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Yield Target Approach under Integrated Nutrient Management for Assessing Fertilizer Requirements of Mustard in Inceptisols of Uttar Pradesh

Y.V. Singh* and Kajal Singh
AICRP on STCR, Department of Soil Science and Agricultural Chemistry,
Institute of Agricultural Sciences, Banaras Hindu University, Varanasi 221005 (Uttar Pradesh)
*Corresponding author (E-mail: yvsingh59@rediffmail.com)

Abstract

Soil test crop response based fertilizer prescription for desired yield target of mustard on alluvial soil. On-farm testing of fertilizer prescription equations is essential to demonstrate the effectiveness of technology delivery to the stake holders in need. The present study was undertaken in five locations to evaluate the model through field experiments in Chandauli district of Uttar Pradesh, during Rabi 2020. The treatments included control, blanket recommendation, soil test crop response (STCR) based fertilizer dose for a yield target of 15 and 20 q ha^{-1}, STCR based fertilizer dose for an yield target of 15 and 20 q ha^{-1} and farmer's practice. Based on the initial soil test values of available N, P and K and the quantities of N, P and K contributed through farm yard manure (FYM), fertilizer doses were calculated and applied for soil test based fertilizer recommendation (STBFR) treatments for the respective yield targets. The results of the experiments indicated that in all the five locations, the per cent achievement of the targeted yield was within ±10% variation proving the validity of the equations for prescribing integrated fertilizer doses for mustered. The highest mean per cent achievement was recorded in the yield target of 20 q ha^{-1} under STBFR followed by STCR 15 q ha^{-1}. The highest benefit: cost ratio (7.39) was also recorded in STBFR 20 q ha^{-1}. The post harvest soil available NPK indicated the build up and maintenance of soil fertility due to soil test based fertilizer recommendation. The fertilizer prescription equations developed for mustard under IPNS can be recommended for alluvial Inceptisol of Uttar Pradesh for achieving a yield target of 20 q ha^{-1} with high economic return.

Keywords: Economic return, STCR, Mustard, B: C Ratio, yield target, Inceptisol etc.

Introduction

The genus Brassica of the family Cruciferae (Brassicaceae) is composed of several multipurpose species that yield edible leaves, roots, stems, and seeds as spices. Brassicas are also extensively cultivated as cash crops, vegetables, and fodder. The average productivity level of 1190 kg ha^{-1} in India is very low compared to that of the developed countries (2500–3000 kg ha^{-1}), as well as the world average of about 1900 kg ha^{-1} (Agriculture and Cooperation Report, Ministry of Agriculture, Government of India 2013–14). India is in first place in area and production of rapeseed and mustard in Asia. In India, rapeseed and mustard are cultivated in the states of Uttar Pradesh, Rajasthan, Haryana, Punjab, Madhya Pradesh, etc. The targeted yield approach was first developed by Troug (1960)[12] and Ramamoorthy (1967)[5]. Established theoretical basis and experimental technique to suit Indian conditions. Soil test-based fertilizer recommendations result in efficient fertilizer use and the maintenance of soil fertility. The soil test and crop response (STCR) approach is based on soil contribution, and yield level is used for recommending fertilizer dose. The targeted yield concept, which has been widely followed since 1967 in the All India Co-ordinated Research Project on STCR, employs multiple regression equations to study the nutrient interactions.

The STCR approach appears to be a viable technology to sustain higher crop productivity and assure better soil quality under an intensive agriculture system. The STCR-based equations are useful for deciding the appropriate dose of chemical fertilizers in conjunction with the organic manures.

Materials and Methods

To assess the validation of the fertilizer prescription equation for mustard developed by the STCR model, field experiments were carried out in different locations by five farmers on alluvial soil in Uttar Pradesh during Rabi 2020. Experiments were set up at five locations in the village of Jharigawan, the Naugarh block of the district of Chandauli, and Uttar Pradesh. Initial soil samples were collected from each location and analyzed for pH was determined in 1:2.5 soil-water suspension by potentiometer method (Jackson 1973)[2]. Electrical conductivity was determined extract using Conductivity Bridge and expressed as dSm^{-1} (Jackson 1973)[2], organic carbon (Walkely and Black, 1934) [14], alkaline $KMnO_4$-N (Subbiah and Asija, 1956) [11], Olsen-P (Olsen *et al.*, 1954)[3], NH_4OAc-K (Hanway and Heidal, 1952) [1]. The initial soil fertility status for different locations is shown in Table 1. Fertilizer prescription equations developed for mustard under STCR on eastern plain zone of utter Pradesh by (Varma *et al.*, 2017) [13], are given below:

Nitrogen dose ($kgha^{-1}$) =12.27*T-0.56SN-.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; T=Grain yield target in $q\ ha^{-1}$; 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 $kg\ ha^{-1}$. The treatments imposed were as follows : (i) Control, (ii) Farmer's Practices, (iii) General Recommended Dose,(iv) STCR based fertilizer dose for an yield target of 15 $q\ ha^{-1}$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 in table 1 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.

Table 1 Initial soil fertility status of the different locations in Villege- Jharigawan, Naugarh block, district Chandauli

Locations	pH	EC. (dSm^{-1})	OC (%)	Avai. N ($kg\ ha^{-1}$)	Avai. P ($kg\ ha^{-1}$)	Avai. K ($kg\ ha^{-1}$)
1.	7.55	0.38	0.61	226.00	16.00	180.00
2.	7.49	0.36	0.68	230.00	17.30	195.40
3.	7.48	0.38	0.64	235.00	17.00	190.10
4.	7.40	0.40	0.70	236.00	17.15	191.00
5.	7.46	0.35	0.68	238.00	16.32	191.96

Fifty per cent of N and full dose of P_2O_5 and K_2O were applied basally and the remaining 50% N was applied on 30 days after sowing and all other packages of practices were carried out periodically. Using the data on grain yield and fertilizer

doses applied, the parameters viz., B:C ratio was worked out based on the price of the produce and cost incurred for the cultivation as per the standard procedure.

Table 2 Treatments of fertilizer doses (kg ha^{-1}) imposed under different locations in Villege-Jharigawan,, 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	50	25	25	50	25	25	50	25	25	50	25	25	50	25	25
GRD	70	35	35	70	35	35	70	35	35	70	35	35	70	35	35
STCR 15 q ha^{-1}	64	12	31	64	12	31	64	12	31	64	12	31	64	12	31
STCR 20 q ha^{-1}	114	28	34	114	28	34	114	28	34	114	28	34	114	28	34

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

Result and Discussions

The highest mean grain yield among the five farmers were recorded in the treatment STCR 20 q ha^{-1}(2028 kg ha^{-1}) followed by STCR 15 q ha^{-1}(1639 kg ha^{-1}), GRD (1515 kg ha^{-1}) and farmer practices (1331 kg ha^{-1}) indicating that the STCR treatment was recorded relatively higher yield over GRD and Farmer's practices (Table 3). Lowest yield recorded in blanket (1100) compare to all other treatments. STCR 20 q ha^{-1} recorded a yield increase of 45.75% over Farmer's practices. All the treatments are significantly different in which STCR 20 q ha^{-1} receive highest mean yield. In all the five verification trials, the per cent achievement of the targeted yield was within ±10% variation proving the validity of the equations for prescribing integrated fertilizer doses for mutated. The highest net benefit was found in STCR 20 q ha^{-1} (Rs.55688) followed by STCR 15 q ha^{-1} (Rs.32340 Rs), GRD (Rs.24900) and farmer practices (Rs.13860). Compare to net benefit, highest B:C ratio was recorded in STCR 20 q ha^{-1} (11.51) followed by STCR 16 q ha^{-1} (11.43). So in STCR 20 q ha^{-1} we obtain a higher yield compare to STCR 15 q ha^{-1} but economic return is less. So STCR treatments obtain higher yield, net benefits and B:C ratio compare to control and blanket treatments due to balanced supply of nutrients from fertilizer, efficient utilization of applied fertilizer nutrients in the presence of organic sources and the synergistic effect of the conjoint addition of various sources of nutrients (Singh *et al.* 2017)[8]; (Singh *et al.* 2019) [6] and (Singh and Singh, 2014)[6].

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

Treatments	Grain yield (kg ha^{-1}) Locations					Mean (kgha^{-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	1121	1140	1180	1110	1100	1100	-	-		-	-
T_2-50 -25 – 25	1335	1281	1322	1272	1331	1331	231	13860	2932	10928	3.73
T_3-70 - 35 -35	1441	1544	1563	1528	1515	1515	415	24900	4105	20795	5.07
T_4-64- 12 – 30-5	1520	1594	1636	1620	1639	1639	539	32340	2602	29738	11.43
T_5-114- 28 – 34-5	2030	1985	2025	2018	2028	2028	928	55680	4450	51230	11.51
CD at 5 %	31.54	11.75	10.61	22.13	15.40	20.28	-	-	-	-	-

Note: Mustard@Rs.60.00 kg^{-1}, N@Rs.17.39 kg^{-1}, P_2O_5@Rs.56.25 kg^{-1}, K_2O@Rs.26.66

T_1 – Control, T_2- Farmer's Practices, T_3- GRD (General recommended Dose), T_4- Target yield (15 q ha^{-1}) with 5t/hac FYM, T_5Target Yield (20 q ha^{-1}) with 5t ha^{-1} FYM.

Post harvest soils value revealed that a sufficient build up and maintenance of SN, SP and SK are found under STCR study compare to farmer practices and general recommended dose. Despite removal of higher amount of nutrient in STCR treatment due to getting a higher yield, higher post harvest soil fertility was observed in STCR plot. Highest post harvest soil nitrogen was found in STCR for 20 q ha^{-1} in location-1 (244.00 kg ha^{-1}), soil potassium in location-3 (232.00 kg ha^{-1}), and soil phosphorus in location-4 (24.00 kg ha^{-1}) in table 4. The greater build up of nutrient in STCR treatment was due to balance application of chemical fertilizer in conjunction with organic manure. Combined application of inorganic fertilizers improved the chemical and physical properties, which may lead to enhanced and sustainable production (Singh *et al.* 2017[10] and Singh *et al.* 2019[9]) Greater profit consistent with maintenance of soil fertility status was realized when fertilizer was applied for appropriate yield targets in succession over years using STCR concept (Ramamoorthy and Velayutham, 2011) [5].

Table 4 Post harvest soil fertility status of various treatments under different locations in Villege- Jharigawan, 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	206	14	180	205	15	181	201	15	181	208	16	180	201	16	180
Farmer's practice	228	15	183	226	16	185	225	17	185	219	18	185	216	18	185
GRD	230	16	194	228	18	187	228	18	189	228	21	188	225	19	189
STCR 16 q ha^{-1}	242	17	211	232	18	191	235	19	216	231	23	195	228	20	191
STCR 20 q ha^{-1}	244	18	220	238	19	232	240	20	232	239	24	204	239	23	204
C.D (0.5%)	1.31	1.01	0.48	0.56	1.03	0.65	1.30	1.15	0.99	0.89	1.39	1.35	0.66	1.19	1.25

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

Conclusions

The fertilizer applied on the basis of yield targets provided higher benefit to cost ratio, indicating superiority over other methods of fertilizer application. The application of fertilizer on the basis of yield targets is meaningful, precise and eco-friendly. These equations therefore, could be used for making fertilizer recommendations for targeted yields of mustered in Inceptisols of Uttar Pradesh. The concept may prove useful in many other mustered growing area of the country.

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References

1. Hanway, J.J., Heidel, H. (1952). Soil analysis methods as used in Iowa State College, Soil Testing Laboratory, Iowa State College Bull, **57**: 1-131.

2. Jackson, M.L. (1973). Soil Chemical Analysis. Prentice Hall of India Pvt. Ltd., New Delhi.
3. Olsen, S.R., Cole, C.V., Watanabe, F.S., Dean, L. (1954). Estimation of available phosphorus in soils by extraction with sodium bicarbonate (USDA Circular 939). Washington, D. C.: U. S. Government Printing Office.
4. Ramamoorthy, B. and Velayutham, M. (2011). The Law of Optimum and soil test based fertilizer use for targeted yield of crops and soil fertility management for sustainable agriculture. *Madras Agricultural Journal,* **98**(10-12): 295-307.
5. Ramamoorthy, B., Narasimham., R.L. and Dinesh, R.S. (1967). Fertilizer application for specific yield targets on Sonora 64 (wheat). *Indian Farming,* **17**: 43-45.
6. Singh, Y.V., Dey, Pradeep, Singh, S.K. and Kumar, Mukesh. (2017). Soil Test Crop Response Technology on yield and economics of wheat in chandauli district of Uttar Pradesh. *Technofame-a journal of multidisciplinary advance research* **6**(2):88-92.
7. Singh, Y.V. (2019). Target yield through soil test crop response technology of wheat in Chandauli district of Uttar Pradesh. *Technofame – a journal of multidisciplinary advance research,* **8**(1): 1-6.
8. Singh, Y.V. and Singh, S.K. (2014). Fertilizer prescription for targeted yield of rice (Oryaza Sativa L var. Saryu-52) in and Inceptisol of Varanasi. Indian Journal of Ecology, **41**(2):282-285.
9. Singh, Y.V., Singh, S.K. and De, P. (2019). Soil Test Crop Response Based Gradient Experiment with Rice (*Oriza Sativa L.*) to NPK Fertilizers in the Alluvial Soil. *Technofame - a journal of multidisciplinary advance research,* **8**(1):79-81.
10. Singh, Y.V., Singh, S.K. and Dey, Pradip. (2017.) Nutrient Management for Chick pea Using Soil Test Target Yield Equation in Hadahi village, Chandauli district of Uttar Pradesh. *Technofame - a journal of multidisciplinary advance research,* **6**(1):153-157.
11. Subbiah, B.V. and Asija, G.L. (1956). A rapid procedure for estimation of available nitrogen in soils. Current Science, **25**:259-60.
12. Truog, E. (1960). Fifty years of soil testing, Proc. Trans 7th International congress soil science. Vol. III Commission IV. Paper No.**7**:46-53.
13. Verma, M., Singh, Y.V., Dey, P. and Babu, A. (2017). Soil test based fertilizer recommendation for mustard (*Brassica Juncea* L.) in eastern plain zone of Uttar Pradesh. *International Journal of Current Microbiology and Applied Sciences,* **6**(2): 155-161.
14. Walkley. A. and Black I.A. (1934). An examination of Degtjareff method for determining soil organic matter and a proposed modification of the chromic acid titration method. Soil Science **27**: 29-38.