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Soil test based fertilizer recommendation under IPNS for aggregatum onion in Inceptisols of Tamil Nadu

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Abstract

Soil Test Crop Response (STCR) correlation studies were conducted with aggregatum onion in red non-calcareous soils (Typic Ustropepts) of Coimbatore and fertilizer prescription equations under Integrated Plant Nutrition System (IPNS) were developed. A ready reckoner of fertilizer doses at varying soil test values for attaining 17 and 20 t ha^{-1} target bulb yield of onion has been worked out. Using these equations, test verification trials were conducted on farmer's holding in Coimbatore district The per cent achievement of the targets aimed was more than 90 indicating the validity of the equations for prescribing fertilizer doses for onion. The STCR treatments recorded relatively higher response ratio (RR) and benefit - cost ratio (BCR) over blanket and farmer's practice and STCR-IPNS treatments recorded relatively higher RR and BCR over STCR-NPK alone treatments. Post-harvest soil tests for NPK revealed that there was maintenance of soil fertility.

Additional key words : Soil fertility, integrated nutrient management.

Introduction

Soil test based fertilizer recommendation plays a vital role in ensuring balanced nutrition to crops and fertilizer schedules should therefore be based on the magnitude of crop response to applied nutrients at different soil fertility levels. Based on this concept, soil test crop response studies were undertaken in different parts of India for different crops (Rao and Srivastava, 2000). Research work done on the nutrient management of vegetable crops showed that they respond to nutrients added through organics, bio and chemical fertilizers. Hence, Integrated Plant Nutrition System (IPNS) is a pre-requisite for achieving continuous advances in biological productivity of the vegetable crops in an ecologically and economically sound manner.

Onion is one of the important commercial bulb vegetable crops grown in India accounting for 16 per cent of the world area and 12 per cent of the world output of onions. Tamil Nadu contributes about 8.86 and 8.19 per cent of India's onion growing area and production, respectively. In Tamil Nadu, onion is being cultivated in an area of about 28,488 ha with a production of 2,94,270 metric tonnes with an average productivity of 10.3 t ha^{-1}. Hence, in order to step up the productivity of onion, soil test based balanced fertilization is essential.

Currently, a general recommendation of 60:60:30 kg N, P_2O_5, and K_2O ha^{-1}, respectively is being followed along with FYM @ 25 t ha^{-1}. Fertilization based on blanket recommendation results in either over use or under use of fertilizers, so balanced fertilization is a must for realising higher efficiency and economy of fertilizer use (Velayutham and Reddy 1990). It demands the maintenance of optimum balance between all essential nutrients, as per the crop requirements of nutrients and their availability in soil and possible recycling of organic sources. In fertilizing the crop the existing soil fertility and crop requirements should be taken in to account. Such studies are possible only through Inductive cum Targeted yield concept (Ramamoorthy *et al.* 1967).

Materials and methods

To suggest soil test based balanced fertilization for onion, fertilizer prescription equations under IPNS were developed for Inceptisols (Typic Ustropepts) of Coimbatore district during 1998-99 following the Inductive cum Targeted yield model of Ramamoorthy *et al.* (1967)

$$FN = 0.98\ T - 0.37\ SN - 0.58\ ON$$

$$FP_2O_5 = 0.58T - 1.43\ SP - 0.69\ OP$$

$$FK_2O = 0.67\ T - 0.25\ SK - 0.44\ OK$$

Where, FN, FP_2O_5 and FK_2O are fertilizer N, P_2O_5 and K_2O in kg ha^{-1}, respectively; T=fresh bulb yield target in q ha^{-1}; SN, SP and SK are alkaline $KMnO_4$-N, Olsen-P and NH_4OAc-K in kg ha^{-1} respectively; ON, OP and OK are N, P and K supplied through FYM+Azospirillum.

These equations were test verified with a view to demonstrate the validity of fertilizer prescription equations under IPNS developed for onion in Inceptisols of Coimbatore district by conducting verification trials in farmer's fields and to suggest the target yield that gives the highest Benefit Cost Ratio (BCR) and Response Ratio (RR) to the farmers in that region. There were six treatments replicated four times in a randomized block design. Based on the initial soil tests and the yield targets aimed at, fertilizer N, P_2O_5 and K_2O doses were applied for STCR treatments. FYM @ 25 t ha^{-1} and Azospirillum @ 2 kg ha^{-1} were applied for STCR-IPNS treatments. 50% N, full P_2O_5 and K_2O were applied basally and routine agronomic practices were carried out periodically. 50% of N was top dressed on 30th day after planting. The crop was grown to maturity and bulb yields were recorded. Plant and bulb samples were collected and analysed for N, P and K contents and uptake values were computed. Using the data on bulb yield, fertilizer doses applied and cost of fertilizer inputs and produce, the parameters viz., Response Ratio (RR) and Benefit -Cost Ratio (BCR) were worked out (Response Ratio=Response in kg ha^{-1}/Quantities of fertiliser N,

P_2O_5 and K_2O applied in kg ha^{-1}; Benefit-Cost Ratio=Cost of additional seed yield over control/Cost of fertiliser N, P_2O_5 and K_2O applied). The treatment details, fertilizer doses applied and the results are furnished in Tables 1 to 6.

Post-harvest soil samples were also collected and analysed for available N (Subbaiah and Asija 1956), available P (Olsen *et al.* 1954) and available K (Hanway and Heidal 1952) status.

Table 1. Effect of soil test based fertilization under IPNS for onion (Mean of four trials)

Sr. No. Treatments	Fertiliser doses applied (kg ha^{-1}) Range values N	P_2O_5	K_2O	Mean fresh bulb yield (kg ha^{-1})	Mean % achieve-ment	Mean RR (kg kg^{-1})	Mean BCR
1. Blanket	60	60	30	17110	–	62.5	13.3
2. 17 t ha^{-1}–NPK alone	81-95	15-27	15-59	17244	101.4	74.4	22.3
3. 20 t ha^{-1}–NPK alone	109-123	27-43	15-78	18750	93.8	62.7	18.2
4. 17 t ha^{-1}–IPNS	29-43	11-15	8-32	17724	104.3	78.0	23.9
5. 20 t ha^{-1}–IPNS	57-71	15-27	8-51	19481	97.4	67.1	19.6
6. Farmer's practice	80	80	60	17100	–	42.7	9.8
SE_d				307			
CD (5%)				654			

Initial Soil Test Values (kg ha^{-1})			Fertilizer prescription equations	
$KMnO_4$–N	:	196-235	FN	= 0.98T-0.37SN-0.58 ON
Olsen–P	:	51-62	FP_2O_5	= 0.58T-1.43 SP-0.69 OP
NH_4OAc–K	:	220-680	FK_2O	= 0.67T-0.25 SK-0.44 OK

Results and discussion

Bulb yield of onion: The mean bulb yield of onion recorded at the four locations are furnished in Table 1. In all the locations, the highest bulb yield was recorded with 20 t ha^{-1}-IPNS treatment which was significantly higher than all other treatments followed by 20 t ha^{-1}-NPK alone, 17 t ha^{-1}-IPNS and 17 t ha^{-1}-NPK alone. The bulb yields recorded under STCR treatments were significantly higher than that under blanket and farmer's practice (Tables 2-5). The bulb yields ranged from 17110 kg ha^{-1} in farmer's practice to 19481 kg ha^{-1} in 20 t ha^{-1} - IPNS treatment recording an

increase of 13.9 per cent over farmer's practice (Table 1). The favourable influence of organics, inorganics and biofertilizers on chemical, physical and biological properties of soils under IPNS would have resulted in such higher bulb yields of onion (Gupta *et al.* 1999). The NPK uptake also followed the same trend as that of bulb yield (Table 2-5).

Table 2. Mean bulb yield, uptake and post-harvest soil test values

Location : Theethipalayam-I Year : 2000-2001

S. No.	Treatments	Mean bulb yield	N uptake	P upake	K uptake	SN	SP	SK
			(kg ha^{-1})					
1.	Blanket	17370	63.29	28.14	64.34	230	60	686
2.	17 t ha^{-1}–NPK	17615	64.18	29.20	66.82	230	64	682
3.	20 t ha^{-1}–NPK	18060	66.20	29.68	68.14	232	64	680
4.	17 t ha^{-1}–IPNS	17760	65.98	30.54	67.26	238	66	398
5.	20 t ha^{-1}–IPNS	19145	70.65	31.92	71.92	244	64	710
6.	Farmer's Practice	17430	64.10	29.08	65.28	238	62	680
SE_d		179	0.97	0.65	0.72	3	NS	5
CD (5%)		382	2.07	1.39	1.54	7		10

Table 3. Mean bulb yield, uptake and post-harvest soil test values

Location : Theethipalayam-II Year : 2000-2001

S. No.	Treatments	Mean bulb yield	N uptake	P upake	K uptake	SN	SP	SK
			(kg ha^{-1})					
1.	Blanket	17170	62.18	26.12	63.10	210	58	578
2.	17 t ha^{-1}–NPK	17200	63.69	27.20	63.86	214	62	575
3.	20 t ha^{-1}–NPK	18000	66.34	27.54	67.92	218	58	580
4.	17 t ha^{-1}–IPNS	17685	64.46	28.88	66.46	216	64	582
5.	20 t ha^{-1}–IPNS	19030	70.14	30.86	70.86	220	66	584
6.	Farmer's Practice	17190	63.46	26.95	63.35	214	60	575
SEd		206	NS	0.75	0.69			
CD (5%)		439		1.6	1.47	NS	NS	NS

Per cent achievement : The highest per cent achievement of the yield targets aimed at were recorded with targeting for 17 t ha^{-1} bulb yield (101.4-104.3). Yield targeting with IPNS recorded relatively higher per cent achievement than that aimed under NPK alone (Table 1). The per cent achievement of the targets aimed was more than 90 and it exceeded 100 for 17 t ha^{-1} yield target under NPK alone and IPNS indicating the validity of the equations for prescribing fertilizer doses for onion.

Response ratio (RR) : The mean RR recorded (Table 1) for various treatments ranged from 42.7 in farmer's practice to 78.0 in 17 t ha^{-1} - IPNS. Among the two targets tried, targeting for 17 t ha^{-1} recorded relatively higher RR than with 20 t ha^{-1} though it has recorded significantly higher yields. This might be due to the better use efficiency of applied NPK fertilizers at low yield target levels. Likewise, IPNS treatments recorded higher RR when compared to their respective NPK alone treatments. Blanket recorded 62.5 RR which is lower than STCR treatments. The relatively higher RR recorded under STCR and IPNS treatments when compared to blanket, might be due to balanced supply of nutrients from fertilizer, efficient utilization of applied fertilizer nutrients in the presence of organic sources and the synergistic effect of the conjoint addition of various sources of nutrients (Rao and Srivastava 2000).

Table 4. Mean bulb yield, uptake and post-harvest soil test values

Location : Theethipalayam-III Year : 2000-2001

S. No.	Treatments	Mean bulb yield	N uptake	P upake	K uptake	SN	SP	SK
			(kg ha^{-1})					
1.	Blanket	17170	61.56	27.28	63.86	205	56	550
2.	17 t ha^{-1}–NPK	17160	63.49	27.60	64.72	210	64	560
3.	20 t ha^{-1}–NPK	19540	70.34	29.42	71.62	214	60	556
4.	17 t ha^{-1}–IPNS	17800	65.86	28.76	66.98	205	68	565
5.	20 t ha^{-1}–IPNS	19950	71.82	31.96	72.60	212	70	570
6.	Farmer's Practice	16900	60.84	26.22	61.58	205	60	560
SE_d		78	1.12	0.77	0.77		3.6	11.6
CD (5%)		167	2.39	1.64	1.63	NS	7.7	24.8

Benefit - Cost Ratio (BCR) : The mean BCR ranged from 9.8 in farmer's practice to 23.9 in 17 t ha^{-1} -IPNS and the trend of results are similar as that of RR. Among the targets aimed, 17 t ha^{-1} recorded higher BCR over 20 t ha^{-1}. When NPK alone and IPNS were compared, IPNS treatments recorded higher BCR (Table 1). In STCR-

IPNS technology, the amounts of fertiliser nutrients that are to be applied to obtain any pre-set yield levels are adjusted for the amount of nutrients present in the soil and organic/bio-fertilizers.

Table 5. Mean bulb yield, uptake and post-harvest soil test values

Location : Chellappagoundanpudur Year : 2000-2001

S. No.	Treatments	Mean bulb yield	N uptake	P upake	K uptake	SN	SP	SK
			(kg ha^{-1})					
1.	Blanket	16800	61.74	26.71	63.26	192	54	220
2.	17 t ha^{-1}–NPK	17000	62.48	27.35	63.46	205	54	222
3.	20 t ha^{-1}–NPK	19400	70.20	29.70	70.80	212	56	220
4.	17 t ha^{-1}–IPNS	17650	65.31	28.48	65.99	220	50	230
5.	20 t ha^{-1}–IPNS	19800	73.26	31.50	71.84	224	56	236
6.	Farmer's Practice	16700	61.79	25.56	60.58	190	50	222
SE_d		149	1.24	0.68	0.72	4.9		3.5
CD (5%)		318	2.64	1.45	1.53	10.5	NS	7.5

Table 6. Soil test based fertilizer recommendations for various yield targets of onion

S. No.	Soil Test Values (kg ha^{-1}) SN	SP	SK	Yield targets (t ha^{-1}) 17 t ha^{-1} of fresh bulb FN	FP_2O_5	FK_2O	20 t ha^{-1} of fresh bulb FN	FP_2O_5	FK_2O
1.	160	10	200	109	85	64	137	102	83
2.	180	12	220	101	83	59	129	100	78
3.	200	14	240	94	80	54	122	97	73
4.	220	16	260	87	77	49	115	94	68
5.	240	18	280	79	74	44	107	91	63
6.	260	20	300	72	71	39	100	88	58
7.	280	22	320	64	68	34	92	85	53
8.	300	24	340	57	65	29	85	82	48

Note : When FYM@ 25 t ha^{-1} with 10,0.90,0.31 and 0.83% of moisture, N, P and K, respectively is applied 36,15 and 27 kg of N, P_2O_5 and K_2O ha^{-1} could be reduced from the recommended dose of fertilizer; 12 kg ha^{-1} of fertilizer N could be reduced when Azospirillum is applied @ 2 kg ha^{-1}; when FYM and Azospirillum are applied jointly, 52,16 and 27 kg ha^{-1} of N, P_2O_5 and K_2O could be reduced from the recommended dose of fertilizers.

On account of this adjustment, there is a reduction in the quantity of the nutrients that are to be supplied through fertilizers (Selvakumari *et al.* 2000).

Post-harvest soil fertility : The data on $KMnO_4$-N, Olsen-P and NH_4OAc-K 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 at higher level in IPNS as compared to NPK alone (Tables 2-5). This might be attributed to the prevention of losses of nutrients under IPNS, even after meeting the crop needs. The findings of Pachauri and Vinay Singh (2001) support the results recorded in the present study.

It is concluded that for obtaining aimed yield targets and profits with sustenance of soil fertility in Inceptisols, soil test based fertilizer recommendation under IPNS could be followed for aggregatum onion (Table 6).

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