Int.J.Curr.Microbiol.App.Sci (2022) *11*(06): 359-365

International Journal of Current Microbiology and Applied Sciences
ISSN: 2319-7706 **Volume 11 Number 06 (2022)**
Journal homepage: http://www.ijcmas.com

Original Research Article https://doi.org/10.20546/ijcmas.2022.1106.040

Growth and Development of Tomato (*Solanum lycopersicum*) under Foliar Application of *Amrut jal* as an Organic Source of Nutrient

Archit Malviya*

Bhawanipur Colony, Annapurna Road, Indore, India

**Corresponding author*

Keywords

Amrut jal, Growth, *Rabi*, Tomato, Yield

Article Info

Received:
20 May 2022
Accepted:
08 June 2022
Available Online:
10 June 2022

A B S T R A C T

An experiment was conducted in Indore, MP to study the influence of a liquid organic manure viz., *Amrut jal* on the growth and yield of tomato during *rabi* season of 2021-22. The experiment was designed considering 2 treatments, viz., T1: standard procedure (control); and T2: *Amrut jal* (1%). Different growth and yield attributes of the crop were highly influenced by different organic treatments. In this context, T2 : *Amrut jal* (1%) emerged as an effective treatment with the higher tomato fruit yield of 14.30 fruits per plant and fruit weight difference of 34.42 g/plant. However, under the exposures of organically designed treatment settings, few growth contributing parameters performed poorly, and some even decreased in length.

Introduction

Tomato (*Solanum lycopersicum* L.) is a significantly popular and important plant species that belongs to the Solanaceae family and originates from the Peru-Ecuador-Bolivia region. Tomato is one of the most significant vegetable crops grown across the world, ranking second only to potato in terms of acreage but first in terms of processing.

It ranks 7th position in worldwide production after maize, rice, wheat, potatoes, soybeans, and cassava. In 2017, global tomato output was over 170.8 million tonnes, covering approximately 5.02 million hectares of farmland. China became the leading producer of tomatoes in the world, accounting for 31% of the total production. In India, it covers an area of 571.70 million ha and produces 10054 million tonnes per year. With a total area of 47.2 million ha and a production of 1285.10 million tonnes, and a yield of 27.2 million tonnes per hectare, Karnataka is one of the largest tomato-growing states (Anon., 2008).

However, most of our country's commercial growing areas use a variety of chemical fertilizers and pesticides to grow the crop (NHB Horticultural Statistics at a Glance, 2017b). As a result of the presence of hazardous residues of many prohibited pesticides or other agrochemicals, the quality of the

product is worsening day by day. Furthermore, the gradual rise in input costs in conventional chemical farming makes it practically impossible for small and marginal farmers in our nation to raise this crop.

In the current context, organic farming, which is a comprehensive production management method for maintaining and strengthening agro-ecosystem health, has acquired widespread acceptance as a viable alternative to conventional food products that provide safe food for human consumption**.** According to IFOAM – Organics International, over 71.5 million hectares of farmland are covered by organic farming as of 2020. This farming system relies on green manures, crop rotations, crop residues, animal manures, biofertilizers, and bio/botanical pesticides rather than synthetic fertilizers, pesticides, and growth regulators. *Amrut jal* is one such well known bio-fertilizer. *Amrut jal* (Sanskrit: अमृत जल) means "elixir of immortality" in Sanskrit. It has remarkable powers when properly prepared and applied. Biofertilizers identical to *Amrut jal* have scriptural references in both Vedas and Vrikshayurveda, which state that they are used to increase soil activity, soil fertility, and plant development, as well as help plants develop resistance to insect pests and diseases.

These organic input approaches have a strong impact on crop development, production, and quality characteristics (Dutta *et al.,* 2016; Nag *et al.,* 2017; Rambuatsaiha *et al.,* 2017; Dutta *et al.,* 2018). Different low-cost organic liquid formulations have fewer plant nutrients, particularly NPK, but they contain a large number of beneficial bacteria that are actively involved in the mineralization process after they are applied to soil, improving soil structure (Swami *et al.,* 2012a; Oraon *et al.,* 2015; Mohanta *et al.,* 2015; Mallick, 2016). The presence of microorganisms in organic liquid manures also starts to break down the available nutrients into a form that plants may easily absorb (Mallick, 2016). Taking into account all of the above-mentioned important factors, the current study focused on the impact of *Amrut jal* on tomato growth and yield parameters.

Materials and Methods

The following sub-sections illustrate the details of the material and methodology employed in the present research:

Experimental site, conditions, design, and material

The experiment was conducted in Indore city (Latitude: 22°43′04″ N; Longitude: 75°49′59″ E and Altitude: 550 m) in Indore district of Madhya Pradesh during the Rabi seasons of 2021-22. The experimental pots, of size 6" Inch Diameter, 16 x 12 x 9 cm, were prepared and tomato seeds were buried at a depth of 3 cm.

The pots were filled with Malwa Black soil, also called *regur* soil. One pot was treated by standard practice (SP), while the other was treated with a 1 percent *Amrut jal* solution as an organic source of nutrients. Thirty-day-old seedlings were uprooted and replanted into earthen pots containing soil, three seedlings per earthen pot containing soil, one treated with standard procedure and the other with a 1 percent *Amrut jal* solution. Plants were uprooted manually for growth analysis. Each sample was separated into its component - leaves, stems, branches, roots, and fruits**.**

Preparation of *Amrut jal*

For the preparation of *Amrut jal*, fresh cow dung: cow urine: and water @ 1:1:10- proportions (cow dung and cow urine should preferably be of indigenous cow's origin) were mixed with 100 g of jaggery and kept the mixture for 3-days for fermentation.

During fermentation, the mixture was stirred twice daily, preferably during the morning and evening hours by using a wooden stick/ladle. Organic input thus obtained after 3-days of fermentation has a 1% concentration considering the proportion of cow urine used for the purpose as against the quantity of water added to prepare *Amrut jal.*

Seed Treatment

For seed treatment, seeds were soaked into 3 to 5 percent of *Amrut jal* solution for 20 minutes before planting.

Physiological Growth

The different biometric observations were recorded from all the plants in each pot at 75 DAS (days after sowing) and harvest (160 DAS). The mean of three plants was considered for analysis. The plant height was measured from ground level to the tip of the main shoot. The root length was measured from the bottom end of the shoot to the end of the root. Plant spread was measured from leaf tip to leaf tip in the broadest region of the plant. To ensure the consistent weight, all plants from each pot were plucked and placed in brown paper bags with holes for air drying, then oven-dried at 70°C. Following that, the dry weight of each plant was recorded and reported as total dry matter per plant.

Yield of Plant

The number of flowers per plant was calculated on the 75 DAS and at harvest (160 DAS). The matured red fruits in each plant were collected from three pickings in all the three plants of each pot. Then the mean of replications represented the number of fruits per plant. The fruit weight per plant at harvest was recorded and the mean fruit weight per plant was expressed in grams per plant.

Results and Discussion

The results illustrated that almost all the growth (Table 1) and yield attributes taken into account in this investigation were influenced by the intervention of *Amrut jal* treatments. In addition to nutrients, cow waste in *Amrut jal* includes microbial load and plant growth-promoting compounds that may aid in enhancing plant development, metabolic activity, and pest and disease resistance (Radha *et al.*, 2014). Consecutively, it was observed in the experiment that *Amrut jal* boosted the number of branches and the spread of the plant. This might be owing to the availability of sufficient critical plant nutrients for crops, which help to improve nitrogen metabolism, auxin levels, photosynthetic activity, and chlorophyll levels in plant tissues. However, when compared to the control, which was 65.01 cm at 75 DAS and 104.50 cm at 160 DAS, and root length was 15.02 cm at 75 DAS and 18.72 cm DAS, there was a significant reduction in plant height, which was 59.68 cm at 75 DAS and 100.00 cm at 160 DAS, and in root length, which was 12.00 cm at 75 DAS and 14.34 cm at 160 DAS, with a mean difference of 4.66 cm in height 3.70 cm in root length. Though, the findings as recorded in the case of plant height and root length in this experiment are not corroborated well with the earlier observations of Mahto *et al.,* (2018) in french beans. This might be because, while liquid organic manures may not deliver the essential amount of nutrients for plants, they do initially encourage crop development owing to the presence of animal dung, urine, and microflora and fauna activity (Nileema S. Gore *et al.*, 2010). Abiotic factors could also have played an important role; Maini (2006) reported that abiotic stress such as adverse temperature, drought, freezing, mechanical and chemical damages, and less viral infection can reduce the application of biofertilizers. The application of standard procedure had a better effect on the dry matter production as compared to *Amrut jal* treatment, but it was on par with *Amrut jal* at crop harvest, which is consistent with the prior findings of Mahto *et al.,* (2018) in french beans. The fruit yield of tomato (Table 2) differed significantly with the application of liquid organic manures. Fruit output per plant was greater with *Amrut jal* treatment than with control, at 14.30 and 11.21, respectively. The biggest variation was in the weight of the fruit, which rose by 34.42 g. Plants yielded considerably more fruit in the experiment than in the control, which might be attributed to appropriate nutrition availability via biofertilizers. Sreenivasa *et al.*, (2009) discovered that bacteria from 'Beejamrutha' (fermented cow urine, also a component in *Amrut jal*) were capable of P solubilization and the generation of growth-promoting chemicals like IAA and GA.

Table.1 Effect of *Amrut jal* on physiological growth parameters of tomato

Treatments	Plant height (cm)		Root length (cm)		Dry matter (g/plant)		Number of branches/ plant (cm)		Plant Spread	
	Flowering Stage	Crop Harvesting	Flowering Stage	Crop Harvesting	Flowering Stage	Crop Harvesting	Flowering Stage	Crop Harvesting	Flowering Stage	Crop Harvesting
	(75 DAS)	**(160 DAS)**	**(75 DAS)**	**(160 DAS)**	**(75 DAS)**	**(160 DAS)**	**(75 DAS)**	**(160 DAS)**	**(75 DAS)**	**(160 DAS)**
T1: SP	65.01	104.50	15.02	18.72	4.08	6.73	3.40	4.00	28.00	32.09
T2 : *Amrut Jal*	59.68	100.00	12.00	14.34	3.89	6.63	5.59	6.54	39.13	43.63

Table.2 Effect of *Amrut jal* on yield parameters of tomato

Treatments	Number of flowers/ plant (75 DAS)		Number of fruits/ plant	Fruit weight (g/plant)
	(75 DAS)	**(160 DAS)**		
T1: SP	13.30	13.47	11.21	60.28
T2 : *Amrut Jal*	14.02	14.54	14.30	94.42

They also found the bacteria to be capable of N2-fixation and suppressing *Sclerotium* sp. Cow waste, one of the essential elements of *Amrut jal*, includes, as previously noted, numerous plant hormones that have a function in increasing chlorophyll content in plant leaves, hence increasing photosynthetic activity (Kumudini *et al.*, 2019) and yield. Higher microbial activity and soil enzyme activity suggest that this was mediated by biological mechanisms. According to Kalarani (1991), the activity of growth regulators in the plant system generated higher output.

According to the findings of the study, it may be concluded that tomatoes are highly responsive to organic growing conditions. In this regard, *Amrut jal* (1%) emerged as effective in terms of growth and yield of the crop variety. *Amrut jal*-like biofertilizers have been popular and widely utilized organic additives in the area of organic farming since the Vedic time. *Amrut jal* is a modernized version of ancient science that is high in critical macro and micronutrients, as well as helpful microorganisms, enzymes, and growth regulators, all of which are necessary for plant growth.

It also acts as a tonic for the plants, increasing crop production. It promotes crop health and reduces the spread of plant diseases. In tomato cultivation, the application of *Amrut jal* has enhanced effects on both plants' physiological growth, development, and yield. This low-cost organic production approach may thus be suggested for commercial-scale tomato growing or, at the very least, for considerably safer tomato production in Central India's Malwa region.

Constraints in Usage of *Amrut jal*

Biofertilizers, according to Robin Rijal *et al.*, (2021), boost the quality and quantity of crops, but they are unable to meet the nutritional needs of crops due to lower nutrient content in bio-manures compared to chemical fertilizers. It takes longer to prepare bio-manures before they are ready to use; *Amrut jal*, for example, takes more than 4-5 days to prepare, or even more, depending on climatic and geographical circumstances. As a result, it is regarded as a time-consuming procedure. Furthermore, farmers are looking for immediate returns on their lands, whereas biofertilizers take longer to provide better results, and their efficiency is affected by storage conditions and duration.

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How to cite this article:

Archit Malviya. 2022. Growth and Development of Tomato (*Solanum lycopersicum*) under Foliar Application of *Amrut jal* as an Organic Source of Nutrient. *Int.J.Curr.Microbiol.App.Sci.* 11(06): 359-365. doi: https://doi.org/10.20546/ijcmas.2022.1106.040