

Fertilizer Recommendations Developed through STCR with Integrated Nutrient Management Supply for Mustard in Inceptisol

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ABSTRACT: A study was conducted of five locations in village-Parsiya, Naugarh block of district-Chandauli, Uttar Pradesh during Rabi-2019 to evaluate the model through Soil Test Crop Response (STCR). Among the treatments were control, blanket recommendation, STCR-based fertilizer doses for yield objectives of 16 and 20 q ha⁻¹, and farmer's practice. Fertilizer doses were calculated and applied for soil test based fertilizer recommendation (STBFR) treatments based on the initial soil test values of available N, P, and K and the amounts of N, P, and K provided by farm yard manure for the corresponding production targets (FYM). The treatments were imposed and cultivation practices were carried out periodically, and the grain yield was recorded at harvest. Using the data on grain yield and fertilizer doses applied, per cent achievement and B:C Ratio (Benefit Cost Ratio) were worked out. Post harvest soil samples were collected and analyzed for available N, P and K status. The results of the studies showed that the percent achievement of the targeted yield was within 10% fluctuation in all five sites, showing the validity of the equations for prescribing integrated fertilizer dosages for mustard. The yield objective of 20 q ha⁻¹ (2020) under STBFR had the highest mean percent attainment, followed by STCR 16 q ha⁻¹. STBFR 20 q ha⁻¹ also had the best benefit: cost ratio (7.39). The post-harvest soil available NPK revealed soil fertility building and maintenance as a result of soil test-based fertilizer recommendations. The IPNS mustard fertilizer prescription equations can be advised for alluvial Inceptisol in Uttar Pradesh's Chandauli district to attain a yield objective of 20 q ha⁻¹ with a good economic return.

Key words: B:C ratio, STCR, Mustard and Yield target.

INTRODUCTION

Mustard (*Brassica Juncea* L.) is the world's third largest oilseed crop, after only soybeans and palm oil. Mustard accounts for 28.6 % of total oil seed output in India. After groundnut, it is the second most significant edible oilseed, accounting for 27.8 % of India's oilseed sector (Shekhawat *et al.*, 2012). Mustard is grown in the Indian states of Rajasthan, Uttar Pradesh, Haryana, Punjab, and Madhya Pradesh. Mustard is comprised of a variety of versatile species that produce edible leaves, stems, seeds, and roots. Mustard is widely grown as a commercial crop, food, and fodder. India's average production level of 1190 kg ha⁻¹ is significantly lower than that of industrialized countries (2500-3000 kg ha⁻¹) and the global average of around 1900 kg ha⁻¹.

(Agriculture and Cooperation report, ministry of agriculture, government of India 2013-14). Truog (1960); Ramamoorthy *et al.* (1967) pioneered the targeted yield approach. Established a theoretical foundation and experimental approaches for use in Indian contexts. Soil test-based fertilizer recommendations result in more efficient fertilizer use and soil fertility management. The soil test and crop response (STCR) technique recommends fertilizer dose depending on soil contribution and yield level. Since 1967, the All India Co-ordinated Research Project on STCR has widely used the targeted yield concept, which uses several regression equations to examine nutrient interactions. Under an intensive agricultural system, the STCR technique looks to be a feasible technology for sustaining higher crop output and

ensuring better soil quality. The STCR-based calculations are helpful in determining the optimal amount of chemical fertilizers to use in conjunction with organic manures. Many researchers in India have conducted tests utilizing the STCR technique. Singh *et al.* (2020) optimized integrated nutrient management supply for Coriander in an Inceptisol in eastern Uttar Pradesh using the STCR technique. During 2017-18, Luthra *et al.* (2021) used the STCR technique to optimise integrated nutrient management supply for hybrid maize (*Zea mays* L.) in Mollisol at the Crop Research Centre at G.B.P.U.A.&T., Pantnagar, Uttarakhand. Kumar *et al.* (2022) employed the STCR technique to optimize integrated nutrient management supply for Oat (*Avena sativa* L.) in an Inceptisol at Banaras Hindu University's agriculture research farm in Varanasi, Uttar Pradesh, during 2018-19. The current research aims to investigate the interaction between soil nutrients and additional fertilizers, their absorption and mustard yield, and to produce a guideline for judicious fertilizer use for maximum mustard yield.

MATERIAL AND METHODS

Field experiments were conducted at different locations of five farms of alluvial soil in Uttar Pradesh during Rabi 2019 to assess the validity of the fertilizer prescription equation for Mustard produced using STCR model. Experiments were set up at five locations in Parsiya village, Naugarh block, Chandauli district, Uttar Pradesh. Initial soil samples were taken from each location and evaluated for pH using the potentiometer technique in a 1:2.5 soil-water solution (Jackson 1973). Electrical conductivity was measured and represented

as $dS\ m^{-1}$ (Jackson 1973), organic carbon (Walkley and Black 1934), alkaline $KMnO_4-N$ (Subbiah and Asjia 1956), Olsen-P (Olsen *et al.*, 1954), and NH_4OAc-K (Hanway and Heidal 1952). Table 1 shows the initial soil fertility status for several locations. (Varma *et al.*, 2017) established fertilizer prescription equations for mustard under STCR on the eastern plain zone of Uttar Pradesh, which are given below:

Nitrogen dose ($kg\ ha^{-1}$) = $12.27^*T - 0.56SN - 0.09^*FYM - N$
 Phosphorus dose ($kg\ ha^{-1}$) = $3.03^*T - 1.34^*SP - 0.10^*FYM - P$

Potassium dose ($kg\ ha^{-1}$) = $3.94^*T - 0.21^*K - 0.22^*FYM - K$
 Where, FN, FP_2O_5 and FK_2O are fertilizers N, P_2O_5 and K_2O in $kg\ ha^{-1}$, respectively; SN, SP and SK are available N, P and K through soil in $kg\ ha^{-1}$, respectively; ON, OP and OK are N, P and K supplied through FYM in $kg\ ha^{-1}$ and T=Grain yield target in $q\ ha^{-1}$. The treatments used were as follows: (i) Control, (ii) Farmer's practice, (iii) General Recommended dosage, (iv) STCR based fertilizer dose for a yield target of $16\ q\ ha^{-1}$ with FYM $5\ t\ ha^{-1}$ (v) STCR based fertilizer dose for an yield target of $20\ q\ ha^{-1}$ with $5\ t\ ha^{-1}$. Based on the initial soil test values of available N, P and K and the quantities of N, P_2O_5 and K_2O supplied fertilizer doses were calculated and applied for STCR treatments for various yield targets.

The remaining 50% N was applied 30 days after planting, together with the full doses of P_2O_5 and K_2O , and all other packages of procedures were carried out on a regular basis. Using data on grain yield and fertilizer dosages used, the parameters, viz., B: C ratio, were calculated based on the price of the produce and cultivation costs as per conventional technique.

Table 1: Soil fertility status of the initial soils of five locations (Village-Parsiya, Naugarh block of district-Chandauli).

Locations	pH	EC. ($dS\ m^{-1}$)	OC (%)	Available N ($kg\ ha^{-1}$)	Available P ($kg\ ha^{-1}$)	Available K ($kg\ ha^{-1}$)
1.	7.45	0.39	0.60	228.00	17.00	190.00
2.	7.39	0.37	0.66	232.00	17.70	190.40
3.	7.46	0.37	0.65	232.00	17.60	190.12
4.	7.50	0.41	0.72	230.00	17.55	192.00
5.	7.52	0.37	0.70	233.00	17.32	190.66

Table 2: Treatments of fertilizer doses ($kg\ ha^{-1}$) imposed under different locations in (Village- Parsiya, Naugarh block, district Chandauli).

Treatments	Location 1			Location 2			Location 3			Location 4			Location 5		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
Control	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Farmer's practice	60	30	30	60	30	30	60	30	30	60	30	30	60	30	30
GRD	80	40	40	80	40	40	80	40	40	80	40	40	80	40	40
STCR $16\ q\ ha^{-1}$	65	13	32	65	13	32	65	13	32	65	13	32	65	13	32
STCR $20\ q\ ha^{-1}$	114	28	34	114	28	34	114	28	34	114	28	34	114	28	34

Where: GRD-General recommended doses and STCR-Soil test crop response

RESULTS AND DISCUSSION

The treatment STCR 20 q ha⁻¹ (2020 kg ha⁻¹) had the greatest mean grain yield among the five farmers, followed by STCR 16 q ha⁻¹ (1620 kg ha⁻¹) GRD (1525 kg ha⁻¹) and farmer practices (1306 kg ha⁻¹) suggesting that the STCR treatment had a higher yield than GRD and farmer practices (Table 3). When compared to all other treatments, the blanket had the lowest yield (1105). STCR 20 q ha⁻¹ increased yield by 54.67% over Farmer's practices. All treatments differ significantly, with STCR 20 q ha⁻¹ receiving the highest mean yield. The percent achievement of the targeted yield was within 10% variation in all five verification trials, demonstrating the validity of the equations for prescribing integrated fertilizer doses for mutated.

STCR 20 q ha⁻¹ (Rs. 32869) provided the greatest net benefit, followed by STCR 16 q ha⁻¹ (Rs. 18658 Rs), GRD (Rs. 13308), and farmer practices (Rs. 5481). In terms of net benefit, STCR 20 q ha⁻¹ had the highest B:C ratio (7.39), followed by STCR 16 q ha⁻¹ (6.90). So, while STCR 20 q ha⁻¹ yields more than STCR 16 q ha⁻¹, the economic return is lower. As a result of the balanced supply of nutrients from fertilizer, efficient utilisation of applied fertilizer nutrients in the presence of organic sources, and the synergistic effect of the concurrent addition of various nutrient sources, STCR treatments achieve higher yield, net benefits, and B:C ratios than control and blanket treatments (Singh *et al.* 2017; Singh *et al.* 2019; Singh and Singh 2014).

Table 3: Grain yield, net benefits and B: C ratio of mustard crop under different locations in Village- Parsiya, Naugarh block, district Chandauli.

Treatments	Grain yield (kg ha ⁻¹) Locations					Mean (kg ha ⁻¹)	% increment in yield over T ₂	Value of additional yield (Rs.)	Cost of fertilizer (Rs.)	Net benefit (Rs.)	B/C ratio
	1	2	3	4	5						
T ₁ -0 - 0 - 0	1120	1150	1185	1115	1105	1135	-	-	-	-	-
T ₂ -60 - 30 - 30	1330	1280	1320	1270	1330	1306	225	9000	3518	5481	1.56
T ₃ -80 - 40 - 40	1440	1543	1562	1525	1555	1525	450	18000	4691	13308	2.84
T ₄ -65- 13 - 32- 5	1620	1595	1635	1618	1639	1621	534	21360	2702	18658	6.90
T ₅ -114- 28 - 34-5	2040	1985	2030	2008	2038	2020	933	37320	4451	32869	7.39
CD at 5 %	33.54	13.75	12.61	25.13	16.40	20.28	-	-	-	-	-

Note: Mustard@Rs.20.00 kg⁻¹, N@Rs.17.39 kg⁻¹, P₂O₅@Rs.56.25 kg⁻¹, K₂O@Rs.26.66

T₁ – Control, T₂- Farmer's Practices, T₃- GRD (General recommended Dose), T₄- Target yield (16 q ha⁻¹) with 5t/hac FYM, T₅Target Yield (20 q ha⁻¹) with 5t ha⁻¹ FYM.

Post-harvest soil values revealed that a sufficient build up and maintenance of SN, SP, and SK were discovered in the STCR study when compared to farmer practices and the general recommended dose. Despite the removal of a greater amount of nutrient in the STCR treatment to achieve a higher yield, the STCR plot had higher post-harvest soil fertility. In Table 4, the highest post harvest soil nitrogen in STCR for 20 q ha⁻¹ was found in location-1 (246.00 kg ha⁻¹), soil potassium in location-3 (235.00 kg ha⁻¹), and soil phosphorus in location-5 (23.10 kg ha⁻¹). The higher nutrient

accumulation in the STCR treatment was due to the balanced application of chemical fertilizer in conjunction with organic manure. The combined use of inorganic fertilizers improved the chemical and physical properties, potentially leading to increased and sustainable production (Singh *et al.*, 2017; Singh *et al.*, 2019). When fertilizer was applied for appropriate yield targets in succession over years using the STCR concept, greater profit was realized while maintaining soil fertility status (Ramamoorthy and Velayutham 2011).

Table 4: Post harvest soil fertility status of various treatments under five locations (in Village- Parsiya, Naugarh block, district Chandauli).

Treatments	Location 1			Location 2			Location 3			Location 4			Location 5		
	N	P	K	N	P	K	N	P	K	N	P	K	N	P	K
Control	205	15	181	204	15	182	202	16	183	206	17	181	208	16	182
Farmer's practice	226	16	185	224	17	186	224	17	188	216	18	183	216	17	186
GRD	231	16	195	228	17	189	228	18	190	226	20	188	224	19	189
STCR 16 q ha ⁻¹	244	17	211	232	16	195	240	19	215	230	22	192	228	21	192
STCR 20 q ha ⁻¹	246	18	220	238	19	235	241	20	242	237	24	204	238	23	204
C.D (0.5%)	1.30	1.00	0.46	0.55	1.03	0.63	1.33	1.15	0.99	0.89	1.49	1.25	0.70	1.29	1.35

Where, GRD – General recommended dose and STCR- Soil test crop response

CONCLUSION

On the basis of the results of the experiments we conducted, we can say that the study will help establish guidelines for the amount of fertilizer used in mustard fields. Therefore, fertilizer recommendations based on the targeted yield approach are not only valuable for achieving desired yield targets but also take care of the efficient and judicious use of fertilizers in increasing mustard production. Follow-up trials on farmer's fields will be conducted to test the validity of these equations while keeping their financial resources in mind. Thereafter, these can be used by soil testing laboratories to make fertilizer recommendations to farming communities in Chandauli district of Uttar Pradesh.

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Conflict of Interest. None.

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