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Effect of Chemicals and Bio-Inoculants on Seedling Growth and Vigour of TNAU Papaya CO.8 (*Carica papaya* L.)

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A B S T R A C T

The present experiment was carried out to find out the role of chemicals and bio-inoculants on one month age old seedlings of TNAU Papaya CO.8 with seven different seed treatments *viz*., control (CB_1), DAP @ 0.25 % (CB_2), DAP @ 0.5 % (CB_3), KH_2PO_4 @ 0.25 % (CB_4), KH_2PO_4 @ 0.5 % (CB_5), PPFM @ 1.0 % (CB_6) and PPFM @ 2.0 % (CB_7). The experiment was laid out in completely randomized design with three replications in polythene bags. For each replication 25 polythene bags were raised for this study. The chemicals and bio-inoculants were drenched in the polythene bag at one month after sowing of seedlings. Seedlings drenched with KH_2PO_4 @ 0.5 % (CB_5) followed by PPFM @ 2.0 % (CB_7) showed the highest seedling growth parameters, showed positive significant influence on shoot and root biomass.

Introduction

Papaya (*Carica papaya* L.) is rapidly growing, perennial herbaceous plant. It is dicotyledonous, polygamous diploid species with a small genome of 372 Mbp/1C (Arumuganathan and Earle, 1991) having nine pairs of chromosomes (Bennett and Leitch, 2005) and was introduced to India in the 16th century. It is one of the most important fruit crops belongs to the family Caricaceae grown in tropical to subtropical areas all over the world and is mainly propagated by seeds which show wide variability in germination and seedling growth. It has long been grown primarily for its delicious fruits which are the rich source of carbohydrate, minerals, vitamin A, and ascorbic acid. The fruits can be used in the preparation of products like jam, jelly, tuty-fruity, marmalade, nectar, wines, syrup, dehydrated flakes and baby foods. The digestive enzyme papain, obtained from latex is an industrial ingredient used in pharmaceuticals, brewery, meat, dairy, textile, photographic, optical, tanning, cosmetic, detergent, food and leather industries and so there is a growing demand for the papain. Papaya is a short duration fruit crop, owing to its high productivity and high returns, it is becoming very popular with many growers (Chattopadhyay, 2003). India is the largest producer of papaya covering an area of 1.15 lakh ha, producing 49.12 lakh tonnes/ ha Anon (2015).

The significant role of chemical treatment through KNO_3, and gibberellic acid in relation to breaking dormancy, seed germination, growth and development of plant has been observed Kadam (1992). Seedlings are raised in the nursery before transplanting to the main field. However, poor germination of seeds and high mortality rate of papaya seedlings after transplanting restrict the availability of healthy planting material Barche *et al.,* (2010).

Healthy seedlings are the pre-requisite for healthy plants in the field to reap the potential yield. Seedling vigour is affected by many factors like seed quality and type of substrate used, environmental factors etc. Some of the problems faced by papaya growers are slow, erratic growth of papaya and high initial seedling mortality. Thus, producing healthier and quality of seedlings obtained from a nursery influences re-establishment in the field and the eventual productivity of an orchard. Plant vigour depends on the seedling vigour. Hence attention has to be given from nursery stage itself in order to improve the seedling vigour.

Materials and Methods

The experiment was conducted at the nursery, University Orchard, Department of Fruit Crops, Horticultural College and Research Institute, Tamil Nadu Agricultural University, Coimbatore during 2015–2016. The chemicals and bio-inoculants were obtained from chemicals and bio-fertilizer unit in Coimbatore.

The experiment was conducted in Completely Randomized Block Design with seven treatments and three replications. For each replication, 25 polythene bags were used. Six seeds were sown at 0.5-1.0 cm depth in black polythene bags of 15 x 10 cm size and polybags thickness in 150 gauge. The experiment comprised of seven different seed treatments *viz*., (CB_1) control (FYM : Red soil: Sand @ 1:2:1 ratio), (CB_2) Di ammonium Phosphate (DAP) @ 0.25 %, (CB_3) Di ammonium Phosphate (DAP) @ 0.5 %, (CB_4) Potassium dihydrogen orthophosphate (KH_2PO_4) @ 0.25%, (CB_5) Potassium dihydrogen orthophosphate (KH_2PO_4) @ 0.5 %, (CB_6) Pink Pigmented Facultative Methylotrophs (PPFM) @ 1.0 % and (CB_7) Pink Pigmented Facultative Methylotrophs (PPFM) @ 2%. These chemicals and bio-inoculants were drenched in the polythene bag at one month after sowing of seedlings.

Results and Discussion

In the present study, the data represented in Table 1–3 showed that significant effect on catena of observations *viz*., seedling height and girth, number of leaves, leaf area, shoot and root biomass, leaf nutrient contents of N,P,K, leaf chlorophyll and soluble protein content parameters were observed. For this experiment, the observations were taken at seven days interval from one month after germination at 37, 44 and 51 days after sowing.

The highest seedling height (1a) was recorded in CB_5 which were 17.30, 19.80 and 25.53 cm at 37, 44 and 51 days after sowing respectively followed by the treatment CB_7. The maximum seedling girth (1b) was recorded in CB_7 (2.53, 2.82 and 3.06 mm at 37, 44 and 51 days after sowing respectively) followed by CB_5. PPFM had a significant impact on seedling height, seedling girth length (plate 1a), on lines with that KH_2PO_4. Madhaiyan *et al.,* 2005, 2006) while studying the influence of PPFM on cotton and sugarcane there was an increased vigour and over all vegetative parameters of the crop since initial stages itself.

Table.1 Effect of chemicals and bio-inoculants on seedling growth parameters

Treatments	Seedling height (cm)			Seedling girth (mm)			Number of leaves			Leaf area (cm^2)		
	37 DAS	44 DAS	51 DAS	37 DAS	44 DAS	51 DAS	37 DAS	44 DAS	51 DAS	37 DAS	44 DAS	51 DAS
CB_1- Control	13.70	14.90	18.50	1.82	1.89	1.94	6.40	6.80	6.50	7.51	8.76	9.21
CB_2- DAP @ 0.25%	15.70	17.20	19.25	1.94	2.12	2.41	6.80	6.60	6.20	8.20	9.24	9.55
CB_3- DAP @ 0.5	15.90	17.87	20.00	1.95	2.18	2.48	6.60	6.87	6.63	8.80	9.97	10.32
CB_4- KH_2PO_4 @ 0.25%	15.80	19.40	22.70	2.41	2.46	2.58	6.30	7.20	6.75	9.06	10.20	11.76
CB_5 - KH_2PO_4 @ 0.5%	**17.30**	**19.80**	**25.53**	**2.49**	**2.71**	**2.78**	6.80	7.01	7.00	**9.25**	**11.60**	**12.20**
CB_6- PPFM @ 1%	16.40	19.40	22.55	2.28	2.40	2.44	6.50	6.80	6.00	9.21	11.64	12.09
CB_7- PPFM @ 2%	**17.20**	**19.60**	**23.25**	**2.53**	**2.82**	**3.06**	6.40	6.50	6.50	**10.30**	**11.80**	**12.68**
Mean	**16.0**	**18.21**	**21.68**	**2.27**	**2.56**	**2.68**	**6.54**	**6.83**	**6.51**	**8.91**	**10.46**	**11.11**
SEd	0.31	0.29	0.33	0.05	0.02	0.04	0.11	0.12	0.05	0.11	0.05	0.17
CD (0.05)	0.68	0.64	0.73	0.11	0.06	0.09	0.24	0.27	0.12	0.25	0.12	0.38
CV%	2.39	2.00	1.89	2.75	1.33	2.35	2.07	2.24	1.11	1.63	0.66	1.94
Significance	*	*	**	**	**	**	NS	NS	NS	**	**	**

(DAP- Di ammonium Phosphate; KH_2PO_4- Potassium dihydrogen orthophosphate; PPFM- Pink Pigmented Facultative Methylotrophs)

Table.2 Effect of chemicals and bio-inoculants on shoot and root growth parameter

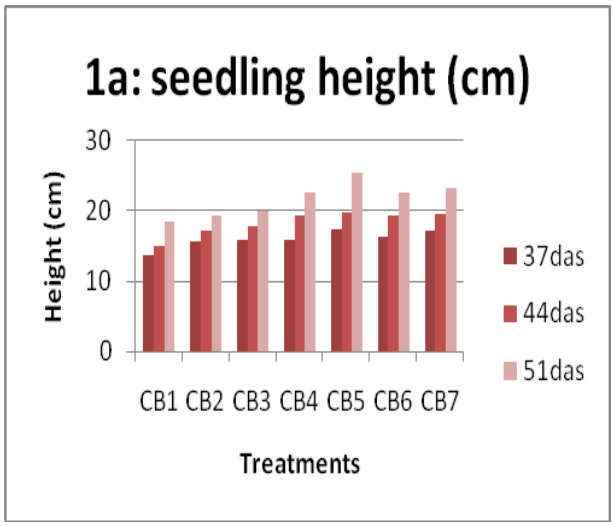
Treatments	Shoot length (cm)	Root length (cm)	Fresh weight of the shoot (g)	Fresh weight of the root (g)	Dry weight of the shoot (g)	Dry weight of the root (g)
CB_1- Control	18.68	10.25	0.84	0.08	0.05	0.03
CB_2- DAP @ 0.25%	22.70	12.50	1.21	0.11	0.10	0.04
CB_3- DAP @ 0.5	22.55	13.25	1.58	0.11	0.13	0.03
CB_4- KH_2PO_4 @ 0.25%	23.60	12.75	1.18	0.12	0.16	0.06
CB_5 - KH_2PO_4 @ 0.5%	**26.75**	**16.30**	**1.73**	**0.15**	**0.21**	**0.09**
CB_6- PPFM @ 1%	23.25	13.25	1.48	0.13	0.16	0.06
CB_7- PPFM @ 2%	**25.28**	**14.25**	**1.66**	**0.14**	**0.19**	**0.07**
Mean	**23.30**	**13.22**	**1.25**	**0.114**	**0.142**	**0.034**
SEd	**0.52**	**0.25**	**0.03**	**0.001**	**0.003**	**0.001**
CD (0.05)	**1.13**	**0.54**	**0.07**	**0.002**	**0.008**	**0.003**
CV%	**2.73**	**2.32**	**3.38**	**1.126**	**3.008**	**2.109**
Significance	**	**	*	**	**	*

(DAP- Di ammonium Phosphate; KH_2PO_4- Potassium dihydrogen orthophosphate; PPFM- Pink Pigmented Facultative Methylotrophs)

Table.3 Effect of chemicals and bio-inoculants on leaf nutrient contents of N, P, K, chlorophyll and soluble protein contents

Treatments	Chlorophyll content (mg g^{-1})	Leaf soluble protein (mg g^{-1})	N (%)	P (%)	K (%)
CB_1- Control	1.96	43.94	0.99	0.62	1.27
CB_2- DAP @ 0.25%	2.21	45.59	1.13	0.69	1.34
CB_3- DAP @ 0.5%	2.17	51.02	1.02	0.74	1.42
CB_4- KH_2PO_4 @ 0.25%	2.29	50.02	1.17	0.82	2.14
CB_5 - KH_2PO_4 @ 0.5%	**2.32**	**52.18**	**1.38**	**0.89**	**2.72**
CB_6- PPFM @ 1%	2.24	50.82	1.14	0.75	2.01
CB_7- PPFM @ 2%	**2.41**	**53.37**	**1.26**	**0.84**	**2.67**
Mean	**2.22**	48.99	**1.16**	**0.76**	**1.94**
SEd	**0.01**	**0.73**	**0.01**	**0.01**	**0.03**
CD (0.05)	**0.03**	**1.59**	**0.02**	**0.02**	**0.07**
CV%	**0.96**	**1.83**	**1.18**	**1.90**	**2.06**
Significance	*	**	*	*	*

(DAP- Di ammonium Phosphate; KH_2PO_4- Potassium dihydrogen orthophosphate; PPFM- Pink Pigmented Facultative Methylotrophs)



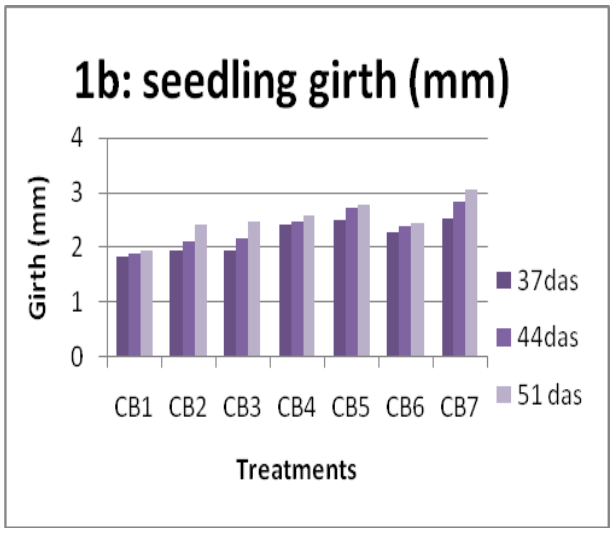
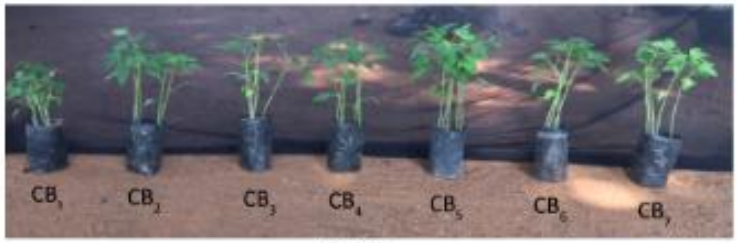
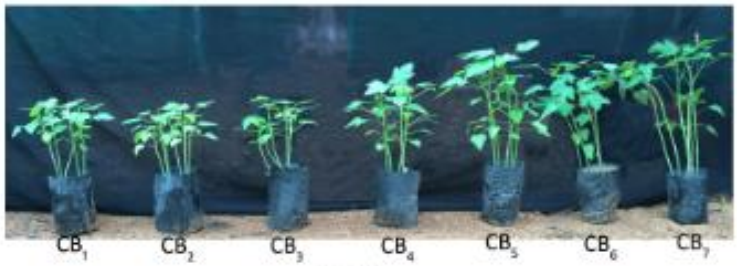


Plate I a: Effect of chemicals and bioinoculants on seedling growth and vigour

37 DAS



44 DAS



51 DAS

CB_1: Control; CB_2: DAP @0.25 %; CB_3: DAP @ 0.5 %;
CB_3: KH_2PO_4 @ 0.25%; CB_4: KH_2PO_4 @ 0.50 %; CB_5: PPFM @ 1%
CB_7: PPFM @ 2%

Plate I b: Effect of chemicals and bioinoculants on root biomass

CB_1: Control; CB_2: DAP @0.25 %; CB_3: DAP @ 0.5 %;
CB_3: KH_2PO_4 @ 0.25%; CB_4: KH_2PO_4 @ 0.50 %; CB_5: PPFM @ 1%
CB_7: PPFM @ 2%

(DAP- Di ammonium Phosphate; KH_2PO_4- Potassium dihydrogen orthophosphate; PPFM- Pink Pigmented Facultative Methylotrophs)

PPFM trends to form a strong, or symbiotic to loose, or epiphytic kind of association with the host plant and potentially dominate the phyllosphere bacterial population. In addition to this ability, they also colonize the rhizosphere of plant species. PPFM also increases the availability of growth regulators such as IAA and cytokinins (Omer *et al.*, 2004; Madhaiyan *et al.*, 2005, 2006 and Senthilkumar *et al.*, 2009). The results obtained also support the beneficial role of PPFM in imparting vigour in papaya seedlings.

The leaf area was the highest in CB_7 which recorded 10.30, 11.80 and 12.68 cm^2 leaf area at 37, 44 and 51 days after sowing respectively followed by CB_5.

The shoot length (plate 1b), fresh and dry weight of shoot was the highest in CB_5 which recorded 26.75 cm, 1.73g and 0.21g respectively followed by CB_7 treatment which recorded 25.28 cm, 1.66g and 0.19g respectively. The root length(plate 1b), fresh and dry weight of the root was the highest in CB_5 which recorded 16.30 cm, 0.15g and 0.09 respectively followed by CB_7 treatment which recorded 14.25 cm, 0.14g and 0.07 respectively. Might be K plays a central role in maintaining photosynthesis and related processes by maintaining the K: Na balance in the plants Cakmak (2005). The same treatment also recorded the highest leaf NPK, chlorophyll and soluble protein content. Sahib *et al.*, (2014) concluded that okra seeds primed for 4 hours at two temperatures (20 and 30° C) in priming media with KH_2PO_4 @ 3% improved seed germination percentage, germination speed index (GSI) and seedling vigour index (SVI). Hence, it might be showed the effect of chemicals and bio-inoculants on nitrogen, phosphorous and potassium content were found significantly different among treatments. The highest nitrogen, phosphorous and potassium contents were recorded in CB_5 (1.38 %, 0.89 % and 2.72 % respectively) followed by 1.12 %, 0.84 % and 2.67 % in CB_7 at 37, 44, 51 DAS respectively.

This experiment pertains to the effect of Potassium dihydrogen orthophosphate (KH_2PO_4), DAP and PPFM (bio-inoculant) on seed germination, seedling vigour. Among the treatments, application of KH_2PO_4 @ 0.5% to the one month old seedlings in the nursery recorded the highest seedling growth characters, followed by PPFM 2.0%. Pertaining to seedling girth, seedling height both the treatments were significantly on same yardstick statistically. It might be due to the Pink pigmented facultative methylotrophs (PPFMs) of the genus *Methylobacterium* are commonly found in association with plants and have been hypothesized potentially to dominate the phyllosphere bacterial population (Corpe and Raheem, 1989). The consistent success of *Methylobacterium* strains in colonizing the phyllosphere is probably due to their ability to utilize methanol as a carbon and energy source, although the surfaces of plants are also covered with soluble carbohydrates, amino acids, organic and phenolic acids, terpenes, and alkaloids (Corpe and Raheem, 1989; Fiala *et al.*, 1990). The seedling weight and shoot length of *Nicotiana tabacum*, *Lycopersicon esculentum*, *Sinapis alba*, and *Fragaria vesca* increased significantly in the presence of the pink-pigmented facultative methylotroph (PPFM) strain *Methylobacteriumextorquens* ME4 (Abanda *et al.*, 2006).

The effect of Chemicals and bio-inoculants application on one month old seedlings showed the best results with KH_2PO_4 @ 0.5 % followed by PPFM @ 2.0 % and can be recommended for improving seedling growth and vigour of TNAU Papaya CO.8.

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