Optimizing integrated plant nutrient supply through STCR approach for targeted yield of forage oat (*Avena sativa L.*) in an Inceptisol

ABSTRACT

In the course of the rabi 2018-19, a field test was conducted at Inceptisol at the Agriculture Research Farm in Banaras Hindu University, Varanasi using an STCR approach, based on which fertilizer recommendation equations for oat can be created. Soil test results, oat fresh forage yield and NPK uptake by oat crop were used to attain four essential basic parameters, i.e., nutrients required to produce one quintal of fresh forage (NR), fertilizer contribution of nutrients (percent CF), soil nutrient contribution (percent CS) and organic matter contribution FYM (CFYMA quintal of fresh forage required 0.26, 0.04, and 0.30 kg of N, P_2O_5 and K_2O, respectively. Soil Nutrient Contribution Proportions: 35.81, 48.44, and 64.87 N, P_2O_5, and K_2O. N, P_2O_5, and K_2O added percent of nutrients of applied fertilizer and applied FYM were 59.17, 47.38, and 115.25, and 24.19, 5.82, and 2.33, respectively. The ready reckoning doses of fertilizer was emphasized on these specific criteria for various soil test values and required to make objectives of fresh forage oat yields alone for NPK and NPK + FYM.

***Key words*:** Oat, nutrient, fresh forage yield, STCR, fertilizer, basic parameters, FYM.

INTRODUCTION

The oat harvest is done once a year (*Avena sativa L.*). It belongs to the Poaceae family of plants. Asia is the originator, and it has spread to many places throughout the world. Russia, Australia, Germany, France, and the United States are among the countries involved. It's a minor grain crop that's grown for both feed and grain. In terms of global cereal production, oat ranks sixth behind wheat, corn, rice, barley, and sorghum. The global cereal output, gross production, and productivity forecasts are 12.86 mha, 27.28 mt, and 21.21 q ha^{-1}, respectively, accounting for nearly 3% of global grain production (FAO, 2018). It is largely grown at the foot of the Himalayas in India's states. Temperate and subtropical climates are ideal for its growth. It's a crop that's been cultivated for grain and fodder. Its choice as a green forage has lustrous growth, good flavors, and a nutritious character due to its high food quality. It is utilized as a portion of food in both green and dry forms. It can also be converted into silage and hay to feed animals when there isn't enough grain available. One of the causes of decreased growth, which has adverse consequences for soil and crops, is farmers' unbalanced fertilizer use without knowing the level of soil fertility and crop nutrient needs. (2000). Farmers apply excess chemical fertilizer to increase yields, but making this decision requires knowledge of the predicted crop production and response to the nutrient application.

It is a part of the need for yield supplements, the availability of supplements from local sources, and the current and long-term fate of the fertilizer supplements used Dobermann *et al.*, (2003). As a result of the soil test crop reaction (STCR) relationship technique, there is a potential to increase oat growth. Fertilizer portions are advised based on fertilizer change circumstances generated after the soil test crop reaction (STCR) approach. Because it necessitates the integrated use of soil and plant evaluation, the fertilizer proposal based on the rule of STCR link is more quantitative, solid, and substantial. It creates a true balance between the nutrients added and the supplements that are naturally present in the soil. Remembering the above realities and the non-accessibility of STCR-Incorporated Plant Supplement Framework (IPNS) information for forage oat in Varanasi, the Coordinated Plant Nourishment Framework (STCR-IPNS) solution of Uttar Pradesh soil test-based fertilizer was produced for forage oat utilizing the STCR approach in Inceptisol.

MATERIALS AND METHODS

At the Agricultural Research Farm, Banaras Hindu University, Varanasi, during Rabi 2018-19, a field experiment was conducted to create targeted yield equations in an Inceptisol, following the protocol of Ramamurthy *et al.,* (1967). To determine a fertility gradient, the 1269.6 m2 site chosen in 2018 was divided into three strips of similar size and different fertilizer doses were added to each strip, low (0, 0, 0), medium (120, 60, 60), and high (240, 120, 120) kg ha^{-1} of N, P_2O_5, and K_2O, respectively. Sorghum (var. M.P. chari) was grown as an exhausting crop during *Kharif* 2018 to balance the fertility gradient.

The crop was harvested when it reached its maturity. In Rabi season 2018-19, oats (var: UPO-212) were cultivated as a test plant in the same area. Every strip was divided into 24 equal-sized plots (21 treated and 3 control plots) (4 m *3 m), yielding a total of 72 plot sizes (288 m).

Within each randomized strip, the urea, single superphosphate, and potash muriate randomized treatments were given in three (A, B, and C) blocks, each containing eight treatments using N, P_2O_5, K_2O, and FYM (FYM). $P_2O_5$and K_2O was added as a base for maximum doses, and N was applied in two split doses, half as a base and the other half 30 days after sowing. Plot-specific nutrient levels were tested before the application of FYM and NPK.

List 1 : Plot-specific nutrient levels testing method

1. Available nitrogen	Alkaline permanganate method
2. Available phosphorus	Olsen *et al.*, (1954)
3. Available potassium	Ammonium acetate method

The soil samples from all 72, by alkaline permanganate process (Subbiah and Asija 1956) from 72 plots were collected and evaluated for available N, and available ($NaHCO_3$ method 0.5 *M* (Olsen *et al.*, 1954; available) and K by ammonium acetate (Hanway and Heidel 1952), as described by Jackson Soil Samples were collected and analyzed for N (1973).

Oats were sown in 30 cm lines, with 10 lines in a complot and a planned set. To estimate the quality of N, P and K for cultivation purposes, a dry oat yield was recorded and the plant samples were taken. The method was defined by Ramamurthy *et al.,* (1967).is used to obtain nutrients required for the quintals production in the drying of fresh oat yields; percent CS (percentage of soil nutrients contribution), percent CF (percentage of fertilizing nutrients contribution) and percent CFYM (percentage of organic nutrients input).

Table 1**.** Levels of nitrogen, phosphorus, potassium and FYM used in experiment

N (kg ha^{-1})	P_2O_5(kg ha^{-1})	K_2O(kg ha^{-1})	FYM (t ha^{-1})
0	0	0	0
40	20	10	5
80	40	20	10
120	60	30	-

Method of developing the basic data

1. Nutrient requirement in kg q^{-1} of fresh forage yield (NR)

$$= \frac{\text{Total uptake of the nutrient (kg ha}^{-1}\text{) in plot}}{\text{Fresh forage yield (q ha}^{-1}\text{) in plot}}$$

2. Per cent contribution of nutrients from soil (%CS)

$$= \frac{\text{Total uptake of nutrient in the control plot (kg ha}^{-1}\text{)}}{\text{Soil test values of nutrient in control plot (kg ha}^{-1}\text{)}} \times 100$$

3. Per cent contribution of nutrients from fertilizer (% CF) without FYM

$$= \frac{\begin{pmatrix}\text{Total uptake of nutrient} \\ \text{(kg ha} - 1\text{) in fertilizer} \\ \text{Treated plot}\end{pmatrix} - \begin{pmatrix}\text{Soil test values} \\ \text{(kg ha} - 1\text{) in fertilizer} \\ \text{treated plot} \times \%CS/100\end{pmatrix}}{\text{Nutrient dose applied through fertilizer (kg ha}^{-1}\text{)}} \times 100$$

4. Per cent contribution of nutrients from organic manure (%CFYM)

$$= \frac{\begin{pmatrix}\text{Total uptake of} \\ \text{nutrient (kg ha} - 1\text{)} \\ \text{in organic manure} \\ \text{Treated plot}\end{pmatrix} - \begin{pmatrix}\text{Soil test values} \\ \text{(kg ha} - 1\text{) of nutrient} \\ \text{in fertilizer treated} \\ \text{plots} \times \%CS/100\end{pmatrix}}{\text{Dose of nutrient added through FYM (kg ha}^{-1}\text{)}} \times 100$$

These variables were used to create equations for soil test-based fertilizer recommendations for forage oat yield targets under NPK alone and NPK plus FYM.

Table 2: Available nutrients in pre-sowing soil and yield of oat crop

Parameters	NPK treated plots		Control plots	
	Range	Mean ± SEm	Range	Mean ± SEm
Available(N)(kg ha^{-1})	219-269	244 ± 2.34	206-257	231.5 ± 1.75
Available (P) (kg ha^{-1})	24.48-36.24	30.36 ± 0.84	18.10-28.81	23.45 ± 0.53
Available K (kg ha^{-1})	201-238	219.5 ± 1.66	191-226	208.5 ± 0.60
Yield (q ha^{-1})	383-648	515.5 ± 7.85	247-400	323.5 ± 2.19

RESULTS AND DISCUSSION

Soil available nutrients and fresh forage yield

Table 2 shows the range and average values of the required soil nutrients and the fresh drill yield of drilling oat in the plots under management and controlKMnO4-N increased from 219 kg ha1 in the strip I to 269 kg ha^{-1} in strip III in the NPK control plots

(NPK plots receiving NPK alone or NPK + FYM) with a medium value of 244 kg. Olsen-P ranged from 24.48 kg ha^{-1} to 36.24 kg ha^{-1} for strip III of 30.36 kg ha^{-1}, whereas NH4OAc-K ranged from 201 kg ha^{-1} to strip I of 238 kg ha^{-1} for strip III of 219.5 kg ha^{-1}.

In NPK-treated plots that received either NPK alone or NPK + FYM, the fresh forage oat yield ranged from 383 to 648 q ha^{-1}, with a mean volume of 515,5 q ha^{-1}. In the total control pieces, the yield ranged from 247 to 400 sq ha^{-1}, with a mean value of 323.5 sq ha^{-1}. Within the three total control maps, KMnO4-N ranged from 206 to 257 kg ha^{-1} for a mean of 231.5 kg ha^{-1}, Olsen-P for a mean range of 18.10 to 28.81 kg ha^{-1} for a mean value of 23.45 kg ha^{-1}, and NH4OAc-K for a mean range of 191 to 226 kg ha^{-1} for a mean value of 23.45 kg ha^{-1}.

On-ranch evaluation of soil site-based site-explicit supplement control in oat under millet trimming frameworks on alluvial soils was discovered by Bera *et al.*, (2006) and Dwivedi *et al.*, (2009The above data clearly demonstrates the concept of the operational arrangement of soil test esteems for usable N, P, and K status and yield of treated and control plots, which is required for the estimation of the specific boundaries and fertilizer remedy conditions for the adjustment of fertilizer portions for life forms, as we increased the fertilizer portion, resulting in a significant increase in fertilizer portions for life forms. Where are the conditions?

NPK Alone

$FN = 1.44\ T – 0.61\ SN$

$FP_2O_5 = 1.08\ T – 1.02\ SP_2O_5$

$FK_2O = 1.26\ T – 0.56SK_2O$

NPK + FYM

$FN = 1.44\ T – 0.61\ SN – 0.41\ ON$

$FP_2O_5 = 1.08\ T – 1.02\ SP_2O_5 – 0.12\ OP_2O_5$

$FK_2O = 1.26\ T – 0.56\ SK_2O – 0.04\ OK_2O$

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

FP_2O_5 = Fertilizer P_2O_5 (kg ha^{-1})

FK_2O = Fertilizer K_2O (kg ha^{-1})

T = Yield target (qha^{-1})

Where, SN, SP_2O_5 and SK_2O, are alkaline $KMnO_4$-N, Olsen-P as P_2O_5 and NH_4OAc-K as K_2O in kg ha^{-1}respectively and ON, OP_2O_5 and OK_2O are the quantities of N, P_2O_5 and K_2O in kg ha^{-1} supplied through FYM, respectively.

Basic parameters

The level of soil supplement commitment (percent CS), fertilizer (percent CF), and FYM (percent CFYM) is resolved for the creation of one quintal of new oat forage (Table 3). These basic boundaries were used to plan the fertilizer remedy conditions for both NPK alone and NPK plus FYM. N, P_2O_5, and K_2Onutrient requirements for new forage oat were 0.26, 0.04, and 0.30 kg q-1, respectively. The rate CS and percent CF of N, P_2O_5, and K_2O, respectively, were 35.81, 48.44, and 64.87 and 59.17, 47.38, and 115.52. Similarly, the contributions of N, P_2O_5, and K_2Orates from FYM were 24.19, 5.82, and 2.33, respectively. The commitment of K from oat fertilizer was found to be higher than that of soil. This high K value could be attributed to the communication effect of higher N, and P portions combined with the preparing effect of starter K dosages in the treated packages, which may have prompted soil K to be delivered, resulting in higher yield from local soil sources. (Ray *et al.*, 2000). Rice has also been found to have a comparative type of higher K-fertilizer proficiency in alluvial soils (Ahmed *et al.*, 2002). Because of the lower FYMM mineralization rate, the FYM supplement commitment is minimal (Sachan *et al.*, 1981). On account of P_2O_5, in any case, the info was more from soil than from fertilizer.

Table 3: Basic data and fertilizer adjustment equations of forage oat (*var.UPO-212*) in Inceptisol

Basic Data	N	P_2O_5	K_2O
Nutrient requirement (kg q^{-1})	0.26	0.04	0.30
Soil efficiency (%) or %CS	35.81	48.44	64.87
Fertilizer efficiency (%) or %CF	59.17	47.38	115.52
Organic efficiency (%) or %CFYM	24.19	5.82	2.33

Based on these equations, fertilizer doses were calculated for a range of soil test values and an oat yield target of 700 q ha^{-1}(Table 4).

Table 4**:** Estimation of soil test-based fertilizer recommendation for 700 q ha^{-1} fresh forage yield target of oat crop

Soil test values (kg ha^{-1})			Fertilizer dose (kg ha^{-1}) under NPK alone			Fertilizer dose (kg ha^{-1}) With NPK+ FYM @ 10 t ha^{-1}		
SN	SP	SK	FN	FP_2O_5	FK_2O	FN	FP_2O_5	FK_2O

180	10	180	195.82	49.08	78.36	175.37	45.39	77.55
200	15	200	183.71	43.97	67.13	163.27	40.28	66.32
220	20	220	171.61	38.86	55.89	151.16	35.17	55.09
240	25	240	159.50	33.74	44.66	139.06	30.06	43.86
260	30	260	147.40	28.63	33.43	126.95	24.95	32.62
280	35	280	135.29	23.52	22.20	114.85	19.83	21.39
300	40	300	123.90	18.41	10.97	102.74	14.72	10.16

SP = Soil available P as P_2O_5, and SK = Soil available K as K_2O.

The level of soil supplement commitment (percent CS), fertilizer (percent CF), and FYM (percent CFYM) is resolved for the creation of one quintal of new oat forage (Table 3). These basic boundaries were used to plan the fertilizer remedy conditions for both NPK alone and NPK plus FYM. N, P_2O_5, and K_2Onutrient requirements for new forage were 0.26, 0.04, and 0.30 kg q-1, respectively. The rate CS and percent CF of N, P_2O_5, and K_2O, respectively, were 35.81, 48.44, and 64.87 and 59.17, 47.38, and 115.52. Similarly, the contributions of N, P_2O_5, and K_2Orates from FYM were 24.19, 5.82, and 2.33, respectively. The commitment of K from oat fertilizer was found to be higher than that of soil. This high K value could be attributed to the communication effect of higher N, and P portions combined with the preparing effect of starter K dosages in the treated plots, which may have prompted soil K to be delivered, resulting in higher yield from local soil sources. (Ray *et al.,* 2000). Rice has also been found to have a comparative type of higher K-fertilizer proficiency in alluvial soils. (Ahmed *et al.,* 2002). Because of the lower FYMM mineralization rate, the FYM supplement commitment is minimal. (Sachan *et al.*, 1981). On account of P_2O_5, in any case, the info was more from the soil than from fertilizer.

It is obvious from these findings that there was net saving of fertilizers in each target and ultimately reduced the cost of cultivation.

The expectation of post-gather soil accessible supplements (N, P and K)

A fertilizer recommendation for the entire trimming plan can be made based on the post-reap expectation condition of soil test values. This is useful because, for obvious reasons, the soil of ranchers' fields under concentrated cultivation cannot be tested for each yield. Table 5 shows the relationships between post-collection soil test values, fertilizer applied dosages, beginning soil test esteems, and new forage yield from the oat crop-treated plots.

Discernibly higher R2 esteems (huge at 1%) were acquired for these conditions. This suggests that such relapse conditions can be used to predict available N, P, and K after oat for making soil test-based fertilizer recommendations for future yields. Comparative significances were likewise found by Bera *et al.*, (2006) for the three significant supplements.

Table 5: Prediction equations for post-harvest soil test value for oat

Nutrient	R^2	Multiple regression equation
N	0.79**	PHN=114.55+0.0487RY**+0.4609SN**+0.1391FN*
P	0.68**	PHP=11.71+0.0289RY*+0.8500SP**- 0.0308FP**
K	0.90**	PHK=67.31+0.7148RY**+1.1956SK**+0.0109FK

** Significant at 1 % level: Here PHN, PHP and PHK stand for the post-harvest soil test values of N, P and K (kg ha^{-1}); RY is the oat fresh forage yield (q ha^{-1}), SN, SP_2O_5 and SK_2O represent the initial soil test values of N, P and K (kg ha^{-1}) and FN, FP and FK represent the fertilizer doses of N, P_2O_5 and K_2O $kgha^{-1}$ required.

CONCLUSIONS

The use of an advanced plant nutrient management scheme has resulted in fertilizer nutrients being saved in oat crops. Instruments in the IPNMS system not only ensure efficient crop development but also reduce the use of high-cost fertilizer inputs. STCR-produced target yield equations- It is critical to popularize the practice of fertilizing crops with fertilizer prescription equations among farmers to increase production, nutrient quality, and profitability. In a test farm, an experiment is carried out in an experimental plot, which may or may not be extended to the entire Gangetic plain, and there may be some variation.

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