__Original Research Article__

Effect of Soil test crop response (STCR) and STCR – Integrated plant nutrition system (IPNS) based fertilizer prescription equations on maize productivity, economics and soil fertility status in *vertisols* of Northern Karnataka

ABSTRACT

A study on Soil Test Crop Response based Integrated Plant Nutrition System (STCR - IPNS) was conducted adopting an Inductive cum Targeted yield model in *vertisols* of Northern Karnataka at Main Agricultural Research Station (MARS), UAS, Dharwad, Karnataka during *kharif* 2020-21 in order to develop STCR and STCR-IPNS fertilizer prescriptions equation (FPEs) for the desired yield targets of maize. Fertilizer doses at varying soil test values, for attaining 60, 80 and 100 q ha^{-1} target grain yield of maize has been worked out 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). Using these equations, validation trials were conducted during *kharif* 2021-22 at Main MARS, Dharwad and Irrigation Water Management Research Centre (IWMRC), Belavatgi. The results of the experiment indicated that at both the 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 maize. The highest grain yield was recorded in STCR-IPNS equation with 100 q ha^{-1} target yield (Dharwad -104.8 q ha^{-1}, Belavatgi – 102.3 q ha^{-1}) recording an increase of 67 and 69 per cent over recommended package of practices at Dharwad and Belavatgi, respectively. However, it was found to be on par with Jabalpur STCR equation with 100 q ha^{-1} target yield and STCR-NPK alone equation with 100 q ha^{-1} target yield. Higher gross returns were recorded under STCR-IPNS equation with 100 q ha^{-1} target yield owing to higher grain and stover yields. While STCR equation developed at Jabalpur with 100 q ha^{-1} target yield recorded higher net returns. The post-harvest soil available NPK indicated better build-up and maintenance of soil fertility by the soil test based fertilizer recommendation under IPNS. Targeting 100 q ha^{-1} grain yield for maize under STCR approach was found to be ideal in terms of yield, economics and soil fertility maintenance in *vertisols* of Karnataka. The fertilizer prescription equations developed for maize under IPNS can be recommended for *vertisols* of Northern Karnataka for achieving target yield of 100 q ha^{-1} with sustained soil fertility and it can be extrapolated to other agro-climatic zones of Karnataka on similar and allied soil types.

Key words: Fertilizer prescription, maize, STCR, STCR-IPNS, target yield, vertisol

1. INTRODUCTION

Maize (*Zea mays* L.) is a versatile crop that thrives in a variety of agro-climatic situations and is grown all-round the year in India. Maize is renowned as the "Queen of Cereals" because it has higher genetic yield potential among cereals. After rice and wheat, maize is India's third most important cereal crop, accounting for around 10% of total food grain production. During 2020-21, the maize area in India has reached 9.86 million hectares, with a production of 31.51 million tonnes and a productivity of 3195 kg ha^{-1}. Among Indian states, Karnataka is the state with the largest maize area (1.68 m ha) and production (5.18 m t), with a productivity of 3092 kg ha^{-1} (Anon, 2021).

In recent years, India's fertiliser demand has shifted toward nitrogen, with phosphorus coming in second. This resulted in a significantly unbalanced NPK utilisation ratio of 7:2.7:1 in 2019–20 as compared to the optimal ratio of 4:2:1. The current condition of nutrient usage efficiency is quite low for N (30-50%), P (15-20%), S (8-12%), Zn (2-5%), Fe (1-2%), and Cu (1-2%) (Goyal *et al.,* 2020). Because of the imbalanced nutrient utilisation, there is a large gap between crop removal and fertilizer application. As a result, balanced NPK fertilization has attracted considerable attention in India. Soil testing is important to ensure balanced fertilizer application and it helps the farmers to use fertilizers according to crop needs. Targeted yield fertilizer application based on Ramamoorthy *et al.* (1967) is an approach, which takes into account the crop needs and nutrients present in the soil. In the intensive agriculture system integrated fertilizer recommendation is an urgent need since, it balance soil and applied nutrients from inorganic as well as organic sources to balance nutrition of crops and maintenance of soil health.

The Soil Test Crop Response (STCR) concept plays an important role as a comprehensive strategy to fertilizer use, in which fertilizer is applied depending on the yield target, site specification, crop specification, and soil test data. The Soil Test Crop Response based Integrated Plant Nutrition System (STCR-IPNS) is critical in ensuring balanced crop nutrition. When determining fertilizer prescriptions, the Soil Test Crop Response based Integrated Plant Nutrition System (STCR-IPNS) considers the contribution of nutrients from organic manures in addition to the contribution from soil and fertilizers. The use of IPNS components such as farm yard manure (FYM) or vermi compost (VC) reduces the need for fertiliser nutrients. Greater economy in fertilizer use can be made if fertilizers are applied under integrated plant nutrition system (IPNS) on the basis of soil test. The STCR equations developed elsewhere cannot be adopted to Northern transition zone of Karnataka due to its site specificity, soil and climatic conditions. Suitable STCR equations are not developed for *vertisols* of Northern transition zone of Karnataka. Hence an attempt is made to develop STCR-IPNS equations for prescribing the fertilizer recommendations based on soil test values as the Government of India is emphasizing on soil health card, target yield and with the application of FYM. Therefore, the present study was carried out for maize on *vertisols* of Northern Karnataka to test verify the suitability and effectiveness of STCR and STCR-IPNS equations in enhancing the productivity, profitability of maize and to sustain soil health.

2. MATERIAL AND METHODS

Field experiments were conducted at two locations during 2021-22 to validate the developed fertiliser prescription equations for maize under STCR and STCR-IPNS approach on *vertisols* in Northern Karnataka. Field trials with maize hybrid NK-6240 were conducted in two locations *viz.,* Dharwad and Belavatgi of Dharwad district. Initial soil samples were collected from each location and analysed for pH, EC, soil N, soil P_2O_5 and soil K_2O. The initial soil fertility status for both the locations is shown in Table 1. STCR and STCR-IPNS equations generated for maize are furnished below in Table 2:

Table 1: Initial soil fertility of the field experiments

Sl. No.	Locations	pH	EC (dS m^{-1})	Soil N	Soil P_2O_5	Soil P_2O_5
1.	Dharwad	7.10	0.30	242	34.1	346
2.	Belavatgi	8.40	0.32	238	29.1	585

Table 2: Fertilizer prescription equations under STCR-NPK alone and STCR-IPNS

STCR-NPK alone	STCR-IPNS
FN = (4.44 x T) – (0.34 x SN)	FN = (4.44 x T) - (0.34 x SN) – (0.78 x FYM N)
FP_2O_5 = (1.81 x T) – (1.18 x SP_2O_5)	FP_2O_5 = (1.81 x T) – (1.18 x SP_2O_5) – (0.62 x FYM P_2O_5)
FK_2O = (2.07 x T) – (0.15 x SK_2O)	FK_2O = (2.07 x T) – (0.15 x SK_2O) – (0.51 x FYM K_2O)

Table 3: The STCR equations developed for maize at Jabalpur (Madhya Pradesh) is as follows:

STCR-NPK alone	Soil type	Location
FN = (4.40 x T) – (0.23 x SN)	Shallow medium and deep black soils	Jabalpur (M. P)
FP_2O_5 = (2.06 x T) – (1.39 x SP_2O_5)		
FK_2O = (2.17 x T) – (0.19 x SK_2O)		

Where, FN, FP_2O_5 and FK_2O are fertilizers N, P_2O_5 and K_2O in kg ha^{-1} respectively; T = Targeted yield in q ha^{-1}; SN, SP_2O_5 and SK_2O are available N, P_2O_5 and K_2O in kg ha^{-1}, respectively; FYM N, FYM P_2O_5 and FYM K_2O are N, P_2O_5 and K_2O supplied through FYM in kg ha^{-1}.

The treatments imposed were as follows: STCR-NPK alone equation with a target yield of 60 q ha^{-1}, 80 q $ha^{-1}$and 100 q ha^{-1}, STCR-IPNS equation with a target yield of 60 q ha^{-1}, 80 q $ha^{-1}$and 100 q ha^{-1}, Jabalpur STCR equation with a target yield of 60 q ha^{-1}, 80 q $ha^{-1}$and 100 q ha^{-1}, RDF + 10 t FYM ha^{-1} and Absolute control. Fertilizer dosages were calculated and applied for STCR treatments for various target yields based on the initial soil values of available N, P_2O_5, and K_2O and the quantities of N, P_2O_5, and K_2O supplied through FYM. Treatments (iv), (v) and (vi) received FYM @ 10 t ha^{-1} and N, P and K fertilizers were administered after the nutrients supplied by FYM were adjusted using STCR-IPNS equations (Table 2). Other STCR treatments received inorganic fertilizers alone based on developed STCR equations and Jabalpur STCR equations. Recommended dose of fertilizers (RDF) were applied @ 150:62.5:62.5 kg N, P2O5 and K2O ha^{-1} along with 10 t FYM ha^{-1} as per the recommendations and no fertilizers and no FYM were applied to Absolute control. The calculated fertilizers as per the different STCR equations are given in table 4. The crop was harvested after attaining the complete maturity on 12th November 2021 at Dharwad and 21st December 2021 at Belavatgi. Cobs at maturity from net plot were harvested and sun dried. Thereafter, cobs were shelled and the grain yield per net plot recorded and expressed as q ha^{-1}. The parameters *viz.,* percent achievement [(yield obtained/yield target aimed) x 100] was calculated using data on grain yield and fertiliser doses administered and economic parameters *viz.,* gross returns, net returns and benefit cost ratio was calculated using the price of the produce and cost of cultivation. Composite soil samples were collected from each treatment after harvest of maize and these samples were analysed for estimation of soil available N, P_2O_5 and K_2O. Plant samples from each strip were collected, processed and analysed for total N, P and K contents and N, P and K uptake was computed. Statistical analysis of the data was analysed by using Randomized block design as suggested by Gomez and Gomez (1984). Post-harvest soil samples were collected and analysed to determine the available of N, P_2O_5, and K_2O status.

Table 4: Fertilizer doses (kg ha^{-1}) imposed at Dharwad and Belavatgi based on fertilizer prescription equations

Tr. No	Treatments	Dharwad			Belavatgi		
		N	P_2O_5	K_2O	N	P_2O_5	K_2O
T_1	STCR-NPK alone T.Y. 60 q ha^{-1}	184.6	68.5	72.1	186.0	74.4	36.5
T_2	STCR-NPK alone T.Y. 80 q ha^{-1}	273.5	104.7	113.5	274.8	110.6	77.9
T_3	STCR-NPK alone T.Y. 100 q ha^{-1}	362.4	140.9	154.8	363.7	146.8	119.3
T_4	STCR-IPNS T.Y. 60 q ha^{-1}	144.5	54.8	49.2	145.8	60.7	13.3
T_5	STCR-IPNS T.Y. 80 q ha^{-1}	233.3	91.0	90.5	234.7	96.9	54.7

T_6	STCR-IPNS T.Y. 100 q ha^{-1}	322.2	127.2	131.9	323.6	133.1	96.0
T_7	Jabalpur STCR equation T.Y. 60 q ha^{-1}	208.3	95.2	96.5	209.3	102.2	77.4
T_8	Jabalpur STCR equation T.Y. 80 q ha^{-1}	296.3	142.8	137.9	297.3	149.8	118.8
T_9	Jabalpur STCR equation T.Y. 100 q ha^{-1}	384.3	190.4	179.3	385.3	197.4	160.2
T_{10}	R.D.F + 10 t FYM ha^{-1}	150.0	62.5	62.5	208.3	95.2	96.5
T_{11}	Absolute control	0	0	0	0	0	0

Fertilizer prescriptions to achieve desired yield targets of 60, 80 and 100 q ha^{-1} of maize was worked out for initial soil test values of Dharwad and Belavatgi and are presented in Table 4. The results indicated that to achieve 60, 80 and 100 q ha^{-1} maize grain yield in Dharwad for a soil test value of 242 kg ha^{-1} of soil N, the fertilizer N doses required were 184.6, 273.5 and 362.4 kg ha^{-1} respectively. With regard to phosphorus, to achieve 60, 80 and 100 q ha^{-1} maize grain yield for soil test value of 34.1 kg ha^{-1} of soil P_2O_5, the fertilizer P_2O_5 doses required were 68.5, 104.7 and 140.9 kg ha^{-1} respectively. In case of potassium, for a soil test value of 346 kg ha^{-1} of soil K_2O, the fertilizer K_2O doses required were 72.1, 113.5 and 154.8 kg ha^{-1}, respectively to obtain target yields of 60, 80 and 100 q ha^{-1} of maize. Under IPNS, for same soil test values, to achieve yield target of 60 q ha^{-1}, the fertilizer doses required were 144.5 N, 54.8 P_2O_5 and 49.2 K_2O kg ha^{-1}. To achieve 80 q ha^{-1} target yield the fertilizer doses required were 233.3 N, 91.0 P_2O_5 and 90.5 K_2O kg ha^{-1}. While to achieve 100 q ha^{-1} target yield the required fertilizer doses were 322.2 N, 127.2 P_2O_5 and 131.9 K_2O kg ha^{-1}.

Similarly, to produce 60, 80 and 100 q ha^{-1} maize in Belavatgi for soil test value of 238 kg ha^{-1} of soil N, the fertilizer N doses required were 186.0, 274.8 and 363.7 kg ha^{-1} respectively. With regard to P, for soil test value of 29.1 kg ha^{-1} of soil P_2O_5, the fertilizer P_2O_5 doses required were 74.4, 110.6 and 146.8 kg ha^{-1} to produce 60, 80 and 100 q ha^{-1} maize grain yield respectively. In case of K, for a soil test value of 585 kg ha^{-1} of soil K the fertilizer K_2O doses required were 13.3, 54.7 and 96.0 kg ha^{-1}, respectively to obtain target yields of 60, 80 and 100 q ha^{-1} of maize (Table 4). In Belavatgi under IPNS, the required fertilizer doses were 145.8 N, 60.7 P_2O_5, and 13. K_2O kg ha^{-1} to meet the yield target of 60 q ha^{-1}. The fertilizer doses of 234.7 N, 96.9 P_2O_5, and 54.7 K_2O kg ha^{-1} were necessary to reach the yield target of 80 q ha^{-1}. While the required fertilizer doses to reach the 100 q ha^{-1} target yield were 323.6 N, 133.1 P_2O_5, and 96.0 K_2O kg ha^{-1}.

3. RESULTS AND DISCUSSION

The grain yield of two locations demonstrated STCR-IPNS equation with 100 q ha^{-1} target yield (Dharwad –104.8 q ha^{-1}, Belavatgi– 102.3 q ha^{-1}) recorded higher grain yieldand was on par with Jabalpur STCR equation with 100 q ha^{-1} target yield (Dharwad –102.9 q ha^{-1}, Belavatgi– 100.4 q ha^{-1}) and STCR-NPK alone equation with 100 q ha^{-1} target yield (Dharwad –101.5 q ha^{-1}, Belavatgi– 98.5 q ha^{-1}). RDF + 10 t FYM ha^{-1}recorded relatively lower yield (Dharwad –62.8 q ha^{-1}, Belavatgi– 60.5 q ha^{-1}) as compared to STCR treatments with 80 and 100 q ha^{-1} target yield (Table 5). STCR-IPNS equation with 100 q ha^{-1}

target yield recorded an increase in grain yield to an extent of 67 and 69 % over Recommended package of practices at Dharwad and Belavatgi, respectively.

The highest percent achievement of yield targets was observed with STCR-IPNS equation with 80 q ha^{-1} target yield (107.1 %) at Dharwad and STCR-IPNS equation with 60 q ha^{-1} target yield (104.5 %) at Belavatgi. Yield targeting with IPNS treatments resulted in higher percentage achievement of the target yields than the comparable NPK alone treatments. The percent achievement of the target yield was within ± 10 % deviation of the aimed targeted yields at both locations, demonstrating the validity of the equations for prescribing integrated fertilizer for maize. The target yield equations established by STCR-IPNS technology not only ensured sustainable crop production but also reduced the use of costly fertiliser inputs. (Mahajan *et al.,* 2013)

Table 5: Grain yield and per cent achievement of maize as influenced by nutrient management through STCR and STCR-IPNS approach at different target yields at Dharwad and Belavatgi

Tr. No	Treatments	Dharwad		Belavatgi	
		Grain yield (q ha^{-1})	% achievement	Grain yield (q ha^{-1})	% achievement
T_1	STCR-NPK alone T.Y. 60 q ha^{-1}	61.7^{c}	102.8	59.7^{c}	99.5
T_2	STCR-NPK alone T.Y. 80 q ha^{-1}	82.0^{b}	102.5	81.1^{b}	101.4
T_3	STCR-NPK alone T.Y. 100 q ha^{-1}	101.5^{a}	101.5	98.9^{a}	98.9
T_4	STCR-IPNS T.Y. 60 q ha^{-1}	63.7^{c}	106.2	62.7^{c}	104.5
T_5	STCR-IPNS T.Y. 80 q ha^{-1}	85.7^{b}	107.1	83.5^{b}	104.4
T_6	STCR-IPNS T.Y. 100 q ha^{-1}	104.8^{a}	104.8	102.3^{a}	102.3
T_7	Jabalpur STCR equation T.Y. 60 q ha^{-1}	62.6^{c}	104.4	60.3^{c}	100.5
T_8	Jabalpur STCR equation T.Y. 80 q ha^{-1}	83.6^{b}	104.5	81.8^{b}	102.3
T_9	Jabalpur STCR equation T.Y 100 q ha^{-1}	102.9^{a}	102.9	100.4^{a}	100.4
T_{10}	RDF +10 t FYM ha^{-1}	62.8^{c}	-	60.5^{c}	-
T_{11}	Absolute control	26.2^{d}	-	28.2^{d}	-

The higher gross returns were noticed in STCR-IPNS equation with 100 q ha^{-1} target yield (Dharwad – 197002 Rs. ha^{-1}, Belavatgi – 195756 Rs. ha^{-1}) and was comparable with Jabalpur STCR equation with 100 q ha^{-1} target yield (Dharwad – 193468 Rs. ha^{-1}, Belavatgi – 192232 Rs. ha^{-1}) and STCR- NPK alone with 100 q ha^{-1} target yield (Dharwad –190779 Rs. ha^{-1}, Belavatgi -189635 Rs. ha^{-1}) as compared to rest of the treatments. Higher grain and stover yields in STCR-IPNS equation with 100 q ha^{-1} target yield may have resulted in higher gross returns. While absolute control (T_{11}) recorded lower amount of gross returns (Dharwad - Rs. 50240 ha^{-1}, Belavatgi - Rs. 53855 ha^{-1}) among all the treatments. The higher net returns were recorded in Jabalpur STCR equation with 100 q ha^{-1} target yield (Dharwad – 123733 Rs. ha^{-1}, Belavatgi– 122891 Rs. ha^{-1}) and was on par with STCR-NPK alone equation with 100 q ha^{-1} target yield (Dharwad –122112 Rs. ha^{-1}, Belavatgi - 121909 Rs. ha^{-1}). Whereas, higher B:C ratio was recorded with STCR-NPK alone equation with 100 q ha^{-1} target yield (Dharwad – 2.78, Belavatgi – 2.77) and was on par with Jabalpur STCR equation with 100 q ha^{-1} target yield (Dharwad – 2.80, Belavatgi – 2.77) (Table 6). Even though higher yields were recorded in STCR IPNS equation with 100 q ha^{-1} target yield, net returns and B:C ratio were lower mainly due to high cost of FYM. These results are in accordance with Basavaraja *et al.* (2017) who reported higher B:C ratio in STCR inorganic approach over IPNS approach due to high cost of FYM.

Table 6: Economics of maize as influenced by nutrient management through STCR and STCR-IPNS approach at different target yields at Dharwad and Belavatgi

Tr. No	Treatments	Dharwad			Belavatgi		
		Gross Returns (Rs. ha^{-1})	Net Returns (Rs. ha^{-1})	B:C ratio	Gross Returns (Rs. ha^{-1})	Net Returns (Rs. ha^{-1})	B:C ratio
T_1	STCR-NPK alone T.Y. 60 q ha^{-1}	117420^{c}	57928^{e}	1.97^{c}	115828^{c}	57259^{e}	1.98^{c}
T_2	STCR-NPK alone T.Y. 80 q ha^{-1}	155069^{b}	90935^{cd}	2.42^{b}	153389^{b}	90038^{c}	2.42^{b}
T_3	STCR-NPK alone T.Y. 100 q ha^{-1}	190779^{a}	122112^{a}	2.78^{a}	189635^{a}	121909^{a}	2.80^{a}
T_4	STCR-IPNS T.Y. 60 q ha^{-1}	121258^{c}	45717^{f}	1.61^{d}	118343^{c}	43457^{f}	1.58^{d}
T_5	STCR-IPNS T.Y. 80 q ha^{-1}	162053^{b}	81612^{d}	2.01^{c}	156127^{b}	76736^{d}	1.97^{c}
T_6	STCR-IPNS T.Y. 100 q ha^{-1}	197002^{a}	112085^{b}	2.32^{b}	195756^{a}	111568^{b}	2.33^{b}
T_7	Jabalpur STCR equation T.Y. 60 q ha^{-1}	119199^{c}	58806^{e}	1.97^{c}	117084^{c}	57334^{e}	1.96^{c}
T_8	Jabalpur STCR equation T.Y. 80 q ha^{-1}	158186^{b}	92995^{c}	2.43^{b}	154654^{b}	90028^{c}	2.39^{b}
T_9	Jabalpur STCR equation T.Y. 100 q ha^{-1}	193468^{a}	123733^{a}	2.77^{a}	192232^{a}	122891^{a}	2.77^{a}
T_{10}	R.D.F +10 t FYM ha^{-1}	119491^{c}	43708^{f}	1.58^{d}	117485^{c}	42040^{f}	1.56^{d}
T_{11}	Absolute control	50240^{d}	964^{g}	1.02^{e}	53855^{d}	2539^{g}	1.05^{e}

The data on soil N, P_2O_5 and K_2O indicated the build-up and maintenance of soil fertility due to soil test based fertilizer recommendation under IPNS. Despite higher removal of nutrients, the fertility status was maintained in STCR-IPNS equation as compared to Jabalpur STCR equation and STCR-NPK alone equation with 100 q ha^{-1} target yields (Table 7). Among the STCR equations, nutrients applied as per STCR-IPNS equation with a target yield of 100 q ha^{-1} (T_6) recorded higher available nutrients (N- 263 kg ha^{-1}, P_2O_5 - 38.2 kg ha^{-1} and K_2O - 369 kg ha^{-1}). However, it was found on par Jabalpur STCR equation with a target yield 100 q ha^{-1} (T_9, N - 261 kg ha^{-1}, P_2O_5 - 37.7 kg ha^{-1} and K_2O - 364 kg ha^{-1}) and STCR-NPK alone equation with a target yield 100 q ha^{-1} (T_3, N - 253 kg ha^{-1}, P_2O_5 - 36.6 kg ha^{-1} and K_2O - 359 kg ha^{-1}). This might be attributed to the prevention of losses of nutrients under IPNS, even after meeting the crop needs. However, these treatments received relatively higher doses of fertilizers for higher yield targets which could have resulted in increase in available NPK status in soil. The effect was further improved with the application of FYM, which had not only increased the build-up of nutrients of the soil but also the ability of the soil to sustain the fertility status over long run. Santhi *et al.* (2011) and Coumaravel (2012) established that soil test based fertilizer prescription for maize-tomato sequence was found to be useful in increasing not only the yields but also maintaining soil fertility.

Table 7: Available soil nutrient status (kg ha^{-1}) after harvest of maize as influenced by nutrient management through STCR and STCR-IPNS approach at different target yields at Dharwad and Belavatgi

Tr. No	Treatments	Dharwad			Belavatgi		
		Soil N (kg ha^{-1})	Soil P_2O_5 (kg ha^{-1})	Soil K_2O (kg ha^{-1})	Soil N (kg ha^{-1})	Soil P_2O_5 (kg ha^{-1})	Soil K_2O (kg ha^{-1})
T_1	STCR-NPK alone T.Y. 60 q ha^{-1}	221^{e}	31.1^{f}	307^{f}	212^{fg}	27.0^{d}	549^{c}
T_2	STCR-NPK alone T.Y. 80 q ha^{-1}	237^{b-e}	33.5^{c-f}	334^{c-e}	230^{b-e}	29.8^{b}	576^{bc}
T_3	STCR-NPK alone T.Y. 100 q ha^{-1}	253^{ab}	36.6^{a-c}	359^{a-c}	246^{ab}	31.6^{ab}	606^{ab}
T_4	STCR-IPNS T.Y. 60 q ha^{-1}	229^{c-e}	33.1^{d-f}	319^{d-f}	227^{c-f}	28.7^{cd}	561^{c}
T_5	STCR-IPNS T.Y. 80 q ha^{-1}	246^{a-c}	35.2^{a-d}	342^{b-d}	241^{a-c}	30.7^{ab}	583^{a-c}
T_6	STCR-IPNS T.Y. 100 q ha^{-1}	263^{a}	38.2^{a}	369^{a}	257^{a}	32.5a	614^{a}
T_7	Jabalpur STCR equation T.Y. 60 q ha^{-1}	226de	32.2^{ef}	317^{d-f}	218^{ef}	27.5^{d}	550^{c}
T_8	Jabalpur STCR equation T.Y. 80 q ha^{-1}	241^{b-d}	34.5^{b-e}	336^{c-e}	237^{b-d}	30.3^{bc}	578^{bc}
T_9	Jabalpur STCR equation T.Y. 100 q ha^{-1}	261^{a}	37.7^{ab}	364^{ab}	254^{a}	32.3^{a}	609^{ab}
T_{10}	R.D.F+10 t FYM ha^{-1}	227de	34.9^{b-e}	315^{ef}	222^{d-f}	27.9^{d}	556^{c}
T_{11}	Absolute control	193^{f}	24.1^{g}	250^{g}	199^{g}	23.7^{e}	496^{d}
	S.Em.±	5.08	0.94	7.97	5.08	0.61	10.21

Conclusion

The grain yield of maize at both Dharwad and Belavatgi indicated that targeting 100 q ha^{-1} target yield under STCR approach was found to record significantly higher yield over all other treatments. The percent achievement of the targeted yield was within 10% variance at both locations, demonstrating the validity of the equations for prescribing integrated fertilizer doses for maize. STCR-IPNS treatments recorded relatively higher per cent achievement than other treatments. STCR equation developed at Jabalpur and STCR-NPK fertilizers alone developed at UAS Dharwad gave higher net returns followed by STCR-IPNS equation. The post-harvest soil available N, P_2O_5, and K_2O status demonstrated soil fertility build-up and maintenance as a result of soil test-based fertiliser recommendation under IPNS. Hence, the fertilizer prescription equations developed for maize under IPNS can be recommended for *vertisols* of Northern Karnataka for achieving yield target of 100 q ha^{-1} with sustained soil health, for both assured rainfall and command areas of maize cultivation belts.

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