Environment Conservation Journal 18(3) 39-44, 2017
ISSN 0972-3099 (Print) 2278-5124 (Online)
Abstracted and Indexed

Comparative response on the growth of the tomato (*Lycopersicon esculentum*) under fertilizer treatment based on on-site soil testing

Kavita Solanki[1]✉, Vishwajeet Singh[2] and Seema Bhadauria[1]

Received: 10.06.2017 **Revised: 28.08.2017** **Accepted: 12.09.2017**

Abstract

With the ever increasing demand for increasing the productivity per unit area and the narrowing cost benefit ratio has made the farmer more sensitive to the soil fertility status and soil health. Focus on the existing soil testing methods used to test the soil all over the India. This paper is an integrated approach of formulating a complete and a balanced fertilizer recommendation was tested in the field with tomato as the crop. This soil test kit is enabling the farmer himself to do the analysis in field and apply fertilizers as per soil test value. This soil test kit has been formulated and fabricated in such a simple mode so that an illiterate farmer can also test his soil of his field.

Keywords: soil, soil testing, soil nutrients, tomato, fertilizers, nutrients recommendation

Introduction

Agriculture plays a vital role in India's economy. 54.6% of the population is engaged in agriculture and allied activities and it contributes 17.4% to country's Gross Value Added by Annual report (2015). Economy of the state as well as of the country is primarily agricultural based. According to the World Bank report, India has nearby 60 percent of the agricultural land and about 50 percent of the Indian population is employed to this sector (Agriculture in India). In spite of having such a cultivable land and agricultural history, our production is not up to the extent as compared to other countries. Modern agriculture is largely dependent on chemical fertilizers and crop yield are highly correlated with levels of fertilizer application. Fertilizer played a key factor for ushering in green revolution in India during mid sixties. The consumption of primary plant nutrients increased from mere 0.785 mt in 1965-66 to 1.77 mt in 1996-97. Though, the increase in fertilizer consumption over the years is impressive, ensuring greater efficiency in use of fertilizer by farmer at large is still to be realized. During the last 10 years, there has been considerable revolution in the agricultural sector. Given the importance of agriculture sector, Government of India took several steps for its sustainable development. Government has tried to reach the farmers are successful in many areas helping them financially in the forms of loans and subsidies as well as proving methods and knowledge that helped them to effectively use right amount of fertilizers, irrigation facilities and soil test for proper yield. The tomato (*Lycopersicum esculentum*) is an important vegetable crop worldwide which is well adapted for different climatic conditions, soil types and altitude. Though farmers use high yielding crop varieties in the country, they rarely reach the potential yield of the crop due to poor fertilizer management. Its cultivation has spread throughout the world occupying an area of 3.5 × 106 ha with the production of 1 × 106 h tons. Tomatoes aside from being tasty and nutritious as they are among other nutrients, a good source of vitamins A and C and lycopene content. More than 90% of the vitamin C in human diets is supplied by fruits and vegetables (Vallejo *et al.,* 2002). Tomato fruits contain high amount of ascorbic acid and lycopene (Tindall, 1983). Lycopene, an antioxidant, is the pigment that imparts red color to some fruits, most notably tomato and watermelon. It is also a highly efficient oxygen radical scavenger and has been implicated in human health as providing protection against cardiovascular disease and some cancers,

Author's Address
[1] R.B.S.College, Deptt. Of Botany, Agra
[2] Deptt. of Botany, Bundelkhand University, Jhansi
E-mail: kavitas_11@rediffmail.com,

particularly that of the prostate. Hence, this crop is gaining importance both in developing and developed countries and efforts are being made for the quality and quantity production of this commodity. Tomato production occupies 60,000 ha within Uttar Pradesh and is the major commercial crop for the region. Despite this, tomato grower have long-standing complaints regarding poor pulp content, disease susceptibility and poor shelf life, low yield, undersized fruit, premature fruit drop owing to loosely attached fruit. Balanced nutrition plays major role to solve all the problems of grower. Balanced fertilization is achieved through soil testing. In many cases, farmers are applying very high doses of fertilizers, particularly N without adequate P and K than required. Crop failure through pests and diseases and also soil deterioration and pollution hazards are the consequences of this practice besides increasing input cost. In this context, balanced nutrition through soil testing will enhance the fertilizer use efficiency of crops and help in achieving sustainable economic farming. Many pre and post harvest factors influence the phytochemical contents of horticulture crops. Large genotypic variation in vitamin content was reviewed by Kurilich *et al.,* (1999) and Vallejo *et al.,* (2002). Other preharvest factors include climatic conditions and cultural practices (Howard *et al.,* 1999; Lisiewska and kmiecik, 1996; Jeffery *et al.,* 2003). Nutrient supply and environment mainly affect the productivity of the crop. Some of these nutrients are supplied by soil while, other are to be added from the external source in the form of organic and inorganic. Tomato crop requires heavy manure and sufficient amount of fertilizer for heavy yield. For improving plant growth directly by providing nutrients (Splittstoesser,W.E.1990). Fruit yield of tomato has been influenced by different levels of nitrogen and phosphorous that's why it needs greater attention to apply these nutrients in proper amount . (Mehla *et al.,* 2000) (Sharma *et al.,* 1999) (Pandey *et al.,* 1996). Present agricultural production largely depends upon fertilizer use to such as extent that its advanced estimate have been closely related to the quantity of fertilizer consumed which may or may not come true always. Our farming community uses different inputs like manures, fertilizers, bio-fertilizers, concentrated cakes, pesticides, bio-control agents, bio-pesticides, microbial consortia and other bio-originated material for agricultural and horticultural crops. The quality of these inputs determines their efficiency and to realize better benefits upon their use in crop production. Similarly, diagnosing the status and quality of soil for their health status and their ability to support for higher level of crop production is an important prerequisite both for remunerative farming and harnessing the potential of natural resources. Few mechanisms are already in place like soil test laboratories in the state to carry out soil. These services are carried out to cater to the needs of farmers and to help them in decision making of crop choices. But soil testing mechanism used in India is a very tedious job and it takes time as different samples of soil is collected from farming land and sent to the laboratories, then test are done and reported back to the farmer. This procedure generally takes almost 7 to 10 days and may be more if the laboratory is far away from the land.Though these supporting measures are available to help to use agricultural and horticultural inputs properly, it is at most important to identify soil fertility status in easy way. In this context, soil analysis is an important and inevitable step to help the farming community with the support and help of advanced methods and instruments.One of the objectives of developing portable soil test kit is to get awareness of importance of soil testing among farming community and thereby to know the importance of soil fertility status for good productivity. To know how soil is becoming poor fertile and polluted in the environment by indiscriminate use of different fertilizers without doing soil analysis and becoming not fit for use in future. To known about different constituents and parameters of soil fertility status which will affect its fitness for production of crops. Measure the level of soil reaction, different soil nutrients and salt concentration which may be useful crop production. Advantages of portable soil testing kits, it is simple, quick and convenient to use. A test for macronutrients can be completed in less than ten minutes once the sample has been collected. It is convenient because the kit is contained in a small box which can easily be carried to even the most remote rural field locations. It is much cheaper than laboratory testing facilities; therefore it is available for the use of poor farmers. The test can be carried out on the spot

where the problem exists and the facts and conditions related to the problem are fresh in mind. In the field testing provides the kit user with immediate answer to nutrient problem. It cuts down on the cost of time, transportation and materials that may be needed to carry soil samples to the laboratory for analysis. It provides a much better guide than blanket fertilizer recommendations that may be adopted in the absence of a functional and accessible soil testing laboratories. It enable the literate and enlightened farmers to conduct their own on the spot analysis and interpretation of the test result without the assistance of an official extension agent. This is very important in most developing countries where the ratio of extension worker to farmer population is very low. The main objective of this study was to investigate the potential of adapting this systematic approach to formulate a fertilizer recommendation on site-specific basis for tomato and to test this recommendation in the field. Working with the device is very easy we just follow the given instructions.

Material and Methods

Here we done all the test by Soil Kit Ferticheck™ Application 5/DEL/2007 published 2008-09-12,filed 2007-01-02 developed by Dr.Seema Bhadauria with the help of BioLink Overseas Company. We follow the standard methods of soil testing describe by Chopra and Kanwar, 2007.

1. **Carbon Test**:

Take the soil sample and fill it up to the lower mark of borosil cup. Add solution 'A_1' up to the middle mark of the borocil cup and shake well. Add solution 'B_1' up to the upper mark of borosil cup. Shake well and wait for 30 min. Match its color with Carbon Color Chat.

2. **Phosphorous test**:

Take the soil sample and fill it up to the lower mark of test tube. Add solution 'C' up to the upper mark of the test tube and shake well. Stand for 5 min. Match its color with Phosphorous Color Chat.

3. **Nitrogen Test**:

Take the soil sample and fill it up to the lower mark of borosil cup. Add solution 'D' up to the upper mark of the borocil cup and shake well. Stand for 5 min. Match its color with Nitrogen Color Chat.

4. **Potash test**:

Take the soil sample and fill it up to the lower mark of test tube. Add solution 'E' up to the upper mark of the test tube and shake well. Stand for 5 min. Match its color with Potash Color Chat.

Results and Discussion

After knowing the fertility status from all soil parameters of each representative soil fertilizer recommendation for the tomato crop given in Table. 1.Inadequate supply of nutrients is most important among the various factors responsible for low productivity of crops. Growth and development of reproductive parameters benefited significantly from balanced NPK fertilization. Plant height and yield were both increased. Results of tomato crop trial shows that after testing soil a farmer can save 20 kg/ha N, 10 kg/ha P and 10 kg/ha K fertilizer. Soil testing can be responsible for reducing the plantation cost and increasing the production value. By soil testing recommendation, height of tomato plant is 8.24 inches after 142 days of sowing and by reference height of plant is 7.05 inches given in Table. 2. These result shows that by testing his soil, a farmer can not only save his fertilizer but also can increase the crop production and quality. This can help in increasing farmers benefit and also save environment and soil depletion by chemical fertilizer. India has undergone many rational changes in last ten years, from information technology to the defense, from agriculture to education. People are now moving from rural areas to the urban areas for better jobs and better lifestyle, Indian population has never been stagnant, and is increasing day by day. Our agricultural sector is fully dependent upon the rural population as farmers and cultivators are from rural areas. Days are not so far when there will be scarcity of farmers and cultivators, our cultivation methods are not so advanced, we can see its impact from the data provided by Wikipedia.org that how from the same field other country like Australia is growing crops almost double of what amount we grow here. Our soil testing system are fully dependent upon the laboratories managed by the agricultural universities of the states, many states are facing man power at this stage how can they increase the number of lab in order to cover whole nation. According to the report published by department of

Table. 1 Crop : Tomato (spacing 60 × 45 cm)

(a) Recommendation by Soil Testing Kit:

Crop	Fertility class	Quantity of Nutrient required				Time of application and remark (if any)
		N (kg/ha)	P (kg/ha)	K (kg/ha)	C (t/ha)	
Tomato (Rabi)	High	60	35	35	10	Basal $\frac{1}{2}$ N, Full P & K; Top dressing of $\frac{1}{4}$ N at 21 DAT, $\frac{1}{4}$ at 42 DAT.
	Medium	80	50	50	15	
	Low	110	60	60	20	

Crop	Fertility class	Quantity of Nutrient required				Time of application and remark (if any)
		N (kg/ha)	P (kg/ha)	K (kg/ha)	C (t/ha)	
Tomato (Zaid)	High	60	30	30	18	Basal $\frac{1}{2}$ N, Full P & K; Top dressing of $\frac{1}{4}$ N at 21 DAT, $\frac{1}{4}$ at 42 DAT.
	Medium	80	40	40	22	
	Low	110	50	50	25	

(b) Recommendation by Reference value:

Crop	Fertility class	Quantity of Nutrient required				Time of application and remark (if any)
		N (kg/ha)	P (kg/ha)	K (kg/ha)	C (t/ha)	
Tomato	High	80	40	40	--	Basal $\frac{1}{2}$ N, Full P & K; Top dressing of $\frac{1}{4}$ N at 21 DAT, $\frac{1}{4}$ at 42 DAT,
	Medium	100	50	50	--	
	Low	120	60	60	--	

Table. 2. Results of Tomato crop trial:

S.No.	Recommendations based on	Plant Height (In Inches)						
		1	2	3	4	5	6	7
1. After 30 days of sowing	Soil testing kit							
	(i)	3	2.9	4	3.5	3	3.11	3.9
	(ii)	3.11	3.5	2.8	2.1	3.5	3.5	3.0
	(iii)	2.5	3	2.4	2.5	3.2	2.11	3.0
	Total mean	3.03						
	Reference value							
	(i)	3	2	2	2.5	4	3.0	2.6
	(ii)	3.1	3.3	1.1	2.8	3.5	3.7	3.2
	(iii)	3	3	2.9	3	3.7	3.11	3
	Total mean	2.93						
2. After 52 days	Soil Testing Kit							
	(i)	3.5	3.1	4.6	4.2	4.5	4.3	4.5
	(ii)	4.2	3.2	3	3	3.1	3.8	3.11
	(iii)	4	3.6	3.2	3..8	3.9	3	3.8
	Total mean	3.69						
	Reference value							
	(i)	3.5	2.8	2.5	2.7	4.3	3.2	3

	(ii)	3.4	3.5	2.3	3.1	3.7	3.8	3.2
	(iii)	3.3	3.2	3	3.4	3.9	4.5	4
	Total mean	3.34						
3. After 64 days	Soil Testing Kit							
	(i)	3	3.11	3.7	2.12	4.7	3.9	3.1
	(ii)	3.5	3.4	3.2	3.2	4	3.8	3.2
	(iii)	4.7	3.6	3.4	3.9	3.3	3	3.11
	Total mean	3.47						
	Reference value							
	(i)	3.7	2.9	2.8	2.7	2.11	4.5	3
	(ii)	3.4	3.7	3	3.8	3.11	3.1	2.8
	(iii)	3.4	3.3	3.6	3.4	3	4	3.8
	Total mean	3.29						
4. After 70 days	Soil Testing Kit							
	(i)	3.5	4B	3.9	4	4.1B	4.2B	4B
	(ii)	4B	3.8B	3.5	3.8B	4.3	4.1B	3.6
	(iii)	4.11	3.1B	3.6B	4.2	3.6B	3.8	4.5B
	Total mean	3.88						
	Reference value							
	(i)	3.8	3.4	3	2.8	4.8	4.1	4
	(ii)	3.4	3.7	3.3	3.1	3.5	3.11	3
	(iii)	3.6	3.3	3.8	3.8	3.8	4.2	4
	Total mean	3.55						
5. After 82 days	Soil Testing Kit							
	(i)	5	4.6F	4.3	6.2F	4.11	6	5.2F
	(ii)	8	5F	5F	4.2F	3.5	5.5	4.2
	(iii)	5.2	5.8F	5.8F	6.5B	4.1F	4.5F	5.2F
	Total mean	5.3						
	Reference value							
	(i)	4.2	3.1	4.1	3.9	6F	7F	6
	(ii)	3.8	4	5F	8.5F	8	8.5F	8
	(iii)	4	3.11	4.2F	5.2F	5.8	4	4
	Total mean	5.25						
6. After 142 days	Soil Testing Kit							
	(i)	6	7.5	8.5B	8.5F	8.11	9.11	7.4
	(ii)	8	8	7F	7.1	7.5	7.5	6.2
	(iii)	10	10.11F	10.11	9F	10	8.3	9B
	Total mean	8.24						
	Reference value							
	(i)	5.4	5.4	6.8	5.6B	8.1	8.3	9.5
	(ii)	6	5.9	5.6	9F	8.5B	9.5F	6
	(iii)	6.1F	6.3B	7.9	9F	7.3	6	6.11
	Total mean	7.05						

agriculture, Government of India 2011 there a 661 soil testing laboratories including 120 mobile vans operating in 608 districts of the country with an average capacity of 11,000 to 20,000 samples per year. Reports also say that we get the opportunity to test our soil once in a year and we grow almost 3

crops over that soil in a year. Our approach can be really helpful in this area as kits are mobile, quick, accurate as well as easy to operate. It can be taken anywhere deep inside the territory and test the farm land and give the report on spot. The portable soil testing kit has been widely accepted by the farming community. Results of fertility status carried by using reagents in portable soil testing kit are compared with quantitative analysis. Its efficiency was calculated for each parameter comparing with quantitative analysis and its overall efficiency is presented. Further it was found that it is helpful to farmers to test their farm holdings themselves on spot and take up fertilizer recommendations to different crops without waiting for laboratory report. Hence, it is farmer's friendly most useful for the Indian farmer at affordable price to know the fertility status immediately.

Conclusion

Application of fertilizer whether organic or inorganic, improved the growth and fruit yield and fruit quality of tomato. Excessive use of organic and inorganic fertilizers was found to be dangerous to soil quality. In this study, the farmer himself to do the analysis in field and apply fertilizers as per soil test value This treatment can be responsible for reducing the plantation cost and increasing the production value.

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