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Yield Targeting and Integrated Plant Nutrition System to Fix Critical Levels of Soil Available N, P and K for Hybrid Brinjal in Inceptisols of Andhra Pradesh

Chintada Kiran Kumar[1*], Kotla Geethanjali[2]
[1]Associate Professor, College of Horticulture, Dr. YSR Horticultural University, Parvathipuram, Andhra Pradesh, India
[2]Assistant Professor, College of Horticulture, Dr. YSR Horticultural University, Parvathipuram, Andhra Pradesh, India

***Abstract*: In order to maintain sustainable soil fertility for long run, the recommendations are made to apply sufficient fertilisers to meet both the nutrient requirements of the crop and to built-up the nutrient level in the soil to a critical soil test level over a scheduled time frame. Soil test level is sustained at, or above, the critical level by using fertiliser rates that should replace the nutrients removed by the crop. The critical level is the soil test level at which maximum yield is achieved. Critical soil test values for available N, P and K were low under IPNS treatments (NPK + FYM @ 25 t ha^{-1}) as compared to NPK alone which in turn resulted in saving of NPK fertilisers. Irrespective of treatments, higher yield targeting resulted in higher critical levels of nutrients in soil.**

***Keywords*: critical soil test values, STCR-IPNS, hybrid brinjal.**

1. Introduction

Crop nutrient requirements are mostly obtained through fertilisers. The total nutrient requirement of crop is considered to be the amount of nutrients supplied through nutrients and amount of nutrients available in soil to crop. In order to maintain sustainable soil fertility for long run, the recommendations are made to apply sufficient fertilisers to meet both the nutrient requirements of the crop and to built-up the nutrient level in the soil to a critical soil test level over a scheduled time frame. Soil test level is sustained at, or above, the critical level by using fertiliser rates that should replace the nutrients removed by the crop. The critical level is the soil test level at which maximum yield is achieved. It is based on yield response curves, which are obtained by result of years of research carried and trials conducted and specific to a particular soil, zone and climatic conditions prevailed. In such a curve, the percentage yield (of maximum) is drawn versus the soil test level for each nutrient.

Fertilizer prescriptions are being developed by employing various mathematical models. Targeted yield model is the one, which is unique in the sense that it provides means for soil test-based fertilizer doses and also for the computation of critical soil test values. These values are the soil test levels above which there would be no requirement of fertilizer application for indicated levels of crop yield. This would help in prescribing rationalized fertilizer doses and avoiding over or under usage of fertilizer inputs. Hence the present study was conducted during 2018-19 in Inceptisols to fix the critical soil test values for $KMnO_4$ -N, Olsen-P and NH_4OAc-K as influenced by yield targeting and Integrated Plant Nutrition System (IPNS) for hybrid brinjal using targeted yield model.

2. Materials and Methods

Targeted yield model comprises fertiliser prescription through soil test calibaration and provides a platform for fixing critical soil test values for available NPK for desired yield targets of crops. Critical soil test values are the soil test values above which there would be no requirement of fertiliser application for indicated levels of crop yield (Randhawa and Velayutham, 1982). Accordingly, in the present investigation, the critical soil test values of $KMnO_4$-N, Olsen-P and NH_4OAc-K were fixed for desired yield target of hybrid brinjal under NPK alone and IPNS.

In the present investigation, principal methodology was adopted to develop a quantitative relationship between different measured levels of any one component (eg. fertiliser nutrient) of a crop production system and yield obtained from that system. Therefore, test crop experiment was conducted with measured levels of fertiliser nutrients *viz*., N, P_2O_5 and K_2O with hybrid brinjal.

Treatment structure and experimental design as followed in AICRP - STCR was adopted. Treatment structure was designed in such ways that yield prediction and optimisation of fertiliser doses could be made by targeted yield model.

Treatment combinations and the levels of N, P_2O_5 and K_2O and farm yard manure (FYM) are furnished in Table 1 and lay out plan is given in Fig. 1. In test crop experiment, there were four levels of N, four levels of P_2O_5 and four levels of K_2O. For N, there were four treatments at zero level, four at first level (80 kg N ha^{-1}), nine at second level (160 kg ha^{-1}), and seven at third

*Corresponding author: chkkumar21@gmail.com

STRIP I		STRIP II		STRIP III		
$N_0P_0K_0$	$N_2P_3K_2$	$N_0P_0K_0$	$N_3P_2K_3$	$N_0P_0K_0$	$N2P_2K_1$	NPK alone OM I
$N_2P_2K_0$	$N_2P_1K_1$	$N_3P_2K_1$	$N_2P_2K_3$	$N_2P_3K_3$	$N_1P_1K_1$	
$N_3P_1K_1$ A	$N_1P_1K_2$	$N_2P_0K_2$ B	$N_1P_2K_1$	$N_0P_2K_2$ C	$N_2P_3K_3$	
$N_1P_2K_2$	$N_3P_3K_2$	$N_2P_2K_2$	$N_3P_3K_3$	$N_3P_2K_2$	$N_2P_1K_2$	
$N_0P_0K_0$	$N_3P_2K_3$	$N_0P_0K_0$	$N2P_2K_1$	$N_0P_0K_0$	$N_2P_3K_2$	NPK+ FYM @12.5 t ha^{-1} OM II
$N_3P_2K_1$ B	$N_2P_2K_3$	$N_2P_3K_3$ C	$N_1P_1K_1$	$N_2P_2K_0$ A	$N_2P_1K_1$	
$N_2P_0K_2$	$N_1P_2K_1$	$N_0P_2K_2$	$N_2P_3K_3$	$N_3P_1K_1$	$N_1P_1K_2$	
$N_2P_2K_2$	$N_3P_3K_3$	$N_3P_2K_2$	$N_2P_1K_2$	$N_1P_2K_2$	$N_3P_3K_2$	
$N_0P_0K_0$	$N2P_2K_1$	$N_0P_0K_0$	$N_2P_3K_2$	$N_0P_0K_0$	$N_3P_2K_3$	NPK+ FYM @25 t ha^{-1} OM III
$_2P_3K_3$ C	$N_1P_1K_1$	$N_2P_2K_0$ A	$N_2P_1K_1$	$N_3P_2K_1$ B	$N_2P_2K_3$	
$N_0P_2K_2$	$N_2P_3K_3$	$N_3P_1K_1$	$N_1P_1K_2$	$N_2P_0K_2$	$N_1P_2K_1$	
$N_3P_2K_2$	$N_2P_1K_2$	$N_1P_2K_2$	$N_3P_3K_2$	$N_2P_2K_2$	$N_3P_3K_3$	

Plot size: 9 x 3 m; Hybrid Brinjal, Spacing: 75 x 55 cm

1. $N_0P_0K_0$	5. $N_1P_1K_1$	9. $N_2P_1K_1$	18. $N_3P_1K_1$
2. $N_0P_0K_0$	6. $N_1P_2K_1$	10. $N_2P_0K_2$	19. $N_3P_2K_1$
3. $N_0P_0K_0$	7. $N_1P_1K_2$	11. $N_2P_1K_2$	20. $N_3P_2K_2$
4. $N_0P_2K_2$	8. $N_1P_2K_2$	12. $N_2P_2K_2$	21. $N_3P_3K_1$
		13. $N2P_2K_1$	22. $N_3P_3K_2$
		14. $N_2P_2K_0$	23. $N_3P_2K_3$
		15. $N_2P_2K_3$	24. $N_3P_3K_3$
		16. $N_2P_3K_2$	
		17. $N_2P_3K_3$	

Fig. 1. Layout plan of test crop experiment with hybrid brinjal

level (240 kg N ha^{-1}). For P_2O_5, there were four treatments at zero level, five at first level (40 kg P_2O_5 ha^{-1}), ten at second level (80 kg P_2O_5 kg ha^{-1}) and five at third level (120 kg P_2O_5 ha^{-1}). For K_2O, there were four treatments at zero level, seven at first level (60 kg K_2O ha^{-1}), nine treatments at second level (120 kg K_2O ha^{-1}) and four treatments at third level (180 kg K_2O ha^{-1}). Treatments were chosen so as to compute the response of each nutrient at different levels of application. IPNS treatments *viz*., NPK alone, NPK plus FYM @ 12.5 and 25 t ha^{-1} were superimposed across strips. There were 21 fertiliser treatments along with three controls which were randomised in each strip in such a way that all treatments occurred in both directions and Fractional Factorial Randomised Block Design was adopted.

After fertility gradients establishment in experimental field, in phase-II test crop experiment, each strip was divided into 24 plots. Before application of fertilisers and manures, initial soil samples were collected from each plot at 0 - 30 cm depth and analysed for available NPK. Straight fertilisers were used *viz.*, urea, single super phosphate and muriate of potash and fertiliser doses were imposed as per the treatments. Fifty per cent of N and whole of FYM, P_2O_5 and K_2O were applied basally as per the doses furnished in Table 2.

After basal application of FYM (with 25 % moisture, 0.73 %, 0.26 % and 0.60 % NPK respectively) and NPK fertilisers, 21 days old brinjal seedlings were transplanted with spacing of 55 cm x 75 cm with plot area 27 m2 (9 m x 3 m) and remaining 50 per cent of N was applied as band placement near plant root zone at 30 days after transplanting. Standard intercultural operations and package of practices were followed as per approved recommendations of Dr. YSRHU, Andhra Pradesh. At maturity, plot wise fruit yield was recorded periodically (30-45 pickings) and stalk weight was recorded at end of growing period. Fruit, plant and post-harvest soil samples were collected from each plot and processed for further analysis.

A. Critical Soil Test Levels for Hybrid Brinjal

Making use of the fertiliser doses computed for desired yield target of hybrid brinjal for a range of soil test values, the critical soil test levels for available N, P and K were fixed. For 50 t ha^{-1} yield target, the critical levels of soil available N, P and K were 403, 57.2 and 404 kg ha^{-1} under NPK alone; 331,17 and 346 kg ha^{-1} for NPK plus FYM @ 25 t ha^{-1}. Similarly, critical soil test levels for 55 and 60 t ha^{-1} yield target of hybrid brinjal are furnished in Table 3. The results showed that IPNS resulted in relatively low critical soil test levels when compared to NPK alone.

According to Randhawa and Velayutham (1982), critical soil test values are the soil test values above which there would be no requirement of fertiliser application for indicated levels of crop yield. Targeted yield model which encompasses fertiliser prescription through soil test calibration provides a platform for fixing the critical soil test values for available N, P and K for

desired yield targets of crops.

Table 1
Treatment structure for the test crop experiment on hybrid brinjal

S.No.	Treatment combinations			Levels of nutrients (kg ha^{-1})		
	N	P	K	N	P_2O_5	K_2O
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	0	0	0
4	0	2	2	0	80	120
5	1	1	1	80	40	60
6	1	2	1	80	80	60
7	1	1	2	80	40	120
8	1	2	2	80	80	120
9	2	1	1	160	40	60
10	2	0	2	160	0	120
11	2	1	2	160	40	120
12	2	2	2	160	80	120
13	2	2	1	160	80	60
14	2	2	0	160	80	0
15	2	2	3	160	80	180
16	2	3	2	160	120	120
17	2	3	3	160	120	180
18	3	1	1	240	40	60
19	3	2	1	240	80	60
20	3	2	2	240	80	120
21	3	3	1	240	120	60
22	3	3	2	240	120	120
23	3	2	3	240	80	180
24	3	3	3	240	120	180

Levels of fertiliser nutrients and FYM for brinjal

Level	N (kg ha^{-1})	P_2O_5 (kg ha^{-1})	K_2O (kg ha^{-1})	FYM (t ha^{-1})
0	0	0	0	0
1	80	40	60	12.50
2	160	80	120	25.00
3	240	120	180	-

Table 2
Doses of fertiliser N, P_2O_5 and K_2O applied to the gradient crop of fodder maize

Strip	Levels of Nutrients			Fertilizer doses (kg ha^{-1})		
	N	P_2O_5	K_2O	N	P_2O_5	K_2O
I	N_0	P_0	K_0	0	0	0
II	N_1*	P_1**	K_1**	200	229	96
III	N_2	P_2	K_2	400	458	192

* N_1: As per blanket recommendation
** P_1 and K_1: As per P and K fixing capacities of the experimental field

In present investigation, the results revealed that critical soil test values for available N, P and K were low under IPNS (NPK + FYM @ 25 t ha^{-1}) as compared to NPK alone for hybrid brinjal which in turn resulted in saving of NPK fertilisers. Irrespective of treatments, higher yield targeting resulted in higher critical levels of nutrients in the soil. The reduction of fertiliser N, P_2O_5 and K_2O requirements under IPNS would have led to attaining the critical levels well in advance as compared to that of NPK alone. The findings emanated from the present investigation were in agreement with Coumaravel (2012), Smitha John *et al.* (2005) on Inceptisol, Dhinesh and Santhi (2016) on Alfisol, Udaykumar and Santhi (2017) for pearl millet on Inceptisol, Suresh and Santhi (2018) for maize on Vertisol.

Therefore, in the present investigation, using targeted yield model, fertilizer prescriptions under IPNS were developed for hybrid brinjal on Visakhapatnam soil series (Typic Haplustept) which is site specific.

Table 3
Critical soil available N, P and K levels for hybrid brinjal under NPK alone and IPNS for various yield targets

Treatments	NPK alone			IPNS (NPK+ FYM @ 25t ha^{-1})		
	SN	SP	SK	SN	SP	SK
	kg ha^{-1}					
50 t ha^{-1}	403	57.2	404	331	17	346
55 t ha^{-1}	444	63.0	445	372	23	387
60 t ha^{-1}	484	68.7	485	412	29	427

3. Conclusion

Critical soil test values for available N, P and K were low under IPNS treatments (NPK + FYM @ 25 t ha^{-1}) as compared to NPK alone which in turn resulted in saving of NPK fertilisers. Irrespective of treatments, higher yield targeting resulted in higher critical levels of nutrients in soil.

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