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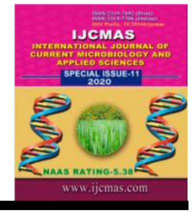

Original Research Article

Efficacy of Organic Manure and System of Rice Intensification (SRI) Method for Growth and Yield of Rice under Citrus based Agroforestry System

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Keywords

Rice, Organic manure SRI Method, Citrus

A B S T R A C T

To find out the best organic manure for using of System of Rice Intensification (SRI) method is an important tool to obtain high growth and yield of rice under Citrus based agroforestry system in Kharif season. Planting in college of Forestry SHUATS Allahabad UP India, an experiment was carried out in *kharif* seasons of 2017 in RBD design with three replications nine treatments. The results revealed that SRI recorded significantly higher values for all growth parameters, plant height cm, No of tillers hill^{-1}, leaf area index, flag leaf length cm, and Dry weight gm, was significantly Length of panicle (cm), Number of panicle per hill-1and Test weight, was significantly. After harvesting time the result recorded the higher Grain yield (3.71 t/ha^{-1}), Straw yield (4.40t/ha^{-1}) and Benefit cost ratio (B.C. ratio). 1:5.4 was in the treatment T_5 75% RDN through FYM+ 25% RDN through PM. significantly. Rice under Citrus based agroforestry system, respectively.

Introduction

Agroforestry systems make maximum use of the land. Every part of the land is considered suitable for useful plants. Emphasis is placed on perennial, multiple purpose crops that are planted once and yield benefits over a long period of time. Such benefits include construction materials, food for humans and animals, fuels, fibers, and shade. Trees in agroforestry systems also have important uses such as holding the soil against erosion and improving soil fertility (by fixing nitrogen or bringing minerals from deep in the soil and depositing them by leaf-fall).Furthermore, well-designed systems of agroforestry maximize beneficial interactions of the crop plants while minimizing unfavorable interactions *agrosilvipasture* (Negi, 1999). The most common interaction is competition, which may be for light, water, or soil nutrients. Competition invariably reduces the growth and yield of any crop. Yet competition occurs in monoculture as well, and this need not be more deleterious in agroforestry than monoculture systems. Interactions between components of an agroforestry system are often complementary.

In a system with trees and pasture, with foraging animals, the trees provide shade and/or forage while the animals provide manure. Thus, agroforestry systems limit the risks and increase sustainability of both small- and large-scale agriculture. Agroforestry systems may be thought of as principle parts of the farm system itself, which contains many other sub-systems that together define a way of life.

Agroforestry is the combination of agriculture and silviculture in one system where the species changes between perennials, annuals and utilization of, for example green manure, coppicing, diverging crop rotation, mulching, contour hedgerows or alley cropping. In agroforestry systems complementarily between the components is crucial to its success, and avoiding competition between different crops and trees are therefore one of the important factors to take into account when choosing species. This means that every agroforestry system must be adapted to the specific environment and socio-economic context (Nair, 1993). defined Agroforestry as the deliberate growing of wood perennials on the same unit of land as agricultural crops and /or animals, either in some form of spatial mixture or sequence. He also mentioned that there must be a significant interaction (positive and / or negative) between the woody and non woody component of the system, either ecologically and / or economically. The Agroforestry farmers allocated more land to agricultural crops relative to forest crops in the ratio 4:1. Various levels of agricultural and forest crop combinations to reduce risk were made. Risk adverse farmers plant more forest crops on their Agroforestry farms. Citrus: (*Citrus auriculum)* Citrus belong to family *Rutaceae*, it is a native of central Nagpur. It has been introduced much in South and Southeast Asia, Africa, South America and the Caribbean. It occurs mostly in lowland dry to humid tropics (600-1700mm annual rainfall) on normal soils but not waterlogged sites. (Donatus Ebereokwu, 2008). Citrus is mainly grown in arid irrigated and sub-mountain zone of Punjab. Due to higher juice content and better price it has becomes very popular among the farmers.

Rice (*Oryza sativa* L.) Rice (*Oryza sativa* L.) is the world's most important food crop of Asian origin, which plays a key role in food security. The genus *Oryza* includes 24 species, of which 22 are wild and two *viz*., *Oryza sativa* L. and *Oryza glaberrima* are cultivated. The basic number of chromosomes of genus *Oryza sativa* L. is 12 (2n=24). More than 90% of total rice production in the world is consumed in Asian countries, where it is a staple food for a majority of the population (Mohanty, 2013). India has 44.14 m ha area under rice and production of 106.65 million tonnes with an average yield of 2416 kg ha-1 during 2013-14 (GOI, 2016). Uttar Pradesh has an area of 5.98 m ha, production of 14.64 million tonnes and productivity of 2.447 t ha-1 of rice (GOI, 2016); but considering the present growth rate of population as well as per capita income, the demand for rice has been projected as much as 40% and around 156 million tonnes by 2030 to satisfy the growing demand without affecting the resource base adversely [ICAR, 2010; Brown, 1996; Brown, 1997]. India needs to produce 1.7 million tonnes of additional rice every year to ensure national food security (Dass and Chandra, 2013). Rice provides 35 to 60% of the dietary calories and 50 to 80% of the energy intake of the people in developing countries. Major constraints to rice production that India faces are high rate of seeds, low productivity and high inputs. Rapid spread of rice-based cropping system in India has caused an eclipse on sustainability and profitability of soil as well as crop productivity in the long run. Area under rice is expected to be reduced about 40 m ha in the next 15 to 20 years due to rapid urbanization (Bhatt, *et al.,* 2015). To avoid these difficulties and fulfill the demand of increasing population of India and lesser area under cultivation, there is an urgent need to adopt some innovative techniques to break the yield ceiling in rice.

Among cereal crops, rice (*Oryza sativa* L.*)*, belongs to the family *Gramineae*, is a major source of food after wheat for more than 2.7 billion people on a daily basis. It is the most important crop of India and second most important crop of the world. It is planted on about one-tenth of the earth's arable land and is the single largest source of food energy to half of humanity particularly in Asia where rice is the staple food. Major growing states in the country are WB, AP, CH, TN, KR, Assam, MS, Orissa, PB and GJ. Rice consumes 70 % of water used in Agriculture; hence judicious use of water for rice production in a sustainable manner has become prime importance. Cereals are the member of grasses, which belong to family *Gramineae* (*Poaceae*) cultivated for edible components of their grain composed of the endosperm, germ and bran and they are particularly important to humans because of their role as staple food crops in many regions of the world. In their natural form, they are rich source of carbohydrates, protein, vitamins, minerals and fats. Approximately 50% of the world's calories are provided by rice, wheat and maize. India shares the world's 21.6% rice production and accounts for 40% of the food grain production (Singh and Singh, 2011) in India.

SRI Method of Rice

SRI production and raises the productivity of land, labour, water and capital through different practices. Under SRI technique seedlings of the age 11-12 days have been transplanted at the spacing of 25 × 25 cm. For one hectare of transplanting 1/5th of seed rate is required compared to traditional system of rice cultivation. That means, instead of 25 kg/ha under traditional cultivation, it requires only 5 kg/ha seeds under SRI. Not only that, but instead of flooding the paddy field, soil should be kept moist during vegetative phase under SRI and only at later stages from panicle initiation till physiological maturity 5 cm water height should be maintained. Under SRI methodology is of interest, because of its potential to achieve higher yield at lower cost of production along with saving of 40 % water (Rao *et al.,* 2005; Anon, 2009).Rice is one of the most important cereal crops of the world. Presently more than 90% of total rice production and consumption is in Asia. Nutrient management in soil is an important aspect for increasing yield of rice. The major plant nutrients (N, P, K and S) and micronutrients (Fe, Zn, Mn, B and Mo) are deficient in several regions of the country which is a major challenge for sustainable rice production. Extractive farming has depleted inherent nutrient reserves and negative nutrient budget has been created. Consequently, both rice yield and response to applied chemical fertilizers have declined. Application of higher amount of high-analyses chemical fertilizers along with a minimal input of organic sources of nutrients is a major reason for deficiencies of secondary and micronutrients, particularly of S, Zn and Fe. Data from long-term experiments showed that neither organic sources nor chemical fertilizers can alone sustain crop production. Therefore, an integrated approach on application of organic and inorganic sources of plant nutrients is a prudent strategy which can maintain higher productivity by alleviating nutrients deficiencies on one hand and creating favourable physical and soil ecological conditions on the other. Hence present study was carried out to assess the effect of organic and inorganic sources of nutrients on growth, yield and soil fertility under 'HUR 105' rice cultivation.

Materials and Methods

Experimental site

The field experiment was conducted during Kharif season of 2017 at the Dept of Agroforestry, forest nursery of college of Forestry Sam Higginbottom University of Agriculture, Technology and Sciences, Allahabad UP.

Soil analysis

Soil samples were collected randomly from 15- 30 cm depth within each 10 m interval at the three physiographic positions of the experimental field prior to sowing and after harvest of the crop. Soil samples were air-dried, gently ground and passed through 2 mm sieve. The Sand 51.40), Silt 16.3,clay 29.57 textural class sandy loam Methods employed International Pipette Method (Piper, 1950) The soil organic matter was estimated by "Hydrochloric and Oxidation Method" as suggested by "Walkley and Black, 1965). The p^H of the soil was determined by Glass electrode p^H method. The results of the soil analysis were presented Chemical composition of soil in Cituse field Organic carbon (%)0.69%, Total Nitrogen (N) kg ha^{-1} 53 kg $ha^{-1.}$ Phosphorus (P) kg ha^{-1} 28.7 kg $ha^{-1.}$Potassium (K) kg $ha^{-1,}$ 23 kg $ha^{-1.}$Soil pH (1:2 soil water suspension w/v) 8.1. Methods employed Glass electrode p^H method Walkey and Black Method (Walkey and Black, 1965)

Treatment details and field layout

The field experiment was laid out in RBD randomized block design with three replications. The experiment comprised 9 treatment combinations consisting of three levels of Organic manure (FYM 10 t/ha, PM2t/h, VC5t/h). Rice variety NDR 3112 was grown within the alleys of 10 year old Citrus (*Citrus Auriculum)* plantation. The citrus trees were planted at a spacing of 4 x 4 m. Rice was transplanting at 25X25cm between the spacing the plants between the Citrus trees. There were a total of 9 rows of Rice within the alley of two rows of citrus The gross area 193.6 and net plot area 108 size was 2 x 2 m respectively. The distance between the citrus and Rice row was 1 m on both sides.

Cultural practices and observations

Organic manure were applied as per treatments 5 days before sowing respectively. FYM 10t/h vermicompost 5 t/h, and poultry manure 5 t/h elemental respectively.

The recommended dose 120N, 60P, 60K. The organic manure was applying the furrows at 5 cm below the seedling depth before sowing at the recommended seed rate Rice was 5 to 6 kg/ha and at 2.5 cm soil depth. The seeds were covered with the soil from the other side of furrow.

Eleven days after Transplanting (DAT) was done to maintain the desired plant population. Periodic hand weeding was done as and when needed. Rice was harvested from each plot when 95 per cent of panicles turned brownish-yellow and started harvesting after drying. The border rows were harvested and kept aside and the yield was measured by manually harvesting the net plot area.

Grain and stalk yields were recorded after proper sun-drying and tagged in bundles. Each bundle was weighed, threshed and cleaned separately and seed yield per plot was calculated from net plot. Grain and straw yields were recorded separately. Moisture in the seed was 10 per cent at the time of harvesting. Randomly selected ten plants were taken from each plot for agronomic observations of yield and yield parameters. Test weight of 1000 seeds from each plot was recorded with the seed yield.

Results and Discussion

Significantly higher values of Growth and Yield parameters in 2017 under citrus were obtained the Vermicompost 5 t/h.

FYM (Farm Yard Manure) 10 t/h and Poultry manure 5 t/h in comparison toT1: 100% RDN through Vermicompost. T2:75% RDN through vermicompost + 25% RDN through FYM. T3:50% RDN VM+ 25% RDN FYM + 25% RDN through PM. T4:100% RDN through FYM. T5: 75% RDN through FYM+ 25% RDN through PM. T6:50% RDN through FYM + 25% RDN PM + 25% RDN through VC. T7:100% RDN through Poultry manure. T8:75% RDN through Poultry manure + 25% RDN through VC T9:50% RDN through PM + 25% RDN VC + 25% RDN through FYM.

Growth parameters

Plant height (cm)

Significantly taller plant height of At 90 DAT interval, the highest plant height (107.40 cm) was observed in treatment (T_5 75% RDN through FYM+ 25% RDN through PM) Significant whereas observed in whereas, plant height was significant (Table 1). Plant height increased and.

Number of tillers hill^{-1}

Significantly tiller of at 90DAT interval, highest Number of tillers hill^{-1} (17.53cm) was observed in treatment (T_5 75% RDN through FYM+ 25% RDN through PM), Number of tillers hill^{-1} was significant (Table 1). Number of tillers hill^{-} increased and.

Leaf (flag) length (cm)

Significantly taller At 90 DAT interval, the highest leaf flag length (62.86 cm) was observed in treatment (T_5 75% RDN through FYM+ 25% RDN through PM) Leaf flag length was significant (Table 1). Leaf flag length (cm) increased.

Plant dry weight (g hill^{-1})

Significantly taller At 90 DAT interval, the highest Plant dry weight (115.06 gm hill^{-1}) was observed in treatment (T_5 75% RDN through FYM+ 25% RDN through PM) was significant (Table 1). Plant dry weight (g hill^{-1}) increased

Leaf Area Index (LAI)

Significantly taller At 90 DAT interval, the highest Leaf Area Index (LAI) (13.00 cm) was observed in treatment (T_5 75% RDN through FYM+ 25% RDN through PM) Leaf Area Index was significant (Table 1). Leaf Area Index (LAI) increased respectively

Generally in treatments with SRI method of transplanting component, which may have allowed greater potential for increase rooting. Further, due to shade plant height, no tillers, leaf length, dry weight and leaf area during the initial growth stages, the stimulating effect on shade but increased soil moister may have caused more soil moisture elongation and increased.

These findings corroborate with Dhananchezhiya (2013) Chaudhary (2014). subashbabu (2015).This parameter is of importance, perhaps due to the fact that SRI organic rice is getting acclimatized to under citrus based agroforestry system.

Table.1 Application of organic manure for growth and yield of rice using SRI method under Citrus based agroforestry system Growth parameters of *Kharif* rice data of 2017

Treatment	**Treatment Combinations**	**Plant Height (cm)**	**Number of tillers hill-1**	**leaf length (cm)**	**Plant dry weight (g hill-1)**	**Leaf Area Index (LAI)**
		90DAT	90DAT	90DAT	90DAT	90DAT
T_1	100% RDN through Vermicompost.	104.80	16.06	57.96	108.93	12.26
T_2	75% RDN through vermicompost + 25% RDN through FYM.	105.13	16.53	56.80	112.26	12.06
T_3	50% RDN VM+ 25% RDN FYM + 25% RDN through PM.	104.13	15.66	60.06	108.73	12.33
T_4	100% RDN through FYM.	105.53	15.46	55.53	111.06	11.40
T_5	75% RDN through FYM+ 25% RDN through PM.	107.40	17.53	62.86	115.06	13.00
T_6	50% RDN through FYM + 25% RDN PM + 25% RDN through VC.	105.67	16.53	60.20	111.53	11.06
T_7	100% RDN through Poultry manure.	98.27	14.60	52.93	97.26	9.80
T_8	75% RDN through Poultry manure + 25% RDN through VC.	105.67	16.80	62.66	113.86	12.53
T_9	50% RDN through PM + 25% RDN VC + 25% RDN through FYM.	105.50	17.06	55.13	100.86	10.46
	F test	S	S	S	S	S
	C.D. (0.05%)	4.456	1.38	2.66	7.28	1.42
	S Ed(±)	1.82	0.39	0.83	1.92	0.57

NOTE: VC: Vermicompost FYM :Farm Yard Manure- PM: Poultry manure - RDN: Recommended dose of nitrogen (100% = 120 kg ha^{-1})
DAT: Days After Transplanting S:Significant SN: Non-significant

Table.2 Application of organic manure for growth and yield of rice using SRI method under citrus based agroforestry system yield attributes: and yield of Kharif rice pooled data of 2017

	Treatment Combinations	Length of panicle (cm)	Number of grains hill-[1]	Test weight (g)	Grain yield (t ha-1)	Straw yield (t ha-1)
		At harvesting time	At harvesting time	After harvesting	After harvesting	After harvesting
T_1	100% RDN through Vermicompost.	30.00	935	29.10	2,36	3,24
T_2	75% RDN through vermicompost + 25% RDN through FYM.	30.26	952	28.60	2,96	3,84
T_3	50% RDN VM+ 25% RDN FYM + 25% RDN through PM.	26.20	869	27.83	3,56	4,21
T_4	100% RDN through FYM.	29.40	857	31.73	3,68	4,26
T_5	75% RDN through FYM+ 25% RDN through PM.	**32.73**	**1,103**	**33.13**	**3,71**	**4,40**
T_6	50% RDN through FYM + 25% RDN PM + 25% RDN through VC.	29.46	1,045	27.60	2,30	3,22
T_7	100% RDN through Poultry manure.	26.06	837	26.86	2,24	3,20
T_8	75% RDN through Poultry manure + 25% RDN through VC.	27.20	898	29.13	2,61	3,50
T_9	50% RDN through PM + 25% RDN VC + 25% RDN through FYM.	27.46	897	28.26	2,47	3,37
	F test	S	**S**	S	S	S
	C.D. (0.05%)	1.09	133.97	1.97	71.6	77.37
	S Ed(±)	0.36	35.32	0.56	18.28	21.43

VC: Vermicompost FYM: Farm Yard Manure PM: Poultry manure RDN: Recommended dose of nitrogen (100% = 120 kg ha-1)
DAT: Days After Transplanting S: Significant SN: Non-significant

Yield attributes and yield

Length of panicle (cm)

Significantly taller at harvesting time, the highest Length of panicle (32.73 cm) was observed in treatment (T_5 75% RDN through FYM+ 25% RDN through PM) Length of panicle was significant (Table 2).

Number of grain per hill^{-1}

Significantly taller at harvesting time the highest Number of panicle per hill-^{1} (1,103) was observed in treatment (T_5 75% RDN through FYM+ 25% RDN through PM) Number of panicle per hill-^{1} was significant.

Test weight

Significantly taller at harvesting time the highest Test weight (g) (33.13 g) was observed in treatment (T_5 75% RDN through FYM+ 25% RDN through PM) Test weight was significant.

Grain yield

Significantly taller At harvesting time the highest Grain yield (3.71 t/ha^{-1}) was observed in treatment (T_5 75% RDN through FYM+ 25% RDN through PM) Grain yield (t/ha-1) was significant.

Straw yield

Significantly taller At harvesting time the highest Straw yield (4.40t/ha^{-1} was observed in treatment (T_5 75% RDN through FYM+ 25% RDN through PM) Straw yield (t/ha^{-1} was significant.

Benefit cost ratio

Significantly taller at harvesting time the highest Benefit cost ratio 1:5.4 was observed in treatment (T_5 75% RDN through FYM+ 25% RDN through PM) was significant. Generally in treatments with SRI method of transplanting component, which may have allowed greater potential for increase rooting. Further, due to shade. Length of panicle, Number of panicle per hill^{-1} Test weight during the initial Yield Attributes, Grain yield, Straw yield and BC ratio during the initial Yield. he stimulating effect on shade but increased soil moister may have caused more soil moisture elongation and increased These findings corroborate with Mamtameena, 2014 Chaudhary, 2014 Amarsingh, 2014. Srivastava, 2014. Sureshkumar, 2016. This parameter is of importance, perhaps due to the fact that SRI organic rice is getting acclimatized to under citrus based agroforestry system

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