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Influence of Different Approaches of Nutrient Recommendations on Growth and Yield of Aerobic Rice

N. BHAVYA AND P. K. BASAVARAJA
Department of Soil Science and Agricultural Chemistry, College of Agriculture, UAS, GKVK, Bengaluru - 560 065
e-Mail : bhavyanagraj.6@gmail.com

ABSTRACT

A field experiment was conducted during *kharif* 2020 in *Alfisols* (*Kandicpaleustalfs*) at Zonal Agricultural Research Station (ZARS), GKVK, Bengaluru to study the influence of different approaches of nutrient recommendations on growth and yield of aerobic rice and also to evaluate the STCR targeted yield equations developed for *Alfisols* of eastern dry zone of Karnataka. The experiment was laid out in RCBD comprising twelve treatments replicated thrice. The results revealed that significantly higher plant height at harvest (91.67 cm), number of tillers hill^{-1} (46.13), productive tillers per hill^{-1} (45.00), panicle length (22.48 cm), number of grains per panicle (144.90) and test weight (24.23 g) was recorded in STCR approach with a target of 65 q ha^{-1} through inorganic approach based on predicted soil test values. Similarly, significantly higher grain yield (68.85 q ha^{-1}) and straw yield (74.19 q ha^{-1}) of aerobic rice was recorded in treatment received fertilizer nutrients based on STCR inorganic approach for the targeted yield of 65 q ha^{-1} based on predicted soil test values which was superior compared to package of practice (POP) and low-medium-high (LMH) / soil test laboratory (STL) approach. Further, the higher value cost ratio was recorded (VCR: 10.99) in STCR target of 55 q ha^{-1} through inorganics based on predicted soil test values followed by STCR target of 65 q ha^{-1} through inorganics based on predicted soil test values (10.09). The per cent deviation was within ± 10.00 per cent at yield target of 65 and 55 q ha^{-1} through inorganics and integrated based on both actual and predicted soil test values indicating that these STCR equations are best to prescribe the fertilizer dose for aerobic rice on *Alfisols* of eastern dry zone Karnataka.

Keywords : STCR, Aerobic rice, LMH, VCR, Per cent deviation

AT present in India Soil Test Laboratory (STL) method also called as Low-Medium-High (LMH) approach is the most commonly followed approach for fertilizer recommendations in all the soil testing laboratories. However, this approach involves modifying the recommended dose of fertilizer (RDF) / general recommended dose (GRD) already exists for each crop for certain range of soil test values which is not more scientific because it does not consider the nutrient requirement of the crops and contribution of nutrients from different sources. In this context, Soil Test Crop Response (STCR) targeted yield approach has been found to be more useful where balanced fertilizer nutrient recommendations are made by considering the available nutrient status of the soil, crop needs and also the contribution of nutrients from soil, fertilizers and manures towards the crop uptake (Basavaraja *et al.,* 2014). Soil test crop response approach strikes a balance between 'fertilizing the crop' and 'fertilizing the soil' (Ramamoorthy *et al.,* 1967). In STCR approach, it is assumed that there is a linear relationship between grain yield and nutrient uptake by the crop and for obtaining a particular yield, a definite amount of nutrients are to be taken up by the plant. Once this nutrient requirement is known for a given yield level, the fertilizer nutrients needed can be estimated (Singh *et al.,* 2018).

Nutrient availability in soil after the harvest of a crop is influenced by initial soil nutrient status, the amount of nutrients added through manures, fertilizers and nature of crop grown. To apply fertilizers based on soil test values for a cropping sequence, the soils are to be tested after each crop, which is not practical. Therefore, it has become necessary to predict the soil test values after the harvest of the first crop in a sequence which can be done by developing prediction equations (Ramamoorthy *et al.,* 1967). This provides the way for computing the fertiliser prescriptions for a whole cropping sequence based on initial soil test values. This is very useful because the soil of farmer's field under intensive cultivation cannot be tested for each crop for practical reasons with in a stipulated period.

Aerobic rice is broadly defined as 'a production system in which, direct seeding of high yielding and input responsive rice cultivars with aerobic adaptation grown in non-puddle, non-flooded and non-saturated soil during the entire growing cycle' (Patil *et al.,* 2020). It is a new concept of reducing water requirement for rice in which rice is grown like an upland crop with high inputs and supplementary irrigations, when rainfall is insufficient (Asma *et al*., 2013). Although India has made considerable advances in agricultural research, still the blanket recommendation of cultivation practices for adoption over larger areas are in vogue. Keeping the above facts in view, the present investigation was carried out with an objective to evaluate the developed targeted yield equations through verification trial by including the post-harvest soil test value prediction equation.

Material and Methods

Soil test crop response based fertilizer prescription equations for aerobic rice was developed as per the methodology outlined by Ramamoorthy *et al.* (1967) during *kharif* 2019 and post harvest soil test value prediction equations were developed through multiple regression analysis. The present investigation was carried out to validate the fertilizer prescription equations and post-harvest soil test values prediction equations through test verification trial with aerobic rice (MAS 946-1) during *kharif* 2020 at ZARS, GKVK, Bengaluru. In this verification trial, different fertilizer recommendation approaches were compared to validate the equation developed in the main test crop experiment, so that this equation can be recommended to the farmers, in addition to validation of post-harvest soil test values developed through post harvest soil test value prediction equation in comparison with the actual soil test values. The soil of the experimental site was sandy loam in texture and acidic in reaction (pH 5.77). Electrical conductivity was 0.085 dSm^{-1} with organic carbon content of 4.44 g kg^{-1}. Available nitrogen was low (261.15 kg N ha^{-1}), phosphorus was high (98.55 kg P_2O_5 ha^{-1}) and potassium was medium (256.35 kg K_2O ha^{-1}). The experiment was laid out in randomized complete block design (RCBD) with twelve treatments comprising T_1: STCR through inorganics (65 q ha^{-1}) - Actual STV* (*Soil Test Value), T_2: STCR through inorganics (65 q ha^{-1}) - Predicted STV, T_3: STCR through integrated (65 q ha^{-1}) - Actual STV, T_4: STCR through integrated (65 q ha^{-1}) - Predicted STV, T_5: STCR through inorganics (55 q ha^{-1}) - Actual STV, T_6: STCR through inorganics (55 q ha^{-1}) - Predicted STV, T_7: STCR through integrated (55 q ha^{-1}) - Actual STV, T_8: STCR through integrated (55 q ha^{-1}) - Predicted STV, T_9: Package of practice, T_{10}: LMH (STL) - Actual STV, T_{11}: LMH (STL) - Predicted STV and T_{12}: Absolute control.

The following STCR fertilizer adjustment equations were used for fertilizer application to STCR treatments.

Where, FN, FP_2O_5 and FK_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T is the yield target in q ha^{-1}; SN, SP and SK are available soil nutrients as $KMnO_4$-N, Bray's-$P_2O_5$and NH_4OAc-K_2O in kg ha^{-1}, respectively and OM is amount of poultry manure (organic manure) added in t ha^{-1}.

STCR- Inorganics (NPK alone) equation	STCR- IPNS (Integrated plant nutrient supply) equation
F.N. = 3.02879 T – 0.20314 STV-N	F.N. = 2.89282 T – 0.20320 STVN –0.72978 OM
$F.P_2O_5$ = 1.24589 T – 0.07368 STV - P_2O_5	$F.P_2O_5$ = 1.13206 T – 0.06960 STV - P_2O_5 – 0.48911 OM
$F.K_2O$ = 1.51168 T – 0.22617 STV-K_2O	$F.K_2O$ = 1.50402 T – 0.21105 STV - K_2O – 0.42410 OM

TABLE 1

Post harvest soil test value prediction equation

Prediction equation	R^2 value
Inorganic approach	
PHN = 188.752 + 0.001** SN + 0.203 FN - 0.184 UN	0.610 **
PHP = - 6.133 + 1.089** SP + 1.188** FP - 1.299* UP	0.965 **
PHK = 5.075 + 1.138** SK + 1.275** FK - 0.249 UK	0.925 **
IPNS approach	
PHN = 191.090** - 0.003 SN + 0.087** FP - 0.008 UN	0.925 **
PHP = 7.325 + 0.721** SP + 1.167** FP + 2.515** UP	0.890 **
PHK = 121.586** + 0.724** SK + 0.765** FP - 0.132 UK	0.907 **

A composite soil sample was collected at 0-20 cm depth from each plot after laying out the plan and before the start of experiment. Based on the soil test values NPK fertilizers nutrients were applied for specific yield target in STCR and LMH approach. An attempt was made to apply the fertilizers based on predicted post harvest soil test values which were predicted using post harvest soil test values prediction equations based on uptake (Table 1) developed during STCR main experiment for aerobic rice.

Using these regression equations, the post-harvest soil test values of nitrogen, phosphorus and potassium were predicted for dry chilli (previous crop) where the verification trial of aerobic rice was taken up. The predicted soil test values after dry chilli were considered as the initial soil test values for prescribing fertilizer nutrients dose for verification trial in selected

TABLE 2

Quantity of fertilizer nutrients and poultry manure applied through different approaches as per the treatments and soil test values

Treatments	Soil test values			Poultry manure applied	Fertilizer nutrients applied		
	N	P_2O_5	K_2O		N	P_2O_5	K_2O
	kg ha^{-1}			t ha^{-1}	kg ha^{-1}		
T_1	260.59	101.05	271.64	0	143.94	73.54	36.82
T_2	207.10	174.48	298.07	0	154.80	68.13	30.84
T_3	261.67	106.92	305.92	10	127.56	61.25	28.96
T_4	205.62	167.75	456.03	10	138.95	57.08	2.12
T_5	260.21	99.88	221.67	0	113.72	61.16	33.01
T_6	202.89	149.36	276.69	0	125.37	56.85	20.56
T_7	262.08	93.65	245.75	10	98.55	50.85	26.62
T_8	201.60	145.27	340.47	10	110.84	47.26	6.62
T_9	272.53	115.60	286.76	10	100.00	50.00	50.00
T_{10}	266.56	98.55	285.69	10	125.00	37.50	50.00
T_{11}	204.08	165.92	322.27	10	125.00	37.50	45.83
T_{12}	243.41	56.96	168.13	0	0.00	0.00	0.00

T_1 : STCR through inorganics (65 q ha^{-1}) - Actual STV
T_2 : STCR through inorganics (65 q ha^{-1}) - Predicted STV
T_3 : STCR through integrated (65 q ha^{-1}) - Actual STV
T_4 : STCR through integrated (65 q ha^{-1}) - Predicted STV
T_5 : STCR through inorganics (55 q ha^{-1}) - Actual STV
T_6 : STCR through inorganics (55 q ha^{-1}) - Predicted STV
T_7 : STCR through integrated (55 q ha^{-1}) - Actual STV
T_8 : STCR through integrated (55 q ha^{-1}) - Predicted STV
T_9 : Package of practice
T_{10} : LMH (STL) - Actual STV
T_{11} : LMH (STL) - Predicted STV
T_{12} : Absolute control

treatments. The data on dry chilli yield, uptake, initial soil test values and fertilizer nutrients applied was procured from AICRP on STCR, UAS, GKVK, Bengaluru, for predicting the post-harvest soil test values.

The quantity of nutrients applied per hectare through different approaches as per the treatments are presented in Table 2. Fifty per cent of nitrogen recommended for each treatment was applied through urea and entire quantity of phosphorus through SSP (single super phosphate) and fifty per cent of potassium through MoP (muriate of potash) were supplied at the time of sowing as basal dose to each plot and remaining twenty five per cent of nitrogen and fifty per cent of potassium was applied at 30 days after sowing and the other twenty five per cent of N was applied at 60 DAS. Biometric observations on various growth parameters and yield parameters aerobic rice were recorded from five randomly selected plants in each plot and expressed as mean values. At harvest the grain and straw yield was computed from the net plot and expressed in q ha^{-1}.

The Response Yard Stick (RYS), per cent deviation and Value Cost Ratio (VCR) were computed by using the standard formulae as shown below.

$$\text{Yield response} = \text{Treated yield (q ha}^{-1}\text{)} - \text{control yield (q ha}^{-1}\text{)}$$

$$\text{RYS} = \frac{\text{Yield response (kg ha}^{-1}\text{)}}{\text{Total nutrient applied (kg N, P}_2\text{O}_5\text{ and K}_2\text{O ha}^{-1}\text{)}}$$

$$\text{Per cent deviation} = \frac{\text{Actual yield obtained (kg ha}^{-1}\text{) - Targeted yield (kg ha}^{-1}\text{)}}{\text{Targeted yield (kg ha}^{-1}\text{)}} \times 100$$

$$\text{VCR} = \frac{\text{(Yield in treated plot (q ha}^{-1}\text{)} - \text{Yield in control plot) x Cost q}^{-1}\text{ of grains (q ha}^{-1}\text{)}}{\text{Cost of fertilizers and FYM applied to treated plot}}$$

RESULTS AND DISCUSSION

Influence of Various Approaches of Fertilizer Recommendation on Growth Parameters of Aerobic Rice

Data pertaining to plant height (cm) and number of tillers of aerobic rice at 30 DAS, 60 DAS, 90 DAS and at harvest as influenced by different approaches of nutrient application are presented in Table 3. Significantly higher plant height of 59.27 cm and 81.33 cm was recorded in treatment T_4 (STCR integrated for the target 65 q ha^{-1} - Predicted STV) at 60 ad 90 DAS, respectively compared to treatment T_{10} (LMH - Actual STV), T_{11} (LMH - predicted STV) and T_{12} (Absolute control) at 60 DAS and T_{12} (Absolute control) at 90 DAS. However, it was on par with all other STCR treatments and package of practice approach (POP) and superior over LMH approach at 60 DAS. However, at harvest significantly higher plant height of 91.67 cm was recorded in the treatment T_2 which was on par with all other treatments except absolute control (66.20 cm). Whereas, plant height at 30 DAS was found non significant. Significantly higher number of tillers were recorded in treatment T_2 (6.53) and T_4 (6.53) at 30 DAS compared to absolute control. However, it was on par with all other approaches of fertilizer recommendation. The number of tillers were significantly higher in treatment T_3 (34.87) compared to treatment T_{10} (27.20) and absolute control (17.80). Similarly, at 90 DAS and at harvest significantly higher number of tillers (43.93 and 46.13, respectively) were recorded in the treatment receiving fertilizers through STCR inorganic approach for the targeted yield of 65 q ha^{-1} based on predicted soil test values (T_2) which was on par with all other treatments except package of practice approach, LMH approach through actual and soil test values and absolute control.

The results clearly indicated that there was no significant difference in growth parameters of aerobic rice crop due to application of fertilizer nutrients based on actual and predicted soil test values, even though numerically higher values in predicted STV treatment. The increased plant height and number of tillers in STCR approach was mainly due to application of higher

TABLE 3

Influence of different approaches of nutrient application on plant height and number of tillers of aerobic rice at different intervals

Treatments	Plant height (cm)				No. of tillers hill^{-1}			
	30 DAS	60 DAS	90 DAS	At Harvest	30 DAS	60 DAS	90 DAS	At Harvest
T_1	21.87	55.47	78.93	90.40	6.27	32.53	43.40	43.87
T_2	22.80	58.67	80.87	91.67	6.53	34.60	43.93	46.13
T_3	23.40	57.67	78.47	89.93	6.33	34.87	42.60	43.73
T_4	25.73	59.27	81.33	91.47	6.53	34.80	43.80	45.67
T_5	22.53	53.98	75.47	87.00	5.63	31.80	40.20	41.00
T_6	25.53	55.87	78.80	88.67	5.73	32.27	40.60	40.73
T_7	24.47	56.60	76.47	86.80	5.60	31.27	39.27	39.40
T_8	24.33	56.93	77.00	87.33	5.70	32.60	40.07	40.33
T_9	22.47	56.30	75.03	87.90	4.83	31.60	35.77	37.67
T_{10}	23.20	49.20	74.20	87.07	5.63	27.20	33.73	36.00
T_{11}	21.80	49.40	75.40	87.47	5.80	28.67	35.40	37.27
T_{12}	20.67	39.47	60.03	66.20	4.87	17.80	19.17	19.77
S.Em. ±	1.29	1.81	2.57	2.33	0.40	2.40	1.98	2.55
C.D. @ 5 %	NS	5.31	7.54	6.84	1.18	7.03	5.80	7.48

dose of nitrogenous fertilizer compared to other treatments. Thapar *et al.* (2019) have also reported the progressive increase in plant height of rice under STCR approach due to the fact that the demand of NPK levels have been sufficient for the formation of nucleic acids which are responsible for crop growth and development.

Influence of Various Approaches of Fertilizer Recommendation on Yield Attributes and Yield of Aerobic Rice

Significantly maximum number of productive tillers hill^{-1} (45.00: T_2) and panicle length (22.48 cm: T_2) were noticed with STCR target of 65 q ha^{-1} through inorganic approach where fertilizer nutrients were applied based on predicted soil test values compared to absolute control and it was on par with all other treatments. Significantly maximum number of grains panicle^{-1} (144.97) was recorded in T_2 treatment which was on par with other STCR treatments except with treatment STCR integrated approach for the targeted yield of 55 q ha^{-1} based on predicted soil test values (T_8: 134.16) followed by T_{11} (LMH - predicted STV) with 124.39 grains panicle^{-1}, T_9 (LMH - Predicted STV) with 123.21 grains panicle^{-1} and T_{10} (LMH - Actual STV) with 120.03 grains panicle^{-1}. However, significantly lower number of grains (83.38) per panicle was recorded in absolute control plots. Test weight varied from 23.12 g (T_{12}: Absolute control) to 24.23 g [T_2: STCR inorganics (65 q ha^{-1}) - Predicted STV]. Even though there was no significant difference among the treatments, numerically higher test weight (24.23) was recorded in treatment T_2.

Significantly higher grain yield of 68.85 q ha^{-1} was recorded with the application of nutrients based on STCR approach for the targeted yield of 65 q ha^{-1} through inorganic based on predicted soil test values (T_2) compared to treatment T_8 (60.14 q ha^{-1}) [STCR integrated (55 q ha^{-1}) - Predicted STV], T_7 (57.55 q ha^{-1}) [STCR integrated (55 q ha^{-1}) - Actual STV], T_9 (53.25 q ha^{-1}) (Package of practice), T_{11} (49.15 q ha^{-1}) (LMH - predicted STV), T_{10} (48.76 q ha^{-1}) (LMH - Actual STV), and T_{12} (20.66 q ha^{-1}) (Absolute control). However, it was on par with treatments receiving fertilizers through STCR inorganic approach for the targeted yield of 65 q ha^{-1} based on actual soil test values (T_1: 65.50 q ha^{-1}); STCR integrated approach for the targeted yield of 65 q ha^{-1} based on predicted soil test values (T_4: 63.79 q ha^{-1}) and actual test values (T_3: 61.70 q ha^{-1}); STCR inorganic approach for the targeted yield of 55 q ha^{-1} for predicted soil test values (T_6: 62.96 q ha^{-1}) and actual soil test values (T_5: 61.58 q ha^{-1}).

Significantly higher straw yield (74.19 q ha^{-1}) was registered under the treatment T_2 [STCR inorganics (65 q ha^{-1}) - Predicted STV] compared to STCR integrated approach where the fertilizers were applied by considering actual soil test values for the targeted yield of 55 q ha^{-1} (T_7: 59.67 q ha^{-1}), POP (T_9: 53.43 q ha^{-1}), LMH approach for predicted (T_{11}: 47.33 q ha^{-1}) and actual (T_{10}: 46.72 q ha^{-1}) soil test values but it was on par with other STCR treated plots *viz.,* STCR integrated (65 q ha^{-1}) - Predicted STV (T_4: 73.38 q ha^{-1}), STCR inorganics (55 q ha^{-1}) - Predicted STV (T_6: 71.47 q ha^{-1}), STCR inorganics (65 q ha^{-1}) - Actual STV (T_1: 67.05 q ha^{-1}), STCR integrated (65 q ha^{-1}) - Actual STV (T_3: 66.04 q ha^{-1}), STCR inorganics (55 q ha^{-1}) - Actual STV (T_5: 63.05 q ha^{-1}) and STCR integrated (55 q ha^{-1}) - Predicted STV (T_8: 61.76 q ha^{-1}). However, significantly lowest straw yield was reported from absolute control plots (T_{12}: 19.73 q ha^{-1}).

The data on yield parameters and yield clearly indicates that STCR inorganic and integrated approach of fertilizer recommendation for both the targets based on actual and predicted soil test values were superior compared to LMH approach and package of practice. The higher yield in STCR treatments could be attributed to the ability of targeted yield approaches to satisfy the nutrient demand of crop more efficiently. These findings are in close accordance with those reported by Kumar and Paramananda (2018) who opined that application of fertilizers based on STCR approach at critical physiological phases would have supported for better assimilation of photosynthates towards grain. Increase in grain yield can also be attributed to favorable effect in accelerating the growth and yield parameters.

TABLE 4

Influence of different approaches of nutrient application on yield parameters and yield of aerobic rice

Treatments	Productive tillers^{-1}	Panicle length (cm)	No. of grains panicle^{-1}	Test weight (g)	Grain yield (q ha^{-1})	Straw yield (q ha^{-1})
T_1	42.87	22.00	143.52	24.12	65.50	67.05
T_2	45.00	22.48	144.97	24.23	68.85	74.19
T_3	41.87	21.55	140.99	23.65	61.70	66.04
T_4	43.47	22.43	142.24	23.72	63.79	73.38
T_5	39.27	21.67	136.40	23.62	61.58	63.05
T_6	40.87	22.27	138.64	24.01	62.96	71.47
T_7	39.33	21.57	135.96	23.51	57.55	59.67
T_8	40.23	21.89	134.16	23.96	60.14	61.76
T_9	39.43	21.56	123.21	23.57	53.25	53.43
T_{10}	38.53	21.95	120.03	23.55	48.76	46.72
T_{11}	39.33	22.32	124.39	23.59	49.15	47.33
T_{12}	18.77	18.51	83.38	23.12	20.66	19.73
S.Em. ±	2.96	0.50	3.58	0.27	2.88	4.24
C.D. @ 5 %	8.68	1.45	10.49	NS	8.39	12.42

Higher grain and biomass yield with STCR nutrient management strategies over RDF or LMH approach of nutrient management clearly indicated the benefit of judicious and balanced nutrient management in rice. Lowest grains and straw yield in control plots was due to the continuous removal of nutrients from the soil without addition of any external inputs (Sundaresh and Basavaraja, 2019). It is important to notice that application of nutrients based on predicted soil test values for the targets of 65 and 55 q ha^{-1} in both inorganic and integrated approach have recorded higher yield and yield attributes which was mainly due to increased and balanced fertilizer nutrient rates as the predicted soil test values were lower compared to actual soil test values. But, there was no significant difference between actual and predicted soil test values indicating the accuracy of soil test values which were predicted making use of the data on initial soil test values, fertilizer dose and yield of dry chilli (previous crop in the experimental site) by adopting post-harvest soil test values prediction equations that were developed during the main experiment. Thus, the predicted soil test values could be used with confidence to prescribe the fertilizer nutrient dose in a cropping sequence therefore testing the soil after each crop to recommend the fertilizer nutrients can be avoided (Gangola *et al.,* 2017).

Yield Response and Economics of Aerobic Rice Production as Influenced by different Approaches of Nutrient Application

The yield response indicates the extra yield obtained over control plot due to applied fertilizer nutrients. The highest yield response of 48.19 q ha^{-1} was noticed where only NPK fertilizers were applied as per STCR inorganic approach for a targeted yield of 65 q ha^{-1} based on predicted soil test values (T_2) followed by 44.84 q ha^{-1} in targeted yield of 65 q ha^{-1} through inorganics based on actual soil test values (T_1). However, the lower yield response of 28.10 q ha^{-1} was recorded in LMH approach where nutrients were applied based on actual soil test values (T_{10}). The response yard stick (RYS) indicates the yield obtained in kg's per kg of NPK applied in that particular ratio of each treatment. The response yard stick (RYS) was higher in STCR integrated approach for the yield target of 55 q ha^{-1} where fertilizer nutrients were applied by considering predicted soil test values (23.97 kg kg^{-1}) followed by targeted yield of 65 q ha-^{1} through integrated (21.77 kg kg^{-1}) approach by considering predicted soil test values. The lower RYS was recorded in LMH approach through actual soil test values (13.22 kg kg^{-1}).

The per cent deviation indicates the yield variation from the target fixed or genetic potentiality of the crop. The per cent (%) deviation in the present study from the fixed target was found to be positive in STCR target of 65 q ha^{-1} and 55 t ha^{-1} through inorganic approach based on actual (0.77 and 11.96%, respectively) soil test value, predicted soil test values (5.92 and 14. 47%, respectively) and with STCR target of 55 q ha^{-1} through integrated approach based on predicted (9.35%) and actual (4.64%) soil test values where the yield obtained was higher than the fixed targets and the lower deviation was noticed in STCR integrated approaches for the targeted yield of 65 q ha^{-1} based on predicted soil test value (-1.86%), package of practice (-3.18%) and STCR integrated approach for the targeted yield of 65 q ha^{-1} based on actual soil test values (-5.08%). However, the deviation was higher in LMH approach through actual soil test values (-11.35%), LMH approach through predicted soil test values (-10.64%) and absolute control (-62.44%) indicating that the crop could not achieve the genetic potential yield in these treatments. The higher value cost ratio (VCR) of 10.99 was recorded treatment T_6 followed by 10.09 in treatment T_2. The lower value cost ratios of 1.34 and 1.37 were recorded in LMH approaches through actual (T_{10}) and predicted (T_{11}) soil test values.

The higher yield response obtained in STCR approach compared to LMH approach and package of practice treatments was due to higher grain yield of aerobic rice obtained in STCR treatments over control plot. Similarly, higher RYS in STCR targets with integrated approach indicated that the NPK fertilizer nutrients were applied in a balanced way and was effectively utilized by the crop to achieve the target as compared to other treatments. The results of the present study are in accordance with Basavaraja *et al.* (2017) who reported that the applied of NPK fertilizers were effectively utilized by the crop under STCR approach compared to other approaches in ragi crop due to balanced and precise dose of NPK application based on soil test and yield targets. The per cent deviation of ±10.00 will be generally considered as a best equation otherwise the equations will be modified (Patel *et al.,* 2011). Value-cost ratio (VCR) worked out was found to be higher in STCR target of 55 q ha^{-1} with inorganic approach based on predicted soil test values followed by STCR target of 65 q ha^{-1} with inorganic approach through predicted soil test values. However, STCR integrated treatments recorded lower VCR than the inorganic treatments.

The higher VCR could be mainly due to lower levels of NPK fertilizer and no poultry manure application associated with higher yields. Even though higher yields were recorded in STCR integrated approach, the VCR was very low mainly due to high cost of poultry manure applied to these treatments. These results are in conformity with Basavaraja *et al.* (2017) in finger millet crop, who reported higher VCR in STCR inorganic approach over integrated approach due to high cost of FYM.

TABLE 5

Yield response, response yard stick, per cent deviation and value cost ratio of aerobic rice production as influenced by different approaches of nutrient application

Treatments	Yield response	RYS	Per cent deviation	VCR
	q ha^{-1}	kg kg^{-1}	%	
T_1	44.84	17.63	0.77	8.90
T_2	48.19	18.99	5.92	10.09
T_3	41.04	18.85	-5.08	1.90
T_4	43.13	21.77	-1.86	2.06
T_5	40.92	19.68	11.96	9.77
T_6	42.30	20.86	14.47	10.99
T_7	36.89	20.96	4.64	1.77
T_8	39.48	23.97	9.35	1.94
T_9	32.59	16.30	-3.18	1.53
T_{10}	28.10	13.22	-11.35	1.34
T_{11}	28.49	13.68	-10.64	1.37
T_{12}	-	-	-62.44	-

The yield response, RYS, per cent deviation and VCR was higher in the treatments receiving fertilizer nutrients through STCR predicted soil test values compared to POP and LMH approach through actual soil test values which indicates that predicted soil test values could be used with confidence to achieve higher yield and economics in STCR targeted yield approach.

Based on this study, it can be concluded that the STCR targeted yield equations developed for aerobic rice crop is most suitable for *Alfisols* of Eastern Dry Zone of Karnataka for getting higher yield as STCR approach with a target of 65 q ha^{-1} based on predicted soil test values through inorganics have recorded 29.17 and 28.62 per cent higher yield compared to LMH approach through actual and predicted soil test values, respectively and 22.65 per cent higher yield compared to POP. Even though VCR was lower in STCR integrated approach due to high cost of poultry manure, these treatments should be recommended for applying balanced dose of fertilizer nutrients in order to encourage the farmers to use their own compost/ FYM to reduce the cost of production and increase the benefit in addition to sustaining the soil health. Predicted soil test values could be used with confidence to prescribe the fertilizer dose in a cropping sequence as there was no significant difference in yield between actual and predicted soil test value based fertilizer recommendations so that testing the soil after each crop in a sequence could be avoided.

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