Effect of Soil Test Crop Response Approach on Growth and Yield of Rabi Onion in Inceptisols

Abstract

A field experiment of fertilizer equation validation was carried out during *Rabi* season of 2022-23 under AICRP on STCR farm, PGI farm and AICRP on IWM farm, MPKV, Rahuri to find out the effect of STCR target equation on growth and yield of *Rabi* onion. The experiment was laid out in randomized block design with ten treatment combinations *viz*. Absolute Control, GRDF, As per Soil Test, STCRC target for 250 qt ha^{-1} without vermicompost, STCRC target for 300 qt ha^{-1} without vermicompost, STCRC target for 350 qt ha^{-1} without vermicompost + Biofertilizer, STCRC target for 250 qt ha^{-1} with vermicompost, STCRC target for 300 qt ha^{-1} with vermicompost, STCRC target for 300 qt ha^{-1} with vermicompost + Biofertilizer, Only 5 t ha^{-1} vermicompost. The research findings revealed that treatment T_9 resulted in a significantly higher number of leaves (8.56 and 11.52) at 40 and 80 DAT, height of crop (42.00 and 57.46 cm) at 40 and 80 DAT, Chlorophyll (41.30 and 51.84) at 45 and 60 DAT, polar and eqatorial diatmeter (6.36 and 9.48 cm), neck girth (4.94 cm) and bulb weight (64.09 gm). Similarly the cttreatment T_9 were achieved significantly superior bulb yield (363.67 q ha^{-1}) with per cent deviation 3.90 % and tops yield (67.18 q ha^{-1}).

Keywords: *STCR, Height, Chlorophyll, Neck Girth, Polar and Equatorial Diameter.*

1. Introduction

'Targeted yield model' is one of the practical approach for efficient use fertilizers. Theory of formulating optimum fertilizer recommendations for targeted yields was first given by [1] Troug which was further modified by [2] Ramamoorthy as 'Inductive-cum targeted yield model'. Addition of Integrated Plant Nutrition System (IPNS) to this concept ensures balanced fertilization by application of inorganic and organic sources of nutrients.

Onion (*Allium cepa*), belonging to the Alliaceae family portrayed as "Queen of the kitchen" is one of the most important commercial bulb vegetable. India is the second-largest producer next to China with cultivating area, production and productivity of 1.65 million hectares, 27.00 million metric tonnes and 18.3 MT ha^{-1}, respectively [3].

Maharashtra stands as the foremost state in both area coverage and production of onions among the different states. Other significant onion-growing states include Gujarat, Karnataka, Odisha, Uttar Pradesh, Andhra Pradesh, Tamil Nadu, and Rajasthan. Maharashtra ranks 1st in onion production with a share of 28.32 per cent in terms of productivity. The principal onion growing districts in the Maharashtra State are Nashik, Satara, Jalgaon, Pune, Solapur and Ahmednagar occupying about 94.68 per cent of area under cultivation of onion in the State.

Vermicompost, created through the earthworm's digestion of organic waste, stands as a rich repository of macro and micronutrients, plant growth regulators, vitamins, and beneficial microflora. This organic resource is hailed for its ability to sustain soil fertility in an environmentally friendly manner,

Comment [N1]: Not necessary in abstract
Comment [N2]: ?
Comment [N3]: STCR or STCRC: write full form
Comment [N4]: q
Comment [N5]: q
Comment [N6]: q
Comment [N7]: q
Comment [N8]: What is T_9?
Comment [N9]: Full form
Comment [N10]: ??
Comment [N11]: ?
Comment [N12]: Not a keyword
Comment [N13]: ?
Comment [N14]: of fertilizers
Comment [N15]: Trough [1]
Comment [N16]: Same as N2
Comment [N17]: production
Comment [N18]: delete

contributing to a more eco-friendly environment [4]. In contrast to inorganic fertilizers, vermicompost is viewed as a superior alternative due to its diverse microbial populations and richness in microbial and enzyme activities, greatly impacting the growth of various plants [5], [6].

Biofertilizers, another sustainable and cost-effective option, contain live microorganisms that enhance organic matter content, enrich soil fertility in cultivable lands, and aid in the conservation and mobilization of plant nutrients within the soil [7]. These eco-friendly alternatives, recognized for their affordability and effectiveness, are gaining prominence in crop production, serving as a supplement to organic matter to convert insoluble nutrients into a soluble and accessible form [8]. While organic manures carry nutrients in smaller quantities compared to chemical fertilizers, they also contain growth-promoting elements like enzymes and hormones, contributing not only to improved soil fertility and productivity but also to overall plant growth.In the future, the adoption of organic manures and biofertilizers to fulfill crop nutrient needs will become an essential practice for sustainable agriculture.

Comment [N19]: how biofertilizers enhance organic matter content??

Comment [N20]: ??

Comment [N21]: Space

xxx

Comment [N22]: What is the objective of the study???

2. Material and Method

The present STCR validation experiments were carried out in STCR farm, PGI field and AICRP on IWM field, MPKV Rahuri during the *rabi* season 2022-23. The experiment was laid out in uniform and nearly levelled land with medium deep black soil belongs to order Inceptisols. The soil having slightly alkaline, low in nitrogen and phosphorus and high in potassium which described in table 1.

Comment [N23]: ??

Comment [N24]: Write full form

Comment [N25]: belonging

Comment [N26]: was

Table 1. Initial Soil properties of all three locations

Comment [N27]: the experimental sites

Sr.No.	Particulars	AICRP on STCR	PGI	AICRP on IWM
1	pH (1:2.5)	8.03	7.92	7.87
2	EC (1:2.5) (d S m^{-1})	0.19	0.17	0.20
3	Organic Carbon (%)	0.56	0.50	0.53
4	Available N (kg ha^{-1})	169	158	201
5	Available P (kg ha^{-1})	14	10	14
6	Available K (kg ha^{-1})	437	414	426

The STCR equation on *rabi* onion (Variety- N: 2-4-1) was derived by test crop trial and given below;

Comment [N28]: as

i) STCR yield target equation without vermicompost

FN= (0.83 x T) – (0.65 x SN)

FP_0O_5 = (0.41 x T) – (3.21 x SP)

FK_2O = (0.45 x T) – (0.18 x SK)

ii) STCR yield target equation with vermicompost (5 t ha^{-1})

FN= (0.65 x T) – (0.51 x SN – 5.05 VC)

FP_0O_5 = (0.39 x T) – (3.06 x SP – 5.22 VC)

FK_2O = (0.38 x T) – (0.15 x SK – 4.04 VC)

iii) STCR yield target equation with vermicompost (5 t ha^{-1}) and Biofertilizer (*Azospirullum* and *PSB*)

FN= (0.63 x T) – (0.49 x SN – 6.57 VC)

FP_0O_5 = (0.27 x T) – (2.13 SP – 5.00 VC)

$FK_2O = (0.36 \times T) – (0.15 \times SK – 5.49\ VC)$

Where, F and S indicate fertilizer and soil nutrients, respectively (kg ha^{-1}), t indicates yield target (t ha^{-1}) , VC indicates vermicompost (t ha^{-1}), VC + BF indicates vermicompost (t ha^{-1}) + Biofertilizer.

These relationships were further used to compute fertilizer dose for different yield targets of *rabi* onion and varying soil test values.

The experiment was laid out in randomized block design with three replications. The treatments comprised with ten treatments such as T_1-Absolute Control, T_2- GRDF, T_3- As per Soil Test, T_4 -STCRC target for 250 qt ha^{-1} without vermicompost, T_5-STCRC target for 300 qt ha^{-1} without vermicompost, T_6-STCRC target for 350 qt ha^{-1} without vermicompost + Biofertilizer, T_7- STCRC target for 250 qt ha^{-1} with vermicompost, T_8- STCRC target for 300 qt ha^{-1} with vermicompost, T_9- STCRC target for 300 qt ha^{-1} with vermicompost + Biofertilizer, T_{10}- Only 5 t ha^{-1} vermicompost. The observations were recorded such as number of leaves, plant height, chlorophyll, polar diameter, equatorial diameter, neck girth, bulb and straw yield. The data were analyzed statistically and results were interpreted by using methods suggested by [9] Panse and Sukhatme.

Comment [N29]: q

Comment [N30]: q

Comment [N31]: Panse and Sukhatme [9]

3. Result and Discussion

3.1 Effect of Prescription Based Fertilizer Application on number of leaves on Onion Crop

Data pertaining to the number of leaves on onion crop as influenced by different treatments during *rabi* season, 2022-23 are presented in Table 2. The data in respect to number of leaves at 40 and 80 DAT on onion crop were influenced significantly with the different nutrient management treatments.

The number of leaves on an onion plant is important for assessing plant health and growth. Too few leaves may indicate nutrient deficiencies, disease, or other stressors that can affect plant development and yield. Conversely, an excessive number of leaves may lead to overcrowding and competition for resources, which can also impact plant growth and bulb development. Those treatments having organic source such as vermicompost, FYM and biofertilizer applied were observed the relatively higher number of leaves.

Comment [N32]: ?

Table 2. Effect of Prescription Based Fertilizer Application on Number of Leaves of Onion Crop

Tr. No	Treatment details	AICRP on STCR	PG Farm	AICRP on IWM	Pooled	AICRP on STCR	PG Farm	AICRP on IWM	Pooled
		40 DAT				80 DAT			
T_1	Absolute Control	4.90	4.00	4.10	4.33	8.10	7.20	7.60	7.63
T_2	GRDF 100: 50: 50 N P_2O_5 K_2O Kg ha^{-1} + FYM 25 t ha^{-1}	6.40	4.70	5.16	5.42	9.24	7.65	8.14	8.34
T_3	As Per Soil Test	7.20	6.19	6.66	6.68	10.00	8.10	9.37	9.15
T_4	STCR Target 250 q ha^{-1} without Vermicompost	7.00	5.64	6.14	6.26	9.71	7.79	8.46	8.65

Comment [N33]: Pooled or mean

Comment [N34]: Pooled or mean

T_5	STCR Target 300 q ha^{-1} without Vermicompost	7.50	6.29	6.75	6.85	10.20	8.39	9.60	9.40
T_6	STCR Target 350 q ha^{-1} without Vermicompost + Biofertilizer	8.53	7.26	7.98	7.92	11.57	9.81	10.98	10.79
T_7	STCR Target 250 q ha^{-1} with 5 t ha^{-1} Vermicompost	6.60	5.49	5.90	6.00	9.87	7.90	9.00	8.92
T_8	STCR Target 300 q ha^{-1} with 5 t ha^{-1} Vermicompost	8.00	7.10	7.55	7.55	10.95	9.20	10.57	10.24
T_9	STCR Target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer	9.10	7.73	8.87	8.56	12.38	10.30	11.87	11.52
T_{10}	Only Vermicompost 5 t ha^{-1}	5.98	4.38	4.97	5.11	8.90	7.46	8.00	8.12
	SE m (±)	0.41	0.34	0.40	0.20	0.59	0.53	0.58	0.29
	CD @ 5%	1.21	1.01	1.19	0.56	1.75	1.58	1.71	0.82

The pooled data of number of leaves at 40 DAT were ranges 4.33 – 8.56; the treatment absolute control showed the significantly lower number of leaves and treatment T_9- STCR Target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer was significantly highest number of leaves. The increased leaf count may stem from heightened metabolic rates, likely fuelled by the richer pool of macro and micro nutrients derived from vermicompost and biofertilizer. This, in turn, leads to elevated synthesis of carbohydrates and phytohormones, culminating in augmented growth, as elucidated by [10] Gebremichael *et al*.

Similarly at 80 DAT, the treatment T_9- STCR target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer (11.52) was observed significantly higher number of leaves. Plants from the control treatments tended to be stunted, grow slowly, and produce fewer leaves than fertilized plots *i.e*. number of leaves *i.e.*7.63 was observed at 80 DAT. Similar increase in number of leaves on onion with combined application of vermicompost and biofertilizer was observed by [11] Solanki *et al.* and [12] Vedpathak and Chavan.

3.2 Effect of Prescription Based Fertilizer Application on Height (cm) of Onion Crop

Data presenting to the height (cm) of onion crop as influenced by different treatments during *rabi* season, 2022-23 are presented in Table 3. The data in respect to height (cm) of onion crop at 40 and 80 DAT were influenced significantly with the different nutrient management treatments.

Comment [N35]: delete

Comment [N36]: ?

Comment [N37]: was observed significantly higher number of leaves (11.52).

Comment [N38]: delete,

Comment [N39]: (7.63)

Comment [N40]: delete

Comment [N41]: delete

Comment [N42]: delete

The crop height is the important growth parameters because it indicates photosynthesis, chlorophyll and overall health of plant. Also they directly involve in vegetative and reproductive growth of crop.

Comment [N43]: plant

Comment [N44]: an

Comment [N45]: ?

Comment [N46]: rewrite

Table 3. Effect of Prescription Based Fertilizer Application on Height (cm) of Onion Crop

Tr. No	Treatment details	AICRP on STCR	PG Farm	AICRP on IWM	Pooled	AICRP on STCR	PG Farm	AICRP on IWM	Pooled
		40 DAT				80 DAT			
T_1	Absolute Control	30.18	27.35	28.78	28.77	38.18	33.80	36.70	36.23
T_2	GRDF 100: 50: 50 N P_2O_5 K_2O Kg ha^{-1} + FYM 25 t ha^{-1}	35.40	32.12	33.80	33.77	44.34	38.60	41.36	41.43
T_3	As Per Soil Test	37.27	33.85	35.14	35.42	49.37	45.37	48.60	47.78
T_4	STCR Target 250 q ha^{-1} without Vermicompost	36.20	33.10	34.57	34.62	46.10	41.91	44.97	44.33
T_5	STCR Target 300 q ha^{-1} without Vermicompost	37.90	34.50	36.50	36.30	50.80	47.17	50.10	49.36
T_6	STCR Target 350 q ha^{-1} without Vermicompost	42.60	37.61	40.17	40.12	56.70	51.83	54.89	54.47
T_7	STCR Target 250 q ha^{-1} with 5 t ha^{-1} Vermicompost	36.00	32.57	34.10	34.22	48.39	42.39	46.37	45.71
T_8	STCR Target 300 q ha^{-1} with 5 t ha^{-1} Vermicompost	40.87	35.10	38.90	38.29	53.90	48.28	51.70	51.29
T_9	STCR Target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer	43.70	39.57	42.73	42.00	59.40	54.67	58.33	57.46
T_{10}	Only Vermicompost 5 t ha^{-1}	33.60	29.90	31.80	31.77	42.97	37.60	40.60	40.39
	SE m (+)	1.91	1.61	1.88	0.91	2.58	2.42	2.55	1.27
	CD @ 5%	5.67	4.78	5.59	2.58	7.67	7.20	7.58	3.57

Comment [N47]: N33

Comment [N48]: N33

The pooled height of onion crop at 40 and 80 DAT were ranged between 28.77 to 42.00 and 36.23 to 57.46 cm. The treatment T_9- STCR target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer was noticed significantly higher crop height (42.00 and 57.46 cm) over all other treatments. The treatment T_6- STCR target 300 q ha^{-1} without Vermicompost + Biofertilizer was at par result with treatment T_9. The lowest plant height was noted in the treatment Absolute control.

Comment [N49]: delete

Comment [N50]: recorded

Comment [N51]: delete

Comment [N52]: a

The treatment having application of vermicomost was observed the higher crop height might be due to the vermicompost having well decomposed and higher content of nutrient and other organic acids. Majorly the Nitrogen was responsible for increasing onion height hence, those treatment having comparatively higher application of nitrogen fertilizer and organic manure applied showed the significantly higher crop height [13]. Similar increase in height of onion crop with combined application of vermicompost and biofertilizer was observed by [11] Solanki *et al.* and [14] Monira *et al.*

3.3 Effect of Prescription Based Fertilizer Application on Chlorophyll content by SPAD of Onion Crop

Data pertaining to the chlorophyll content of onion crop as influenced by different treatments during *rabi* season, 2022-23 are presented in Table 4. The data in respect to chlorophyll content of onion crop at 45 and 60 DAT were influenced significantly with the different nutrient management treatments.

Chlorophyll estimation is a method used to quantify the amount of chlorophyll present in plant tissues. Chlorophyll is the pigment responsible for the green colouration in plants and is crucial for photosynthesis, the process by which plants convert light energy into chemical energy to fuel growth and development. The chlorophyll determinations can be made using a portable SPAD502 meter that makes nondestructive and rapid measurements of leaf chlorophyll based on spectral transmittance properties of leaves [15]. The SPAD 502 meter measure the chlorophyll content of live latex tissue of standing crop. SPAD-502 readings and chlorophyll contents were determined on fully expanded, middle, and recently expanded leaves, which were selected to maximize the visual variation in leaf color. Each SPAD value obtained was the average of 5 readings [16].

Table 4. Effect of Prescription Based Fertilizer Application on Chlorophyll Content by SPAD

Tr. no	Treatments	AICRP on STCR	PG Farm	AICRP on IWM	Pooled	AICRP on STCR	PG Farm	AICRP on IWM	Pooled
		45 DAT				60 DAT			
T_1	Absolute Control	32.70	28.34	30.27	30.44	38.60	33.67	35.40	35.89
T_2	GRDF 100: 50: 50 N P_2O_5 K_2O Kg ha^{-1} + FYM 25 t ha^{-1}	34.90	30.88	33.58	33.12	41.80	38.00	39.59	39.80
T_3	As Per Soil Test	35.84	33.59	34.28	34.57	45.80	42.00	44.62	44.14
T_4	STCR Target 250 q ha^{-1} without Vermicompost	35.37	32.97	34.00	34.11	42.38	39.40	40.31	40.70
T_5	STCR Target 300 q ha^{-1} without Vermicompost	36.14	34.10	35.71	35.32	46.00	42.20	45.10	44.43
T_6	STCR Target 350 q ha^{-1} without Vermicompost	41.10	37.48	39.84	39.47	51.80	47.82	50.48	50.03

Comment [N53]: rewrite as 'the higher crop height in the treatment having application of vermicomost

Comment [N54]: delete

Comment [N55]: delete

Comment [N56]: is

Comment [N57]: delete

Comment [N58]: delete

Comment [N59]: delete

Comment [N60]: delete

Comment [N61]: not necessary.

Comment [N62]: N33

Comment [N63]: N33

T_7	STCR Target 250 q ha^{-1} with 5 t ha^{-1} Vermicompost	35.10	32.67	33.49	33.75	45.21	40.87	42.35	42.81
T_8	STCR Target 300 q ha^{-1} with 5 t ha^{-1} Vermicompost	39.50	35.26	37.19	37.32	49.60	44.39	47.67	47.22
T_9	STCR Target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer	42.60	39.73	41.56	41.30	53.34	49.36	52.83	51.84
T_{10}	Only Vermicompost 5 t ha^{-1}	34.10	30.24	33.12	32.49	40.72	37.55	39.00	39.09
SE m (±)		1.92	1.76	1.87	0.94	2.41	2.26	2.39	1.19
CD @ 5%		5.71	5.24	5.54	2.65	7.17	6.71	7.09	3.35

The pooled chlorophyll content of three locations were comparatively higher in treatment T_9- STCR target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer (41.30 and 51.84) and lower in treatment T_1 – Absolute Control (30.44 and 35.89). The highest chlorophyll might be due to enhanced vegetative growth observed in onion plants under the combined treatment of vermicompost and plant growth-promoting rhizobacteria (PGPR) could be attributed to the advantageous properties of vermicompost over traditional compost. Vermicompost typically contains higher levels of nitrate, a more readily absorbed form of nitrogen for plants. Furthermore, vermicompost releases nutrients over a shorter period compared to compost, as noted by [17] Hassan *et al.* The treatment T_6- STCR target 350 q ha^{-1} without 5 t ha^{-1} Vermicompost + Biofertilizer (39.47) was at par with treatment T_9. The followed result were treatment T_8- STCR target 300 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer, the treatment T_5- STCR target 300 q ha^{-1} without Vermicompost. Similar results were reported by [18] Vishwakarma *et al.*, [19] Shedeed *et al.*, [20] Singh and Ram.

3.4 Effect of Prescription Based Fertilizer Application on Polar and Equatorial Diameter (cm) of Onion Crop

Data represnting to the polar diameter (cm) of onion crop as influenced by different treatments during *rabi* season, 2022-23 are presented in Table 5. The data in respect to polar diameter (cm) of onion crop were influenced significantly with the different nutrient management treatments.

The polar diameter of an onion bulb refers to the measurement from the top (pole) to the bottom (base) of the bulb, taken along a line perpendicular to the equatorial diameter. This measurement helps to describe the overall size and shape of the onion bulb. Onion bulbs typically have a spherical to slightly elongated shape in nature.

The equatorial diameter of an onion bulb refers to the measurement taken around the widest part of the bulb, perpendicular to the polar diameter. This measurement provides insight into the overall size

Comment [N64]: ?

Comment [N65]: Is higher chlorophyll is due to enhanced vegetative growth??

Comment [N66]: Write correct sentence

Comment [N67]: delete

Comment [N68]: delete

Comment [N69]: repeatation of earlier sentence, make one sentence and shape of the onion bulb and is an essential consideration for growers, cooks, and consumers alike. The equatorial diameter plays a significant role in determining the culinary applications and market preferences for onion bulbs.

Comment [N70]: delete

Table 5. Effect of Prescription Based Fertilizer Application on Polar Diameter (cm) and Equatorial diameter (cm) of Onion Crop

Tr. no	Treatments	AICRP on STCR	PG Farm	AICRP on IWM	Pooled	AICRP on STCR	PG Farm	AICRP on IWM	Pooled
		Polar Diameter (cm)				Equatorial diameter (cm)			
T_1	Absolute Control	4.10	3.59	3.88	3.86	6.76	5.67	6.14	6.19
T_2	GRDF 100: 50: 50 N P_2O_5 K_2O Kg ha^{-1} + FYM 25 t ha^{-1}	4.87	4.36	4.60	4.61	7.42	6.40	7.10	6.97
T_3	As Per Soil Test	5.51	4.89	5.00	5.13	8.29	7.12	8.00	7.80
T_4	STCR Target 250 q ha^{-1} without Vermicompost	5.00	4.52	4.62	4.71	7.63	6.78	7.21	7.21
T_5	STCR Target 300 q ha^{-1} without Vermicompost	5.87	5.00	5.24	5.37	8.67	7.20	8.24	8.04
T_6	STCR Target 350 q ha^{-1} without Vermicompost	6.57	5.65	6.21	6.14	9.94	8.13	9.15	9.07
T_7	STCR Target 250 q ha^{-1} with 5 t ha^{-1} Vermicompost	5.22	4.68	4.87	4.92	8.10	6.97	7.45	7.51
T_8	STCR Target 300 q ha^{-1} with 5 t ha^{-1} Vermicompost	6.34	5.49	6.10	5.98	9.24	7.82	8.91	8.66
T_9	STCR Target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer	6.89	5.83	6.35	6.36	10.22	8.33	9.89	9.48
T_{10}	Only Vermicompost 5 t ha^{-1}	4.76	4.13	4.49	4.46	7.10	6.10	6.87	6.69
SE m (±)		0.29	0.24	0.28	0.14	0.42	0.34	0.40	0.20
CD @ 5%		0.86	0.71	0.83	0.39	1.24	1.02	1.18	0.57

Comment [N71]: N33

Comment [N72]: N33

The onion crop before the harvesting stage the pooled polar and equatorial diameter were founded remarkably higher in treatment T_9- STCR target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost +

Biofertilizer (6.36 and 9.48 cm) and lower in the treatment T_1- Absolute Control (3.86 and 6.19 cm). The treatments T_6- STCR target 300 q ha^{-1} without 5 t ha^{-1} Vermicompost + Biofertilizer and T_8- STCR target 300 q ha^{-1} with 5 t ha^{-1} Vermicompost was at par with treatment T_9. The diameter of bulb increased significantly with different treatments of organic manures, inorganic fertilizers and biofertilizer. This may be due to application of organic manures which provide major and micro nutrients resulted in increased the photosynthetic activity, chlorophyll formation, nitrogen metabolism and auxin contents in the plants which ultimately improving the diameter of bulb [14], [21]. Those target which have achieved having highest diameter than remaining all other treatments. Similar significancy of result with vermicompost and biofertilizer like organic sources were observed in [22] Gour *et al.* and [13] Singh *et al.*

3.5 Effect of Prescription Based Fertilizer Application on Neck Girth (cm) and Bulb Weight (gm) of Onion Crop

Data presenting to the neck girth (cm) and bulb weight (gm) of onion crop as influenced by different treatments during *rabi* season, 2022-23 are presented in Table 6. The data in respect to neck girth (cm) and bulb weight (gm) of onion crop were influenced significantly with the different nutrient management treatments xxxx.

The "neck girth" of an onion refers to the diameter or circumference of the neck portion of the bulb where the leaves emerge. This measurement is taken at the point where the neck transitions from the bulb, often just above the surface of the soil. The neck girth is an important indicator of onion quality, maturity and ultimately nutrient use efficiency.

Table 6. Effect of Prescription Based Fertilizer Application on Neck Girth (cm) and Bulb Weight (gm) of Onion Crop

Tr. no	Treatments	AICRP on STCR	PG Farm	AICRP on IWM	Pooled	AICRP on STCR	PG Farm	AICRP on IWM	Pooled
		Neck Girth (cm)				Bulb Weight (gm)			
T_1	Absolute Control	3.57	2.98	3.14	3.23	24.37	20.55	32.93	25.95
T_2	GRDF 100: 50: 50 N P_2O_5 K_2O Kg ha^{-1} + FYM 25 t ha^{-1}	3.88	3.60	3.71	3.73	53.76	40.46	64.26	52.83
T_3	As Per Soil Test	4.14	3.89	3.98	4.00	54.99	41.68	66.56	54.41
T_4	STCR Target 250 q ha^{-1} without Vermicompost	3.97	3.65	3.80	3.81	47.55	38.67	57.71	47.98
T_5	STCR Target 300 q ha^{-1} without Vermicompost	4.37	4.00	4.18	4.18	58.39	43.29	68.28	56.65
T_6	STCR Target 350 q ha^{-1} without Vermicompost	4.96	4.50	4.83	4.76	65.18	45.83	75.09	62.03

Comment [N73]: Correct the sentence

Comment [N74]: delete

Comment [N75]: improved

Comment [N76]: not clear???

Comment [N77]: Write correct sentence

Comment [N78]: delete

Comment [N79]: delete

Comment [N80]: ???

Comment [N81]: Delete

Comment [N82]: (Table 6)

Comment [N83]: Not necessary to explain.. it is part of Materials and method

Comment [N84]: delete

Comment [N85]: delete

Comment [N86]: 33

Comment [N87]: 33

T_7	STCR Target 250 q ha^{-1} with 5 t ha^{-1} Vermicompost	4.00	3.71	3.84	3.85	56.03	42.59	67.45	55.36
T_8	STCR Target 300 q ha^{-1} with 5 t ha^{-1} Vermicompost	4.78	4.38	4.57	4.58	60.94	44.28	72.13	59.12
T_9	STCR Target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer	5.13	4.73	4.97	4.94	67.66	46.17	78.43	64.09
T_{10}	Only Vermicompost 5 t ha^{-1}	3.81	3.41	3.67	3.63	29.44	24.36	45.27	33.03
SE m (±)		0.24	0.21	0.24	0.12	2.86	1.46	3.01	1.94
CD @ 5%		0.72	0.63	0.71	0.33	8.51	4.32	8.94	5.77

Neck diameter was varied significantly due to different targets of presence and absence of vermicompost and biofertilizer. The highest pooled neck girth (4.94 cm) was found in treatment T_9- STCR target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer which was statistically identical with treatment T_6- STCR target 350 q ha^{-1} without 5 t ha^{-1} Vermicompost + Biofertilizer (4.76 cm) where the lowest neck girth (3.23 cm) was found in absolute control treatment.

The pooled bulb weight were ranges 25.95 - 64.09 gm, however the treatment T_9- STCR target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer showed the significantly higher bulb weight (64.09 gm) over all other treatments. This might be due to more translocation of photosynthates from leaves to bulb and solubilization effect of plant nutrients from vermicompost and biofertilizer [10]**.** Similar result with vermicompost and biofertilizer were reported by [23] Datt and Kaur, [24] Kumari *et al.,* [22] Gour *et al.* and [25] Yogita and Ram (2012).

3.6 Effect of Prescription Based Fertilizer Application on Bulb Yield (q ha^{-1}) of Onion Crop

Data pertaining to the bulb yield (q ha^{-1}) of onion crop as influenced by different treatments during *rabi* season, 2022-23 are presented in Table 7. The data in respect to bulb yield (q ha^{-1}) of onion crop were influenced significantly with the different nutrient management treatments.

Table 7. Effect of Prescription Based Fertilizer Application on Bulb Yield (q ha^{-1})

Tr. no	Treatments	AICRP on STCR	PG Farm	AICRP on IWM	Pooled	Deviation in Bulb Yield (%)
T_1	Absolute Control	73.43	63.99	80.01	72.48	–
T_2	GRDF 100: 50: 50 N P_2O_5 K_2O Kg ha^{-1} + FYM 25 t ha^{-1}	231.58	237.10	246.92	238.53	–

Comment [N88]: Correct the sentence

Comment [N89]: Correct the sentence

Comment [N90]: delete

Comment [N91]: Not necessary to repeat in every results

Comment [N92]: Write in one sentence

Comment [N93]: N33

T_3	As Per Soil Test	252.73	247.01	253.31	251.02	–
T_4	STCR Target 250 q ha^{-1} without Vermicompost	245.41	244.17	234.15	241.24	**-3.50**
T_5	STCR Target 300 q ha^{-1} without Vermicompost	310.25	296.03	311.93	306.07	**2.02**
T_6	STCR Target 350 q ha^{-1} without Vermicompost + Biofertilizer	357.24	347.61	342.33	349.06	**-0.27**
T_7	STCR Target 250 q ha^{-1} with 5 t ha^{-1} Vermicompost	247.74	246.18	239.53	244.49	**-2.21**
T_8	STCR Target 300 q ha^{-1} with 5 t ha^{-1} Vermicompost	326.89	321.00	314.26	320.72	**6.90**
T_9	STCR Target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer	365.90	358.56	366.54	363.67	**3.90**
T_{10}	Only Vermicompost 5 t ha^{-1}	130.39	121.25	117.71	123.12	–
SE m (±)		12.84	16.35	13.72	7.41	–
CD @ 5%		38.16	48.58	40.75	20.88	–

In respect to pooled bulb yield, application of fertilizer in treatment T_9- STCR target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer (363.67 q ha^{-1}) was identified higher bulb yield as compared to the control (72.48 q ha^{-1}) and only vermicompost application (123.12 q ha^{-1}) treatments. The utilization of vermicompost could potentially yield positive impacts on soil microbial populations and mycorrhizal activity, thereby facilitating nutrient solubilization. The favorable C:N ratio of vermicompost also contributes to enhancing the nutrient mineralization process in the soil [26].

Also the *Azospirullum* and *PSB* biofertilizer increase the nutrient use efficiency by reducing nutrient losses which ultimately increase vegetative and reproductive growth of Onion crops. The pooled bulb yield of treatment T_6- STCR target 350 q ha^{-1} without Vermicompost + Biofertilizer (349.06 q ha^{-1}) was at par with treatment T_9.

Comment [N94]: rewrite

It can be inferred that the yield target equation, derived from soil tests and crop responses, proved effective in attaining desired onion yields, whether used in conjunction with vermicompost or alone. Application of inorganic fertilizers guided by the targeted yield equation, combined with vermicompost and biofertilizer, resulted in higher onion bulb yields. This outcome could be attributed to the additional nutrient supplementation from vermicompost and improved nutrient availability through balanced fertilization, as demonstrated by [27] Santhi *et al.*, [28] Jadhav *et al.* and [29] Kokate *et al.* Similar results of yield target achieved in IPNS based fertilizer application were reported by [30] Tolanur and Badanur, [31] Shrivas *et al.*, [32] Singh *et al.* and [33] Dhruw *et al.*

Deviation in Bulb Yield (%):

The treatment T_4- STCR target 250 q ha^{-1} without Vermicompost, treatment T_6- STCR target 300 q ha^{-1} without Vermicompost + Biofertilizer and treatment T_7- STCR target 250 q ha^{-1} with Vermicompost were missed with 3.50, 0.27 and 2.21 % deviation to achieving the target. The treatment T_9- STCR target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer, treatment T_8- STCR target 300 q ha^{-1} with 5 t ha^{-1} Vermicompost and treatment T_5- STCR target 300 q ha^{-1} without Vermicompost were reported additional increments of yield 3.90, 6.90 and 2.02 % respectively.

Comment [N95]: ??

Comment [N96]: ??

3.7 Effect of Prescription Based Fertilizer Application on Tops Yield (q ha^{-1}) of Onion Crop

Comment [N97]: delete

Data presenting to the tops yield (q ha^{-1}) of onion crop as influenced by different treatments during *rabi* season, 2022-23 are presented in Table 8. The data in respect to tops yield (q ha^{-1}) of onion crop were influenced significantly with the different nutrient management treatments.

Comment [N98]: Make one sentence

Table 8. Effect of Prescription Based Fertilizer Application on tops Yield (q ha^{-1})

Tr. no	Treatments	AICRP on STCR	PG Farm	AICRP on IWM	Pooled
T_1	Absolute Control	13.52	13.67	14.68	**13.96**
T_2	GRDF 100: 50: 50 N P_2O_5 K_2O Kg ha^{-1} + FYM 25 t ha^{-1}	42.84	44.65	46.02	**44.51**
T_3	As Per Soil Test	46.76	46.38	46.96	**46.70**
T_4	STCR Target 250 q ha^{-1} without Vermicompost	45.40	50.97	43.55	**46.64**
T_5	STCR Target 300 q ha^{-1} without Vermicompost	57.40	59.98	58.02	**58.27**
T_6	STCR Target 350 q ha^{-1} without Vermicompost + Biofertilizer	65.98	65.70	63.67	**65.12**
T_7	STCR Target 250 q ha^{-1} with 5 t ha^{-1} Vermicompost	45.83	46.53	44.44	**45.60**
T_8	STCR Target 300 q ha^{-1} with 5 t ha^{-1} Vermicompost	60.48	60.30	58.09	**59.62**
T_9	STCR Target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer	67.48	65.95	68.00	**67.18**
T_{10}	Only Vermicompost 5 t ha^{-1}	24.12	23.80	21.91	**23.28**
SE m (±)		**2.38**	**3.21**	**2.54**	**1.45**
CD @ 5%		**7.06**	**9.55**	**7.55**	**4.06**

Comment [N99]: pooled mean?

The pooled tops yield in treatments T_1- Control (13.96 q ha^{-1}) and T_{10}- only vermicompost application (23.28 q ha^{-1}) were noticed significantly lower over the rest of all other treatments. The treatment T_9- STCR target 350 q ha^{-1} with 5 t ha^{-1} Vermicompost + Biofertilizer (67.14 q ha^{-1}) was considerable result obtained, however this result could be attributed due to better translocation of assimilates towards sink. Application of N, P and K based on STCR equation with vermicompost and biofertilizer enhanced the nutrient metabolism, biological activity and growth parameter which encourage vegetative foliage *i.e.* tops yield [29]. Similar target achieved by [34] Salunkhe *et al*., [35] Sekaran *et al.*, [32] Singh *et al.* and [33] Dhruw *et al.*

Comment [N100]: ?

Comment [N101]: Rewrite the sentence

4. Conclusion

The growth parameters, such as the number of leaves, crop height, chlorophyll content, diameter, neck girth, and bulb weight, were found to be significantly higher in the treatment T_9, which used vermicompost and biofertilizer. The bulb and top yields of *Rabi* onion indicated that treatment T_9 (STCR target 350 q ha^{-1} with vermicompost and biofertilizer) were significantly higher than all other treatments. The per cent achievement of the targeted yield in treatments T_9 and T_8 showed variances of 3.90% and 6.90%, respectively, at all locations, demonstrating the validity of the equations for prescribing for *Rabi* onion. The fertilizer equations with vermicompost and vermicompost + biofertilizer are recommended for *Rabi* onion grown in Inceptisols.

Comment [N102]: plant

Comment [N103]: diameter of what??

Comment [N104]: ?

Comment [N105]: ?

Comment [N106]: can be

5. References:

1. Truog E. Fifty years of soil testing, Proc. Trans 7th Intl. Congr. Soil Sci. Vol. III Commission IV paper No.7:1960;46-53.

2. Ramamoorthy B, Narasimhan RL, Dinesh RS. Fertilizer application for specific yield targets of Sonara-64. Indian Farming. 1967;17(5):43-45.

3. Agricultural Statistics at a Glance. Government of India, Ministry of Agriculture and Cooperation, Directorate of economics and Statistics. 2023;pp-324-325.

4. Pathma J, Sakthivel N. Microbial diversity of vermicompost bacteria that exhibit useful agricultural traits and waste management potential. Springer Plus. 2012;1,pp.1-19.

5. Joshi R, Vig AP, Singh J. Vermicompost as soil supplement to enhance growth, yield and quality of Triticum aestivum L. A field study. International Journal of Recycle Organic Waste Agriculture. 2013;2:1-7.

6. Atiyeh RM, Lee CA. Edwards, Arancon N.Q. and Metzger, J.D. The influence of humic acids derived from earthworms- processed organic wastes on plant growth. Bioresource Technology. 2002;84:7-14.

7. Kawalekar SJ. Role of biofertilizers and biopesticides for sustainable agriculture. Journal of Biological Innovation. 2013;2:73–78.

Comment [N107]: ??

8. Karchoo D, Razdan R. Growth, nutrient uptake and yield of wheat as influenced by biofertilizers and nitrogen. Indian Journal of Agronomy. 2006;51:37- 39.

9. Panse VG, Sukhatme PV. Statistical Methods for Agricultural Workers. IVEd. ICAR, New Delhi; 1995.

10. Gebremichael Y, Woldetsadik K, Arvind Chavhan A, Gedamu F. Effect of integrated nutrient management on growth and bulb yield of onion (Allium cepa L.) under irrigation at Selekleka, Northern Ethiopia. International Journal of Life Sciences. 2017;5(2):151-160.

11. Solanki MS, Parmar K, Singh D, Kushwah R. Effects of vermicompost and psb on the vegetative growth and yield of onion (Allium cepa L.). International Journal of Plant and Soil Science. 2023;35(19):1761-1765.

12. Vedpathak MM, Chavan BL. Effects of organic and chemical fertilizers on growth and yield of onion (Allium cepa L). International Journal of Environment, Agriculture and Biotechnology. 2016;1(4):1033-1037.

13. Singh R, Singh N, Singh BK. Response of organic manures with macro and micro nutrients on growth and yield of onion. Journal of Agriculture Sciences. 2022;9(1):50-53.

14. Monira S, Mostarin Y, Khatun K, Haq ME, Soniya IA, Akhter S, Sharmin I, Ghosh A. Effect of vermicompost and earthing up on the growth and yield of onion. Asian Plant Research Journal. 2019;3(1):1-12.

15. Madeira AC, Ferreira A, de Varennes A, Vieira MI. SPAD meter versus tristimulus colorimeter to estimate chlorophyll content and leaf color in sweet pepper. Communications in soil science and plant analysis. 2003;34(17-18):2461-2470.

16. Leon AP, Vina SZ, Frezza D, Chaves A, Chiesa A. Estimation of chlorophyll contents by correlations between SPAD-502 meter and chroma meter in butterhead lettuce. Communications in Soil Science and Plant Analysis. 2007;38:2877–2885.

17. Hassan SAE, Elmehrat HG, Ragab AA, Meguid A, Dahab MMA. Growth, yield, bulb quality and storability of some onion cultivars response to compost, vermicompost and plant growth promoting rhizobacteria. Middle East Journal of Agriculture Research. 2018;7(2):292-306.

18. Vishwakarma M, Kulhare PS, Tagore GS. Estimation of chlorophyll using SPAD meter. International Journal of Environment and Climate Change. 2023;13(11):1901-1912.

19. Singh A, Ram RB. Evaluation of the performance of onion cv. NHRDF red 2 in response to inorganic, organic and bio-fertilizers. India Journal of Applied Research. 2014;4(11):263-265.

20. Shedeed SI, EL-Sayed SAA, Abo Bash DM. Effectiveness of bio-fertilizers with organic matter on the growth, yield and nutrient content of Onion (Allium cepa L.) plants. European International Journal of Science and Technology. 2014;3(9):115-122.

Comment [N108]: capitalize

Comment [N109]: India or Indian?

21. Dhaker B, Sharma RK, Chhipa BG, Rathore RS. Effect of different organic manures on yield and quality of onion (Allium cepa L.). International Journal of Current Microbiology and Applied Sciences. 2017;6(11):3412-3417.
22. Gour R, Sharma R, Thakur R. Effect of integrated nutrient management on growth and yield of onion (Allium cepa L.). The Pharma Innovation Journal. 2023;12(11):1035-1038.
23. Datt R, Kaur H. Impact of organic manures and biofertilizers on growth and yield of onion (Allium cepa L.). The Pharma Innovation Journal. 2023;12(6):4838-4841.
24. Kumari P, Jha AK, Kumar G, Kumar V, Kumar R. Efficacy of vermicompost and inorganic source of potassium on yield attributing characters, bulb yield of kharif onion and residual fertility status of soil. International Journal of Current Microbiology and Applied Sciences. 2020;9(2):1230-1241.
25. Yogita, Ram RB. Effect of chemical and biofertilizers on quality of onion. Hortflora Research Spectrum. 2012;1(4):367-370.
26. Gayathri A, Vadivel A, Santhi R, Boopathi PM, Natesan R. Soil test based fertilizer recommendation under integrated plant nutrition system for potato (Solanum tuberosum L.) in hilly tracts of nilgiris district. Indian Journal Agriculture Research. 2009;43(1):52-56.
27. Santhi R, Natesan R, Selvakumari G. Soil test based fertilizer recommendation under IPNS for aggregatum onion in Inceptisols of Tamil Nadu. Agropedology. 2002;12:141-147.
28. Jadhav AB, Kadlag AD, Patil VS, Bachkar SR, Dale RM. Response of chickpea to conjoint application of inorganic fertilizers based on STCR approach and vermicompost on Inceptisol. Journal Maharashtra agriculture University. 2009;34(2):125-127.
29. Kokate A, Suryavanshi VP, Sawant D, Gawande R, Waghmare P. Response of gram (Cicer arietinum L.) to STCR based fertilizer application. The Pharma Innovation Journal. 2022;11(1):1150-1152.
30. Tolanur SI, Badanur VP. Effect of integrated use of organic manure, green manure and fertilizer nitrogen on sustaining productivity of rabi sorghum-chickpea system and fertility of a vertisol. Journal of Indian Society of Soil Science. 2003;51(1):41-44.
31. Shrivas SK, Dash AC, Urkukar JS. Effect of different organic sources of nutrients on growth, yield attributes of chickpea. Journal of Soils and Crops. 2007;15.
32. Singh VK, Gautam P, Nanda G, Dhaliwal SS, Pramanick B, Meena SS, Walaa FA, Gaber A, Sayed S, Hossain A. Soil Test Based Fertilizer Application Improves Productivity, Profitability and Nutrient Use Efficiency of Rice (Oryza sativa L.) under Direct Seeded Condition. Agronomy. 2021;11:1756.

Comment [N110]: Check it

Comment [N111]: check

33. Dhruw D, Srivastava LK, Paikra B, Jatav G, Mishra H, Banwasi R, Prakash O. Validation of STCR based fertilizer prescription on the farmer's field. The Pharma Innovation Journal. 2023; 12(7):569-572.
34. Salunkhe SH, Kadlag AD, Durgude SA. Soil test crop response approach for chickpea in an Inceptisol. International Journal of Chemical Studies. 2018;6(4):1954-1959.
35. Sekaran U, Santhi R, Dey P, Meena S, Maragatham S. Validation of soil test and yield target based fertilizer prescription model developed for pearl millet on Inceptisol. Research on Crops. 2019;20(2):266-274.