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# On-farm Fertility Management through Target Yield Approach for Sustenance of Tribal Farmers

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***Authors' contributions***

*This work was carried out in collaboration among all authors. Author KR conducted the experiment and analysed soil samples in the study, performed the statistical analysis, wrote the protocol, and first draft of the manuscript. Authors AM and TS executed the experimental work. Authors PSB and PD provided technical guidance for the study. All authors read and approved the final manuscript.*

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## ABSTRACT

The demonstrations on on-farm fertility management through desired yield target were conducted with castor and maize crops at 15 farmers' fields during *rabi* 2016-17 at Peddatanda and Sainapally tanda of Nagarkurnool District, Telangana to improve sustenance of tribal farmers and to verify the fertilizer prescription models & to analyze the economics of these models to enhance the productivity and profitability. The results revealed that the targeted yield prescription models ensured higher seed yield, response yard-stick and nutrient ratio to the applied fertilizers, and additional benefits from higher produce, a good benefit-cost ratio obtained over the farmers'

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practice. The seed yield from the pre-fixed targets of 25 and 60 q $ha^{-1}$ of castor and maize were achieved within ± 10 % yield deviation at almost all the locations, which ensure for further nourishment of tribal farmers. The targeted yield prescription models for fertilizer recommendations were more precise to achieve the targeted yield, additionally led to higher profits and soil health.

*Keywords: Farm fertility; management; tribal farmers; yield models; India.*

## 1. INTRODUCTION

Feeding the projected population of 9.1 billion globally and 1.6 billion in India by 2050 is one of the greatest challenges of the century, and this endeavor to ensure future food security and efficient soil nutrient management [1]. Also, in recent years fertilizer prices escalated steeply, and widespread nutrient imbalances & deficiencies compelled judicious application of nutrients through fertilizers and manures based on soil test and crop requirement. Most farmers and stakeholders are not aware of soil fertility issues and management alongside water and crop management, which are the main reason for large yield gaps, but science-led interventions bridge these yield gaps to ensure future sustenance of smallholding farmers particularly in tribal areas for their sustainable farm productivity, as well as their economic improvement. Several approaches of fertilizer recommendations have been followed world over of which soil test crop response based fertilizer recommendation for specific yield target of crops is unique as it not only indicates soil test based balanced fertilizer recommendations but also the level of yield which farmers' can obtain with optimum crop management under favorable climatic conditions [2]. Under Soil Test Crop Response (STCR) approach, the fertilizer dose varies for each unit change in soil test value and balanced doses are recommended for higher targets [3]. A systematic study on the effect of soil test crop response based fertilizer recommendations for specific yield targets of Castor and Maize in Nagarkurnool district is lacking. The present study was undertaken to verify the soil test based fertilizer prescription equations for targeted yields and to compare the fertilizer response and economics with farmers' practices and package recommendation of fertilizers for Castor and Maize under irrigated conditions at farmers' fields in parts of semi-arid southern Telangana zone [4]. A linear response of seed yield (1620 kg $ha^{-1}$) and higher gross return (Rs. 54320 $ha^{-1}$), net return (Rs. 35135 $ha^{-1}$) and B:C ratio (2.6) was observed due to application of 40 kg $P_2O_5$ $ha^{-1}$+seed treatment of PSB 20g $kg^{-1}$ compared to biophos (30gm/50gm of seeds) alone at farmers fields of Gudihalli village in Chitradurga District for validation of technology [5].

## 2. METHODOLOGY

The soil test based fertilizer prescription equations for a targeted yield of Castor and Maize were tested at fifteen farmers' fields (ten for castor and five for maize) during *rabi*, 2016-2017 at Peddatanda and Sainapally tanda of Nagarkurnool district, Telangana. Before laying out the demonstrations, composite surface (0-15 cm) soil samples were drawn from the farmer's field and processed in the laboratory at Regional Agricultural Research Station (RARS), Palem, and were analyzed for physico-chemical (pH, EC & OC) and chemical properties (available N, phosphorous and potassium) using standard methods. The fertilizer prescription equations developed for yield target of Castor and Maize for Southern Telangana soil series are furnished in Table 1.

Where, FN, $FP_2O_5$ and $FK_2O$ are fertilizer N, $P_2O$ and $K_2O$ in kg $ha^{-1}$, respectively, T is the yield targeted in q $ha^{-1}$; SN, SP and SK are soil available N, P and K in kg $ha^{-1}$, respectively. The treatments include farmer's fertilizer practice and soil test crop response (STCR) based fertilizer doses formulated to achieve a yield target of 25 and 60 q $ha^{-1}$ for Castor and Maize crops. The test crops were raised during *rabi,* 2016 by following cultivation practices periodically and harvested crops at their maturity stage and recorded seed and stover yield, as well as worked out BCR (B: C ratio) based on the standard procedures [6]. Further, the available status of nutrients was used to compute fertilizer doses for Castor and Maize crops through target yield equations using basic data that had earlier been generated from fertility gradient field experiments.

## 3. RESULTS AND DISCUSSION

### 3.1 Initial Soil Fertility Status of Farmers Fields

The soils of the experimental fields (Table 2) were slightly acidic to strongly alkaline in reaction, varied from 6.36 to 8.82 at Peddatanda

and neutral to moderately alkaline in reaction at Saainapally tanda ranged from 6.69 to 7.83 in reaction with an overall mean of 7.31, non-saline with electrical conductivity which is ranged from 0.14 to 0.57 with a mean value of 0.30 $dSm^{-1}$ at Peddatanda and 0.27 to 0.57 with a mean value of 0.32 $dSm^{-1}$at Sainapally tanda and both locations registered low organic carbon content (0.27 to 0.45% at Peddatanda and 0.24 to 0.42% at Sainapallytanda with an overall mean of 0.34 %). The soils were low in available N (143 to 197 with a mean of 179 kg $ha^{-1}$at Peddatanda and 168 to 181 with a mean of 172 kg $ha^{-1}$ at Sainapally tanda), low to medium (24 to 49 with mean of 40 kg $ha^{-1}$) in available P at Peddatanda and medium (38 to 47 with mean of 42 kg $ha^{-1}$) at Sainapally tanda and both locations registered low to medium in available K (128 to 253 with mean of 178 kg $ha^{-1}$ at Peddatanda and 106 to 269 with a mean of 202 kg $ha^{-1}$ at Sainapally tanda). The soil test values of different fields indicated considerable variations in organic carbon and available N, P & K [7] in Telangana soils. Despite higher removal of nutrients, the fertility status was maintained in STCR plots as compared to farmers practice and similar trend of result was also observed for Bt-cotton [8] and beetroot [9] in Alfisol. The doses of fertilizer nutrients applied in different treatments in the fields are presented in Table 3.

### 3.2 Seed Yield of Castor and Maize (q $ha^{-1}$)

The seed yield of Castor and Maize (q $ha^{-1}$) obtained at different locations ranged widely presented in Table 4.The castor yield of farmer practice varied from 13 to 19 with a mean yield of 16 q $ha^{-1}$ and STCR based applied fertilizers registered yield varied from 17 to 22 with a mean yield of 20 q $ha^{-1}$, indicating an improvement of yield by about 69 percent in STCR based applied fertilizers plot over farmer practice at Peddatanda, while maize yield of farmer practice ranged from 41 to 52 with a mean yield of 46 q $ha^{-1}$ and STCR based applied fertilizers registered yield ranged from 42 to 58 with a mean yield of 51 q $ha^{-1}$ indicating an improvement of yield by about 42 percent in STCR based applied fertilizers plot over farmer practice at Sainapallytanda. The higher response of fertilizers observed in targeted yield treatments, due to more precise/balanced application of fertilizers as compared to imbalanced fertilization in farmer practice [10] and this study area under low to medium category in available K and farmers didn't apply potassium fertilizers, it might be the reason for low yields in farmers fields at Peddatanda as well as Sainapally tanda [11]. These results elucidated the beneficial effect of STCR-IPNS treatments on the yield of castor and maize crops [12,3].

### 3.3 Response yardstick and Nutrient Response Ratio

The STCR response yardstick varied widely from 0.90 to 3.83 with a mean value of 2.54 at Peddatanda and 0.20 to 3.31 with a mean value of 2.14 at Sainapallytanda, while the nutrient response ratio ranged from 10.64 to 30.28 with a mean value of 17.94 at Peddatanda and 16.47 to 23.45 with a mean value of 19.86 at Sainapallytanda (Table 4). These high response yardsticks and nutrient response ratio values at different locations revealed the high responsiveness of test crops to nutrient application. The higher response yardstick and nutrient response ratio under STCR approach over farmer practice might be due to a balanced supply of nutrients from soils as well as fertilizers [13].

### 3.4 Benefit-Cost Ratio

The B:C ratio of farmers practice varied from 0.93 to 1.55 with a mean value of 1.24 and STCR approach ranged from 1.09 to 1.82 with a mean value of 1.48 at Peddatanda for castor crop, while B:C ratio of farmers practice varied from 1.39 to 1.90 with a mean value of 1.65 and STCR approach ranged from 1.40 to 1.97 with a mean value of 1.71 at Sainapally tanda for maize crop at different locations (Table 4). These results clearly revealed the superiority of STCR based fertilizer recommendations over farmers' practices [14].

**Table 1. Soil test crop response correlation equations for castor and maize for Southern Telangana Zone**

| STCR Equation | : | Castor | Maize |
|---|---|---|---|
| FN | = | 15.54 T – 2.30 SN | 4.00T – 0.49 SN |
| $FP_2O_5$ | = | 4.72 T – 6.44 SP | 2.15 T – 2.58 SP |
| $FK_2O$ | = | 4.75 T – 0.44 SK | 2.58 T – 0.30 SK |
| RDF | : | 80:40:30 kg $ha^{-1}$ | 240:80:80 kg $ha^{-1}$ |

**Table 2. Initial soil fertility status of farmers field's at Peddatanda and Sainapallytanda**

| S.No | Name of the Farmer | Village | Physico-chemical properties | | | Initial Nutrient Availability (kg ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|
| | | | pH | EC (dSm$^{-1}$) | OC (%) | N | $P_2O_5$ | $K_2O$ |
| **Castor** | | | | | | | | |
| 1 | Naavya S/o Chandu | Peddatanda | 7.68 | 0.23 | 0.27 | 193 | 48 | 175 |
| 2 | Raju | Peddatanda | 6.36 | 0.16 | 0.30 | 143 | 30 | 160 |
| 3 | Tara singh | Peddatanda | 6.84 | 0.39 | 0.33 | 191 | 46 | 128 |
| 4 | Gopal | Peddatanda | 7.44 | 0.14 | 0.27 | 158 | 46 | 253 |
| 5 | Bhaskar | Peddatanda | 7.43 | 0.44 | 0.39 | 193 | 41 | 152 |
| 6 | Neenya S/o Rajya | Peddatanda | 6.62 | 0.27 | 0.42 | 181 | 40 | 156 |
| 7 | Jagya S/o Ram Singh | Peddatanda | 8.82 | 0.21 | 0.27 | 192 | 43 | 153 |
| 8 | Jumya | Peddatanda | 7.50 | 0.57 | 0.36 | 196 | 24 | 163 |
| 9 | RajyaNayak | Peddatanda | 7.20 | 0.20 | 0.45 | 168 | 42 | 245 |
| 10 | Neenu | Peddatanda | 6.61 | 0.22 | 0.30 | 197 | 49 | 165 |
| **Maize** | | | | | | | | |
| 1 | Ramu kunya | Sainapallytanda | 7.56 | 0.23 | 0.36 | 181 | 40 | 191 |
| 2 | Anjaneyulu | Sainapallytanda | 7.20 | 0.22 | 0.27 | 168 | 38 | 269 |
| 3 | Ramu | Sainapallytanda | 6.69 | 0.20 | 0.39 | 168 | 45 | 250 |
| 4 | Tara Singh | Sainapallytanda | 7.35 | 0.57 | 0.27 | 168 | 40 | 106 |
| 5 | Pandu | Sainapallytanda | 7.83 | 0.26 | 0.42 | 168 | 47 | 225 |

**Table 3. Details of fertilizer doses at farmers field's of Peddatanda and Sainapallytanda**

| S.No | Name of the Farmer | Village | Farmers Fertilizer Practice (kg ha$^{-1}$) | | | STCR Recommendation (kg ha$^{-1}$) | | |
|---|---|---|---|---|---|---|---|---|
| | | | N | $P_2O_5$ | $K_2O$ | N | $P_2O_5$ | $K_2O$ |
| **Castor** | | | | | | | | |
| 1 | Naavya S/o Chandu | Peddatanda | 55 | 23 | - | 40 | 20 | 55 |
| 2 | Raju | Peddatanda | 23 | - | - | 60 | 37 | 60 |
| 3 | Tara singh | Peddatanda | 46 | - | 30 | 40 | 20 | 72 |
| 4 | Gopal | Peddatanda | 18 | 46 | - | 25 | 20 | 26 |
| 5 | Bhaskar | Peddatanda | 55 | 23 | 30 | 40 | 20 | 63 |
| 6 | Neenya S/o Rajya | Peddatanda | 46 | - | - | 40 | 10 | 62 |
| 7 | Jagya S/o Ram Singh | Peddatanda | 55 | 23 | - | 40 | 20 | 63 |
| 8 | Jumya | Peddatanda | 46 | - | - | 40 | 53 | 59 |
| 9 | RajyaNayak | Peddatanda | 55 | 23 | - | 40 | 20 | 29 |
| 10 | Neenu | Peddatanda | 55 | 23 | - | 40 | 20 | 58 |
| **Maize** | | | | | | | | |
| 1 | Ramu kunya | Sainapallytanda | 73 | 23 | - | 151 | 54 | 53 |
| 2 | Anjaneyulu | Sainapallytanda | 69 | - | 30 | 158 | 56 | 68 |
| 3 | Ramu | Sainapallytanda | 50 | 23 | 30 | 158 | 48 | 43 |
| 4 | Tara Singh | Sainapallytanda | 69 | - | - | 158 | 54 | 51 |
| 5 | Pandu | Sainapallytanda | 50 | 46 | - | 158 | 46 | 48 |

**Table 4. Seed yield, B:C ratio, Response yard-stick and Nutrient response ratio at farmers field's of Peddatanda and Sainapallytanda**

| S.No | Name of the Farmer | Village | Yield (q ha$^{-1}$) | | B:C Ratio | | STCR approach | |
|---|---|---|---|---|---|---|---|---|
| | | | Farmers Practice | STCR recom. | Farmers Practice | STCR recom. | Response Yard-stick | Nutrient response ratio |
| **Castor** | | | | | | | | |
| 1 | Naavya S/o Chandu | Peddatanda | 18 | 22 | 1.17 | 1.52 | 3.83 | 19.13 |
| 2 | Raju | Peddatanda | 13 | 17 | 0.93 | 1.09 | 2.48 | 10.64 |
| 3 | Tara singh | Peddatanda | 14 | 18 | 1.10 | 1.26 | 2.65 | 13.26 |
| 4 | Gopal | Peddatanda | 19 | 22 | 1.55 | 1.81 | 3.24 | 30.28 |
| 5 | Bhaskar | Peddatanda | 18 | 22 | 1.15 | 1.49 | 3.41 | 17.80 |
| 6 | Neenya S/o Rajya | Peddatanda | 14 | 18 | 1.16 | 1.34 | 3.21 | 15.89 |
| 7 | Jagya | Peddatanda | 19 | 21 | 1.41 | 1.54 | 1.71 | 17.24 |
| 8 | Jumya | Peddatanda | 17 | 20 | 1.09 | 1.30 | 2.24 | 13.29 |
| 9 | RajyaNayak | Peddatanda | 17 | 18 | 1.55 | 1.82 | 0.90 | 19.89 |
| 10 | Neenu | Peddatanda | 18 | 20 | 1.33 | 1.67 | 2.03 | 16.95 |
| **Maize** | | | | | | | | |
| 1 | Ramu kunya | Sainapallytanda | 50 | 57 | 1.71 | 1.91 | 3.02 | 22.21 |
| 2 | Anjaneyulu | Sainapallytanda | 42 | 48 | 1.60 | 1.61 | 2.34 | 17.06 |
| 3 | Ramu | Sainapallytanda | 52 | 58 | 1.90 | 1.97 | 2.59 | 23.47 |
| 4 | Tara Singh | Sainapallytanda | 44 | 52 | 1.65 | 1.71 | 3.31 | 19.85 |
| 5 | Pandu | Sainapallytanda | 41 | 42 | 1.39 | 1.40 | 0.20 | 16.47 |

## 4. CONCLUSION

A summary of the on-farm response of test crops to the applied deficient nutrients together with target yield approach demonstrated that balanced nutrient management has indeed the potential to significantly enhance the productivity and quality of Castor and Maize crops under rainfed conditions. The targeted yield based fertilizer prescription models for Castor and Maize are dynamic as they can be increased or decreased for each unit decrease or increase in soil available nutrients. The seed yield of Castor and Maize at different locations of Peddatanda and Sainapallytanda of Nagarkurnool district of Telangana registered the highest yield (22 and 58 q $ha^{-1}$) at STCR approach with a target yield of 25 and 60 q $ha^{-1}$over farmer practice (13 and 41 q $ha^{-1}$) and this approach will be helpful to improve sustenance of tribal farmers at Southern Telangana Zone.

## CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

## COMPETING INTERESTS

Authors have declared that no competing interests exist.

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