



## RESEARCH ARTICLE

### EFFECT OF ORGANIC AND BIO-FERTILIZERS ON GERMINATION OF PAPAYA (*CARICA PAPAYA L.*)

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#### ABSTRACT

The present investigation entitled "Effect of Organic and Bio-fertilizers on germination of papaya (*Carica papaya L.*) cvs. Red Lady and Pusa Dwarf" was conducted at Agriculture Research farm, Guru Kashi University, Talwandi Sabo, Bathinda, Punjab, India during 2021-2022. The experiment was carried out for the period during Rabi-Kharif season between February 2022 to April 2022. The experiment was laid out in randomized block design comprising of 13 treatment combinations replicated 3 times which consisted of papaya cultivars namely Red Lady and Pusa Dwarf. Among the cultivars, Red Lady showed early germination in (5.33) days, while Pusa Dwarf took (6.67) days for first seedling emergence was observed in both the cultivars. Red Lady took (7.67) days taken to 50 percent germination of seedlings, while Pusa Dwarf took (10.33) days for germination, showing germination percentage of 83.33% and 76.66% for both the cultivars. In case of growth parameters such as Plant height and number of leaves at 45 DAS, the maximum was recorded to be (18.26cm) & (10.06) for the cultivar Red Lady, while for Pusa Dwarf (14.23cm) & (8.93cm), respectively. Maximum leaf area at 45 DAS for Red Lady (30.55cm<sup>2</sup>) and Pusa Dwarf (28.72cm<sup>2</sup>) was observed and maximum stem girth at 45 DAS (1.56cm and 1.43cm) was also recorded. These all maximum observations were recorded under the treatment application of Cocopeat (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g), respectively.

#### INTRODUCTION

Papaya (*Carica papaya L.*) belongs to family Caricaceae. It is an important fast-growing. Short-living herb (Niklas and Maler, 2007; Vyas *et al.*, 2014). Papaya is commonly cultivated in tropical and some parts of subtropical region (Reddy and Gowda 2014) and its origin is South Mexico. In world, India is the largest producer with highest production area. In India, papaya occupies a cultivated area of 97.7 thousand hectares and 5.95 million MT of production (National Horticulture Board 2020-2021). Andhra Pradesh is the leading producer of papaya but it also cultivated in the states of Karnataka, Gujarat, Orissa, West Bengal, Assam, Kerala, Maharashtra and Madhya Pradesh. In Punjab precise estimate of area production of papaya is not available. Papaya is a rich source of vitamin C, B6 and K. It also consists of niacin, thiamine, and riboflavin (Bari *et al.*, 2006; Adetuyiet *al.*, 2010). It also contains many active components like papain, and flavonoids (otsukiet *al.*, 2010). The latex secreted from immature fruit which is dried and prepared as papain which is useful for digestion of protein, stomach ulcer, of chewing gum, in meat tenderizing, cosmetic, shrink resistance to wool (Singh *et al.*, 2010) and against dengue fever. It is also used in dyspepsia and kindred ailments and clarification of beer (Ayoola and Adeyrye 2010).

Ripen fruit is used as desert, Jam, pies, juice, pastries and wine unripe while the green fruit is cooked as vegetable (Ahmed *et al.*, 2002; Mastsuura *et al.*, 2004 and Storck *et al.*, 2013). The plant nutrient content of neem cake (*Azadirachta indica*) is thought to be high (5.2% N, 1.0% P, and 1.4% K) (Ramanathan, 2006). In order to maintain soil fertility and ensure proper plant growth, mustard cake (*Brassica napus*) is rich in N, P, and K (4.8% N, 2% P, and 1.3% K) (Ramachandran *et al.*, 2007). With its high water content, total pore space, low shrinkage, low bulk density, and slow biodegradation, cocopeat has good physical characteristics (Evans *et al.*, 1996; Prasad, 1997).

Microorganisms in bio-fertilizers can mobilise nutrients from an unusable form to a usable form through a biological process (Athani *et al.*, 2009). AMF fungi are mutualistic associations that exist between fungi and the roots of numerous higher plants. It has been demonstrated that AM associations lessen damage from soil-borne and plant pathogens (Clark and Zeto, 1996 a & b). It is well known that when AM fungi colonise papaya, the fruit responds by growing rapidly (Sukhada, 1989). Trichoderma species create or release a variety of chemicals that cause plants to exhibit localised or systemic resistance responses (Cubillos-Hinojosa *et al.*, 2011). In order to improve plant growth, yield, and fruit quality, a balanced nutrition plan that includes organic, bulky organic manures and a few bio-fertilizers is essential.

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## MATERIALS AND METHODS

During the years 2021–2022, an experiment titled "Effect of organic and bio-fertilizers on germination of papaya cvs Red Lady and Pusa Dwarf (*Carica papaya L.*)" was carried out at the Agriculture Research Farm of Guru Kashi University in Talwandi Sabo, Bathinda, Punjab, India. The following provides specifics on the tools, processes, and statistical techniques used throughout the investigation. For each replication, 10 papaya seeds were sown @ one seed per polybag (6 x 4 inches) and there are 13 treatments such as T1-Control (FYM + Soil + Sand (1: 1: 1)), T2- Neem cake (10g/ poly bag), T3- Mustard cake (10g/ poly bag), T4- Cocopeat (10g/ polybag), T5- Neem cake (10g) + A.M fungi (5g), T6- Mustard cake (10g) + A.M fungi (5g), T7- Cocopeat (10g) + A.M fungi (5g), T8- Neem cake (10g) + *T. harzianum* (3g), T9- Mustard cake (10g) + *T. harzianum* (3g), T10- Cocopeat (10g) + *T. harzianum* (3g), T11- Neem cake (10g) + A.M fungi (5g) + *T. harzianum* (3g), T12- Mustard cake (10g) + A.M fungi (5g) + *T. harzianum* (3g), T13- Cocopeat (10g) + A.M fungi (5g) + *T. harzianum* (3g). The observation recorded on germination and growth characters viz., Days to first emergence of seedling, Days taken to 50% germination, Germination Percentage, Plant height, Number of leaves, Leaf Area, Stem Girth of the seedlings.

## RESULT AND DISCUSSION

**Days to first emergence of seedlings:** Days taken to emergence of seedlings were recorded based on the seedlings which emerged from the seeds and are visible above the surface of soil. The data obtained on both cultivars Red Lady and Pusa Dwarf of papaya as influenced by different treatments are presented in Table 4.1. Significant differences were observed in the days taken for emergence of seedling. The data revealed that cultivar Red Lady and Pusa Dwarf took minimum number of days (5.33 and 6.67) for seedling emergence at treatment application of T13 (Cocopeat+ A.M Fungi+ Trichoderma harzianum) which were at par with treatment T12 but the maximum number of days (10.33 and 12.00) were recorded under control treatment (T1) for Red Lady and Pusa Dwarf. Effect of interaction of Cocopeat+ A.M Fungi+ Trichoderma harzianum and papaya cultivars showed significant results revealing that cultivar Red Lady took minimum number of days for first seedling emergence (5.33) whereas the maximum days to first emergence of seedling were recorded in case of cultivar Pusa Dwarf along with control (12.00), respectively.

**Days taken to 50% germination:** Effect of fertilizers on days to 50% germination of papaya was depicted in Table 4.2. A noteworthy variation was observed in the days to 50% germination with the application of organic and bio-fertilizers. At T13 treatment (Cocopeat+ A.M Fungi+ Trichoderma harzianum), the seedlings took 7.67 days for Red Lady and 10.33 days for Pusa Dwarf to germinate, however, under control treatment (T1), the seedlings took 14.33 days and 15.33 days to germinate for the cultivars Red Lady and Pusa Dwarf. Effect of interaction of Cocopeat+ A.M Fungi+ Trichoderma harzianum and papaya cultivars showed significant results revealing that cultivar Red Lady took minimum number of days for first seedling emergence (7.67) whereas the maximum days to first emergence of seedling were recorded in case of cultivar Pusa Dwarf along with control (15.00), respectively.

**Germination percentage:** It can be depicted from the data presented in Table 4.3, that application of Cocopeat+ A.M Fungi+ Trichoderma harzianum (T13) showed highest germination percentage for both cultivars Red Lady and Pusa Dwarf (83.33% and 76.66%) which remained at par with application of T12 (Mustard Cake+ A.M Fungi + Trichoderma harzianum) resulting in 76.66% and 70.00% of germination percent in both cultivars Red Lady and Pusa Dwarf. While, the lowest percentage of germination was recorded at control treatment (FYM + Soil + Sand @1:1:1). Effect of interaction of Cocopeat+ A.M Fungi+ Trichoderma harzianum and papaya cultivars showed significant results revealing that cultivar Red Lady was observed with maximum percentage of germination (83.33%) whereas the minimum germination percentage (50%) were recorded in case of cultivar Pusa Dwarf along with control (T1), respectively.

**Plant Height at 45 DAS:** Significantly, maximum heights of plant for Red Lady and Pusa dwarf at 45 DAS, were recorded to be 18.26cm and 14.23cm in Cocopeat+ A.M Fungi+ Trichoderma harzianum (T13), remaining at par with T12 resulting in plant height of 17.06cm and 13.46cm respectively. Though, minimum plant height was recorded to be 11.16cm and 8.83cm in cultivars Red Lady and Pusa Dwarf under the control treatment (T1). The following data were recorded and presented in Table 4.4. Effect of interaction of Cocopeat+ A.M Fungi+ Trichoderma harzianum and papaya cultivars showed significant results revealing that cultivar Red Lady attained maximum height of seedlings (18.26cm) whereas the minimum height of seedlings were recorded in case of cultivar Pusa Dwarf along with control (8.83cm). Similar finding were also observed by Verma and Jamaluddin Thakur (2008) in Aonla seedlings and Rupnawar and Navale (2000) in Pomegranate plants when supplied with A,M fungi. The minimum Plant Height (3.42, 6.20 and 9.30cm) was recorded in T1(control) at 15,30 and 45 DAS.

**Number of leaves at 45 DAS:** Data of number of leaves at 45 DAS was recorded and the average is presented in Table 4.5. Among cultivars maximum number of leaves were recorded in cultivar Red Lady (10.06) and in Pusa Dwarf (8.93) at the treatment application of application of Cocopeat+ A.M Fungi+ Trichoderma harzianum (T13) and it was at par with T12 (Mustard cake+ A.M Fungi+ Trichoderma harzianum), showing number of leaves (9.8) and (8.53) for Red Lady and Pusa Dwarf. The data of the combined effect of Cocopeat+ A.M Fungi+ Trichoderma harzianum and the papaya cultivars showed significant results revealing that cultivar Red Lady retained highest number of leaves and cultivar Pusa Dwarf at control retained least number of leaves (7.08). In a similar type of experiment by Devi *et al.*, (2019) reported that application of castor cake+ A.M Fungi+ Trichoderma harzianum enhanced the number of leaves at 15 DAG, 30 DAG and 45 DAG, respectively, which is somewhat similar to the results of the present findings.

**Leaf Area (cm<sup>2</sup>) at 45 DAS:** Significant to the data showing leaf area at 45 DAS is presented in Table 4.6, respectively. The maximum leaf area observed was 30.55 cm<sup>2</sup> and 28.72 cm<sup>2</sup> for Red Lady and Pusa Dwarf in the treatment application of Cocopeat+ A.M Fungi + Trichoderma harzianum, respectively, however the minimum was recorded to be 26.17 cm<sup>2</sup> and 24.84 cm<sup>2</sup> for Red Lady and Pusa Dwarf in the treatment application control, correspondingly. The combined effect of papaya cultivars and different organic and bio-fertilizers

**Table 4.1. Days to first emergence of seedlings in papaya cvs. Red Lady and Pusa Dwarf treated with different Organic and Bio-fertilizers**

Treatment	Treatment Details	Red Lady	Pusa Dwarf
T1	Control	10.33	12.00
T2	Neem Cake (10g)	9.00	11.00
T3	Mustard Cake (10g)	8.67	9.67
T4	Cocopeat (10g)	7.67	8.33
T5	Neem Cake (10g) + A.M Fungi (5g)	8.67	10.00
T6	Mustard Cake (10g) + A.M Fungi (5g)	8.33	9.33
T7	Cocopeat (10g) + A.M Fungi (5g)	7.00	9.00
T8	Neem Cake (10g) + Trichoderma harzianum (3g)	8.00	9.33
T9	Mustard Cake (10g) + Trichoderma harzianum (3g)	7.33	8.67
T10	Cocopeat (10g) + Trichoderma harzianum (3g)	6.33	7.67
T11	Neem Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	7.33	9.00
T12	Mustard Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	6.00	7.33
T13	Cocopeat (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	5.33	6.67
	SE(m) ±	0.29	0.20
	C.D. (5%)	0.84	0.59

**Table 4.2. Days taken to 50 percent germination in papaya cvs. Red Lady and Pusa Dwarf treated with different Organic and Bio-fertilizers**

Treatment	Treatment Details	Red Lady	Pusa Dwarf
T1	Control	14.33	15.00
T2	Neem Cake (10g)	13.67	14.33
T3	Mustard Cake (10g)	13.00	13.67
T4	Cocopeat (10g)	11.67	12.33
T5	Neem Cake (10g) + A.M Fungi (5g)	13.33	14.00
T6	Mustard Cake (10g) + A.M Fungi (5g)	11.33	13.33
T7	Cocopeat (10g) + A.M Fungi (5g)	10.33	11.67
T8	Neem Cake (10g) + Trichoderma harzianum (3g)	11.00	13.00
T9	Mustard Cake (10g) + Trichoderma harzianum (3g)	10.33	12.33
T10	Cocopeat (10g) + Trichoderma harzianum (3g)	9.33	11.00
T11	Neem Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	10.67	13.33
T12	Mustard Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	9.00	12.00
T13	Cocopeat (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	7.67	10.33
	SE(m) ±	0.30	0.23
	C.D.(5%)	0.87	0.68

**Table 4.3. Germination percentage in papaya cvs. Red Lady and Pusa Dwarf treated with different Organic and Bio-fertilizers**

Treatment	Treatment Details	Red Lady	Pusa Dwarf
T1	Control	53.33	50.00
T2	Neem Cake (10g)	56.66	53.33
T3	Mustard Cake (10g)	60.00	56.66
T4	Cocopeat (10g)	66.66	63.33
T5	Neem Cake (10g) + A.M Fungi (5g)	56.66	53.33
T6	Mustard Cake (10g) + A.M Fungi (5g)	63.33	56.66
T7	Cocopeat (10g) + A.M Fungi (5g)	66.66	60.00
T8	Neem Cake (10g) + Trichoderma harzianum (3g)	56.66	53.33
T9	Mustard Cake (10g) + Trichoderma harzianum (3g)	66.66	63.33
T10	Cocopeat (10g) + Trichoderma harzianum (3g)	70.00	66.66
T11	Neem Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	60.00	56.66
T12	Mustard Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	76.66	70.00
T13	Cocopeat (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	83.33	76.66
	SE(m) ±	3.81	3.77
	C.D. (5%)	11.19	11.05

**Table 4.4. Plant height (cm) at 45 DAS in papaya cvs. Red Lady and Pusa Dwarf treated with different Organic and Bio-fertilizers**

Treatment	Treatment Details	Red Lady	Pusa Dwarf
T1	Control	11.16	8.83
T2	Neem Cake (10g)	11.96	9.50
T3	Mustard Cake (10g)	13.16	9.33
T4	Cocopeat (10g)	14.63	10.06
T5	Neem Cake (10g) + A.M Fungi (5g)	12.06	9.13
T6	Mustard Cake (10g) + A.M Fungi (5g)	12.43	10.20
T7	Cocopeat (10g) + A.M Fungi (5g)	13.06	10.46
T8	Neem Cake (10g) + Trichoderma harzianum (3g)	12.66	11.13
T9	Mustard Cake (10g) + Trichoderma harzianum (3g)	14.23	11.30
T10	Cocopeat (10g) + Trichoderma harzianum (3g)	15.70	12.13
T11	Neem Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	12.86	10.06
T12	Mustard Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	17.06	13.46
T13	Cocopeat (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	18.26	14.23
	SE(m) ±	0.35	0.22
	C.D. (5%)	0.90	0.64

**Table 4.5 Number of leaves at 45 DAS in papaya cvs. Red Lady and Pusa Dwarf treated with different Organic and Bio-fertilizers**

Treatment	Treatment Details	Red Lady	Pusa Dwarf
T1	Control	8.73	7.08
T2	Neem Cake (10g)	8.80	7.25
T3	Mustard Cake (10g)	8.86	7.45
T4	Cocopeat (10g)	9.20	8.00
T5	Neem Cake (10g) + A.M Fungi (5g)	9.13	7.68
T6	Mustard Cake (10g) + A.M Fungi (5g)	9.20	7.83
T7	Cocopeat (10g) + A.M Fungi (5g)	9.33	7.93
T8	Neem Cake (10g) + Trichoderma harzianum (3g)	9.13	8.00
T9	Mustard Cake (10g) + Trichoderma harzianum (3g)	9.40	8.06
T10	Cocopeat (10g) + Trichoderma harzianum (3g)	9.67	8.40
T11	Neem Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	9.26	8.06
T12	Mustard Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	9.80	8.53
T13	Cocopeat (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	10.06	8.93
	SE(m) ±	0.22	0.28
	C.D.(5%)	0.66	0.43

**Table 4.6. Leaf area (cm<sup>2</sup>) at 45 DAS in papaya cvs. Red Lady and Pusa Dwarf treated with different Organic and Bio-fertilizers**

Treatment	Treatment Details	Red Lady	Pusa Dwarf
T1	Control	26.17	24.84
T2	Neem Cake (10g)	27.07	25.68
T3	Mustard Cake (10g)	27.56	26.11
T4	Cocopeat (10g)	28.15	26.30
T5	Neem Cake (10g) + A.M Fungi (5g)	28.18	26.14
T6	Mustard Cake (10g) + A.M Fungi (5g)	28.56	26.35
T7	Cocopeat (10g) + A.M Fungi (5g)	28.24	25.69
T8	Neem Cake (10g) + Trichoderma harzianum (3g)	28.18	26.19
T9	Mustard Cake (10g) + Trichoderma harzianum (3g)	28.29	26.11
T10	Cocopeat (10g) + Trichoderma harzianum (3g)	28.62	26.13
T11	Neem Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	28.55	26.06
T12	Mustard Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	28.71	26.94
T13	Cocopeat (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	30.55	28.72
	SE(m) ±	0.49	0.35
	C.D. (5%)	1.43	1.03

**Table 4.7. Stem girth (cm) at 45 DAS in papaya cvs. Red Lady and Pusa Dwarf treated with different Organic and Bio-fertilizers**

Treatment	Treatment Details	Red Lady	Pusa Dwarf
T1	Control	1.10	1.03
T2	Neem Cake (10g)	1.13	1.10
T3	Mustard Cake (10g)	1.16	1.13
T4	Cocopeat (10g)	1.20	1.20
T5	Neem Cake (10g) + A.M Fungi (5g)	1.16	1.13
T6	Mustard Cake (10g) + A.M Fungi (5g)	1.20	1.16
T7	Cocopeat (10g) + A.M Fungi (5g)	1.26	1.16
T8	Neem Cake (10g) + Trichoderma harzianum (3g)	1.16	1.13
T9	Mustard Cake (10g) + Trichoderma harzianum (3g)	1.23	1.16
T10	Cocopeat (10g) + Trichoderma harzianum (3g)	1.30	1.20
T11	Neem Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	1.20	1.13
T12	Mustard Cake (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	1.33	1.23
T13	Cocopeat (10g) + A.M Fungi (5g) + Trichoderma harzianum (3g)	1.56	1.43
	SE(m) ±	0.06	0.05
	C.D. (5%)	0.19	0.16

concentrations showed significant results indicating that maximum leaf area was in cultivar Red Lady (30.55 cm<sup>2</sup>) and the minimum was recorded in Pusa Dwarf at control application (24.84 cm<sup>2</sup>). Similar finding were reported Aseriet *al.*, (2009) in Aonla seedlings inoculated with *Glomus mosseae* who observed maximum leaf area. Papaya seedling inoculated with A.M Fungi significantly increased leaf area, that non inoculated plants Alarcon et al., (2002)

**Stem girth (cm):** It can be depicted from the Table 4.7. that the maximum stem girth at 45 DAS was recorded to be 1.56cm for Red Lady and 1.43 cm for Pusa Dwarf in the application of treatment T13 (Cocopeat+ A.M Fungi + Trichoderma harzianum), respectively. However, the minimum stem girth recorded was 1.10 cm and 1.03 cm for Red Lady and Pusa Dwarf under the control (T1) treatment application.

Maximum stem girth at T13 was found to be at par with treatment T12 resulting in stem girth of 1.33cm and 1.23cm for cultivars Red Lady and Pusa Dwarf. The combined effect of papaya cultivars and different organic and bio-fertilizers concentrations showed non-significant results revealing that maximum Stem girth was in cultivar Red Lady (1.56cm) and the minimum was recorded in Pusa Dwarf at control application (1.03cm). The similar result were reported by Marcos et al., (2011) found in papaya plants when they are treated with a combination of organics and bio-fertilizers.

## Conclusion

It may be inferred that cultivar Red Lady significantly showed early germination, maximum plant height, maximum number of leaves, leaf area and showed nonsignificant results for stem

girth and remained superior over the cultivar Pusa Dwarf under the study. Pusa dwarf showed relatively late germination, minimum plant height and leaf number. Also, showed minimum area of leaf and stem girth in all the application of treatments. Among all the treatments, T13 (Cocopeat (5g) + A.M Fungi(5g) +Trichoderma harzianum(3g)) showed best results compared to the rest of the treatments as it highly influenced the growth and germination attributes in papaya, remaining at par with treatment T12 (Mustard Cake(10g) + A.M Fungi(5g) + Trichoderma harzianum(3g)), while the control conditions T1 (FYM + Soil +Sand (1:1:1)) resulted in poor performance of the cultivars.

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