International Journal of Chemical Studies

P-ISSN: 2349–8528
E-ISSN: 2321–4902
www.chemijournal.com
IJCS 2020; 8(4): 3322-3326

Received: 28-05-2020
Accepted: 30-06-2020

Anil Kumar Netam
Agronomist, AICRP on IFS – On Farm Research, IGKV, Krishi Vigyan Kendra, Kanker, Chhattisgarh, India

SS Porte
Senior Scientist, AICRP on Integrated Farming Systems, IGKV, Raipur, Chhattisgarh, India

Chainu Ram Netam
Associate Professor, College of Agriculture & Research Station, Bemetara, Chhattisgarh, India

Corresponding Author:
Anil Kumar Netam
Agronomist, AICRP on IFS – On Farm Research, IGKV, Krishi Vigyan Kendra, Kanker, Chhattisgarh, India

On farm response of nutrient management practices on soil, yield and economics of rice-chickpea cropping system in Chhattisgarh

Anil Kumar Netam, SS Porte and Chainu Ram Netam

DOI: https://doi.org/10.22271/chemi.2020.v8.i4ao.10164

Abstract
On –farm experiments were conducted during *Kharif* and *Rabi* seasons of 2017-18 at 24 farmers fields at 6 villages viz. Aaturgaon, Bevarti and Mohpur of Block- Kanker and Hatkondal, Gotulmunda and Damkasa villages of Block- Durgukondal, District- Uttar Bastar Kanker, situated in Chhattisgarh Plain Zone (CG-1) and Bastar Plateau Zone (CG-2) of Chhattisgarh. Experiment conducted at 4 farmer's field in each village. The soils of experimental site were sandy loam to loam; with low in available nitrogen (217.79 kg ha^{-1}) and medium in available phosphorus (11.3 kg ha^{-1}), available potassium (303.21 kg ha^{-1}) and organic carbon (0.51%) and acidic in reaction (6.2 pH). The rice- chickpea cropping system experiment was conducted with seven treatments viz. control (T_1), N (T_2), NP (T_3), NK (T_4), NPK (T_5), NPK+ micro nutrient (T_6) and Farmers practice (T_7). For Zn micro nutrient $ZnSO_4$ applied in rice and Single Super Phosphate applied for both P and S in chickpea under T_6 treatment. The recommended dose of nutrients were: 100:60:40:20 kg/ha N: P: K: ZnSO4 for rice and 20:40:20:20 kg/ha N: P: K: S for chickpea. Whereas, in farmer's practices 60:40:30 kg/ha N: P: K and 10:20:10 kg/ha N: P: K: were applied in rice and chickpea crops respectively. IGKV R-1 variety of rice and JAKI-9218 variety of chickpea grown with recommended package of practices under irrigated condition. The application of recommended dose of NPK + micro nutrient recorded significantly higher grain yield of rice (54.47 q ha^{-1}), chick pea (14.27 q ha^{-1}) and RGEY (93.95 q ha^{-1}). Farmers practice treatment recorded highest nutrient response 16.09 kg grain/ kg nutrient and application of recommended dose of N in rice- chickpea cropping system recorded highest nutrient response Rs/Re (8.62). Application of recommended dose of NPK+ micronutrient recorded significantly higher nutrient uptake N (152.58 kg ha^{-1}), P (34.11 kg ha^{-1}) and K (172.57 kg ha^{-1}) by rice- chickpea cropping system. Application of recommended dose of NPK+ micronutrient recorded significantly higher organic carbon (0.68%), available nitrogen (263.57 kg ha^{-1}), phosphorus (18.13 kg ha^{-1}) and potassium (366.36 kg ha^{-1}) at end of the cropping system. Highest positive balance of available nitrogen (98.36 kg ha^{-1}) and potassium (195.72 kg ha^{-1}) recorded in application of recommended dose of NPK + micronutrient and application of recommended dose of NK resulted higher positive balance of phosphorus ((21.5 kg ha^{-1}). Highest gross return (86602 Rs ha^{-1}) and net return (56028 Rs ha^{-1}) of rice, gross return (62764 Rs ha^{-1}) and net return (42430 Rs ha^{-}) of chickpea and gross return (149366 Rs ha^{-1}), net return (98458 Rs ha^{-}) and B: C ratio (2.93) of rice- chickpea cropping system recorded under application of recommended dose of NPK + micronutrient.

Keywords: On farm, nutrient management, rice, chickpea, cropping system, yield, nutrient uptake, soil, economics

Introduction
Chhattisgarh state is popularly recognized as "Rice Bowl" of the country, as rice is the principal crop of this state and about 84.35 per cent of crop area is covered under *kharif* rice. Rice occupies an area of 3.88 million hectares with the production of 5.75 million tones and average productivity of 1482 kg ha^{-1} and chickpea occupies an area of 0.34 million hectares with the production of 0.33 million tones and average productivity of 990 kg ha^{-1} during 2017-18 (Anonymous, 2018) [1] in the state and most of the area under rice- chickpea system. An intensive cropping which is not only highly productive and profitable but also stable over time and maintains soil fertility has a great importance in present conditions. An intensification of cropping sequence is essential depending on the need of the area. Inclusion of pulses and oilseeds in a sequence changes the economics of the cropping sequences. Pulses are the cheapest source of and dietary protein, valuable animal feed, also plays a key role in

improving and sustaining soil productivity on account of biological nitrogen fixation and addition of organic matter in soil. Pulses are integral part of the cropping system because these crops fit well in the cropping system *viz.* crop rotation, mixed cropping, intercropping and sequential cropping.

Occurrence of multi-nutrient deficiency due to imbalanced use of nutrients and decling soil organic matter are the factor affecting the productivity of major food crops at farmer's fields and these contribute the wider gap between on-station and on-farm condition. Fertilizer response in irrigated areas of country has declined almost three times from 13.4 kg grain/kg NPK in 1970 to 3.7 kg grain/kg NPK in 2005 (Samra and Sharma, 2009). In 1970, only 54 kg NPK/ha was required for an yield of 20 q/ha, but approximately 218 kg NPK/ha is now being used to obtain the same yield (Biswas and Sharma, 2008). For the present level of production, the estimated nitrogen– phosphorus–potassium removal is about 28 metric tonne, resulting in a negative balance of about 10 metric tones in India (Mangal *et al.* 2018) [6]. To fulfill such a negative balance of fertilizers, there is an urgent need to identify suitable integrated plant nutrient systems for different crops and cropping systems. It is worthwhile to mention that although organic manures ameliorate the physical, chemical and biological properties of the soils, they cannot substitute chemical fertilizers because of the low amount of plant nutrients present in them. Fertilizer input has been the mainstay of food production system of India, contributing about 50% towards crop productivity over the period of last three decades. The productivity of rice and chickpea of Chhattisgarh state are lower than national productivity might be due to low and imbalance application of nutrients. Application of imbalanced and excessive nutrients leads to declining nutrient use efficiency making fertilizer consumption uneconomic and producing adverse effect on ecosystem (Aulakh and Adhya, 2005) [2] and ground water quality causing health hazards and climate change (Aulakh *et al.* 2009) [3]. On other hand, nutrient mining has occurred in many soils due to lack of affordable fertilizers sources and where fewer or no organic residues are returned to the soils. Therefore, to overcome this problem there is need to develop balance nutrient management for cropping system, helps to conserve land, water, biodiversity, living organisms and ecosystem which is technically appropriate, productive, economically viable and socially acceptable.

Materials and Methods

On –farm experiments were conducted during *Kharif* and *Rabi* seasons of 2017-18 at 24 farmers fields at 6 villages viz. Aaturgaon, Bevarti and Mohpur of Block- Kanker and Hatkondal, Gotulmunda and Damkasa villages of Block- Durgukondal, District- Uttar Bastar Kanker, situated in Chhattisgarh Plain Zone (CG-1) and Bastar Plateau Zone (CG-2) of Chhattisgarh. Experiment conducted at 4 farmer's field in each village. The soils of experimental site were sandy loam to loam; with low in available nitrogen (217.79 kg ha^{-1}) and medium in available phosphorus (11.30 kg ha^{-1}), available potassium (303.21 kg ha^{-1}) and organic carbon (0.51%) and acidic in reaction (6.2 pH).The rice- chickpea cropping system experiment was conducted with seven treatments viz. control (T_1), N (T_2), NP (T_3), NK (T_4), NPK (T_5), NPK+ micro nutrient (T_6) and farmers' practice (T_7). For Zn micro nutrient $ZnSO_4$ applied in rice and Single Super Phosphate applied for both P and S in chickpea under T_6. The recommended dose of nutrients were: 100:60:40:20 kg/ha N: P: K: ZnSO4 for rice and 20:40:20:20 kg/ha N: P: K: S for chickpea. Whereas, in farmers practice 60:40:30 kg/ha N: P: K and 10:20:10 kg/ha N: P: K were applied in rice and chickpea crops respectively. Half of the nitrogen and full doses of P, K and $ZnSO_4$ were applied at the time of transplanting of rice and remaining ¼ N applied at tillering (30 DAT) and ¼ N applied at panicle emergence stage. In chickpea entire quantity of NPKS applied at the time of sowing. IGKV R-1 variety of rice and JAKI-9218 variety of chickpea grown with recommended package of practices under irrigated condition.

Both the crops were evaluated in terms of total system productivity, gross return, net return and benefit: cost ratio. On system basis, chickpea seed yield converted into rice grain equivalent yield (RGEY). Soil samples were analyzed for available N, P, and K, OC, pH and Electric conductivity at initial and end of the cropping system. The plant samples were analyzed for N, P and K concentration in grain and straw and total N, P and K uptake was calculated by multiplying the respective nutrient concentrations with the yield. Balance sheet of nutrient in soil was calculated by using the formulae as suggested by Raghuwanshi *et al.* (1991) [7].

Results and Discussion

Productivity of crops and cropping system

The grain and straw yield of rice and chickpea significantly influenced due different nutrient management practices (Table 1). Results reveal that application of recommended dose of NPK + micro nutrient recorded significantly higher grain yield of rice (54.47 q ha^{-1}), chick pea (14.27 q ha^{-1}) and RGEY (93.95 q ha^{-1}), followed by recommended dose of NPK *i.e.* 52.57 q ha^{-1} of rice, 13.70 q ha^{-1} of chick pea and 90.47 q ha^{-1} of RGEY . The increase in grain yield 47, 69, 64, 111, 118, 75 percent of rice and 17, 41, 29, 59, 66, 42 percent of chick pea respectively with the application of recommended dose of N, NP, NK, NPK, NPK + micro nutrient, Farmers practice over control. The application of recommended dose of NPK + micronutrient recorded significantly higher straw yield of rice (50.04 q ha^{-1}) and chick pea (16.31 q ha^{-1}), followed by recommended dose of NPK *i.e.* 47.98 q ha^{-1} of rice and 15.61 q ha^{-1} of chick pea. Application of NPK + micro nutrient in cropping system recorded significantly higher Rice Grain Equivalent Yield (93.95 q ha^{-1}) fallowed by NPK *i.e.* 90.47 q ha^{-1}. Increase in grain and straw yield of rice and chickpea may be due to optimum and balance supply of plant nutrients which increase the growth and yields of crops. C.K. Chandrakar et *al.* (2017) [5] conducted experiment at villages of district -Kabirdham, Chhattisgarh and recorded higher grain and straw yield of rice - chickpea cropping system with application of recommended dose of NPK + $ZnSO_4$. Similarly at Navsari, Gujarat, R. N. Mansuri (2016) recorded significantly higher grain and straw yield of rice and chickpea with application of 100% RDN through inorganic fertilizers.

Nutrients response in cropping system

In rice – chickpea cropping system, application of 60:40:30 kg NPK ha^{-1} (FP) recorded highest nutrient response 16.09 kg grain/ kg applied nutrient followed by application of recommended dose of NPK+ micronutrient. Application of recommended dose of N in rice- chickpea cropping system resulted highest nutrient response in terms of Rupees return per Rupee investment (8.62 Rs/Re) followed by application of recommended dose of NK (8.22 Rs/Re).

Nutrient Uptake

Data presented in Table 4, reveal that application of recommended dose of NPK + $ZnSO_4$ recorded significantly higher nutrient uptake N (69.67 kg ha^{-1}), P (16.84 kg ha^{-1}), K (26.52 kg ha^{-1}) by rice grain and N (27.83 kg ha^{-1}) and K (96.97 kg ha^{-1}) by rice straw followed by recommended dose of NPK, whereas, application of recommended dose of NPK recorded significantly higher P (5.14 kg ha^{-1}) uptake by rice straw. Application of recommended dose of NPK+ S recorded significantly higher nutrient uptake N (42.18 kg ha^{-1}), P (7.19 kg ha^{-1}) and K (5.99 kg ha^{-1}) by chickpea grain and N (12.90 kg ha^{-1}) and P (5.19 kg ha^{-1}) by chickpea straw followed by recommended dose of NPK, whereas, significantly higher K (44.32 kg ha^{-1}) uptake of chickpea straw recorded with application of recommended dose of NPK. Application of recommended dose of NPK+ micronutrient recorded significantly higher nutrient uptake N (152.58 kg ha^{-1}), P (34.11 kg ha^{-1}) and K (172.57 kg ha^{-1}) by rice- chickpea cropping system followed by application of recommended dose of NPK. C.K. Chandrakar et *al.* (2017) [5] conducted On Farm Experiments at Kabirdham district of Chhattisgarh and recorded that N, P and K uptake of rice-chickpea cropping system significantly higher with application of recommended dose of NPK + $ZnSO_4$. Similarly R. N. Mansuri (2016) recorded significantly higher N, P and K uptake of rice and chickpea with application of 100% RDN through inorganic fertilizers at Navsari, Gujarat.

Fertility status of soil

Fertility status of soil at end of the cropping system presented in Table 3 and reveal that Application of recommended dose of NPK+ micronutrient recorded significantly higher organic carbon 0.68%, available nitrogen (263.57 kg ha^{-1}), phosphorus (18.13 kg ha^{-1}) and potassium (366.36 kg ha^{-1}). pH and electric conductivity not influenced significantly. Similarly C.K. Chandrakar *et al.* (2017) [5] conducted experiment at villages of Kabirdham district and recorded significantly higher available nitrogen, phosphorus and potassium with application of recommended dose of NPK + $ZnSO_4$.

Nutrient balance

Data on balance sheet of available nitrogen, phosphorus and potassium in soil indicated that there was a positive balance of available nitrogen and potassium in the soil under all treatments (Table 5). All the treatments showed positive balance of available nitrogen and highest positive balance of available nitrogen (98.36 kg ha^{-1}) recorded in application of recommended dose of NPK + micronutrient followed by application of recommended dose of NPK (90.02 kg ha^{-1}). Lowest balance of available nitrogen (46.94 kg ha^{-1}) recorded in application of recommended dose of N. Control, recommended dose of N, NK treatments recorded positive available phosphorus balance and highest positive balance of available phosphorus (21.5 kg ha^{-1}) recorded under application of NK followed by N (18.79 kg ha^{-1}) and Control (13.02 kg ha^{-1}). Recommended dose of NP, NPK, NPK + micronutrient and Farmers practice treatments recorded negative balance of available phosphorus. All the treatments showed positive balance of available potassium and highest positive balance of available potassium (195.72 kg ha^{-1}) recorded under the application of recommended dose of NPK + micronutrient followed by application of recommended dose of NPK (187 kg ha^{-1}). Lowest balance of available potassium (89.64 kg ha^{-1}) recorded in control. Similarly R.N. Mansuri (2016) conducted an experiment at Navsari, Gujarat and recorded positive balance of available nitrogen, phosphorus and potassium with application of 100% RDN through inorganic fertilizers.

Economics of cropping system

Effect of different treatments can not be assessed without the gross and net return from those treatments. The economics of different treatments presented in Table 2. Highest gross return (86602 Rs ha^{-1}) and net return (56028 Rs ha^{-}) of rice, gross return (62764 Rs ha^{-1}) and net return (42430 Rs ha^{-}) of chickpea and gross return (149366 Rs ha^{-1}), net return (98458 Rs ha^{-1}) and B: C ratio (2.93) of rice- chickpea cropping system recorded under application of recommended dose of NPK + micronutrient followed by application of recommended dose of NPK. Similarly C.K. Chandrakar *et al.* (2017) [5] conducted experiment at villages of District-Kabirdham Chhattisgarh and recorded significantly higher net return, and B: C ratio with application of recommended dose of NPK + $ZnSO_4$.

Table 1: Yield parameters and nutrient response of rice-chickpea cropping system as influenced by nutrient management practices

	Yield of rice (q ha^{-1})		RGEY (q ha^{-1})	Yield of chickpea (q ha^{-1})		Nutrient response	
Treatment	**Grain**	**Straw**		**Grain**	**Straw**	**Kg grain/kg nutrient**	**Rs/Re**
Control	24.95	23.84	48.72	8.59	10.04	-	-
N	36.70	35.02	64.49	10.04	11.67	12.13	8.62
NP	42.24	38.70	75.78	12.12	14.13	11.58	4.97
NK	40.86	39.72	71.43	11.05	12.86	11.85	8.22
NPK	52.57	47.98	90.47	13.70	15.61	14.02	6.60
NPK + $ZnSO_4$/S	54.47	50.04	93.95	14.27	16.31	14.41	6.63
Farmers practice	43.76	42.58	77.70	12.27	14.38	16.09	7.18
SEm±	0.71	1.12	0.97	1.64	0.22	-	-
CD (P = 0.05)	2.05	3.24	2.81	4.74	0.63	-	-

Table 2: Economics of rice-chickpea cropping system as influenced by nutrient management practices

Treatment	Rice (Rs. ha^{-1})			Chickpea (Rs. ha^{-1})			Cropping system (Rs. ha^{-1})			
	Cost of cultivation	Gross return	Net return	Cost of cultivation	Gross return	Net return	Cost of cultivation	Gross return	Net return	B:C ratio
Control	25282	39674	14392	16495	37794	21299	41777	77468	35691	1.85
N	26575	58691	32116	17784	44183	26399	44359	102874	58515	2.32
NP	29102	67160	38058	19638	53313	33675	48740	120473	71733	2.47
NK	27347	64965	37618	18240	48602	30362	45587	113567	67980	2.49
NPK	29874	83588	53714	20368	60243	39875	50242	143831	93589	2.86
NPK + $ZnSO_4$/S	30574	86602	56028	20334	62764	42430	50908	149366	98458	2.93
Farmers practice	28320	69572	41252	18910	53964	35054	47230	123536	76306	2.62

Table 3: Final soil nutrient status of rice-chickpea cropping system as influenced by nutrient management practices

Treatment	pH	EC (ds/m)	Organic carbon (%)	Available N (kg ha^{-1})	Available P (kg ha^{-1})	Available K (kg ha^{-1})
Control	7.18	0.19	0.60	214.98	10.77	320.43
N	7.25	0.20	0.62	258.68	11.29	326.40
NP	7.24	0.19	0.65	255.91	16.40	334.57
NK	7.34	0.19	0.66	262.19	11.35	363.60
NPK	7.30	0.19	0.67	259.69	17.68	361.97
NPK + $ZnSO_4$/S	7.27	0.19	0.68	263.57	18.13	366.36
Farmers practice	7.20	0.19	0.61	239.99	14.15	352.31
SEm±	0.05	0.01	0.01	3.22	0.59	3.31
CD (P = 0.05)	NS	NS	0.02	9.30	1.70	9.57

Table 4: Nutrient uptake by rice-chickpea cropping system as influenced by nutrient management practices

Treatment	Nutrient uptake (kg ha^{-1}) by Rice						Nutrient uptake (kg ha^{-1}) by Chickpea						Total uptake (kg ha^{-1}) by Rice - chickpea system		
	N		P		K		N		P		K				
	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	Grain	Straw	N	P	K
Control	28.00	12.17	6.38	1.85	7.88	34.04	23.52	7.46	2.73	2.59	2.92	27.58	71.15	13.55	72.42
N	46.83	20.00	9.21	2.95	12.24	50.84	30.01	9.21	3.50	3.14	3.75	30.84	106.05	18.80	97.67
NP	53.33	21.83	13.27	3.92	14.26	57.05	36.62	10.70	6.22	4.39	4.27	33.72	122.48	27.80	109.30
NK	51.33	21.67	10.53	3.48	19.37	74.76	33.19	10.07	3.80	3.64	4.54	29.09	116.26	21.45	127.76
NPK	67.83	26.67	16.48	5.14	25.87	92.20	41.44	12.18	7.00	5.02	5.85	44.32	148.12	33.64	168.24
NPK + $ZnSO_4$/S	69.67	27.83	16.84	4.89	26.52	96.97	42.18	12.90	7.19	5.19	5.99	43.09	152.58	34.11	172.57
Farmers practice	52.00	21.67	12.57	3.48	17.65	76.08	36.22	11.15	5.75	4.33	4.69	34.16	121.04	26.13	132.58
SEm±	**1.41**	**0.67**	**0.35**	**0.22**	**1.15**	**3.59**	**0.73**	**0.24**	**0.26**	**0.15**	**0.20**	**0.92**	-	-	-
CD (P = 0.05)	**4.07**	**1.95**	**1.01**	**0.63**	**3.32**	**10.38**	**2.12**	**0.69**	**0.75**	**0.42**	**0.59**	**2.66**	-	-	-

Table 5: Balance sheet of Nitrogen, Phosphorus and Potassium at end of cropping system as influenced by nutrient management practices

	Nitrogen (kg ha^{-1})						Phosphorus (kg ha^{-1})						Potassium (kg ha^{-1})					
Treatment	Initial status	Applied	Uptake by crop	Expected balance	Final status	Balance	Initial status	Applied	Uptake by crop	Expected balance	Final status	Balance	Initial status	Applied	Uptake by crop	Expected balance	Final status	Balance
Control	217.79	0	71.15	146.64	214.98	68.34	11.3	0	13.55	-2.25	10.77	13.02	303.21	0	72.42	230.79	320.43	89.64
N	217.79	100	106.05	211.74	258.68	46.94	11.3	0	18.80	-7.5	11.29	18.79	303.21	0	97.67	205.54	326.40	120.86
NP	217.79	100	122.48	195.31	255.91	60.6	11.3	60	27.80	43.5	16.40	-27.1	303.21	0	109.30	193.91	334.57	140.66
NK	217.79	100	116.26	201.53	262.19	60.66	11.3	0	21.45	-10.15	11.35	21.5	303.21	40	127.76	215.45	363.60	148.15
NPK	217.79	100	148.12	169.67	259.69	90.02	11.3	60	33.64	37.66	17.68	-19.98	303.21	40	168.24	174.97	361.97	187
NPK + $ZnSO_4$/S	217.79	100	152.58	165.21	263.57	98.36	11.3	60	34.11	37.19	18.13	-19.06	303.21	40	172.57	170.64	366.36	195.72
Farmers practice	217.79	60	121.04	156.75	239.99	83.24	11.3	40	26.13	25.17	14.15	-11.02	303.21	30	132.58	200.63	352.31	151.68

Conclusion

On the basis of experimental findings, it is concluded that application of 100: 60:40 kg NPK + 20 kg $ZnSO_4$ in rice and 20:40:20:20 kg NPKS in chickpea could be recommended for higher productivity, soil nutrient status and profitability of rice- chickpea cropping system in the Chhattisgarh state.

Reference

1. Anonymous. Directorate of Agriculture. Government of Chhattisgarh, Raipur, 2018.
2. Aulakh MS, Adhya TK. Impacts of agricultural activities on emission of green house gases – Indian perspectives. International Conference on Soil, Water anf Environmental Quality – Issues and strategies. Indian Society of Soil Science, New Delhi, 2005, 319-335.
3. Aulakh MS, Khurana MPS, Singh D. Water pollution related to agricultural, industrial and urban activities and its effects on food chain: Case studies from Punjab. Journal of New seeds. 2009; 10:112-137.
4. Biswas PP, Sharma PD. A new approach for estimating fertilizer response ratio-the Indian scenario. Indian Journal of fertilizers. 2008; 4(7):59-62.
5. Chandrakar CK, Bhambri MC, Pali GP, Sunil Kumar, Jangde A, Pandey KK, Sanjeev Singh. Response of Plant Nutrients on Soil Fertility, Productivity and Profitability of Rice (*Oryza sativa*) -Chickpea (*Cicer arietinum*) Cropping System in Chhattisgarh Plains. Int. J Curr. Microbiol. App. Sci. 2017; 6(4):1867-1875
6. Mangal Deep, Mahender Kumar R, Soumya Saha, Aarti Singh. Rice based cropping systems for enhancing

productivity of food grains in India: decadal experience of AICRP. Indian Farming. 2018; 68(01):27-30.
7. Raghuwanshi RKS, Umat R, Nema ML, Dubey DD. Balance sheet of nitrogen, phosphorus and potash in soil as influenced by wheat- based cropping sequence. Indian Journal of Agronomy. 1991; 36(3):322-325.
8. Samra JS, Sharma PD. Food security- Indian Scenario In Proceedings IPI-OUAT-IPNI, International Symposium, Bhuneshwar, India, 5-7 November, 2009.