



## Effects of organic and inorganic fertilizers on growth and yield of kitchen garden vegetables

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### Abstract

The organic bio-stimulants are molecules functional in mounting crops productivity, foliar fertilizer supply of macro and micro nutrients, stimulants, plant hormones and other advantageous substances are dose dependents. Effects of organic and inorganic fertilizers were observed on vegetables of kitchen garden by using Panchagavya Solution, Amirthakaraisal, Inorganic nutrient solution (DAP). They are used in pot culture method, morphological studies conducted. Results showed that case of the system with Panchagavya (7%) the supply of the organic solution favored the growth of the experimental plants. The foliar spray of recommended dosage of the Panchagavya solution also resulted in good yield. The plants supplemented with the foliar spray of Amirthakaraisal yielded fewer fruits than that of panchagavya. Foliar spray of 2% DAP was not preferred by any of the plants and that was evident from the vegetative growth parameters and the yield of the plants. DAP solution (3%) less effective of all the three nutrient sources and it is evident that the experimental plants preferred organic nutrients over inorganic nutrient source for the growth and subsequent yield. The results evidently showed that the plants preferred organic nutrients over inorganic form of Nitrate and Phosphorous as provided by DAP.

**Keywords:** eggplant, fertilizers, panchagavya, solanine, vegetables

### Introduction

In modern years, innovation in agriculture production has been evolving towards low-cost, organic, sustainable and environmental friendly system and at the same time increases the yield and quality of the crops. Organic biostimulants are such molecules useful in increasing productivity of crops. Foliar fertilization is used as a means of supply extra doses of plant growth hormones, micro and macro nutrients, stimulants and supplementary beneficial substances (Sam Ruban *et al.*, 2019) [1]. Eggplant (*Solanum melongena* L.) is second most popular vegetable and native of India. It can be grown throughout the year across India. Along with tomato and onion, eggplant is an important vegetable in India. Eggplant is a rich source of proteins, essential minerals and vitamins (Isshiki *et al.*, 2003) [2]. The fruit (as part of the diet) helps to lower blood cholesterol and is also helpful in regulation of blood pressure. The eggplant fruit contains an alkaloid called "Solanine" which is used for treatment of diabetes, asthma, cholera, bronchitis, diarrhoea and many more diseases. Contains proteins, fats, minerals, carbohydrates (1.4, 0.3, 0.3, 4.0g), Ca (18.0 mg), Mg (16.0 mg), oxalic acid (18.0 mg), P (47.0 mg), thiamine (0.04 mg), vitamin A (124 IU), vitamin C (12.0 mg), niacin (0.65 mg), riboflavin (0.11 mg), nicotinic acid (0.09 mg), sugar (3.53 mg) and zinc (0.16 mg) 100g of fresh eggplant. Plant nourishment plays a significant role for improving yield and superiority in eggplant. Nitrogen is considered as one of the essential macronutrients required by the plant for their growth, development and yield. It is also one of the most important mechanisms of co-enzymes, nucleic acid, and cell membranes concerned in numerous metabolic processes like, photosynthesis, cell division, protein synthesis, plant growth and development, expansion of root and shoots growth (Karihaloo and Gottlieb, 1995) [3]. Eggplant crop is extremely approachable to N fertilizer

submission where N accessibility might be narrow and application time is dangerous. N plays a significant responsibility in nourishment and consequently is the yield limited factor in numerous areas particularly in low fertile soils. So, managing application time, rate and type of nitrogen fertilizer is very important (Bhanwar Singh, 2014) [4]. Okra (*Abelmoschus esculentus* (L.) Moench) is an herbaceous annual plant of the family Malvaceae and an economically important vegetable grown in many parts of tropics and sub-tropics. In India, okra is being cultivated in an area of 5, 01, 000 ha with 5,7,83,000 MT production and in Tamil Nadu, the area and production of Okra are 11,000 ha and 75,400 Metric ton. Heavy fertilization is essential for realizing potential okra fruit yield (Nwachukwu *et al.*, 2014) [5]. The demand for the crop has increased and as a result the growers started applying inorganic sources of plant nutrients. This led to inadequate and imbalanced application of nutrients and this resulted in low yield and poor quality of Okra fruits. Also, the restricted submission of non-living fertilizers creates a poisonous consequence on soil productiveness outstanding to restriction of solitary or supplementary nutrients counting micro nutrients and deprived soil physical condition foremost to productivity decline. Therefore, the substitute choice of the farmers for maintaining the sustainable production can be achieved by the application of nutrients throughout organic amendments such as farm yard manure and bio fertilizers (Olivera *et al.*, 2012) [6]. The fundamental perception of Integrated Plant Nutrient Supply System (IPNS) is the preservation and probable development of soil fertility for sustaining the productivity of crops through the combined use of bio-fertilizer, organic manure and chemical fertilizer. Organic manures not only balance the nutrient supply but also improve the chemical and physical properties of soil (Qhureshi 2007) [7]. Thus, a strategy for judicious

combination of both inorganic and organic sources of nutrient is the most viable option for nutrient management. Fertilization by foliar with multi micronutrients to accomplish balanced nutrition in plant is measured to engage in recreation aim port ant responsibility in contemporary sustainable for vegetable productions (Hemalatha *et al.*, 2018) <sup>[8]</sup>. Chilli (*Capsicum annuum* L.) comes under Solanaceae family, its marvelous economic importance, extracts used in different pharmaceutical products. The pungency in chilli is presence of Oleoresin capsaicin a volatile alkaloid, capsaicinoids produced merely in capsicum fruits. It's extremely nutritive and surrounds an elevated proportion of palatable carbohydrates, proteins, vitamins and minerals (Thulasiramireddy *et al.*, 2018) <sup>[9]</sup>. Chilli is a vegetable crop and is widely grown in India. In hot regions, there is a great problem of premature flower and fruit drop in chilli due to hormonal imbalance and this becomes more problematic when there is sudden rise in atmospheric temperature (Kaur *et al.*, 2016) <sup>[10]</sup>. The organic formulation is Panchagavya, which in Sanskrit means the mix together of five products obtained from ghee, cow milk, curd, cow dung and urine (all these products are independently called as Gavya and cooperatively named as Panchagavya) (Maramag, 2013) <sup>[11]</sup>. Panchagavya has got orientation in the Vedas scripts and Vrikshayurveda. In India, its use in organic farming is ahead reputation in current years particularly in states similar to Tamil Nadu and Kerala (Mangtu Ram, 2017) <sup>[5]</sup>. This study was carried out as an attempt to improve plant productivity through using organic manure, panchagavya, DAP Chosen the best interval of irrigation and reduces the water losses by anti-transparent application under standard conditions (Usman *et al.*, 2014) <sup>[12]</sup>. The present study has been conducted using the important and the most common kitchen garden plants *Abelmoschus esculentus* (L.) Moench, belonging to the family Malvaceae and *Solanum melongena* L., and *Capsicum annuum* L. Belonging to the Solanaceae family, that has been given organic liquid fertilizer in the form of panchakavya and amirthakaraisal Based on literature selected to determine the effects of organic fertilizers such as panchakavya and amirthakaraisal on the growth and yield parameters in comparison with DAP (Diammonium phosphate), an inorganic fertilizer, study the effect of panchakavya and amirthakaraisal on the extent of plant growth development. Determine whether concentrated panchakavya and amirthakaraisal has any negative effect on plant growth. Establish the positive effects of homemade organic fertilizers on the common plants of the kitchen garden. The study was conducted with these objectives in mind and the experiment were devised accordingly

### Materials and methods

The plant species utilized in the current investigation is the present study has been conducted using the important and the most common kitchen garden plants *Abelmoschus esculentus* (L.) Moench, belonging to the family Malvaceae and *Solanum melongena* L., and *Capsicum annuum* L. belonging to the Solanaceae family. Certified and pretreated seeds of the plants were purchased from local nursery and were sowed in nursery beds prepared for the purpose of raising the seedlings. Seedlings once raised are transplanted to the pots for the pot experiments. When grown in pots, the plants were kept under direct sunlight and were watered everyday till the completion of

the experiments. Control was maintained for each case which was sprayed with RO water.

### Preparation of Panchagavya Solution

Prepared panchagavya by using the ingredients *viz.*, cow urine (3 litre), milk (2 litre), curd (2 litre), dung (5 kg) and ghee made from cow milk (1 litre). All the above substrates were added to a extensive mouthed sludge pot and reserved under shade. The inside was entused two times a day for about 20 min together evening and morning to make possible the aerobic microbial activity. In seven days, the customized panchagavya will be prepared, and it can be watery before use on animals and plants, it's used in dissimilar means such as foliar spray, soil application the length of with water irrigation, seedling or seed treatment etc. Cow dung acts as a intermediate for the beneficial Microbes growth. Milk provides carbohydrate, fat, protein, amino acid and Ca. Curd provides the lactobacillus microbe which acts as a channel in the organic wastes digestion. Ghee provides vitamin A, B, Ca, and fat, cow urine has numerous beneficial properties predominantly in therapeutics and agriculture. Cow urine contents are water (95%), urea (2.5%), hormones, minerals, salt and enzymes (2.5%). It is also contains Ca, iron, P, carbonic acid, salts, K, nitrogen, ammonia, manganese, iron, sulphur, phosphates, potassium, urea, uric acid, amino acids, cytokine, enzymes, and lactose etc. The panchagavya is diluted (7%) sprayed different day intervals (3<sup>rd</sup>, 7<sup>th</sup>, 11<sup>th</sup>, 16<sup>th</sup>, 20<sup>th</sup>, and 24<sup>th</sup> day) in morning to all the plants. The plants were irrigated every a day.

### Preparation of Amirthakaraisal

#### Ingredients are as follows:

Cow dung - 1 Kg Cow urine - 1 L Jaggery - a hand full Water - 10 litre The cow dung and urine were taken in a wide mouthed pot and thoroughly mixed. The 10 litre was added to the mixture and a handful of country sugar (jaggery) was also added and stirred well until the sugar gets dissolved. The mixture was allowed to ferment for 24 hours and stored in the shade by covering it with plastic mosquito net to prevent house flies. The Amirthakaraisal solution was diluted to 7% solution and was sprayed on 3<sup>rd</sup>, 7<sup>th</sup>, 11<sup>th</sup>, 16<sup>th</sup>, 20<sup>th</sup>, and 24<sup>th</sup> day in morning to all the plants, the plants were irrigated every day.

### Preparation of Inorganic nutrient solution (DAP)

#### Pot culture experiment

The plants were reared through the pot culture method. The soil required is sandy loam, but the experimentation has been conducted with garden soil having red soil, smooth and humus in the ratio (1:1:1). The seedlings transplanted from nursery beds were sown in 15 cm wide pots and greater height to help the roots to grow deep. The plants were irrigated uniformly throughout the experiment. The plants were assessed for their exo-morphological typescript that were Recorded on the field. The plants under the experimental setup received a foliar spray with the panchakavya and amirthakaraisal at an interval of the 10 days up to about five times. The control plants were given distilled water as the foliar spray. The composition of the panchakavya and amirthakaraisal and distilled water were analyzed using standard methods. Each set had one pot, each with the three plants and so total of 15 plants were analyzed for exo-morphological characters.

**Data and sample collection**

**Pot culture experiment**

*A. esculentus*, *S. melongena* and *C. annuum* grown in pots was sprayed with the test solutions of DAP, panchakavya and amirthakaraisal and distilled water for control plants. The spraying was done at the end of each weak for five successive weeks. The subsequent aspects of study were conceded out in treated and control plants.

**Exo-morphological studies**

The fifth week end the plant morphological data were recorded in the treated and control plants. Plant samples were observed and analyzed in terms of vegetative growth and yield by Number of branches, no. of leaves per plant, no. of flowers and no. of fruits per plant in each case were recorded in each case.

**Results and discussion**

The exo-morphological parameters and the fruit yield per plant were considered for the effectiveness of the nutrients when applied as foliar spray to the plants. The results show

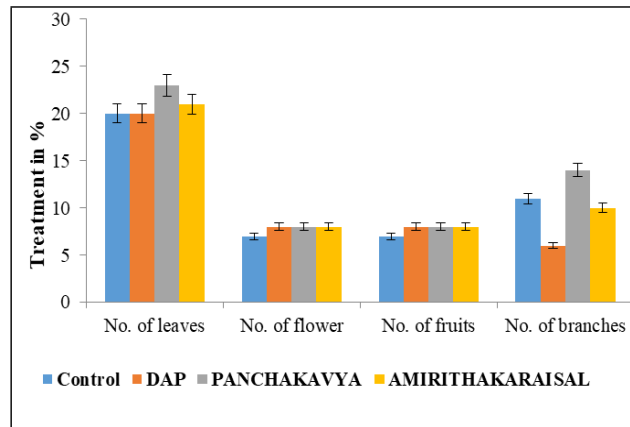
that the plants preferred panchagavya the most when applied as foliar spray. A 7% solution of panchagavya was effective when administered on foliage of plants rather than other nutrients. All the parameters of vegetative growth considered in the study Show remarkable results for panchagavya solution. The shoot system which was developed extensively in a period of 20 d is considered that the plant establishes itself well with panchagavya nutrient solution (Table 1-3).

**Effect of Panchagavya on the vegetative enlargement and plants yield**

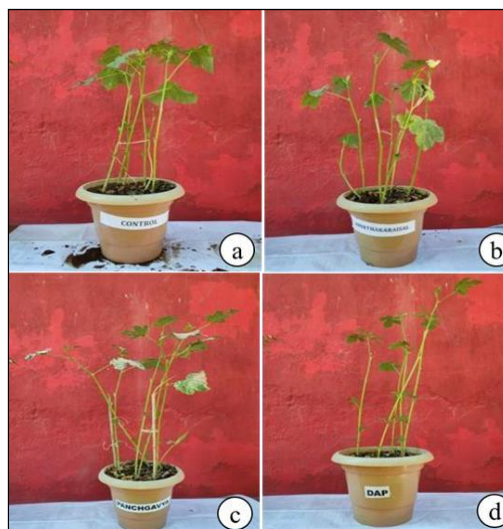
In case of the system with Panchagavya (7%) the supply of the organic solution favored the growth of the experimental plants. About 10 to 12 leaves were produced and the leaves were pale yellow in colour. The leaf size was much more as compared with the other nutrient solutions so also the intermodal length. The colour of the leaves was dark yellow denoting the well-developed chlorophyll, the foliar spray of recommended dosage of the Panchagavya solution also resulted in good yield (Table1).

**Table 1:** Showing the effect of panchakavya on exo-morphological characters of *A. esculentus*

| S. No | Treatment        | No. of leaves | No. of flower | No. of fruits | No. of branches |
|-------|------------------|---------------|---------------|---------------|-----------------|
| 1     | Control          | 20            | 07            | 07            | 9               |
| 2     | DAP              | 20            | 08            | 08            | 5               |
| 3     | Panchakavya      | 23            | 08            | 08            | 7               |
| 4     | Amirithakaraisal | 21            | 08            | 08            | 6               |



**Graph 1:** Showing the effect of panchakavya on exo-morphological characters of *A. esculentus*



**Fig 1:** Effect of panchakavya on exo-morphological characters of *A. esculentus* a. Control, b. Amirithakaraisal, c. Panchakavya, d. Dap

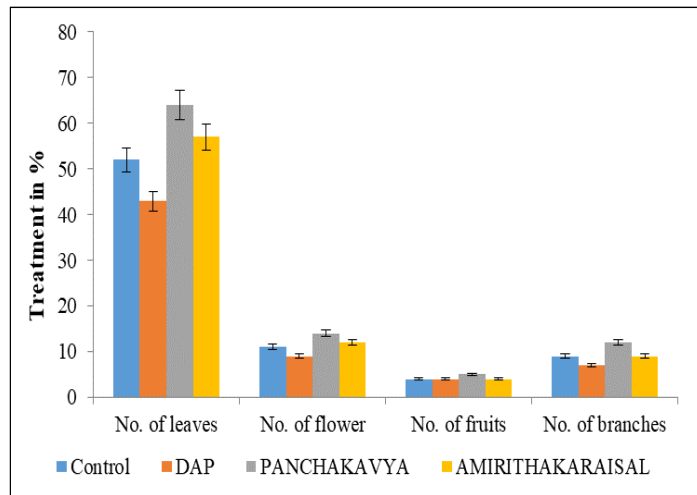
**Effect of Amirthakaraisal on the vegetative growth and plants yield**

When Amirthakaraisal was used as nutrient foliar solution for the growth of the plants and the performance of the plant with regard to yield were less when compared with Panchagavya. Amirthakaraisal was not as supportive as

Panchagavya with regard to the study parameters of the plants but was better to support the growth and yield of the plants as provided by DAP the colour of the leaves were not as green as that of panchagavya treated plants. The plants supplemented with the foliar spray of Amirthakaraisal also yielded fewer fruits than that of panchagavya (Table 2).

**Table 2:** Showing the effect of panchakavya on exo-morphological characters of *S. melongena*

| S. No | Treatment       | No. of leaves | No. of flower | No. of fruits | No. of branches |
|-------|-----------------|---------------|---------------|---------------|-----------------|
| 1     | Control         | 52            | 11            | 04            | 09              |
| 2     | DAP             | 43            | 09            | 04            | 07              |
| 3     | Panchakavya     | 64            | 14            | 05            | 12              |
| 4     | Amirthakaraisal | 57            | 12            | 04            | 09              |



**Graph 2:** Showing the effect of panchakavya on exo-morphological characters of *A. esculentus*



**Fig 2:** Panchakavya on exo-morphological characters of *A. esculentus*

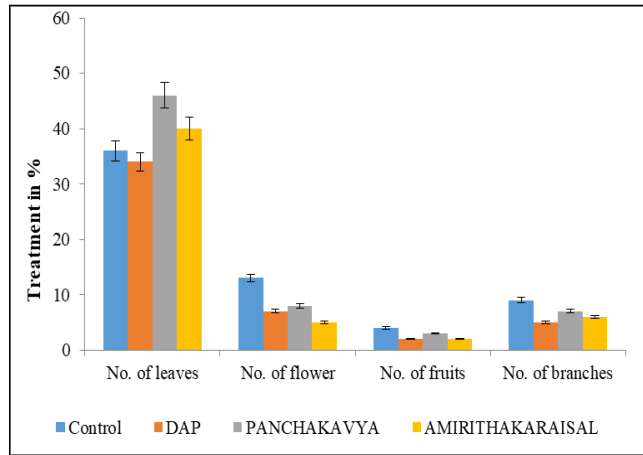
**Effect of DAP on the vegetative development and yield of the plants**

The results show that the inorganic source of nutrients as given by foliar spray of 2% DAPS was not preferred by any

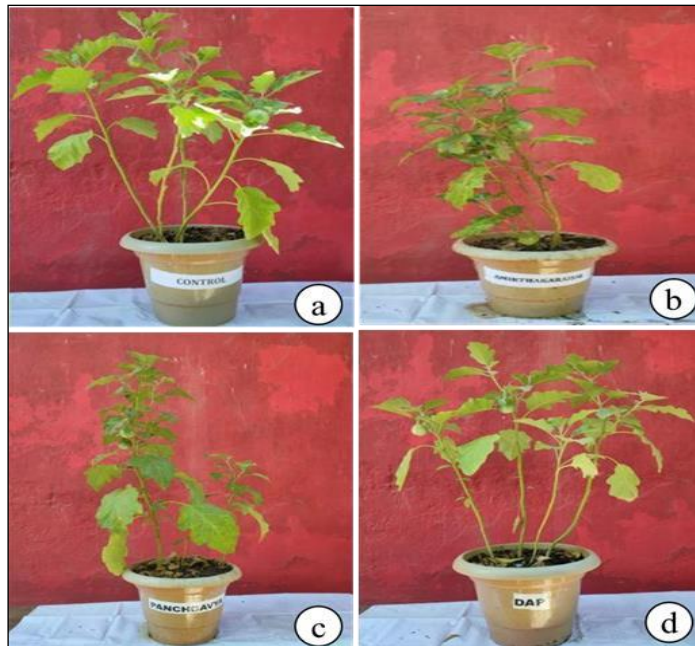
of the plants and that was evident from the vegetative growth parameters and the yield of the plants (Table 3).

**Table 3:** Showing the effect of panchakavya on exo-morphological characters of *C. annuum*

| S. No | Treatment       | No. of leaves | No. of flower | No. of fruits | No. of branches |
|-------|-----------------|---------------|---------------|---------------|-----------------|
| 1     | Control         | 36            | 13            | 04            | 09              |
| 2     | DAP             | 34            | 07            | 02            | 05              |
| 3     | Panchakavya     | 46            | 08            | 03            | 07              |
| 4     | Amirthakaraisal | 40            | 05            | 02            | 06              |



**Graph 3:** Showing the effect of panchakavya on exo-morphological characters of *C. annuum*



**Fig 3:** Effect of panchakavya on exo-morphological characters of *S. melongena* a. Control, b. Amirthakaraisal, c. Panchakavya, d. Dap

**Effect of RO water (control) on the vegetative expansion of the plants**

For all the above experiments, RO water foliar spray was kept as control to compare the vegetative growth and yield

of the plant in the experiment which are devoid of any foliar application of nutrients. Even the control showed growth for the sustenance of the plant.



**Fig 4:** Panchakavya on exo-morphological characters of *S. melongena*

Soil serves as the nutrient elements source and so the nutrients availability is governed through properties of soil. The inorganic essentials in the form of fertilizers are supplementary for outwardly. The majority of fertilizers are formulated to conquer the mineral elements deficiencies in the soil. Mineral cations such as ammonium (NH<sub>4</sub><sup>+</sup>) and potassium (K) adsorb to the negatively charged surface of the organic and inorganic soil particles.

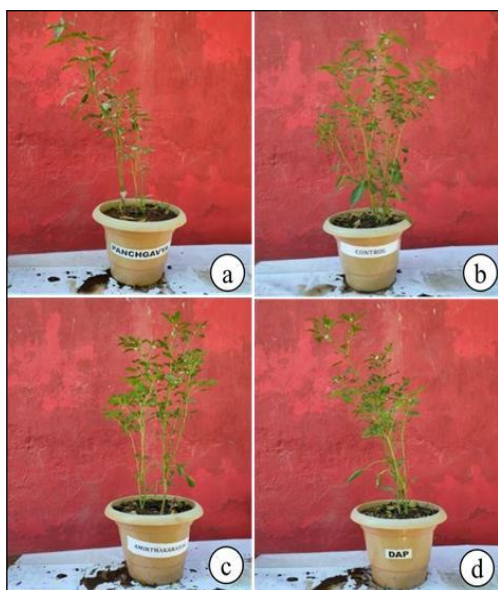
This adsorption is an important factor in governing soil fertility. The adsorption major improvement is that the cations are not effortlessly misplaced from the outside of soil particles when the soil is exhausted with water. However, these nutrients adsorbed can be replaced through other cations in a procedure known as exchange of cation. The adsorption capacity of soil to ions and replace it through other ions is termed as exchange of cation capability (CEC) and is extremely independent on the soil types (Deore *et al.*, 2010) [13].

Crop production is currently dependent on chemical fertilizers as the main source of plant nutrition. Organic fertilizers have the potential to significantly reduce the application of traditional inorganic fertilizers while simultaneously increasing crop stress resistance and yield.

Therefore, it is key to study if foliar application of organic fertilizers or nutrients can have an impact on reducing conventional soil application of inorganic fertilizer and its indiscriminate usage which results in irreversible damage to the soil nutrition.

The essential elements concentrations required through plants are important to understand and for optimum growth maintain and several deficiency symptoms prevents. Such philosophy provides as functional conduct to plant physiologists and farmers since elements concentration in tissues of plant is supplementary dependable than in soil representative.

However, for plant growth determining optimum, a farmer must obtain into deliberation the analysis of soil in his grassland. Soil analysis is the chemical fortitude of nutrient contented and their quantifications in soil example. Plant analysis and soil analysis data are useful in establishing fertilizer schedules.



**Fig 5:** Effect of panchakavya on exo-morphological characters of *C. annuum* a. Control, b. Amirthakaraisal, c. Panchakavya, d. Dap

Previously the elements absorbed through plant roots are trans located to different plant parts anywhere they are concerned in transportation out significant natural functions resultant in usual development and growth.

In agriculture, mineral elements accumulation in soil is encouraged for plant growth improvements. About 150 years ago, the function of plant growth mineral nutrients a topic of scientific debate, however, it was Justus von Liebig (1803–1873) who composed, compiled and summarizes the sprinkled in sequence pertaining to the mineral elements significance for plant growths.

This mineral nutrition established in plant as a scientific regulation. These achievements led to an expression in the mineral use of fertilizers in agriculture fields, conclusion of the 19<sup>th</sup> Century, predominantly in Europe, huge amount of K, P, inorganic N used in agriculture and horticulture for improve the plant growths (Muhammad *et al.*, 2014) [14].



**Fig 6:** Effect of panchakavya on exo-morphological characters of *C. annuum*

Its completed based exclusively on surveillance and conjecture somewhat than through accurate sting that mineral elements; N, S, K, phosphorus, Ca, Mg, silicon, sodium and iron are essential for the plant growths, through the end of 19<sup>th</sup> Century, a huge number of study were undertaken to ascertain the mineral element theory. From the widespread examination carried out on composition minerals in dissimilar plant species mounting on dissimilar type of soils, it was accomplished that neither the attendance nor the mineral element concentration in plants criteria for essentiality. Plants have an incomplete ability to understand selectively those mineral nutrients that are necessary for plant growths. Improved nutrients absorption in the plants through foliar spray in mineral elements supplementary exactly and led to an improvement in plant metabolism. Soil as foundation of nutrient soil is a multifaceted physical, chemical and biological substrates which acts as an environment for different nutrients organic and in-organics. The soil solution or liquid phase extremely significant from the observation point of incorporation of nutrients through roots since it contains nutrient ions dissolved and facilitates the ions association towards plant root exterior.

The air-spaces flanked by soil particles which are engaged with gases such as O<sub>2</sub>, CO<sub>2</sub> and N constitute the gaseous phase of soil. From the biological view point, soil constitutes a miscellaneous bionetwork in which plant roots and microorganisms struggle powerfully for mineral nutrients. Hence foliar spray as a method of providing essential nutrients by way is cost effective as the amount required alone is administered by foliar spray thus saving on

the loss due to leaching and utilization by other organisms and microorganisms (Muhammad *et al.*, 2014) <sup>[14]</sup>.

They recognized that the subsequent criteria should be met for a constituent to be measured necessary. 1. Plant necessity is powerless to absolute its existence sequence in the non-attendance of mineral elements. 2. The element function necessity is not consumable through another mineral element. 3. The element should subsist honestly concerned in metabolism of plants, for illustration, as a constituent of a plant essential component such as an enzyme or its obligation be mandatory for a dissimilar metabolic footstep such as an enzymatic reaction, such elements are not important but present confident imperative functions and are confidential as helpful elements. The most favorable crop plants genetic potential cannot be achieved if the valuable elements are disqualified from the production agricultural system. Based on the essentiality criteria, limestone elements have essential and specific functions in metabolism plants (Satpute *et al.*, 2013) <sup>[15]</sup>. The macronutrients are necessary in superior quantity and are in attendance in plant tissues in amounts ranged between 0.2 and 4.0% (dehydrated weight basis), whilst the micronutrients concentration in plant tissue ranges 5 to 200 ppm or less than 0.02%, its further separated based on their requirements into main macronutrients consisting of N, P and K and secondary macronutrients are included as Ca, S and Mg. Another categorization based on physiochemical properties divides nutrients into metals (Ca, K, Mg, Mn, Fe, Zn, Mo, Cu, Ni) and non-metals (N, S, B, Cl, P). However, the majority are used classification based on the amount of mineral element requirements somewhat than the physiochemical properties (Indikumari *et al.*, 2016) <sup>[16]</sup>.

#### Quantitative Requirements of Nutrient and Tissue Analysis

Such standard supply as functional conduct to plant farmers and physiologists because attentiveness of rudiments in tissues of plants supplementary dependable than in soil representative whether the plant determination produce faster if additional of a prearranged nutrient is applied. Nevertheless, for formative the most select plant growth, a cultivator must obtain into contemplation the soil examination of his grassland. Soil analysis is the chemical fortitude of the nutrient comfortable and their quantification in soil illustration. However, it fails to estimate the uptake surroundings and nutrients quantity essentially absorbed through the plants. This supplementary in order can exist obtained through plant tissue examination. Appropriate plant tissue using analysis requires a thoughtful of the association between plant enlargement and the sandstone contented of plant tissue samples. The present investigation carried out to establish the efficacy of the application of organic nutrient by foliar spray on the most common kitchen garden vegetable crop plants such as Brinjal, Chilli and Bindi and the results obtained were similar to the studies made on the same lines with other crops and cereals. The results evidently showed that the plants preferred organic nutrients over inorganic form of Nitrate and Phosphorous as provided by DAP.

#### Conclusion

The foliar application of nutrients was well observed by the experimental plants. The Panchagavya solution (7%) when applied to the plants by foliar spray supported vegetative

growth and yield per plant. The Panchagavya solution effectively supported and improved the growth and yield of the plants as evident from the observed growth parameters of the present experiment. The Amirthakaraisal solution (7%) applied to the plants as foliar spray was effective than DAP as vegetative growth and yield were better in Amirthakaraisal treated plants than that of DAP treated plants. Amirthakaraisal proved to be less effective than Panchagavya with regard to the study parameters of the experiment. DAP solution (3%) less effective of all the three nutrient sources and it is evident that the experimental plants preferred organic nutrients over inorganic nutrient source for the growth and subsequent yield.

#### References

1. Sam Ruban J, Priya MR, Barathan G, Suresh Kumar SM. Effect of Foliar Application of Biostimulants on Growth and Yield of Brinjal (*Solanum melongena* L.) Plant Archives, 2019;19(2):2126-2128.
2. Isshiki S, Suzuki S, Yamashita K. RFLP analysis of mitochondrial DNA in eggplant and related *Solanum* species. Genet Resour Crop Evol, 2003;50:133-137.
3. Karihaloo JL, Gottlieb LD. Allozyme variation in the eggplant, *Solanum melongena* L. (Solanaceae). Theor Appl Genet, 1995;90:578-583.
4. Bhanwar Singh effect of foliar application of nitrogen source (urea) on growth and yield of eggplant (*Solanum melongena* L.) M.Sc. Thesis, Lovely Professional University, Punjab, 2014.
5. Nwachukwu VN, Asiegbu FN, Ogwo Uzoamaka. Utilization of library oriented software packages among university libraries in north central zone of Nigeria. International Journal of Advanced Research, 2014;2(5):111-116.
6. Olivera IM, Hidekiyo H, Pamela A, Halley, Kate GS. Loss of FGF-Dependent Mesoderm Identity and Rise of Endogenous Retinoid Signalling Determine Cessation of Body Axis Elongation, PLoS Biol, 2012;10(10):e1001415.
7. Qhureshi Z. Breeding investigation in bhendi (*Abelmoschus esculentus* (L.) Moench). Master Thesis, University of Agriculture Sciences, GKVK, Bangalore, 2007.
8. Hemalatha M, Selvi D, Vasanthi D. Integrated Plant Nutrients Supply and Foliar Nutrition on Fruit Yield, Nutrient Uptake and Availability in Okra, (*Abelmoschus esculentus* (L.) Moench] Hybrid COBhH- 4 in an Alfisol of Tamirabarani Command Area, International Journal of Advances in Agricultural Science and Technology, 2018;5(8):47-66.
9. Thulasiramireddy T, Bidari BI, Patil PL, Manjunatha M.V. Studies on Nitrogen Substitution through Organics and Foliar Application of Water Soluble Fertilizers on Chemical Parameters and Micro Nutrient Uptake by Chilli (*Capsicum annum* L.) In a Vertisol, Int. J. Curr. Microbiol. App. Sci, 2018;7(12):3023-3031.
10. Kaur N, Singh AP, Singh Z, Gupta M, Kaur J and Goyal PK. Assessment of Age From Early Mandibular Growth – Case Reports. Human Biology Review, 2016;5(2):161-167.
11. Maramag RP. Diuretic potential of *Capsicum frutescens* L., *Corchorus olitorius* L., and *Abelmoschus esculentus* L. Asian journal of natural and applied science, 2013;2(1):60-69.

12. Usman B, Munir A, Mozammil H, Mohsin N, Mudassar A, Umair K, Gul N, Zhao N. Gene action for various morphological and yield contributing traits in maize (*Zea mays* L.) International Journal of Agronomy and Agricultural Research,2018:12(3):9-18.
13. Deore GB, Limaye AS, Shinde BM, Laware SL. Effect of Novel Organic Liquid Fertilizer on Growth and Yield in Chilli (L.) Asian j. exp. biol. Sci, 2010, 15-19.
14. Muhammad Waseem K, Amir Muhammad L, Muhammad Siddique D, Ali Sher C, Attaullah Khan P, Hamz Ali S, Beahri L. M. Impact of foliar spray of zinc on fruit yield of chillies *Capsicum annum* L, Life Sci. Int. J.,2014:8(1):2944-2949.
15. Satpute NR, Suryawanshi LB, Waghmare JM, Jagtap PB. Response of summer okra (cv. Phule utkarsha) to iron, zinc and boron in inceptisol, the Asian journal of horticulture,2013:8(2):541-546.
16. Indikumari Devi T, Haripriya K, Rajeswari R. effect of organic nutrients and biostimulants on yield characters of beetroot (*Beta vulgaris* l.) Plant Archives,2016:16(1):399- 402.
17. Sabuz AA, Khan MH, Rahman MT, Rana R, Brahma S. Stability of organic food colorant extracted from annatto seeds on food matrix. Int. J. Food Sci. Nutr. 2020;5:10-6.