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Target Yield through Soil Test Crop Response Technology of Spinach in Chandauli district of Uttar Pradesh

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Abstract

The present study was conducted in five locations of Naugarh block in Chandauli district during the year 2018-19, to study the effect of soil test crop response technology on yield and economics of spinach crop. The fertilizer adjustment equations are derived by the All India Coordinated Research Project, Institute of Agricultural Science, B.H.U., Varanasi centre. Results revealed that targeted yield of spinach (10 q ha^{-1}) and (12 q ha^{-1}) have been achieved by using the plant nutrients on the basis of targeted yield concept (soil test crop response technology).The maximum net returns of spinach first location (Rs.21923 and Rs.29939), second location (Rs.21773 and Rs.31439), third location (Rs.22523 and Rs.29189), fourth location (Rs.21423 and Rs.30489), and fifth location (20773 and 30189) were obtained. 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.

Key words: *Spinach, target yield, soil test crop response and FYM etc.*

Introduction

In an intensively cultivated areas of India, a high annual productivity of spinach results in removal of nutrients in substantial amounts that after exceed replenishment through fertilizers and manures ultimately leading to deterioration of soil health. Yields decline and decreasing total factor productivity have been reported. Farmers are using excess chemical fertilizers to achieve higher yield but the decision on fertilizer use requires knowledge of the expected crop yield and response to nutrient application. It is a function of crop nutrient needs, supply of nutrients from indigenous sources and the short- and long-term fate of the applied fertilizer nutrients (Dobermann *et al.* 2003)[3]. One of the reasons for lower production is imbalanced use of fertilizers by the farmers without knowing soil fertility status and nutrient requirement of crops causes adverse effects on soil and crop both in terms of nutrient toxicity and deficiency (Ray *et al.* 2000) [10]. Micro situation level specific fertilizer recommendations are possible for soils of varying fertility resource conditions of farmers and levels of targeted yield and for similar soil classes and environment (Ahmed *et al.,* 2002)[1]. Field specific balanced amounts of primary nutrients (N.P and K) were prescribed based on crop based estimates of the supply of N,P and K and by modelling the expected yield response as a function of nutrient interaction (Ramamurthy *et al.,* 2009)[9]. These equations are developed after establishing significant relationship between soil test values and the added fertilizer. Keeping the above facts in view and non availability of STCR data for spinach in eastern Uttar Pradesh this study was conducted.

The objective of this study was to

evolve the sound basis of fertilizer prescriptions for wheat crop in alluvial soil (Inceptisol) at different soil fertility levels under the conditions of fertilizer scarcity and to ensure maximum fertilizer use efficiency. The study also intended to find the relationship between the nutrients supplied by the soil and added by inorganic sources, their uptake and to develop a guideline for judicious application of fertilizer for desired yield target of coriander by using STCR model. This will ensure efficient utilization and profitable fertilizer application rates for higher and profitable crop production.

Materials and Methods

The on farm testing trials were conducted in village – Persiya, block - Naugarh of Chandauli district, Uttar Pradesh, India during year *rabi*- 2018-19 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 by Jachson (1973)[3]. Available nitrogen, by the alkaline permanganate method (Subbiah and Asija, 1956)[14]; available phosphorus, by Olsen *et al*. (1954)[8] and available potassium, by the ammonium acetate method (Hanway and Heidal, 1952)[4] as described by Jackson (1973)[5]. Seven fertilizers treatments viz., Control, Farmers practice, General recommendation dose of fertilizer, soil test crop response (STCR) for 10 q ha^{-1} target yield, soil test crop response (STCR) for 12 q ha^{-1} target yield, soil test crop response (STCR) for target yield 10 q ha^{-1} with 2 t ha^{-1} FYM and soil test crop response (STCR) for target yield 12 q ha^{-1} with 2 t ha^{-1} FYM in coriander (Pusa Harit) targeted yield were 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. Quantities of nitrogen, phosphorus and potassium were calculated with the help of fertilizer adjustment equations as follow.

$FN = 1.46\ T - 0.48\ SN - 0.07\ NFYM$

$FP_2O_5 = 0.19\ T - 0.75\ SP - 0.04\ PFYM$

$FK_2O = 0.51\ T - 0.22\ SK - 0.02\ KFYM$

Where - T = Yield target (t ha^{-1})

F.N. = Fertilizer N (kg ha^{-1})

$F.P_2O_5$ = Fertilizer P (kg ha^{-1})

$F.K_2O$ = Fertilizer K (kg ha^{-1})

SN = Soil available nitrogen (kg ha^{-1})

SP = Soil available phosphorus (kg ha^{-1})

SK = Soil available potassium (kg ha^{-1})

OFYN = Amount of Nitrogen thorough FYM (kg ha^{-1})

OFYM = Amount of Phosphorus thorough FYM (kg ha^{-1})

OFYM = Amount of Potassium thorough FYM (kg ha^{-1})

The crop received one third N and full dose of P_2O_5 and K_2O as basal application and remaining half N were applied and 27 days after sowing in wheat crop. Remaining nitrogen was applied at panicle initiation stage. Nitrogen was

applied through urea and phosphorus through single super phosphate and potassium through muriate of potash. The spinach variety of test crop was Pusa Harit. The same variety was used in STCR treatment and other treatments.

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	7.2-8.1	0.48-0.55	0.59-0.71	180.75	10.20	160.45
Location-II	6.8-8.4	0.45-0.51	0.62-0.71	181.25	10.50	161.55
Location-III	7.0-7.4	0.47-0.58	0.65-0.78	180.80	10.62	162.10
Location-IV	7.0-7.8	0.51-0.59	0.60-0.75	180.72	10.35	162.27
Location-V	7.2-8.1	0.50-0.57	0.65-0.79	182.58	10.38	162.74

Table 2 Economics of Verification Trails for coriander crop

Fertilizer dose N, P_2O_5, K_2O ($kgha^{-1}$) & FYM (t ha^{-1}) Treatmnets	Actual mean grain yield (kg ha^{-1})	Actual mean straw yield (kg ha^{-1})	Additional yield (kg ha^{-1})	Value of additional yield (Rs.)	Cost of fertilizer (Rs.)	Net Benefit (Rs.) Over T_1	B/C ratio
Location - I: Name – Sri. , Sohanlal, Village-Persiya							
T_1-0-0-0	510	765	-	-	-	-	-
T_2-35-15-30	630	945	120	6000	2240.2	3760	1.68
T_3-50 -30- 60	740	1243	230	11500	4132.6	7367	1.78
T_4-92-22- 44-2	1060	1781	550	27500	5576.9	21923	3.93
T_5 -127- 30- 64-2	1252	2141	742	37100	7160.7	29939	4.18
Location - II: Name – Anand Mohan, Village-Persiya							
T_1-0-0-0	498	822	-	-		-	-
T_2-35-15-30	610	1006	112	5600	2240.2	3360	1.50
T_3-50 -30- 60	710	1207	212	10600	4132.6	6467	1.56
T_4-92-22- 44-2	1045	1776	547	27350	5576.87	21773	3.90
T_5 -127- 30- 64-2	1270	2159	772	38600	7160.72	31439	4.39
Location - III: Name – Smt. Phuleswari Devi, Village-Persiya							
T_1-0-0-0	518	777	-	-	-	-	-
T_2-35-15-30	638	957	120	6000	2240.2	3760	1.68
T_3-50 -30- 60	765	1300	247	12350	4132.6	8217	1.99
T_4-92-22- 44-2	1080	1836	562	28100	5576.87	22523	4.04
T_5 -127- 30- 64-2	1245	2116	727	36350	7160.72	29189	4.08
Location - IV: Name – Smt – Shakuntala devi, Village-Persiya							
T_1-0-0-0	515	824	-	-	-	-	-
T_2-35-15-30	610	976	95	4750	2240	2510	1.12
T_3-50 -30- 60	720	1152	205	10250	4133	6117	1.48
T_4-92-22- 44-2	1055	1899	540	27000	5577	21423	3.84
T_5 -127- 30- 64-2	1268	2282	753	37650	7161	30489	4

Location - V: Name – Sri. Ramlakhan, Village – Persiya							
T_1-0-0-0	538	796	-	-	-	-	-
T_2-35-15-30	647	957	109	5450	2240	3210	1.43
T_3-50 -30- 60	762	1379	224	11200	4133	7067	1.71
T_4-92-22- 44-2	1065	1928	527	26350	5577	20773	3.72
T_5 -127- 30- 64-2	1285	2326	747	37350	7161	30189	4.22

Note: Spinach@Rs.50.00/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

Results and Discussion

Soil characteristics

The soil was alluvial (Inceptisol) in reaction with pH varying from 7.52 – 7.65. The organic carbon content varied from 0.68 - 0.77 soils were medium in available nitrogen (ranging from 180.72-182.58 kg ha^{-1}), low to medium in available phosphorus (ranging from 10.20.-10.62 kg ha^{-1}) and medium to high in available potassium (ranging from 160.45-162.74 kg ha^{-1}) in table 1. Though these soils are considered to be most fertile, they are deficient in nitrogen and humus but moderately supplied with phosphorus and potassium.

Yield targeting of spinach based on soil test

Experimental data on follow up trails as frontline demonstration, for each location during the period 2018-19 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 wheat, percent 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 and NPK with FYM. The nutrient requirement of N, P_2O_5 and K_2O were 0.75, 0.08 and 0.70 kg q^{-1} of grain yield, respectively. The percent contribution of nutrients from soil and fertilizers were found to be 24.74 and 33.96 for N, 29.95 and 51.22 for P_2O_5 and 45.08 and 138.51 for K_2O, respectively. It was noted that contribution of potassium from fertilizer for wheat 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 (Ray *et al*. 2000) [10]. Similar type of higher efficiency of potassic fertilizer was also reported for rice by Ahmed *et al*. (2002)[1] in alluvial soils and for finger millet by Kadu and Bulbule (2007)[6].

Target yield of 10 and 12 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 rice yield was 6.0 t/ha regardless of the N level used but could be raised to 7.4 t/ha with

increased application of K fertilizers (Tiwari, 2002) [15]. This is probably due to the higher N use efficiency as well as increased N recovery by crop under increased K application (Marschner, 1995) [7].Yield targets of 40 and 50 q ha^{-1} for wheat (GD 2937) were achieved in table 2 from the expected yield targets in all the cases. In all sites, grain yields of wheat through general recommendation (GRD) of fertilizers lagged behind the yield obtained at 40 and 50 q ha^{-1} fixed target. These results accorded with the findings of Singh *et al.* (2014)[13] and Avtari *et al.*, (2010)[3]. Between the two targets tried, targeting for 50 q ha^{-1} recorded relatively higher response ratio than with 40 q ha^{-1} though it has also recorded higher yields. This might be due to the better use efficiency of applied NPK fertilizers at low yield target levels (Santhi *et al.*, 2002) [12] and Singh *et al.*, (2014) [13].

However for efficient utilization of applied fertilizer some other parameters like soil pH, organic carbon status 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.

Conclusion

The study will help to make guidelines for the amount of fertilizer used in wheat 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.

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