*Madras Agric. J.,* 2019; doi:10.29321/MAJ 2019.000309

RESEARCH ARTICLE

# Validation of Soil Test Crop Response based Fertiliser Prescription Equations under Integrated Plant Nutrition System for Hybrid Brinjal on Inceptisol of Andhra Pradesh

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Received : 04th September, 2019

Revised : 09th September, 2019

Accepted : 12th September, 2019

## ABSTRACT

Experiments were conducted at two locations in the northern coastal zone of Andhra Pradesh to validate the fertilizer prescription equations developed from Soil Test Crop Response Studies under the Integrated Plant Nutrition System (STCR-IPNS) for hybrid brinjal on Visakhapatnam Soil series (Typic Haplustept) based on inductive cum target yield model. Using the data of fruit yield and fertilizer doses applied, parameters *viz*..,per cent achievement, response ratio (RR), benefit: cost ratio (BCR) were computed. The results revealed that the target yield has been achieved within ±10 per cent variation proving the validity of the equations. The mean values for validation experiments of two locations showed that the higher fruit yield (59.91 t $ha^{-1}$), BCR (3.94), ascorbic acid content (17.0 mg $100g^{-1}$) and dry matter content of fruit (8.11%) were recorded in STCR-IPNS for a target yield of 60 t $ha^{-1}$. Though, higher response ratio (93.12 kg $kg^{-1}$), per cent achievement (103.3) and minimum total phenol (69.0 mg 100 $g^{-1}$) content were recorded in STCR-IPNS-50 t $ha^{-1}$, higher BCR of 3.94 was recorded in STCR-IPNS-60 t $ha^{-1}$, The mean increase in yield due to STCR-IPNS-60 t $ha^{-1}$ was 41.3 per cent over blanket (100% RDF alone), 13.3 per cent over blanket + FYM @ 25 t $ha^{-1}$ and 30.7 per cent over farmer's practice. STCR-IPNS based fertilization resulted in increased yield, efficient fertilizer use, economic returns in invest, quality parameters and sustenance of soil health, The magnitude of built-up was higher with STCR-IPNS treatments as compared to STCR-NPK alone, blanket recommendations, farmer's practice and absolute control.

**Keywords:** *Fertiliser Prescription Equations, STCR-IPNS, Typic Haplustept, hybrid brinjal, validation*

## INTRODUCTION

Brinjal (*Solanum melongena* L.), a major vegetable crop belongs to the family Solanaceae, is a major source of vitamins and minerals like phosphorus, calcium, and iron. The estimated area and production of brinjal in India during 2017-18 is about 0.73 million hectares and 12.80 million tonnes respectively with average productivity of 19.10 t $ha^{-1}$ (Ministry of Agriculture and farmers welfare, 2018).

India is the second-largest producer of vegetables next to china in the world and the productivity of different vegetables in our country is comparatively lower than the world's average productivity. Again the per capita availability of vegetables (210 g $head^{-1}$ $day^{-1}$) is still behind the recommended quantity (285 g $head^{-1}day^{-1}$). Our demand by 2020 will be around 250 million tonnes. In India, the blanket fertilizer recommendation for vegetable crops suggests 2:1:1 ratio of NPK, whereas, nutrient removal in various vegetable crops is 2.65:1:3.42 NPK which warrants the attention that fertilization should be based on the nutrient requirement of various crops (Naik *et al*.,2013). Moreover, the blanket recommendation is not based on soil fertility and crop requirement and therefore it leads to either over or under usage of fertilizers.

At this juncture, Soil Test Crop Response based Integrated Plant Nutrient System(STCR-IPNS) plays a vital role in ensuring balanced nutrition of crops. STCR-IPNS takes into account the nutrient requirement of crops, the contribution of nutrients from soil, fertilizer and organic manures in deriving fertilizer prescriptions and ensuring balanced nutrition to crops with sustained soil fertility. These prescriptions of practical importance for efficient and judicious use of fertilizers in increasing crop production and in addition, the prescription for

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desired yield target of crops could be made based on the resource availability of farmers (Dey and Santhi, 2014). Though soil test based fertilizer prescriptions for brinjal is available for various soil types and agro-climatic zones in different parts of India, so far, STCR-IPNS studies have not been carried out for brinjal in Andhra Pradesh. Also, Ramamoorthy and Velayutham (2011) emphasized that soil testing is the first entry point to the farmer's field for extending agro-technology transfer to the farming community, including long term soil fertility management and ensure balanced fertilization. Keeping these aspects in view, the present investigation was undertaken to validate the fertilizer prescription equations developed under the Integrated Plant Nutrition System for hybrid brinjal on the Visakhapatnam soil series (Typic Haplustept) of the north coastal zone of Andhra Pradesh.

## MATERIAL AND METHODS

Validation experiments were conducted during rabi 2018-19 to validate the fertiliser prescription equations developed from Soil Test Crop Response correlation studies under Integrated Plant Nutrition System for hybrid brinjal on Visakhapatnam soil series (Typic Haplustept) in north coastal zone of Andhra Pradesh at two locations *viz*., farm of College of Horticulture, Parvathipuram and farmer's field at Naiduvalasa village,Vizianagaram district, Andhra Pradesh.

Initial soil samples were collected from both the locations and analyzed for $KMnO_4$-N (Subbaiah and Asija,1956), Olsen-P (Olsen *et al*.,1954), $NH_4OAc$-K (Standford and English,1949) and DTPA extractable micronutrients (Lindsay and Norwell,1978). The initial soil fertility status for both the locations is shown in Table 1 and Fertiliser prescription equations developed for hybrid brinjal is furnished below:

| STCR-NPK | | STCR-IPNS | |
|---|---|---|---|
| FN | 0.75 T - 0.93 SN | FN | 0.75 T - 0.93 SN - 0.53 ON |
| $FP_2O_5$ | 0.34 T - 2.97 SP | $FP_2O_5$ | 0.34 T - 2.97 SP - 0.83 OP |
| $FK_2O$ | 0.55 T - 0.68 SK | $FK_2O$ | 0.55 T - 0.68 SK - 0.51 OK |

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 target of fruit yield in q $ha^{-1}$; SN, SP, and SK are available soil N, P, and K in kg $ha^{-1}$ respectively, ON, OP, and OK are N, P and K supplied through FYM in kg $ha^{-1}$.

The experiments were laid out in a randomized block design (RBD) with three replications. Ten treatments were imposed as follows (i) Blanket (100% RDF alone) (ii) Blanket plus FYM @ 25 t $ha^{-1}$ ( iii to v) STCR based NPK fertiliser dose for an yield target of 50, 55 and 60 t $ha^{-1}$ (vi-viii) STCR-IPNS based fertiliser dose for an yield target of 50, 55 and 60 t $ha^{-1}$ (ix) farmer's practice and (x) absolute control. Growth and yield attributes and yields were recorded plot-wise; fruit samples were collected periodically and at harvesting, stalk weight was recorded. Fruit and stalk samples from each plot were collected and analyzed for total N (Humphries,1956), P and K contents (Piper,1966) and uptake of N, P and K by hybrid brinjal was computed. Based on the initial soil test values, the fertilizer doses were calculated and applied (Table 1). Using the data of fertilizer doses applied and fruit yield, the per cent achievement, response ratio, and benefit-cost ratio (Gittinger,1982) were worked out.

## RESULTS AND DISCUSSION

### *Growth and yield attributes*

High growth and yield attributes were recorded in STCR-IPNS-60 t $ha^{-1}$ for plant height (141.7 cm) and the number of fruits per plant (37.4) which was comparable with STCR-NPK alone-60 t $ha^{-1}$ with the plant height of 137 cm and 36.9 number of fruits per plant, (Figure 1). Among the same yield targets, STCR-IPNS treatments recorded relatively higher values for all the growth and yield attributes than those under STCR-NPK alone. The growth and yield attribute recorded under the blanket (100% RDF), farmer's practice and absolute control was significantly lower than STCR treatments and blanket plus FYM @ 25 t $ha^{-1}$.

### *Fruit and stalk yield*

STCR-IPNS-60 t $ha^{-1}$ significantly increased the fruit yield (59.91 t $ha^{-1}$) as compared to blanket (100% RDF), blanket plus FYM@ 25 t $ha^{-1}$ and farmer's practice which has recorded 42.39, 52.63 and 45.83 t $ha^{-1}$, respectively (Table 1). Among STCR treatments, STCR-IPNS-60 t $ha^{-1}$ recorded numerically higher yield over their respective STCR-NPK alone treatments. STCR-IPNS-60 t $ha^{-1}$ significantly improved the fruit yield than all other STCR treatments except STCR-NPK alone- 60 t $ha^{-1}$ (58.12 t $ha^{-1}$). The increased yield of STCR-IPNS-60 t $ha^{-1}$ over the blanket (100% RDF), a blanket plus FYM@ 25 t $ha^{-1}$ and farmer's practice was 41.3, 13.3 and 30.7 per cent respectively. The highest stalk yield was recorded in STCR-IPNS-60 t $ha^{-1}$ (5.34 t $ha^{-1}$), which was comparable with STCR-NPK alone-60 t $ha^{-1}$ with a stalk yield of 5.12 t $ha^{-1}$ (Figure 1).

These results clearly elucidated the beneficial effect of STCR-IPNS treatments on the fruit and stalk yield of hybrid brinjal which might be due to meeting the immediate nutrient requirement of the crop through inorganic fertilizers in the early growth stages and continuous supply of nutrients throughout the crop growth period by the organic sources. These findings were supported by Vinod Kumar (2016) and Basavaraja *et al*.(2019).

**Table 1.Results of validation experiments on hybrid brinjal (Range and mean values of two locations)**

| S.No | Treatments | Fertiliser doses (kg ha$^{-1}$) | | | Mean fruit yield (t ha$^{-1}$) | Per cent achievement | RR (kg kg$^{-1}$) | BCR |
|---|---|---|---|---|---|---|---|---|
| | | FN | $FP_2O_5$ | $FK_2O$ | | | | |
| T1 | Blanket (100% RDF) | 200 | 100 | 150 | 42.39 | - | 57.51 | 2.84 |
| T2 | Blanket (100% RDF+FYM @ 25 t ha$^{-1}$) | 200 | 100 | 150 | 52.86 | - | 58.73 | 3.45 |
| T3 | STCR-NPK alone –Target I (50 t ha$^{-1}$) | 164-175 | 110-112 | 88-93 | 50.57 | 101.2 | 91.84 | 3.42 |
| T4 | STCR-NPK alone – Target II (55 t ha$^{-1}$) | 202-213 | 127-129 | 116-120 | 54.16 | 98.5 | 83.05 | 3.63 |
| T5 | STCR-NPK alone – Target III(60 t ha$^{-1}$) | 239-250 | 144-146 | 143-148 | 58.12 | 96.9 | 77.79 | 3.86 |
| T6 | STCR- IPNS–Target I (50 t ha$^{-1}$) | 100-109 | 65-67 | 38* | 51.66 | 103.3 | 93.12 | 3.46 |
| T7 | STCR- IPNS–Target II (55 t ha$^{-1}$) | 136-147 | 82-84 | 58-62 | 55.30 | 100.6 | 85.56 | 3.67 |
| T8 | STCR-IPNS–Target III(60 t ha$^{-1}$) | 173-184 | 99-101 | 85-90 | 59.91 | 99.9 | 81.13 | 3.94 |
| T9 | Farmer's Practice | 230 | 50 | 180 | 45.83 | - | 52.22 | 3.04 |
| T10 | Absolute Control | 0 | 0 | 0 | 18.24 | - | - | 1.29 |
| | | | SEd | | 1.78 | | | |
| | | | CD (P=0.05) | | 2.48 | | | |

*maintenance dose

| Soil available major nutrients (kg ha$^{-1}$) | | | DTPA extractable micro nutrients (mg kg$^{-1}$) | | |
|---|---|---|---|---|---|
| KMnO4-N | : | 215-227 | DTPA-Zn | : | 1.13-1.24 |
| Olsen-P | : | 19.5-20.3 | DTPA-Fe | : | 6.31-7.12 |
| NH4OAc-K | : | 268-275 | DTPA-Mn | : | 4.23-6.23 |
| | | | DTPA-Cu | : | 1.89-2.14 |

***Per cent achievement***

According to Velayutham *et al.*(1985), if the targeted yield was achieved within ± 10 per cent variation, then the equations are found to be

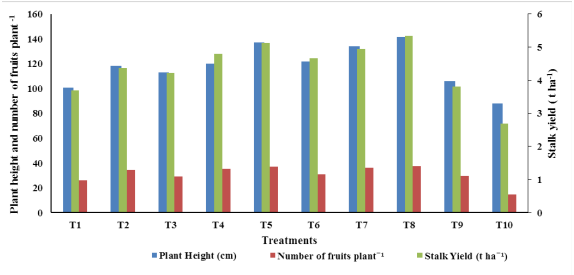



**Figure 1. influence of various treatments on growth and yield attributes of hybrid brinjal (Mean of two locations)**

valid. The results of the validation experiment on hybrid brinjal clearly indicated that the per cent achievement was within ± 10 per cent (90 - 110 %)

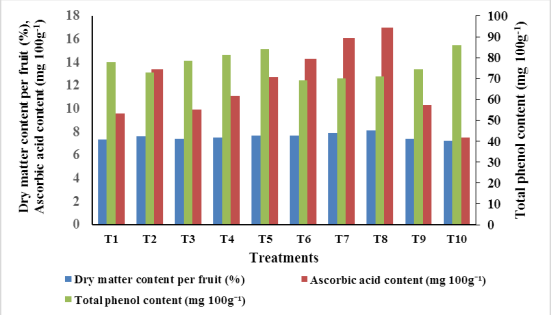



**Figure 2. influence of various treatments on quality parameters of hybrid brinjal (Mean of two locations)**

variation at all yield target levels proving the validity of the fertilizer prescription equations for hybrid brinjal (Table 1). The highest mean per cent achievement of the yield targets of both the locations was recorded with STCR-IPNS-50 t ha$^{-1}$ (103.3 %) followed by STCR-NPK alone- 50 t ha$^{-1}$ (101.2 %), STCR-IPNS-55 t ha$^{-1}$ (100.6 %) and STCR- IPNS-60 t ha$^{-1}$ (99.9%). It was evident from the data that lower yield targets (50 and 55 t ha$^{-1}$) were better achieved than higher yield target (60 t ha$^{-1}$) under both NPK alone and IPNS. Similar results were reported by Suresh and Santhi (2018) in maize and Dinesh (2015) in brinjal.

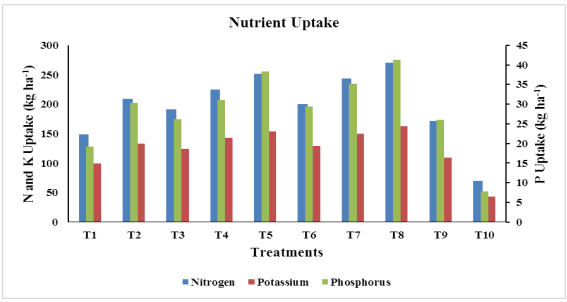



**Figure 3. Effect of various treatments on nutrient uptake of hybrid brinjal (Mean of two locations)**

***Response ratio (RR) and Benefit-Cost Ratio (BCR)***

Among the STCR treatments, STCR-IPNS recorded relatively higher RR than their corresponding NPK alone treatments (Table 1). Blanket (100% RDF) and blanket plus FYM@25 t ha$^{-1}$ recorded 57.51 and 58.73 kg kg$^{-1}$ respectively, which was lower

as compared to STCR-NPK alone and STCR-IPNS treatments for 50, 55 and 60 t $ha^{-1}$ yield targets. The increase in RR due to STCR-IPNS-60 t $ha^{-1}$ over the blanket (100% RDF alone), a blanket plus FYM @ 25 t $ha^{-1}$ and farmer's practice was 23.62, 22.40 and 28.91 kg $kg^{-1}$, respectively. Though the highest response ratio had been recorded in STCR-IPNS-50 t $ha^{-1}$, the highest BCR value was obtained in STCR-IPNS-60 t $ha^{-1}$ (3.94) followed by STCR-NPK alone-60 t $ha^{-1}$(3.86) (Table 1). Increase in BCR due to STCR-IPNS-60 t $ha^{-1}$ over the blanket (100% RDF alone), a blanket plus FYM @ 25 t $ha^{-1}$ and farmer's practice was 1.10, 0.49 and 0.90, respectively. Overall, STCR treatments recorded relatively higher yield, RR and BCR as compared to blanket recommendations and farmer's practice and the magnitude of increase were higher with STCR-IPNS. The differences in the BCR is attributed to yield differences and varying costs when organic manures were added. It is evident that organic manures (FYM) can be used in combination with inorganic fertilizers for more profitable income. A similar trend of the superiority of STCR-IPNS over farmer's practice was reported by Sharma *et al*. (2016).

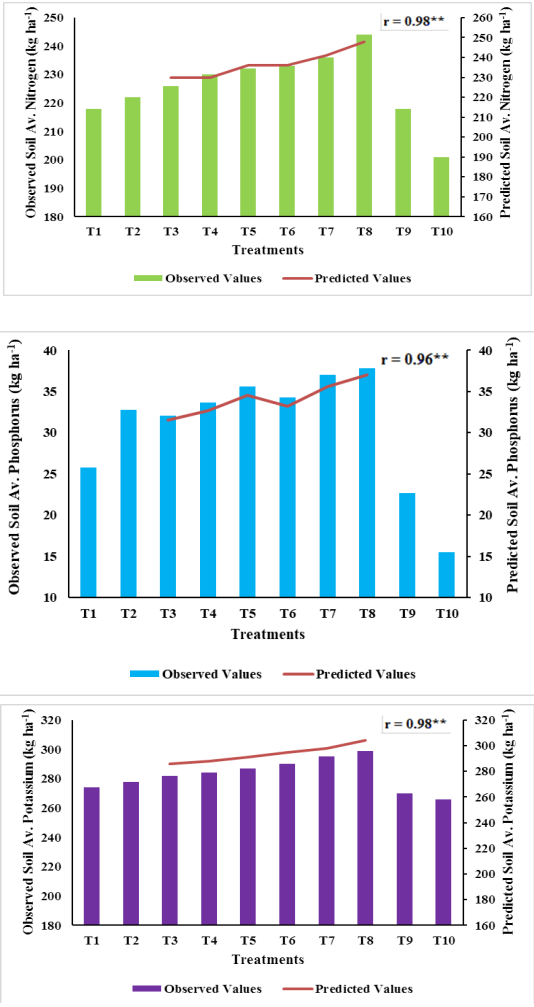
***Quality parameters of hybrid brinjal***

In the present investigation, in both the locations the results showed that STCR-IPNS- 60 t $ha^{-1}$, recorded higher values for quality parameters *viz.*, ascorbic acid (17.0 mg 100 $g^{-1}$) and dry matter content of fruit (8.11 %). The STCR-IPNS-50 t $ha^{-1}$ recorded the lowest phenol content (69.0 mg 100 $g^{-1}$) which was on par with STCR-IPNS-55 t $ha^{-1}$(70.0 mg 100 $g^{-1}$) and STCR-IPNS -60 t $ha^{-1}$ recorded relatively lower phenol content as compared to rest of the treatments (Figure 2). All the STCR-IPNS treatments recorded superior quality parameters as compared to all other treatments. Pappacha *et al.* (2015) reported that availability of nutrients is affected by the presence of anti-nutrients (*viz.,* oxalates, phytates, phenols, and tannins) and the findings of the present investigation is in line with Ugade *et al.* (2014) and Dhinesh(2015) in brinjal.

***Nutrient uptake by hybrid brinjal***

The data pertaining to nutrient uptake revealed that STCR-IPNS-60 t $ha^{-1}$ recorded the highest mean total N, P and K uptake of 269.8, 41.3 and 162.6 kg $ha^{-1}$), respectively and was found to be comparable with STCR-NPK alone-60 t $ha^{-1}$ with the uptake values of 251.7, 38.3 and 153.5 kg $ha^{-1}$, respectively (Figure 3).

All the STCR-IPNS treatments recorded higher uptake as compared to their corresponding STCR-NPK alone treatments. All the STCR treatments (except STCR-NPK alone-50 t $ha^{-1}$) proved to be superior to blanket treatments and farmer's practice. The increase in uptake of nutrients might be attributed to solubility action of organic acids produced during decomposition of FYM resulting in higher release of N, P and K from soil and also the contribution of nutrients from FYM which has




increased the yield over the resultant uptake by the crop (Dwivedi *et al*., 2016).

**Figure 4. Effect of STCR treatments on post-harvest soil fertility status (mean of two locations)**

***Post-harvest soil fertility status***

Post-harvest soil fertility status after hybrid brinjal was higher with STCR-IPNS-60 t $ha^{-1}$ (244, 37.8 and 299 kg $ha^{-1}$ of $KMnO_4$-N, Olsen-P and $NH_4OAc$-K) followed by STCR-IPNS-55 t $ha^{-1}$(236, 37.0 and 295 kg $ha^{-1}$ of $KMnO_4$-N, Olsen-P and $NH_4OAc$-K). A comparison made between the predicted PHSTVs using prediction equations developed after hybrid brinjal and observed PHSTVs estimated by lab analyses were in good agreement with each other proving the validity of the equations for use in the cropping sequence which was evidenced by highly significant 'r' values for available N, P and K respectively (0.98**, 0.96** and 0.98**) (Figure.4). Post-harvest soil test values clearly brought forth the fact that fertilization based on soil test resulted in a built-up of soil fertility and the magnitude of

built-up was higher with STCR-IPNS followed by STCR-NPK alone, blanket recommendations and farmer's practice. This improvement in soil fertility was attributed to the addition of FYM along with inorganic fertilizers which stimulated the growth and activity of microorganisms. They participate in the biological cycling of elements and transformation of the mineral compounds and thus increases the availability of nutrients in the soil. On the other hand, the depletion of soil available N, P, and K was noticed in absolute control. A similar trend of results was also observed by Uday Kumar (2017) on Inceptisol of Tamil Nadu.

## CONCLUSION

The research findings of the validation experiments clearly elucidated the fact that the per cent achievement of target yield at both the locations was within ± 10% variation proving the validity of the fertilizer prescription equations for hybrid brinjal. The fruit yield of hybrid brinjal indicated that STCR-IPNS based fertilizer dose for a yield target of 60 t $ha^{-1}$ was found to record significantly higher yield over all other treatments whereas farmer's practice, blanket (100% RDF) and absolute control recorded significantly lower yields. Among the treatments, STCR-IPNS recorded relatively higher benefit: cost ratio, per cent achievement, growth and yield attributes, and yield, superior quality parameters over other treatments. Post-harvest soil available N, P and K status indicated the built-up and sustenance of soil health due to soil test based fertilizer recommendations under IPNS. Hence, Fertiliser prescription equations developed for hybrid brinjal under the Integrated Plant Nutrition System for the Inceptisol can be recommended for the Visakhapatnam soil series (Typic Haplustept) of Andhra Pradesh for achieving higher yield with sustained soil health.

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