Pummelo (Citrus maxima L) seedlings growth as influenced by bio-fertilizers and organic amendments

Aziz Fayaz, SV Patil, GSK Swamy, TH Shankarappa and BR Premelatha

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Abstract
Experiment was conducted in poly-house at College of Horticulture, Bengaluru to study the effect of Bio fertilizers and organic amendments on growth and establishment of pummelo under nursery condition during 2019-20. The nursery were established in potting mixture; sand, soil and farm yard manure in the ratio of 2:1:1 (Sand: Soil: FYM;) taken in polythene bags of size 12 cm x 24 cm. Applied with bio-fertilizers such as Azospirillum spp., Phosphorus solubilizing bacteria (PSB), Pseudomonas fluorescens; @ 6 g per plant (single / dual / combinations 6 g only) plus Vesicular Arbuscular Mycorrhiza (VAM), soil based bio-fertilizers @ 6 g per plant. A total of nine treatments were tested in four replications. The results at the end of 120 days showed that the inoculation of consortium of three bio-fertilizers; Azospirillum, spp. Phosphorus solubilizing bacteria and VAM had produced significantly highest seedling height (36.32 cm), seedling girth (4.67 mm), number of leaves (23.10 no.), leaf area (28.25 cm²), fresh and dry Weight of shoot (17.47 and 7.16g respectively) in T1 treatment. The maximum fresh and dry weight of root (10.02 and 5.07 g), number of primary and secondary roots (37.95), length of primary root (35.95 cm) and root volume (10.34 cm³) was recorded the treatment Azospirillum, Phosphate solubilizing bacteria and Pseudomonas fluorescens and VAM at the end of 120 days in nursery.

Keywords: Pummelo CV. Devanahalli seedlings, Bio-fertilizers and organic amendments on growth and establishment

Introduction
Pummelo (Citrus maxima or citrus grandis,) is the largest fruit among Citrus fruits. It has thickrind and locally it is known as Chakotha, Chakotara etc. In India this fruit is commercially grown onavery limited scale but the trees are found in North Eastern states, North Western Himalayan region, Eastern Uttar Pradesh, Bihar, Karnataka and Kerala. It is used in religious programmes in the country. In Manipur it is also used for religious purposes. In Bihar and eastern UP, this fruit is essential for Chhatpooja. Every house of this area has a pummelo tree in their kitchen garden. Pummelo grown in the far northeastern states of India, and some southern regions of Karnataka and Kerala. The states mainly Assam, Manipur and Tripura cultivate the fruit up to 1,500 meters MSL. It is commercially grown in parts of Karnataka. This is also found in Kentucky region of Tamil Nadu and lower hills of Uttarakhnd, Himachal, Bihar and West Bengal. In the world, presently pummelo is grown in many eastern countries including China, Japan, India, Fiji, Malaysia, Vietnam and Thailand. It is also now grown in the Caribbean and in the United States, in California and Florida. Vietnam, Thailand, China, USA are main producer of pummelo. The area of pummelo is increasing due to health benefits. (Sankar et al. 2014) [9]. However, pummelo development area is still very limited. Pummeloproduction is still low in 2014 and 2015 reached 141,296 tons and 111,753 tons respectively or around 5% of national citrus production reported by (Susanto et al. 2018) [11]. Bio-fertilizers is used in live formulation of beneficial microorganism which on application to seed, root or soil mobilizes the availability of nutrients particularly by their biological activity help build up the lost micro flora and in turn improve the soil health (Pathak et al., 2018) [8]. Bio-fertilizer is a substance used to increase the fertility of the soil, it contains microorganisms which help the soil to gain its nutrient back and make the soil available for cultivation (Malik Asif et al. 2008) [4].
Azospirillum a non-symbiotic micro aerophilic bacterium commonly found in association with roots of horticultural crops nitrogen fixation capacity and tolerance to high soil temperatures. The phosphate solubilizes containing bacteria or fungi may convert insoluble form of phosphate to soluble form by producing organic acids. In general about 15 – 25% of insoluble phosphate can be solubilized (Sankara Rao Karriet al. 2012) [9].

Materials and Methods

The present investigation entitled “Effect of bio-fertilizers and organic amendments of growth and establishment of pummelo seedlings under nursery condition, (Citrus maxim CV. Devanahalli) “ The experiment was conducted under poly-house condition at Regional Horticultural Research and Extension Centre (RHREC), University of Horticultural sciences campus, GKVK, post Bengaluru, during the year 2019-20. The experimental was laid out in completely randomized design with four replications. The experiment comprised of nine treatments with the combinations of effect of biofertilizers and organic amendments on growth and establishment of Pummelo under nursery condition. Pummelo seeds were collected from pummelo plot of RHREC. Seedlings were raised in polythene bags of (12 x 24) cm with 4 holes punched on the polythene bags from bottom to top to facilitate proper drainage. Then the seeds were sown into the media polybags containing mixtures of Soil, FYM and Sand (2:1:1) and treated with bio-fertilizers combinations such as Azospirillum spp., Phosphorus solubilizing bacteria(PSB), Pseudomonas fluorescens(PF) and Vesicular Arbuscular Mycorrhiza (VAM) @ 6 g per seedling (all together) per treatment. These polythene bags were kept under poly-house, at 30 days interval liquid organic manurespanchagavaya, jeevamrutha, beejamrutha and bio digester @ 5, 10, 10 and 10 per cent respectively were applied through foliar application and observations were recorded at 30, 60, 90 and 120 days after germination.

Results and Discussion

The evaluation of bio-fertilizers on growth and establishment of mango grafts var. Alphonso under poly-house condition showed that the biofertilizers, nitrogen fixer, phosphate solubilize, bio control agent and phosphorous mobilize in the form of Azospirillum spp., Pseudomonas striata, Pseudomonas fluorescens and VAM respectively had increased the growth parameters. The growth and establishment was significantly superior as reported by Shankarappa et al. 2018. In case of three and four months old acid lime seedlings (Citrus aurantifolia Swingle) cv. Balaji, the maximum plant height, number of leaves, stem girth, were recorded in the potting media containing soil + sand + vermicompost + Arbuscular mycorrhiza (5g) + neem cake 20g each per bag. Azotobacter chroococcum (A), Bacillus megatherium var phospaticum (B), mixture of 50% (A) and 50% (B) (v/v) and algae extraction. The growth vigor parameters in number of leaves and plant height content were estimated in Orange Seedlings (Omayma et al. 2011) [6]. Biofertilizers which increases (PSB) level in the rootzone that stimulated more root initiation, more nutrient uptake and root cell elongation, thus resulting into increased taproot length resulted in increasing dry weight. The results are in conformity with the findings of (Anjanawe et al. 2013) [1] in papaya and (Panchal et al. 2015) [7] in khirni. Azotobacter with GA3 (1:1+ 5g/kg +GA3 100 ppm increase seedling height, number of leaves per seedling, girth of stem (Mohini Parmar et al. 2019) [5] in acid lime. GA3 150 ppm + NAA 150 ppm has recorded the maximum seedling height, seedling diameter, number of leaves, leaf area, fresh and dry weight of seedlings, number of primary and secondary roots, Length of primary root, root volume and fresh and dry weight of root of pummelo seedlings reported by (Harsha et al. 2017) [3]. The combination of Azospirillum and phosphate solubilize bacteria for Banana cv. Grand Nine, recorded the highest growth parameters plant height, plant girth, number of leaves, leaf area leaf area index by reported (Ganapathi and Dharmatti, 2018) [2].

Table 1: Effect of bio-fertilizers and organic amendments on growth of plant height, seedling girth, number of leaves, leaf area and fresh and dry weight of shoot of pummelo CV. Devanahalli seedlings at 120 DAG.

| Treatments                                      | Seedlingheight (cm) | Seedling girth (mm) | Number of leaves | Leaf area (cm²) | Fresh weight of shoot (g) | Dry weight of shoot (g) |
|------------------------------------------------|---------------------|---------------------|------------------|-----------------|------------------------|------------------------|
| **T₀**: Water Spray (control)                   | 27.82               | 4.01                | 17.95            | 29.48           | 11.69                  | 4.05                   |
| **T₁**: Azospirillum spp. + Phosphorus solubilizing bacteria (PSB) + Pseudomonas fluorescens (PF) (2 g each) | 29.92               | 4.26                | 19.15            | 30.98           | 12.35                  | 4.50                   |
| **T₂**: Azospirillum spp. + Phosphorus solubilizing bacteria (PSB) + Vesicular Arbuscular Mycorrhiza (VAM). (2 g each) | 36.32               | 4.67                | 23.10            | 32.53           | 17.47                  | 7.16                   |
| **T₃**: Azospirillum spp. + Pseudomonasfluorescens + Vesicular Arbuscular Mycorrhiza (VAM). (2 g each) | 33.82               | 4.44                | 21.85            | 29.18           | 16.40                  | 6.11                   |

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Table 2: Effect of bio-fertilizers and organic amendments on root parameters of pummelo CV. Devanahalli seedlings at 120 DAG.

| Treatments                                                                 | Fresh weight of root (g) | Dry weight of root (g) | Number of primary and secondary roots | Length of primary root (cm) | Root volume (cm³) |
|---------------------------------------------------------------------------|--------------------------|------------------------|--------------------------------------|-----------------------------|-------------------|
| T₁- Water Spray (control)                                                | 7.75                     | 2.89                   | 30.50                                | 27.07                       | 6.94              |
| T₂- Azospirillum spp. + Phosphorus solubilizing bacteria (PSB) + Pseudomonas fluorescens (PF). (2 g each) | 9.00                     | 3.68                   | 34.10                                | 32.25                       | 7.95              |
| T₃- Azospirillum spp. + Phosphorus solubilizing bacteria (PSB) + Vesicular Arbuscular Mycorrhiza (VAM). (2 g each) | 9.73                     | 4.02                   | 34.65                                | 33.49                       | 8.43              |
| T₄- Azospirillum spp. + Pseudomonas fluorescens + Vesicular Arbuscular Mycorrhiza (VAM). (2 g each) | 8.65                     | 3.12                   | 36.35                                | 34.37                       | 9.14              |
| T₅- Azospirillum spp. + Phosphorus solubilizing bacteria (PSB) + Pseudomonas fluorescens + Vesicular Arbuscular Mycorrhiza (VAM). (1.5 g each) | 10.02                    | 5.07                   | 37.95                                | 35.95                       | 10.34             |
| T₆- Panchagavya Spray @ 5% after germination                              | 8.19                     | 3.46                   | 32.35                                | 31.52                       | 8.94              |
| T₇- Jeevamrutha Spray @ 10% after germination                             | 8.80                     | 3.68                   | 31.45                                | 30.45                       | 8.34              |
| T₈- Beejamrutha Spray @ 10% after germination                             | 8.30                     | 3.67                   | 33.60                                | 31.45                       | 8.33              |
| T₉- Biodigested liquid Spray @ 10% after germination                      | 8.49                     | 3.40                   | 32.15                                | 29.87                       | 8.63              |
| SD±                                                                        | 0.41                     | 0.03                   | 0.32                                 | 1.17                        | 0.37              |
| CD @ 5%                                                                   | 1.20                     | 0.11                   | 0.94                                 | 3.39                        | 1.10              |

DAG.* Days after germination

Fig.1 Effect of bio-fertilizers and organic amendments on growth of plant height, seedling girth, number of leaves, leaf area and fresh and dry weight of shoot of pummelo CV. Devanahalli seedlings at 120 DAG.
Conclusion
The treatment of *Azospirillum* spp. + PSB + VAM (2 g each) in poly bags to Pummelo seedlings recorded maximum plant height, seedling girth, number of leaves, fresh and dry weight of shoot and with combination of four bio-fertilizers recorded maximum fresh and dry weight of root, number of primary and secondary root, length of primary root and root volume at 120 days after germination.

Reference
1. Anjanawe SR, Kanpure RN, Kachouli BK, Mandloi DS. Effect of plant growth regulators and growth media on seed germination and growth vigour of papaya. Annals of Plant and Soil Res. 2013; 15(1):31-34.
2. Ganapathi T, Dharmatti PR. Effect of Integrated Nutrient Modules on Growth, Yield and Quality Parameters of Banana cv. Grand Nine. Int. J Curr. Microbial. App. Sci. 2018; 7(1):1974-1984.
3. Harsha HR, Venkata Rao, Dayamani KJ, Shivanna M. Pummelo (*Citrus maxima* Merill) Seedlings Growth as Influenced by Plant Growth Regulators and Macronutrients. Int. J Curr. Microbial. App. Sci. 2017; 6(12):1750-1754.
4. Malik Asif, Mughal AH, Bisma R, Zafar Mehdi, Saima S, Misbah Ajaz, Malik MA et al., Application of Different Strains of Biofertilizers for Raising Quality Forest Nursery. Int. J Curr. Microbial. Sci. 2018; 7(10):3680-3686.
5. Mohni Parmar, Pandey SK, Pandey CS, Pawandeep Singh, Aiswarya Ravi. Effect of Growing Media and GA3 on Seed Germination and Seedling Growth of Acid Lime (*Citrus aurantifolia* Swingle) Cv. Vikram. Int. J Curr. Microbial. App. Sci. 2019; 8(8):1260-1271.
6. Omayma Ismail M, Dakhly F, Ismail MN. Influence of Some Bacteria Strains and Algae as Biofertilizers on Growth of Bitter Orange Seedlings. Aust. J Basic. And App. Sci. 2011; 5(11):1285-1289.
7. Panchal GP, Parasana JS, Patel SR, Patel MV. Effect of different growing medias and levels of IBA on growth and development of khirni (Manilkara hexandra roxb) seedlings cv. Local. Soc. Sci. Nature. 2015; 3(4):379-383.
8. Pathak DV, Kumar M, Rani K. Bio-fertilizers Application in Horticultural Crops, 2017,. DOI: 10.1007/978-981-10-6241-4-11.
9. Sankara Rao Karri. Role of bio fertilizers in horticulture crops. J Plant Development. Sci. 2012; 4(1):125-129.
10. Shankarappa TH, Narayana Ready, Subramanyam B, Sreenatha A, Aswathanarayanra. Bio-fertilizers for growth and establishment of alphonso mango grafted under nursery condition. Int. J Curr. Microbial. App. Sci. 2018; 7:5205-5211.
11. Susanto S, Hermansah D, Amanda F. The growth and quality of fruit of three pummelo (*Citrus maxima* (Burn.) Merr.) Accessions. IOP Conf. Series: Earth and Environmental. Sci. 2018; 196:012014.