Research study

Application of EM® Technology in ginger cultivation and evaluation of its morphophysiological traits

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Investigating the use of humic acid, amino acid and biofertilizer on morpho-physiological and phytochemical characteristics of the ginger medicinal plant (*Zingiber officinale*)

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Introduction

Ginger medicinal plant with the scientific name (*Zingiber officinale*) from the Zingiberaceae family is one of the perennial flowering plants with rhizomes (Plotto et al. 2002), which is grown as an annual crop (Malhorta et al. 2003). Rhizomes (underground roots) are used as spices, condiments and traditional medicine (Trujillo, 2000). Dry ginger rhizome has biologically active compounds and contains carbohydrates, fats, proteins, vitamins, minerals, amino acids, monoterpenoids (camphene, cineol, borneol, citral curcumin), gengerol and sesqui-terpenoids. There are hundreds of nutritional and medicinal properties of this plant in the refrences, which are omitted in this report, but it is important to mention that these properties can be improved in the plant with a correct fertilizer program, which will be discussed further.

It is common to use organic, biological and chemical fertilizers to increase vegetative and reproductive growth, which affects the product both quantitatively and qualitatively (increasing effective medicinal compounds in ginger). It is important to use biological and organic fertilizers instead of chemical fertilizers in order to increase the quality of products such as ginger.

Currently, biofertilizers have been proposed as an alternative to chemical fertilizers in order to increase soil fertility in sustainable agriculture. Biological fertilizers include various types of microorganisms that have the ability to convert elements from inaccessible to accessible forms and lead to better root development and seed germination, while improving the absorption of nutrients and eliminating toxicity. In the case of EM®, it has been reported that it had the ability to significantly improve the growth and performance of medicinal plants (Akbari et al, 2022) and improved the agromorphological parameters and nutritional composition of ginger and had a significant effect in increasing the amount of carotenoid, phenolic compound and flavonoid. (Tchiaze et al. 2023).

Ginger growth condition

Ginger needs a warm (22-28°C) and humid climate with moderate light intensity and is cultivated in tropical regions at an altitude of 1500 meters above sea level. The length of the cultivation period is usually 8 to 10 months, and the germination and initial growth of the ginger plant takes place slowly. The production of ginger is the result of three main factors: soil, climatic conditions and management methods during growth (Aiyadurai, 1966).

The root system of ginger has little expansion and its growth is superficial, so the ability to absorb water is weak and the plant does not tolerate drought, as a result the plant is shortened, photosynthesis is reduced and more fiber is formed in the rhizome, which reduces its quality (Loknath and Das, 1964).

The suitable soil for the growth of rhizomes is sandy loam, sandy-clay loam that is more than 30% sand, 30 cm deep with proper drainage and rich in organic matter and humus (Whiley, 1974), which should also be used in the case of mechanized cultivation of rhizomes. By specific attention to this subject, one of the issues that we have been promoting and training in Iran since the beginning of the activities of the Emkanpazir Pars company with the Japanese EMRO international organization is the processing of animal manure using EM® Technology, which fortunately has been well received and is increasing day by day. From a technical point of view, both in terms of cost management and the extraordinary effects of using EM® compost in increasing the quantity and quality of the product and improving soil conditions, including improving soil structure, increasing water storage capacity, reducing soil pH, which is alkaline in 90% of Iranian soils. and the absorption of elements is disturbed.

The effect of nutrition on the growth and quality of ginger

Increasing the yield and growth of ginger is directly related to the nutrients in the soil. The use of organic fertilizers not only improves soil fertility, but is also effective in improving the physical and chemical properties of the soil, and by increasing the water storage capacity (up to more than 2 times) in the soil, it causes the vegetative and reproductive growth of plants (Ye et al. 2022). Ginger plants need a balanced consumption of fertilizer, and in case of lack of some performance elements, as well as effective substances in the rhizome, it will be affected and lead to a decrease in its protein and essential oil (Lujiu et al, 2004). A crop can absorb about 400 kg of nitrogen (N), 145 kg of phosphate (P_2O_5) and 950 kg of potassium (K_2O) per hectare from the soil, for example, the reduction of potassium makes plants susceptible to pests and diseases and reduces root performance (Lujiu et al, 2004). It should be mentioned that the balance between elements, especially N and K, is important because the roots will not be able to absorb minerals in high fertilizer concentration and low soil water potential, as a result the growth of aerial branches is stopped, photosynthesis is reduced and performance decreases. Here we must mention that EM® has shown the ability to establish nutritional balance and regulate the absorption of elements for the plant. The simultaneous application of micronutrient elements such as zinc, boron and iron along with NPK in appropriate proportions, in addition to increasing the absorption of elements in the rhizome, also helped the activity of soil element conversion enzymes and improved the mineral nutrition of the rhizome (Jabborova et al, 2021). Many micronutrient elements in the soil are in the form of cations and the negative charge of the soil does not allow the plant to absorb these elements. According to our observations, EM® and humic acid, together or separately, have the ability to absorb these elements. increase the balanced form.

The purpose of the study

In this research, we will examine the effect of using EM® Technology on the quantitative and qualitative characteristics of ginger and explain the performance of EM® in increasing the absorption of elements and establishing the nutrient balance in the soil.

Study review

Organic fertilizer

As mentioned in the introduction, one of the primary recommendations of the experts of EmkanpazirPars Company to all experts, farmers and fertilizer sellers throughout Iran is to process animal manure with EM® Technology, which they have seen good effects, including replacing fertilizers mineralization, better access to elements, returning nutrients to the soil, increasing the population of beneficial soil bacteria, etc. In an experiment on the effect of animal manure on the growth characteristics and absorption of nutrients of chili pepper with the highest amount in the plastic greenhouse and then in the plastic tunnel, it has a favorable effect compared to the cultivation conditions in the open field (Khaitov et al, 2019). In another study, the effect of cow manure and NPK in different treatments on the growth and yield of peanuts was investigated, and cow manure had a significant effect on plant height, nitrate reductase activity, and total chlorophyll content (Purbajanti et al, 2019).

One of the cases that was previously presented to EMRO in a detailed report was the use of EM® and EM® compost in saline conditions, which is also mentioned in the sources. In a study, the effect of vermicompost under salinity stress at zero, 40- and 80-mM levels on the growth and physiological and biochemical characteristics of two fennel stands in Urmia and Shiraz was investigated. The results showed that vermicompost treatment can improve plant growth characteristics such as length and dry weight of shoot, leaf area and dry weight of roots, photosynthetic pigments, relative water content, soluble sugar, soluble protein, proline, total phenol and anthocyanin compared to the control. Vermicompost increased mineral elements such as phosphate, nitrate, zinc, molybdenum, magnesium and iron in aerial parts and potassium and calcium in aerial parts and roots (Beyk-Khormizi et al., 2023).

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Biofertilizers containing a sufficient number of one or more beneficial soil microorganisms that are placed in a substrate of preservatives. In other words, these types of fertilizers, which contain effective microbial species to supply nutrients needed by the plant, increase production efficiency per unit area (Tilak et al. 2005).

Long-term environmental stress, such as drought, heat, frost, and waterlogging of the land for a long time, as well as the excessive use of chemical pesticides and the absence of a suitable host plant for a long time, cause a decrease in the population of beneficial microorganisms in the soil of that region (Gewaily et al., 2006).

In this research, the effect of EM® Technology on morphology, growth, increase of rhizome and yield of ginger medicinal plant and essential oil etc. was investigated.

Results

plant height

Biofertilizers increase soil mineral elements by fixing nitrogen, dissolving phosphorus and potassium, and producing significant amounts of hormones such as gibberellin, auxin, and cytokinin, which increase vegetative growth and plant height, and biofertilizers increase plant root growth. It causes the absorption of water from a larger volume of soil and helps to increase the height of the plant (Struz and Christie, 2003) compared to the control.

Wet and dry weight of aerial parts

By producing growth hormones, biofertilizers increase cell division and increase the vegetative growth of plants, and the dry and wet weight of the plant increases and by increasing the root surface, it absorbs water and nutrients and increases photosynthesis. which leads to better growth of plant organs (Ghasemi and Zahedi, 2018), in our experiment, the treatment of 2 per thousand, 24.1% increased the fresh weight of the ginger plant, and the treatment of 1 per thousand, 24.5% increased the dry weight.

Fresh weight of the rhizome in the pot

The treatment of 1 per thousand EM® Technology resulted in an increase in rhizome weight by 36.6% compared to the control. Biofertilizers increase the weight of plant roots by improving the soil structure and increasing the efficiency of nitrogen absorption, while in addition to fixing nitrogen and availability of phosphorus, they also have an effect on the better development of the root system and high synthesis of plant growth hormone (Mirzakhani et al. 2014).

Chlorophyll a, chlorophyll b, total chlorophyll and carotenoid

The amount of chlorophyll a was 0.69 mg.g in EM® Technology treatment 2 per thousand and 0.52 mg.g in 1 per thousand treatment compared to the control (0.35 mg.g). In the case of chlorophyll b, it was 0.39 mg.g in the 2 per thousand treatment, 0.28 mg.g in the 1 per thousand treatment, and 0.14 mg.g in the control. In the case of total chlorophyll, the 2 per thousand treatment was 1.09 mg.g, the 1 per thousand treatment was 62.4%, and the control was 0.5 mg.g.

The amount of chlorophyll in different plants is one of the important factors in maintaining the photosynthetic capacity (Gusegnova et al. 2006) and increasing the amount of chlorophyll increases the ability to use more sunlight and the plant tolerates different light intensities better. There are four nitrogen atoms in the structure of chlorophyll, as well as elements such as sulfur (turning it into sulfate) and other nutrients dependent on pH such as phosphorus, zinc, iron and copper play an important role in photosynthetic cycles, which biofertilizers increase the absorption of these elements causing an increase in photosynthetic pigments. Also, by increasing the amount of hormone such as cytokinin and by increasing the amount of sugar, they increase the amount of chlorophyll in the plant (Demir, 2004).

In the treatment of 2 per thousand EM®, 61.4% and in the treatment of 1 per thousand, 41.3% of carotenoid increased, and its amount in the control was 0.38 mg.g. Carotenoids are a group of natural pigments that have antioxidant properties and, on the other hand, increase the efficiency of photosynthetic light reactions. Biofertilizers increase the amount of carotenoid in plants by increasing the absorption of nutrients such as phosphorus, potassium and nitrogen (Ramadan et al. 2003).

Total phenols and flavonoids

Total phenol in EM® fertilizer treatment was 16.4 mg.g in 2 per thousand and 13.9 mg.g in 1 per thousand treatment compared to the control (12.1 mg.g). The amount of total flavonoids in the 2 per thousand treatment was 7.1 mg.g of body weight, which was 3.5 mg.g in the control. Phenol and flavonoid are antioxidant substances that are produced through the shikimic acid pathway, and the most important biosynthesizing enzyme of these compounds is phenylalanine ammonialyase.

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