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Original Research Article

Organics and Bio-Fertilizers Effect on Growth Characters of Papaya at Nursery Level (*Carica papaya* L.)

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A B S T R A C T

An experiment was conducted during the year 2017-2018 at College of Horticulture, Anantharajupeta, to study the influence of organics and bio-agents on growth characters of papaya *(Carica papaya* L.)" cv. Red lady. The present investigation was envisaged to produce robust, healthy seedlings by decreasing the duration of seedlings at nursery, before transplanting in the main field. Required growth of the seedlings was achieved through combined application of organics and bio-agents along with the potting medium. The experiment was laid out in a Randomized Block Design and replicated trice with 9 treatments *i.e*,T_1 – Control (FYM+ Soil + Sand (1:1:1)), T_2 – Neem cake (10g/ poly bag), T_3 – Castor cake (10 g), T_4 – Neem cake (10g) + *A.M* fungi(5g), T_5 – Neem cake (10g) + *T.harzianum* (3g), T_6 – Neem cake (10g) + *T. harzianum* (3g)+ *A.M* fungi (5g), T_7 – Castor cake (10g) + *A.M* fungi (5g), T_8 – Castor cake (10g) + *T. harzianum* (3g),T_9 – Castor cake (10g) + *T. harzianum* (3g)+ *A.M* fungi(5g). The results reveals that different combinations of potting media mixed with organics (neem cake and castor cake @ 10 g/poly bag), bio-fertilizers (VAM 5 g and *Trichoderma harzianum* (3g) (T_9) noticed the maximum values for seedling shoot length (13.16 cm), girth (6.45 mm), vigour index (3442.74), leaf SCMR values (51.16), leaf area (30.94 cm^2), number of leaves (8.40), petiole length (4.43) and diameter of petiole (1.48) at 15, 30 and 45 days after germination (DAG).

Keywords

Papaya, Organics, bio-fertilizers, Seedlings, Shoot length, Shoot girth

Introduction

Papaya (*Carica papaya* L.) is an important fruit crop of tropical world and is popularly known as wonder fruit of the tropics. Papaya belongs to the family Caricaceae and is native of Tropical America (Hofmeyr, 1945) with a diploid chromosome number 2n=18. It is introduced to India during the 16th century, (Kumar and Abraham, 1943). Papaya is grown extensively as a filler plant in orchards and also an ideal fruit for growing in a kitchen garden, backyards of home, especially near the cities and big towns (Chadha, 1992) moreover as intercrop in homestead gardens. Papaya fruit is prized for

its curative properties such as piles, dyspepsia of spleen and liver, digestive disorders diphtheria and skin blemishes. In India, with a little difference in planting season, it is successfully cultivated in almost all the states with an area of 1.38 lakh hectares and production of 61.45 lakh MT ha^{-1} (NHB, 2016-17). In Andhra Pradesh, papaya is cultivated in an area of 13.56 thousand hectares with a production of 1288.58 thousand MT ha^{-1} respectively (Anonymus, 2017). In Andhra Pradesh, Kadapa district is the largest producer of papaya with 6000 acres area under papaya cultivation.

Our college is located amidst of papaya fields and around nursery is involved in propagation and selling of seedlings to different part of A.P district.

Neem cake (*Azadirechta indica*) is considered as the rich source of plant nutrients (5.2 % N, 1.0 % P and 1.4 % K) (Ramanathan, 2006).

Castor cake (*Ricinus communis*) is a rich source of N, P, K and micronutrients considered as good value manure with a good source of nitrogen (4.37 % N, 1.85 % P_2O_5 and 1.39 % K_2O). It helps in mineralization process of plant nutrients during decomposition (Tandon, 1992).

Bio-Fertilizers contain microorganisms which are able to mobilize the nutrients from un-usable form to usable form by biological processes (Athani *et al.,* 2009).

Arbuscular mycorrhiza (AMF) fungi are mutualistic associations existing between fungi and roots of many higher plants. AM associations have been shown to reduce damage caused by soil-borne plant pathogens (Clark and Zeto, 1996 a & b). Papaya is known to exhibit a strong growth response to colonization by AM fungi (Sukhada, 1989). *Trichoderma* spp. produce or release a variety of compounds that induce localized or systemic resistance response in plants (Cubillos-Hinojosa *et al.,* 2011). Hence, balanced nutrition including organic, bulky organic manures and a few bio-fertilizers is the key factor to enhance plant growth, yield and fruit quality. So no one has to show more interest in supplying balanced nutrition at nursery level itself. Hence, management of seedlings at nursery level and planting in the main field plays a vital role during production and productivity of papaya.

Materials and Methods

A field experiment was conducted at College of Horticulture, Anantharajupeta, YSR Kadapa District of Andhra Pradesh during 2017-18 on "Organics and bio-fertilizers effect on growth characters of papaya at nursery level (*Carica papaya* L.)".The treatments were laid in a randomized block design (RBD) replicated thrice with F_1 hybrid seeds of papaya Cv. Red Lady.

For each replication, 25 papaya seeds were sown @ one seed per poly bag (6 x 4 inches) and three raised beds were prepared (8 m x 1 m x 15 cm).There are nine treatments such asT_1 – Control (FYM+ Soil + Sand (1:1:1)), T_2 – Neem cake (10 g/poly bag), T_3 – Castor cake (10 g/poly bag), T_4 – Neem cake (10g) + *A.M* fungi(5g), T_5 – Neem cake (10g) + *T.harzianum* (3g), T_6 – Neem cake (10g) + *T. harzianum* (3g)+ *A.M* fungi (5g), T_7 – Castor cake (10g) + *A.M* fungi(5g), T_8 – Castor cake (10g) + *T. harzianum* (3g), T_9 – Castor cake (10g) + *T. harzianum* (3g) + *A.M* fungi(5g).The observations recorded on growth characters *viz.,* shoot length, seedling girth, vigour index, leaf SCMR values, leaf area, number of leaves, petiole length and petiole girth of the seedlings. The experimental data were statistically analyzed by following standard procedures of Panse and Sukhatme, 1985.

Results and Discussion

Length of shoot (cm)

The shoot length of papaya seedlings was significantly differed among the treatments (Table 1, 2 & 3).

Maximum shoot length (6.32 and 8.39 cm) was recorded at 15, 30 days after germination (DAG) with treatment T_9 (castor cake + *T. harzianum*+ A.M *fungi*) which was on par with T_7 (castor cake + A.M *fungi*) (5.68 & 8.28 cm) and T_6 (neem cake + *T. harzianum* + A.M *fungi*) (5.57, 8.08 cm). Whereas, at 45 DAG maximum shoot length (13.16cm) was recorded in T_9(castor cake + *T. harzianum* + A.M *fungi*) which was on par with T_7 (castor cake + A.M *fungi* (12.73cm).

Additive effect of *T. harzianum* and *G. mooseae* in different combinations with organics like neem and castor cake improved plant growth parameters better than their individual treatments. Organics as themselves useful to the microbes for providing them a substratum for their quick multiplication.

Hence synergistic effect of both organics and bio-fertilizer has brought significant changes in plant growth parameters. Similar findings were also observed by Verma and Jamaluddin Thakur (2008) in Anola seedlings and Rupnawar and Navale (2000) in Pomegranate plants when supplied with A.M *fungi.* The minimum shoot length (3.42, 6.20 and 9.30 cm) was recorded in T_1(control)at 15, 30 & 45 DAG.

Stem girth (mm)

The highest stem girth (2.74, 4.24 and 6.45mm) of the seedlings at 15, 30 and 45 DAG (Table 1,2 & 3) was recorded in T_9 (castor cake + *T. harzianum*+ A.M *fungi*). T_9 is on par with T_7 (castor cake + A.M fungi), T_6 (neem cake + *T. harzianum* + A.M *fungi*)and T_5 (neem cake + *T. harzianum*) (2.65, 4.16, 6.41; 2.62, 4.08, 6.36 and 2.59, 3.96and 6.26mm).

The results are in conformity with the findings of Rakesh *et al.,* (2012) in acid lime. Marcos *et al.,* (2011) found in papaya plants, when they are treated with a combination of organics and bio-fertilizers. The least stem girth (1.48, 2.48 & 4.76mm) was recorded in) T_1 (control) at 15, 30 and 45 DAG.

Vigour index

Vigour index of the papaya seedlings differed significantly among the treatments (Table 1, 2 & 3). The maximum vigour index (3442.74) of papaya seedlings was recorded at 45 DAG in T_9 (castor cake + *T.harzianum* + A.M *fungi*), which was superior over other treatments. The treatment was closely followed by T_7 (castor cake + A.M *fungi*) which gave the vigour index of 3176.21 at 45 DAG.

Complementary effect of *T. harzianum* and *G. mosseae* in different combinations improved plant growth parameters in banana better than their individual treatments. *G. mosseae*+ *T. harzianum* being the best (Sukhada *et al.,* 2011) in banana. The least vigour index (2218.67) was recorded in T_1 (control) at 45 DAG.

Number of leaves

The data revealed that there is no significant difference was observed among the treatments (Table 1,2& 3). The maximum number of leaves (7.67, 7.83and8.40) was recorded at 15, 30 and 45 DAG in T_9 (castor cake + *T. harzianum* + A.M *fungi*) and the less number of leaves (4.74, 6.20 and 7.13) was recorded in T_1 (control)at different days (15, 30 and 45 DAG).

SPAD Chlorophyll Meter Reading (SCMR)

The SCMR values of the papaya seedlings differed significantly among the treatments (Table 1, 2 & 3).

The highest SCMR values (32.26. 45.86 and 51.16) at 15, 30 and 45 DAG was recorded in T_9 (castor cake + *T. harzianum* + A.M *fungi*). T_9 is on par with T_6 (neem cake + *T.harzianum* + A.M *fungi*) (30.47, 44.02 & 49.81), T_8 (castor cake + *T. harzianum*) (29.77, 42.56. 49.21), T_5(neem cake + *T.harzianum*) (29.19, 42.06, 48.39), T_7 (castor cake + A.M *fungi)* (29.07, 41.99, 47.38)was recorded at 15, 30 and 45 DAG. The lowest SCMR values (23.85, 37.06 and 41.14) was recorded in T_1(control) at15, 30 and 45 DAG.

Petiole length (cm)

The data revealed that there is no significant difference among the treatments with regard to the petiole length (Table 1, 2 & 3). The highest length of the petiole (2.91, 3.18 and 4.43 cm) was recorded (at 15, 30 and 45 DAG) in T_9 (castor cake + *T. harzianum* + A.M *fungi*). The least petiole length (0.74, 1.51 and 2.35 cm) was recorded in T_1(control) on different days (15, 30 and 45 DAG).

Petiole diameter (mm)

There is no significant difference was observed between the treatments on petiole diameter of papaya seedlings (Table 1, 2 & 3). The highest petiole diameter (0.94, 1.77 and 1.78 mm) was recorded (at 15, 30 and 45 DAG) in T_9 (castor cake + *T.harzianum*+ A.M *fungi*) While, least petiole diameter (0.40, 1.22 and 1.30 mm) was recorded in T_1(control) at different days (15, 30 and 45 DAG).

Leaf area (cm^2)

Leaf area data shows some irregular trends, seedlings leaf area was significantly increased by all the treatments compared with control (Table 1, 2 and 3). At 15 DAG the seedlings noticed maximum leaf area (8.03 cm^2) in T_9 (castor cake + *T. harzianum* + A.M *fungi*). T_9 is on par with T_7 (castor cake + A.M *fungi*), T_6 (neem cake + *T. harzianum* + A.M *fungi*) and T_5 (neem cake + *T.harzianum*) (7.98, 7.94 and 7.87 cm^2). At 30 DAG, the maximum leaf area (24.87cm^2) was recorded in T_9 (castor cake + *T.harzianum* + A.M *fungi*), T_9 is on par with T_7 (castor cake + A.M *fungi*), T_6 (neem cake + *T. harzianum* + A.M *fungi*) (24.72 and 24.62 cm^2).

However, at 45 DAG maximum leaf area (30.94 cm^2) was recorded in T_9 (castor cake + *T. harzianum* + A.M *fungi*), which is on par with T_7 (castor cake + A.M *fungi*) (30.86 cm^2). But, minimum leaf area (6.85, 23.81 & 30.10 cm^2) was always recorded in T_1(control) at 15, 30 and 45DAG.

The results on leaf area during 15, 30 and 45 DAG were recorded highest in T_9 treatment, among all the treatments T_9 is on par with T_7 at all growth stages. But at 15 DAG, T_9 is on par with T_7, T_6, T_5. At 30 DAG T_9 is on par with T_7& T_6.

Similar findings were reported Aseri *et al.*, (2009) in Aonla seedlings inoculated with *Glomus mosseae* who observed maximum leaf area. Papaya seedlings inoculated with A.M *Fungi* significantly increased leaf area, than non inoculated plants Alarcon *et al.*, (2002).

Increase in the endogenous chlorophyll levels in A.M fungal treated seedlings was due to the direct consequence of symbiotic association, which led to a higher water uptake and nutrients (Dutt *et al.*, 2013).

Table.1 Influence of organics and bio fertilizers on growth parameters of papaya seedlings at 15 DAG Days after germination

S.No.	Treatments	Shoot length (Cm)	Stem girth (mm)	Petiole length (Cm)	petiole diameter (mm)	No. of leaves	Leaf area (cm^2)	SCMR values
1.	T_1 Control (Potting media only)	3.42	1.48	0.74	0.40	4.74	6.85	23.85
2.	T_2 Neem cake (10g/poly bag)	3.98	2.07	1.33	0.50	5.54	7.10	25.17
3.	T_3 Caster cake (10g/ poly bag)	4.08	1.94	1.57	0.52	5.66	7.34	27.39
4.	T_4 Neem cake + *AM fungi* (in potting mixture)	4.97	1.65	1.77	0.65	6.37	7.44	27.04
5.	T_5 Neem cake + *T.harzianum* (inpotting mixture)	5.28	2.59	1.85	0.85	6.47	7.87	29.19
6.	T_6 Neem cake+ *T. harzianum* + *A.M fungi*(in potting mixture)	5.57	2.62	1.91	0.89	6.87	7.94	30.47
7.	T_7 Caster cake+ *A.M fungi*(in potting mixture)	5.68	2.65	2.16	0.68	7.13	7.98	29.07
8.	T_8 Caster cake+ *T. harzianum*(in potting mixture)	5.02	2.08	2.65	0.85	7.27	7.13	29.77
9.	T_9Caster cake+ *T. harzianum* + *A.M fungi* (in potting mixture)	**6.32**	**2.74**	**2.91**	**0.94**	**7.67**	**8.03**	**32.26**
10.	**SE(m) ±**	0.19	0.09	0.41	0.08	0.67	0.04	1.42
11.	**C.D. (5%)**	1.01	0.50	NS	NS	NS	0.20	4.26

Table.2 Influence of organics and bio fertilizers on growth parameters of papaya seedlings at 30 (DAG)

S.No.	Treatments	Shoot length (cm)	Stem girth (mm)	Petiole length (cm)	petiole diameter (mm)	No. of leaves	Leaf area (cm^2)	SCMR values
1.	T_1 Control (Potting media only)	6.20	2.48	1.51	1.22	6.20	23.81	37.06
2.	T_2 Neem cake (10g/poly bag)	6.52	3.43	1.71	1.34	7.08	24.15	39.26
3.	T_3 Caster cake (10g/ poly bag)	6.63	3.10	2.06	1.28	6.53	24.00	40.13
4.	T_4 Neem cake + *AM fungi*(in potting mixture)	7.00	3.71	2.15	1.40	6.53	24.07	41.07
5.	T_5 Neem cake + *T.harzianum*(inpotting mixture)	7.71	3.96	2.39	1.46	6.83	24.45	42.06
6.	T_6 Neem cake+ *T. harzianum* + *A.M fungi*(in potting mixture)	8.08	4.08	2.89	1.53	7.55	24.62	44.02
7.	T_7 Caster cake+ *A.M fungi*(in potting mixture)	8.28	4.16	2.19	1.43	7.54	24.72	41.99
8.	T_8 Caster cake+ *T. harzianum*(in potting mixture)	6.99	3.71	2.68	1.48	7.50	24.12	42.56
9.	T_9Caster cake+ *T. harzianum* + *A.M fungi*(in potting mixture)	**8.39**	**4.24**	**3.18**	**1.77**	**7.83**	**24.87**	**45.86**
10.	**SE(m) ±**	0.32	0.06	0.46	1.09	0.37	0.05	1.45
11.	**C.D. (5%)**	0.96	0.33	NS	NS	NS	0.28	4.35

Table.3 Influence of organics and bio fertilizers on growth parameters of papaya seedlings at 45 DAG

S.No.	Treatments	Shoot length (cm)	Stem girth (mm)	Petiole length (cm)	petiole diameter (mm)	No. of leaves	Leaf area (cm^2)	SCMR values	Vigour index
1.	T_1 Control (Potting media only)	9.30	4.76	7.13	2.35	1.30	30.10	41.14	2218.67
2.	T_2 Neem cake (10g/poly bag)	11.79	6.09	7.82	3.08	1.35	30.35	43.32	2672.80
3.	T_3 Caster cake (10g/ poly bag)	9.78	5.17	7.82	2.57	1.34	30.55	45.76	2399.40
4.	T_4 Neem cake + *AM fungi*(in potting mixture)	12.21	5.24	7.80	3.69	1.47	30.66	44.59	2670.74
5.	T_5 Neem cake + *T.harzianum*(inpot ting mixture)	12.33	6.26	8.29	3.89	1.48	30.74	48.39	2813.44
6.	T_6 Neem cake+ *T. harzianum* + *A.M fungi*(in potting mixture)	12.46	6.36	7.80	4.17	1.56	30.78	49.81	2951.68
7.	T_7 Caster cake+ *A.M fungi*(in potting mixture)	12.73	6.41	8.32	4.00	1.44	30.86	47.38	3176.21
8.	T_8 Caster cake+ *T. harzianum*(in potting mixture)	11.68	5.46	8.21	4.06	1.49	30.57	49.21	2648.79
9.	T_9Caster cake+ *T. harzianum* + *A.M fungi*(in potting mixture)	**13.16**	**6.45**	**8.40**	**4.43**	**1.78**	**30.94**	**51.16**	**3442.74**
10.	**SE(m) ±**	0.19	0.04	0.36	0.13	0.19	0.03	1.47	93.98
11.	**C.D. (5%)**	0.57	0.24	NS	NS	NS	0.15	4.40	281.77

The high percentage of root colonization in A.M *fungal* treated plants is directly correlated with a better nutrient uptake, increased total chlorophyll content, an increase in the rate of photosynthesis and transpiration (Rajasekaran and Nagarajan, 2005) and thereby improved root and shoot growth were expected (Thaker and Fasrai, 2002 and Farschian *et al.,* 2007). Leaf area at different levels of plant growth period has recorded uneven results. It might be due to the various levels of mobilization of nutrients that occur at different days after germination. The morphological and physiological changes in plant might have favor the establishment of symbiotic activity which led to a greater rate of absorption of nutrients by the seedlings. An increase of leaf area in A.M *Fungi* inoculated plants has caused the higher photosynthetic efficiency. Finally assisting

the formation of external mycelium around the roots in anola seedlings (Balathandayutham *et al.*, 2008).

The different potting mixture treatments with organic manures and bio-fertilizers on growth characters of papaya seedlings revealed that, potting mixture enriched with castor cake, *T.harzianum* and A.M*Fungi* (T_9) enhanced the shoot length, stem girth, petiole length, petiole diameter, number of leaves, SCMR values, vigour index and leaf area. Finally concluded that the organic manures with bio-fertilizers should be preferred for use as a beneficial growth activator, especially for a vigorous healthy seedlings for quicker germination and for production of healthy robust seedlings in just 35 days.

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