Response of integrated nutrient management on growth of Tomato (*Solanum lycopersicon* L.) cv. Pusa Ruby

Abstract

The present investigation entitles "Response of integrated nutrient management on growth of Tomato (*Solanum lycopersicon* L.) cv. Pusa Ruby" was carried out at department of Horticulture Research Farm, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow (Uttar Pradesh), during the year 2020-21. The treatment comprised of twelve treatments *i.e.,* T_1 Control (No treatment), T_2 RDF (100%), T_3 FYM (100%), T_4 Azotobacter (100%), T_5 Azospirillum (100%), T_6 RDF + FYM (50% each), T_7 RDF + Azotobacter (50% each), T_8 RDF + Azospirillum (50% each), T_9 FYM + Azotobacter (50% each), T_{10} FYM + Azospirillum (50% each), T_{11} Azotobacter + Azospirillum (50% each) and T_{12} RDF + FYM + Azotobacter + Azospirillum (25% each). The experiment was laid out in Randomized block design (RBD) with three replications. The results indicated that among maximum plant height ware recorded (16.15, 22.11, 26.59 and 30.53 cm), respectively, in treatment T_{12} at 30, 60, 90 and 120 DAT. The maximum number of branches were recorded (4.36 5.79, 6.31 and 7.04) in treatment T_{12} at 30, 60, 90 and 120 DAT. Minimum number of days required for flower blooming (32.44) in T_{12}. A maximum number of flowers per plant (39.34) were recorded at T_{12} and also maximum number of clusters per plant was recorded (9.78) in $T_{12.}$

Key Word: Integrated nutrient management, Tomato, Azotobacter, Azospirillum

1. INTRODUCTION

"Tomato (*Solanum lycopersicon* L.) 2n=24, is one of the important vegetable crops which contains some important minerals and vitamins. Tomato, the world's largest grown vegetable crop known as a protective food occupies an important place in the economy of human societies because of its high nutritive value-added products and its wide spread production in different agro- climatic conditions" [3-5].

"This can be accomplished through integrated nutrient management, which involves a combined use of fertilizers and organics to sustain crop production and maintenance of soil health" (Nanjappa *et al*., 2001). "Also, the organic manures supply the trace of micronutrients, which is not supplied by chemical fertilizers" (Kachat *et al*. 2001). "However, bio-fertilizers offer an alternative to chemical inputs, which have ability to mobilize the nutritionally important elements from non-usable to usable from through biological process and are known to increase yield in several vegetables" (Purkayastha *et al*. 1998 and Kumar *et al*. 2001). Organic manures like FYM, Vermicompost and Pressmud are available in our locality and can be efficiently utilized for vegetable production besides bio-fertilizers are cost effective and renewable source of plant nutrients to supplement the chemical fertilizers. Bio-fertilizers are natural manures containing carrier-based micro-organism which helps in enhancing the productivity by biological nitrogen fixation or solubilizing of insoluble phosphate and decomposed from wastage resulting in the release of plant nutrients. In recent years, the concept of integrated nutrient supply use or management systems involves efficient and judicious supply of all major components of plant nutrient sources. Chemical fertilizers in combination with animal manures, farm yard manures, vermi-compost, bio-fertilizers, crop residues or recyclable waste and other locally available nutrient sources for sustaining soil fertility, health and productivity which assumes significance.

"The integrated supply and use of plant nutrients from the chemical fertilizers and organic manures have been proved to produce higher crop yields than when each applied alone. This increase in crop productivity results from their combined effect the synergistic effect, improve chemical, physical and biological properties of the soil. Manure and fertilizers are the kingpins of improved technology contributing about 50-60% increase in productivity of vegetable in India irrespective of soil and agro-ecological zone. But without an integrated supply and use of plant nutrient from chemical fertilizers and organic sources, increased production is not possible" [1,2]. The soil analysis from these sites clearly showed that the unbalanced use of fertilizer over a long period led to emergence of deficiency of one or the other plant nutrients not included in the fertilizers schedule as these nutrients got depleted from the soils with higher biomass harvest under intensive agriculture. However, the yields of crops considerably improved where application of 20 tonnes FYM per ha along with recommended dose of NPK were applied. This emphasizes the necessity of an integrated nutrient supply and use with a harmonious combination of chemical fertilizers, organic manures and bio-fertilizers to maximize nutrients use efficiency and minimize their losses to achieve the goals of improving and sustaining the soil fertility, soil water relationship and their quality as well as socioeconomic conditions of the farmers. In Tomato, azotobacter and phosphorus solubilizing bacteria are mainly used *azotobacter spp.*, Azotobacter is free living nitrogen fixing bacteria, which fixing nitrogen equivalent to 30-40 kg/ha. It also produces hormones like IAA and GA3 vitamin, like biotin, folic acid supported by judicious use of organic matter ensure good seed germination and increasing productivity. These bio-fertilizers play a significant role in solubilizing insoluble phosphate. Around 95-95% of total soil phosphorous is insoluble which is not directly available to plants. The phosphate solubilizing bacteria may convert insoluble form of phosphate to soluble form by producing organic acid. About 15-25% of insoluble phosphate can be solubilized saving chemical fertilizer significantly. It produces growth promoting substances to like IAA, Gibberellins, Cytokinin and Vitamin B *etc.* These bacteria secrete some fungi static and antibiotic substances which help in producing occurrence of certain crop diseases and resistance in plant. Its help in decomposing plant residue in soil, thereby improving soil structure which also helps in increasing water holding capacity of soil. In order to meet the demand of vegetables for rising population of 21^{st} century, one should be causes to manage nutrients for proper growth of the plants and soil fertility. In view of this, present investigation entitled **"Response of integrated nutrient management on growth of Tomato (*Solanum lycopersicon* L.) cv. Pusa Ruby.**

2. MATERIAL AND METHODS

The present investigation entitles "Response of integrated nutrient management on growth of Tomato (*Solanum lycopersicon* L.) cv. Pusa Ruby" was carried out at department of horticulture, BBAU, Lucknow, during the year 2020-21. The treatment comprised of twelve level

T_1 Control (No treatment), T_2 RDF (100%), T_3 FYM (100%), T_4 Azotobacter (100%), T_5 Azospirillum (100%), T_6 RDF + FYM (50% each), T_7 RDF + Azotobacter (50% each), T_8 RDF + Azospirillum (50% each), T_9 FYM + Azotobacter (50% each), T_{10} FYM + Azospirillum (50% each), T_{11} Azotobacter + Azospirillum (50% each) and T_{12} RDF + FYM + Azotobacter + Azospirillum (25% each). The experiment was laid out in Randomized block design (RBD), with three replications. During the *Rabi* season of 2020- 21 at the Horticulture Research Farm, Department of Horticulture, Babasaheb Bhimrao Ambedkar University, Lucknow (Uttar Pradesh) which is subjected to the extreme of weather conditions. Geographically this area falls under humid sub-tropical climate and located between18.6^0 and 20.20^0 north latitude and 76.0^0 and 78.0^0 east longitude on an elevation of about 123 meters from sea level in the genetic alluvial plains of eastern Uttar Pradesh, which is subjected to the extreme of weather conditions.

Treatment combinations:

S. No.	**Treatment Combinations**	**Notations**
1	Control (No treatment)	$\mathbf{T_0}$
2	RDF (100%)	$\mathbf{T_1}$
3	FYM (100%)	$\mathbf{T_2}$
4	Azotobacter (100%)	$\mathbf{T_3}$
5	Azospirillum (100%)	$\mathbf{T_4}$
6	RDF+FYM (50% each)	$\mathbf{T_5}$
7	RDF + Azotobacter (50% each)	$\mathbf{T_6}$
8	RDF + Azospirillum (50% each)	$\mathbf{T_7}$
9	FYM + Azotobacter (50% each)	$\mathbf{T_8}$
10	FYM + Azospirillum (50% each)	$\mathbf{T_9}$
11	Azotobacter + Azospirillum (50% each)	$\mathbf{T_{10}}$
12	RDF + FYM + Azotobacter + Azospirillum (25%each)	$\mathbf{T_{10}}$

VARIETY

One variety of tomato *viz.* Pusa Ruby was selected for the present study. The seeds of the cultivar were obtained from the Indian Agricultural Research Institute, New Delhi. Pusa Ruby was can even set fruit when night temperatures drop to 8 ^{0}C. The plant has moderate foliage cover and prolific bearing. The fruits are flattish-round, smooth and develop a uniform red colour at maturity.

Field operations: Seedling preparation:

The seeds were sown in nursery beds on 2nd Nov. 2020 and seed were germinated after 5-6 days.

Preparation of the experimental field:

The land of the experimental site was irrigated prior to sowing for optimum moisture level. The first ploughing was done with disc plough and sub-sequent ploughing was done with cultivator followed by planking. The required area was then marked and plots were prepared according to the layout plan.

Manures and Bio-fertilizers application:

The land was ploughed and harrowed 3 or 4 times to obtain a fine tilth. About 10 tonnes of Farm Yard Manure (FYM) or vermin- compost/ compost @ 1-1.5 t per acre, Neem cake 100% and 50%, is applied at the last ploughing. Seedling treated with Azospirillum 2Kg/ ha and 1Kg/ ha, PSB 2Kg/ha and1Kg/ha.

Transplanting:

Seedlings were transplanted at a spacing of 45 x 30 cm and thus in a plot, 16 seedlings of specific cultivar were accommodated. Immediately after transplanting a light watering with rose can was given to avoid transplanting shock.

Irrigation:

First light irrigation was given one day after transplanting and subsequent irrigations were given as per need of the crop.

Cultural operations:

First hand weeding was done at 10 days after transplanting to keep away the weeds. The second weeding was done 30 days after the first weeding followed by hoeing.

1	Net plot size	1.80 x1.20 m
2	Field border	1.00 m
3	No. of row in each plot	04
4	No. of columns in each plot	04
5	Main irrigation channel	1 m
6	Block Border	1 m
7	Spacing	45 x 30 cm
8	Date of seed sowing	2nd November, 2020
9	Date of transplanting	7th December, 2020

Observations were recorded:

Growth characters:

Plant height (cm):- The data on plant height was recorded at 30, 60, 90 and 120 days after transplanting. Plant height was measured in centimeters from the base to the top of the plant by meter scale.

Number of branches per plant:- The number of branches on all three tagged plant was counted which was started after 30 days after transplanting.

Flowering characters:

Number of days to first flowering- The of flower initiation one each tagged plant was recorded and three flowers per plant were tagged again number of days from days of from date of transplanting were counted and recorded

Number of flowers per plant- Number of flowers appeared on individual plants in a plot were recorded and average was calculated over selected plants.

Yield & yield attributing characters:

Number of Fruit Per Plant:- Several pickings were required as all the fruits did not mature at a time. In each picking, fruits were counted and after last picking, the average number of fruits per plant was calculated.

Fruit yield per (ha)

From fruit yield per plant the fruit yield per plot and the fruit yield per hectare were determined in quintal.

3. RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads.

Growth characters

Plant height (cm)

The results indicated that maximum plant height ware recorded (16.15, 22.11, 26.59 and 30.53cm), respectively in T_{12} at 30, 60, 90 and 120 DAT, which was at par with T_{11} and T_{10} at 30, 60, and 120 DAT also at par with T_{11} at 90 DAT. While minimum plant height ware recorded (12.78, 16.49, 20.95 and 24.52 cm), respectively in T_1 at 30, 60, 90 and 120 DAT). The effect of FYM, Neem-cake, Azospirillum, phosphor-bacteria and NPK in different combinations on tomato plant. Results showed that a combination of organic and inorganic fertilizers gave the best result in terms of growth, plant height. Similar results were obtained by Kumaran *et al*. (1998), Naidu *et al*. (1990). Number of primary branches, dry matter accumulation and leaf area index were significantly influenced by application of organic manures, inorganic fertilizers, biofertilizers and organic formulations. Results were similarly found Kumar *et al*. (2013), Bhardwaj *et al*. (2010).

Number of branches per plant-

The data clearly indicates that different treatments increase the number of branches. The maximum number of branches were recorded (4.36, 5.79 6.31 and 7.04) in T_{12} at 30, 60, 90 and 120 DAT, which is a at par with T_8, T_{10} and T_{11} at 30 DAT also at par with T_8 and T_9 at 90 DAT. Whereas minimum number of branches were recorded (2.67, 3.26, 4.08 and 4.75) in the $T_{1.}$ Numbers of branches are the contributors of yield as they bear the leaves, which fix the carbon dioxide through 34 photosynthetic mechanisms. 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 results of the study are similar with Siddaling *et al*. (2017).

Flowering character:

Days of first flowering-

The data on the number of days taken by plants for blooming are the data indicated that the required a minimum of days T_{12} (32.44) and maximum were found in treatments T_1 (37.72). "Might invested that combined application of bio- fertilizers and inorganic NPK which increased the number of flowers per plant, fruit weight and fruit set increased in the crop fertilized with both organic and inorganic sources as compared to the crop treated with NPK alone". Raut *et al*. (2003)

Number of flowers per plant:

A maximum number of flowers per plant (39.34) were recorded at T_{12}. While the minimum number of flowers per plant (24.26) was recorded from T_1 (control). "This might be due to the fact that nitrogen in plants increased cell division and cell differentiation. Thus, plant remained in vegetative phase and resulted in imbalance between C: N ration, thus delayed flowering at higher nitrogen level". Parmar *et al*. (2019).

Number of flower cluster per plant:

A maximum number of clusters per plant (9.78) were recorded at T_{12}. While the minimum number of clusters per plant (5.67) was recorded from control (T_1). "This might be due to the fact that nitrogen in plants increased cell division and cell differentiation. Thus, plant remained in vegetative phase and resulted in imbalance between C: N ration, thus delayed flowering at higher nitrogen level". Parmar *et al*. (2019).

Fruit yield (q/ha):

The data regarding the fruit yield q/ha are presented in Table 2 Results clearly depict the superiority of the treatment over these characters. Here T_{11} have yielded highest (482.47q/ha) and Lowest yield was recorded T_0 (301.58 q/ha) control.

STATISTICAL ANALYSIS

Data collected for various growth, yield at successive stages of plants growth were analyses statistically and the significance of the treatment effect was judged with the help of "F" (Variance ratio) test following Randomized Block Design.

Sum of squares: -

1. Correction factor = (C.F.) = $(G.T.)^2 / N$

2. Total S.S. = (T.S.S.) = $(X12 + X^2 + \ldots\ldots + X)^2$ - C.F.

S.S. due to block = $_1$ $(B^2 + \ldots\ldots + B_3{}^2)^2$ -C.F.

3. S.S. due to treatments = $(Z_1^2 + Z_2^2 + \ldots\ldots + Z^2)^2$ -C.F. $_{11}$

4. S.S due to error= (Total S. S.) - (Block S.S.) – (Treatment S.S.)

Analysis of Variance: -

Suppose the number of treatmentsis "n" and number of replication "r", the total number of degree of freedom (D.F.) was divided into three parts representing the independent comparison.

Between blocks

Between treatments.

Random variation which provides a basis for the estimation of error

Thus the structure of analysis adopted was as follows:-

Source of variation	**D.F.**	**S.S.**	**M.S.S.**	**Variation ratio**	**Table value of F at**	
					5%	1%
Block	r-1		V_B	VB/VE		
Treatments	n-1		V_T	VT/VE		
Error	(n-1) (r-1)		V_E			
Total	nr-1					

Hence, the total number of observation in nr, the total degree of freedom will be nr-1, as the block and treatments are represented by "r" and "n" respectively their corresponding degree of freedom will be (r-1) and(n-1) standard error (S.E.) due to treatment =√VE/r

Standard Error (S.E.) and critical difference(C.D.): -

The standard error of the mean based on "r" replication was estimated By relation: -

(S. E.)Mean =√VE/r

Critical difference (C.D.) at 5% level of significance= (SE) diff **×** at 5% for error degree of freedom.

The results significant at 5% levels of significance were marked with one asterisk and those significant at 1% levels of significance were marked with two asterisks.

4. CONCLUSION

From the present investigation, it is concluded that T_{12} (RDF + FYM + Azotobacter + Azospirillum (25% each), gave superior enhancing performance in all growth parameters

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Table 1: Effect of Integrated Nutrient Management on Plant height cm and number of branches in tomato

S. No.	Treatments	Plant height cm (DAT)				Number of branches (DAT)			
		30	60	90	120	30	60	90	120
1	Control (No treatment)	12.78	16.49	20.95	24.52	2.67	3.26	4.08	4.75
2	RDF (100%)	14.20	18.80	22.53	25.43	2.94	3.79	4.99	5.55
3	FYM (100%)	14.14	18.57	22.24	27.09	2.80	3.45	4.70	5.15
4	Azotobacter (100%)	13.85	19.04	23.40	26.22	3.39	3.98	5.35	5.85
5	Azospirillum (100%)	14.68	20.06	21.84	25.55	3.67	3.88	4.96	5.74
6	RDF + FYM (50% each)	16.07	17.02	23.42	26.96	3.38	4.06	4.70	5.26
7	RDF + Azotobacter (50% each)	15.61	17.98	22.91	26.03	3.10	3.54	4.78	5.55
8	RDF + Azospirillum (50% each)	14.10	18.53	23.63	26.21	3.85	4.18	5.46	6.07
9	FYM + Azotobacter (50% each)	14.92	18.63	23.38	27.79	3.58	3.98	5.45	5.76
10	FYM + Azospirillum (50% each)	15.46	19.38	23.69	28.90	3.72	4.06	5.07	6.07
11	Azotobacter + Azospirillum (50% each)	15.12	20.35	22.60	28.98	3.88	4.15	4.94	5.87
12	RDF + FYM + Azotobacter + Azospirillum (25%each)	16.15	22.11	26.59	30.53	4.36	5.79	6.31	7.04
S.E. +		0.367	0.782	0.603	0.894	0.252	0.309	0.338	0.250
C.D.		1.083	2.310	1.781	2.638	0.745	0.911	0.997	0.737

Table 2: Effect of Integrated Nutrient Management on Days taken of first flowering, Number of flowers per plant and Number of flower cluster per plant of tomato

S. No.	Treatment	Days taken of first flowering	Number of flowers per plant	Number of flower cluster per plant	fruit yield per/ ha (Q)
1	Control (No treatment)	37.72	24.64	5.67	301.58
2	RDF (100%)	36.75	29.05	6.84	306.04
3	FYM (100%)	36.54	31.10	6.56	371.91
4	Azotobacter (100%)	36.60	32.10	8.16	363.01
5	Azospirillum (100%)	36.45	34.59	6.58	419.40
6	RDF + FYM (50% each)	36.30	29.66	6.78	416.78
7	RDF + Azotobacter (50% each)	36.57	28.02	7.28	411.41
8	RDF + Azospirillum (50% each)	37.03	35.44	8.13	469.92
9	FYM + Azotobacter (50% each)	36.83	36.75	8.31	412.85
10	FYM + Azospirillum (50% each)	36.60	35.63	7.88	373.81
11	Azotobacter + Azospirillum (50% each)	36.27	36.32	8.30	365.54
12	RDF + FYM + Azotobacter + Azospirillum (25% each)	32.44	39.34	9.78	482.47
	S.E. +	0.727	0.727	0.479	42.228
	C. D	2.146	2.146	1.414	84.456