf length (LL) are presented on table 3.1 under open and under Chironji based Agroforestry System which revealed that there were significant differences between integrated nutrient management on the growth parameters. At 90 DAS treatment T_9 (75% RDF + 25% Poultry Manure) showed the best results in both the experimental sites where a maximum plant height of (61.97 cm under open and 59.20 cm under Chironji based Agroforestry System), maximum no. of leaves of (11.37 under open and 8.60 under Chironji based Agroforestry System), maximum leaf length of (52.63 cm under open and 49.87cm 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: Effect of integrated nutrient management on the yield of onion.

Sl.	Treatments	Open Condition			Agroforestry System		
		PH (cm) 90DAS	NL 90DAS	LL (cm) 90DAS	PH (cm) 90 DAS	NL 90DA	LL (cm) 90DAS
T_1	RDF (100% NPK)	59.43	11.23	50.57	56.67	8.47	47.80
T_2	100% FYM	43.23	10.50	40.50	40.47	7.73	37.73
T_3	100% Vermicompost	45.37	10.63	42.37	42.60	7.87	39.60
T_4	100% Bonemeal	44.43	10.63	41.57	41.67	7.87	38.80
T_5	100% Poultry Manure	46.10	10.77	41.90	43.33	8.00	39.13
T_6	75% RDF + 25% FYM	51.57	10.77	46.23	48.80	8.00	43.47
T_7	75% RDF + 25% Vermicompost	61.03	11.23	51.57	58.27	8.47	48.80
T_8	75% RDF + 25% Bonemeal	58.03	11.10	49.57	55.27	8.33	46.80
T_9	75% RDF + 25% Poultry Manure	61.97	11.37	52.63	59.20	8.60	49.87
T_{10}	50% RDF + 25% FYM + 25% Vermicompost	52.77	10.70	44.10	50.00	7.93	41.33
T_{11}	50% RDF + 25% FYM + 25% Bonemeal	47.97	10.83	43.77	45.20	8.07	41.00
T_{12}	50% RDF + 25% FYM + 25% Poultry Manure	51.17	10.97	59.57	48.40	8.20	56.80
T_{13}	50% RDF + 25% Vermicompost+ 25% Bonemeal	57.97	11.10	46.83	55.20	8.33	44.07
T_{14}	50% RDF + 25% Vermicompost+ 25% Poultry Manure	56.97	11.03	48.90	54.20	8.27	46.13
T_{15}	50% RDF + 25% Bonemeal+ 25% Poultry Manure	56.30	11.03	48.37	53.53	8.27	45.60
T_16	20% RDF +20% FYM + 20% Vermicompost+ 20% Bonemeal+ 20% Poultry Manure	47.30	10.70	43.03	44.53	7.93	40.27
F-Test		S	S	S	S	S	S
S.E d (±)		0.93	0.15	0.28	0.93	0.15	0.14
C.D at 5%		1.90	0.26	0.58	1.90	0.31	0.28

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 3.2 under open and under Chironji based Agroforestry System which revealed that there were significant differences between different treatments. T_9 showed the highest survival percentage of (94.48% under open and 95.73% under Chironji based Agroforestry System), maximum bulb diameter of (88.37 cm under open and 87.69 cm under Chironji based Agroforestry System), maximum bulb weight of (203.46 g under open and 198.26 g under Chironji based Agroforestry System), maximum bulb yield per plot of (25.37 kg under open and 25.05 kg under Chironji based agroforestry System), maximum bulb yield per hectare of (63.43 t under open and 62.63 t under Chironji based agroforestry System).

Table 2: Effect of integrated nutrient management on the yield of onion.

Sl.	Treatments	Open Condition					Agroforestry Syste m				
		SP	BW	BD	BYP	BYH	SP	BW	BD	BYP	BYH
T_1	RDF (100% NPK)	91.97	164.33	77.08	19.9	49.87	93.7	158.53	76.	19.61	49.03
T_2	100% FYM	82.83	76.53	44.45	8.36	20.91	84.7	72.36	42.	8.09	20.22
T_3	100% Vermicompost	84.83	88.43	47.23	9.90	24.75	86.4	83.86	46.	9.57	23.93
T_4	100% Bonemeal	84.46	84.53	46.28	9.42	23.56	85.5	80.33	45.	9.07	22.69
T_5	100% Poultry Manure	86.09	90.4	48.88	10.2	25.68	87.2	89.6	47.	10.31	25.79
T_6	75% RDF + 25% FYM	88.84	116.6	60.30	13.6	34.18	90.1	113.66	58.	13.51	33.79
T_7	75% RDF + 25% Vermicompost	93.35	195.73	80.42	24.1	60.29	94.6	189.26	79.	23.63	59.09
T_8	75% RDF + 25% Bonemeal	91.97	148.2	71.93	17.9	44.98	92.9	141.6	70.	17.37	43.44
T_9	75% RDF + 25% Poultry Manure	94.48	203.46	88.37	25.3	63.43	95.7	198.26	87.	25.05	62.63
T_{10}	50% RDF + 25% FYM + 25% Vermicompost	88.09	105.53	55.50	12.2	30.67	89.2	98.83	54.	11.64	29.10
T_{11}	50% RDF + 25% FYM + 25% Bonemeal	87.59	98.8	52.17	11.4	28.55	88.7	96.5	51.	11.30	28.25
T_{12}	50% RDF + 25% FYM + 25% Poultry Manure	88.84	113.4	58.19	13.2	33.24	89.8	104.06	57.	12.34	30.85
T_{13}	50% RDF + 25% Vermicompost+ 25% Bonemeal	89.59	121.4	62.17	14.3	35.89	90.7	117.66	60.	14.09	35.22
T_{14}	50% RDF + 25% Vermicompost+ 25% Poultry Manure	90.72	145.4	68.39	17.4	43.53	91.7	138.06	67.	16.71	41.79
T_{15}	50% RDF + 25% Bonemeal+ 25% Poultry Manure	89.59	136.46	65.75	16.1	40.34	90.9	129.53	64.	15.55	38.88
T_16	20% RDF +20% FYM + 20% Vermicompost+ 20% Bonemeal+ 20% Poultry Manure	86.71	95.2	50.26	10.8	27.24	87.8	92.6	49.	10.73	26.84
F-Test		S	S	S	S	S	S	S	S	S	S
S.E d (±)		0.47	1.29	0.20	0.15	0.39	0.22	1.14	0.1	0.39	0.37
C.D at 5%		0.96	2.64	0.40	0.32	0.79	0.45	2.32	0.3	0.79	0.75

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 16 treatments, treatment T_9 (75% RDF + 25% Poultry Manure) 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 onian 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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