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Selection of Suitable Particle Size, Pellet Diameter of Coco Peat, Type of Fertilizer and Rate of Fertilizer Mix for Tomato (*Lycopersicon esculentum* L.) Nurseries

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ABSTRACT: This study was conducted to select the best particle size of coco peat for green house tomato nurseries and develop the easy use compressed coco peat pellets mixed with fertilizer for nurseries of tomato. The experiment was carried out in International Foodstuff Company and Faculty of Agriculture, University of Ruhuna, Sri Lanka during 2015 to 2016. Under experiment one, three types of different particle sizes were used; namely fine (≤0.5mm) (T2), medium (3mm-0.5mm) (T3) and coarse (4mm<) (T4) with normal coco peat (T1) as treatments. Complete Randomized Design (CRD) used as experimental design with five replicates. Germination percentage, number of leaves per seedling, seedling height in frequent day intervals was taken as growth parameters. Analysis of variance procedure was applied to analyze the data at 5% probability level. The results revealed that medium size particle media (sieve size 0.5mm -3mm) of coco peat was the best particle size for tomato nursery practice, when considered the physical and chemical properties of medium particles of coco peat. In the experiment of selecting of fertilizer and mixing rate of fertilizer**;** Yara mix fertilizer was better than Albert's solution. However type of fertilizers and diameters of the pellet, were not significantly affect for germination, but pellets which 32mm in diameter with mixed 5.5g/kg Yara mix fertilizer combination was shown significantly high vegetative growth.

KEYWORDS: Coco peat pellet, Fertilizer, Green house, Particle size, Tomato.

1 INTRODUCTION

Controlled Environment Agriculture (CEA) is a total concept of modifying the natural environment for optimum plant growth. This concept has been carried forward to the extent of supplying the optimum aerial and root environment to optimize plant growth. Factors such as control of temperature, relative humidity and composition of the atmosphere and protection from rain, insects can be functions of CEA along with the supply of optimum levels of moisture, air and nutrients to the root zone. [1]. CEA is a total concept of modifying the natural environment for optimum plant growth. CEA is a potential area to boost the production.

Tomatoes are important crop which are grown in protected agriculture systems. However to get an optimum production from tomatoes, it is essential to establish strong nursery plants. At the initial stage of plant growth different factors are affecting plant development such as seed vigor, moisture content, substrate conditions, environmental conditions etc. Among these factors substrate condition directly affect to the plant development. [2] According to the substrate the moisture content, bulk density and porosity are being changed. Researchers have tried to provide the perfect growth media for nursery production by characterizing the physical properties of different media. The physical quality of these mixes is dependent on the substrates ability to store and supply air and water. The physical components that are important to quality media include: pore size, porosity, water-holding capacity, hydraulic conductivity, aeration porosity, and bulk density. Bulk density is an important factor to consider in interpreting the physical and chemical properties of media on a volume basis. Bulk density of soilless media are low, therefore additions of sand are usually added to increase weight [3], [5], [6]. Increasing bulk density provides support to the plant in lightweight containers. [5] also found that shrinkage and settling in a pot will increase bulk density. Considering these facts this experiment was done to investigate the suitable particle size, effect of pellet diameter, fertilizer type and mixing rate of fertilizer on nursery stage of tomato.

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2 MATERIALS AND METHODS

2.1 EXPERIMENT (1): IDENTIFICATION OF SUITABLE PARTICLE SIZE OF COCO PEAT FOR TOMATO

The experiment was carried out in International Foodstuff Company, Embilipitiya and Faculty of Agriculture, University of Ruhuna, Sri Lanka under protected condition. Three types of different particle sizes were used with normal coco peat (control) treatment.

Normal coco peat (control) = T1
Fine particle (≤0.5mm) = (T2)
Medium particle (3mm-0.5mm) = (T3)
Coarse particle (4mm<) = (T4)

Before start the experiment, Bulk density, air filled porosity, water holding capacity, pH, Cation Exchange Capacity (CEC) and Electrical Conductivity (EC), were measured of an in treatment. Then four treatments (general coco peat, fine particles, medium particles and coarse particles) were wetted by using equal an amount of water. The tomato nursery trays were filled by using above wetted four materials. The experimental design was arranged according to complete randomized design (CRD) with five replicates. After arranging experimental units, tomato seeds (Var. Rub) were sown in each replicates and covered with black polythene to control the light penetration. Daily watering was applied up to germination. Two days after germination fertilizer application schedule was started.

Albert's solutions were used as fertilizer, at first, stock solution was prepared. The electrical conductivity and pH of the stock solution was 60mS/cm and 5.8 respectively. Working solution was prepared from stock solution the electrical conductivity and pH values of that solution were 1.8mS/cm and 5.8 respectively. These tomato seedlings were adapted for above working solution within 15 days. Therefore following dilution and application procedure were used.

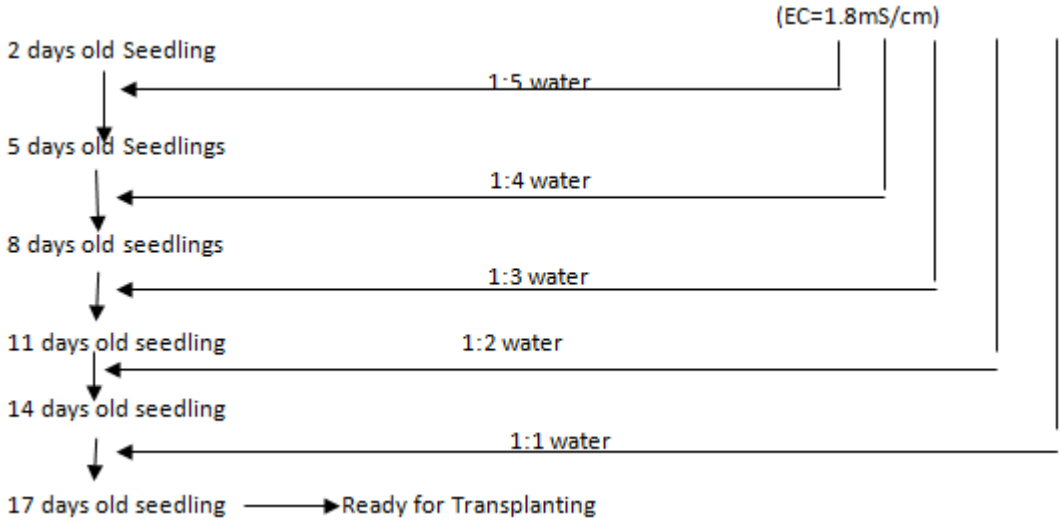

Figure 1: Nutrient application pattern for tomato nurseries

Germination percentage was recorded after 5 days of seed sowing and other growth parameters such as seedling height and number of leaves per seedling were recorded at 2 days, 5 days 8 days 11 days 14 days and 17 days after germination.

2.2 EXPERIMENT (2): SELECTION OF BEST PELLET DIAMETER OF COCO PEAT, TYPE OF FERTILIZER AND RATE OF MIX FOR GREENHOUSE VEGETABLE NURSERIES

According to the results of experiment 1, the best particle size of coco peat was medium size particles for tomato nurseries. Therefore medium size particles were used for rest of the nursery trials. The main objectives of this experiment were found out suitable pellet diameter, fertilizer and rate of mix of fertilizer for tomato. Initially, two different fertilizer grades (Albert's fertilizer, ($10.6N+9.3P_2O_5+16.3K_2O+2.25MgO+11CaO$) and Yara PG mix fertilizer, ($10N+15P_2O_5+15K_2O+5MgO+9CaO$) were selected as nursery fertilizer and mixed with three levels (5.5g/1kg of coco peat,

11g/1kg of coco peat and 16.5g/1kg of coco peat) of each fertilizer grade into medium size coco peat which is best particle size of coco peat selected from experiment 1. The coco peat that enriched with above fertilizer rates were used to produce three diameter sized (32mm, 38mm and 42mm) pellet. The pellets were produced using manual pressure equipment and biodegradable rapping material was used for rapping. According to the above procedure, the following treatments were created.

Table 1: Combination of different types of fertilizer and rate of mixed and diameter of pellets (treatment combination)

Pellet diameter (mm)	Type of fertilizer and rate of mixed (g/kg)	Treatment code
32	Albert's, 5.5	T_1
32	Albert's, 11.0	T_2
32	Albert's, 16.5	T_3
32	Yara PG mix, 5.5	T_4
32	Yara PG mix, 11.0	T_5
32	Yara PG mix, 16.5	T_6
38	Albert's, 5.5	T_7
38	Albert's, 11.0	T_8
38	Albert's, 16.5	T_9
38	Yara PG mix, 5.5	T_{10}
38	Yara PG mix, 11.0	T_{11}
38	Yara PG mix, 16.5	T_{12}
42	Albert's, 5.5	T_{13}
42	Albert's, 11.0	T_{14}
42	Albert's, 16.5	T_{15}
42	Yara PG mix, 5.5	T_{16}
42	Yara PG mix, 11.0	T_{17}
42	Yara PG mix, 16.5	T_{18}

Above 18 treatments (T_1-T_{18}) were laid in nursery trays. The treatments were arranged according to the factorial complete randomized design with five replicates and applied water. Then pellets were expanded and allowed one hour for drain out excess water. Tomato (var. Ruby) seeds were sown in the pellets and watered. All the trays were covered using inner black and outer white polythene for maintaining moisture and dark condition to induce germination. Daily watering was practiced up to germination. Just after germination polythene was removed. After five days of seed sowing germination percentages were recorded and then numbers of leaves per plant, seedling height were measured once a week up to three weeks as growth parameters. All the data were analyzed using ANOVA procedure.

3 RESULTS AND DISCUSSION

3.1 EFFECT OF DIFFERENT PARTICLE SIZES ON TOMATO SEED GERMINATION, NUMBER OF LEAVES PER SEEDLING AND SEEDLING HEIGHT

According to the analysis of variance of germination percentages of tomato seeds, significant ($p \leq 0.05$) variation was observed among the three different particle sized (fine particles of coco peat, medium particles of coco peat and coarse particles of coco peat) media of coco peat at 3, 4 and 5 days after seed sowing. Significantly highest seed germination percentages (32% at 3 days, 70% at days and 92% at 5day) (Figure 2) were observed in medium sized particle media at 3, 4 and 5 days after seed sowing compared to the fine and coarse particles respectively. The lowest seed germination percentages (10% at 3 days, 42% at 4 days and 63% at 5 days) were observed in fine particle sized coco peat medium at 3, 4 and 5 days after seed sowing (Figure 2).

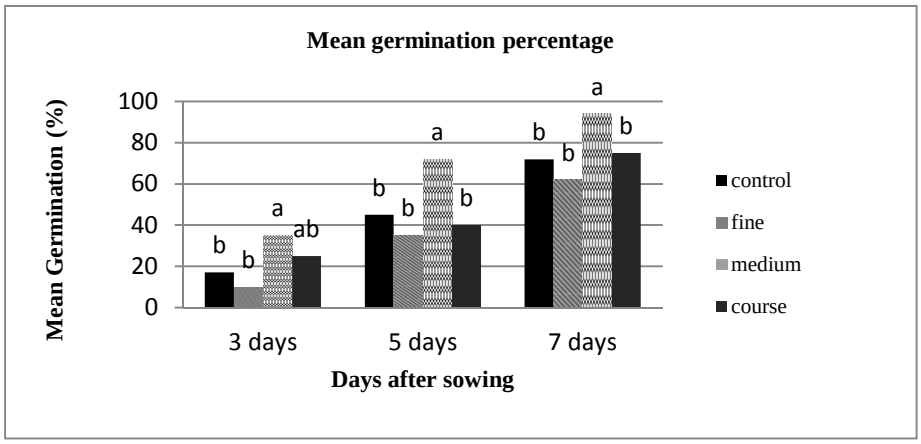

Figure 2: Changes of mean germination percentages of tomato seed in three different particle size of coco peat within 5 days after seed sowing. Bars represented by the same letter are not significantly different at α ≤ 0.05

The number of leaves of tomato seedlings was not significant (p≤0.05) among the three different particle sizes of coco peat up to 8 days after germination. But significantly highest mean number of leaves/seedling (4.2 at 11day, 5.2 at 14 days and 7.2 at 17 days) were observed in medium particle sized media (sieve size 0.5mm -3mm), followed by coarse particles (sieve size 3mm - 8mm) and fine particles (fine ≤ 0.5mm) at 11, 14 and 17 days after germination. Also same pattern was observed in variation of seedling height of tomato, According to the results of height of tomato seedlings, there was not significantly (p≤0.05) difference among the seedling heights which was grown in three different particle size of coco peat up to 11 days after germination. But at 14 days and 17 days after germination, significant difference was observed among the seedling heights of different coco peat particle sizes. The significantly highest seedling height (14.8cm at 14 days and 17.2cm at days) were observed in medium size particle media (sieve size 0.5mm -3mm) at 14 and 17 days after germination compared to the fine and coarse particle sizes. The height of the seedlings which were grown in fine and coarse particles was shown same height changes during nursery period of tomato. According to the results medium size particle media (sieve size 0.5mm -3mm) of coco peat was the best particle size for tomato nursery practice, when considered the physical properties of medium particles of coco peat; it had moderate bulk density (108.29g/l) comparing with fine (164.3g/l) and coarse (53.82g/l) as a results, coarse particle contains more macro pores and retain low moisture amount and high air content [9] as a results required amount of water for seed germination is less in coarse particle media, it may be a reason for lower germination percentages of tomato seeds. Other growth performances such as number of leaves/seedling, seedling height of tomato were higher in medium sized particle media comparing with fine and coarse media, because of that medium sized media maintains moderate bulk density (108.29g/l) and moderate water holding capacity (550ml/l), good air filled porosity (25%) and best pH 6.1. When increase the bulk densities of substrates reduce the pore spaces for air [7] as a result, retain higher moisture content and low O_2 for root growth hence, nutrient absorption is low [8] Also significantly higher EC and CEC was observed in fine particle media, when increase the EC, soluble salt content in the media is increase [4] it makes the stress on vegetative growth of seedlings, this effect can be seen in fine particle media, this may be the reason for lower number of leaves per seedling and low seedling height in fine media. Also in opposite way, coarse particles contain lowest bulk density hence it maintains more spores for air and low water and contains low CEC. It reduces the growth performances (no leaves/seedling and height of seedling).

3.2 EFFECT OF PELLET DIAMETER, FERTILIZER TYPE AND MIXING RATE OF FERTILIZER ON NURSERY STAGE OF TOMATO

Germination percentages of tomato seeds was not significantly (p≤0.05) affected on interaction among the fertilizer type, mixing rate of fertilizer and diameter of the pellets. Germination percentage of tomato was significantly (p≤0.05) affected on only rate of fertilizer mixed. Significantly (p≤0.05) highest germination percentage (97.2%) was observed at the rate of 5.5g/kg of fertilizer in both PG mix fertilizer and Albert's fertilizer mixture (Figure 3a)

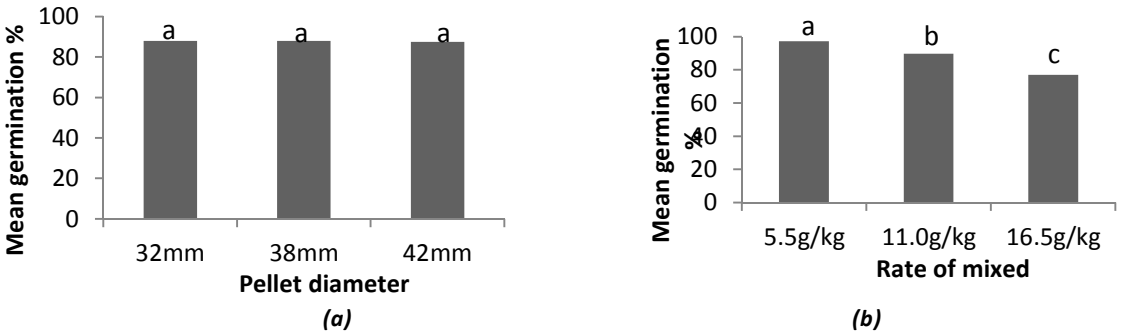

Figure 3: Changes of mean germination percentages of tomato seed in different types of fertilizer, diameter of pellets and rate of mixed 7 days after seed sowing. Bars represented by the same letter are not significantly different at α ≤ 0.05

When increasing the mixing rate of fertilizer, germination percentage of tomato was significantly (p≤0.05) decreased as 89.7% and 76.9% for 11g/kg and 16.5g/kg respectively. However, no significant difference was observed (87.8%, 87.9% and 87.4%) in three different diameters of pellets Fertilizers are soluble salts, when increase the rate of mixed of fertilizer; EC of the coco peat is increased. As a result water absorption by the seed is decrease due to high osmotic pressure [10]; hence germination percentage is reduced, this is a reason for descending order of germination percentages when increase the rate of mix of fertilizer. Number of leaves of tomato seedling was significantly (p≤0.05) affected on main effect of three factors (types of fertilizer, mixing rates of fertilizer and diameter of the pellets). There were no any interaction effect of three factors on number of leaves per seedling of tomato during nursery period (3 weeks after germination), the highest number of leaves per seedling at first week (2.13), second week (3.17) and third week (5.13) in PG mix fertilizer respectively (Figure 4a). Mixing rate of 5.5g/kg showed significantly (p≤0.05) higher number of leaves in tomato seedling at first week (2.24), second week (3.11) and third week (5.06) respectively. Also comparing with 38mm and 42mm diameter pellets, 32mm pellet showed significantly (p≤0.05) higher number of leaves (5.07) per seedling of tomato (Figure 4b)

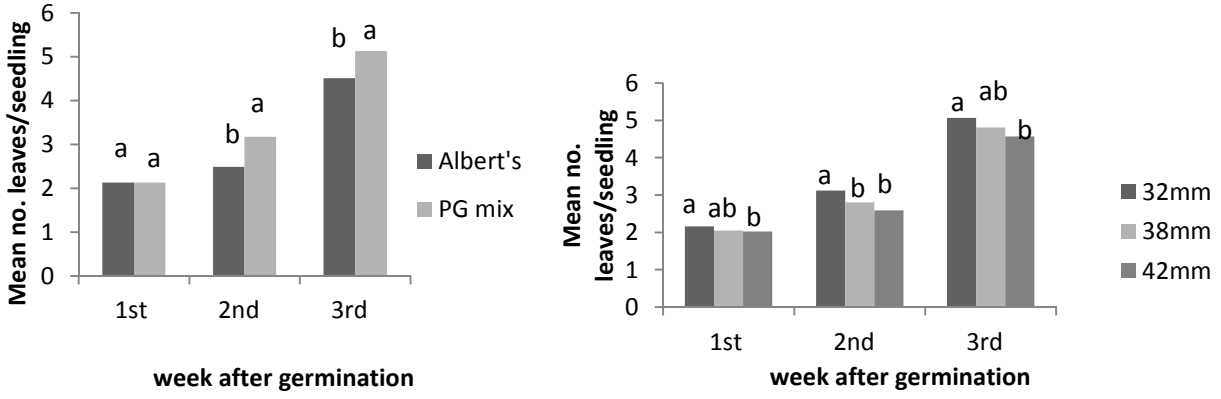

Figure 4: Changes of mean no. of leaves/seedling of tomato seedlings in (a) rate of mixed (b) different types of fertilizer at 1st, 2nd and 3rd weeks after seed germination. Bars represented by the same letter are not significantly different at α ≤ 0.05

Results revealed that seedling height of tomato was significantly (p≤0.05) affected only on three factor interaction (types of fertilizer * mixing rates * diameter of pellet) of the experiment at first, second and third weeks after germination. Significantly highest seedling height was observed in treatment of 32mm diameter pellets with PG mixed fertilizer at the rate of 5.5g/kg. They were 4.49cm, 7.98cm and 12.28cm respectively (Figures 5) When considered the nutrient composition of Albert's and PG mix fertilizers, potassium content relatively high in Albert's solution; its makes stress on vegetative growth parameters such as no of leaves per plant and height of seedling, Also P_2O_5 content is high in PG mix fertilizer with compared to Albert's fertilizer it helps to develop the root mass of seedlings. Therefore no of leaves per plant and seedling height of tomato is relatively high in seedlings that grown in PG mix fertilizer. When increase diameter of the pellet, rooting media volume per seedling is increased as a result root mass will be increased and areal parts of the seedlings will be reduced. It

may be a reason for reducing no of leaves per seedling and height of seedling of tomato when increase the diameter of the coco peat pellet.

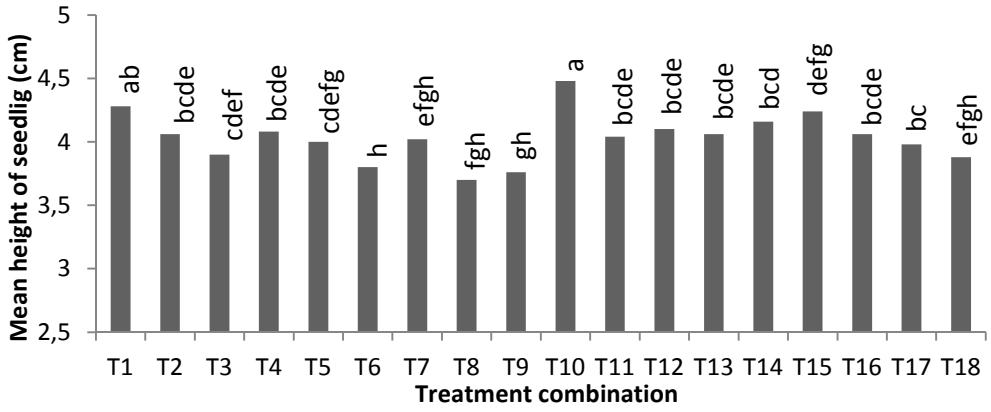

Figure 5: Changes of mean seedling height of tomato in different types of fertilizer,diameter of pellets and rate of mixed 1st week after seed germination.T_1-T_{18} - Combination of different levels types of fertilizer, diameter of pellets and rate of mixed (refer to table 1)Bars represented by the same letter are not significantly different at α ≤ 0.05

4 CONCLUSION

According to the results medium size particle media (sieve size 0.5mm -3mm) of coco peat was the best particle size for tomato nursery practice, when considered the physical and chemical properties of medium particles of coco peat. In the experiment of selecting of best pellet diameter, type of fertilizer and mixing rate of fertilizer**,** for enriching nursery media, PG mix fertilizer was better than Albert's solution. For tomato seed germination which was not significantly depended on the factors of type of fertilizers and diameters of the pellet, but significantly highest germination percentage was recorded at 5.5g/kg rate of mixed comparing with 11.0g/kg and 16.5g/kg rates of mixed. The pellets which 32mm in diameter with mixed 5.5g/kg PG mix fertilizer combination was shown significantly highest tomato seedling height.

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