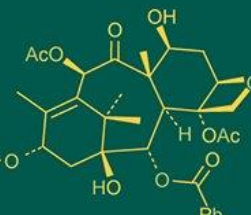
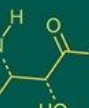
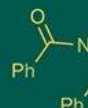


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## Effect of different organic manures and biostimulants on yield and fruit quality of papaya (*Carica papaya* L.)

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### Abstract

The present investigation entitled “Effect of Different Organic Manures and Biostimulants on Yield and Fruit Quality of Papaya (*Carica papaya* L.)” was conducted to evaluate the influence of organic nutrient sources and biostimulants on yield and fruit quality parameters of papaya. The experiment comprised three organic manure treatments, viz., 100% Farmyard Manure (FYM), 100% Poultry Manure and 100% Sheep Manure, along with five biostimulant treatments, namely Seaweed Extract @ 4%, Jeevamruth @ 3%, Panchagavya @ 3%, Cow Urine @ 3%, and Vermiwash @ 3%. The study was laid out in a factorial arrangement to assess the interactive effects of organic manures and biostimulants. The combination of 100% Sheep Manure + Seaweed Extract @ 4% recorded superior performance over all other treatments. It produced the highest number of fruits per plant (74.00), maximum average fruit weight (1546.30 g), highest fruit yield per tree (82.56 kg), and fruit yield per hectare (165.12 t ha<sup>-1</sup>). The same treatment also recorded improved fruit physical characteristics, including maximum flesh weight (1319.85 g) and pulp thickness (3.38 cm), along with minimum seed weight (65.32 g) and seed-to-flesh ratio (0.049). The enhanced performance under this treatment may be attributed to improved soil fertility, better nutrient availability, and the synergistic effect of organic manure with seaweed extract, which collectively promoted vegetative growth, fruit development, and quality improvement in papaya.

**Keywords:** Papaya, organic manures, bio stimulants, sheep manure, seaweed extract, yield, fruit quality

### Introduction

Papaya (*Carica papaya* L.), a member of the family Caricaceae (2n = 18), is one of the most important fruit crops cultivated in tropical and subtropical regions of the world. Native to tropical America, it is widely grown for its high nutritional value, medicinal properties and economic importance. India is the leading producer of papaya globally. The crop is popularly known as the “wonder fruit” due to its rich content of vitamins, minerals and antioxidants, and its fruits are consumed fresh as well as processed into various value-added products. Among the commercially cultivated hybrids, F<sub>1</sub> Hybrid Exp-15 is widely preferred for its high yield, early bearing, superior fruit quality and resistance to Papaya Ring Spot Virus (PRSV) (Paull and Duarte, 2011; Karthikeyan *et al.*, 2017) <sup>[17, 11]</sup>.

In recent years, organic nutrient management has gained considerable attention in papaya cultivation owing to the increasing demand for sustainable production systems. Organic manures improve soil fertility, enhance microbial activity and ensure a sustained supply of nutrients, while biostimulants such as seaweed extract, panchagavya, cow urine and vermiwash promote plant growth through the action of bioactive compounds, enzymes, amino acids and beneficial microorganisms. Their combined application improves nutrient uptake, plant growth, yield and fruit quality, making them important components of eco-friendly papaya production. Panchagavya acts as an effective biostimulant by promoting plant growth, improving yield and quality and enhancing the plant's natural defense mechanisms (Choudhary *et al.*, 2017) <sup>[6]</sup>. Application of Jeevamruth as a foliar spray or soil drench facilitates the conversion of otherwise unavailable soil nutrients into soluble forms, thereby improving their availability to plants (Kaur *et al.*, 2021) <sup>[12]</sup>. Seaweed liquid fertilizer enhance seed germination, promote shoot and root development, improve nutrient uptake and help maintain soil fertility while increasing plant tolerance to biotic and abiotic stresses.

Materials and Methods

The present investigation was carried out at a farmer’s field in Gajwel village, Siddipet district of Telangana, during 2022-2024. The experiment was laid out in a Factorial Randomized Block Design (FRBD) with three replications, comprising fifteen treatment combinations involving different organic manures and biostimulants. The experiment was laid out in a Factorial Randomized Block Design (FRBD) with three replications, comprising fifteen treatment combinations. The treatments consisted of two factors. Factor I (Organic Manures) included three levels: A<sub>1</sub>-100% Farmyard Manure (FYM), A<sub>2</sub>-100% Poultry Manure and A<sub>3</sub>-100% Sheep Manure. Factor II (Biostimulants) comprised five levels: B<sub>1</sub>-Seaweed Extract @ 4%, B<sub>2</sub>-Jeevamruth @ 3%, B<sub>3</sub>-Panchagavya @ 3%, B<sub>4</sub>-Cow Urine @ 3% and B<sub>5</sub>-Vermiwash @ 3%. Accordingly, the fifteen treatment combinations were: T<sub>1</sub>: A<sub>1</sub>B<sub>1</sub>: 100%-FYM + Sea weed extract @ 4%, T<sub>2</sub>: A<sub>1</sub>B<sub>2</sub>: 100% FYM + Jeevamruth @ 3%, T<sub>3</sub>: A<sub>1</sub>B<sub>3</sub>: 100% FYM + Panchagavya @ 3%, T<sub>4</sub>: A<sub>1</sub>B<sub>4</sub>: 100% FYM + Cow urine @ 3%, T<sub>5</sub>: A<sub>1</sub>B<sub>5</sub>: 100% FYM + Vermiwash @ 3%, T<sub>6</sub>: A<sub>2</sub>B<sub>1</sub>:100%-Poultry manure + Sea weed extract @ 4%, T<sub>7</sub>: A<sub>2</sub>B<sub>2</sub>: 100%-Poultry manure + Jeevamruth @ 3%, T<sub>8</sub>: A<sub>2</sub>B<sub>3</sub>: 100%-Poultry manure + Panchagavya @ 3%, T<sub>9</sub>: A<sub>2</sub>B<sub>4</sub>: 100%-Poultry manure + Cow urine @ 3%, T<sub>10</sub>: A<sub>2</sub>B<sub>5</sub>: 100%-Poultry manure + Vermiwash @ 3%, T<sub>11</sub>: A<sub>3</sub>B<sub>1</sub>: 100%-Sheep manure + Sea weed extract @ 4%, T<sub>12</sub>: A<sub>3</sub>B<sub>2</sub>: 100%-Sheep manure + Jeevamruth @ 3%, T<sub>13</sub>: A<sub>3</sub>B<sub>3</sub>: 100%-Sheep manure + Panchagavya @ 3%, T<sub>14</sub>: A<sub>3</sub>B<sub>4</sub>: 100%-Sheep manure + Cow urine @ 3%, T<sub>15</sub>: A<sub>3</sub>B<sub>5</sub>: 100%-Sheep manure + Vermiwash @ 3%. Papaya seedlings were planted at a spacing of 1.8 m × 1.8 m. The organic manures, namely Farmyard Manure (FYM), Poultry Manure and Sheep Manure, were applied as per the treatment schedule. The total quantity of manure was applied in three equal splits, consisting of a basal application at the time of planting, followed by two subsequent applications at 90-day intervals. The liquid bio stimulants were sprayed at every 30 days intervals.

Results and Discussion

Number of fruits per plant

The number of fruits per plant was significantly influenced by organic manures and biostimulants (Table 1). Among the organic manures, 100% sheep manure (A<sub>3</sub>) recorded the highest mean fruit number (69.68 fruits/plant), while 100% poultry manure (A<sub>2</sub>) recorded the lowest (59.16 fruits/plant). Among the biostimulants, seaweed extract @ 4% (B<sub>1</sub>) produced the highest number of fruits (66.49 fruits/plant), which was on par with Panchagavya @ 3% (B<sub>3</sub>) (66.34 fruits/plant). The interaction effect was significant, with A<sub>3</sub>B<sub>1</sub> (100% sheep manure + seaweed extract @ 4%) recording the highest fruit number (74.00 fruits/plant). The superior performance may be attributed to improved nutrient availability, enhanced flowering and better fruit retention, resulting in increased fruit production. Similar findings were reported by Athani *et al.* (2007) <sup>[1]</sup>, Garhwal *et al.* (2014) <sup>[8]</sup> and Nandi *et al.* (2013) <sup>[16]</sup>.

Average fruit weight

Fruit weight was significantly influenced by the application of organic manures and bio stimulants (Table 1). Among the organic manures, 100% sheep manure (A<sub>3</sub>) recorded the highest fruit weight (1371.43 g), followed by 100% FYM (A<sub>1</sub>) (1209.56 g), while the lowest was observed with 100% poultry manure (A<sub>2</sub>) (1169.83 g). Among the bio stimulants, seaweed extract @ 4% (B<sub>1</sub>) produced the highest fruit weight (1321.97 g), which was on par with Panchagavya @ 3% (B<sub>3</sub>) (1281.39 g). The interaction effect was significant, with A<sub>3</sub>B<sub>1</sub> (100% sheep manure + seaweed extract @ 4%) recording the maximum fruit weight (1546.30 g). The increased fruit weight under this treatment may be attributed to improved nutrient availability and the growth-promoting effects of seaweed extract, which enhanced fruit development and accumulation of assimilates. Similar findings have been reported under integrated organic nutrient management in papaya and other fruit crops.

Table 1: Effect of organic manures on Number of fruits per plant and Average fruit weight (g) of papaya (*Carica papaya* L.)

| Number of fruits/plants |                |                |                |       | Average fruit weight(g) |                |                |                |         |
|-------------------------|----------------|----------------|----------------|-------|-------------------------|----------------|----------------|----------------|---------|
|                         | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | Mean  |                         | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | Mean    |
| B <sub>1</sub>          | 64.23          | 61.25          | 74.00          | 66.49 | B <sub>1</sub>          | 1223.26        | 1196.36        | 1546.30        | 1321.97 |
| B <sub>2</sub>          | 64.23          | 60.53          | 68.63          | 64.46 | B <sub>2</sub>          | 1206.63        | 1178.59        | 1312.93        | 1232.72 |
| B <sub>3</sub>          | 64.58          | 62.25          | 72.18          | 66.34 | B <sub>3</sub>          | 1215.63        | 1182.56        | 1445.97        | 1281.39 |
| B <sub>4</sub>          | 63.56          | 59.52          | 67.23          | 63.44 | B <sub>4</sub>          | 1203.60        | 1162.26        | 1295.63        | 1220.50 |
| B <sub>5</sub>          | 63.56          | 52.24          | 66.36          | 60.72 | B <sub>5</sub>          | 1198.69        | 1129.36        | 1256.32        | 1194.79 |
| Mean                    | 64.03          | 59.16          | 69.68          |       | Mean                    | 1209.56        | 1169.83        | 1371.43        |         |
|                         | Sem            | CD @ 0.05      |                |       |                         | Sem            | CD @ 0.05      |                |         |
| A                       | 0.40           | 1.16           |                |       | A                       | 12.79          | 37.05          |                |         |
| B                       | 0.52           | 1.50           |                |       | B                       | 16.51          | 47.84          |                |         |
| AXB                     | 0.90           | 2.60           |                |       | AXB                     | 28.60          | 82.85          |                |         |

**Factor I: Organic manures**

- A<sub>1</sub>:100%-FYM
- A<sub>2</sub>:100%-Poultry manure
- A<sub>3</sub>:100%-Sheep manure

**Factor II: Bio stimulants**

- B<sub>1</sub>: Sea weed extract @ 4%
- B<sub>2</sub>: Jeevamruth @ 3%
- B<sub>3</sub>: Panchagavya @ 3%
- B<sub>4</sub>: Cow urine @ 3%
- B<sub>5</sub>: Vermiwash @ 3%

Fruit yield per tree

Fruit yield per tree was significantly influenced by the application of organic manures and bio stimulants (Table 2). Among the organic manures, 100% sheep manure (A<sub>3</sub>)

recorded the highest fruit yield (79.19 kg tree<sup>-1</sup>), followed by 100% FYM (A<sub>1</sub>) (70.97 kg tree<sup>-1</sup>), while the lowest yield was observed with 100% poultry manure (A<sub>2</sub>) (65.16 kg tree<sup>-1</sup>). Among the bio stimulants, seaweed extract @ 4%

(B<sub>1</sub>) produced the highest yield (74.34 kg tree<sup>-1</sup>), which was closely followed by Panchagavya @ 3% (B<sub>3</sub>) (73.20 kg tree<sup>-1</sup>), whereas the lowest yield was recorded with Vermiwash @ 3% (B<sub>5</sub>) (69.27 kg tree<sup>-1</sup>). The interaction effect was significant, with A<sub>3</sub>B<sub>1</sub> (100% sheep manure + seaweed extract @ 4%) recording the maximum fruit yield (82.56 kg tree<sup>-1</sup>), while the minimum yield (63.56 kg tree<sup>-1</sup>) was observed in A<sub>2</sub>B<sub>5</sub> (100% poultry manure + vermiwash @ 3%). The higher yield obtained under A<sub>3</sub>B<sub>1</sub> may be attributed to improved nutrient availability and enhanced physiological activity, resulting in increased fruit number and fruit weight.

#### Fruit yield per hectare (t/ha)

Fruit yield per hectare was significantly influenced by the application of organic manures and bio stimulants (Table 2). Among the organic manures, 100% sheep manure (A<sub>3</sub>)

recorded the highest yield (158.38 t ha<sup>-1</sup>), followed by 100% FYM (A<sub>1</sub>) (141.94 t ha<sup>-1</sup>), while the lowest yield was observed with 100% poultry manure (A<sub>2</sub>) (130.31 t ha<sup>-1</sup>). Among the bio stimulants, seaweed extract @ 4% (B<sub>1</sub>) produced the highest yield (148.68 t ha<sup>-1</sup>), which was on par with Panchagavya @ 3% (B<sub>3</sub>) (146.39 t ha<sup>-1</sup>). The interaction effect was significant, with A<sub>3</sub>B<sub>1</sub> (100% sheep manure + seaweed extract @ 4%) recording the maximum yield (165.12 t ha<sup>-1</sup>), whereas the minimum yield (127.12 t ha<sup>-1</sup>) was observed in A<sub>2</sub>B<sub>5</sub> (100% poultry manure + vermiwash @ 3%). The higher yield obtained under A<sub>3</sub>B<sub>1</sub> may be attributed to improved nutrient availability from sheep manure and the growth-promoting effects of seaweed extract, which enhanced fruit growth and yield. Similar findings were reported by Sankar *et al.* (2006) [20], Bisht *et al.* (2012) [41] and Garhwal *et al.* (2014) [8].

**Table 2:** Effect of organic manures on Fruit yield per tree (kg), Fruit yield per ha (t/ha) of papaya (*Carica papaya* L.)

|                | Fruit yield per tree (kg) |                |                |       |                | Fruit yield per ha (t/ha) |                |                |        |
|----------------|---------------------------|----------------|----------------|-------|----------------|---------------------------|----------------|----------------|--------|
|                | A <sub>1</sub>            | A <sub>2</sub> | A <sub>3</sub> | Mean  |                | A <sub>1</sub>            | A <sub>2</sub> | A <sub>3</sub> | Mean   |
| B <sub>1</sub> | 74.23                     | 66.23          | 82.56          | 74.34 | B <sub>1</sub> | 148.46                    | 132.46         | 165.12         | 148.68 |
| B <sub>2</sub> | 70.23                     | 64.98          | 79.63          | 71.61 | B <sub>2</sub> | 140.46                    | 129.96         | 159.26         | 143.23 |
| B <sub>3</sub> | 72.26                     | 66.12          | 81.21          | 73.20 | B <sub>3</sub> | 144.52                    | 132.24         | 162.42         | 146.39 |
| B <sub>4</sub> | 69.56                     | 64.89          | 76.86          | 70.44 | B <sub>4</sub> | 139.12                    | 129.78         | 153.72         | 140.87 |
| B <sub>5</sub> | 68.56                     | 63.56          | 75.69          | 69.27 | B <sub>5</sub> | 137.12                    | 127.12         | 151.38         | 138.54 |
| Mean           | 70.97                     | 65.16          | 79.19          |       | Mean           | 141.94                    | 130.31         | 158.38         |        |
|                | Sem                       | CD @ 0.05      |                |       |                | Sem                       | CD @ 0.05      |                |        |
| A              | 0.56                      | 1.63           |                |       | A              | 1.19                      | 3.44           |                |        |
| B              | 0.72                      | 2.10           |                |       | B              | 1.53                      | 4.43           |                |        |
| AXB            | 1.26                      | 3.64           |                |       | AXB            | 2.65                      | 7.68           |                |        |

#### Factor I: Organic manures

- A<sub>1</sub>:100%-FYM
- A<sub>2</sub>:100%-Poultry manure
- A<sub>3</sub>:100%-Sheep manure

#### Factor II: Bio stimulants

- B<sub>1</sub>: Sea weed extract @ 4%
- B<sub>2</sub>: Jeevamruth @ 3%
- B<sub>3</sub>: Panchagavya @ 3%
- B<sub>4</sub>: Cow urine @ 3%
- B<sub>5</sub>: Vermiwash @ 3%

#### Equatorial diameter (cm)

The equatorial diameter of papaya fruits was significantly influenced by the application of organic manures and bio stimulants (Table 3). Among the organic manures, 100% sheep manure (A<sub>3</sub>) recorded the highest mean equatorial diameter (14.46 cm), followed by 100% FYM (A<sub>1</sub>) (12.37 cm), while the lowest value was observed with 100% poultry manure (A<sub>2</sub>) (11.50 cm). Among the bio stimulants, seaweed extract @ 4% (B<sub>1</sub>) produced the largest fruits (13.85 cm), whereas Vermiwash @ 3% (B<sub>5</sub>) recorded the smallest fruits (12.12 cm). The interaction effect was significant, with A<sub>3</sub>B<sub>1</sub> (100% sheep manure + seaweed extract @ 4%) producing the maximum equatorial diameter (16.63 cm), while the minimum diameter (11.08 cm) was recorded in A<sub>2</sub>B<sub>5</sub> (100% sheep manure + vermiwash @ 3%). The increase in fruit size under A<sub>3</sub>B<sub>1</sub> may be attributed to improved nutrient availability and enhanced physiological activity, which promoted better fruit development.

#### Polar diameter (cm)

The polar diameter of fruits was significantly influenced by organic manures, whereas the effect of biostimulants (Table 3) and their interaction with organic manures was non-significant. Among the organic manures, 100% sheep manure (A<sub>3</sub>) recorded the highest polar diameter (29.01 cm), followed by 100% FYM (A<sub>1</sub>) (27.35 cm), while the lowest

value was observed with 100% poultry manure (A<sub>2</sub>) (26.65 cm). Although the effect of biostimulants was not significant, seaweed extract @ 4% (B<sub>1</sub>) recorded the highest numerical value (28.47 cm). The increased fruit dimensions under sheep manure may be attributed to improved nutrient availability and sustained nutrient release, which enhanced cell division, cell expansion and fruit development. Similar findings were reported by Bisht *et al.* (2012) [4], Marathe and Bharambe (2007) [14] and Sankar *et al.* (2006) [20].

#### Pulp thickness

Pulp thickness was significantly influenced by organic manures and biostimulants (Table 3). Among the organic manures, 100% sheep manure (A<sub>3</sub>) recorded the highest pulp thickness (3.24 cm), followed by 100% FYM (A<sub>1</sub>) (3.01 cm), while the lowest value was observed with 100% poultry manure (A<sub>2</sub>) (2.57 cm). Among the biostimulants, seaweed extract @ 4% (B<sub>1</sub>) produced the highest pulp thickness (3.12 cm), which was on par with Panchagavya @ 3% (B<sub>3</sub>) (3.04 cm). The interaction effect was significant, with A<sub>3</sub>B<sub>1</sub> (100% sheep manure + seaweed extract @ 4%) recording the maximum pulp thickness (3.38 cm), whereas the minimum (2.26 cm) was observed in A<sub>2</sub>B<sub>5</sub> (100% poultry manure + vermiwash @ 3%). The increased pulp thickness under sheep manure and seaweed extract may be attributed to improved nutrient availability and enhanced

assimilate translocation, which promoted better fruit growth and pulp development. Similar findings have been reported

by Garhwal *et al.* (2014)<sup>[8]</sup> and Naik and Babu (2007)<sup>[15]</sup>.

**Table 3:** Effect of organic manures and bio stimulants on Equatorial (cm) and Polar diameter (cm), pulp thickness (cm) of papaya (*Carica papaya* L.)

|                | Equatorial(cm) |                |                |       |                | Polar(cm)      |                |                |       |                | Pulp thickness(cm) |                |                |      |
|----------------|----------------|----------------|----------------|-------|----------------|----------------|----------------|----------------|-------|----------------|--------------------|----------------|----------------|------|
|                | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | Mean  |                | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | Mean  |                | A <sub>1</sub>     | A <sub>2</sub> | A <sub>3</sub> | Mean |
| B <sub>1</sub> | 12.98          | 11.93          | 16.63          | 13.85 | B <sub>1</sub> | 28.00          | 26.86          | 30.54          | 28.47 | B <sub>1</sub> | 3.10               | 2.89           | 3.38           | 3.12 |
| B <sub>2</sub> | 12.23          | 11.58          | 13.95          | 12.59 | B <sub>2</sub> | 27.20          | 26.54          | 28.36          | 27.37 | B <sub>2</sub> | 2.96               | 2.56           | 3.25           | 2.92 |
| B <sub>3</sub> | 12.45          | 11.77          | 14.63          | 12.95 | B <sub>3</sub> | 27.33          | 26.61          | 29.50          | 27.81 | B <sub>3</sub> | 3.09               | 2.76           | 3.27           | 3.04 |
| B <sub>4</sub> | 12.22          | 11.13          | 13.81          | 12.39 | B <sub>4</sub> | 27.13          | 26.86          | 28.37          | 27.45 | B <sub>4</sub> | 3.00               | 2.38           | 3.15           | 2.84 |
| B <sub>5</sub> | 11.97          | 11.08          | 13.30          | 12.12 | B <sub>5</sub> | 27.07          | 26.40          | 28.27          | 27.25 | B <sub>5</sub> | 2.92               | 2.26           | 3.13           | 2.77 |
| Mean           | 12.37          | 11.50          | 14.46          |       | Mean           | 27.35          | 26.65          | 29.01          |       | Mean           | 3.01               | 2.57           | 3.24           |      |
|                | Sem            | CD @ 0.05      |                |       |                | Sem            | CD @ 0.05      |                |       |                | Sem                | CD @ 0.05      |                |      |
| A              | 0.12           | 0.34           |                |       | A              | 0.21           | 0.61           |                |       | A              | 0.03               | 0.08           |                |      |
| B              | 0.15           | 0.44           |                |       | B              | 0.27           | 0.79           |                |       | B              | 0.04               | 0.11           |                |      |
| AXB            | 0.26           | 0.76           |                |       | AXB            | 0.47           | NS             |                |       | AXB            | 0.06               | 0.19           |                |      |

**Factor I: Organic manures**

- A<sub>1</sub>:100%-FYM
- A<sub>2</sub>:100%-Poultry manure
- A<sub>3</sub>:100%-Sheep manure

**Factor II: Bio stimulants**

- B<sub>1</sub>: Sea weed extract @ 4%
- B<sub>2</sub>: Jeevamruth @ 3%
- B<sub>3</sub>: Panchagavya @ 3%
- B<sub>4</sub>: Cow urine @ 3%
- B<sub>5</sub>: Vermiwash @ 3%

**Seed weight (g)**

The mean seed weight of fruits varied significantly among the treatments (Table 4), ranging from 67.07 g to 80.67 g. The highest seed weight was recorded in A<sub>2</sub> (100% Poultry manure) (80.67 g), followed by A<sub>1</sub> (100% FYM) (75.22 g), while the lowest was observed in A<sub>3</sub> (100% Sheep manure) (67.07 g). Among the bio-stimulants, B<sub>5</sub> (Vermiwash @ 3%) recorded the highest mean seed weight (76.29 g), followed by B<sub>4</sub> (Cow urine @ 3%) (75.56 g), whereas the lowest was recorded in B<sub>1</sub> (Seaweed extract @ 4%) (71.69 g).

The variation in seed weight among treatments may be attributed to differences in nutrient availability and assimilate partitioning during fruit development. The higher seed weight observed under poultry manure (80.67 g) and FYM (75.22 g) treatments could be due to improved soil fertility, enhanced microbial activity and sustained nutrient release, which promote efficient nutrient uptake and seed filling. Organic manures improve soil physical and biological properties, thereby supporting reproductive growth and seed development. Similar findings were reported by Kaur *et al.* (2007)<sup>[13]</sup> and Naik and Babu (2007)<sup>[15]</sup>. Goyal *et al.* (1999)<sup>[9]</sup> also observed that organic amendments enhance microbial biomass and nutrient mineralization, contributing to improved reproductive performance and seed formation in fruit crops.

Higher seed weight recorded under vermiwash and cow urine treatments may be attributed to enhanced microbial activity and improved nutrient availability in the rhizosphere. Vermiwash contains readily available nutrients, enzymes and growth-promoting substances that support metabolic processes and seed filling, while cow urine supplies nitrogen and micronutrients essential for reproductive development. Similar improvements in seed

and fruit characteristics under organic nutrient inputs have been reported by Atiyeh *et al.* (2002)<sup>[2]</sup>, Rai *et al.* (2009)<sup>[18]</sup> and Singh *et al.* (2010)<sup>[22]</sup>

**Flesh weight (g)**

Flesh weight was significantly influenced by organic manures, bio-stimulants and their interaction (Table 4). Among the organic manures, the highest flesh weight was recorded in A<sub>3</sub> (100% Sheep manure) (1155.00 g), followed by A<sub>1</sub> (100% FYM) (1006.86 g), while the lowest was observed in A<sub>2</sub> (100% Poultry manure) (946.43 g). Among the bio-stimulants, B<sub>1</sub> (Seaweed extract @ 4%) recorded the highest flesh weight (1106.42 g), followed by B<sub>3</sub> (Panchagavya @ 3%) (1064.82 g), whereas the lowest was recorded in B<sub>5</sub> (Vermiwash @ 3%) (980.30 g). The interaction effect was significant, with A<sub>3</sub>B<sub>1</sub> (Sheep manure + Seaweed extract) recording the highest flesh weight (1319.35 g), while the lowest flesh weight (911.44 g) was observed in A<sub>1</sub>B<sub>5</sub> (Poultry manure + Vermiwash).

The higher flesh weight obtained under sheep manure and seaweed extract treatments may be attributed to improved nutrient availability, enhanced assimilate translocation and efficient fruit development. Sheep manure provides a sustained supply of nutrients that supports carbohydrate accumulation, cell expansion and pulp formation, while seaweed extract contains growth-promoting substances that enhance photosynthetic efficiency and fruit growth. The superior performance of the A<sub>3</sub>B<sub>1</sub> combination suggests a synergistic effect of organic nutrition and bio-stimulant application on pulp development. Similar findings were reported by Bisht *et al.* (2012)<sup>[4]</sup>, Marathe and Bharambe (2007)<sup>[14]</sup>, Vanilarasu and Balakrishnamurthy (2014)<sup>[23]</sup> and Naik and Babu (2007)<sup>[15]</sup>.

**Table 4:** Effect of organic manures and bio stimulants on seed weight (g) and flesh weight (g) of papaya (*Carica papaya* L.)

|                | Seed weight(g) |                |                |       |                | Flesh weight(g) |                |                |         |
|----------------|----------------|----------------|----------------|-------|----------------|-----------------|----------------|----------------|---------|
|                | A <sub>1</sub> | A <sub>2</sub> | A <sub>3</sub> | Mean  |                | A <sub>1</sub>  | A <sub>2</sub> | A <sub>3</sub> | Mean    |
| B <sub>1</sub> | 69.86          | 79.89          | 65.32          | 71.69 | B <sub>1</sub> | 1026.90         | 972.50         | 1319.85        | 1106.42 |
| B <sub>2</sub> | 76.36          | 80.12          | 67.35          | 74.61 | B <sub>2</sub> | 1002.96         | 953.26         | 1117.12        | 1024.45 |
| B <sub>3</sub> | 73.99          | 80.02          | 66.36          | 73.46 | B <sub>3</sub> | 1006.75         | 962.90         | 1224.81        | 1064.82 |
| B <sub>4</sub> | 77.36          | 81.36          | 67.96          | 75.56 | B <sub>4</sub> | 1002.74         | 932.07         | 1078.71        | 1004.51 |
| B <sub>5</sub> | 78.52          | 81.98          | 68.36          | 76.29 | B <sub>5</sub> | 994.97          | 911.44         | 1034.50        | 980.30  |
| Mean           | 75.22          | 80.67          | 67.07          |       | Mean           | 1006.86         | 946.43         | 1155.00        |         |
|                | Sem            | CD @ 0.05      |                |       |                | Sem             | CD @ 0.05      |                |         |
| A              | 0.64           | 1.84           |                |       | A              | 9.81            | 28.42          |                |         |
| B              | 0.82           | 2.38           |                |       | B              | 12.66           | 36.69          |                |         |
| AXB            | 1.42           | NS             |                |       | AXB            | 21.93           | 63.54          |                |         |

|                                                                                                                                                              |                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Factor I: Organic manures</b>                                                                                                                             | <b>Factor II: Bio stimulants</b>                                                                                                                                                                                                                      |
| <ul style="list-style-type: none"> <li>A<sub>1</sub>:100%-FYM</li> <li>A<sub>2</sub>:100%-Poultry manure</li> <li>A<sub>3</sub>:100%-Sheep manure</li> </ul> | <ul style="list-style-type: none"> <li>B<sub>1</sub>: Sea weed extract @ 4%</li> <li>B<sub>2</sub>: Jeevamruth @ 3%</li> <li>B<sub>3</sub>: Panchagavya @ 3%</li> <li>B<sub>4</sub>: Cow urine @ 3%</li> <li>B<sub>5</sub>: Vermiwash @ 3%</li> </ul> |

**Fruit Volume (cm<sup>3</sup>)**

The mean fruit volume of papaya varied significantly among the treatments (Table 5). Among the organic manures, the highest fruit volume was recorded in A<sub>3</sub> (100% Sheep manure) (1443.61 cm<sup>3</sup>), followed by A<sub>1</sub> (100% FYM) (1273.22 cm<sup>3</sup>), while the lowest was observed in A<sub>2</sub> (100% Poultry manure) (1231.40 cm<sup>3</sup>). Among the bio-stimulants, B<sub>1</sub> (Seaweed extract @ 4%) recorded the highest fruit volume (1391.55 cm<sup>3</sup>), followed by B<sub>3</sub> (Panchagavya @ 3%) (1348.83 cm<sup>3</sup>), whereas the lowest was recorded in B<sub>5</sub> (Vermiwash @ 3%) (1257.67 cm<sup>3</sup>). The interaction effect was significant, with A<sub>3</sub>B<sub>1</sub> (Sheep manure + Seaweed extract) recording the highest fruit volume (1627.68 cm<sup>3</sup>), while the lowest fruit volume (1188.80 cm<sup>3</sup>) was observed in A<sub>2</sub>B<sub>5</sub> (Poultry manure + Vermiwash).

The higher fruit volume obtained under sheep manure and seaweed extract treatments may be attributed to improved nutrient availability, enhanced cell division and efficient assimilate translocation during fruit development. Sheep manure provides a sustained supply of nutrients that supports fruit enlargement, while seaweed extract contains plant growth regulators and bioactive compounds that promote cell expansion and fruit growth. The superior performance of the A<sub>3</sub>B<sub>1</sub> combination suggests a synergistic effect of organic nutrition and bio-stimulant application on fruit development. Similar findings were reported by Bindu (2003) [3], Ravishanker *et al.* (2010) [19] and Singh *et al.* (2010) [22].

**Seed: flesh Ratio**

The seed ratio was significantly influenced by organic manures, bio-stimulants and their interaction (Table 5). Among the organic manures, the lowest and most desirable seed ratio was recorded in A<sub>3</sub> (100% Sheep manure) (0.059), followed by A<sub>1</sub> (100% FYM) (0.075), while the highest ratio was observed in A<sub>2</sub> (100% Poultry manure) (0.085). Among the bio-stimulants, B<sub>1</sub> (Seaweed extract @ 4%) recorded the lowest ratio (0.067), followed by B<sub>3</sub> (Panchagavya @ 3%) (0.070), whereas the highest ratio was observed in B<sub>5</sub> (Vermiwash @ 3%) (0.078). The interaction effect was significant, with A<sub>3</sub>B<sub>1</sub> (Sheep manure + Seaweed extract) recording the lowest seed ratio (0.049), while the highest ratio (0.090) was observed in A<sub>3</sub>B<sub>5</sub> (Sheep manure + Vermiwash).

The lower seed ratio obtained under sheep manure and seaweed extract treatments indicates greater pulp development and improved assimilate partitioning towards fleshy tissues. Enhanced nutrient availability and physiological activity under these treatments may have promoted cell division, cell enlargement and carbohydrate accumulation in the mesocarp, resulting in a higher edible portion of the fruit. The superior performance of the A<sub>3</sub>B<sub>1</sub> combination suggests a synergistic effect of organic nutrition and bio-stimulant application on pulp development and fruit quality. Similar findings were reported by Yadav *et al.* (2011a) [24], Hazarika and Ansari (2010) [10], Sharma (1990) [21] and Dighe *et al.* (2014) [17].

**Table 5:** Effect of organic manures and bio stimulants on fruit volume and seed: flesh ratio of papaya (*Carica papaya* L.)

|                | Fruit volume(cm <sup>3</sup> ) |                |                |         |                | Seed: flesh ratio |                |                |       |
|----------------|--------------------------------|----------------|----------------|---------|----------------|-------------------|----------------|----------------|-------|
|                | A <sub>1</sub>                 | A <sub>2</sub> | A <sub>3</sub> | Mean    |                | A <sub>1</sub>    | A <sub>2</sub> | A <sub>3</sub> | Mean  |
| B <sub>1</sub> | 1287.64                        | 1259.33        | 1627.68        | 1391.55 | B <sub>1</sub> | 0.068             | 0.082          | 0.049          | 0.067 |
| B <sub>2</sub> | 1270.14                        | 1240.62        | 1382.03        | 1297.60 | B <sub>2</sub> | 0.076             | 0.084          | 0.060          | 0.073 |
| B <sub>3</sub> | 1279.61                        | 1244.80        | 1522.07        | 1348.83 | B <sub>3</sub> | 0.073             | 0.083          | 0.054          | 0.070 |
| B <sub>4</sub> | 1266.95                        | 1223.43        | 1363.82        | 1284.73 | B <sub>4</sub> | 0.077             | 0.087          | 0.063          | 0.076 |
| B <sub>5</sub> | 1261.78                        | 1188.80        | 1322.44        | 1257.67 | B <sub>5</sub> | 0.079             | 0.090          | 0.066          | 0.078 |
| Mean           | 1273.22                        | 1231.40        | 1443.61        |         | Mean           | 0.075             | 0.085          | 0.059          |       |
|                | Sem                            | CD @ 0.05      |                |         |                | Sem               | CD @ 0.05      |                |       |
| A              | 12.64                          | 36.62          |                |         | A              | 0.001             | 0.002          |                |       |
| B              | 16.32                          | 47.27          |                |         | B              | 0.001             | 0.002          |                |       |
| AXB            | 28.26                          | 81.88          |                |         | AXB            | 0.001             | 0.004          |                |       |

|                                                                                                                                                              |                                                                                                                                                                                                                                                       |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <b>Factor I: Organic manures</b>                                                                                                                             | <b>Factor II: Bio stimulants</b>                                                                                                                                                                                                                      |
| <ul style="list-style-type: none"> <li>A<sub>1</sub>:100%-FYM</li> <li>A<sub>2</sub>:100%-Poultry manure</li> <li>A<sub>3</sub>:100%-Sheep manure</li> </ul> | <ul style="list-style-type: none"> <li>B<sub>1</sub>: Sea weed extract @ 4%</li> <li>B<sub>2</sub>: Jeevamruth @ 3%</li> <li>B<sub>3</sub>: Panchagavya @ 3%</li> <li>B<sub>4</sub>: Cow urine @ 3%</li> <li>B<sub>5</sub>: Vermiwash @ 3%</li> </ul> |

## Conclusion

The present study demonstrated that the yield and fruit quality of papaya were significantly influenced by the application of organic manures and biostimulants. Among the treatments, 100% Sheep Manure + Seaweed Extract @ 4% (A<sub>3</sub>B<sub>1</sub>) recorded the highest values for yield and fruit quality parameters. The treatment 100% Sheep Manure + Panchagavya @ 3% (A<sub>3</sub>B<sub>3</sub>) also performed comparably and can be considered a suitable alternative. Therefore, the combined application of 100% Sheep Manure with Seaweed Extract @ 4% is recommended for enhancing productivity and fruit quality of papaya under organic cultivation conditions.

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