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Effect of Nutrient Management through STCR Equation in Groundnut-Potato Cropping Sequence on Nutrient Uptake of Sequence

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Abstract

A field investigation on "Nutrient management through STCR equation in groundnut-potato cropping sequence" was carried out at PGI Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.) during the year 2014-15 and 2015-16 to study residual soil fertility status of groundnut– potato cropping sequence. The experiment was laid out in split plot design with 3 replications. The main plot comprised of 6 nutrient management treatments *viz.,* STCR equation 20 q ha^{-1} without FYM, STCR equation 25 q ha^{-1} without FYM, STCR equation 30 q ha^{-1} without FYM, STCR equation 35 q ha^{-1} without FYM, GRDF and RDF. Sub plot treatments consisted of 3 fertilizer levels *viz.,* Control (No fertilizer), 75 % of RDF and 100 % RDF. The uptake of N, P and K by groundnut plant, kernel and in total after harvest was influenced significantly GRDF recorded significantly higher uptake of N, P and K by plant, kernel and in total during both the years, respectively. However, the treatment GRDF was at par with STCR equation for 35 q ha^{-1} without FYM, was during first year and second year. The uptake of N, P and K by potato plant, tuber and in total after harvest was influenced significantly GRDF recorded significantly higher uptake of N, P and K by plant, tuber and in total respectively, during both the years. Application of 100% RDF noticed significantly maximum uptake of N,P and K by plant, tuber and in total respectively, during both the years

Keywords: STCR equation, growth, yield, groundnut, potato

1. Introduction

Groundnut (*Arachis hypogea* L.) is an important oilseed cum legume crop of India. Groundnut is a species in the legume family (Fabaceae) native to South America, Mexico and Central America. It is an annual herbaceous plant growing 30 to 50 cm tall. The word groundnut (*Arachis hypogeal* L.) is derived from the Greek word "Arachis" meaning legume and "hypogea" meaning below ground. It is commonly known as peanut, monkey-nut and groundnut. Groundnut is self-pollinated, tetraploid with chromosome number 2n=4x=40. The genus *Arachis* is a member of family Fabaceae (Synonym : Leguminoseae), Groundnut belongs to C_3 plant it needs good sunshine and high temperature to produce more pods.

Commercially and nutritionally it is a very important source of oil. Groundnut contains 13 different vitamins (including A, the B group C and E) along with 26 essential trace minerals, including calcium and iron.

Fertilizers are the kingpin in the present system of agriculture. Scientific use of fertilizer assumes vital importance in sustainable agriculture. Fertilizer pay back to the farmer more profit per unit investment. Judicious use of fertilizer is an important management practice to increase groundnut production.

Potato (*Solanum tubersum* L.) is one of the most important vegetable crop after wheat, maize and rice, contributing to food and nutritional security in the world. This tuber crop of the family solanaceae has about 200 wild species. It originated in the high Andean hills of South America, from where it was first introduced into Europe towards the end of 16th century through Spanish conquerors. It was introduced to India by early 17th century probably through British missionaries or Portuguese traders (CRI and Technical bulletin, 2014 or 2014a). Potato was officially dubbed the "Food of the future" as the recently concluded flagship event of the United Nation's International year of Potato in Peru.

The continuous use of high analysis fertilizers increased the crop yield in initial years and adversely affected the yield stability at a later stage (Virmani, 1994). In India the demographic projections indicated that the per capita land availability from 0.14 ha in the year 2000 will be reduced to 0.10 ha in the year 2025. Moreover, besides the shrinking land area, the quality of land likely to remain available for agriculture which will be poor due to severe competition from urbanization, industrialization and civic needs. Also

the decline in soil fertility and resultant productivity are the matter of nutrient imbalance which has been recognized as one of the most important factor that limits crop yield. The high cost fertilizers and very poor purchasing capacity of marginal farmers restrict the use of costly fertilizer inputs under the condition of enscalating energy crisis. Total nutrient (N, P_2O_5 and K_2O) consumption is estimated as 30-35 mt in 2025 A.D. and according to Katyal (2001), the gap between nutrients' removal by crops and addition through fertilizers would be about 10 mt per annum. The fertilizer production in the country lags behind actual consumption and the import bill for augmenting the deficit is staggering high.

To meet the total nutritional needs under intensive cropping systems an integrated supply of nutrients from fertilizers and organic manures seems to be a need of time. Hence the present investigation Nutrient management through STCR equation in Groundnut- Potato cropping sequence is planned.

2. Materials and Methods

A field experiment was carried out at Post Graduate Institute Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri during year 2014-15 and 2015-16.Soil of the experimental plot was clay and well drained. It could be seen that the soil physical properties *viz*., field capacity, permanent wilting point and bulk density were 32.23%, 16.21% and 1.34 g cm^{-3}, respectively. The soil chemical properties *viz*., pH, EC and organic carbon content were 8.22, 0.29 dSm^{-1} and 0.52 per cent, respectively with low in available nitrogen (170.03 kg ha^{-1}), medium in available phosphorous (18.02 kg ha^{-1}) and very high in available potassium (425.2 kg ha^{-1}).

The experiment was laid out in split plot design with three replications. The main plot treatments were applied to *kharif* groundnut comprised of six nutrient management *viz.,* T_1-STCR equ^n for 20 q ha^{-1} without FYM, T_2-STCR equ^n for 25 q ha^{-1} without FYM, T_3-STCR equ^n for 30 q ha^{-1} without FYM, T_4- STCR equ^n for 35 q ha^{-1} without FYM, T_5- GRDF, T_6-RDF. The residual effect of the nutrient applied to *kharif* groundnut was tested in the succeeding *rabi* potato. Three fertilizer levels as sub plot treatments to potato which comprised *viz.,* F_1- Control, F_2-75 % RDF, F_3- 100 % RDF.

STCR Equations without FYM:

N (kg ha^{-1})=4.16×T-0.37×SN

P_2O_5 (kg ha^{-1})=4.96×T-4.36×SP

K_2O (kg ha^{-1})=3.14×T-0.16×SK

Whereas, T is targeted yield and SN, SP and SK are soil available N, P and k in soil. Nutrients applied to the groundnut experimental plots on the basis of analysis.

As per the treatments, organic manures were applied 15 days before sowing and incorporated through land preparation in the soil; and the nutrient levels of recommended dose of fertilizer were applied broadcast and incorporated into the soil during final seed bed preparation. Urea, single superphosphate and muriate of potash were used as sources of N, P and K respectively for supplying the levels RDF.

Groundnut (phule Unnati) was sown @100 kg ha^{-1} in 30 cm rows during the third fortnight of July. The seeds were treated with cultures of *rhizobium* (*Bradyrhizobium japonicum*) and phosphate solubilizing bacteria (PSB) (*Pseudomonas striata*) before sowing. After emergence of seedlings, these were thinned manually to maintain a plant population of 0.33 million ha^{-1}. The crop was irrigated by surface flooding as and when dry spells occurred. On an average 5 irrigations were given during the entire crop growing period. Two manual weedings were carried out at 21 and 35 days after sowing (DAS) and earthing up was done after manual weeding. There were no incidents of severe insect pests or diseases during any of these year. However, one spray of Carbendazim and Profenofos solution was undertaken as preventive measure to control aphid and jassid during the peak vegetative period (45 DAS). After the harvest of groundnut, the land was harrow and levelled without disturbing the lay-out. As per the treatments dose of fertilizers to all plots of potato given in the form of urea, single superphosphate and muriate of potash. potato ('Kufri Pukhraj') was planted in 60 cm rows using a tuber rate of 25q ha^{-1} in the first week of January, and the crop was raised with normal agronomic practices.

The kernel/tuber and plant of observational plants of groundnut and potato was collected after harvest for chemical analysis. These plant samples were sundried first for a period of 10 days and then kept in Hot Air Oven at 65^0C till constant weight was obtained. The dried plant samples were grinded in stainless still willey mill to fine powder and used for chemical analysis of N, P and K content in kernel/tuber and plant of groundnut and potato plant by using standard methods total N by Parkinson and Allen, 1975, total P by Vanadomolybdate yellow colour method in nitric acid system by Jackson, 1973, total K by Flame photometer by AOAC, 2005.

The uptake of NPK by groundnut and potato was worked out by multiplying the nutrient concentration to dry matter yield of groundnut and potato plant and pods/ tuber and expressed in kg ha^{-1} for each treatment (Table 1).

$$\text{Uptake by} = \frac{\text{Nutrient (\%) x Pod tuber}^{-1}\text{ yield (kg ha}^{-1}\text{)}}{\text{pod tuber}^{-1}\text{ (kg ha}^{-1}\text{)}} \times 100$$

$$\text{Uptake by} = \frac{\text{Nutrient (\%) x Haulm yield (kg ha}^{-1}\text{)}}{\text{haulm (kg ha}^{-1}\text{)}} \times 100$$

3. Results and Discussion

3.1. Performance of groundnut

Studies on chemical analysis of plants indicated that nitrogen, phosphorous and potassium content in kernel and haulm increased significantly in GRDF, it was at par with STCR equation for 35 q ha^{-1} without FYM during both the years.

Table 1: Nutrient uptake by groundnut plant as influenced by different treatments at harvest (2014)

Treatment	Nutrient uptake (kg ha^{-1})								
	Nitrogen			Phosphorous			Potassium		
	Kernel	Haulm	Total	Kernel	Haulm	Total	Kernel	Haulm	Total
T_1	58.54	19.22	77.76	8.50	7.23	15.73	14.53	29.81	44.34
T_2	67.38	21.53	88.90	10.36	8.24	18.60	17.21	33.28	50.49
T_3	77.63	24.90	102.52	12.57	10.50	23.07	20.21	37.10	57.31
T_4	96.13	27.98	124.12	15.78	11.91	27.69	25.33	39.63	64.97
T_5	99.15	29.82	128.97	16.39	13.15	29.54	26.14	41.29	67.43
T_6	55.22	17.00	68.02	7.31	5.72	13.03	11.97	24.66	36.62
SEm±	1.82	0.58	1.71	0.38	0.64	0.84	0.55	0.80	0.94
C.D (*p*=0.05)	5.21	1.67	4.9	1.11	1.84	2.41	1.57	2.30	2.70
General mean	74.91	23.41	98.38	11.82	9.46	21.28	19.23	34.29	53.53

T_1: STCR equn 20 q ha^{-1} without FYM; T_2: STCR equn 25 q ha^{-1} without FYM; T_3: STCR equn 30 q ha^{-1} without FYM; T_4: STCR equn 35 q ha^{-1} without FYM; T_5: GRDF; T_6: RDF

Sunder (1999) reported that there was significantly increase in uptake of N, P, K with increase in fertilizer levels maximum and the significantly more uptake of N, P and K. similar results were found by Rao and Shekhawat (2002) (Table 2).

The nitrogen uptake was also highest in GRDF (29.82, 99.15, 128.97 and 31.45, 103.25, 134.69 kg ha^{-1}), and it was at par with STCR equation for 35 q ha^{-1} without FYM (27.98, 96.13, 124.12 and 29.81, 100.36 and 130.16 kg ha^{-1}) during both

Table 2: Nutrient uptake by groundnut plant as influenced by different treatments at harvest (2015)

Treatment	Nutrient uptake (kg ha^{-1})								
	Nitrogen			Phosphorous			Potassium		
	Kernel	Haulm	Total	Kernel	Haulm	Total	Kernel	Haulm	Total
T_1	61.21	19.98	81.19	9.42	7.73	17.15	16.33	31.34	47.67
T_2	70.74	23.77	94.50	11.16	9.59	20.75	19.22	34.57	53.80
T_3	81.65	26.19	107.83	13.50	11.39	24.89	22.40	38.47	60.87
T_4	100.36	29.81	130.16	16.95	13.24	30.19	27.94	40.98	68.92
T_5	103.25	31.45	134.69	17.60	14.15	31.75	28.65	42.17	70.82
T_6	53.48	18.04	71.53	7.91	6.46	14.37	13.06	25.54	38.60
SEm±	2.41	0.54	2.45	0.46	0.60	0.86	0.81	0.69	1.09
CD (*p*=0.05)	6.88	1.55	7.02	1.33	1.72	2.48	2.31	1.98	3.13
General mean	78.45	24.87	103.32	12.76	10.43	23.18	21.27	35.51	56.78

the years of experimentation. The combined application of inorganic fertilizer with farmyard manure, could stimulate the uptake of nutrients due to enhanced microbial and *Rhizobium* activity, better root growth under congenial soil physical condition created by farmyard manure. The result corroborated the findings of Kachot et al. (2001).

Increase in P uptake (13.15, 16.39, 29.54 and 14.15, 17.60, 31.75 kg ha^{-1}) was due to increase in P availability from applied fertilizer and inherent soil source and combined effect of released organic acids and organic anions on decomposition of farmyard manure in acid lateritic soil. Dutta and Mondal (2006) also opined alike. Jain et al. (1990) reported that N uptake in Kernels increased significantly with increasing doses of P. similar trend in increase was also obtained by increasing the levels of K from 0 to 25 kg K ha^{-1}. The P uptake in kernels increased with increase in P levels. STCR equation for 35 q ha^{-1} without FYM added nutrients in soil as per its demand. Due to this reason GRDF was at par with STCR equation for 35 q ha^{-1} without FYM (11.91, 15.78 , 27.69 and 13.24, 16.95, 30.19 kg ha^{-1} kg ha^{-1}) during both the years.

The enhanced potassium absorption (41.29, 26.14, 67.43 and 42.17, 28.65, 70.82 kg ha^{-1}) might be due to increased supply

of potassium by FYM and increased dose under STCR equation for 35 q ha^{-1} without FYM in groundnut plant (39.63, 25.33, 64.97 and 40.98, 27.94, 68.92 Kg ha^{-1} kg ha^{-1}).

The trend of nutrient uptake was very well resembled with the dry matter accumulation and ha^{-1} yield data. The increased uptake of groundnut might be due to improvement in soil physical chemical properties through application of GRDF

The uptake of nutrients was maximum in GRDF during both the years. Due to availability of nutrients throughout the growth period. Similar results were recorded by Vidyavati *et al.* (2011)

3.2. Performance of proceeded crop on Potato

The concentration of N, P and K in haulm and tuber was more due to GRDF. This might be due to the addition of more organic matter in this treatment. The uptake of nutrients was maximum in GRDF during both the years. Due to availability of nutrients throughout the growth period. Similar results were recorded by Vidyavati et al. (2011) (Table 3).

The uptake of nitrogen, phosphorous and potassium by potato plant, tuber and in total after harvest was influenced significantly due to the different nutrient management

Table 3: Nutrient uptake by potato plant as influenced by different treatment at harvest (2014-15)

Treatment	Nutrient uptake (kg ha^{-1})								
	Nitrogen			Phosphorous			Potassium		
	Tuber	Haulm	Total	Tuber	Haulm	Total	Tuber	Haulm	Total
A. Nutrient management to *kharif* groundnut									
T_1	51.42	3.41	54.83	6.09	5.42	11.51	70.63	4.65	75.28
T_2	61.00	5.08	66.08	7.48	7.14	14.62	83.65	8.11	91.77
T_3	73.99	7.18	81.17	9.49	8.56	18.06	103.67	12.23	115.90
T_4	89.18	9.34	98.52	11.78	10.43	22.21	121.73	13.53	135.26
T_5	100.55	10.92	111.47	12.54	11.46	24.00	144.79	15.06	159.85
T_6	39.19	2.15	41.34	4.01	3.92	7.93	51.02	2.95	53.97
SEm±	0.71	0.12	0.64	0.39	0.22	0.46	1.30	0.20	1.30
C.D (*p*=0.05)	2.25	0.40	2.02	1.24	0.70	1.46	4.11	0.65	4.12
B. Fertilizer levels to *rabi* potato									
F_1	53.93	4.46	58.39	5.37	5.92	11.29	73.67	7.19	80.86
F_2	75.88	7.07	82.95	9.54	8.47	18.02	106.06	10.25	116.31
F_3	77.86	7.51	85.37	10.78	9.08	19.86	108.02	10.82	118.85
SEm±	0.37	0.07	0.38	0.14	0.09	0.17	0.34	0.09	0.38
CD (*p*=0.05)	1.08	0.21	1.13	0.41	0.26	0.50	1.01	0.28	1.11
Interaction (Ax B)	Sig.	Sig	Sig.	Sig.	N.S.	Sig.	Sig.	Sig.	Sig.
General mean	69.22	6.35	75.57	8.57	7.82	17.03	95.92	9.42	105.34

F_1: Control; F_2: 75 % RDF; F_3: 100% RDF

treatments. Application of GRDF recorded significantly higher uptake of nitrogen (10.92, 100.55, 111.47 and 12.74, 108.65, 121.38 kg ha^{-1}), phosphorous (11.46, 12.54, 24.00 and 13.37, 14.67, 28.04 kg ha^{-1}) and potassium (15.06, 144.79, 159.85 and 16.96, 157.55, 174.51 kg ha^{-1}) by plant, tuber and in total respectively, during both the years.

3.3. Fertilizer levels to potato

The uptake of nitrogen, (7.51, 77.86, 85.37 and 8.74, 84.03, 92.77 kg ha^{-1}) phosphorous (9.08, 10.78, 19.86 and 10.41, 13.02, 23.43 kg ha^{-1}) and potassium (10.82, 108.02, 118.85 and 12.27, 117.56, 129.83 kg ha^{-1}) by potato plant, tuber and in total after harvest was influenced significantly due to the different fertilizer levels 100% RDF noticed significantly maximum uptake of nitrogen, phosphorous and potassium respectively, during both the years of experimentation. Uptake of N, P and K by potato increased significantly with increase in application of nutrients observed by Mohanty et al. (2014); Chatterjee et al. (2014). This increase in the uptake of N, P and K might be due to the increase in tuber yield by the manorial application.

The total nutrient uptake by groundnut-potato was influenced significantly due to residual effect of *kharif* groundnut during both the years.

3.4. Interaction

Nutrient management through GRDF to preceding *kharif* groundnut registered maximum total uptake of nitrogen,

phosphorus and potassium by potato crop at harvest during both the years. The nutrient uptake by groundnut-potato was influenced significantly due to different levels of fertilizer to *rabi* potato. Application of 100% RDF has registered significantly maximum total uptake of nitrogen, phosphorus and potassium by potato crop during both the years. Nutrient uptake in cropping system increased with increasing fertilizer rates given to the preceding crop. Similar finding was observed by Islam et al. (2013).

The total uptake of nutrients *viz.,* nitrogen, phosphorus and potassium were influenced significantly during both the years of experimentation. The highest values were recorded in groundnut with application of GRDF and potato with application of 100% RDF. The results are in conformity with the Data et al. (2002) and Singh et al. (1996). The nutrient uptake by potato was found closely linked with productivity Sharma and Mohanty et al. (2014) (Table 4).

The application of chemical fertilizers in conjunction with

Table 4: Nutrient uptake by potato plant as influenced by different treatment at harvest (2015-16)

Treatment	Nutrient uptake (kg ha^{-1})								
	Nitrogen			Phosphorous			Potassium		
	Tuber	Haulm	Total	Tuber	Haulm	Total	Tuber	Haulm	Total
A. Nutrient management to *kharif* groundnut									
T_1	57.15	3.90	61.05	8.00	6.24	14.23	78.65	5.17	83.83
T_2	67.21	5.82	73.02	9.57	7.87	17.44	91.55	9.16	100.71
T_3	81.74	8.52	90.26	11.75	9.84	21.59	115.41	14.18	129.59
T_4	94.70	11.26	105.97	13.74	12.53	26.27	130.13	15.90	146.04
T_5	108.65	12.74	121.38	14.67	13.37	28.04	157.55	16.96	174.51
T_6	42.18	2.54	44.72	5.29	4.52	9.81	56.96	3.26	60.23
SEm±	1.02	0.18	0.97	0.36	0.25	0.39	1.66	0.48	1.62
CD (*p*=0.05)	3.24	0.58	3.05	1.14	0.80	1.24	5.24	1.53	5.12
B. Fertilizer levels to *rabi* potato									
F_1	59.96	5.35	65.31	6.82	6.91	13.73	82.25	8.26	90.51
F_2	81.83	8.30	90.13	11.67	9.85	21.53	115.32	11.79	127.11
F_3	84.03	8.74	92.77	13.02	10.41	23.43	117.56	12.27	129.83
SEm±	0.42	0.07	0.41	0.11	0.07	0.11	0.68	0.12	0.75
CD (*p*=0.05)	1.25	0.22	1.22	0.32	0.21	0.33	1.99	0.37	2.20
Interaction (A×B)	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig.	Sig..	Sig.
General mean	75.27	6.35	82.74	10.50	9.06	19.56	105.04	10.77	115.82

organic manures (FYM) increased the use efficiency of fertilizers was due to organic manure, which improved the physical and biological health of soil, which in turn increased the nutrients availability. Apart from that the organic manure also contains almost all the essential elements in variable quantities which have synergistic effect with each other essential elements for their availability. This effect might be reflected in increased uptake of nutrients.

4. Conclusion

GRDF recorded significantly higher uptake of NPK by groundnut crop. However, the treatment GRDF was at par with STCR equation for 35 q ha^{-1} without FYM. The uptake of NPK by potato was influenced significantly due to the different fertilizer levels to rabi season crop. Application of 100% RDF noticed significantly higher uptake of NPK by potato crop.

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