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Effect of nutrient management through STCR equation in groundnut-Potato cropping sequence on residual soil fertility status 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 Post Graduate Institute Research Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri (M.S.) during the year 2014-15 and 2015-16 to study production potential of groundnut– potato cropping sequence.

The experiment was laid out in split plot design with three replications. The main plot comprised of six 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 three fertilizer levels *viz.*, Control (No fertilizer), 75 per cent of RDF and 100 per cent RDF.

The soil available nitrogen, phosphorous and potassium in soil after harvest of groundnut crop was not influenced significantly due to the different nutrient management treatments. GRDF recorded maximum available nitrogen (181.4 and 198.7 kg ha^{-1}), phosphorous (20.00 and 21.37 kg ha^{-1}) and potassium (426.7 and 434.8 kg ha^{-1}) after harvest of groundnut crop during both the years, respectively.

Mean available nitrogen (172.64 and 187.29 kg ha^{-1}), phosphorous (19.21 and 20.79 kg ha^{-1}) and potassium (394.4 and 408.3 kg ha^{-1}) during 2014 and 2015 after harvest of potato crop during both the years.

Application of GRDF recorded maximum available nitrogen (186.3 and 206.8 kg ha^{-1}), phosphorous (20.5 and 22.4 kg ha^{-1}) and potassium (433.0 and 442.8 kg ha^{-1}) after harvest of potato crop during both the years.

Application of 100 % RDF registered maximum available nitrogen (178.6 and 192.4 kg ha^{-1}), phosphorous (19.9 and 21.3 kg ha^{-1}) and potassium (399.6 and 412.6 kg ha^{-1}) after harvest of potato crop during both the years.

Keywords: STCR equation, Available, Nitrogen, Phosphorus, Potassium, groundnut, potato

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 (Anonymous, 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 million tonnes in 2025 A.D. and according to Katyal (2001), the gap between nutrients' removal by crops and addition through fertilizers would be about 10 million tonnes 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.

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 per cent, 16.21 per cent 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.,* T1- 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 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. 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). All the growth and yield parameters were recorded at physiological maturity (84 DAS), and the crop was manually harvested, threshed and pod yields were recorded. 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. All the growth and yield parameters were recorded at physiological maturity (75 DAP). The crop was harvested, and the yield was recorded.

After harvest of potato crop, soil samples at 0 to 30 cm depth were collected from each treatment plot. After air drying these samples were grinded in wooden mortar and pestle and passed through 2 mm sieve and used for chemical analysis *viz*., pH, EC, Organic carbon and soil available N, P, K content in soil by using standard analytical methods as indicated in Table 1 during both the years of experimentation.

Table 1: Analytic methods used for soil analysis

Sr No.	Particulars	Method	Reference
A.	**Soil analysis**		
1.	Available N	Alkaline Permanganate	Asija and Subbiah, 1956
2.	Available P	0.5M $NaHCO_3$ (P^H 8.5)	Olsen *et al*., 1954
3.	Available K	NN NH_4Oac	Knudsen *et al*., 1982

Resulsts and discussion

Performance of Groundnut

The soil available nitrogen, phosphorous and potassium in soil after harvest of groundnut crop was not influenced significantly due to the different nutrient management treatments. GRDF recorded maximum available nitrogen (181.4 and 198.7 kg ha^{-1}), phosphorous (20.00 and 21.37 kg ha^{-1}) and potassium (426.7 and 434.8 kg ha^{-1}) after harvest of groundnut crop during both the years, respectively.

Incorporation of FYM in the treatment schedule improved the organic carbon content. Similar results were obtained by Acharya *et al.* (1988), Sharma *et al.* (1988), Sud *et al.* (1990) and Roy *et al.* (2001).

Singh *et al.* (2003) observed at Gwaliar (M.P.) that green manuring with soybean, application of recommended dose of NPK and residue incorporation of potato and wheat crop improved organic carbon content (0.24 – 0.34 %) and available P of soil (58-80 ppm).

Performance of proceeded crop on Potato

The soil available nitrogen, phosphorous and potassium in soil after harvest of potato crop was influenced due to the nutrient management to *kharif* groundnut. Application of GRDF recorded maximum available nitrogen (186.3 and 206.8 kg ha^{-1}), phosphorous (20.5 and 22.4 kg ha^{-1}) and potassium (433.0 and 442.8 kg ha^{-1}) after harvest of potato crop during both the years

Results of building up of available P and K in soil with the application of FYM was also reported by Rao and Dakhore (1985) also reported higher soil organic C, soluble P, exchangeable K in soil in a four years study. Higher availability of P in manured treatments may be attributed to P solubilization by organic acids released from organic manures, reduction of P fixation in soil due to chelation of P fixing cations like Ca, Mg, Fe, Al, Zn *etc*. similar results reportd by Biradar and Jayadeva (2013).

Rao and Srivastava (2000) obtained three years data for Maize-Wheat cropping system and examined the extent of fertility build up was a result of continuous fertilization based on targeted yield approach. Initial soil P and K levels improved over the time and showed less P and K requirements to obtain the targates. Vidyavati *et al.* (2011) observed that, application of organic manures resulted in significantly higher organic carbon. Whereas integrated application of manure and fertilizers resulted in significantly higher available N, P_2O_5, K_2O and S than chemical fertilizers alone. Significantly higher uptake of N, P and K by *kharif* and *rabi* crops was recorded in integrated practice compared to inorganic nutrient management practice. The available N, P_2O_5, K_2O and S were significantly higher in legume based cropping systems during both the seasons of the study than non-legume system.

Fertilizer levels to potato

The soil available nitrogen, phosphorous and potassium in soil after harvest of potato crop was influenced due to the different fertilizer levels *rabi* potato. Application of 100 % RDF registered maximum available nitrogen (178.6 and 192.4 kg ha^{-1}), phosphorous (19.9 and 21.3 kg ha^{-1}) and potassium (399.6 and 412.6 kg ha^{-1}) after harvest of potato crop during both the years. Application of higher nutrients was resulted higher available nutrients during both the years.

Chavan *et al.* (2014) a field experiment was conducted during two *rabi* seasons on groundnut at Agricultural Technical School (Dr. B. S. Konkan Krishi Vidyapeeth Dapoli, Maharashtra) farm, campus-Deodhe (Lanja), district Ratnagiri, Maharashtra, India. Reported that, treatment 125 % RDF as well as biofertilizers significantly increased soil available N, P and K status,

Table 2 Soil chemical properties as influenced by different treatments after harvest of Groundnut (2014 and 2015)

Treatment		Available nutrient (kg ha^{-1})					
		Nitrogen		Phosphorous		Potassium	
		2014	2015	2014	2015	2014	2015
T_1 :	STCR equ^n 20 q ha^{-1} without FYM	162.3	173.8	18.33	19.00	382.3	391.3
T_2 :	STCR equ^n 25 q ha^{-1} without FYM	164.8	178.2	18.56	20.11	388.6	398.6
T_3 :	STCR equ^n 30 q ha^{-1} without FYM	166.2	183.3	18.68	20.36	394.8	400.5
T_4 :	STCR equ^n 35 q ha^{-1} without FYM	169.7	187.7	19.54	20.78	397.9	404.2
T_5 :	GRDF	181.4	198.7	20.00	21.37	426.7	434.8
T_6 :	RDF	161.3	169.5	18.09	19.13	380.2	386.8
	S. Em. (±)	0.34	0.39	0.46	0.43	0.54	0.63
	C. D. at 5 %	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
	General mean	167.7	181.9	18.87	20.13	395.1	402.7
	Initial	170	--	18	--	425.2	--

Table 3: Soil chemical properties as influenced by different treatments after harvest of Potato (2014 and 2015)

Treatment		Available nutrient (kg ha^{-1})					
		Nitrogen		Phosphorous		Potassium	
		2014	2015	2014	2015	2014	2015
A. Nutrient management to *kharif* groundnut							
T_1 :	STCR equ^n 20 q ha^{-1} without FYM	164.2	177.7	18.7	20.03	383.7	391.2
T_2 :	STCR equ^n 25 q ha^{-1} without FYM	168.80	185.4	19.2	20.4	382.6	406.5
T_3 :	STCR equ^n 30 q ha^{-1} without FYM	174.9	187.3	19.0	20.9	391.6	407.6
T_4 :	STCR equ^n 35 q ha^{-1} without FYM	178.1	191.4	19.3	21.2	393.6	410.9
T_5 :	GRDF	186.3	206.8	20.5	22.4	433.0	442.8
T_6 :	RDF	163.5	175.6	18.6	19.9	382.0	390.9
	S. Em. (±)	0.46	0.49	0.35	0.16	0.34	0.36
	C. D. at 5 %	1.45	1.57	1.13	0.50	1.09	1.13
B. Fertilizer levels to *rabi* potato							
F_1 :	Control	165.9	181.0	18.7	20.2	388.5	402.5
F_2 :	75 % RDF	173.5	188.5	19.0	20.9	395.1	409.8
F_3 :	100 % RDF	178.6	192.4	19.9	21.3	399.6	412.6
	S.Em.±	0.20	0.24	0.18	0.17	0.36	0.28
	C.D.at 5 %	0.60	0.70	0.53	0.51	1.05	0.84
	Interaction(A x B)	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
	General mean	172.64	187.29	19.21	20.79	394.4	408.3
	Initial	170.03	--	18.02	--	425.2	--

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