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Effect of integrated nutrient management on growth, yield and quality of tomato (*Solanum lycopersicum* L.) var. Kashi amrit

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Abstract
An investigation on the “Effect of integrated nutrient management on growth, yield and quality of tomato (*Solanum lycopersicum* L.) var. Kashi Amrit” was conducted at department of horticulture farm of udai pratap college, varanasi during 2018-19 in winter season.. The study consisting of 12 treatments with and without bio-fertilizers along with Recommended Dose of Nutrient (RDF 250 kg each of NPK ha^{-1}) with 3 replications was laid out in RBD. The growth parameters *viz.,* plant height (72.24, 83.24 and 98.37 cm) and number of branches (13.40, 15.00 and 16.20) was highest in combined application of 100 % RDF + *Azotobacter*+ PSB + VAM (T_{11}) at 30, 60 and 90 days after transplanting respectively. The yield, economics and quality characters *viz.,* fruit weight (80.12 g), number of fruits per plant (44.60), fruit yield per plant and fruit yield ha^{-1}(3.57 kg and 794.07 q ha^{-1}).

Keywords: Tomato, INM, growth, yield and quality, fertilizer

Introduction
Tomato (*Solanum lycopersicum* L.) belongs to family solanaceae, is an annual vegetable crop grown throughout the world and ranks second in importance after potato. The tomato is believed to have been originated in Central Africa and South America. Tomato having chromosome number 2n=24. It is herbaceous annual which is sexually propagated by seed. It is used as salad. Tomato is one of the most widely, grown vegetable in India and has become popular within the last six decades. It is grown in small home gardens and market gardens for fresh consumption as well as processing purposes. It is consumed raw, cooked or processed as puree, ketchup, sauce etc. Although, a ripe tomato has 94 per cent water, being a good source of vitamin A and B and excellent source of vitamin C and has good nutritive value. It is very appetizing, removes constipation and has a pleasing taste. In India, tomato is cultivated in almost all parts of country. It is grown in an area of 789.15 thousand hectare with a production of 19759.3 MT ha^{-1} respectively. In Karnataka it is grown in an area of 54,287 ha with a production 19, 06,865 metric tons and productivity of 35.13 tones ha^{-1}. The major tomato producing states are Bihar, Karnataka, Uttar Pradesh, Orissa, Andhra Pradesh, Maharashtra, Madhya Pradesh and West Bengal. Tomato is rich in minerals, vitamins and organic acids and contains total sugar content of 2.5 per cent in ripe fruit, ascorbic acid of 16.0-65.0 mg/100 g, 94.1 g of water, 1.0 g of protein, 0.3 g of fat, 4.0 g of carbohydrates, 0.6 g of fibers, vitamin A of 1100 I.U, vitamin B 0.20 mg, vitamin C 23 mg. The fruits are also rich in minerals like potassium 268 mg and phosphorus 27 mg. several processed items like paste, sauce, puree, syrup, juice, ketch up, drinks etc. are prepared on large scale.
The main principle of integrated nutrient management is to maximize the use of organic inputs while minimizing nutrient losses and to make supplementary use of chemical fertilizers. Good practices for integrated nutrient management often involve a combination of organic and inorganic sources of nutrients. Organic material maintains and improves soil productivity. Whereas chemical fertilizers are often needed if production is to increase. Integrated nutrient management contributes to better farm waste management, minimizing environmental

pollution, improving soil productivity, and the production of safe food and feed. Application of different levels of nitrogen increases the plant growth significantly by increasing the plant height, number of branches, number of leaves ultimately resulted in increase in the yield of tomato fruits. Photosynthetic activity is also enhanced due to large leaf area. The role of bio-fertilizers in improving soil fertility has long been studied in various crops. The bio-fertilizers such as *Azotobacter*, Phosphate Solubilising Bacteria and Arbuscular Mycorrhiza (VAM fungi) helps to enhance overall soil fertility by modifying soil texture, soil structure integrity, aeration, increased nutrient availability there by greatly influencing plant growth and yield. *Azospirillum* diazotropic bacterium which is widely distributed in soil rhizosphere and roots of a number of plants has ability to fix nitrogen. Many reports have indicated the importance of *Azospirillum*in vegetable crops. Bio-fertilizers are involved in symbiotic and associative microbial activities with higher plants. These are natural mini-fertilizer factories that are economical and safer source of plant nutrition for increasing the agricultural production and improving soil fertility. Apart from the above applications bio-fertilizers are ready to use live formulates of such beneficial microorganism which on application to seed, root or soil, mobilize the availability of nutrients by their biological activity in particular and help in building up the micro flora and in turn the soil health.

In the present day cultivation, continuous use of chemical fertilizers affects soil health and leads to environmental pollution. By using the bio-fertilizers to supplement part of the nutrient needs of the plant, not only the cost of inputs be brought down, but also the environmental hazards associated with the chemical fertilizers can be avoided. Therefore, the current trends is to explore the possibility of supplementing chemical fertilizers with organic ones more particularly, bio-fertilizers of microbial origin. Bio-fertilizers are known to enhance the growth, yield and quality of vegetables. With this background the present study was conducted to study the Effect of Integrated Nutrient Management on growth, yield and quality of Tomato (*Solanum lycopersicum*.) var. Kashi Amrit with the following objectives.

Material and Methods

This chapter comprises the detail about the material used and method adopted during course investigation entailed "Effect of integrated nutrient management on growth, yield and quality of tomato (*Solanum lycopersicum* L) var.Kashi Amrit" was carried out at Udai Pratap College, Varanasi during 2018-19 in winter season.

Experimental site

The experiment was conducted at Department Of Horticulture Farm, Udai Pratap Autonomous College, Varanasi (Utter Pradesh) during Rabi season 2018-19.

Geographical location of experimental site

Department of Horticulture Farm Udai Pratap College, Varanasi (Uttar Pradesh) which in humid sub- tropical climactic zone. The place is situated between 25.00 to 26.00 north latitude and 82.00 to 83.00 east longitude on an elevation of about 80.71 meters from sea level in the genetic alluvial plains of eastern Uttar Pradesh.

Soil type

The soil of the experimental field was sandy loam. Soil samples were collected randomly up to a depth of 15 cm from the experimental field, with the help of soil auger, before sowing. All the samples were mixed to prepare a composite sample, which was then air dried sieved through 2 mm sieve and finally used for physical and chemical analysis.

Physical and chemical properties of experimental field soil

Aggregate soil samples were drawn from the experimental field prior, the application of farm yard manure to assess the initial physical and chemical status of soil. The result of analysis is presented below.

Table 1: Physical and chemical properties soil

S. No.	Soil properties	Value (%)	Method of determination	References
A.	**Mechanical analysis**			
1.	Sand	50.96	International Pipette method	Piper, 1996
2.	Silt	29.81	International pipette method	Piper, 1996
3.	Clay	19.21	International Pipette method	Piper, 1996
B.	**Chemical analysis**			
1.	P^H	7.40	Glass electrode P^H method	Chopra and Kanwar, 1999
2.	EC (dS m^{-1})	0.23	Glass electrode method	Chopra and Kanwar, 1999
3.	Organic carbon (%)	0.68	Walkley and Black`s rapid titration method	Walkley and Black, 1934
4.	Available nitrogen (kg ha^{-1})	285.6	Alkaline permanganate method	Subbiah and Asija, 1956
5.	Available Phosphorus (kg ha^{-1})	18.6	Olsen`s method	Olsen *et al.*, 1954
6.	Available Potassium (kg ha^{-1})	173.4	Ammonium acetate method	Honway and Heidel, 1952

Details of layout

Crop: Tomato
Variety: Kashi Amrit
Spacing: 75 cm × 60 cm
Replications: 3
Treatments: 12
Design: RBD
Plot size: 3.75 m × 3.0 m
Net plot size: 3.0 m × 2.40 m
Season: *Kharif* - 2018
Bio-fertilizers: *Azotobacter*, PSB and VAM

Soil analysis

Soil pH

The pH of soil was determined from 1:2.5 (Soil: Water) suspension by glass electrode using pH meter.

Standard error of mean

Standard error of mean (SEm±) was calculated as follows:

$$\text{Standard error of mean} = \sqrt{\frac{\text{EMSS}}{r}}$$

Where,
SEm± = Standard error of mean
EMSS = Error mean sum of squares

r = Number of replication on which the observation is based
The treatment differences were tested by least significant difference at 5 percent of probability and calculated by the following formula:

$$CD = \sqrt{(2 \text{ x Error mean square})/r} \text{ x t } 0.05$$

Where,
CD = Critical difference
r = Number of replications of the factor for which C.D. is to be calculated.

$t_{0.05}$ = Value of percentage point of 't' distribution for error degree of freedom at 5 per cent level of significance.

Experimental results
Effect of integrated nutrient management on growth attributes of tomato
Growth and development in plants are a consequence of excellent coordination of several processes operating at different growing phases of plant. The growth parameters decide the final yield of a plant. In the present investigation the growth parameters *viz.*, plant height, number of primary branches, leaf area and dry matter accumulation were significantly influenced by application of organic and inorganic stimulants as soil and foliar means.
In the present study the treatment T_{11} *i.e.*, 100 % RDF + *Azotobacter* + PSB + VAM had greater effect on improving the plant height (72.24, 83.24 and 98.37 cm) at 30, 60 and 90 DAT respectively over control. The improvement in the plant height at all stages with application of 100 % RDF + *Azotobacter* + PSB + VAM might be due to better uptake and translocation of nitrogen to the growing plants as a result of their availability in the treatment. Similar results were reported by application of inorganic N fertilizer (Anburani and Manivannan, 2002) [6, 7, 8], (Suthar and Singh 2005) [71, 72] in brinjal and Deka *et al.* (2001) [16] in chilli by non-symbiotic *Azotobacter* in presence of organic manure.
Similarly, the bio-fertilizer *Azotobacter* is known to increase N fixation in soil by root elongation, increase in root surface area and number of roots, which in turn ultimately reflect on enhanced growth of the plant as reported by Neeraj *et al.* (2010), Prativa and Bhattarai (2011) [52], Vijaykumar (2010) [74] and Adeel *et al.* (2014) [2]. The significant role of VAM fungi in increasing the plant height of tomato was reported earlier by Gosavi (2010) [21] in tomato. Numbers of branches are the most important contributors of yield as they bear the leaves which fix the carbon dioxide through photosynthetic mechanism. As far as tomato is concerned, the leaf production is an important phenomenon especially at the time of fruiting, since every leaf is acting as a source of assimilates for all the developing fruits.
The present study also revealed that application of 100 % RDF + *Azotobacter* + PSB + VAM increase the number of branches over control at harvesting stage which might be attributed to the stimulatory effect of bio-fertilizers especially *Azatobactor* and phoshate solubalisng bacteria for the development of photosynthetic structures like size of the chloroplast and the number of grana mm-2 as reported by Forton *et al.* (1985). Besides the production of cytokinin by the AM fungi caused an increase in cell division and differentiation thereby increasing the leaf area as observed in the present study also. Similar effect on number of branches and leaves was also reported earlier in tomato by similar trend of increased number of branches was reported by Renuka and Ravishankar (2001) [57], Gosavi *et al*. (2010) [21] in tomato.
The enlarged leaf area might be due to combined application of inorganic and bio-fertilizers might be attributed to synthesis of metabolically active enzymes as well as production and translocation of the metabolites due to synergistic effects of particularly zinc aids in the formation of auxin, a growth promoting compound which is directly involved in cell division and cell elongation (Gosavi *et al.*, 2010) [21].
The possible reason for the increase in stem girth is that, the application of organic stimulants in the soil at appropriate stage and adequate levels would have improved the fertilizer use efficiency of trees and in turn aided in building up a strong vegetative frame through the production of enhanced levels of auxins. In addition to this, foliar application of micronutrients particularly zinc directly resulted in the formation of auxins, which increased cell division process resulted in better growth of trees.
The increase in the dry matter accumulation of final harvest was also varied significantly in the present study. This might be due to combined effect of RDF and bio-fertilizers which produced bio active substances and also would have mobilized the nutrients in the immediate environment. Similarly results were reported by Anburani and Manivannan (2004) [6, 7, 8], Prabhu *et al.* (2010) [49, 50] in tomato. Besides, the fact that application of bio-fertilizer provides prolonged availability of nutrients during the crop growth period. Also in addition to macro and micro nutrients, bio-fertilizer produces enzymes, vitamins and growth regulators like GA3, which regulates the growth of plant and facilitates more branching, leaf production which in turn helps in increase the accumulation of dry matter at the end of the harvest.

Reproductive parameters
The reproductive parameters includes days taken for first flowering, number of flowers per plant, days taken for fruit set from flowering and fruit set were recorded higher with 100 % RDF + *Azotobacter* + PSB + VAM. Similar resulted were also reported by Azin *et al*. (2012) [9], Chumyani *et al*. (2010) [15] and Sathyjeet *et al.* (2014) [58].
Phosphorus is an essential element required for flowering and its development. Since Vesicular Arbuscular Mycorrhiza is known to enhance the P uptake, it may have resulted in early flowering bud initiation and number of flowers per plant days taken for results in higher fruit set. The better availability of nutrients and growth promoting effects from the bio-fertilizers and would have been responsible for higher number of flowers per plant and better fruit. The similar results were obtained with Yeptho *et al*. (2010).

Yield and yield attributing parameters
The yield attributing parameters *viz.*, No. of fruit per plant, Yield per plant (kg), Yield per ha (q), fruit weight (g) varied significantly due to integrated application of nutrients. The plants supplied with 100 % RDF + *Azotobacter* + PSB + VAM recorded the maximum fruit weight (80.12 g), number of fruits (44.60), fruit yield per plant (3.57 kg)and fruit yield per hector 794.07 q/ha^{-1}.
Several workers have reported fruit length, fruit diameter fruit weight and fruit volume due to integrated management. Sathyajeet *et al.* (2014) [60, 61] recorded the better fruit

attributes in tomato when plants are inoculated with 50 per cent N from inorganic source + 50m per cent N from poultry manure. Similar results were obtained by Azin *et al*. (2012) [9], Chumyani *et al*. (2012) [15], Mudasir *et al*. (2009) [41] and Sathyajeet *et al.* (2014) [60, 61].

Increase in length and size of the fruits may be also due to complementary action of phosphorous and potassium which helps in synthesize the auxins which are responsible for the cell elongation by increasing the cell permeability to water and osmotic solutes of the cells. Besides, auxins are also responsible for inducing the synthesis of specific DNA dependent new m-RNA and specific enzymatic proteins causes increased cell plasticity and extension resulting ultimately in cell enlargement. Besides, increase in the fruit size might be due to the higher uptake of nutrients and more food material synthesis by plant when treated with bio-fertilizers. FYM is store houses of the nutrients in soil, which enhance the fruit length (cm) fruit diameter fruit weight (g), and fruit volume workers Mohankumar and Narasegowda (2010) [40]. The similar results were confirmative to the findings of Mudasir *et al*. (2009) [41] and Sathyjeet *et al*. (2014) [58].

Increase growth parameters *viz*., plant height, leaf area, and weight, length and number of the fruits results in the maximum total yield. Increase in the total fruit yield might be due to better nutrient uptake as evident from the enhanced recorded growth and reproductive characters of the tomato plants in T15. The organic manures provides prolonged and better availability of nutrients during crop growth period, while, bio-fertilizer VAM and *Azotobacter* increased the availability of nutrients and growth promoting substances synthesized by micro-organisms (Sathyjeet *et al*., 2014) [58]. There are many reports indicating increased fruit yield due to the application of organic manures along with inorganic fertilizers as also was found in the present investigation as by Sudhakar and Purushothum (2008) [70], Manoj Kumar Singh (2014) [30], Mudasir *et al*. (2009) [41], Shashidhar (2000) and Satyjeet *et al*. (2014) [65].

Quality parameters

The data registered in the present investigation indicated that soil application of treatment which consist of 100 % RDF + *Azotobacter* + PSB + VAM (T_{11}) retained higher TSS during the period of observations.

An increase in fruit yield with concomitant increase in fruit quality is a desirable factor in any studies. The biochemical aspects such as lycopene, ascorbic acid, titrable acidity and total soluble solids (TSS) decide the edible quality of the fruit. In the present investigation increased TSS, ascorbic acid and lycopene was observed with T_{11} over control. Improvement in TSS, ascorbic acid and lycopene by inoculation of VAM + *Azatobactor* were noticed by Sathyajeet *et al*. (2014) [60, 61] TSS and lycopene content due to AM fungi inoculation in tomato by, TSS and ascorbic acid content with VAM + *Azotobacter* by Ramakrishnan and Selvakumar (2012) [54].

The increase in TSS and sugars in the present study might be also due to exogenous supply of potassium (Quality nutrient) which increased the flow of plant assimilates into the developing fruits especially when assimilate flow from other parts of plant become limited. Besides, supply of potassium also plays a major role in carbohydrates synthesis, and its breakdown, translocation and synthesis of protein and also neutralizes the physiologically important organic acids. Apart from this, potassium favours the conversion of starch into simple sugars during ripening by activating the sucrose synthetase enzyme thus resulting in higher TSS. The similar findings Bavaria *et al.* (2005) [21], Gosavi *et al*. (2010) [21], Ranjeeth (2013) and Kumar *et al*. (2014) [30] were also recorded higher TSS due to soil application of potassium in tomato. In the present study, there was a marginal increase in ascorbic acid content and shelf life due to combined application of inorganic and bio-fertilizers majorly Potassium could have helped to slow down the enzyme system that catalysis the oxidation of ascorbic acid, thus helping in plants to accumulate more ascorbic acid content in the fruits. This finding in the present study is in corroboration with the results of Prameshekhar and Rajashree (2009) [53], Adeel *et al.* (2014) [2] and Kumar *et al.* (2014) [30] who recorded higher ascorbic acid content in tomato due to the inoculation VAM with inorganic nutrients.

Available nutrients status of the soil

The soil properties like pH, EC, available N, P and K after the harvest of tomato crop and post-harvest soil available nutrients have been discussed here. The soil pH got decreased in all the treatment. However, the decreases in the soil pH were marginal in the treatments which received organic manure. The acidification was mostly due to removal of bases by crop the removal of nutrients by tomato resulted in drop in soluble salt concentration of the soil thus resulting in decreasing the EC. Treatment receiving inorganic fertilizer exhibited a drop in inorganic carbon content, and the treatments which received the organic manures showed and increases in organic carbon content.

The observations on the soil available N indicated a gradual declining from the initial stage of observation and at the harvest, showing continuous uptake of N by the crop. Among the treatments, soil application of 75 % RDF + *Azotobacter* + PSB (T_{10}), which maintained comparatively higher available soil N content at a medium level of 06.01 kg ha^{-1}.

Significant low level of available P level in the soil in the treatment of soil application of 75 RDF along with bio-fertilizers indicated the efficient absorption of P by the crop especially by the action of phosphate solubilising bacteria and symbiotic effect of VAM. Similar results were obtained with Yeptho *et al*. (2010).

The similar trend was observed with available K level in the soil at the time of harvest. This indicates that under the influence of the treatments transformation reactions took place, which led to greater availability of potassium in soil and consequently resulted in rapid absorption and better utilization by the plant (Singh *et al.*, 1995) [15]. Similar findings were observed by Yeptho *et al*. (2010).

Table 2: Plant height

Treatments	Plant height (cm)		
	30 DAT	60 DAT	90 DAT
T_1	42.91	53.83	64.92
T_2	52.36	65.23	74.24
T_3	54.27	68.24	78.42
T_4	53.32	63.85	72.94
T_5	59.42	72.24	79.48
T_6	53.13	68.35	77.16
T_7	60.34	73.35	82.34
T_8	54.24	69.25	77.93
T_9	68.24	78.24	90.28
T_{10}	62.42	72.42	82.23
T_{11}	72.24	83.24	98.37
T_{12}	65.56	75.53	84.27
SEM±	2.85	3.40	3.86
CD (0.05)	8.35	9.98	11.32

Table 3: Leaf area and dry matter accumulation

Treatments	Leaf area (cm^2)	Dry matter accumulation (g)
T_1	35.23	120.23
T_2	48.83	162.86
T_3	50.82	168.65
T_4	48.15	164.58
T_5	55.23	172.63
T_6	51.82	169.83
T_7	56.28	173.27
T_8	52.16	171.85
T_9	65.73	183.89
T_{10}	61.73	175.14
T_{11}	71.36	201.58
T_{12}	67.29	193.68
SEM±	2.72	8.25
CD (0.05)	7.98	24.20

Table 4: Branch per plant

Treatments	Branch per plant		
	30 DAT	60 DAT	90 DAT
T_1	7.80	8.20	9.00
T_2	9.00	10.20	11.40
T_3	9.80	10.80	12.20
T_4	8.80	9.60	10.40
T_5	10.00	11.20	12.20
T_6	8.60	9.80	10.60
T_7	10.40	11.80	12.80
T_8	9.20	10.40	11.60
T_9	12.20	14.60	15.80
T_{10}	10.60	11.80	12.80
T_{11}	13.40	15.00	16.20
T_{12}	11.80	13.20	14.40
SEM±	0.49	0.56	0.61
CD (0.05)	1.45	1.64	1.79

Table 5: Reproductive parameters

Treatments	Days taken to 1st flowering	No. of flower par plant	Days taken for 1st fruit from flowering	Percent fruit set	Days taken for 1st harvest
T_1	30.12	62.27	10.20	44.00	67.59
T_2	26.34	74.69	8.16	47.39	59.33
T_3	25.37	78.38	7.37	46.95	56.89
T_4	26.98	73.92	8.25	45.45	61.16
T_5	25.16	78.54	7.27	47.62	56.59
T_6	26.87	73.80	8.73	44.44	60.76
T_7	25.20	78.81	7.28	47.96	56.60
T_8	26.92	75.24	8.14	45.45	60.29
T_9	23.26	79.42	6.86	52.63	53.04
T_{10}	24.70	74.48	7.43	51.02	56.00
T_{11}	22.17	79.83	6.10	55.87	50.39
T_{12}	23.67	74.49	7.26	51.28	54.56
SEM±	1.22	3.12	0.37	2.33	2.75
CD (0.05)	3.56	9.14	1.08	6.83	8.05

Table 6: Yield and yield attributes

Treatments	No. of fruit per plant	Yield per plant (kg)	Yield per ha (q)	Fruit weight (g)
T_1	27.40	1.60	355.33	58.36
T_2	35.40	2.52	560.34	71.23
T_3	36.80	2.66	591.82	72.37
T_4	33.60	2.33	517.96	69.37
T_5	37.40	2.75	610.53	73.46
T_6	32.80	2.31	512.84	70.36
T_7	37.80	2.77	615.38	73.26
T_8	34.20	2.40	534.05	70.27
T_9	41.80	3.31	736.14	79.25
T_{10}	38.00	2.94	653.13	77.35
T_{11}	44.60	3.57	794.07	80.12
T_{12}	38.20	2.99	665.10	78.35
SEM±	1.78	0.13	29.57	3.51
CD (0.05)	5.22	0.39	86.71	10.31

Table 7: Quality parameters

Treatments	TSS (^{0}brix)	Ascorbic acid (mg/100g)	Lycopene (mg/100g)	Shelf life (days)
T_1	3.98	12.76	5.24	15.20
T_2	4.07	13.64	5.83	17.40
T_3	4.08	14.25	6.12	17.80
T_4	4.06	12.98	5.45	16.60
T_5	4.16	15.12	6.33	18.50
T_6	4.06	13.12	5.55	16.80
T_7	4.09	14.79	6.28	18.40
T_8	4.07	13.21	5.63	16.80
T_9	4.18	15.14	6.65	19.80
T_{10}	4.13	14.19	6.14	19.20
T_{11}	4.21	15.93	6.95	20.40
T_{12}	4.16	14.25	6.23	19.40
SEM±	0.12	0.40	0.17	0.51
CD (0.05)	NS	1.18	0.50	1.48

Table 8: Soil analysis

Treatments	Soil pH	EC (dsm^{-1})	Available N	Available p	Available K
T_1	7.40	0.31	170.37	16.28	175.37
T_2	7.30	0.32	195.32	17.93	194.93
T_3	7.30	0.30	196.36	18.12	197.38
T_4	7.40	0.31	191.58	18.11	183.94
T_5	7.42	0.30	197.54	19.69	198.66
T_6	7.56	0.32	191.91	19.45	191.92
T_7	7.30	0.32	193.85	19.58	199.42
T_8	7.50	0.31	193.05	19.56	190.97
T_9	7.25	0.29	198.54	20.46	198.09
T_{10}	7.61	0.32	191.04	20.84	192.22
T_{11}	7.42	0.33	206.01	22.29	205.71
T_{12}	7.37	0.30	192.76	21.31	194.13
SEM±	0.18	0.01	5.08	0.49	5.13
CD (0.05)	NS	NS	14.89	1.43	15.04

Conclusion

The study revealed that maximum fruit yield is coupled with favourable fruit set and quality characters could be achieved by the integrated application of 100 % RDF + *Azotobacter* + PSB + VAM in tomato (*Solanum lycopersicum*) var. Kashi Amrit.

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