



Establishment of Coffee Seedlings as Influenced by Planting Pit Size and Rock Phosphate along with Plant Growth Promoting Rhizobacteria Inoculations

D. S. Mukharib¹, Rudragouda^{1*}, C. Babou¹, M. Govindappa², Ramya¹, Nagaraj Gokavi¹, Kishore Mote¹, A. N. Manjunath¹ and Y. Raghuramulu¹

¹Central Coffee Research Institute, Coffee Research Station Post – 577 117, Karnataka, India.

²Coffee Research Sub Station, Chettalli – 571 248, Karnataka, India.

Authors' contributions

This work was carried out in collaboration between all authors. Author DSM, Rudragouda and CB designed the study and authors DSM, Rudragouda, CB, MG, NG, KM carried out the study in collaboration between all. Authors Ramya and KM did statistical analysis. Authors ANM and YR read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2018/38955

Editor(s):

(1) Alejandro Hurtado Salazar, Professor, Departamento de Produccion Agropecuaria, Universidad de Caldas, Colombia.

Reviewers:

(1) Javan Ngeywo, Kenya.

(2) Salisu Muhammad Tahir, Kaduna State University, Nigeria.

Complete Peer review History: <http://www.sciencedomain.org/review-history/23074>

Original Research Article

Received 22nd November 2017
Accepted 2nd February 2018
Published 7th February 2018

ABSTRACT

A multi-location field experiment was initiated to boost the growth of supply planting of young coffee seedlings in the main field during the year 2015-16 at Central Coffee Research Institute (CCRI) and its substations. Observations were recorded on growth parameters, root characters and percent mortality of the seedlings and statistical data were analysed with WASP Web Based Agricultural Statistics Software Package. Results indicated that all the treatments significantly improved plant growth and showed the better establishment of coffee seedlings in the field. The treatment with increased square pit size of 45 x 45 x 45 cm³, addition of rock phosphate at 30g, supplementation of 25 gm each of Azospirillum, PSB and VAM fungi enriched with 2 kg of compost and 10 gm of phorate per pit showed significantly increased tap root length (127%), root volume (113.82%), fresh root biomass (106.89%), dry root biomass (69.42%), secondary roots (72.59%), primaries branches (51.0%) and length of primaries (39%). The treatment with pit size of 30 x 30 x

*Corresponding author: E-mail: agronomistcrss@gmail.com;

45 cm³ with addition of 30 g rock phosphate and 2 kg compost per pit also showed significant increase in tap root length (96.43%), root volume (92.53%), fresh root biomass (78.76%), dry root biomass (89.81%), secondary roots (55.07%), primaries branches (37.82%) and length of primaries (34.24%) compared to control. Hence, the initial results of the experiment indicated that planting of young coffee seedlings with increased square pit size along with P nutrition and plant growth promoting rhizobacteria (PGPR) application could be beneficial in achieving the better establishment of seedlings in the main field under changing climatic conditions.

Keywords: Growth and root parameter; plant growth promoting rhizobacteria; pit size; young coffee seedlings.

1. INTRODUCTION

Coffee is the second largest traded commodity in the world next to petroleum products. The major coffee producing countries are Brazil, Colombia, Vietnam, Indonesia, Mexico, India and Guatemala, whose economies earn significant foreign exchange from the export of coffee. The genus *Coffea* has more than 70 species, but only two species, *Coffea arabica* L. and *Coffea canephora* Pierre, contributing 70 and 30% of world's coffee, respectively [1]. The coffee plant is perennial has the dual functions of nurturing the developing berries and production of fresh wood for succeeding crop [2]. Under standard management, Arabica bushes remain productive for about 35-40 years while Robusta for about 60-70 years. Hence, the vigorous and healthy establishment of plants in the early years of planting is essential for the maintenance of longevity of any plantation. Many researchers reported that factors such as transplantation shock effect and prolonged dry spells after field transplanting of seedlings have adversely affected the establishment of young coffee seedlings and increased mortality of 50 to 60% in the primary field [3]. A problem identified in the production of coffee is low survival rate of coffee seedlings after field transplanting is one among all the coffee growing areas [4]. In India, usually coffee planting is taken up on the primary field during August - September at the end of the South West monsoon followed by dry season during November – December and results in mortality of supply planting taken up for gap filling. Hence, in general, the establishment of young coffee seedlings without irrigation remains

to the extent of 40 to 60% only, which leads to a more significant number of vacancy in the main field [5]. These gaps have to be filled by supply planting and seen that the mortality is minimized for maintaining high production and productivity. To achieve healthy growth and better establishment of coffee plants during early stage, special attention should be given to proper pit size and plant depth, proper Phosphorous nutrition and use of PGPR for better availability of nutrients to coffee seedlings [6,2]. With these above backgrounds, a multi-location field experiment was initiated to boost the growth of supply planting of young coffee seedlings and have a better establishment of coffee plants in the primary field.

2. MATERIALS AND METHODS

A multi location field experiment was initiated at Central Coffee Research Institute (13° 22' N latitude and 75° 28' E longitude, elevation ranging from 823 to 914 meters above MSL) and its sub stations at CRSS, Chettali, RCRS, Chundale & RCRS, Thandigudi during 2015-16. The average annual rainfall of these coffee growing areas ranges from 1200 mm to almost 2500 mm from 80-127 rainy days. Nearly 69-80% of rainfall is received only during the South West monsoon period, which lasts for five to six months, with peaks in mid June to mid September and in case of RCRS Thandigudi, which receives majority of rains during North East monsoon period. The experiment was comprised of five treatments and laid out in Randomized Complete Block Design (RCBD) with four replications and healthy coffee

T ₁	Planters Method (30x30x30 cm ³)
T ₂	45x45x45 cm ³ (Recommended) +Rock phosphate (30 g per pit) + compost (2 kg per pit)
T ₃	45x45x45 cm ³ (Recommended) +Rock phosphate (30 g per pit + Compost (2 kg per pit) + PSB + Azospirillum + VAM 25 gm each enriched with compost
T ₄	30x30x45 cm ³ +Rock phosphate (30 g per pit) + compost (2 kg per pit)
T ₅	30x30x45 cm ³ (Recommended) +Rock phosphate (30 g per pit+ Compost (2 kg per pit) + PSB+ Azospirillum+ VAM 25 gm each enriched with compost

seedlings (variety C x R) of 6 months old were transplanted in the main field. The sample size of experiment used is ten plants per treatment per replication from total hundred plants per treatment per replication. Observations were recorded on growth parameters, root characters and percent mortality of the seedlings and statistical data were analyzed with procedure suggested by [7].

3. RESULTS AND DISCUSSION

The results of the investigation revealed that growth of coffee seedlings evaluated by non-destructive sample like average no. of primaries (Branches that is arises from mean stem) per plant and average length of primary etc. and destructive sample like tap root length, no. of secondary roots, root volume, fresh and dry weight of roots parameters which were significantly affected by different treatments. Whereas plant height, no. of leaves, leaf area were found non significantly affected by the treatments. At Central Coffee Research Institute 14 months after planting in the main field the coffee seedling planted at increased square shape pit size (45 x 45 x 45 cm³), addition of rock phosphate @ 30g with plant along with plant growth promoting rhizo-bacteria (PGPR) @ 25 g each of Azospirillum, PSB and VAM fungi enriched with compost @ 2 kg (T₃) recorded significantly higher no of primaries per plant (8.17) and average length of primaries (21.06 cm) which was stastically on par with 30x30x45 cm³ +Rock phosphate (30 g per pit) + compost (2 kg per pit) (T₄) and 30x30x45 cm³ (Recommended) +Rock phosphate (30 g per pit+ Compost (2 kg per pit) + PSB+ Azospirillum+ VAM 25 gm each enriched with compost (T₅). The lower no of primaries per plant and average primaries length was registered under planters method (30x30x30 cm³) (T₁).

However, plant height, no. of leaves per plant and leaf area found non-significant (Table 1). Similarly, growth parameters found non-significant at CRSS, Chettali; RCRS, Chundale & RCRS, Thandigudi.

Observation on destructive growth parameters like tap root length, no. of secondary roots, root volume, fresh and dry weight of roots were shown significantly impact among the treatments (Table-2). Significantly higher tap root length (43.35 cm), no of secondary roots (21.28), root volume (32.33 cc), root fresh (24.93 g) and dry weight (7.13 g) were observed when coffee seedlings planted with increased square shape pit size of 45 x 45 x 45 cm³, addition of rock phosphate @ 30 g with plant along with plant growth promoting rhizo-bacteria (PGPR) @ 25 g each of Azospirillum, PSB and VAM fungi enriched with compost @ 2 kg (T₃). The percent increase of tap root length, secondary roots, root volume, fresh root biomass and dry root biomass in 45 x 45 x 45 cm³, addition of rock phosphate @ 30 g with plant along with plant growth promoting rhizo-bacteria (PGPR) @ 25 g each of Azospirillum, PSB and VAM fungi enriched with compost @ 2 kg (T₃) were 127, 72.59, 113.82, 106.89 and 69.42% respectively, over control (Planters Method (30x30x30 cm³). Similarly, the treatment was on par with pit size of 30 x 30 x 45 cm³ with addition of 30 g rock phosphate and 2 kg compost per pit which significantly increased tap root length (96.43%), secondary roots (55.07%), root volume (92.53%), fresh root biomass (78.76%) dry root biomass (89.81%), primary branches (37.82%) and length of primaries (34.24%) compared to control. Similar trend was also observed at CRSS, Chettali; RCRS, Chundale & RCRS, Thandigudi for all the root characteristics.

Table 1. Plant growth as influenced by different treatments at 14 months after planting

Treatments	Plant height (cm)	No. of leaves	Leaf area (cm ²)	Average no of primaries / Plant	Average primaries length (cm)
T ₁	71.81	28.25	90.57	5.50	15.07
T ₂	86.53	39.83	111.49	7.50	19.99
T ₃	95.25	51.67	101.14	8.33	21.06
T ₄	87.58	48.67	100.29	8.17	20.23
T ₅	93.96	45.33	99.90	7.58	17.91
Mean	87.03	42.75	100.68	7.42	18.85
SEm±	6.318	5.269	10.819	0.968	1.859
C D (0.05)	NS	NS	NS	2.811	5.421

Table 2. Root performance as influenced by different treatments at 14 months after planting

Treatments	Tap root length (cm)	Number of secondary roots	Root volume (cc)	Fresh biomass (gm)	Dry biomass (gm)
T ₁	19.05	12.33	15.12	12.05	3.63
T ₂	22.21	15.21	25.65	15.89	4.98
T ₃	43.35	21.28	32.33	24.93	7.13
T ₄	37.42	19.12	29.11	21.54	6.89
T ₅	33.56	18.77	27.77	18.32	5.97
Mean	31.12	17.34	26.00	18.55	5.72
SEm±	4.56	1.98	1.93	4.23	0.89
CD (0.05)	13.22	5.74	5.59	12.23	2.32

The better growth and root parameters at higher pit size and rock phosphate with PGPR may be due to adequate moisture and nutrients for optimum growth. This is in line with the work of [2,6,8,9].

4. CONCLUSION

With the above results it can be concluded that coffee board recommend practice of planting of young coffee seedlings with increased pit size 45x45x45 cm³ along with phosphorus nutrition and PGPR and VAM fungi application +Rock phosphate and compost (30 g per pit + Compost (2 kg per pit) + PSB + Azospirillum + VAM 25 gm each enriched achieved better establishment of seedlings by improving root parameters, better anchorage and higher seedlings growth of coffee in the main field over planters method (30x30x30 cm³) under changing climatic conditions.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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Peer-review history:

The peer review history for this paper can be accessed here:
<http://www.sciencedomain.org/review-history/23074>