Impact of Nutrient Management Technologies in Mustard under Irrigated Condition of Chandauli District, Uttar Pradesh

ABSTRACT: A field experiment was conducted in Jharigawan village, Naugarh block in Chandauli district during 2023–2024 to assess yield, soil, plant and fertilizer nitrogen, phosphorus and potassium (NPK) nutrient relationships and calibrate optimum fertilizer doses for attaining yield targets. The fertilizer adjustment equations are derived by the All India Coordinated Research Project, Institute of Agricultural Science, Banaras Hindu University, Varanasi centre. Results revealed that targeted yield of mustard (20 q ha^{-1}) have been achieved by using the plant nutrients on the basis of targeted yield concept (soil test crop response technology). The percent increase in yield was 33.10 % in first location, 34.54 % in second location and 31.27 % in third location over Farmers practice i.e. the fertilizer doses the farmers generally applied in the area which was 15.51, 15.20 and 15.35 q ha^{-1}, respectively. The maximum net returns of mustard first location (Rs.54280.54), second location (Rs.54630.54) and third location (Rs.56030.50) were obtained in treatment where plant nutrients applied as per soil test value (STCR treatment). This technology also maintained the soil available plant nutrients. Thus, for obtaining maximum gain and sustain the soil fertility, application of plant nutrients as per soil test value (STCR technology) is essential. The fertilizer doses were validated for attaining yield targets of 20 q ha^{-1} in farmer's fields. Mustard yield within 10% deviation was attained, which indicated that soil test based fertilizer dose was superior. This approach could be adopted for regions with similar soil and agro-climatic conditions in other parts of the world to increase Mustard yields.

Key words: Target yield, soil test crop response, economics, FYM and B:C ratio.

1. INTRODUCTION

The mustard plant is any one of several plant species in the genera *Brassica*, *Rhamphospermum* and *Sinapis* in the family Brassicaceae (the mustard family). Mustard seed is used as a spice. Grinding and mixing the seeds with water, vinegar, or other liquids creates the yellow condiment known as prepared mustard. The seeds can also be pressed to make mustard oil, and the edible leaves can be eaten as mustard greens. Mustard is

one of the oldest recorded spices, with references dating back to 3000 BC [4]. It was originally known as a condiment, with the term derived from the Latin *mustum*. Over time, various mustard seed combinations led to a wide range of mustard varieties worldwide. Besides being used as a spice, mustard serves multiple purposes, including as a vegetable, oilseed crop, green manure, and fodder.

Current crop production systems are characterized by inadequate and imbalanced uses of fertilizers e.g. blanket fertilizer recommendations over large domains with least regard to the variability in soil fertility and productivity. Future gains in productivity and input use efficiency require soil and crop management technologies that are tailored to specific characteristics of individual farms or fields. Farm research demonstrated existence of large field variability in terms of soil nutrient supply, nutrient use efficiency, crop responses etc. Management of this variability is a principal challenge for further increasing crop productivity of intensive Rice crop systems [7]. The targeted yield approach, first developed by [14] and [5], is based on soil testing and crop response (STCR) to optimize fertilizer use and maintain soil fertility. This approach has been widely implemented in India since 1967 through the All India Coordinated Research Project on STCR. By using multiple regression equations, the method helps determine nutrient interactions and ensures sustainable crop productivity. The integration of chemical fertilizers with organic manures (IPNS-based STCR) is recommended for improving soil quality and achieving higher yields.

2. MATERIALS AND METHODS

2.1 Experimental Site

The on farm testing trials were conducted in village–Hadahi, block - Naugarh of Chandauli district, Uttar Pradesh, India during year *Rabi* 2023-24 on alluvial soil (Inceptisol). Soil samples (0-15 cm in depth) were collected, dried and passed through 2 mm sieve and analyzed for physico chemical properties as described [3]. Available nitrogen, by the alkaline permanganate method [11], available phosphorus, by Olsen method [5] and available potassium, by the ammonium acetate method [2] as described by [3]. Five fertilizers treatments viz., Control, Farmers practice, General recommendation dose of fertilizer, Soil test crop response (STCR) for 20 q ha^{-1} in Mustard variety of test crop was Ashirbad, 20 q ha^{-1} targeted yield was taken. The targeted yield of crop was decided as per yield potential of varieties. Pre sowing soil samples were analyszed according to the standard procedures. Soil resource inventory of the study area in given in the table 1. Fertilizer prescription equations developed for mustard under STCR- IPNMS on eastern plain zone of utter Pradesh by [15], are given below:

Nitrogen dose (kg ha^{-1}) =12.27*T-0.56SN-.09*ON

Phosphorus dose (kg ha^{-1}) = 3.03*T- 1.34* SP-0.10*OP

Potassium dose (kg ha^{-1}) = 3.94*T-0.21*K-0.22*OK

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 a yield target of 20 q $ha^{-1}$with 2 t ha^{-1} FYM. 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.

2.4 Statistical Analysis

The research data were analyzed using statistical software SPSS 16.0 for ANOVA (simple randomized block design).

3. RESULTS AND DISCUSSION

3.1 Yield targeting of Mustard based on soil test

Experimental data on follow up trails as frontline demonstration, for each location during the period 2023-24 were conducted in farmers field and are given in Table 2. From the field experiment the basic data on nutrient requirement for producing one quintal grain yield of mustard, per cent contribution of nutrients from soil (%CS) and fertilizer (%CF) were evaluated. These basic parameters were used for developing the fertilizer prescription equations under NPK alone. The nutrient requirement of N, P_2O_5 and K_2O were 6.22, 0.99 and 4.25 kg q h^{-1} of grain yield, respectively. The per cent contribution of nutrients from soil, fertilizers and farm yard manure were found to be 23.94, 42.53 and 4.02 for N, 70.45, 21.44 and 1.24 for P_2O_5 and 22.14, 90.52 and 4.96 for K_2O, respectively. It was noted that contribution of potassium from fertilizer for mustard was higher in comparison to soil. This high value of potassium could be to the interaction effect of higher doses of N, P coupled with priming effect of starter K doses in the treated plots, which might have caused the release of soil potassium form, resulting in the higher uptake from the native soil sources by the crop [7]. Similar type of higher efficiency of potassic fertilizer was also reported for mustard [1] in alluvial soils.

Target yield of 20 q ha^{-1} has been achieved with comparatively lower application of N and P_2O_5 fertilizers but higher application of K_2O, in comparison to doses applied in farmer's practice and soil based recommendations. As for example in the alluvial soil of West Bengal, In

the winter season highest mustard yield was 6.0 t ha^{-1} regardless of the N level used but could be raised to 7.4 t ha^{-1} with increased application of K fertilizers [12]. This is probably due to the higher N use efficiency as well as increased N recovery by crop under increased K application [4]. Yield targets of 20 q ha^{-1} for Mustard variety Ashirbad were achieved in table 2 from the expected yield targets in all the cases. In all sites, grain yields of mustard through general recommendation (GRD) of fertilizers lagged behind the yield obtained at 20 q ha^{-1} fixed target. These results accorded with the findings [9] and [10]. Targets tried, targeting for 20 q ha^{-1} recorded relatively higher response ratio it has also recorded higher yields. This might be due to the better use efficiency of applied NPK fertilizers at low yield target levels [11] and [10].

However for efficient utilization of applied fertilizer some other parameters like soil pH, organic carbon status etc. should also be considered, since these are the major determining factors of soil nutrient retention. This is for the development of an effective fertilizer schedule as well as nutrient supply source in view of the better nutrient absorption and assimilation by the plants.

Table 1. Physico-chemical properties of the experimental area

Locations	**Physico chemical properties**			**Fertility status**		
	pH	**EC (dSm^{-1})**	**OC (%)**	**Av-N (kg ha^{-1})**	**Av-P (kg ha^{-1})**	**Av-K (kg ha^{-1})**
Location-I	7.48	0.47	0.54	213.80	14.85	179.50
Location-II	7.55	0.48	0.57	214.00	15.45	184.70
Location-III	7.65	0.49	0.56	206.00	16.00	185.20

***** Av = Available

Table 2. Economics of verification trails for mustard in various treatments under different locations of Villege- Jharigawan, Naugarh block in district Chandauli

Treatments	Fertilizer dose NPK (kg ha^{-1}) and FYM (t ha^{-1})	Actual mean yield (kg ha^{-1})	Additional yield (kg ha^{-1})	Value of additional yield (Rs.)	Cost of fertilizer (Rs.)	Net benefit (Rs.)	B/C ratio
	Location - I: Sri. Prabhu Singh S/O. Sri.Ramkrishan, Village- Jharigwan						
T_1-Control	0-0-0	1195	-	-		-	-
T_2-FP	60-30-30	1551	356	24920	3518.7	21401.3	6.08
T_3-GRD	80-40-40	1690	495	34650	4691.6	29958.4	6.39
T_4-20 q ha^{-1}	123-39-49-2	2065	870	60900	6619.46	54280.54	8.20
	Location - II: Name Sri. Sanjai Singh S/O. Sri. Girja, Village- Hadahi						
T_1-Control	0-0-0	1170	-	-		-	-
T_2-FP	60-30-30	1520	350	24500	3518.7	20981.3	5.96

T_3-GRD	80-40-40	1730	560	39200	4691.6	34508.4	7.36
T_4-20 q ha^{-1}	123-39-49-2	2045	875	61250	6619.4	54630.54	8.25
	Location - III: Name Sri.Govind S/O Sri.Ram pyare, Village- Jharigwan						
T_1-Control	0-0-0	1120	-	-		-	-
T_2-FP	60-30-30	1535	415	29050	3518.7	25531.3	7.26
T_3-GRD	80-40-40	1695	575	40250	4691.6	35558.4	7.58
T_4-20 q ha^{-1}	123-39-49-2	2015	895	62650	6619.4	56030.5	8.46

Note: Mustard@Rs.70.00/kg, N@Rs.17.39/kg P_2O_5@Rs.56.25/kg, K_2O@Rs.26.66/kg.
A miner modification was made in the ready reckoner, FP: Farmers practice i.e. the fertilizer doses the farmers generally applied in the area, GRD: General recommendation of agricultural department of the district on the basis of soil test value, B: C ratio: benefit cost ratios

3.2 Post harvest soil fertility status

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, Sri. Prabhu Singh S/O. Sri.Ramkrishan, Village- Jharigwan (244.00 kg ha^{-1}), soil potassium in location-3, Sri.Govind S/O Sri.Ram pyare, Village- Jharigwan (215.00 kg ha^{-1}), soil phosphorus in location-3, Sri.Govind S/O Sri.Ram pyare, Village- Jharigwan (19.50 kg ha^{-1}) in table 3. 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 [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 [7].

Table 3. Post harvest soil fertility status of various treatments under different locations of Villege- Jharigawan, Naugarh block in district Chandauli.

Treatments	Location 1			Location 2			Location 3		
	N	P	K	N	P	K	N	P	K
Control	207	15.5	186	218	17.4	180	210	16.4	174
Farmer's practice	226	17.1	188	226	18.3	186	228	17.3	185
GRD	233	18.2	198	231	19	191	235	18.5	196
STCR 20 q ha^{-1}	244	19.1	205	232	17.5	211	237	19.5	215
CD at 5%	1.40	1.051	0.56	0.69	1.06	0.75	0.69	1.07	0.75

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

4. CONCLUSION

The study will help to make guidelines for the amount of fertilizer used in mustard cultivation. The specific yield equation based on soil health will not only ensure sustainable crop production but will also steer the farmers towards economic use of costly fertilizer inputs depending on their financial status and prevailing market price of the crop under consideration.

DISCLAIMER

Author(s) hereby declare that no generative AI technologies such as Large Language Models (ChatGPT, COPILOT, etc) and text-to-image generators have been used during writing or editing of manuscripts.

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