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Screening of growth and biomass of Tomato (*Lycopersicum esculentum* L) under organic substrates and physiological assessment

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ABSTRACT: Chlorophyll pigment composition, stomatal frequency, and relative humidity are all biochemical characteristics to consider the T1VC1 Control, T2VC2 (Soil+ 10% Vermicompost), T3VC3 (Soil+ 20% Vermicompost), T4VC4 (Soil+ 30% Vermicompost), and T5VC5 (Soil+ 40% Vermicompost) were the different treatments utilised to generate varying quantities of soil and vermicompost combinations. For each treatment, the percentage of germination was noted. Seedlings from each treatment were transplanted at random into pots containing the same treatments as the trays. For each treatment, various growth characteristics such as root length, shoot length, mean leaf number, and total dry weight were recorded. The highest germination % was recorded in the T5VC5 treatment, and it gradually declined in succeeding treatments. When compared to control plants, almost all of the T3VC3 treatment plants performed better and increased significantly, so changing climatic condition physiological modification required for better growth and development.

Keywords: Vermicompost, Growth, Tomato, Electric Conductivity, Field Pots

INTRODUCTION

Growers are using significant quantities of fertilzers and pesticides to acquire a higher yield of varied agricultural plants in today's environment. These chemical fertilzers and insecticides reduced soil fertility and caused consumer health issues. Because of the negative impacts of synthetic fertilzers, there has been a push to promote the usage of organic manure.

Tomatoes (*Lycopersicon esculentum*) are one of the most extensively farmed vegetables in Liaoning Province, with more than 85,000 hectares of tomato-growing land in 2014 (Zhang *et al.,* 2017). However, figuring out how to improve tomato quality without lowering fruit yield remains a pressing issue. Organic farming using organic amendments as nutrient inputs to the soil is growing more popular, and organic farming is emerging as an alternative agricultural strategy for sustaining cost-effective vegetable production while reducing pollution and improving fruit quality.

Tomatoes (*Solanum lycopersicum* L.) are a commonly farmed produce around the world, despite the fact that persistent monocropping of tomato plants and excessive fertilizer use have led in soil acidity and salinization in many areas, lowering tomato yields and fruit quality (Liu *et al.* 2014).

Tomatoes are India's most extensively farmed vegetable and the country's second most important vegetable crop after potato. The current global production of fresh fruits is estimated to be around 100 million tonnes from 3.7 million hectares. It's a day-neutral plant that thrives in temperatures between 18 and 25 degrees Celsius. This crop is extremely sensitive to environmental conditions such as soil moisture, temperature, and salt, among others. Germination, early plant development, and flowering are the most vulnerable stages of this crop. Tomatoes are a popular crop in high-tech farming operations.

However, little is known about how the roots interacted when tomato is companion cultivated with potato onion, or whether root growth and companion-cropped tomato at various P levels are related. To view the root system in situ in a nondestructive manner, we used a special equipment consisting of a transparent manual root box. In a tomato/potato onion companion-cropping system with no P added or 120 mg•kg1 P added, we investigated how cropping patterns and P levels influenced tomato growth and root interactions. We also estimated root distribution by incorporating the relationship between root length distribution and tomato growth.

We expected that following partner cropping with potato onion, tomato root distribution would be more proliferated and asymmetric than in monoculture, and that a greater space root proliferated would be favourably connected with tomato growth.

In modern agriculture, intercropping and companion cropping have long been employed to boost crop yield and biomass (Tsubo and Walker 2002; Awal *et al.* 2006; Zhang *et al.* 2007; Zhou *et al.* 2011, 2017; Li *et al.,* 2014). In agro-ecosystems, interspecific facilitation has been observed by improving nutrient absorption to promote intercropped plant growth and yield (Li et al. 2001, 2003, 2007, 2010; Cu *et al.* 2005; He *et al.* 2013). Furthermore, interspecific belowground interactions are linked to nutrient absorption.

For example, Zhang *et al.* (2003) shown that wheat N and P uptake can be improved by nearly 50% when intercropped with maize through belowground interactions. Li *et al.* (2006) and Gao *et al.* (2010) also observed that more lateral root deployment and compatibility of spatial root distribution in intercropping species contributed to higher yields and plant growth. Because plant root systems are submerged beneath the earth, observing and quantifying root growth when two species intercropped is challenging (Fang *et al.* 2009, 2011). As a result, root interactions in intercropping and companion-cropping agricultural systems have received comparatively little attention.

Root growth can be impacted by a variety of circumstances because plant roots live in such a complicated environment (Karban 2008). Water and nutrient supplementation variability in soil can alter plant roots over time (Liao *et al.* 2001, 2004; Hodge 2004; Fang *et al.*, 2009), especially for non-mobile elemental nutrients. Phosphorus nutrients, for example, are heterogeneous in soil because phosphate ions react with soil cations to produce soluble complexes or insoluble precipitates, or they adsorb to the surfaces of diverse positively charged soil particles (Cu *et al.*, 2005). (Hinsinger *et al.*, 2003).

As a result, roots always demonstrate varying levels of flexibility in addition to different P levels in order to activate and consume more P nutrients (Eissenstat 1992; Narang *et al.* 2000). Xia *et al.* (2013) reported that P application can impact total root length and root space distribution across cropping systems (Xia *et al.* 2013). (Xia *et al.* 2013).

Root interactions in an intercropping system are influenced not only by soil heterogeneity but also by the presence of nearby roots (Maina *et al.* 2002; de Kroon *et al.* 2003; Falik *et al*. 2003; Dudley and File 2007; Karban and Shiojiri 2009). A growing number of academics are interested in the topic of root recognition. When two plants interact, their root activity is always altered by an adjacent species. Gersani *et al*. 2001; Maina *et al.* 2002; Falik *et al.* 2003; O'Brien *et al.* 2005; Padilla *et al.* 2013) found that the presence of a resource competitor can cause an increase in root biomass allocation. The Great Lakes Sea Rocket (Cakileedentula), for example, accumulates greater biomass in its fine roots when planted with nonkin species rather than siblings (Dudley and File 2007). Furthermore, Impatiens pallida plants can only recognise their kin when the roots of another plant are present (Murphy and Dudley 2009). We conclude from our findings that plant root activity is far more complex than previously considered, particularly when two plants interact, and that the result of plant growth and root contact is highly related to the nutrition and their neighbours.

MATERIAL AND METHODS

The experiment was undertaken with the main objective to evaluate the Physiological modifications of growth and biomass of Tomato (*Lycopersicum esculentum* L.) under Vermicompost application. For this, pot culture experiments were conducted. Experimental plants were maintained in pot culture. Observations on growth, physiological and biochemical parameters were recorded during crop period.

The experiment was conducted in department of Plant Physiology located at Sampoorna International Institute of Agri. Sciences and Horticultural Technology, situated at Belekere, Channapatna. Planting material, crop Tomato (*Lycopersicum esculentum* L plants were used for the study. The seed materials were procured from Sampoorna International Institute of Agriculture Sciences and Horticultural Technology.CRD laid out with nine treatments experiments with two replications.

Procedure: After successful germination test (Plate 01) we shifted to pots, potted plants (3 plants/pot 2kg potting mixture) were used for this experiment. Plants were maintained different percentage of vermicompost treatment. Observations were taken at biweekly intervals, till stress period of two weeks (Plate 1). Observation were taken from average of three replication

Observations: Growth Parameters

1. **Number of Leaves**
   Total numbers of leaves in the experimental plants were counted.
2. **Root length (cm)**
   The roots of plants were cut at the base level and washed free of adhering soil with low jet of water. The roots were then oven dried and dry weight was recorded.
3. **Dry Shoot Weights (g)**
   Shoot weight were measured weighing the above ground part of the plants in a weighing balance after oven drying at70^{o}C.
4. **Root ShootRatio:**
   Ratio of weights of dried roots, shoots of sample plants were calculated and mean value arrived.
5. **Dry matter Production(g)**
   The sum of root shoot dry weights was taken as the total dry matter yield.

Physiological and Biochemical parameters

Chlorophyll pigments (mgg^{-1}). Arnon's technique was used to estimate the chlorophyll content of leaf samples (1949). A weighed quantity of leaf sample (0.5g) was chopped into little bits from a fully developed third leaf. After pouring 10 ml DMSO:80 percent acetone mixture (1:1 v/v) into test tubes, the pieces were incubated overnight at room temperature. The coloured solution was decanted into a measuring cylinder, and the DMSO-acetone mixture was used to make up to 25 ml. At 663, 645, 480, and 510 nm, the absorbance was measured. By replacing the absorbance values in the supplied formulas, the chlorophyll content was calculated.

$$TotalChl\,(a+b) = \left(8.02 \times A_{663} - 20.2 \times A_{645}\right) \times \frac{V}{1000} \times \frac{1}{fresh\,weight}$$

Stomatal Frequency (no.cm^{-2}). The number of stomata per unit area of leaf is referred to as stomatal frequency. A thick combination of thermocol and xylene was made and applied over both surfaces of the leaves before drying. After drying, the peel was carefully peeled and counted under a microscope with a 40X objective and 10X eyepiece. A stage micrometre was used to measure the microscope's field of view, and the stomatal frequency per unit area was computed.

Relative Water Content. By measuring the fresh weight, turgid weight, and dried weight of a known number of leaf discs from the experimental plants, relative water content was determined according to Barr and Weatherly (1962). After determining the sample's fresh weight, it was immersed in distilled water for 3 hours before determining the turgid weight. After three days in an oven at 80 degrees Celsius, the dry weight of the samples was determined. The following formula was used to determine the RWC

Germination Percentage: On ancient and contemporary seed samples, a routine germination test was performed by planting 12-14 seeds on whatman filter paper (9 mm diam.) inside a petri dish (one dish= one replicate). The experiment was carried out four times. To ingest the seed, the filter paper of each petri dish was wet with 2 cc distilled water (ISTA 1996). At room temperature, petri dishes were used. The standard germination test was used to assess germination and seed vigour.

The first germination count was done three days after planting and then every two days after that (i.e., day 5 and 7). The percentage of seeds that generated normal seedlings was used to assess germination (ISTA 1993). Germination indices such as

(GRI) were calculated from germinated data according to Olisa *et al.* (2010). A standard germination test was conducted on seed samples (old and new) by placing 25 seeds on Whatman filter paper (9 mm diam.) inside a Petri dish (one dish = one replicate). The test was replicated four times. The filter paper of each Petri dish was moistened with 2 ml of distilled water to imbibe the seed (ISTA 1996). Petri dishes were placed at room temperature (approx. 25 ± 2°C.

Preparation of Soil and VC' Mixtures: Soil from the Botanical Garden mixed with different concentrations of VC was used in the experiment. All five treatments used a total of four trays for germination. Each tray included 20 seeds of the treatment combination in it. In each tray, 13 tomato seeds were sowed at a depth of 3 cm with a spacing of 2 cm. As a result, a total of 20 seeds were sown in each of the eight trays. After 20 days, the percentage of germination in each of the four treatments was determined. Seedlings with a normal structure were classified as normal, while seedlings with defects or no secondary roots were classified as abnormal. Only normal seedlings were utilised to calculate germination percentages because they were the only ones capable of producing a complete plant.

It was discovered that germination vermicompost in soil has always been connected with percentage in terms of normal seedlings, with the treatment VC15 (soil+15 percent VC) having the highest rising germination, percentage, and yield (86 percent). In several tests VC30 (soil + 30% VC) and VC45 (soil +45 percent VC), there was a steady drop in germination percentage in treatments independent of nutrient delivery, even at low replacement rates. The germination percentage was higher in the VC30 and VC45 treatments.

Statistical analysis. The experiment used a CRD with three treatments, each of which was replicated three times. Statistical analysis was performed using ANOVA. P values of less than 0.05 were deemed significant.

RESULTS AND DISCUSSION

The current experiment entitled Physiological modifications of growth and biomass of Tomato (*Lycopersicum esculentum* L) under Vermicompost application for significant utilization of nutrients through vermicompost by plants. It was undertaken with the objective to study the effect of vermicompost as a major nutrient percentage on tomato under varying different percentages. Three sets of pot culture experiments were conducted during 2020. The experiments were laid out in CRD factorial.

Alteration in growth performance of tomato under the studied by treatment of vermin compost percentage analyzing the parameters viz leaf number, root length, shoot length and total root weight accumulation were significantly increasing.

In this study highest values of growth parameters (Table 1 and 2) were recorded in T3VC3 for number of leaves per plant, root lengths (cm), shoot lengths, total dry weight, (13.66, 4.23, 11.25, 4.24) showed significantly increasing as compared to control T1VC1(Fig 01), germination percentage (89.26%) (Fig 04) was also observed under different percentage of vermicompost. Highest values in biochemical parameters were recorded for total chlorophyll content (1.365mg g^{-1}) (Fig. 2), Stomatal frequency (566.34 n/mm^2) (Fig 03) and RWC relative water content (88.45 %). Among the different treatment plants responded better under the concentration in T3VC3 treatment.

Table 1: Comparison of physiological growth parameters under vermicompost in tomato at 20 DAS.

Treatments	Number of leaves	Root length	Shoot length	total dry weight	Germination percentage (%)
T1VC1 Control,	10.00	2.46	8.36	2.40	84.35
T2VC2 (Soil+ 10%Vermicompost),	12.00	2.21	10.23	2.68	86.34
T3VC3 (Soil+ 20%Vermicompost),	13.66	4.23	11.25	4.24	89.26
T4VC4 (Soil+ 30% Vermicompost) and	11.87	2.34	9.62	2.76	85.31
T5VC5 (Soil+ 40%Vermicompost).	10.36	1.98	8.21	2.89	86.34
Mean Value	**11.57**	**2.64**	**9.53**	**2.99**	**86.32**
CD (0.05)	0.418	0.015	0.014	1.235	0.094
SE± (m)	0.131	0.005	0.004	0.387	0.029
SE± (d)	0.185	0.007	0.006	0.547	0.041

Significant differences at CD (0.05), Replication-3, T- Treatment

Table 2: Comparison of biochemical parameters under vermicompost in tomato.

Treatments	Chlorophyll pigment composition	Stomatal frequency	Relative water content
T1VC1 Control,	1.029	523.62	86.11
T2VC2 (Soil+ 10% Vermicompost),	1.264	498.36	86.68
T3VC3 (Soil+ 20%Vermicompost),	1.365	566.34	88.45
T4VC4 (Soil+ 30% Vermicompost)	1.126	463.48	85.36
T5VC5 (Soil+ 40%Vermicompost).	1.153	475.19	86.16
Mean Value	**1.187**	**505.39**	**86.55**
CD (0.05)	0.001	0.131	0.088
SE±(m)	0.002	0.041	0.028
SE±(d)	0.004	0.058	0.039

Significant differences at CD (0.05), Replication-3, T- Treatment

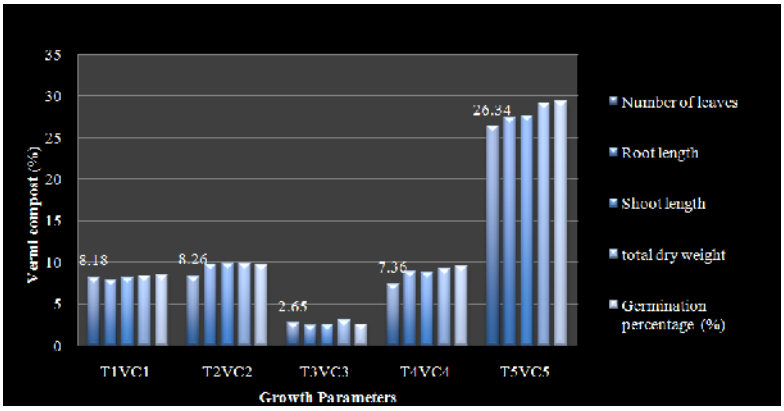

Fig. 1. Effect of vermicompost on physiological growth parameters in tomato.

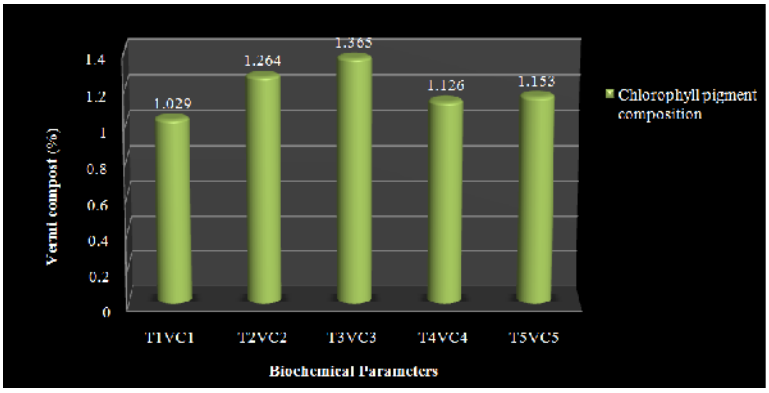

Fig. 2. Effect of vermicompost on biochemical parameter chlorophyll composition in tomato.

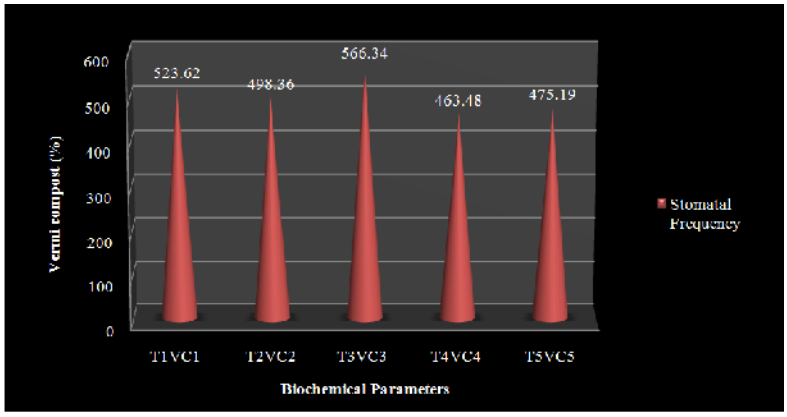

Fig. 3. Effect of vermicompost on biochemical parameter stomatal frequency in tomato.

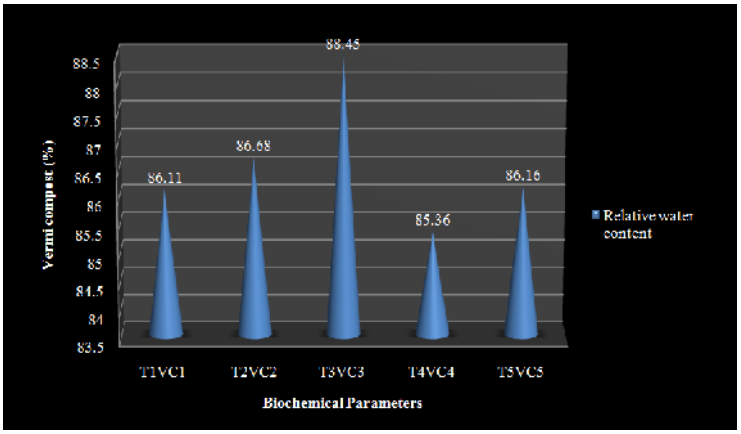

Fig. 4. Effect of vermicompost on biochemical parameter relative water content in tomato.

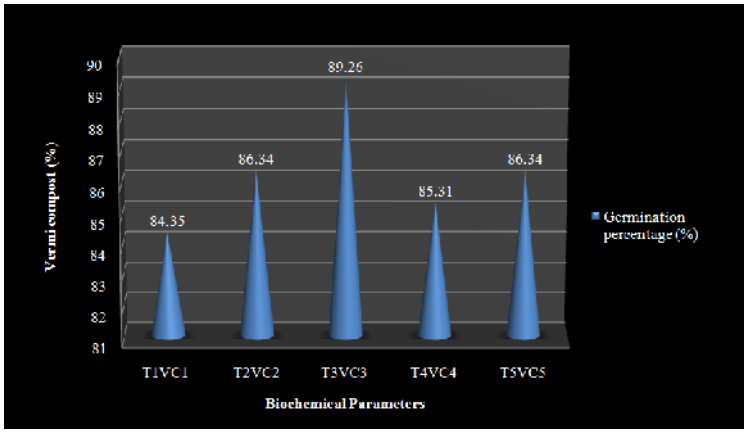

Fig. 5. Effect of vermicompost on biochemical parameter germination percentage in tomato.

Plate 1. Germination percentage on tomato under the treatment of Vermicompost; Plants maintained under the treatment of Vermicompost.

CONCLUSION

Our findings show that in tomato/potato onion companion-cropping systems, deeper and more evasive root dispersion in tomato plants can support more tomato biomass. Furthermore, the cropping pattern has a bigger impact on the distribution of tomato roots than the P level. However, one limitation of our research was that we were unable to determine how the potato onion altered tomato root spread, whether root exudates operate, or whether changing soil microorganisms work. These questions will need to be investigated further. Our findings were only tested in a small number of greenhouses; they still need to be confirmed in large-scale tests for future crop growth under betterment in agriculture.

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