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Fertilizer Recommendations for Pearl Millet through Soil Test Crop Response-integrated Plant Nutrition System Approach on *Alfisol*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

The field experiment was conducted in RBD with three replications at farmer's field which is located at Vagarai village, Dindigul district during February to May 2023 for refining the already existing Fertilizer Prescription Equations (FPEs) of hybrid pearl millet, which has been developed for Periyanaikenpalayam series to suit Palaviduthi soil series (*Typic Rhodustalf*). The performance of the pearl millet TNAU hybrid CO 10 was evaluated. The results of the experiment revealed that highest grain yield obtained from STCR - IPNS - 4.0 t ha^{-1}, where farmyard manure along with inorganic fertilizers were combinedly applied. From the experimental data, basic parameters *viz.,*

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nutrient requirement (NR), percent contribution of nutrients from soil (Cs), fertilizers (Cf) and FYM (Cfym) were computed. It has been found that the nutrient requirement for producing one quintal grain of pearl millet was 2.23 kg of N, 1.19 kg of P_2O_5, and 2.22 kg of K_2O. The percent contribution from soil (Cs) and fertilizers (Cf) were 15.7 and 47.1 for N, 32.09 and 45.06 for P_2O_5, 10.04 and 66.71 for K_2O respectively. Percent contribution from FYM was 36.09 for N, 16.84 for P_2O_5 and 33.29 for K_2O. FPEs for Pearl millet were generated using these basic parameters through the Soil Test Crop Response based Integrated Plant Nutrition System (STCR-IPNS). Applying FYM at 12.5 t ha^{-1} combined with NPK fertilizers, was projected to result in a saving of 40, 21, and 27 kilograms of fertilizer N, P_2O_5, and K_2O, respectively. Soil test-based fertilizer recommendations and integrated plant nutrient management will help farmers to conserve fertilizers as well as sustain soil health and high rates of productivity.

Keywords: Pearl millet; alfisol; fertilzer prescriptions; STCR-IPNS.

1. INTRODUCTION

"Around the world, the pearl millet is becoming more and more well-liked by those who are concerned with their health. It can be extremely important in preventing malnutrition and ensuring nutritional and food security. Pearl millet is recognized as a nutri-cereal (Gazette of India, No. 133, April 13, 2018) for production, consumption, trade, and inclusion in the public distribution system due to its superior nutritional qualities" [1]. The Indian government designated 2018 as the "Year of Millets," and the United Nations designated 2023 as the "International Year of Millets," to mainstream millets and capitalize on its nutritionally rich qualities while boosting their cultivation [2]. Bajra, or pearl millet, is a member of the Poaceae family of plants and is native to Africa. One of the main crops for coarse grains, pearl millet is regarded as a staple diet for working-class people because it contains more fiber and is healthy for diabetes and cardiac patients, The nutritional content of this crop opens up a lot of potential for the development of value-added goods in new customer categories who are health conscious [3]. "Protein (11.6%), iron (8.8%), fat (5%) and carbohydrates (67%) are all abundant in its grains. In India, pearl millet was cultivated in 6.93 million ha. with 8.61 million tons production and 1243 kg ha^{-1} of productivity during 2018-2019. In Tamil Nadu pearl millet was cultivated in 0.60 lakh ha with production of 1.57 lakh tonnes and productivity of 2616 kg ha^{-1} during 2021-22" [4]. To meet the needs of an expanding population, modern agriculture heavily relies on inorganic fertilizer. Continuous application of inorganic fertilizer endangers the physical, chemical, and biological health of the soil. The population of beneficial organisms declines and the soil's ability to naturally regenerate nutrients stops, making it barren and infertile. Therefore, balanced use of fertilizers should be followed to decrease the environmental degradation without affecting the yield of the crop. One of the best ways to provide balanced fertilization is through Soil Test Crop Response – Integrated Plant Nutrition System (STCR-IPNS), it is also known as targeted yield approach which not only indicates the amount of fertilizer based on the results of soil tests, but also the level of yield that may be obtained under the right management procedures for crop production. The targeted yield strategy also offers the scientific foundation for balanced fertilization, which is based on both nutrients that are present in the soil and those that are applied as nutrients from external sources. Hence, an attempt was made to refine the already existing fertilizer prescription equations for pearl millet through STCR-IPNS approach for different yield targets on red non-calcareous soil (Palaviduthi series).

2. MATERIALS AND METHODS

The field experiment was carried out in a farmer's field which is located at Vagarai village of Dindigul district, it was at 254 meters above mean sea level, latitude 10°57'N and longitude 77°56'E. The experimental crop was TNAU Pearl millet hybrid CO 10. Hybrid pearl millet seeds were sown on February 16th using line sowing technique, with a spacing of 45 x 15 cm. Subsequently, the seeds were covered with soil. Following the sowing of pearl millet, all the enhanced package of practices were done in accordance with the Crop Production Guide for Agriculture 2020 (CPG 2020) of TNAU, Coimbatore [5]. The soil of the experimental field is red, non-calcareous, sandy loam, slightly alkaline (pH – 8.08), non-saline (EC – 0.06 dS m^{-1}), low in organic carbon (4 g kg^{-1}), low in available nitrogen (222 kg ha^{-1}), high in available phosphorus

(25 kg ha^{-1}) and available potassium (330 kg ha^{-1}) and sufficient in Fe, Zn, Cu and Mn. The experiment was laid out in Randomized Block Design (RBD) consisting of eleven treatments and three replications. The treatments were T_1: Absolute control, T_2: FYM at 6.25 t ha^{-1}, T_3: FYM at 12.5 t ha^{-1}, T_4: NPK alone - 3 t ha^{-1}, T_5: NPK alone - 3.5 t ha^{-1}, T_6: NPK alone - 4 t ha^{-1}, T_7: IPNS (Integrated Plant Nutrition System) - 3.0 t ha^{-1}, T_8: IPNS - 3.5 t ha^{-1}, T_9: IPNS - 4.0 t ha^{-1}, T_{10}: Blanket (100% Recommended Dose of Fertilizer) and T_{11}: Blanket(100% RDF) + FYM at 12.5 t ha^{-1}. Based on the initial soil test value of available N, P and K the doses of nutrients supplied to soils are calculated for STCR treatments based on the already existing fertilizer prescription equations which have been developed for *Inceptisol*. The quantities of N, P and K contributed through FYM were subtracted from inorganic fertilizers for STCR - IPNS treatments. The sources of nitrogen, phosphorus and potassium are urea, single super phosphate (SSP) and muriate of potash (MOP). For the treatments T_4 to $T_{11,}$ SSP and MOP are applied basally, and urea is applied in three levels at 25: 50: 25 percent at basal,15 and 30 DAS respectively. Soil samples were collected from each plot before imposing the treatments and analyzed for available N [6], P [7] and K [8]. When the crop reached maturity, it was harvested, and the yields of grain and straw were noted and the samples of grain and straw were analyzed for their N [9], P and K [10] contents. "Uptake of N, P and K were calculated by multiplying the grain and straw yield with its respective nutrient content. The influence of the treatment on crop yield and uptake was examined through statistical analysis of experimental data using AGRES software version 7.01. The Level of significance used was $P < 0.05$. Critical difference (CD) values were calculated for the $P < 0.05$ whenever 'F' test was found significant" [11]. "The basic parameters *viz.,* Nutrient requirement (NR), Percent contribution from soil (Cs), Percent contribution from fertilizer (Cf) and Percent contribution from farmyard manure (Cfym) were calculated with the data *viz.,* Initial available N, P and K status of the soil and doses of fertilizer applied, yield and total N, P and K uptake by pearl millet obtained from the treatment 1 to 9 by adopting the methodology developed by" [12]. By using these basic parameters fertilizer prescription equations were developed with and without FYM.

1. Nutrient Requirement (NR in kg q^{-1})

i) Kg N required per quintal of grain production = Total uptake of N (kg ha^{-1}) / Grain yield (q ha^{-1})
ii) Kg P_2O_5 required per quintal of grain production = Total uptake of P_2O_5 (kg ha-^{1}) / Grain yield (q ha^{-1})
iii) Kg K_2O required per quintal of grain production = Total uptake of K_2O (kg ha-^{1}) / Grain yield (q ha^{-1})

2. Percent contribution of nutrients from soil to total nutrient uptake (Cs)

i) Percent contribution of N from soil = [Total uptake of N in control plot (kg ha^{-1}) / Soil test value for available N in control plot (kg ha^{-1})] x 100
ii) Percent contribution of P_2O_5 from soil = [Total uptake of P_2O_5 in control plot (kg ha^{-1}) / Soil test value for available P_2O_5 in control plot (kg ha^{-1})] x 100
iii) Percent contribution of K_2O from soil = [Total uptake of K_2O in control plot (kg ha^{-1}) / Soil test value for available K_2O in control plot (kg ha^{-1})] x 100

3. Percent contribution of nutrients from fertilizers to total uptake (Cf)

i) Percent contribution of N from fertilizers = [Total uptake of N in treated plot (kg ha^{-1}) - (Soil test value for available N in treated plot (kg ha^{-1}) x Average Cs for N) / Fertilizer N applied (kg ha^{-1})] x 100
ii) Percent contribution of P_2O_5 from fertilizers = [Total uptake of P_2O_5 in treated plot (kg ha^{-1}) - (Soil test value for available P_2O_5 in treated plot (kg ha^{-1}) x Average Cs for P_2O_5) / Fertilizer P_2O_5 applied (kg ha^{-1})] x 100
iii) Percent contribution of K_2O from fertilizers = [Total uptake of K_2O in treated plot (kg ha^{-1}) - (Soil test value for available K_2O in treated plot (kg ha^{-1}) x Average Cs for K_2O) / Fertilizer K_2O applied (kg ha^{-1})] x 100

4. Percent nutrient contribution of nutrients from organics to total uptake (Co)

i) Percent contribution from FYM (Cfym)

Cfym = [(Total uptake of N/P_2O_5/K_2O in FYM treated plot (kg ha^{-1}) - (Soil test value for

available $N/P_2O_5/K_2O$ in FYM treated plot (kg ha^{-1}) x Average Cs for $N/P_2O_5/K_2O$) / Nutrient $N/P_2O_5/K_2O$ added through FYM (kg ha^{-1})] x 100

2.1 Fertilizer Prescription Equations

Making use of these basic parameters, the FPEs were developed [12] as follows:

i) Fertilizer Nitrogen (FN)

$$FN = \frac{NR}{Cf}\ 100\ T - \frac{Cs}{Cf} SN$$

$$FN = \frac{NR}{Cf}\ 100\ T - \frac{Cs}{Cf} SN - \frac{Cfym}{Cf} ON$$

ii) Fertilizer Phosphorus (FP_2O_5)

$$FP_2O_5 = \frac{NR}{Cf}\ 100\ T - \frac{Cs}{Cf} x\ 2.29\ x\ SP$$

$$FP_2O_5 = \frac{NR}{Cf}\ 100\ T - \frac{Cs}{Cf} x\ 2.29\ x\ SP - \frac{Cfym}{Cf}\ x\ 2.29\ x\ OP$$

iii) Fertilizer Potassium (FK_2O)

$$FK_2O = \frac{NR}{Cf}\ 100\ T - \frac{Cs}{Cf} x\ 1.21\ x\ SK$$

$$FK_2O = \frac{\frac{NR}{Cf}}{100} T - \frac{Cs}{Cf} x\ 1.21\ x\ SK - \frac{Cfym}{Cf}\ x\ 1.21\ x\ OK$$

Where, FN: Fertilizer N (kg ha^{-1}); FP_2O_5: Fertilizer P_2O_5 (kg ha^{-1}); FK_2O: Fertilizer K_2O (kg ha^{-1}); NR: Nutrient requirement of N or P_2O_5 or K_2O (kg q^{-1}); Cs: Percent contribution of nutrients from soil; Cf: Percent contribution of nutrients from fertilizer; SN: Soil test value for available N (kg ha^{-1}); SP: Soil test value for available P (kg ha^{-1}); SK: Soil test value for available K (kg ha^{-1}); Cfym: Percent contribution of nutrients from FYM; ON: Quantity of N applied through FYM (kg ha^{-1}); OP: Quantity of P applied through FYM (kg ha^{-1}); OK: Quantity of K applied through FYM (kg ha^{-1}).

The aforementioned equations are used to provide fertilizer doses for specified yield targets of Pearl millet under IPNS for varying soil available nutrient levels.

3. RESULTS AND DISCUSSION

3.1 Grain Yield

The range and mean values of grain yield of hybrid pearl millet are furnished in Table 1. Grain yield recorded due to imposition of different treatments ranged from 1130 kg ha^{-1} to 3932 kg ha^{-1}. Among the treatments, T_9 (STCR-IPNS-4.0 t ha^{-1}) has recorded higher grain yield of about 3932 kg ha^{-1} followed by T_6 (STCR-NPK-4.0 t ha^{-1}) with a grain yield of 3804 kg ha^{-1}. At all target levels, STCR – IPNS recorded a higher yield than that of STCR-NPK alone. Similar trend of superiority was reported by Sharma et al. [13] in pearl millet [13], Agila et al. [14] in tomato [14], Sivaranjini et al. [15] in maize [15] and Riya et al. [16] in bhendi [16]. The yield advantage of STCR-IPNS over STCR-NPK was due to the addition of secondary and micronutrients by farmyard manure [17,18]. Integrating the use of organic and inorganic nutrient sources is preferable to the use of inorganic fertilizer alone since STCR-IPNS treatments resulted in greater yields than STCR-NPK alone treatments. Next to T_9 and T_6, significantly higher yield was recorded in T_8 (STCR-IPNS-3.5 t ha^{-1}) with grain yield of 3432 kg ha^{-1} followed by T_5 (STCR-NPK alone - 3.5 t ha^{-1}) which was on par with T_{11} (Blanket + FYM) with grain yield of 3276 kg ha^{-1} and 3228 kg ha^{-1}, respectively. The lowest grain yield was recorded in T_1 (Absolute control) with a grain yield of 1130 kg ha^{-1}.

3.2 Nutrient Uptake

The N, P and K uptake of pearl millet ranged from 35.32 to 75.80 kg ha^{-1}, 8.66 to 17.21 kg ha^{-1} and 33.22 to 63.30 kg ha^{-1} respectively. The uptake of N, P and K of pearl millet was found significantly higher in all the treatments over absolute control. The highest uptake of N, P and K was found in T_9 (STCR-IPNS-4.0 t ha^{-1}) with 75.80, 17.21 and 63.30 kg ha^{-1} respectively followed by T_6 (NPK alone-4.0 t ha^{-1}) with 73.17, 16.84 and 58.56 kg ha^{-1} respectively. The outcomes amply demonstrated the reliability of the fertilizer recommendations based on the soil test for sustaining targeted grain yields. In treatments where FYM was added to fertilizers, plants also exhibited a stronger trend in their uptake of N, P, and K. This may be related to the mobilization and accumulation of nutrients to various sections of the plant, as well as the solubilization of native nutrients and chelation of nutrients with FYM. Absolute control recorded the lowest N, P and K uptake of 35.32, 8.66 and 33.22 kg ha^{-1}. Similar results were also reported by [19,20 and [21].

3.3 Response

An essential phenomenon to consider when deciding how to optimize nutrients is the

Table 1. Mean and range of grain yield, pre-sowing soil test values and NPK uptake by Pearl millet

Treatments	Grain Yield kg ha^{-1}	UN	UP	UK	SN	SP	SK	FN	FP_2O_5	FK_2O	FYM t ha^{-1}
T_1 Absolute control	1130	35.32	8.66	33.22	225	27	331	0	0	0	0
T_2 FYM alone @ 6.25 t ha^{-1}	1910	45.16	9.63	41.22	220	24	329	0	0	0	6.25
T_3 FYM alone @ 12.5 t ha^{-1}	2212	51.63	11.91	41.45	226	23	328	0	0	0	12.5
T_4 STCR - NPK alone - 3.0 t ha^{-1}	2740	62.83	14.38	44.21	224	28	333	72	42	43	0
T_5 STCR - NPK alone - 3.5 t ha^{-1}	3276	65.54	15.52	52.43	222	25	327	103	56	59	0
T_6 STCR - NPK alone - 4.0 t ha^{-1}	3804	73.17	16.84	58.56	225	23	330	120**	60**	60**	0
T_7 STCR-IPNS - 3.0 t ha^{-1}	2900	62.22	14.82	46.20	219	27	332	32	20*	20*	12.5
T_8 STCR-IPNS – 3.5 t ha^{-1}	3432	67.67	16.22	55.12	221	26	328	63	32	31	12.5
T_9 STCR-IPNS – 4.0 t ha^{-1}	3932	75.81	17.21	63.30	225	24	331	93	46	47	12.5
T_{10} Blanket (100% RDF)	2665	58.12	13.25	41.82	218	26	329	80	40	40	0
T_{11} Blanket (100% RDF)+ FYM @12.5 t ha^{-1}	3228	65.28	15.15	52.28	223	25	332	80	40	40	12.5
Range	1130-3932	35.32-75.81	8.66-17.21	33.22-63.30	218-226	23-28	327-333				
Mean	2839	60.25	13.96	48.16	223	25	330				
Sed	48.68	2.45	1.28	2.07							
CD (*P*=0.05)	102	5.11	2.67	4.32							

Note: UN, UP & UK: Total uptake of N, P and K; SN, SP & SK are soil available N, P and K; FN FP_2O_5 & FK_2O are fertilizer N, P_2O_5 and K_2O applied

response to applied fertilizer nutrients. The functional link between an increase in crop output and added fertilizers serves as a marker for fertilizer response. By comparing the differences between grain yield under absolute control and grain yield under various treatments, response has been calculated. The response of hybrid pearl millet ranged from 780 kg ha^{-1} in T_2 (FYM at 6.25 t ha^{-1}) to 2802 kg ha^{-1} in T_9 (STCR-IPNS-4.0 t ha^{-1}). The data demonstrated a progressive rise in response from lower target to higher target regardless of STCR-NPK alone or STCR-IPNS, and the degree of response was greater under STCR-IPNS than under STCR-NPK alone treatments. Similar trend in the response was reported by [22] in pearl millet.

3.4 Basic Parameters

Using the pre-sowing soil available N, P and K, applied fertilizer doses, grain yield and NPK uptake obtained from the experiment, the basic parameters *viz.,* nutrient requirement (NR), contribution of nutrients from soil (Cs), fertilizers (Cf) and FYM (Cfym) were computed (Table 2). The findings of the current experiment showed that pearl millet TNAU hybrid CO 10 requires 2.23 kg N, 1.19 kg P_2O_5 and 2.22 kg K_2O for producing one quintal of grain (Fig. 1). The N requirement was relatively higher followed by K_2O and P_2O_5. The order of nutrient requirement was similar to results of [23] in pea. The percent contribution of nutrients from soil and fertilizers were 15.70 and 47.10 for N, 32.09 and 45.06 for P_2O_5 and 10.04 and 66.71 for K_2O. The percent contribution of nutrients from FYM was 36.09, 16.84 and 33.29 for N, P_2O_5 and K_2O respectively (Fig. 2). When it comes to the contribution of nutrients from soil, P was comparatively more abundant, followed by N and K. An increase in soil P supply was by a factor of 2.04 times N and 3.2 times K_2O. The percent contribution of nutrients from fertilizers was higher in K_2O N and P_2O_5. The current study's rise in the contribution of nutrients from fertilizer was consistent with findings presented by Mohamed *et al.* (2023) in finger millet [24]. The estimated percent contribution of N, P_2O_5 and K_2O from FYM (Cfym) were 36.09, 16.84 and 33.39 respectively for hybrid pearl millet which indicated that relatively higher contribution was recorded for N and K_2O followed by P_2O_5. Similar findings were reported by Lalitha *et al*. (2022) in greengram [25].

Table 2. Basic parameters

Basic parameters	N	P_2O_5	K_2O
NR (kg q^{-1})	2.23	1.19	2.22
Cs (%)	15.70	32.09	10.04
Cf (%)	47.10	45.06	66.71
Cfym (%)	36.09	16.84	33.29

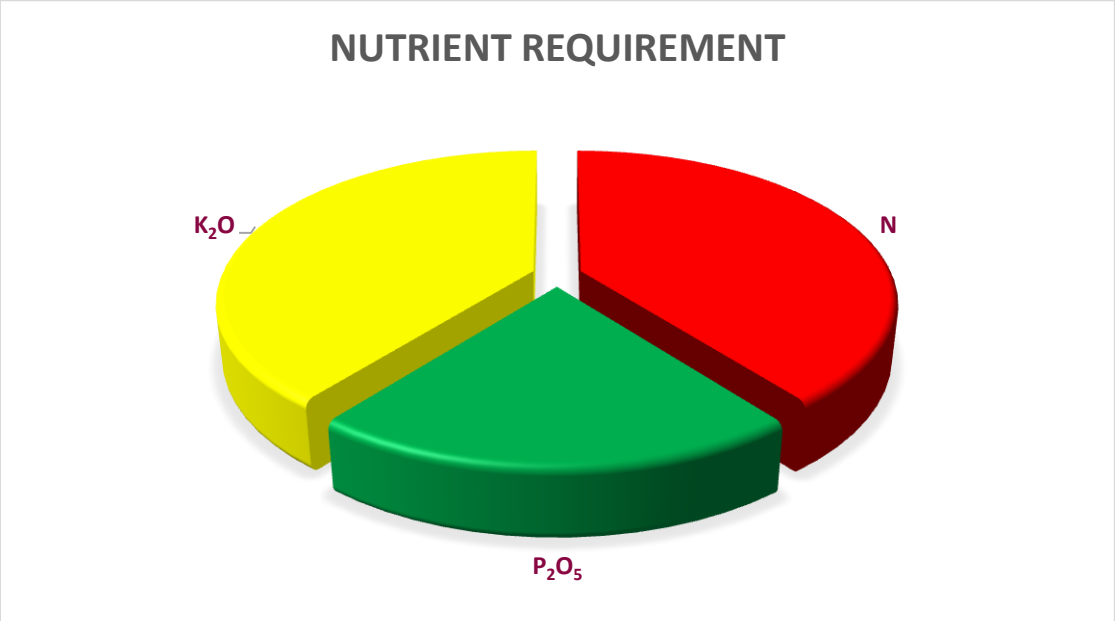

Fig.1. Nutrient Requirement (NR-kg q^{-1})

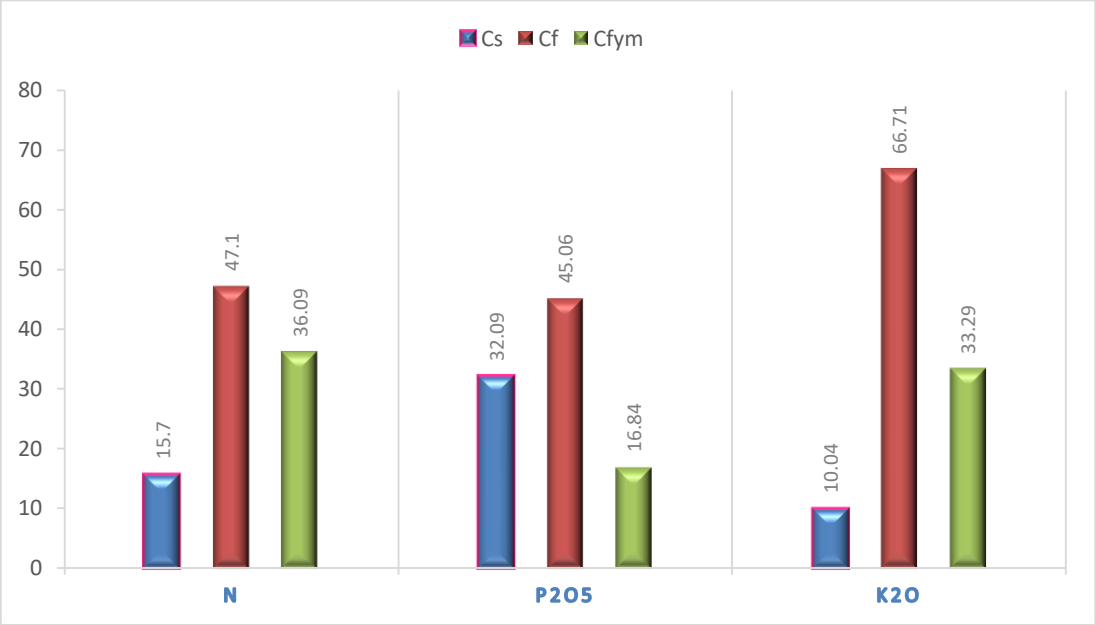

Fig. 2.Contribution of nutrients from soil (Cs), fertilizer (Cf), and (Cfym)

3.5 Fertilizer Prescription Equations for Pearl Millet Under *Typic Rhodustalf*

Table 3. The basic parameters NR, Cs, Cf and Cfym were used to generate fertilizer prescription equations under STCR - NPK alone and STCR - IPNS for pearl millet

STCR-NPK	STCR-NPK+FYM
FN = 4.74 T – 0.33 SN	FN = 4.74 T – 0.33 SN – 0.77 ON
FP_2O_5 = 2.64 T – 1.63 SP	FP_2O_5 = 2.64 T – 1.63 SP – 0.86 OP
FK_2O = 3.33 T – 0.18 SK	FK_2O = 3.33T – 0.18 SK – 0.60 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}

Table 4. Ready reckoner of fertilizer doses for STCR -NPK alone, STCR-IPNS (FYM) for desired yield target of 3.0 t ha^{-1} for Pearl millet

Soil Test Value (kg ha^{-1})	Treatments		
	STCR –NPK Alone	STCR –IPNS	Percent reduction due to IPNS over STCR-NPK alone
$KMnO_4$ - N			
200	76	40*	47.4
220	70	40*	42.9
240	63	40*	36.5
260	56	40*	28.6
280	50	40*	20.0
300	43	40*	7.0
Olsen – P			
16	53	32	39.6
18	50	29	42.0
20	47	26	44.7
22	43	22	48.8
24	40	20*	50
26	37	20*	45.9

Soil Test Value (kg ha^{-1})	Treatments		
	STCR –NPK Alone	STCR –IPNS	Percent reduction due to IPNS over STCR-NPK alone
NH_4OAc – K			
300	46	20*	56.5
320	42	20*	52.4
340	39	20*	48.7
360	35	20*	42.9
380	32	20*	37.5
400	28	20*	28.6

*(NB: * maintenance dose)*

- *Blanket dose: 80:40: 40 kg ha^{-1} of fertilizer N, P_2O_5& K_2O respectively for pearl millet (hybrids)*
- *If the calculated fertilizer dose tends to fall below 50 percent of the blanket, a maintenance dose of 50 percent of the blanket is recommended.*
- *If the calculated dose exceeds 150 percent of the blanket, a maximum dose of 150 percent of the blanket is recommended for N, P_2O_5& K_2O respectively*

Table 5. Ready reckoner of fertilizer doses for STCR-NPK alone, STCR-IPNS (FYM) for desired yield target of 3.5 t ha^{-1} for Pearl millet

Soil Test Value (kg ha^{-1})	Treatments		
	STCR-NPK Alone	STCR-IPNS	Percent reduction due to IPNS over STCR-NPK alone
$KMnO_4$ - N			
200	100	60	40.0
220	93	53	43.0
240	87	47	46.0
260	80	40	50.0
280	74	34	54.1
300	67	27	59.7
Olsen – P			
16	60**	45	25.0
18	60**	42	30.0
20	60	39	35.0
22	57	36	36.8
24	53	32	39.6
26	50	29	42.0
NH_4OAc – K			
300	60**	36	40.0
320	59	32	45.8
340	55	28	49.1
360	52	25	52.0
380	48	21	56.3
400	45	20*	55.6

*(NB: ** maximum dose)*

- *Blanket dose: 80:40: 40 kg ha^{-1} of fertilizer N, P_2O_5& K_2O respectively for pearl millet (hybrids)*
- *If the calculated fertilizer dose tends to fall below 50 percent of the blanket, a maintenance dose of 50 percent of the blanket is recommended.*
- *If the calculated dose exceeds 150 percent of the blanket, a maximum dose of 150 percent of the blanket is recommended for N, P_2O_5& K_2O respectively.*

Table 6. Ready reckoner of fertilizer doses for STCR -NPK alone, STCR-IPNS (FYM) for desired yield target of 4.0 t ha^{-1} for Pearl millet

Soil Test Value (kg ha^{-1})	Treatments		
	STCR –NPK Alone	STCR –IPNS	Percent reduction due to IPNS over STCR-NPK alone
$KMnO_4$ - N			
200	120**	84	30.0
220	117	77	34.2
240	110	70	36.4
260	104	64	38.5
280	97	57	41.2
300	91	51	44.0
Olsen – P			
16	60**	59	1.7
18	60**	55	8.3
20	60**	52	13.3
22	60**	49	18.3
24	60**	45	25
26	60**	42	30
NH_4OAc – K			
300	60**	52	13.3
320	60**	49	18.3
340	60**	45	25.0
360	60**	41	31.7
380	60**	38	36.7
400	60**	34	43.3

*(NB: ** maximum dose; *maintenance dose)*

- *Blanket dose: 80:40: 40 kg ha^{-1} of fertilizer N, P_2O_5& K_2O respectively for pearl millet (hybrids)*
- *If the calculated fertilizer dose tends to fall below 50 percent of the blanket, a maintenance dose of 50 percent of the blanket is recommended.*
- *If the calculated dose exceeds 150 percent of the blanket, a maximum dose of 150 percent of the blanket is recommended for N, P_2O_5& K_2O respectively.*

3.6 Fertilizer Prescriptions for Pearl Millet

Fertilizer Prescription Equations which have been developed for pearl millet on *Alfisol* were used to develop a ready reckoner for a range of soil test values for the desired yield targets of 3.0, 3.5 and 4.0 t ha^{-1}. Fertilizer prescriptions for both NPK alone and IPNS were computed and presented (Tables 4-6). With the soil test values of 222, 25 and 330 kg ha^{-1} of $KMnO_4$-N, Olsen P and NH_4OAc-K, fertilizer prescriptions were calculated with the yield target of 3.0, 3.5 and 4.0 t ha^{-1}. The calculated fertilizer doses of N, P_2O_5 and K_2O for NPK alone was 68: 38: 41, 91: 52: 57 and 113:65:74 Kg ha^{-1} for yield targets of 3.0, 3.5 and 4 t ha^{-1} respectively. When 12.5 t ha^{-1} of FYM (with 26% moisture, 0.56%N, 0.27% P and 0.49% K) was applied in STCR-IPNS treatments, the fertilizer N, P_2O_5 and K_2O reduced was 40, 21 and 27 kg ha^{-1} respectively. The amount of fertilizer used increased when yield targets were high and reduced in soils with high nutrient availability. Similar trends were also observed in [26,27 and [28].

4. CONCLUSION

The Soil Test Crop Response based Integrated Plant Nutrition System (STCR-IPNS) for pearl millet has been developed in the present study on *Typic Rhodustalf* (red, non-calcareous, Palaviduthi soil series) of Tamil Nadu. From the results it was clear that there was a balance between the applied fertilizer nutrients and the nutrients already present in the soil. The organic fertilizer enhances a soil's physical, chemical, and biological qualities but the nutrients may not be as easily accessible to the plants. However, inorganic fertilizer is typically available quickly and contains all the nutrients that are required by plants. The integrated soil fertility management system is an alternative strategy for the efficient and cost-effective control of soil fertility and is characterized by a decreased input of inorganic fertilizers and the combination of inorganic and organic manures. The nutrient uptake was higher when organic manures and inorganic fertilizers were used together than when either organic or inorganic fertilizers were used alone, or when no fertilizers were used. By employing the STCR-IPNS approach, productivity is upheld through

the precise and balanced application of fertilizers, meeting the crop's nutrient needs effectively [29]. In addition to ensuring sustainable crop output, target yield equations created using STCR-IPNS expertise also assure the economical application of expensive fertilizers. Hence, this approach is considered as one of the best approaches to improve farmer's income.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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