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Role of STCR approach in improving yield and growth parameters of cropping systems under *Vertisol* conditions in Chhattisgarh

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Abstract
A field experiment was conducted over two consecutive years (2022-23 and 2023-24) to evaluate the effect of Soil Test Crop Response (STCR)-based fertilizer application on the performance of a Cowpea-Potato-Cucumber cropping system in *Vertisols* of Chhattisgarh, India. The study, executed at the Research cum Demonstration Farm of IGKV, Raipur, followed the STCR methodology developed by Ramamoorthy *et al.* (1967) and involved graded nutrient applications to create fertility gradients. Three fertilizer treatments, Control ($N_0P_0K_0$), Recommended Dose of Fertilizers (RDF) and STCR-based fertilizer dose were tested for each crop. Results demonstrated that the STCR-based treatment T8 (ST-ST-ST) significantly improved all measured growth and yield parameters across crops. Cowpea under STCR based nutrient management showed the highest plant height (77.78 cm), early flowering (48.68 days), and pod yield (9.55 t/ha). Similarly, potato recorded the highest plant height (55.95 cm at 90 DAS), highest total tuber yield (25.78 t/ha) and marketable yield (21.91 t/ha). In cucumber, the STCR approach recorded maximum vine length (154.57 cm), number of branches (3.20), number of leaves (86.03) and fruit yield (5.65 t/ha). These findings highlight the effectiveness of STCR-based nutrient management in enhancing crop productivity and resource use efficiency in intensive cropping systems. Adoption of such site-specific fertilization strategies holds promise for sustainable intensification and improved soil health in rainfed and irrigated agro-ecosystems of Chhattisgarh region.

Keywords: Soil Test Crop Response (STCR), cowpea-potato-cucumber cropping system, fertility gradient approach, *Vertisols*, sustainable intensification, crop productivity, Chhattisgarh

Introduction
A vegetable-based farming system involves the strategic selection of suitable crops for each season, aligning with the region's agro-climatic conditions and meeting both farmer and consumer needs. This system ensures optimal utilization of available farm resources across production enterprises to achieve key objectives such as maximizing farm income and generating employment. In the context of addressing poverty alleviation, enhancing nutritional and food security, and promoting competitiveness and sustainability, several researchers have emphasized the adoption of a farming system approach, including vegetable-based farming systems (Anon, 2011) [3].

Cowpea (*Vigna unguiculata* L.) holds significant nutritional value, especially in its green tender pod stage, which contains 84.6% moisture, 4.6% protein, 8.0% carbohydrates, and 0.2% fat. It is also a rich source of essential minerals such as calcium, phosphorus, and iron (Aykroyd, 1963) [1].

Potato (*Solanum tuberosum* L.) is an important carbohydrate source, providing 22.6 g of carbohydrates and 16.3 g of starch per 100 g, along with 1.6 g of protein. It is also rich in essential amino acids like leucine, tryptophan, and isoleucine (Khurana and Naik, 2003) [4].

Cucumber (*Cucumis sativus* L.) is packed with several vital vitamins, including vitamin K (16.4 µg), vitamin A (105 IU), vitamin C (2.8 mg), vitamin E (0.03 mg), and B-complex vitamins such as riboflavin (0.033 mg), niacin (0.098 mg), pantothenic acid (0.259 mg), and pyridoxine (0.040 mg). It also contains minerals like calcium (16 mg), potassium (147 mg), sodium (2 mg), and iron (0.28 mg). Nutritionally, cucumber offers 15 kcal of energy, 3.63 g of carbohydrates, 0.65 g of protein, 0.11 g of total fat, no cholesterol, and 0.5 g of dietary fiber per 100 g (USDA Nutrient Database).

Fertilizer recommendations are typically based on the nutrient status of the soil, which is categorized as low, medium, or high. Among the various methods, the Soil Test Crop Response (STCR) approach is considered one of the most scientific. It uses soil test values and targeted yield equations that take into account nutrient contributions from soil, organic manures, and fertilizers (Ramamoorthy *et al.*, 1969) [6].

A cropping system refers to the specific pattern and sequence of crops grown on a farm and how they interact with farm resources, technologies, and the local environment. It encompasses combinations of crops in time (different growing periods) and space (intercropping). For annual crops, a cropping system typically represents the crop combinations grown within a single year (Willey *et al*., 1989). Vegetable-based cropping systems are often practiced near urban or peri-urban regions due to their high market demand and cash flow potential. While higher cropping intensity generally leads to greater returns, systems involving high-value crops with lower intensity may yield greater economic benefits than high-intensity systems based on low-value crops (Singh *et al.*, 2013) [7].

Materials and Methods

A field experiment was conducted based on STCR methodology on Cowpea - Potato - Cucumber cropping system with the variety Kashi Kanchan, Kufri Pukhraj and Pusa Uday at Research cum Demonstration Farm, Indira Gandhi Krishi Vishwavidyalaya, Raipur district of Chhattisgarh (India) during the *Kharif*, *Rabi* and Summer season of the year 2022-2023 and 2023-2024. The present study was carried out following the approved layout plan of the All India Coordinated Research Project (AICRP) on Soil Test-Crop Response (STCR). The experimental design was based on the field methodology developed by Ramamoorthy *et al.* (1967) [6], which involves creating fertility gradients to study soil test-crop yield relationships. The experimental field was divided into three equal strips, nominated as R-I, R-II, and R-III, to develop variations in soil fertility status. Prior to the main cropping sequence, fertility gradients were established by applying graded doses of nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O) fertilizers to generate differential soil test values and yield responses.

For cowpea, the fertilizer treatments included Control (0-0-0), Recommended Dose of Fertilizers (RDF) at 20:60:40 kg N: P_2O_5: K_2O ha^{-1}, and STCR-based dose (ST) at 36:78:28 kg N: P_2O_5: K_2O ha^{-1}. For potato, the corresponding treatments were Control (0-0-0), RDF (150:100:100 kg N: P_2O_5: K_2O ha^{-1}), and ST (195:130:70 kg N: P_2O_5: K_2O ha^{-1}). Similarly, for cucumber, the treatments included Control (0-0-0), RDF (70:50:50 kg N: P_2O_5: K_2O ha^{-1}), and ST (91:65:35 kg N: P_2O_5: K_2O ha^{-1}). Urea was used as the nitrogen source, single super phosphate (SSP) for phosphorus, and muriate of potash for potassium (MOP). For all crops, 50% of the nitrogen along with the full dose of phosphorus and potassium was applied as a basal dose at the time of sowing or planting. The remaining 50% of nitrogen was top-dressed 30 days after sowing (DAS). This method allowed for evaluating crop responses under varying soil fertility levels in *vertisols* of the Chhattisgarh plains.

Various growth and yield parameters were recorded throughout the cropping cycle for each crop. In cowpea, plant height was measured from the ground level to the growing tip at the time of harvest, and the average height was expressed in centimeters. The number of leaves was counted at 30 days after sowing (DAS) from the upper portion of the plant. The number of branches per plant was recorded from five randomly selected, labelled plants, and the mean was calculated and expressed as shoots per plant. Additionally, the number of days from sowing to the appearance of the first flower was documented. In potato, plant height was recorded from the base to the tip of the main shoot at 30, 60, and 90 DAS, and the mean height was calculated using five randomly selected labelled plants. The number of leaves per plant was counted at the same intervals. Total tuber yield (t/ha) was determined by weighing the freshly harvested tubers after harvest. Marketable yield was calculated by categorizing tubers into three size grades (25-50 g, 50-75 g, and >75 g), followed by summing the weights of all marketable grades. In cucumber, vine length was measured from the base to the tip of the vine at 60 and 90 DAS from five labelled plants per treatment, and the average length was expressed in centimeters. The number of leaves per vine was counted at 90 DAS, while the number of branches per vine was recorded at 60 DAS, with average values calculated for each treatment.

Results

The application of STCR-based fertilizer treatments had a significant impact on the growth and yield attributes of cowpea, potato, and cucumber during the 2022-23 and 2023-24 cropping cycles. In general, the treatments based on the Soil Test Crop Response (STCR) approach outperformed both the Recommended Dose of Fertilizers (RDF) and the control ($N_0P_0K_0$), emphasizing the importance of site-specific nutrient management for maximizing crop productivity in *Vertisols* of Chhattisgarh.

Cowpea

The highest plant height was recorded in treatment T8 (ST-ST-ST), with a pooled mean of 77.78 cm, followed by T6 (73.49 cm) and T7 (72.96 cm), whereas the lowest was observed under T9 ($N_0P_0K_0$), with a mean of 49.71 cm. Similarly, the number of branches per plant was also significantly influenced, with T8 recording the highest (5.70), followed by T7 (4.89), and the lowest in the control (2.78). For the number of leaves production, T8 again recorded the highest mean number of leaves per plant (56.92), while T9 had the lowest (39.18). Regarding days to first flowering, early flowering was observed in T8 (48.68 days), followed by T7 (51.24), compared to the delayed flowering in T9 (63.92 days). In terms of yield, the highest pod yield (9.55 t/ha pooled mean) was obtained from T8, which was 115% higher than the control T9 (4.44 t/ha), and significantly higher than RDF.

Potato

The STCR-based fertilizer treatments significantly enhanced the vegetative growth of potato across all growth stages. The highest plants at 90 DAS were observed in T8 (ST-ST-ST) 55.95 cm, followed by T6 (53.58 cm), while T9 showed the shortest plants (40.41 cm). At all three stages of observation (30, 60, and 90 DAS), treatments with STCR application maintained consistently greater plant heights. The number of compound leaves per plant followed a similar trend, with T8 (ST-ST-ST) 41.66 showing significantly higher leaf count at 90 DAS compared to T9 30.03. T8 also recorded the highest total tuber yield (25.78 t/ha), representing a 134% increase over the control (11.01 t/ha), and outperforming RDF. Correspondingly, the marketable yield followed the same pattern, with T8 (ST-ST-ST) recorded yield of 21.91 t/ha, significantly higher than T9 (9.81 t/ha).

Cucumber

Cucumber growth and productivity were also significantly influenced by STCR-based nutrient management. The vine length at harvest reached a maximum of 154.57 cm under T8 (ST-ST-ST), which received STCR-based fertilizer throughout the crop sequence. This was substantially higher than the control T9 (100.69 cm). The number of branches and leaves per plant at harvest were also highest in T8 (3.20 branches and 86.03 leaves), compared to the control (1.57 branches and 56.09 leaves). In terms of yield, the cucumber fruit yield under T8 was 5.65 t/ha, surpassing T9 (2.07 t/ha), confirming the role of STCR-based fertilization in improving marketable output.

Table 1: Effect of different fertilizer treatments on growth and yield of cowpea

Treatments	Plant height (cm)			Number of branches per plant			Number of leaves per plant			Days to 1st flowering			Pod Yield t/ha		
	2022-23	2023-24	mean	2022-23	2023-24	mean	2022-23	2023-24	mean	2022-23	2023-24	mean	2022-23	2023-24	mean
T 1 (R-R-R)	60.03	71.25	65.64	4.23	4.50	4.37	42.61	50.34	42.61	55.20	54.25	54.73	5.32	9.24	7.28
T2 (R-R-ST)	59.57	69.00	64.28	4.33	4.50	4.42	43.09	53.30	43.09	56.90	54.71	55.81	5.37	9.69	7.53
T3 (R-ST-R)	60.84	74.20	67.52	3.99	4.00	3.99	46.22	53.24	46.22	57.36	55.10	56.23	5.14	9.58	7.36
T4 (R-ST-ST)	61.25	77.25	69.25	4.28	4.50	4.39	49.22	57.54	49.22	58.60	54.10	56.35	5.55	9.71	7.63
T5 (ST-R-R)	64.67	76.40	70.53	3.89	4.20	4.04	44.33	55.20	44.33	53.20	49.52	51.36	5.99	10.26	8.13
T6 (ST-ST-R)	65.38	81.60	73.49	4.33	4.80	4.57	44.10	52.41	44.10	53.60	49.84	51.72	5.90	10.92	8.41
T7 (ST-R-ST)	63.52	82.40	72.96	4.78	5.00	4.89	50.84	57.30	50.84	52.30	50.17	51.24	6.09	11.77	8.93
T8 (ST-ST-ST)	68.35	87.20	77.78	5.50	5.90	5.70	56.92	65.61	56.92	49.80	47.57	48.68	6.60	12.50	9.55
T9 (N0P0K0)	43.58	55.84	49.71	2.57	3.00	2.78	39.18	43.20	39.18	63.50	64.34	63.92	2.55	6.32	4.44
CD	13.15	16.82	14.36	1.00	1.07	1.12	9.61	10.96	9.76	8.56	9.23	7.55	0.52	1.65	0.85

Table 2: Effect of different fertilizer treatments on plant height of potato

Treatments	Plant height (cm)								
	Plant height (30 DAS)			Plant height (60 DAS)			Plant height (90 DAS)		
	2022-23	2023-24	Pooled mean	2022-23	2023-24	Pooled mean	2022-23	2023-24	Pooled mean
T 1 (R-R-R)	26.60	36.73	31.67	38.20	48.20	43.20	44.23	52.97	48.60
T2 (R-R-ST)	28.36	35.97	32.16	36.50	49.35	42.93	42.61	53.21	47.91
T3 (R-ST-R)	27.84	37.26	32.55	39.80	50.30	45.05	46.32	54.61	50.47
T4 (R-ST-ST)	29.17	37.72	33.44	39.98	53.20	46.59	45.95	57.53	51.74
T5 (ST-R-R)	27.10	37.08	32.09	39.00	48.72	43.86	45.63	53.16	49.40
T6 (ST-ST-R)	28.46	37.24	32.85	41.50	55.34	48.42	47.65	59.51	53.58
T7 (ST-R-ST)	27.12	37.13	32.12	36.50	48.08	42.29	42.81	52.43	47.62
T8 (ST-ST-ST)	30.93	41.56	36.25	43.50	57.32	50.41	50.32	61.57	55.95
T9 (N0 P0 K0)	24.14	32.33	28.24	29.87	40.35	35.11	36.21	44.61	40.41
CD	NS	NS	NS	6.68	8.74	8.02	7.00	8.80	7.33

Table 3: Effect of different fertilizer treatments on Number of compound leaves per plant of potato

Treatments	Number of compound leaves per plant								
	Number of compound leaves per plant (30 DAS)			Number of compound leaves per plant (60 DAS)			Number of compound leaves per plant (90 DAS)		
	2022-23	2023-24	Pooled mean	2022-23	2023-24	Pooled mean	2022-23	2023-24	Pooled mean
T 1 (R-R-R)	18.35	24.12	22.36	25.31	30.25	27.78	33.86	40.20	37.03
T2 (R-R-ST)	18.94	24.00	21.67	25.41	30.45	27.93	33.91	39.91	36.91
T3 (R-ST-R)	19.93	24.66	22.30	26.89	31.84	29.37	35.94	43.50	39.72
T4 (R-ST-ST)	19.87	24.77	23.15	26.87	31.55	29.21	35.25	42.31	38.78
T5 (ST-R-R)	19.13	23.94	21.54	25.48	30.84	28.16	33.85	40.05	36.95
T6 (ST-ST-R)	21.53	25.78	22.21	27.36	32.78	30.07	35.84	43.43	39.64
T7 (ST-R-ST)	18.46	23.90	20.90	25.21	30.90	28.06	33.45	40.17	36.81
T8 (ST-ST-ST)	20.30	28.31	25.66	29.40	32.84	31.12	37.95	45.37	41.66
T9 (N0 P0 K0)	17.54	21.73	18.05	21.38	27.45	24.42	29.85	30.20	30.03
CD	NS	NS	NS	4.72	4.64	3.46	5.68	5.76	5.31

Table 4: Effect of different fertilizer treatments on yield parameter of potato

Treatments	Total tuber yield (t/ha)			Marketable yield (t/ha)		
	2022-23	2023-24	Pooled mean	2022-23	2023-24	Pooled mean
T 1 (R-R-R)	17.13	20.35	18.74	13.99	15.52	14.76
T2 (R-R-ST)	17.30	23.12	20.21	14.24	17.85	16.05
T3 (R-ST-R)	19.26	26.34	22.80	16.42	21.17	18.80
T4 (R-ST-ST)	19.35	28.38	23.87	15.56	22.03	18.80
T5 (ST-R-R)	18.11	23.09	20.60	15.34	18.89	17.12
T6 (ST-ST-R)	20.75	28.49	24.62	17.71	22.52	20.12
T7 (ST-R-ST)	18.99	25.09	22.04	15.40	20.10	17.75
T8 (ST-ST-ST)	21.35	30.20	25.78	18.14	25.67	21.91
T9 (N0 P0 K0)	10.44	11.57	11.01	8.64	10.97	9.81
CD	4.03	5.45	4.74	3.37	3.8	3.88

Table 5: Effect of different fertilizer treatments on vine length (cm) of cucumber at 30 DAS and at harvest

Treatments	Vine length at 30 DAS (cm)			Vine length at harvest (cm)		
	2022-23	2023-24	Pooled mean	2022-23	2023-24	Pooled mean
T 1 (R-R-R)	60.03	71.25	65.64	112.54	145.68	129.11
T2 (R-R-ST)	59.57	69.00	64.28	126.35	158.61	142.48
T3 (R-ST-R)	60.84	74.20	67.52	119.65	140.25	129.95
T4 (R-ST-ST)	61.25	77.25	69.25	134.25	155.34	144.795
T5 (ST-R-R)	64.67	76.40	70.53	115.84	138.49	127.165
T6 (ST-ST-R)	65.38	81.60	73.49	110.54	143.57	127.055
T7 (ST-R-ST)	63.52	82.40	72.96	128.35	161.84	145.095
T8 (ST-ST-ST)	68.35	87.20	77.78	138.5	170.64	154.57
T9 (N0 P0 K0)	51.35	61.25	56.30	90.84	110.54	100.69
CD	NS	NS	NS	26.01	32.26	27.78

Table 8: Effect of different fertilizer treatments on number of branches per plant and number of leaves per plant at harvest

Treatments	Number of branches per plant			Number of leaves per plant at harvest			Yield (t/ha)		
	2022-23	2023-24	Pooled mean	2022-23	2023-24	Pooled mean	2022-23	2023-24	Pooled mean
T 1 (R-R-R)	2.20	2.30	2.25	68.56	81.25	74.91	2.17	6.11	4.14
T2 (R-R-ST)	2.40	2.45	2.43	70.97	84.65	77.81	2.41	7.27	4.84
T3 (R-ST-R)	2.30	2.41	2.36	68.79	80.43	74.61	2.25	6.55	4.40
T4 (R-ST-ST)	2.40	2.43	2.42	70.54	86.72	78.63	2.63	7.82	5.23
T5 (ST-R-R)	2.10	2.24	2.17	66.57	79.89	73.23	2.20	6.29	4.25
T6 (ST-ST-R)	2.30	2.38	2.34	66.84	81.52	74.18	2.28	7.06	4.67
T7 (ST-R-ST)	2.70	2.80	2.75	74.38	89.54	81.96	2.60	7.50	5.05
T8 (ST-ST-ST)	3.10	3.29	3.20	78.51	93.54	86.03	3.25	8.05	5.65
T9 (N0 P0 K0)	1.50	1.64	1.57	48.59	63.58	56.09	0.71	3.42	2.07
CD	0.49	0.59	0.49	13.58	17.75	15.27	0.54	1.44	1.03

Conclusion

The findings of the present study demonstrate that the application of Soil Test Crop Response (STCR)-based fertilizer recommendations significantly improved the growth, development, and yield of cowpea, potato and cucumber in a Cowpea-Potato-Cucumber cropping system under *Vertisol* conditions of Chhattisgarh. The treatment receiving STCR-based fertilizer throughout the cropping sequence T8 (ST-ST-ST) consistently outperformed both the Recommended Dose of Fertilizers (RDF) and the control in terms of plant height, number of leaves and branches, early flowering, and final yield across all three crops. Thus, adoption of STCR-based fertilization strategies in multi-crop systems can serve as a reliable and efficient tool for achieving sustainable intensification, higher resource use efficiency, and long-term soil health in the rainfed and irrigated agro-ecosystems of Chhattisgarh.

References

1. Aykroyd WR. ICMR Special Report, Series 42. 1963:477-487.
2. FoodData Central. Beltsville (MD): US Department of Agriculture, Agricultural Research Service. About FoodData Central. https://fdc.nal.usda.gov/about-us.html
3. Indian Institute of Vegetable Research. Vision-2030. Varanasi (India): Indian Institute of Vegetable Research; 2011. http://www.iivr.org.in
4. Khurana PSM, Naik PS. The potato: an overview. In: Khurana SMP, Minas JS, Pandey SK, editors. The potato production and Utilization in sub-tropics. New Delhi (India): Mehta Publication; 2003. p. 1-14.
5. Kumar NK, Vennila S. Indian Agriculture Towards 2030. New Delhi (India): NITI Aayog, Food and Agriculture Organization of the United Nations; 2021.
6. Ramamoorthy B, Narasimham RL, Dinesh RS. Fertilizer application for specific yield target of Sonora 64. Indian Fmg. 1967;17(5):43-45.
7. Singh RP, Pande PADMAJA, Solankey SS, Chatterjee A. Cropping Systems in Vegetables. In: Olericulture-Fundamental of Vegetable Production. 2013. p. 347-373.