THE EFFECT OF *Trichoderma viride* COMBINATION WITH INORGANIC FERTILIZER ON GROWTH AND YIELD OF CAPSICUM

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Sri Lankan isolated phosphorus - solubilizing fungi based biofertilizer is a sustainable approach to increase phosphorus availability in the soil to reduce inorganic fertilizer usage. This experiment was conducted to determine phosphorus solubilizing fungi *T.viride* with inorganic fertilizer on Capsicum growth and yield under the field pot condition at Care Agro Biotech (Pvt) Ltd. The experiment was arranged in a Two Factor Factorial Randomized Complete Block Design with Thirteen treatments randomized in four replicates. Twelve (12) treatments were applied with two different phosphorous supplements; Eppawala Rock Phosphate (ERP), and Tripple Super phosphate (TSP), in three different percentages of phosphorous; 50%, 75%, and 100%, while adding Urea and Muriate of Potash (MOP) as recommended by the Department of Agriculture (DOA) with the presence and absence of the of *T. viride* for all treatment combinations. Control treatment was conducted without adding any fertilizers. The results showed that *T. viride* treated treatments increased growth, yield parameters, and available phosphors in soil. Among the treatments, *T. viride* and 100% NPK-treated treatments showed the highest growth and yield parameters. However, the result of *T.viride* with 75% TSP and ERP with inorganic fertilizer treatments were higher than the DOA recommendation for inorganic fertilizer for Capsicum. Therefore, *T. viride* can be a biofertilizer to reduce 25% TSP and ERP inorganic fertilizer usage. Compared with ERP and TSP, TSP was the best fertilizer performed with *T. viride*. Control treatment (without fertilizer and *T. viride*) showed the lowest growth, yield, and quality response.

Keywords: Biofertilizer, Capsicum, Eppawala Rock Phosphate, Triple Super Phosphate

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INTRODUCTION

In Sri Lanka, Capsicum is a popular vegetable, and most often, it is planted in arid and intermediate zones. Every year, about 4000 acres are cultivated, yielding around 36000 mt (HORDI, n.d.). Less soil fertility is one of the most important obstacles to increasing agricultural productivity. Numerous health issues and irreversible environmental degradation resulted from the extensive use of inorganic fertilizers in agriculture around the world to maintain global food security (Kumar and Prakash, 2019). Phosphorus is one of the main elements required by plants, which has a basic role in the formation of seeds and is found in large quantities in fruits and seeds (Araei and Mojaddam, 2014). Triple Super Phosphate (TSP) is a synthetic phosphate fertilizer in Sri Lanka. Because of its high-water solubility, TSP is utilized as the P fertilizer for numerous crops, including annuals and perennials. Eppawala Rock Phosphate (ERP) is considered a cheap and environmentally friendly alternative to TSP (Dissanayaka & Jayaneththi, 2021). Apatite mined from Eppawala cannot be directly used as a fertilizer for annual crops such as paddy and vegetables because of its low water solubility (Weerasooriya et al., 2018). In addition to chemical fertilizers, biofertilizers are non-bulky, inexpensive, renewable, and environmentally friendly sources of plant nutrients. Biofertilizer consists of microorganisms bringing about the improvement of the nutrients of the soil enhancing their accessibility to the crops. Producing healthy crops for the fulfillment of the demands of the world's growing population is completely dependent upon kind of the fertilizers being used to provide the plants with all the major nutrients but more dependability on the chemical fertilizers is destroying the environmental ecology and negatively influencing the health of humans (Kour et al., 2020). *Trichoderma viride* acts as a bio-fertilizer (Begum and Shaila, 2018). It was previously thought that *Trichoderma's* ability to manufacture antibiotics, parasitize other fungus, and engage in competition with harmful microbes was the mechanism by which it benefited plant growth and development (Harman et al., 2004). Therefore, this research is designed to study the effect of *T. viride* combination with inorganic fertilizer on the growth and yield of the Capsicum plant. Based on the study findings we can assess the proper ERP and TSP amount to reduce the application rate.

METHODOLOGY

A field pot experiment was carried out at Care Agro Biotech (Pvt.) Ltd. Geographically, Kandy is located in the Upcountry Wet Zone (WU1) in Sri Lanka. The experimental area is located at "7°18'01" N 80°39'10"E." Previously isolated and identified fungal culture *T. viride* was obtained from the Care Agro Biotech laboratory. *T. viride* was maintained in a Potato Dextrose Agar (PDA) medium. 5 X 10^7 – 5.7 X 10^7 CFU / ml viable spore contains *T. viride* inoculum 15 ml was prepared and applied to each related treatment as a seed treatment, nursery application, soil drenching, and foliar spraying according to the instructions given by Care Agro Biotech (Pvt.) Ltd.

Inoculation effect of *T. viride* added with inorganic fertilizer for growth and yield of capsicum

Soil was collected from uncultivated land to fill the pots and tested for pH, total phosphorous, available phosphorous, and electrical conductivity. 5 kg of sieved soil was filled into polythene pots, and the water level was maintained until it reached the field capacity. Treatments were established based on different combinations of Nitrogen fertilizer as urea, Phosphorous fertilizer as Triple superphosphate (TSP), and Eppawala Rock Phosphate (ERP), Potassium fertilizer as Muriate of Potash (MOP), *T. viride* inoculums. The treatment applied were, T1L1 is the control added with no fertilizers without *T.viride*, T1L2 was added with MOP, Urea and TSP as recommended by the Department of Agriculture (DOA) without inoculum (100% NPK – DOA Recommendation) , T1L3 was added with MOP, Urea , and ERP without inoculum (100% NPK – DOA Recommendation), T1L4 was added with MOP, Urea , and TSP without inoculum (75% P + NK), T1L5 was added with MOP, Urea and ERP without inoculum (75% P + NK), T1L6 was added with MOP, Urea , and TSP without inoculum (50% P + NK), T1L7 was added with MOP, Urea and ERP without inoculum (50% P + NK), T2L2 was added with MOP, Urea and TSP with inoculum (100% P + NK + *T.viride*), T2L3 was added with MOP, Urea , and TSP with inoculum(100% P + NK + *T.viride*), T2L4 was added with MOP, Urea , and TSP with inoculum (75% P + NK + *T.viride*), T2L5 was added with MOP, Urea and TSP with inoculum (75% P + NK + *T.viride*), T2L6 was added with MOP, Urea and TSP with inoculum (50% P + NK+ *T.viride*), T2L7 was added with MOP, Urea and TSP with inoculum (50% P + NK + *T.viride*). Data were collected for plant height in centimeters, girth in centimeters, number of leaves, number of flowers, fruit length in centimeters, fresh weight fruit in kilograms, total yield, and yield per plant in kilograms. The available phosphorous content in the treated soil was determined. The experiment was arranged in a Two Factor Factorial Randomized Complete Block Design with Thirteen treatments randomized in four replicates.

All the statistical analysis was done using the Analysis of Variance (ANOVA) procedure of the statistical analysis system (SAS). Duncan's New Multiple Range Test (DNMRT) was performed to compare the differences among treatment means at $p = 0.05$

RESULTS AND DISCUSSION

Inoculation effect of *T. viride* added with inorganic fertilizer for growth and yield of capsicum

The soil pH of the studied soil was 4.5, thus the soil which is within the acidic range. Total P (mg kg^{-1}) was 1100.5, Available P (mg kg^{-1}) was 30.26 and Electrical conductivity was 0.08.

The influence of inoculation of *T. viride* with different rates of inorganic fertilizer levels on Capsicum total yield (Kg), yield per plant (Kg), girth (cm), number of flowers, average fruit weight (kg), average fruit length (cm) and number of pods were shown in Table 1. T X L interaction was found Significant ($P < 0.05$) for total yield (kg), yield per plant (kg), girth (cm), number of flowers, average fruit weight (kg), average fruit length (cm), and number of pod values. Therefore, in the interpretation of this parameter, each main factor was not considered separately, but the results of the interaction at the factorial level are given in Table 1. The highest yield per plant was determined in T2L2 (8.33 kg). It was on far with T2L4 (7.93 kg) The maximum number of flowers per plant was observed from the treatment T2L2 (11.75). The highest number of pods was observed from T2L2 (12.00). The significant maximum average fruit weight and average fruit length were observed from T2L2 (13.92 g and 12.92 cm). The highest girth was observed from T2L2 (15.02 cm).

Treatment T2L2 showed the (T. *viride* with 100% TSP + NK) highest values of total yield, yield per plant, girth (cm), number of flowers, average fruit weight (kg), average fruit length (cm), and number of pods compared with treatment full rates of DOA recommended inorganic fertilizer applied treatments without *T. viride* for Capsicum. Furthermore, *T. viride* with 75% TSP and ERP inorganic fertilizer treatment results were higher than the full rates of DOA recommended inorganic fertilizer applied treatments for Capsicum. These results might be due to the *Trichoderma* was able to enhance rice growth components such as plant height, leaf number, tiller number, root length and shoot fresh weight (Doni et al., 2014).

Table 1: Effect of different treatments on total yield (Kg), yield per plant (Kg), girth (cm), number of flowers, average fruit weight (kg), average fruit length (cm), and number of pods.

Treatments	Total yield (Kg)	Yield per plant (Kg)	Number of pods	Average Fruit weight	Average Fruit length	Girth	Number of flowers
T1L1	11.22^{g}	2.80^{g}	3.20^{f}	8.05^{e}	7.52^{f}	3.42^{h}	2.50^{f}
T1L2	27.75^{c}	6.18^{c}	10.00^{bc}	12.35^{bc}	11.32^{cd}	14.55^{bc}	9.50^{b}
T1L3	19.95^{de}	4.98^{ed}	8.75^{cd}	11.56^{d}	10.52	12.37^{e}	7.00^{cd}
T1L4	21.37^{d}	5.34^{d}	9.25^{c}	11.73^{cd}	10.72^{cd}	13.42^{d}	7.50^{bc}
T1L5	21.05^{d}	5.26^{d}	7.25^{de}	11.12^{cd}	10.12^{de}	11.45^{f}	6.50^{bc}
T1L6	18.37^{e}	4.59^{e}	6.75^{e}	11.03^{cd}	10.02^{de}	13.07^{d}	5.00^{de}
T1L7	15.75^{f}	3.93^{f}	6.00^{e}	10.32^{d}	9.32^{e}	11.12^{f}	4.00^{ef}
T2L2	33.35^{a}	8.33^{a}	12.00^{a}	13.92^{a}	12.92^{a}	15.02^{a}	11.75^{a}
T2L3	25.45^{c}	6.36^{c}	10.50^{ab}	11.54^{cd}	10.62^{cd}	14.20^{c}	8.25^{bc}
T2L4	27.75^{b}	7.93^{a}	11.75^{ab}	13.30^{ab}	12.20^{ab}	14.85^{ab}	12.00^{a}
T2L5	23.95^{c}	5.98^{c}	8.50^{cd}	11.44^{cd}	10.42^{de}	12.20^{e}	7.25^{c}
T2L6	20.5^{d}	5.13^{d}	9.00^{cd}	12.46^{bc}	11.72^{bc}	13.35^{d}	8.50^{bc}
T2L7	18.25^{e}	4.56^{e}	6.25^{e}	11.13^{cd}	10.12^{de}	4.5^{g}	5.75^{de}

*The mean value ± standard deviation (n = 4). Values with the same letter do not differ significantly ($P < 0.05$).

According to the obtained results for the growth and yield parameters of Capsicum, different treatments show statistically different results. All the treatments of the combination of *T. viride* inoculated with reduced levels of ERP and TSP resulted in better plant growth and yield parameters as compared to their respective non-inoculated treatments, full rates of inorganic fertilizer applied treatment, and no fertilizer treatment. The obtained results might be because of the inoculation of *T.viride*. *T. viride* could be used to enhance soil fertility and promote the growth of mangroves (Saravanakumar et al., 2013).

The available phosphorous in the soil after harvesting was highest in T2L2 (104.15 mg kg^{-1}), shown in Table 2. Moreover, the available phosphorus level was significantly higher ($p<0.05$) in all inoculated treatments compared to uninoculated treatments and the initially measured available phosphorous in soil (30.26 4 mg kg^{-1}*). T. viride* is eco-friendly and has a potential approach for managing plant diseases. It also aids in phosphate solubilization (Donbiaksiam & Jyotsna, 2024).

Table 2: Effect of different treatments on Available p in soil (mg kg^{-1}) after harvesting.

Treatments	Available Phosphorus in soil (mg kg^{-1})
T1L1	34.95^{i}

T1L2	55.42[c]
T1L3	40.97[gh]
T1L4	49.42[e]
T1L5	39.37[h]
T1L6	41.97[g]
T1L7	40.97[gh]
T2L2	104.15[a]
T2L3	51.42[d]
T2L4	90.25[b]
T2L5	46.47[f]
T2L6	56.42[c]
T2L7	45.97[f]

*The mean value ± standard deviation (n = 4). Values with the same letter do not differ significantly (P < 0.05).

CONCLUSIONS

T. viride with inorganic fertilizer treated treatments increased growth, yield parameters of capsicum and available phosphors in soil after harvesting. Among the treatments, the best TSP fertilizer rate was *T, viride* with 100% TSP + MOP + Urea treatment. The best ERP fertilizer rate was *T,viride* with 100% ERP + MOP + Urea treatment. However, *T.viride* with 75% TSP and ERP with inorganic fertilizer treatment results were higher than the DOA recommendation for inorganic fertilizer for Capsicum. Therefore, *T. viride* can be used as a biofertilizer to reduce 25% TSP and ERP inorganic fertilizer usage. Compared with ERP and TSP, TSP was the best fertilizer performed with *T. viride.*

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