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# Influence of "Arka Vegetable Special" and Superabsorbent Cellulose Based Hydrogel on Growth of Brinjal (*Solanum melongena* L.) Seedlings in Protrays

**Saloni Thakur* and Deven Verma**

*Lovely Professional University, Phagwara, Punjab, India*

***Correspondence to:**
Saloni Thakur
Lovely Professional University,
Phagwara, Punjab, India.
**E-mail:** salonithakur155@gmail.com

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## Abstract

The achievement of successful eggplant production is directly associated with the utilization of high-quality seedlings. Incorporation of polymers into the substrate as a water conditioner have been found to enhance water retention capacity, Arka vegetable special increases nutrient content, and improve seedling quality. The study investigated the impact of "Arka vegetable special" and superabsorbent cellulose-based hydrogel on the growth of brinjal seedlings in protrays. The experiment was conducted at a Lovely Professional University Phagwara, Punjab. Three treatments were evaluated using Arka vegetable special sprayed after 15 days of sowing (DAS) and superabsorbent cellulose based hydrogel on growth of brinjal. The experiment was conducted by using three replications. The growth characters and biochemical parameters moisture content, ash content, ascorbic acid content, carotenoids, mineral content, chlorophyll content (chlorophyll a, b and total chlorophyll) and ascorbic acid content were evaluated. The statistical analysis of the data was conducted using the method of analysis of variance (OP STAT statistical software). The best seedling can be obtained by using 3 g/tray of Arka vegetable special and 3 g/tray of hydrogel.

## Keywords

Brinjal, Arka vegetable special, Hydrogel

## Introduction

Brinjal is one of the most consumed vegetables. It is a commonly grown species from the Solanaceae family [1]. It is commonly grown under Punjab conditions. In Punjab, vegetables have enhanced the maximum use of resources and in demand. The focus of this study lies on the small-scale farmers who are being investigated [2]. The popularity and utilization of vegetables is frequently rising in the Northwest region therefore supplying market opportunities to growers of vegetables. The seeds must germinate properly to grow healthy nursery. Hence, many small holder farmers in urban and rural areas in Punjab are increasing with respect producing of vegetables. The seeds are the first seedlings that were initially cultivated in a specialized nursery and subsequently transplanted into the main field. However, producing good quality brinjal seedling is in which growing media and its quality is important factor. Farmers' choice of growing medium is mostly influenced by price, availability, and plant requirements. Commonly utilised materials are cocopeat, perlite, vermiculite and rockwool are all used in nursery growing [3].

Micronutrients are essential for plants. They increase the chlorophyll content of leaves; further develop photosynthesis which strengthens the absorbing impact of entire plant. Foliar nourishment is ideally designed to give numerous elements in conditions that might restrict metabolism when supplement take-up from the soil is inefficient.

Microelements occur in fewer amounts in soil than macroelements but are equivalently important for plants. Therefore, plants cultivated in microelement lacking soils show indistinguishable depletion in production as those cultivated in insufficient macronutrient soils show same depletion in productivity are those cultivated in macro element deficient soils. The vegetables that belong to the Solanaceous family are the component of diet all over the world. With high requirement for good quality of vegetables as people are being more conscious for health, there is necessity to go stabilization of both macroelement and microelement. Hence, micronutrients perform an important role in metabolic activity of the plant for that reason without the application of multinutrients the deficiency occurs and ultimately reduces in quality and yield. Foliar application of microelements gives best result than application in soil as the absorption and assimilation of microelements by application in soil takes long time. Subsequently, to adapt up to the necessities of the yield, use of multi nutrients must be ensured.

However, vegetables crops in general are critically influenced by water stress at the time of their growth and cause considerable depletion in yield [4]. Super absorbent-based hydrogel are a class of modern soil conditioners and water-absorbing compounds that have found extensive use in agriculture. They are hydrogels that may release slowly supplying water around the root zone as per the demand after absorbing and holding a sizable amount of water. Due to several agronomic characteristics, including non-toxicity, biodegradability, and sources, hydrogels are becoming significant agricultural inputs stabilizers of soil pH and nutrients. Additionally, hydrogels exhibit a prolonged ability to release water due to their high water-retention capacity [5, 6].

Over the past 40 years, hydrogels have been widely recommended for use in horticulture with the basic idea of using the swelling and water release capabilities to improve water availability for plants. Acrylic acid is a significant ingredient in the commercial production of SAPs [7]. It has been demonstrated that the integration of polymers into the substrate acts as water conditioners, resulting in an improvement in water retention capacity and ultimately, seedling quality is one of the many technologies used in the seedling production system in pro trays [8]. Polymers, whether they are of synthetic or natural origins, demonstrate a remarkable ability to absorb significant amounts of water in their three-dimensional structure, without mixing entirely, thereby producing hydrogels.

Water inadequacy classifies among the greatest essential abiotic factors restricting growth and productivity of plants [9]. Vegetables are categorized as crops with maximum water necessity [10]. The time after sowing can be classified as one where a lot of water is important [11]. Hydrophilic polymers are used in horticulture and agriculture practice as water penetrable for good water hold up of plants with less water deficiency [12]. Other authors suggested that a hydrophilic polymer for replanting reduces stress of water [13]. Kumaran et al. [14] in 2010 reported that hydrophilic polymers act as agents with capability to absorb 100-300 times their weight in water. Kazanskii and Dubrosvskii [15] described the capability of hydrophilic polymers to maintain retention of soil water.

Bortolin et al. [16] have successfully developed a new series of hydrogels comprising polyacrylamide, methylcellulose, and 50% montmorillonite clay. Mineral clay can improve some material qualities, save costs, and enable a more effective and controlled release of pure hydrogel one that is nearly 200 times more gradual than pure urea. Several seedlings have responded favourably to this novel hydrogel formulation [17]. It is necessary to specify the doses of this hydrogel for formulation with substrates, specifically for aubergine. Growth and yield of brinjal can be maximized by the implementation of considered composition of hydrogel and multinutrients may give significant rise in growth and yield of brinjal due to their combining effect. The present study focused on the influence of hydrogel and Arka vegetable special on growth of brinjal (*Solanum melongena* L.) seedling in protrays (Figure 1).

## Material and Methodology

### Site of experiment

The investigation was conducted in a protected environment during the month of June in the year 2023 at the Lovely Professional University located in Phagwara, Jalandhar. The examination was carried out within a greenhouse structure that spanned a length of 25 meters, a width of 8 meters, and a height of 25 meters, and was covered by a film composed of low-density polyethylene with a thickness of 150 microns. Throughout the duration of the experiment, the internal temperature and humidity levels were recorded at three separate intervals each day, specifically at 9 o'clock in the morning, 12 o'clock noon, and 3 o'clock in the afternoon. The temperature readings obtained during the assay indicated that the mean temperature was 22.3 °C, with a minimum temperature of 21.7 °C and a maximum temperature of 23 °C. Additionally, the average relative humidity value recorded was 73%.

### Seedling production

Seedlings were cultivated in 99-celled plastic trays utilizing the "Punjab Raunak" variety of brinjal, which was selected due to its extensive geographic adaptability and favorable agronomic/horticultural performance across diverse regions of Punjab [18]. The trays were filled with a substrate composed of cocopeat, vermiculite, perlite (in a 3:1:1 ratio), containing varying concentrations of hydrogel, and seeds were planted at a depth of 6 mm (one seed per plug). Usually, the watering is done twice a day in Hi–Tech polyhouse but here the watering was done once a day to determine the effect of hydrogel on seedlings of brinjal.

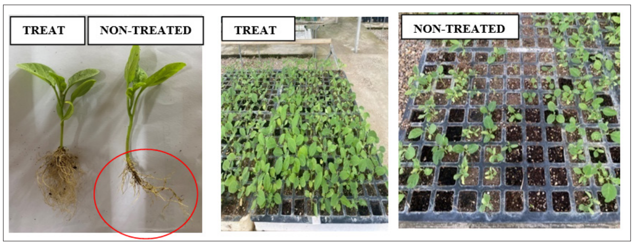


**Figure 1:** Comparison of brinjal seedlings treated (Arka vegetable special + hydrogel) and non-treated.

## Treatment and experimental design

The trial was conducted in 3 × 3 factorial arrangements in complete randomized design, with three replications. Three different concentrations of hydrogel as shown in table 1 were used while preparing the media.

## Measured parameters

After 30 DAS all the morphological traits were evaluated. The following parameters related to the growth of brinjal seedlings were assessed:

### Days to emergence

Five best plants are selected from each treatment and days were counted by the days from seed emergence.

### Germination percentage (%)

The proportion of seeds that have successfully developed into normal seedlings within a specified time under favorable environmental conditions is indicated by the germination percentage. This computation can be determined by utilizing the following formula.

$$\text{Germination Percentage}\ (\%) = \frac{\text{Seeds Germinated}}{\text{Total Seeds}} \times 100$$

### Seedling height (cm)

The measurement of seedling height was conducted on a sample of five plants chosen at random. The height was determined by means of a meter scale in centimeters, extending from the ground level to the tip of the longest leaf. The resulting values were used to calculate the mean height.

### Leaf area ($cm^2$)

Leaf area is a measurement of the total area of leaves per unit of ground area and is a direct indicator of how many light plants can absorb. It is an important factor that is used to forecast evapotranspiration, photosynthetic primary production, and as a reference for crop development. It was measured by using a leaf area meter.

### Number of leaves

The number of leaves per plant was counted from a total of five plants that were chosen at random. The data obtained from the observations were recorded and subsequently, the mean value was computed.

**Table 1:** Different concentration of Arka vegetable special with the combination of superabsorbent cellulose based hydrogel.

| Arka vegetable special and hydrogel | Concentration |
|---|---|
| $T_1R_1$ | 1 g/tray + 1 g/tray |
| $T_1R_2$ | 1 g/tray + 1 g/tray |
| $T_1R_3$ | 1 g/tray + 1 g/tray |
| $T_2R_1$ | 2 g/tray + 2 g/tray |
| $T_2R_2$ | 2 g/tray + 2 g/tray |
| $T_2R_3$ | 2 g/tray + 2 g/tray |
| $T_3R_1$ | 3 g/tray + 3 g/tray |
| $T_3R_2$ | 3 g/tray + 3 g/tray |
| $T_3R_3$ | 3 g/tray + 3 g/tray |

### Moisture content of leaves (%)

At first leaves of chosen plants were gathered, cut into pieces and oven dried under daylight for 3 days and afterward dried in an oven at 60 °C for 24 and 48 hours. The sample was then moved into desiccators and permitted to chill off at room temperature. The last weight of the sample was taken. The dry matter contents of leaves were computed by simple calculation from the weight recorded by the following formula:

$$\text{Moisture content of leaves}\ (\%) = \frac{\text{weight of container and sample before drying} - \text{weight of container with sample}}{\text{weight of container and sample before drying} - \text{weight of container}}$$

### Ash content

A quantity of 3 g of leaf sample was subjected to treatment within a silica crucible under the influence of a burner flame. The resultant substance, which exhibited charring, was then exposed to temperatures ranging from 600 to 650 degrees Celsius for a duration of approximately six hours within a muffle furnace. The resulting ash, showed a whitish colour and its free of carbon content, was subsequently allowed to cool for a period before being weighed upon an ash-free filter paper.

$$\text{Ash value} = \frac{\text{Initial value} - \text{final weight}}{\text{Initial weight}} \times 100$$

### Ascorbic acid content

Five grams of leaf sample meshed with mortar and pestle added fixed amount of 3% metaphosphoric acid. Then this sample was filtered with Whatman filter paper No. 42 and the final volume of filtered solution made up to 25 ml by adding 3% metaphosphoric acid in a volumetric flask. After this, 5 ml of aliquot taken from this filtered solution in a conical flask and titrated against standardized dye solution to pink end point, persisting for at least 15 seconds. The calculation done with the following formula:

$$\text{Ascorbic acid content} = \frac{0.5\ \text{mg}}{V_1\ \text{ml}} \times \frac{V_2\ \text{ml}}{5\ \text{ml}} \times \frac{100\ \text{ml} \times 100}{\text{weight of sample}}$$

### Chlorophyll and carotenoid content

Chlorophyll is extracted in 80% acetone and the absorbance at 663 nm, 645 nm and 470 nm are read in spectrophotometer. Using the absorption coefficients, the amount of chlorophyll a, b and total chlorophyll is calculated.

Chlorophyll a (mg/g) = $12.7(A_{663}) - 2.69(A_{645}) \times V/1000 \times W$

Chlorophyll b (mg/g) = $22.9\ (A_{645}) - 4.68\ (A_{663}) \times V/1000 \times W$

Total chlorophyll (mg/g) = $20.2(A_{645}) - 8.02(A_{663})\ V/1000 \times W$

Carotenoids (mg/g) = $1000 \times (A_{470}) - 1.82$ nm × Chlorophyll a − 85.02 × Chlorophyll b)/198

(A = wavelength selected in a spectrophotometer)

### Mineral content

The estimation of nitrogen contents was carried out using the

Kjeldal method, which was described by Okalebo et al. [19]. The analysis of phosphorus was performed calorimetrically with the help of a Jemway 6100 spectrophotometer, as per established protocols [20]. Potassium was examined using a flame photometer in accordance with standardized procedures [21].

### Statistics

All observation recorded from this experimental study tabulated in a systematic manner. The final observation growth and biochemical parameters of brinjal plants were statistically analyzed using ANOVA for factorial randomized block design.

## Result and Discussion

### Growth characters

#### Days to emergence

The days to emergence of brinjal seedling were significantly affected by the combination of Arka vegetable special and hydrogel (Table 2 and figure 2). The significantly less days to emergence was found to be 10 days (2 g/tray + 2 g/tray) while maximum days to emergence was recorded 12 days (control) this may be due to the water retention capacity of the medium and the limited availability of essential nutrients [22].

Hydrogel greatly influences the emergence of seeds and growth of seedlings in a nursery because it acts as a reservoir of moisture. The days to emergence values for intermediate dosages, on the other hand, are regarded as adequate and are in accordance with various treatments applied to eggplant seeds [23].

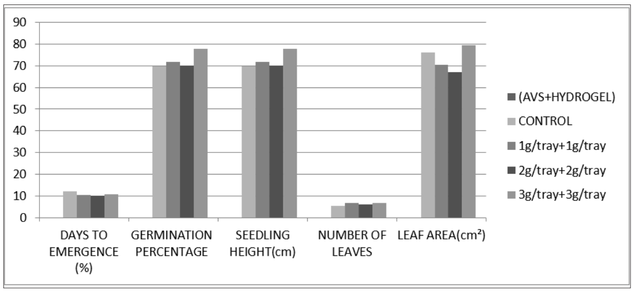


**Figure 2:** Growth character of brinjal seedlings with combination of different concentration of Arka vegetable special and hydrogel.

#### Germination percentage

The combination of Arka vegetable special and hydrogel treatments had significant differences on germination percentage (Table 2 and figure 2). $T_1$ (1 g/tray + 1 g/tray) 71.76 treatment at par with the $T_0$ (control) 69.70 treatment shows the minimum germination percentage which was statistically lesser than other treatments. The maximum germination percentage 77.70 found from $T_3$ (3 g/tray + 3 g/tray). The minimum germination may be due to the less availability of nutrients or hydrogel which may cause restriction in growing media of seedlings [23].

#### Seedling height

The growth of the brinjal seedling was found to be impacted by various treatments. Particularly, it was observed that treatment involving a dosage of 3 g/tray + 3 g/tray demonstrated a markedly higher degree of effectiveness, leading to a recorded seedling length of 18.82 cm (Table 2), with the seedlings being 30 days old at the time of observation. The higher concentration of multi nutrients and hydrogel increases the height of seedlings and the minimum seedling height was found in control. The findings of this study were found to be consistent with the research conducted by Mahala and Sharma [24] on tomato seedlings. Luna et al. [25] have suggested that seedlings exceeding 19 cm in height are not preferable due to their susceptibility to stem breakage during transplantation caused by strong winds.

#### Number of leaves

The number of leaves per seedling was subject to modification by the application of varied treatments of Arka vegetable special and hydrogel. Upon evaluation, seedlings that were 30 days old and grown in a medium consisting of 3 g of Arka vegetable special and 3 g of hydrogel per tray, were found to have a statistically significant greater number of leaves per seedling (6.83). This outcome could be attributed to the nutritional benefits contributed by the treatment, which facilitated the maximum number of leaves. However, seedlings that were grown in a medium consisting of 1 g of Arka vegetable special and 1 g of hydrogel per tray had the lowest number of leaves. During the analysis of brinjal seedlings, the improper availability of multi-nutrients or water may have contributed to the reduced number of leaves.

**Table 2:** Growth character of brinjal seedlings with combination of different concentration of Arka vegetable special and hydrogel.

| Treatment (Arka vegetable special + hydrogel) | Days to emergence (%) | Germination percentage | Seedling height (cm) | Number of leaves | Leaf area ($cm^2$) |
|---|---|---|---|---|---|
| **$T_0$ (Control)** | 12.00$^{a}$ | 69.70$^{b}$ | 15.32$^{b}$ | 6.61$^{a}$ | 76.20$^{b}$ |
| **$T_1$ (1 g/tray + 1 g/tray)** | 10.33$^{a}$ | 71.76$^{b}$ | 15.42$^{b}$ | 5.50$^{a}$ | 70.43$^{c}$ |
| **$T_2$ (2 g/tray + 2 g/tray)** | 10.00$^{a}$ | 70.06$^{b}$ | 16.57$^{b}$ | 5.93$^{a}$ | 67.06$^{d}$ |
| **$T_3$ (3 g/tray + 3 g/tray)** | 10.66$^{a}$ | 77.70$^{a}$ | 18.82$^{a}$ | 6.83$^{a}$ | 79.36$^{a}$ |
| **S.E(m)** | 0.96 | 1.14 | 0.5 | 0.16 | 1.41 |
| **CD** | 0.27 | 4.04 | 1.76 | 0.56 | 4.97 |
| **CV** | 4.38 | 2.74 | 5.23 | 4.4 | 3.33 |

**Note:** Data are mean of three replications on the fresh weight basis Duncan's multiple range test.

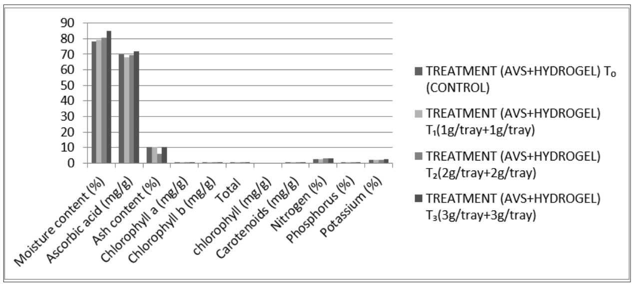


**Figure 3:** Some biochemical parameters of brinjal seedlings with combination of different concentration of Arka vegetable special and hydrogel.

## Leaf area

The mean leaf area of different treatment is given in table 2. At 30 DAS the maximum leaf area was found in (79.36) are significantly at par (70.43) compared to other treatment higher the area of leaf more photosynthesis capacity of seedling. While minimum leaf area was recorded in (67.06).

## Biochemical characters

The nutritional constituents and antioxidant factors such as moisture content, chlorophyll, and carotenoids present in brinjal leaves have been reported in table 2 and figure 3. The mean values of these parameters were obtained from three replications based on fresh weight basis.

### Moisture content

Brinjal is known for its high moisture percentage. In the present study, the moisture content was high in 3 g/tray of Arka vegetable special + 3 g/tray hydrogel (85.21) and lower content was in (78.37) significantly at par (79.01). The reduction in levels of hydrogel resulted in a decrease in soil moisture content, which led to water stress of plants and caused suffering of plants to get water.

### Ash content

The application of different treatments resulted in exceptional variations in the ash content of brinjal, signifying a high degree of significance (Table 3). The Arka vegetable special affected the percentage of ash content. The maximum ash content was in (10.40) significantly at par (10.14) and (10.22) whereas minimum ash content was found in (6.03).

### Chlorophyll and carotenoid content

The maximum chlorophyll a content was found in 3 g/tray of Arka vegetable special + 3 g/tray hydrogel (0.86) whereas chlorophyll b (0.17) and total chlorophyll (0.63) when compared to control plants given in table 3 and figure 3. The present findings are consistent with the outcomes obtained by Beeflink et al. [26], Shahriari [27], Mensah et al. [28] and Geravandi et al. [29]. However, several scholars Kirnak et al. [30] have also documented a decline in chlorophyll content in response to drought stress. On the other hand, certain reports Rensburg and Kruger have indicated no change in chlorophyll content under drought stress [31]. This highlights the need for comprehensive and systematic research on the fate of chlorophyll content under moisture stress in different crops. Behboudian noted that eggplant exhibited better maintenance of photosynthesis under water stress levels than other vegetable

**Table 3:** Some biochemical parameters of brinjal seedlings with combination of different concentration of Arka vegetable special and hydrogel.

| Biochemical parameters | Treatment (Arka vegetable special + Hydrogel) | | | |
|---|---|---|---|---|
| | $T_0$ (control) | $T_1$ (1 g/tray + 1g/tray) | $T_2$ (2 g/tray + 2 g/tray) | $T_3$ (3 g/tray + 3 g/tray) |
| Moisture content (%) | 78.37$^{b}$ | 79.04$^{b}$ | 80.70$^{b}$ | 85.21$^{a}$ |
| Ascorbic acid (mg/g) | 70.06$^{b}$ | 68.0$^{c}$ | 69.35$^{bc}$ | 72.06$^{a}$ |
| Ash content (%) | 10.22$^{a}$ | 10.40$^{a}$ | 6.03$^{b}$ | 10.14$^{a}$ |
| Chlorophyll a (mg/g) | 0.72$^{b}$ | 0.84$^{a}$ | 0.85$^{a}$ | 0.86$^{a}$ |
| Chlorophyll b (mg/g) | 0.16$^{a}$ | 0.14$^{a}$ | 0.13$^{a}$ | 0.17$^{a}$ |
| Total chlorophyll (mg/g) | 0.59$^{a}$ | 0.54$^{a}$ | 0.56$^{a}$ | 0.63$^{a}$ |
| Carotenoids (mg/g) | 0.45$^{a}$ | 0.37$^{a}$ | 0.47$^{a}$ | 0.42$^{a}$ |
| Nitrogen (%) | 2.60$^{c}$ | 2.79$^{c}$ | 3.02$^{b}$ | 3.25$^{a}$ |
| Phosphorus (%) | 0.10$^{b}$ | 0.18$^{a}$ | 0.15$^{ba}$ | 0.21$^{a}$ |
| Potassium (%) | 1.97$^{c}$ | 2.19$^{b}$ | 2.20$^{b}$ | 2.63$^{a}$ |

Data are mean of three replications on the fresh weight basis Duncan's multiple range test.

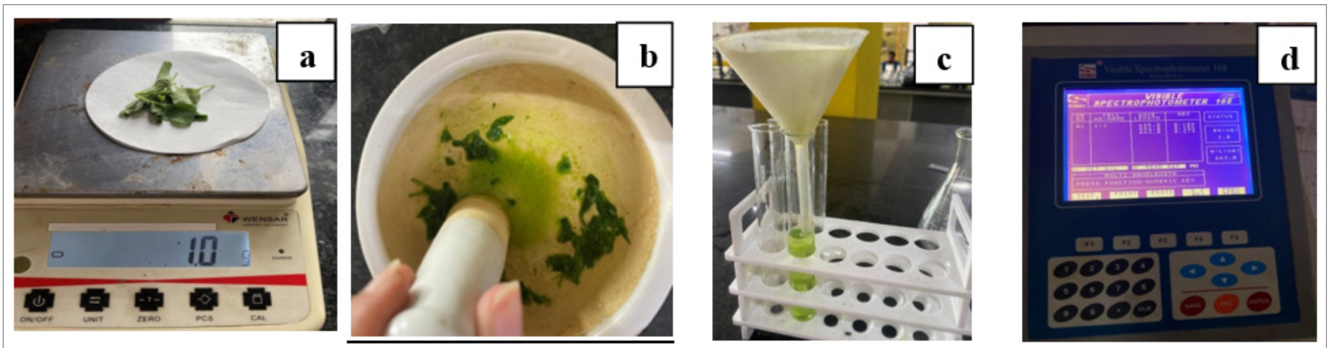


**Figure 4:** Process of chlorophyll (a, b and total chlorophyll) content in leaves through spectrophotometer.

crops, thereby indicating the fair drought tolerance capacity of eggplant in comparison to other vegetables [32]. Whereas maximum carotenoid content was found in 2 g/tray AVS and 2 g/tray hydrogel (0.47) and minimum 1 g/tray Arka vegetable special and 1 g/tray hydrogel (0.37). The procedure of chlorophyll and carotenoids is described in figure 4.

- Measure out 1 g of a finely cut and thoroughly blended sample of leaf.
- Grind tissue into a fine pulp by adding 20 ml of acetone.
- Filter it with Whatman filter paper to sieve the substance and then subject it to centrifugation.
- Determine the solution's absorbance level at 645, 663, and 652 nm against the solvent (80% acetone) acting as a reference.

### Ascorbic acid content

The ascorbic acid substance of brinjal seedlings was discovered to be fundamentally impacted by the high content Arka vegetable special and hydrogel. The most extreme ascorbic acid was found in $T_3$ (3 g/tray Arka vegetable special + 3 g/tray hydrogel) (72.06) significantly at par (70.06) and least ascorbic acid was found in $T_1$ (1 g/tray + 1 g/tray) (68.02). The storage of nutrients in leaves and their subsequent translocation for growth and development is a well-established phenomenon. Consequently, the process of nutrient translocation is comparatively higher in young leaves. Ascorbic acid oxidation was observed to be rapidly growing plant parts such as leaves, leading to a higher concentration of ascorbic acid in such regions improves the photosynthesis in plants and yield of crop. The information with respect to the ascorbic acid substance in brinjal seedling as impacted by various combinations is displayed in table 3.

### Minerals content

Arka vegetable special used in agriculture sector to improve nutritional in plants and for better germination of seeds. Mineral content like nitrogen, phosphorus and potassium markedly increased (3.25), (0.21) and (2.63) by experimental treatment $T_3$ (3 g/tray Arka vegetable special + 3 g/tray hydrogel) compared to control plants (Table 3 and figure 3). It was observed that mineral content was highest in brinjal seedling grown in 3 g/tray Arka vegetable special and 3 g/tray of hydrogel. Amit et al. [33] demonstrated that application of Arka vegetable special to plants increases the mineral content in plants.

## Conclusion

Based on the above results, lead to the conclusion that the most beneficial method for cultivating strong brinjal seedlings is by sowing seeds in Arka vegetable special 3 g/tray + hydrogel 3 g/tray. This study's findings recommend that farmers adopt this approach due to its significant positive impact on various plant growth parameters.

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## Conflict of Interest

None.

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