International Research Journal of Pure & Applied Chemistry

21(6): 1-10, 2020; Article no.IRJPAC.55915
ISSN: 2231-3443, NLM ID: 101647669

Nutrient Uptake and Soil Fertility Status under Different Cropping Systems for Integrated Farming Systems of Telangana State, India

Ch. Pragathi Kumari[1*], M. Goverdhan[1], G. Kiran Reddy[2] and S. Sridevi[3]

[1]Department of Agronomy, AICRP on Integrated Farming Systems, PJTSAU, Hyderabad-30, Telangana, India.
[2]Department of Soil Science, AICRP on Integrated Farming Systems, PJTSAU, Hyderabad-30, Telangana, India.
[3]Department of Soil Science, Agricultural Polytechnic, PJTSAU, Tornala, Siddipet District, Hyderabad-30, Telangana, India.

Authors' contributions

This work was carried out in collaboration among all authors. Author CPK designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors MG and GKR managed the analyses of the study. Author SS managed the literature searches. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IRJPAC/2020/v21i630170
Editor(s):
(1) Dr. Wolfgang Linert, Vienna University of Technology Getreidemarkt, Austria.
Reviewers:
(1) Jimmy Walter Rasche Alvarez, Universidad Nacional de Asunción, Paraguay.
(2) Bhaskara Phaneendra, India.
(3) Jacob Omondi Omollo, Kenya Agricultural and Livestock Research Organization, Kenya.
Complete Peer review History: http://www.sdiarticle4.com/review-history/55915

Original Research Article

Received 08 February 2020
Accepted 14 April 2020
Published 21 April 2020

ABSTRACT

An Randamised Block Design (RBD) field investigation with ten crop sequences under irrigation with recommended package of practices in sandy loam soils of Southern Telangana Zone (STZ), Telangana was carried out during *Kharif, Rabi* and summer of 2018-2019 with an objective of the nutrient uptake and soil fertility status under different cropping systems and to assess agro economic benefit. These ten cropping systems were grouped in to five categories *viz*., pre dominant cropping systems of the zone, ecological cropping systems, household nutritional security giving cropping systems, fodder security giving cropping systems and cropping systems involving high value crops. So that from each category, best cropping system can be identified and can be

**Corresponding author: E-mail: pragathi.agronomy@gmail.com, drpragathiagro@gmail.com;*

suggested to different integrated farming systems models. In the context of farming systems, under high value crops such as Okra–Marigold–Beetroot system recorded significantly higher rice grain equivalent yield (36,434 kg ha^{-1}) over other systems. Among the ecological cropping systems for improving soil health, Bt cotton + green gram (1:3) - groundnut cropping system was recorded significantly higher rice grain equivalent yield (14,080 kg ha^{-1}) as compared to pigeon pea + green gram (1:7) – sesame cropping system. Among the household nutritional security giving crops, pigeon pea + maize (1:3) – groundnut system was recorded higher rice grain equivalent yield (13,693 kg ha^{-1}). Within the two fodder crops, fodder maize – lucerne system was resulted in higher rice grain equivalent yield (7,709 kg ha^{-1}). Rice - maize and Bt cotton which were the pre-dominant cropping systems of the region wherein rice – maize system recorded comparatively higher rice grain equivalent yield (11,771 kg ha^{-1}) than Bt cotton. Fodder systems were found to be more exhaustive than all other cropping systems. However, within two years of experimentation the changes in physic-chemical properties and soil fertility status were not significantly affected except organic carbon. Organic carbon was high (0.45 %) in case of pigeon pea + green gram (1:6) - sesame cropping system.

Keywords: Cropping systems; system productivity; nutrient uptake; soil fertility.

1. INTRODUCTION

There is a pressing need to meet the food grain requirements of the growing population and to sustain a reasonably higher productivity level. Hence, there is an urgency to diversify into new areas like vegetables, fodder, oilseeds, pulses and allied fields crops. Crop diversification has been recognized as an effective strategy for achieving the objectives of food security, nutritional security, growth of income, poverty alleviation, employment generation and the judicious use of land and water resources, sustainable agriculture development and environmental improvement [1]. Diversified cropping systems broaden the source of a farmer's food and income, increases their land productivity, and minimizes unpredictable risks such as the build-up of pest and diseases. Gangwar and Ram [2] reported that inclusion of legumes and other crops using intensification and interruptive approaches, as per resource availability, leads to considerable improvement in productivity and profitability, including soil fertility. Intercropping of short duration cereals and pulses provides an opportunity to utilize of available resources more efficiently with enhancement of productivity and profitability of different cropping systems. Demand for fodder has increased due to increase in dairy units during the last few decades in different farming systems. Therefore, there is possibility of growing crops like fodder cowpea and fodder maize to solve the problem of fodder scarcity.

Rice, maize and Bt cotton are the predominant crops which are either grown solely or in rotation with other crops in the Sothern Telangana Zone of Telangana state, India. As all the above crops are exhaustive, non–leguminous in nature, some other cropping systems are to be identified to compliment the crops and to improve soil sustainability in cropping system module. Several workers [3,4,5] reported that the productivity and income is far higher when integrated farming systems are practiced than crops alone. In view of this farming system perspective, inclusion of ecological cropping systems, involving pulses for improving soil health, cropping system involving cereals / pulses / oilseeds to meet the household nutritional security, cropping system for round the year green fodder production and cropping systems involving vegetables and other high value crops are to be studied for their productivity and sustainability. The choice of appropriate nutrient management and crop sequence determines the efficiency of nutrients. Nutrient uptake by crop is driven by the demand for nutrients from the developing crop, which is regulated by the supply of nutrients from the soil. Nutrients are taken up throughout the growing season and in proportion with the demand for nutrients as dictated by the developing crop biomass. Hence, judicious nutrient management planning in a cropping system perspective is the need of the hour. Keeping this in mind, present study was conducted.

2. MATERIALS AND METHODS

The study was conducted at college farm, All India Coordinated Research Project on Integrated Farming Systems unit, Professor Jayashankar Telangana Sate Agricultural University, Rajendranagr, Hyderabad during 2018-19. The soil was sandy loam, low in organic carbon (0.39%), available nitrogen (112 kg ha $^{-1}$), medium in available phosphorus (23.4 kg ha^{-1}) and available potassium (170 kg ha^{-1}). The treatments consisted of ten crop sequences. The experiment was laid out in Randomised Block Design, replicated thrice and the site of the experimental field was same through out the experimentation. The varieties of different crops used were rice - RNR 15048, groundnut – K 6, green gram- MGG 295, pigeon pea – PRG 176, sesamum- Swetha thil, finger millet – Hima, fodder sorghum – CSH 24 MF and fodder cowpea – Vijaya. Crops were sown under irrigated conditions with recommended package of practices of the region. In the context of identifying best crops and cropping systems that are suitable for farming systems of Southern Telangana Zone of Telangana state, various combination of crop sequences were studied. The ten combinations of cropping systems tested were grouped in to five subsets. They are pre-dominant cropping systems of the region (T_1 and T_2), T_1: rice - maize, T_2: Bt cotton, second sub set (T_3 and T_4) included ecological cropping systems for improving soil health *viz.*, T_3: Bt cotton + greengram (1:3) - groundnut, T_4: pigeonpea + greengram (1:6) - sesame, under cropping systems to meet the household nutritional security (T_5 and T_6) T_5 : pigeonpea + maize (1:3)-groundnut, T_6: pigeonpea + groundnut (1:7) - ragi, within cropping systems for round the year green fodder production (T_7 and T_8) T_7: fodder sorghum + fodder cowpea (1:2) – horsegram - sunhemp, T_8: fodder maize - lucerne, under cropping systems involving vegetables and other high value crops for income enhancement (T_9 & T_{10}) T_9 : sweet corn - vegetables (tomato), T_{10}: okra – marigold – beetroot. All the *kharif* crops were sown on04.07.2018 and the same sequence of crops during *rabi* were taken up as and when the preceding *kharif* crops were harvested in the respective plots. Economic yield and stover/straw/stalk yields were recorded individually for all the crops. For comparison of different crop sequences, the yields of all the crops were converted in to rice grain equivalent yield on price basis. Rice equivalent yield (REY) was calculated to compare system performance by converting the yield of non-rice crops into equivalent rice yield on a price basis, using the formula,

REY = Yx(Px/Pr), where Yx is the yield of non-rice crops (kg ha^{-1}), Px is the price of non-rice crops (Rs) and Pr is the price of rice crop. Grain and seed samples at harvesting stage were collected, oven dried and ground for analysis of nitrogen, phosphorous and potassium uptake. The total nitrogen content (%) in the dried plant sample was determined by microkjeldahl distillation method [6]. The diacid extract (9:4 nitric acid: perchloric acid) was used for analysis of total phosphorus and potassium in plant samples. Concentration of nutrient was multiplied by yield for calculation of nutrient uptake. Used randomized block design with three replications and ten treatments.

3. RESULTS AND DISCUSSION

3.1 Performance of Crop Sequences

Results of field experiment revealed that out of ten crop sequences under study, okra–marigold–beetroot system recorded significantly higher rice grain equivalent yield (36,434 kg ha^{-1}) over other crops evaluated in different cropping systems (Table 1). Among the ecological cropping systems, means cropping systems for improving soil health, *Bt* cotton + greengram (1:3) groundnut cropping system recorded significantly higher rice grain equivalent yield (14,080 kg ha^{-1}) than pigeon pea + green gram (1:6) - sesame (8,391 kg ha^{-1}) cropping system. Out of the two systems tested to meet the household nutritional security, maize + pigeonpea (1:3) – groundnut system recorded higher rice grain equivalent yield (13,693 kgha^{-1}) over pigeonpea + groundnut (1:7) - ragi system. Out of the two fodder crops, fodder maize – lucerne system resulted in higher rice grain equivalent yield (7,709 kgha^{-1}) than fodder sorghum + fodder cow pea (1:2) - horsegram – sunhemp system (6,666 kg ha^{-1}). Rice and Bt cotton were tested as pre-dominant cropping systems of the region and rice – maize system recorded higher rice grain equivalent yield (11,771 kgha^{-1}) than Bt cotton alone (6,561 kgha^{-1}). Among the cropping systems involving vegetables and other high value crops for income enhancement sweet corn –tomato system was found to be more remunerative (25,557 kgha^{-1}) than okra–marigold–beetroot system. These results are in accordance with Pragathi Kumari et al. [7,8].

Banik and Sharma [9] also reported that cereal - legume intercropping systems were superior to mono cropping. For instance, studies in the semi-arid tropics of India revealed that the addition of pigeonpea, as a sole crop or as an intercrop in a cropping system, not only helps soil N fertility, but also makes more phosphorus reserves available for subsequent crops [10].

3.2 Nutrient Uptake

Nutrient uptake by various crops and cropping systems varied significantly and the uptake of nitrogen, phosphorus and potassium are presented in the Tables 2 to 8.

3.3 Nitrogen Uptake

During *kharif*, among the crops and cropping systems, fodder crops were found to be more exhaustive (Table 2). Out of the two fodder crops, fodder sorghum + fodder cow pea (1:2) system removed maximum nitrogen (273.0 kg ha^{-1}) and was followed by fodder maize (207.4 kg ha^{-1}). Among the ecological cropping systems for improving soil health, nitrogen removal by both the systems was statistically on par. However, Bt cotton + greengram (1:3) cropping system removed slightly higher quantities of nitrogen (100.7 kg ha^{-1}) than pigeonpea + greengram (1:3) cropping system (84.8 kg ha^{-1}). Out of the two systems tested to meet the household nutritional security, both maize + pigeonpea (1:3) and pigeonpea + groundnut (1:7) systems removed almost similar quantities of nitrogen with 128.4 and 137.9 kg ha^{-1} respectively. Sweet corn and okra were tested under cropping systems involving vegetables and other high value crops for income enhancement and sweet corn was found to be more exhaustive with 189.8 kg ha^{-1} nitrogen removal than bhendi (40.9 kg ha^{-1}). Rice and Bt cotton were tested as pre-dominant cropping systems (Check) of the region and nitrogen removal by both the crops was at par.

During *rabi* and summer (Table 5), marigold-beetroot removed maximum nitrogen (236.6 kg ha^{-1}) and was closely followed by lucerne crop (212.7 kg ha^{-1}). Lowest nutrient uptake was observed with sesame (33.4 kg ha^{-1}). In terms of system uptake, rice-maize and Bt cotton were tested as pre-dominant cropping systems (check) of the region and nitrogen removal by rice-maize was higher (165.2 kg ha^{-1}). The system nitrogen uptake out of the two fodder crops was maximum with fodder sorghum + fodder cowpea (1:2) – horsegram - sunhemp fodder system (448.4 kg ha^{-1}) and was followed by fodder maize - lucerne system (420.1 kg ha^{-1}). Among the ecological cropping systems, for improving soil health, nitrogen removal by Btcotton+greengram (1:3)-groundnut cropping system slightly higher (160.3 kg ha^{-1}) than pigeonpea + greengram (1:6) – sesame cropping system (118.2 kg ha^{-1}). Out of the two systems tested to meet the household nutritional security, both pigeonpea+maize (1:3)-groundnut and pigeonpea + groundnut (1:7) – ragi systems removed almost similar quantities of nitrogen with 190.3 and 197.8 kg ha^{-1} respectively. Sweet corn-vegetables (tomato) system (362.1 kg ha^{-1}) and okra – marigold – beetroot (277.5 kg ha^{-1}) systems were tested under cropping systems involving vegetables and other high value crops for income enhancement and the former was found to be more exhaustive.

3.4 Phosphorus Uptake

Among the crops and cropping systems tested, sweet corn was found to be more exhaustive with higher phosphorus removal (Table 3). In case of fodder crops, both fodder sorghum + fodder cowpea (1:2) (23.9 kg ha^{-1}) and fodder maize (31.6 kg ha^{-1}) removed significant quantities of phosphorus. Among the ecological cropping systems for improving soil health, phosphorus removal by both the systems was statistically on par. However, Bt cotton + greengram (1:3) cropping system removed slightly higher quantities of phosphorus (10.8 kg ha^{-1}) than pigeonpea + greengram (1:3) cropping system (9.2 kg ha^{-1}). Out of the two systems tested to meet the household nutritional security involving , maize + pigeonpea (1:3) system removed significantly higher quantities of phosphorus (30.5 kg ha^{-1}) than pigeonpea + groundnut (1:7) system (14.7 kg ha^{-1}). Sweet corn and okra were tested under cropping systems involving vegetables and other high value crops for income enhancement and sweet corn was found to be more exhaustive with four times higher phosphorus removal (34.3 kg ha^{-1}) than bhendi (8.4 kg ha^{-1}). Rice and Bt cotton were tested as pre-dominant cropping system of the region and phosphorus removal by rice (27.1 kg ha^{-1}) was significantly higher than Bt cotton (9.1 kg ha^{-1}).

During *rabi* and summer (Table 6), marigold-beetroot removed maximum phosphorus (40.3 kg ha^{-1}) and was followed by maize crop (29.9 kg ha^{-1}). Lowest nutrient uptake was observed with sesame (6.9 kg ha^{-1}). In terms of system uptake (Table 8), rice-maize and Bt cotton were tested as pre-dominant cropping systems (Check) of the region and phosphorus removal by maize was 57 kg ha^{-1}. The system phosphorus uptake out of the two fodder crops was high in fodder maize - lucerne system (45.7 kgha^{-1}) over fodder sorghum + fodder cowpea (1:2) – horsegram - sunhemp fodder system (38.2.4 kg ha^{-1}). Among

Table 1. Performance of crops in various cropping systems

Treatments		*Kharif* (2018)				*Rabi* (2018-19)		Summer (2018-19)		Rice grain equivalent yield (kg ha^{-1})						Productivity			
Kharif-Rabi		Grain yield (kg ha^{-1})		Straw/Stover yield(kg ha^{-1})		Grain Yield	Straw/Stalk/ Stover yield	Grain Yield	Stover yield	*Kharif*		*Rabi*		Summer		(RGEY kg ha^{-1})			
		Main crop	Inter crop	Main crop	Inter crop	(kg ha^{-1})	(kg ha^{-1})	(kg ha^{-1})	(kg ha^{-1})	Grain	Straw	Grain	Straw	Grain	Straw	*Kharif*	*Rabi*	*Summer*	*System*
T1	Rice-Maize	5885	0	6884	0	5313	6907			5885	393	5103	390			6278	5493	0	11771
T2	Bt Cotton	2084	0	4947	0	0	0			6490	71	0	0			6561	0		6561
T3	Btcotton+Greengram (1:3)- Groundnut	1971	384	4687	800	2016	2420			7669	158	5570	684			7827	6253	0	14080
T4	Pigeon pea + Greengram (1:6) - Sesame	1104	440	3672	925	814	1799			5334	158	2874	25			5492	2899	0	8391
T5	Pigeon pea+Maize (1:3)-Groundnut	5642	445	7347	1532	2040	2447			6924	442	5636	691			7366	6327	0	13693
T6	Pigeonpea + Groundnut (1:7) - Ragi	1178	1360	3944	2184	1912	4155			7621	431	3129	59			8052	3188	0	11240
T7	Fodder sorghum + Fodder cowpea (1:2) – Horsegram - Sunhemp	0	0	13559	15690	0	8406		17422	0	4239	0	950		1476	4239	950	1476	6666
T8	Fodder maize - Lucerne	0	0	39349	0	0	28427			0	4497	0	3212			4497	3212	0	7709
T9	Sweetcorn-Vegetables (Tomato)	16845	0	20431	0	26667	5386			8663	1751	15066	76			10415	15142	0	25557
T10	Okra – Marigold - Beetroot	6111	0	1585	0	12157	6434	15375	3168	6984	23	20605	91	8686	45	7007	20696	8731	36434
	S Em±															363	2579.0		
	CD (0.05)															1088	861.0		
	CV (%)															9.8	19.0		

Sale price for Grain (kg-1): Rice = Rs 17.7, Maize = Rs 17.0, Groundnut = Rs 48.9, Bhendi = Rs 20.00, Bt Cotton = Rs 54.5, Greengram = Rs 69.75, Pigeonpea = Rs 56.75, Sweet corn = Rs 9.0, Tomato = Rs 10.0, Sesame = Rs 62.49, Fingermillet = Rs 28.97, Marigold = Rs 50.00, Beetroot = Rs 10.00.

Sale price for stover (kg-1): Rice = Rs 1.00 Maize = Rs 1.00, Bhendi = Rs 0.25, Groundnut = 5.00, Greengram = Rs 2.00, Bt cotton = 0.25, Pigeonpea = Rs 0.25, Fodder sorghum = Rs 2.00, Fodder cowpea = 3.00, Fodder maize = 2.00, Tomato = Rs 0.25 Sesame =Rs 0.25, Fingermillet = Rs 0.25, Horsegram = Rs 2.0, Sunhemp = Rs1.5, Lucerne = Rs 2.0, Marigold = Rs 0.25, Beetroot = Rs 0.25 the ecological cropping systems for improving soil health, phosphorus removal by Bt cotton+greengram (1:3)- groundnut cropping system slightly higher (18.5 kg ha^{-1}) than pigeonpea + greengram (1:6) – sesame cropping system (16.1 kg ha^{-1}) and both were on par. Out of the two systems tested to meet the household nutritional security, both pigeonpea+maize (1:3)-groundnut (38.1 kg ha^{-1}) removed significantly more phosphorus than pigeonpea + groundnut (1:7) – ragi system (23.7 kg ha^{-1}). Sweet corn-vegetables (tomato) system (58.6 kg ha^{-1}) and okra – marigold – beetroot (48.7 kg ha^{-1}) systems were tested under cropping systems involving vegetables and other high value crops for income enhancement and the former was found to be more exhaustive. These results were supported by Pragathi Kumari et al. [7,8].

3.5 Potassium Uptake

Similar to nitrogen removal fodder maize was found to be more exhaustive among the crops and cropping systems with more potassium removal (Table 4). Fodder maize (359.2 kg ha^{-1}) removed significantly higher potassium than fodder sorghum + fodder cowpea (1:2) fodder system (159.7 kg ha^{-1}). Among the ecological cropping systems for improving soil health, Bt cotton + greengram (1:3) cropping system removed significantly higher quantities of potassium (62.3 kg ha^{-1}) than pigeonpea+ greengram (1:3) cropping system (43.6 kg ha^{-1}). Out of thetwo systems tested to meet the household nutritional security, both maize + pigeonpea (1:3) removedsignificantly higher quantities of potassium (100.4 kg ha^{-1}) than

Table 2. Nitrogen uptake (kg ha-1) by crops in various cropping systems during *kharif,* 2018

Treatment		Grain			Stover			Total G+S
Crop /Cropping System (*kharif*)		Main crop	Inter crop	Total	Main crop	Inter crop	Total	
T1	Rice	58.3	0.0	58.3	39.0	0.0	39.0	97.3
T2	Bt cotton	35.6	0.0	36.1	53.6	0.0	53.6	89.2
T3	Bt cotton + Greengram (1:3)	30.8	10.1	40.9	50.9	8.9	59.8	100.7
T4	Pigeon pea + Greengram (1:3)	27.0	12.3	39.3	35.0	10.5	45.5	84.8
T5	Maize + Pigeon pea (1:3)	60.9	11.9	72.8	41.6	14.0	55.6	128.4
T6	Pigeon pea + Groundnut (1:7)	30.4	41.6	71.6	38.0	27.9	65.9	137.9
T7	Fodder sorghum + Fodder Cow pea (1:2)	0.0	0.0	0.0	118.7	154.3	273.0	273.0
T8	Fodder maize	0.0	0.0	0.0	207.4	0.0	207.4	207.4
T9	Sweet corn	85.6	0.0	85.6	104.2	0.0	104.2	189.8
T10	Bhendi	36.4	0.0	36.4	4.5	0.0	4.5	40.9
	SE(m)±							11.46
	CD @ 5%							34.31
	CV(%)							14.73

Table 3. Phosphorus uptake (kg ha^{-1}) by crops in various cropping systems during *kharif*, 2018

Treatment		Grain			Stover			Total G+S
Crop /Cropping System (*kharif*)		Main crop	Inter crop	Total	Main crop	Inter crop	Total	
T1	Rice	18.0	0.0	18.0	9.1	0.0	9.1	27.1
T2	Bt cotton	4.8	0.0	4.8	4.3	0.0	4.3	9.1
T3	Bt cotton + Greengram (1:3)	4.7	1.1	5.8	4.2	0.8	5.0	10.8
T4	Pigeon pea + Greengram (1:3)	3.4	1.3	4.7	3.6	0.9	4.5	9.2
T5	Maize + Pigeon pea (3:1)	15.6	1.4	17.0	11.9	1.6	13.5	30.5
T6	Pigeon pea + Groundnut (1:7)	3.6	4.6	8.2	4.9	1.7	6.6	14.7
T7	Fodder sorghum + Fodder Cow pea (1:2)	0.0	0.0	0.0	9.0	14.9	23.9	23.9
T8	Fodder maize	0.0	0.0	0.0	31.6	0.0	31.6	31.6
T9	Sweet corn	17.7	0.0	17.7	16.6	0.0	16.6	34.3
T10	Bhendi	7.0	0.0	7.0	1.4	0.0	1.4	8.4
	SE(m)±							1.84
	CD @ 5%							5.53
	CV(%)							16.04

Table 4. Potassium uptake (kg ha^{-1}) by crops in various cropping systems during *kharif*, 2018

Treatment		Grain			Stover			Total G+S
Crop /Cropping System (*kharif*)		Main crop	Inter crop	Total	Main crop	Inter crop	Total	
T1	Rice	28.0	0.0	28.0	92.8	0.0	92.8	120.8
T2	Bt cotton	15.9	0.0	15.9	44.2	0.0	44.2	60.1
T3	Bt cotton + Greengram (1:3)	15.3	2.9	18.2	40.7	3.4	44.1	62.3
T4	Pigeon pea + Greengram (1:3)	8.5	3.3	11.8	28.0	3.8	31.8	43.6
T5	Maize + Pigeon pea (1:3)	22.6	3.4	26.0	62.8	11.6	74.4	100.4
T6	Pigeon pea + Groundnut (1:7)	8.9	7.3	16.2	31.5	7.7	38.3	55.4
T7	Fodder sorghum + Fodder Cow pea (1:2)	0.0	0.0	0.0	106.3	53.4	159.7	159.7
T8	Fodder maize	0.0	0.0	0.0	359.2	0.0	359.2	359.2
T9	Sweet corn	26.3	0.0	26.3	204.8	0.0	204.8	231.1
T10	Bhendi	51.1	0.0	51.1	8.5	0.0	8.5	59.6
	SE(m)±							13.50
	CD @ 5%							40.66
	CV(%)							16.78

Table 5. Nitrogen uptake (kg ha^{-1}) by crops in various cropping systems during *rabi* and summer, 2018-19

Treatment		Grain			Stover			Total (G+S)
Crop / CS (*Rabi* / Summer)		Rabi	Summer	Total	Rabi	Summer	Total	
T1	Maize	33.1	0.0	33.1	34.8	0.0	34.8	67.9
T2	Fallow	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T3	Groundnut	50.9	0.0	50.9	8.7	0.0	8.7	59.6
T4	Sesame	18.4	0.0	18.4	15.0	0.0	15.0	33.4
T5	Groundnut	52.4	0.0	52.4	9.5	0.0	9.5	61.9
T6	Ragi	24.8	0.0	24.8	35.1	0.0	35.1	59.9
T7	Horsegram-Sunhemp	0.0	0.0	0.0	29.5	145.9	175.4	175.4
T8	Lucerne	0.0	0.0	0.0	212.7	0.0	212.7	212.7
T9	Tomato	161.7	0.0	161.7	10.6	0.0	10.6	172.3
T10	Marigold-Beetroot	71.4	121.9	193.3	32.9	10.4	43.3	236.6
	SE(m)±							4.64
	CD @ 5%							13.61
	CV(%)							7.45

pigeonpea + groundnut (1:7) system (55.4 kg ha^{-1}). Sweet corn and okra were tested under cropping systems involving vegetables and other high value crops for income enhancement and sweet corn was found to be four times more exhaustive with 231.1 kg ha^{-1} potassium removal than okra (59.6 kg ha^{-1}). Rice and Bt cotton were tested as pre-dominant cropping system of the region and potassium removal by rice crop (120.8 kg ha^{-1}) was two times higher than Bt cotton (60.1 kg ha^{-1}).

During *rabi* and summer (Table 7), horsegram - sunhemp (162.2 kg ha^{-1}) system removed maximum potassium and was followed by lucerne crop (146.7 kg ha^{-1}). Lowest nutrient uptake was observed with sesame (14.7 kg ha^{-1}). In terms of system uptake, rice-maize and Bt cotton were tested as pre-dominant cropping systems (Check) of the region and potassium removal by rice-maize was higher (199.4 kg ha^{-1}). The system potassium uptake, out of the two fodder crops was maximum with fodder maize – lucerne system (505.9 kg ha^{-1}) and was followed by fodder sorghum + fodder cowpea (1:2) – horsegram - sunhemp (321.9 kg ha^{-1}). Among the ecological cropping systems for improving soil health, potassium removal by Bt cotton+greengram (1:3)- groundnut cropping system slightly higher (79.3 kg ha^{-1}) than pigeonpea + greengram (1:6) – sesame cropping system (58.3 kg ha^{-1}). Among the two systems tested to meet the household nutritional security, both pigeonpea + maize (1:3)-groundnut (117.4 kg ha^{-1}) removed higher quantities of potassium than pigeonpea + groundnut (1:7) – ragi system

Table 6. Phosphorus uptake (kg ha^{-1}) by crops in various cropping systems during rabi and summer, 2018-19

	Treatment	Grain			Stover			Total
	Rabi & summer	Rabi	Summer	Total	Rabi	Summer	Total	(G+S)
T1	Maize	16.3	0.0	16.3	13.6	0.0	13.6	29.9
T2	Fallow	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T3	Groundnut	6.2	0.0	6.2	1.5	0.0	1.5	7.7
T4	Sesame	2.9	0.0	2.9	4.0	0.0	4.0	6.9
T5	Groundnut	5.9	0.0	5.9	1.7	0.0	1.7	7.6
T6	Ragi	4.9	0.0	4.9	4.1	0.0	4.1	9.0
T7	Horsegram-Sunhemp	0.0	0.0	0.0	5.6	8.7	14.3	14.3
T8	Lucerne	0.0	0.0	0.0	14.1	0.0	14.1	14.1
T9	Tomato	23.2	0.0	23.2	1.1	0.0	1.1	24.3
T10	Marigold-Beetroot	15.1	21.4	36.5	2.4	1.4	3.8	40.3
	SE(m)±							1.36
	CD @ 5%							3.98
	CV(%)							15.25

Table 7. Potassium uptake (kg ha^{-1}) by crops in various cropping systems during *rabi and summer*, 2018-19

	Treatment	Grain			Stover			Total
	Crop / Crop System	Rabi	Summer	Total	Rabi	Summer	Total	(G+S)
T1	Maize	25.9	0.0	25.9	52.7	0.0	52.7	78.6
T2	Fallow	0.0	0.0	0.0	0.0	0.0	0.0	0.0
T3	Groundnut	9.8	0.0	9.8	7.2	0.0	7.2	17.0
T4	Sesame	2.4	0.0	2.4	12.3	0.0	12.3	14.7
T5	Groundnut	9.9	0.0	9.9	7.1	0.0	7.1	17.0
T6	Ragi	5.5	0.0	5.5	16.7	0.0	16.7	22.2
T7	Horsegram-Sunhemp	0.0	0.0	0.0	34.4	127.8	162.2	162.2
T8	Lucerne	0.0	0.0	0.0	146.7	0.0	146.7	146.7
T9	Tomato	76.6	0.0	76.6	15.6	0.0	15.6	92.2
T10	Marigold-Beetroot	81.9	35.3	117.2	16.6	8.2	24.8	142.0
	SE(m)±							3.72
	CD @ 5%							10.90
	CV(%)							9.29

(77.6 kg ha^{-1}). Sweet corn-vegetables (Tomato) system (323.3 kg ha^{-1}) and okra – marigold – beetroot (201.6 kg ha^{-1}) systems were tested under cropping systems involving vegetables and other high value crops for income enhancement and the former was found to be significantly more exhaustive. Summarise it and briefly highlight outcome of this chapter discussion be made critically under a separate heading.

3.6 Soil Fertility

The soil pH, EC and available nutrient status of experiment were studied at the end of crop sequence (Table 9). Within two years of experimentation the changes in physicochemical properties and soil fertility status were not significantly affected except OC, which was higher in pigeonpea + greengram (1:6) - sesame compared to remaining cropping systems.

Table 8. Nutrient (Nitrogen, Phosphorus and Potassium) uptake by crops in various cropping systems during *kharif*, *rabi and* summer, 2018-19

Treatment		Kharif uptake			Rabi uptake			System uptake		
		N	P	K	N	P	K	N	P	K
T1	Rice-Maize	97.3	27.1	120.8	67.9	29.9	78.6	165.2	57	199.4
T2	Bt Cotton	89.2	9.1	60.1	0.0	0.0	0.0	89.2	9.1	60.1
T3	Btcotton+Greengram (1:3)- Groundnut	100.7	10.8	62.3	59.6	7.7	17.0	160.3	18.5	79.3
T4	Pigeon pea + Greengram (1:6) - Sesame	84.8	9.2	43.6	33.4	6.9	14.7	118.2	16.1	58.3
T5	Pigeon pea+Maize (1:3)-Groundnut	128.4	30.5	100.4	61.9	7.6	17	190.3	38.1	117.4
T6	Pigeonpea + Groundnut (1:7) - Ragi	137.9	14.7	55.4	59.9	9.0	22.2	197.8	23.7	77.6
T7	Fodder sorghum + Fodder cowpea (1:2) – Horsegram - Sunhemp	273.0	23.9	159.7	175.4	14.3	162.2	448.4	38.2	321.9
T8	Fodder maize - Lucerne	207.4	31.6	359.2	212.7	14.1	146.7	420.1	45.7	505.9
T9	Sweetcorn-Vegetables(Tomato)	189.8	34.3	231.1	172.3	24.3	92.2	362.1	58.6	323.3
T10	Okra – Marigold - Beetroot	40.9	8.4	59.6	236.6	40.3	142.0	277.5	48.7	201.6
	SE(m)±	11.46	1.84	13.50	4.64	1.36	3.72	13.06	2.13	15.15
	CD @ 5%	34.31	5.53	40.66	13.61	3.98	10.90	38.30	6.24	44.42
	CV(%)	14.73	16.04	16.78	7.45	15.25	9.29	9.32	10.42	13.49

Table 9. Soil fertility status as influenced by different cropping systems

Treatment	Cropping sequence	pH	EC	OC	Avail. N	Avail. P	Avail. K
			(dS m^{-1})	(%)	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}
	Initial (Before sowing)	7.81	0.11	0.39	112.2	23.4	170.3
T1	Rice-Maize	7.59	0.41	0.35	154.7	36.1	200.7
T2	Bt Cotton	7.91	0.46	0.38	179.8	32.5	202.2
T3	Btcotton+Greengram (1:3)- Groundnut	7.54	0.47	0.42	192.3	44.6	200.9
T4	Pigeon pea + Greengram (1:6) - Sesame	7.77	0.52	0.45	204.9	47.7	225.2
T5	Pigeon pea+Maize (1:3)-Groundnut	7.61	0.46	0.38	146.3	47.5	195.8
T6	Pigeonpea + Groundnut (1:7) - Ragi	7.74	0.46	0.44	192.3	48.7	214.5
T7	Fodder sorghum + Fodder cowpea (1:2) – Horsegram - Sunhemp	7.10	0.40	0.42	196.5	42.6	202.6
T8	Fodder maize - Lucerne	7.24	0.50	0.42	213.2	51.3	205.0
T9	Sweetcorn-Vegetables(Tomato)	7.15	0.43	0.38	234.2	36.3	192.2
T10	Okra – Marigold - Beetroot	7.57	0.49	0.41	200.7	42.1	207.1
	SEm±	0.18	0.03	0.01	1.9	4.4	6.2
	CD @ 5%	NS	NS	0.03	NS	NS	NS
	CV (%)	4.17	10.04	4.04	15.49	17.90	7.02

4. CONCLUSION

Under high value crops, okra – marigold - beetroot system, among the ecological cropping systems, Bt cotton + greengram (1:3) – groundnut, under the cropping systems for household nutritional security, pigeonpea + maize (1:3) - groundnut system, under two fodder crops/cropping systems, fodder maize – lucerne system and under pre-dominant cropping systems, rice – maize systems were most profitable and can be suggested for different integrated farming systems models of Southern Telangana Zone of Telangana.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Hedge DM, Tiwari PS, Rai M. Crop diversification in Indian Agriculture. Agricultural Situation in India. 2003;60(5): 255-272.
2. Gangwar B, Ram Baldev. Effect of crop diversification on productivity andprofitability of rice (*Oryza sativa*) – wheat (*Triticumaestivum*) system. Indian Journal of Agricultural Sciences. 2005;75: 435–438.
3. Ravishankar N, Pramanikrai, Rai SC, Shakila Nawab, Tapan RB, Biwas KR, Nabisat Bibi. Study on integrated farming system in hilly areas of Bay Islands. Indian Journal of Agronomy. 2007;52:7-10.
4. Jayanthi C, Balusamy M, Chinnusamy C and Mythily S. Integrated nutrient supply system of linked components in lowland integrated farming system. Indian Journal of Agronomy. 2003;48(4):241-246.
5. Rangaswamy A, Venkittasamy R, Premsekar N, Jayanthi C, Purusothamam S, Palaniappan Sp. Integrated farming system for rice based ecosystem. Madras Agricultural Journal. 1995;82(4):287-290.
6. Piper CS. Soil and Plant Analysis. Hans Publishers, Bombay; 1966.
7. Pragathi Kumari Ch, Goverdhan M, Sridevi S, Reddy GK, Pasha MdL, Ramana MV, Rani B. Profitability of cropping systems module for different farming systems in Southern Telangana zone of Telangana state. Journal of Pharmacognosy and Phytochemistry. 2019;8(3):153-157.
8. Pragathi Kumari Ch, Goverdhan M, Sridevi S, Ramana MV, Reddy GK, Pasha MdL. Studies on productivity, nutrient uptake and post-harvest nutrient availability in different cropping systems module for different farming systems in Telangana state. International Journal of Chemical Studies. 2019;7(5):116-121.
9. Banik P, Sharma RC. Yield and resource use efficiency in baby corn - legume intercropping system in the eastern plateau of India. Journal of sustainable Agriculture. 2009;33:379–395.
10. Ae N, Arihara J, Okada K Phosphorus response of chickpea and evaluation of phosphorus availability in Indian Alfisols and Vertisols. In: Phosphorus Nutrition of Grain Legumes in the Semi-Arid Tropics. Johansen, C., Lee, K.K., and Sahrawat, K.L. (eds.). International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India. 1991;33-41.

Peer-review history:
The peer review history for this paper can be accessed here:
http://www.sdiarticle4.com/review-history/55915