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Transformation of dolomite powder into value added fertilizer and its effect on growth and yield of tomato plant

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Abstract

In Dolomite industry, various purposes have led to the generation of large amount of dolomite powder during mechanical processing. Dolomite is a rich source of Ca and Mg and XRF analysis showed the presence of certain micro and ultra micro plant nutrients in it. In the raw form these nutrients are not in easily plant accessible form. In the present research, dolomite powder was converted into easily plant accessible form and its value-added fertilizer is formed by mixing vermicompost with chemically converted dolomite powder. Three types of experiments- control (simple soil), control with compost (soil + vermicompost), and different percentages [X, 2X, 3X, 4X & 5X (X= 3%)] of value-added fertilizer with soil were performed on growth and yield of tomato plant. It was found that among all treatments, 5X showed maximum plant growth, crop yield with increased biomass.

Keywords: dolomite, fertilizers, plant nutrients, tomato, vermicompost

Introduction

Dolomite is an anhydrous carbonate mineral composed of Calcium and Magnesium carbonate ($CaCO_3.MgCO_3$). Dolomite has a vast number of applications. In many industries such as iron, steel, construction etc., dolomite is used as a crucial raw material. Dolomite industry produces significant amounts of dolomite powder (dolomite dust) during mining, quarrying, cutting, and shaping. About 30% to 40% of the material is wasted during mechanical processing. This powder waste can result in a range of respiratory issues, blurred vision, and environmental issues in that area. Therefore, it is necessary to convert them into a more usable, readily available, healthier, and environmentally beneficial form (Yurdakul, 2020).

Due to easily availability and abundant resources, many researchers have used dolomite powder as ingredient in cement and construction field. Dolomite powder is a rich source of Ca and Mg, therefore research has been done on the use of dolomite powder on many plants. I. Damrongrak et al. reported the research of the effect of fertilizer and dolomite application on growth and yield of tapping rubber trees (Damronarak et al. 2015). S. Suntoro et al. studied the effect of cow manure and dolomite on nutrient uptake and growth of corn (Suntoro et al., 2018). N.H. Nufus et al. studied the role of dolomite and vermicompost in nutrient uptake and production of sweet potato on acid soil (Nufus et al., 2021). S. Soeparjono et al. studied the effect of lime of dolomite and NPK fertilizers on the response of growth, yield and protein content on black soybean in acid soils (Soeparjono et al., 2021). A. Perdanalika et al. studied the effect of rice husk ash and dolomite on soybean yield at Latosol soil (Perdanalika et al.). P. Cahyono et al. studied on the influence of liming on soil properties and plant growth of pineapple (*Ananas Comusus L. Merr.*) on

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red acid soil (Cahyono et al., 2019). N. Dewisambi et al. studied the effect of dolomite and pig manure on growth and production of carrots (*Daucus carota*) (Dewisambi et al., 2022). Y Cao et al. studied the immobilization of trace elements and lettuce growth in soil amended with activated dolomite phosphate rock fertilizers (Cao et al., 2023). M. Ilyas et al. investigated the interactive effect of calcium and magnesium on the growth and yield of tomato (*Lycopersicon esculentum L.)* (Ilyas et al., 2016). A. Krismawati et al. studied about effectiveness of dolomite on growth and yield of maize (Zea mays l.) in dry land (Krismawati et al., 2022).

The dolomite powder contains large amount of Calcium and Magnesium carbonates, which are secondary plant nutrients. Besides this, some other elements also present in it, which can be used for increasing soil productivity and plant growth. In the raw form, dolomite powder is not in easily plant accessible form, hence direct application to the soil is not beneficial. Particle size of dolomite powder is very small therefore it blocks the pores of the soil resulting in degradation of soil productivity and it increases basicity of soil, hence dolomite powder is not beneficial for those plants which require low pH for their development.

Therefore, in the present research, it is converted into easily plant accessible form, and its value-added fertilizer was prepared. Tomato is third most cultivated crop in worldwide. It is Calcium and Magnesium deficient plant, therefore effect of value-added fertilizer of dolomite powder was performed on vegetative growth, crop yield and biomass of tomato plant to find out the efficiency and workability of converted and value-added fertilizer of dolomite powder.

Materials and Methods

Materials:

Soil: For the purpose of this study, Soil was collected From Narayan Vihar area of Jaipur, Rajasthan, India. The chemical analysis of soil is: Moisture = 1.8%, pH = 7.82, Electric conductivity = 0.810 dSm^{-1}, organic matter = 4.47%, available Nitrogen as N = 223.2 kg/ha, available Phosphorous as P = 14.3 kg/ha, available Potassium as K = 228 kg/ha, bulk density = 1.36 gm/cm^3, Calcium as Ca = 8.32 mg/ kg, Magnesium as Mg = 3.65 mg/kg, alkalinity (as $CaCO_3$) = 20.2 mg/kg.

Dolomite powder*:* Significant amount of dolomite power produced during cutting and shaping of dolomite stone. In the present research dolomite powder was collected from Rajgarh, Alwar, Rajasthan, India. The chemical analysis of Dolomite powder is: SiO_2 = 8.45%, CaO = 36.68%, MgO = 11.80%, Fe_2O_3 = 0.73%, Al_2O_3 = 0.13%, LOI = 41.80%, Brightness = 89.20%, Whiteness = 92.60%, $CaCO_3$ = 65.50%, $MgCO_3$ = 24.78%, Ret. on 300 Mesh = 1.52%

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Tomato seeds*:* Local variety of Tomato (*Lycopersicon esculentum) seeds were used in the study.*

Methods

Soil preparation: 1 quintal soil was collected and air dried for 72 hours. It crushed with a wooden mortar and pestle and then sieved through a 2 mm mesh.

Chemical transformation of Dolomite powder: Dolomite is acid sensitive. Therefore, concentrate Hydrochloric acid was used to dissolve dolomite powder. Soluble salts (mainly chlorides of Calcium and Magnesium) and insoluble or silicious residue (B) were formed. The above solution along with (B) treated with Diammonium hydrogen phosphate in alkaline medium and precipitated phosphate hydrate (mainly $CaHPO_4$ and $MgHPO_4$) and insolubles (C) were obtained. The insoluble part is silicious in nature and hence beneficial for plants so it does not require to remove. Soluble ammonium salts (D) were also formed which were acidic in nature and a major source of Nitrogen. Precipitated phosphate hydrates with insolubles were filtered, dried and used as converted product (**Figure 2**). Schematic transformation was shown in **Figure 1**.

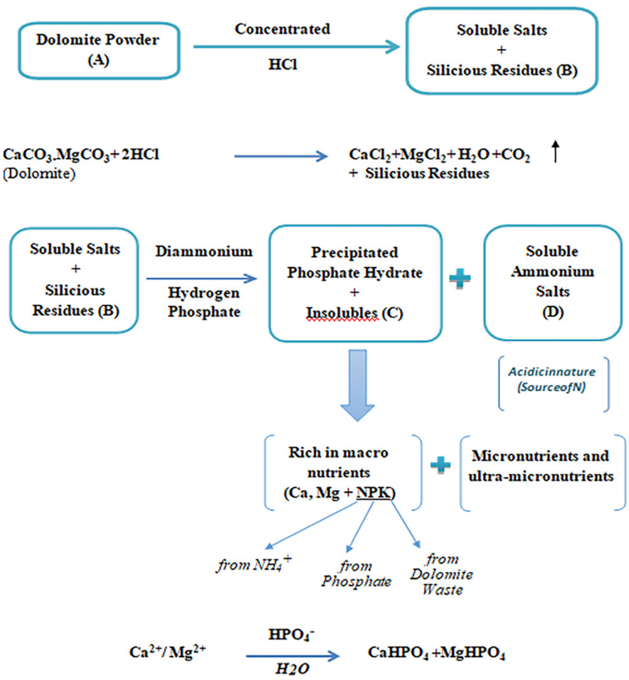
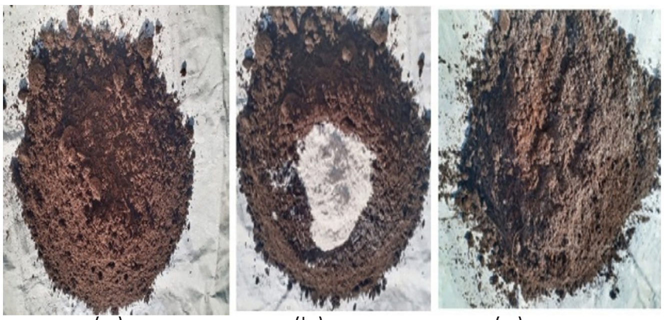


Figure 1. Schematic presentation of chemical conversion of dolomite powder

Figure 2. Chemically converted product of dolomite powder

Formation of value-added fertilizer of dolomite powder: For increasing nutritious ability of this converted product, it was mixed with vermicompost to prepare value added fertilizer (**Figure 3**). To prepare vermicompost plant leaves and kitchen wastes were taken. Shredded them and mixed them with cow dung. Wetted them time to time and covered them after adding earthworms [red wigglers (*Eisenia fetida* and *Eisenia andrei*)]. After about two months vermicompost is ready. When the earthworm consumes organic wastes, the substrate passes through earthworm's gut and gets digested in the intestine of earthworm with the aid of beneficial microbes (Gomez et al., 2020). In the intestinal tract, mucus or chemical secretions, enzymes, and antibiotics help in the breakdown of substrate to finely divided peat like material called vermicompost, which is readily available to plants (Gomez et al., 2019; Monroy et al. 2008, Aira et al., 2009).



(a) (b) (c)

Figure 3. Formed vermicompost (a), mixing of converted waste with vermicompost (b), and prepared value added fertilizer (c)

XRF Analysis: The analysis of elements in dolomite powder, soil, soil with vermicompost, and value-added dolomite fertilizer with soil were carried out by X-Ray Fluorescence spectroscopic technique (XRF). Results of WD XRF are included in **Table no. 2 and 3.**

Experimental set up: This study was conducted by pot culture technique as shown in **Table 1**. C [Control (simple soil)], CC [Control + vermicompost (Soil containing recommended dose of vermicompost)], and VAD [value added fertilizer formed by mixing 10% converted dolomite powder with vermicompost, and then this was mixed with soil in recommended amount] were used to study the effect on development of tomato plant. Seed germination, plant height, No. of leaves, crop yield and biomass were studied. The pots were numbered prior to filling soil so that intermixing of pots could be avoided. In accordance with the plan of the study five doses of value-added fertilizer - X, 2X, 3X, 4X, and 5X (X = 3%) were added to soil [VAD]. Nine replicates of each dose of the C, CC, and VAD were considered for experiment (**Figure 4**). Recommended dose of vermicompost and different % of value-added fertilizer was mixed with the soil of the pots at the initial stage before sowing of seeds of tomato.

Table 1. Schematic presentation of pot culture technique

Treatments	C	CC	% of VAD				
			X	2X	3X	4X	5X
Pots							

Nine pots

(a) (b)

Figure 4. Numbering of pots [VAD (a), C, CC (b)]

Results and Discussion

XRF analysis of dolomite powder: The XRF analysis of dolomite powder is presented in **Table 2**.

XRF analysis of C, CC and VAD: The XRF analysis of C, CC and VAD is presented in **Table 3**.

Seed germination results: Seed germination results are represented in **Figure 5**.

Average plant height results: Average plant height results are shown in **Figure 6**.

Average number of leaves results: Results related to average number of leaves are shown in **Figure 7**.

Average number of flowers: Results related to average number of flowers are summarized in **Figure 8**.

Table 2. XRF analysis of dolomite powder

Elements	Na	Mg	Al	Si	P	S	Cl	K	Ca	Mn	Fe	Sr
Concentration %	0.681	16.531	1.278	7.115	0.104	0.04	0.115	0.273	72.214	0.156	1.443	0.05

Table 3: XRF analysis of C, CC, and VAD

Test parameter	Concentration %		
	Simple soil (C)	Soil + Vermicompost (CC)	Soil + Value added fertilizer (VAD)
Na_2O	4.051	3.895	3.54
MgO	1.498	1.588	2.392
Al_2O_3	12.677	12.799	12.877
SiO_2	73.21	72.296	71.735
P_2O_5	0.559	0.517	0.604
SO_3	0.323	0.299	0.241
K_2O	1.429	1.765	1.564
CaO	1.434	1.899	2.399
TiO_2	0.456	0.614	0.553
Cr_2O_3	0.101	0.12	0.181
MnO	0.078	0.063	0.086
Fe_2O_3	3.686	3.942	3.658
NiO	0.287	0.017	-
ZnO	0.015	-	-
Rb_2O	0.015	0.017	0.015
SrO	0.036	0.039	0.036
Y_2O_3	0.006	0.004	0.004
ZrO_2	0.061	0.06	0.048
Nb_2O_5	0.003	-	-
BaO	0.074	0.067	0.068

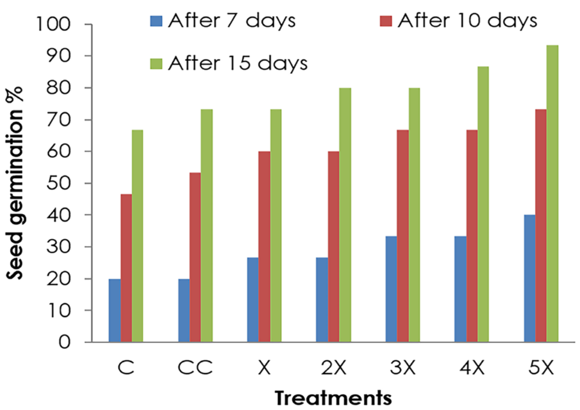


Figure 5. Seed germination percentage after 7, 10 and 15 days in different types of treatments

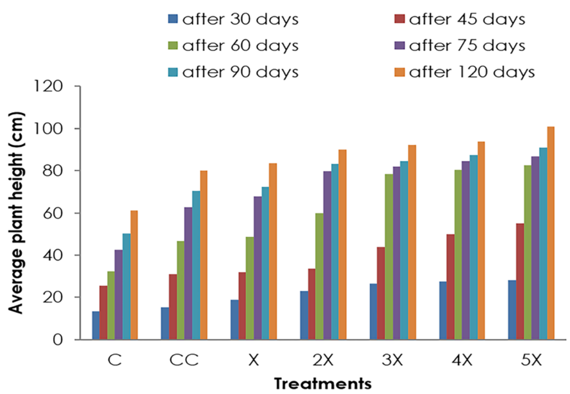


Figure 6. Average plant height after 30, 45, 60, 75, 90 and 120 days in different types of treatments

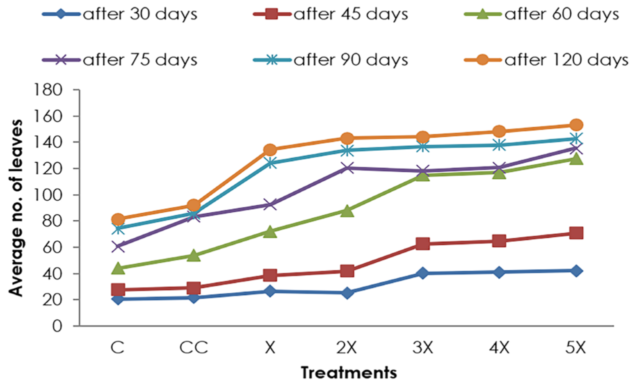


Figure 7. Average no. of leaves after 30, 45, 60, 75, 90, & 120 days in different types of treatments

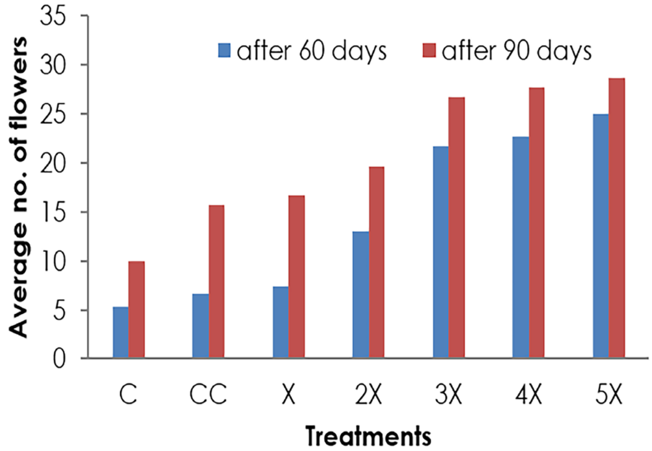


Figure 8. Average no. of flowers after 60 and 90 days in different types of treatments

Average number of fruits: Results of average number of fruits are shown in **Figure 9**.

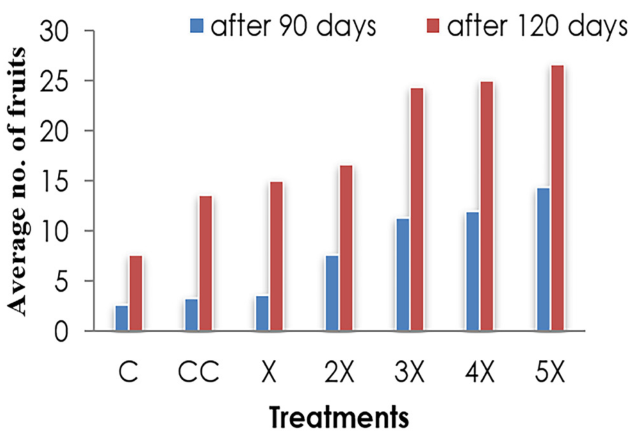


Figure 9. Average no. of fruits after 90 and 120 days in different types of treatments

Average crop yield: Table 4 represents average crop yield related results.

Table 4. Average crop yield of C, CC and different types of VAD

Treatments	Crop yield		
	Average no. of fruits	Average weight of fruits (gm)	Crop yield (gm)
C	7.60	60.1	456.76
CC	13.66	62.22	849.92
X	15	66.12	991.8
2X	16.66	69.23	1153.37
3X	24.33	71.12	1730.34
4X	25	75.54	1888.5
5X	26.66	77.86	2075.74

Biomass results: Biomass related results are shown in **Figure 10**.

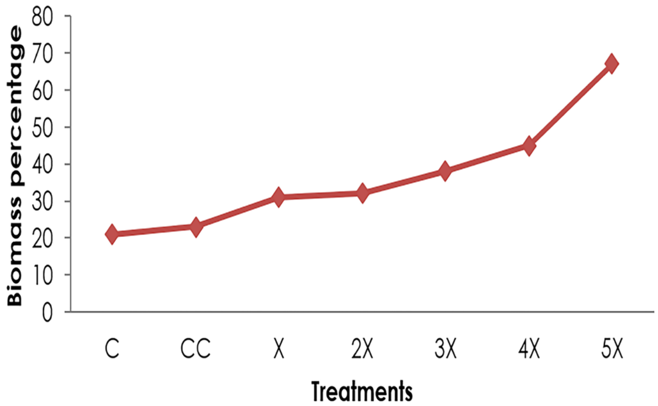


Figure 10. Biomass percentage of C, CC and different types of VAD treatments.

Growths of plants at different time intervals are shown in **Figures 11-16**.

(a) **(b)** **(c)**

Figure 11. Plant growth after 30 days in C (a), CC (b) & VAD (c)

(a) **(b)**

Figure 12. Plant growth after 45 days in C, CC (a), & VAD (b)

XRF analysis of Dolomite powder: Table 2 represents the results of XRF analysis of dolomite powder. This analysis reveals that this waste dolomite powder has

(a) **(b)** **(c)**

Figure 13. Plant growth after 60 days in C (a), CC (b) & VAD (c)

(a) **(b)** **(c)**

Figure 14. Plant growth after 75 days in C (a), CC (b) & VAD (c)

(a) **(b)** **(c)**

Figure 15. Plant growth after 90 days in C (a), CC (b) & VAD (c)

(a) **(b)** **(c)**

Figure 16. Plant growth after 120 days in C (a), CC (b) & VAD (c)

an immense potential as a source of nutrients for the soil and plant. The dolomite powder contains primary plant nutrient (P, K), secondary plant nutrients (Ca, Mg, S), micronutrients (Fe, Mn, Cl), ultra micro nutrients (Al, Sr) and beneficial plant nutrients (Na, Si). Therefore, it can play a crucial role in enhancing soil productivity and plant growth.

XRF analysis of C, CC and VAD: The nutrient compositions of C, CC, and VAD are presented in Table 3. It was clear that after conversion and value addition, the nutrient availability of waste dolomite powder was increased. It is clear that significant amount of Macro and micro nutrients found in VAD. The primary nutrients of plants are N, P & K. Ca, Mg and S are secondary plant nutrients. The concentration % of P increases to 0.087%

and 0.045 % in VAD than of CC and C respectively. The concentration of K is 0.135% greater than C in VAD. The concentration of Ca in VAD increases to 0.965% and 0.5% than CC and C. VAD contain Mg is 0.894% and 0.804% more than C and CC. The availability of S is 0.005% and 0.011% lower than CC and C. Fe, Zn, Cu, Mn, B, Cl and Ni are micro nutrients and required less than 1000 ppm for plants. Fe is 0.284% and 0.028% greater in CC and C than VAD. Mn is 0.023% and 0.008% greater in VAD than CC and C. Na, Co, V, and Si are considered as beneficial plant nutrients. In VAD, Na is 0.511% and 0.355% less than C and CC. Si is 71.735% in VAD, which is 0.561% and 1.475% lower than CC and C respectively. Mo, Se, Al, Rb, Sr, Ni, Cr, As are considered as ultra micro nutrients for plants. Al is 0.078% and 0.2% more in VAD than CC and C. In VAD Cr is 0.80% and 0.061% greater than C and CC. Significant amount of Rb, Sr, and Ni also present in VAD.

Effect on Tomato plant: Effect of C, CC and different doses of VAD on growth of tomato plant have been analysed by monitoring the following parameters at different time intervals.

Seed germination: Seeds of tomato were soaked for 24 hours before sowing. Results of the pot culture experiment was carried out to investigate the variation in percentage germination of the seeds of C, CC and different doses of VAD have been recorded in Fig 5. The results were recorded after 7, 10 and 15 days after sowing. In comparison to C, early germination was reported in CC. Several investigations have shown that vermicompost contain plant growth regulators such as auxins, gibberellins, cytokinins of microbial origin and humic acids in considerable amount (Tomati et al., 1988). Vermicompost has solubilizing effect on some mineral compounds present in the soil and brings about the conversion of a number of chemical elements into available form to plants which are responsible for fast process of germination (Gupta et al., 2014).

Experimental data reveals that the rate of germination is significantly increased by the addition of VAD and the percentage of seed germination increases with increasing doses of VAD due to the level of macro nutrients rises up to the required need of the plant. Among all plant nutrients, Phosphorous (P) is needed for seed germination and growth of roots. It provides required energy for nutrient transport. P promotes respiration, energy storage and transfer, cell division, cell development, and several other processes in plants which in turn accelerate seed germination and P is maximum amount found in VAD than C and CC.

Early germination was observed in 4X and 5X concentration of VAD. It may be attributed to the readily availability and accessibility of required different mineral elements of plants in VAD. Mainly high P content is responsible for early germination, root development and early growths in 5X, and it was supported by Ca, Mg and increased other plant nutrient's concentration in 5X VAD. Ca is important for cell membrane formation. In root formation rapidly cell division and development occur, therefore requirement of Ca increases, hence high amount of Ca in 5X VAD also support early germination.

Plant height: Measuring the height from the base of the stem at the soil surface to the highest part of the plant is known as plant height. Plant height data of C, CC and VAD of tomato plant is depicted in Fig. 6. In comparison to control, addition of vermicompost stimulated plant growth which was further enhanced in the soil treated with value added compost. It may be attributed to the increase in nutrient elements in soil by adding vermicompost enriched converted dolomite powder. The biological activity of earthworms provides nutrient rich vermicompost for plant growth thus facilitating the transfer of nutrients to plants. The electrical conductivity of soil increases due to the presence of exchangeable calcium, magnesium and potassium in worm cast. The loss of organic matter and the release of various soluble ions in usable form (such as phosphate, ammonium, and potassium) from earthworm activity in vermicompost were the main causes of the rise in electrical conductivity. This increases the population of plant growth promoting microorganism in soil which stimulate the plant growth directly by solubilisation of nutrients (Karmegam et al., 2009; Khorami et al., 2019). It was also observed that the maximum plant height was observed in 5X treatment which might be caused by the enhanced level of macronutrients like Ca, Mg, P, K along with various micronutrients. These nutrients promote the formation of some plant hormones which are responsible for fast growth of plant. Ca is a component of cell wall, and plays a role in the structure and permeability of membranes. Mg is enzyme activator, and a key component of chlorophyll, K is involved in photosynthesis, carbohydrate translocation and protein synthesis. S is important component of plant proteins. Rapid change in plant height was observed during initial 60 days due to readily availability of nutrients to plants. After that no such big difference was observed due to a lot of nutrients already absorbed by the plants.

No. of leaves: The average no. of leaves was recorded at 30, 45, 60, 75, 90 and 120 days after sowing the plants treated with different doses of VAD along with C and CC was presented in Fig. 7. There is a big increase in the no. of leaves after application of VAD as compared to the control and CC. It is due to high concentration of nutrients and their availability in plant accessible form in VAD. In all treatments 5X VAD shows maximum no. of leaves. No. of leaves rapidly increases about 45 to 60 days, after that not so big change was observed. This was attributable due to lack availability of nutrients in the soil because plants already absorbed a large amount of nutrients for their growth and remaining are responsible for flowering and fruiting stage of plant. VAD is rich in Ca and Mg. VAD contains Mg is 2.392% which is 0.894% and 0.804% more than C and CC.

Mg is responsible for healthy leaves. Mg also takes part in the transport of sucrose, energy metabolism, nitrogen use, interactions between plants and soil microbes, and many other biological activities (Chen et al., 2009; Cakmak et al., 2008; Ishfaq et al., 2021; Li et al., 2020; Li et al., 2008; Xu et al., 2015). It also helps to create ATP and calcium pectinate, helps glue the cell walls to each other. Mg is essential to the formation of chlorophyll (Chl) pigments in chloroplasts, which contributes to the uptake of CO_2 during photosynthetic processes (Cakmak et al., 2010; Geredas et al., 2013). The majority (65–85%) of the magnesium that plants take is used for protein synthesis and other relevant biological processes, while only around 15–35% of it is fixed in Chl pigments (Karley et al., 2009; Marschner, 2012). More than 300 enzymes, including several involved in Chl production and photosynthetic CO_2 fixation, also use magnesium as a cofactor (Billard et al., 2016; Chen et al., 2018; Ma et al., 2016; Peng et al., 2015).

Numerous additional enzymes, including protein kinases, RNA polymerases, glutathione synthase, adenosine triphosphatases (ATPases), phosphatases, and carboxylases, need Mg to be activated (Maguire et al., 2002; Shaul, 2002; Dann et al., 2007). Magnesium plays a role in the nitrogen metabolism by plant, and thus the higher the magnesium absorption, the higher protein level plant root or top part. Magnesium contained in VAD is a micro plant mineral that acts as an activator of various enzymes related to the metabolism of proteins and carbohydrates. Mg and K function as chlorophyll composers and activators of diverse enzymes in photosynthetic and respiratory reactions, as well as in RNA and DNA formation (Doberman et al., 2000; Khwairakpam et al., 2009).

Ca in VAD increases to 0.965% and 0.5% than CC and C. High level of Ca in VAD plays an important role in proper leaf growth and development. Ca participates in metabolic processes of other nutrients uptake. Calcium in VAD plays an important role involving processes that preserve the structural and functional integrity of the plant membrane by stabilizing cell wall structures, leading to strengthening of plant tissues (Renzel, 1992). Calcium is an element that is immobile in the plant, it should be applied to the plant during the early stage of growth, owing to the fact that the root system absorbs calcium quickly and linearly in the early stages of development, which helps to stabilize the cell wall and maintain the integrity of the membrane. Before harvest, these features show a significant reduction (Demello et al., 2005; Hanson et al., 1991). Ca is necessary for the development of a new middle lamella. Therefore, the persistent cell division found in the meristematic zones of roots, stems, and leaves makes them very susceptible to the low availability or absorption of calcium in soil.

Ca plays an important role in plant resistance to disease based on the protection of cell wall disintegrating enzyme secreted by pathogens. As a result, plants grown in soil treated with value-added fertilizers had improved leaf development due to high levels of Ca. Ca stabilizes cell membranes to find the phosphate group and the carboxylic acid in phospholipids and proteins, preferably at the membranes surface. P promotes cell division and development of new tissues. It is associated with complex energy transformations in the plant. Fe goes into cytochrome, which are necessary for plant transpiration. It also helps to make chlorophyll. Mn controls several oxidation-reduction systems and photosynthesis. The enhanced level of nutrients in VAD increases no. of leaves. Presence of S also favors leaves formation. It is important component of plant proteins. Used by plant to make amino acids. It is needed for N stabilization, chlorophyll formation and activation of enzymes and vitamins. K regulates water use with stomatal activity.

Crop yield: Crop yield is a standard measurement of the amount of agricultural production harvested. Crop yield data was represented in Table no. 4. It is related to flowering and fruiting of plant. The mean no. of flowers per plant produced at different doses of VAD and control with and without vermicompost during the flowering stage of the plant was recorded in Figure 8. The mean number of flowers converted into fruits per plant was compared at different doses of VAD, C and CC in Fig. 9. Weight of the fruits were also taken to assess the yield and compared in different treatments and with control. Data reveals that no. of flowers were found to be more in 5X treatment and maximum of them converted into fruits in the same treatment. The weight of the fruit was also significantly increased by the addition of vermicompost with converted mineral waste. The enrichment of vermicompost with converted mineral waste further enhanced the crop yield. It is also affected the quality of fruits. The increase in yield may be explained by the betterment of plant nutrition. Presence of macro and micronutrients in the stone waste improved the nutrients status of value-added fertilizer which may be responsible for increase in crop yield by the application of different doses of mineral based fertilizer.

The function of macronutrients and micronutrients is vital in nutrition for improved yield and quality (Saeed et al., 2012). The application of micronutrients along with macronutrients in a balanced quantity play a vital role in enhancing the yield quality of a crop. Easy uptake of nutrients and simultaneous transportation of growth promoting substances like cytokinins to axillary buds, resulting in breaking of apical dominance may be responsible for early transformation of plant parts from vegetative to reproductive phase leading to early flowering. The combination of organic and mineral fertilizers does not only improve the physical status of the soil, but also improves crop yield.

Plants need a balanced source of nutrients including N, P, K, Ca, Mg and S to develop flowers and fruits. Flowering and fruiting in plants get affected by soil's pH level and nutrient deficiencies or imbalances. The stimulation of flowering in plants treated with value added compost can be attributed to the improvement of physiochemical characteristics of soil and the attainment of balanced level of nutrients. Micronutrients also assist in fruit and flower production. Mg responsible for pollen production and male fertility, and stress tolerance. Potassium is necessary for the creation of flowers and fruits. It also imparts disease resistance. It controls how water is taken up in the roots and how it is discharged through the leaves. High level of P stimulates more uniform and early crop maturity. Florigen hormone is a systematically mobile signal that is synthesized in leaves and the transported via the phloem to the shoot apical meristem where it initiates flowering (Taiz, 2018; Tsuji, 2017). In the working mechanism of florigen hormone, the Ca ions bind to calmodulin and the Ca^{2+}/CaM signaling system triggers the expression of G1 mRNA or FT and CO mRNA. The accumulation of G1 mRNA or or GI-CO-FT mRNA during the day causing the plant to flower (Gagliano, 2014). Therefore, high Ca concentration in VAD promotes early flowering than C and CC respectively and highest no. of flower produced in 5X VAD.

Biomass: Biomass includes the total of net average weight of the plant and crop yield. Clipping and weighing method was used to calculate biomass. After full growth, tomato plants were removed carefully from the soil system without damaging any part of the plant to record the biomass. Biomass percentages were calculated by difference between fresh plant weight and weight after 48 hours and this difference was divided by fresh weight of plant. Plants were gently washed with a stream of water and dry it. After that weight of the freshly clipped plants were calculated. Then they are allowed to air dried for 48 hours and weighed them. Biomass data of tomato plant of different treatments is represented in Figure 10.

On comparing the results of the percentage of plant biomass, a significant difference was observed between the plants grown in the soil without treatment and treated with vermicompost and value-added product. The increase in biomass of the plants treated with vermicompost enriched with mineral waste can be attributed to the increase in the level of macronutrients, micronutrients and growth hormone required for the optimum growth of the plant. The difference in growth, yield and fruits quality of tomato may be due to difference in their genetic status and biofertilizers having capability of supplying a range of nutrients and improving the physical and biological properties of the soil which lead to increase in uptake of essential nutrients and reduce nutrient losses improving the fertilizer use efficiency thus increasing the soil nutrient availability (Gruhn et al., 2000).

The number and mass of the fruits were considerably higher in plants treated with value added product. Different nutrient elements present in the converted stone waste are actually responsible for the health and biomass of the crop. This gives a firm footing that significant increase in biomass is a synergistic effect of organic extracts and minerals in available forms in the soil. These available nutrients in the soil are absorbed by the plants leading to stimulated vegetative growth and yield.

Presence of primary nutrients, secondary nutrients, essential nutrients and ultra micro nutrients in the mineral waste is the driving force for increased biomass. Increase of P affects photosynthesis, respiration energy storage and transfer, cell division, cell enlargement and several other processes in plants. K is essential for water uptake and for synthesizing plant sugar for use as food. Thus, promotes plant growth, root development, fruit and seed development etc. Ca plays fundamental role in the stability of the membrane and cell integrity. Mg is an activator of several enzymes involved in carbohydrate metabolism and synthesis of nucleic acids existing in chlorophyll molecule. Mg^{2+} acts as a phosphatic carrier. Micronutrients play an active role in plant metabolism processes starting from cell wall development to respiration, photosynthesis, chlorophyll formation enzyme activity and nitrogen fixation and reduction. Presence of micronutrients Mn, Fe etc. in the value-added compost improved the quality and quantity of the crop yield. All these factors are responsible for increased biomass in 5X VAD in comparison to C, CC and other VAD treatments.

Conclusions

In the present study, dolomite powder was converted into value added compost which is more plant accessible form and it increases nutritious value of soil by enhancing the level of certain macro and micro plant nutrients. It was found that in comparison to simple soil and soil with vermicompost, value added compost with soil contains several plant nutrients. Tomato is Ca & Mg deficient plant and this value-added compost is rich in Ca and Mg with some other useful nutrients in accessible form and its application of tomato plant showed that seed germination, plant height, no. of leaves, crop yield and biomass are better for VAD than C and CC. In all VAD treatments, 5X showed maximum vegetative growth, crop yield and biomass due to highest level of nutrients present in 5X treatment.

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Conflicts of interest

The authors have no conflicts of interest to declare.

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