



Exogenous Application of Organic and Inorganic Nutrients and Their Impact on Agronomical Traits, Yield and Quality of Vegetable Cowpea [*Vigna unguiculata* (L) Walp]

Pallavkumar J. Savaliya ^a, Vivek S. Mehta ^{b*},
Vinay K. Parmar ^c, Naren K. Patel ^a
and Dushyant D. Champaneri ^a

^a Department of Vegetable Science, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari 396450, Gujarat, India.

^b Regional Horticultural Research Station, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari 396450, Gujarat, India.

^c Department of Fruit Science, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari 396450, Gujarat, India.

Authors' contributions

This work was carried out in collaboration among all authors. Authors PJS, VKP, NKP have contributed in conceptualization, planning of this research project, interpretations of the experimental data and proof reading of this manuscript. Authors VSM and PJS have rendered their services by performing the research study along with compilation, documentation of this manuscript. Author DDC reviewed and edited the manuscript as part of the contribution. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJPSS/2023/v35i193529

Open Peer Review History:

This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: <https://www.sdiarticle5.com/review-history/104258>

Original Research Article

Received: 02/06/2023
Accepted: 04/08/2023
Published: 16/08/2023

*Corresponding author: E-mail: vivekmehta10@gmail.com;

ABSTRACT

The study was undertaken on heavy black soil at Regional Horticulture Research Station, Navsari Agricultural University, Navsari, Gujarat (India) in order to analyze the effect of foliar application of organic and inorganic nutrients on growth, yield and quality of vegetable cowpea. The field was thoroughly ploughed and harrowed followed by land levelling using wooden plank. Basal dose of manure and fertilizer of 20:40:00 kg ha⁻¹ was incorporated in the soil during land preparation. The seeds were planted 45 cm between rows and 30 cm between plants laid out in a Randomized Complete Block Design with nine treatments replicated three times. Treatments were as follows: Control (T₁), 2% Panchagavya (An organic solution made from cow dung, cow urine, cow butter, cow curd and cow milk) (T₂), 3% Panchagavya (T₃), 0.5% Novel plus organic liquid nutrients (T₄), 1% Novel plus organic liquid nutrients (T₅), 1.5 % Novel plus organic liquid nutrients (T₆), 0.5% Micronutrient grade IV (T₇), 1% Micronutrient grade IV (T₈) and 1.5% Micronutrient grade IV (T₉). The observations were made at the intervals of 60 and 90 DAS and data was collected on plant growth, yield and quality parameters. Results showed that the application of 1% Novel plus organic liquid nutrients (NOVEL) (T₅) exhibited maximum plant height (35.73 and 56.93 cm, respectively), number of leaves per plant (39.27 and 52.73, respectively) at 60 and 90 days after sowing (DAS) and increased leaf area (162.14 cm²). Substantial effect of foliar application of 1% Novel plus organic liquid nutrients (NOVEL) (T₅) was detected in yield parameters viz., number of clusters per plant (12.07), number of pods per plant (58.00), marketable pod yield (6.04 kg/plot). Further to this, 1% Novel plus organic liquid nutrients indicated notable effect on protein content of pods (24.04%), iron (Fe) content (220.12 ppm) and zinc (Zn) content (62.76 ppm) of cowpea pods at final harvest. Novel Plus organic liquid nutrient can play a major role in growth, yield and quality in vegetable cowpea production.

Keywords: Novel organic liquid nutrient (NOVEL); foliar spray; vegetable cowpea; growth; yield.

1. INTRODUCTION

Cowpea [*Vigna unguiculata* (L) Walp] being in the family of Fabaceae is an important leguminous crop believed to be originated in Central Africa. It is self-pollinated annual herb with an extensive growth habit. It is also known as lobia, black-eye pea and southern pea. Predominantly, cowpea is grown in summer and winter (*kharif*) season in India, often cultivated as an intercrop in pigeon pea, maize, sorghum and tapioca. Due to expansion growing habit, it covers the ground area leading to reduction in erosion. Cowpea merited with resistance to drought, wider adaptability to soil types, improving soil nutrient status by N-fixation and having a high protein content, it is being crowned as an important vegetable across the nation. Cowpea is shallow rooted crop and flourishes well under low fertile soil and low moisture condition. It can fix atmospheric nitrogen in the soil by their symbiotic relationship with a specific soil bacterium (*Rhizobium* spp.). Regular intake of cowpea seeds helps to ameliorate the new cell development which boosts the immunity of the body [1]. There has been a major role of macro and micro nutrients in major plant morpho-physiological processes such as respiration, metabolic activation of the enzyme,

photosynthesis, chloroplast formation, chloroplast synthesis and hormone biosynthesis [2]. However, routine practices of using extravagant chemical fertilizers, their amounts and method of application have led to loss of nutrients in soil and water resulting in eutrophication. In order to sustain a higher yield potential and de-escalate the nutrient losses, it becomes very pertinent to evolve suitable technologies for vegetable production. Foliar application of soluble fertilizers is one of the tactics to reduce fertilizer unavailability through absorption, leaching or other process associated with soil application [3]. Therefore, in order to achieve the benefits of foliar feeding, combining proper methods of application and the best suited nutrient materials related to specific crops is essential. Hallock [4] observed that foliar application of nutrients is better than soil application for increasing yield in legume crops required not only adequate macronutrient but also micronutrients for increasing the bacterial activity of nodules. Eisa and Ali [5] have indicated that foliar spray of micronutrient mix on cowpea significantly increased the plant growth and yield traits. Therefore, an optimum supply of micronutrients through foliar application under balanced condition is of utmost necessary for higher productivity. Along with chemical

fertilizers, organic source of fertilizers for the crop production have been of keen interest these days to ease of operation, cost effective and better results. Numerous studies indicates the better plant growth and yield with application of organic source of nutrients as compared to inorganic fertilizers [6] and [7]. Very few studies on the effect of foliar sprays of inorganic nutrients and organic nutrients (Such as NOVEL) were done on cowpea to check its feasibility for production and quality during summer in this region. Therefore, the present aimed to evaluate and compare foliar application of inorganic and organic nutrients for growth, production and qualitative traits in cowpea.

2. MATERIALS AND METHODS

2.1 Experimental Site and Planting

The field trial was conducted in summer season of 2018-19 at Vegetable Research Farm, Regional Horticultural Research Station, Navsari Agricultural University, Navsari (Gujarat). The experimental site soil was deep black, deep drainage with good water holding capacity. The experiment used cowpea variety "Gujarat Dantiwada Vegetable Cowpea 2" (GDVC 2) which was released in 2012 from SDAU, Sardarkrushinagar, Dantiwada (Gujarat). The field was thoroughly prepared by ploughing and harrowing followed by land levelling with the help of wooden plank. Basal dose of manure and fertilizer as per the recommendation of 20:40:00 kg ha⁻¹ were incorporated in soil during land preparation. The seeds were planted at a distance of 45 cm between rows and 30 cm between plants in the Randomised Block Design with nine treatments replicated three times. The treatments were as follows: Control (T₁), 2% *Panchagavya* (An organic solution made from cow dung, cow urine, cow butter, cow curd and cow milk) (T₂), 3% *Panchagavya* (T₃), 0.5% Novel plus organic liquid nutrients (T₄), 1% Novel plus organic liquid nutrients (T₅), 1.5% Novel plus organic liquid nutrients (T₆), 0.5% Micronutrient grade IV (T₇), 1% Micronutrient grade IV (T₈) and 1.5% Micronutrient grade IV (T₉). Irrigation was applied at the time of planting in all treatments using furrow method and subsequently irrigation was applied when needed. All other crop cultural practices were followed accordingly. Foliar application of nutrients was done at 30 and 60 days after sowing (DAS). The observations were made at the intervals of 60 and 90 DAS. Data was collected on plant height (cm), number of leaves per plant, leaf area, number of primary

branches, clusters per plant, number of pods per cluster, number of pods per plant. Pod length and pod weight were calculated at 3rd and 6th picking and averaged. Pod yield per plot and pod yield per hectare were recorded within the total six pickings. Quality parameters such as crude fibre content (%), protein content (%), iron (Fe) content (ppm) and zinc content (ppm) were measured during 6th picking (final harvest). The NOVEL Plus organic nutrient which is an International Patented Product by NAU was used as one of the treatments and the content analysis of the product is presented in Table 1 (Champaneri et al., 2021).

Table 1. Nutritional composition of Novel plus organic liquid nutrient

Content	Mean
Nitrogen (N)	0.071 %
Phosphorous (P)	0.016 %
Potassium (K)	0.158 %
Sodium (Na)	0.059 %
Calcium (Ca)	0.026 %
Magnesium (Mg)	0.147 %
? (S)	0.015 %
Iron (Fe)	742.00 ppm
Manganese (Mn)	11.53 ppm
Zinc (Zn)	2.30 ppm
Copper (Cu)	0.26 ppm
Ureas activity	63-81 U/ml/min
Gibberellic acid	110.2-205.0 mg/l
Cytokinin	137.8-244.3 mg/l

2.2 Weather and Climate of Experiment Site

During the growing season (March to June 2019) maximum and minimum temperatures (39.4°C) and (28.2°C) were recorded and it was the hot summer season in the region. Relative humidity was mild (73.10%) with a maximum sunshine hour of (10.8 h) during peak crop growth stage.

2.3 Estimation of Fe and Zn

Fe and Zn content of the pods were estimated at the final harvest by following the diacid mixture method of Elwell and Gridley [8]. The dried, digested and filtrated samples were analyzed using atomic absorption spectrophotometry.

2.4 Estimation of Protein

Nitrogen content of pods was analyzed using Kjeldahl method and further protein content (%) in

pod was calculated using multiplication factor 6.25 (Anonymous, 1960).

2.5 Estimation of Crude Fibre

Crude fibre content (%) for pods was estimated at the final harvest by taking pods of five tagged plants from each treatment. Two grams of sample was mixed with ether or petroleum ether to remove fat and boiled and 2g of dried sample was mixed with 200 ml of H₂SO₄ for 30 minutes and then filtered through muslin cloth and washed with boiling water until substance was free of acid. The residue was boiled with 200 ml of NaOH for 30 minutes and filtered through muslin cloth again and washed with 25 ml of boiling H₂SO₄ followed with 50 ml portion of water and 25 ml alcohol. The residue was removed and transferred to pre-weighted petri plate (W₁, g) then dried for 2 hours at 130 ± 2 °C, cooled in a desiccator and weighed (W₂, g). Ignited for 30 minutes at 600 ± 15 °C, and cooled in a desiccator and reweighed (W₃, g) according to Maynard [9].

$$\text{Crude Fibre (\%)} = \frac{\text{Loss in weight on ignition } (W_2 - W_1) \times (W_3 - W_1)}{\text{Weight of original sample (g)}} \times 100$$

2.6 Statistical Analysis

The parameter data were analyzed using Indo-Stat statistical software. The ANOVA test was performed and the significance differences between mean values was determined using Tukey's (CD = 0.05) test.

3. RESULTS AND DISCUSSION

3.1 Effect of Foliar Application of Organic and Inorganic Nutrients on Growth Parameters

Foliar application of nutrients significantly influenced the plant growth characters (Table 2). The result revealed that foliar application of 1 % Novel plus organic liquid nutrients (T₅) recorded the maximum plant height (35.73 cm and 56.93 cm) and number of leaves (39.27 and 52.73) at 60 and 90 DAS, respectively. There has been an increase in leaf area (162.14 cm²) with the same treatment. This effect might be attributed to availability of nitrogen which stimulates the plant growth. Nitrogen being the major constituents of chlorophyll, protein and amino acid, their synthesis could have been escalated by the adequate supply of nitrogen from the Novel plus

organic liquid nutrients. Further to this might be due to Novel plus organic liquid nutrients which contains plant growth regulators such as gibberellic acid, cytokinin and micro nutrients (Mn, Cu and Zn) which enhance the cell division and cell elongation which results into rapid elongation of internodes that might have upscaled the plant height. It also enhance the conversion of tryptophan to IAA leading to the enhanced activity of cell division and cell elongation through the effect of gibberellic acid and cytokinin singly or due to combine effect due to phytohormone content of Novel Plus organic liquid nutrient. Moreover, nitrogen increases the cation exchange capacity of plant roots and makes them potent in absorbing other nutrient ions like H₂PO₄⁻, K *etc.* These findings are in line with the results reported by Kalariya et al. [10] in okra, Anonymous [11,12] in banana, and Desai Supal et al. [13].

3.2 Effect of Foliar Application of Organic and Inorganic Nutrients on Yield Parameters

The results in Table 3 showed no significant difference on number of clusters per plant, number of pods per plant and pod yield however, maximum number of clusters per plant (12.07), number of pods per plant (58) and pod yield (6.72 kg/plot) were attained with foliar application of 1% Novel plus organic liquid nutrients (T₅). The number of pods per cluster (4.81), average pod length (15.52 cm) and average pod weight (2.48) were also recorded with a 1% foliar spray of Novel plus organic liquid nutrient. The number of clusters per plant was closely associated with growth components like plant height, leaf area and number of leaves per plant. The findings are in line with those reported by Manani [14] in cluster bean. Lavish amount of macro and micro nutrient which ameliorate photosynthetic activity leads to augment in production traits and allocation of carbohydrates and photosynthates which ultimately increases the production and productivity of the crop [15]. The findings are similar to those reported by Kalariya et al. [16] in okra; Patel et al. [17] in green gram and Deore et al. [18] in chilli. The augmentation in yield is closely associated with components like maximum number of clusters per plant, number of pods per plant, leaf area and number of leaves per plant. Additionally, this effect might be contributed to easy assimilation of nutrients and balance in NPK ratio leads to improved crop production. The application of water soluble nutrients accelerates an uptake of water and

nutrients, commanding higher photosynthesis and enhanced food accumulation in edible parts [15,19]. The results are further in accordance with the finding of Shah [20] in sweet potato,

Patel et al. [21] in cabbage, El-sayed et al. [22] in legume pea, Patil and Kolambe [23] in garlic, Salunkhe et al. [24] in onion and Deore et al. [18] in chilli.

Table 2. Effect of foliar application of organic and inorganic nutrients on growth parameters

Treatment	Plant Height (cm)		Number of Leaves per Plant		Leaf Area (cm ²)	No. of Primary Branches per Plant
	60	90	60	90		
	DAS	DAS	DAS	DAS		
T ₁ : Control (No spray)	24.70	39.87	29.13	39.47	110.12	3.47
T ₂ : Panchagavya (2%)	29.10	45.10	32.27	42.53	123.01	3.80
T ₃ : Panchagavya (3%)	29.60	48.17	32.07	42.80	126.11	3.87
T ₄ : Novel plus organic liquid nutrients (0.5%)	31.60	53.13	34.93	50.00	141.13	4.00
T ₅ : Novel plus organic liquid nutrients (1%)	35.73	56.93	39.27	52.73	162.14	4.20
T ₆ : Novel plus organic liquid nutrients (1.5%)	30.40	48.67	34.00	46.20	134.05	4.07
T ₇ : Micronutrient grade IV (0.5%)	29.70	47.07	33.60	45.93	125.77	3.93
T ₈ : Micronutrient grade IV (1%)	30.93	50.90	35.27	48.80	132.90	4.00
T ₉ : Micronutrient grade IV (1.5%)	31.57	51.80	35.80	49.40	137.72	4.07
S.Em. ±	1.73	2.80	1.67	2.18	7.48	0.17
CD (P=0.05)	5.20	8.39	5.01	6.52	22.44	NS
C.V. %	9.89	9.88	8.51	8.12	9.78	7.34

(*Panchagavya - an organic nutrient solution made using cow urine, cow dung, cowmilk and jaggery)

Table 3. The effect of foliar application of organic and inorganic nutrients on yield parameters

Treatment	Clusters/ plant	Pods per cluster	Pods per plant	Average pod length (cm)	Average pod weight (g)	Total pod yield (kg plot ⁻¹)
T ₁ : Control (No spray)	9.93	4.51	44.73	12.80	2.31	4.85
T ₂ : Panchagavya (2%)	10.00	4.54	45.40	13.59	2.32	4.96
T ₃ : Panchagavya (3%)	10.40	4.59	47.60	13.62	2.35	5.30
T ₄ : Novel plus organic liquid nutrients (0.5%)	11.80	4.72	55.73	15.26	2.44	6.45
T ₅ : Novel plus organic liquid nutrients (1%)	12.07	4.81	58.00	15.52	2.48	6.72
T ₆ : Novel plus organic liquid nutrients (1.5%)	10.67	4.64	49.40	13.65	2.38	5.52
T ₇ : Micronutrient grade IV (0.5%)	10.60	4.62	48.93	13.31	2.36	5.43
T ₈ : Micronutrient grade IV (1%)	11.00	4.67	51.20	13.38	2.39	5.87

Treatment	Clusters/ plant	Pods per cluster	Pods per plant	Average pod length (cm)	Average pod weight (g)	Total pod yield (kg plot ⁻¹)
T ₉ : Micronutrient grade IV (1.5%)	11.53	4.68	53.93	13.94	2.40	6.15
S.Em. ±	0.45	0.22	2.72	0.63	0.07	0.35
CD (P=0.05)	1.34	NS	8.16	NS	NS	1.04
C.V. %	7.08	8.23	9.33	7.85	5.31	10.57

Table 4. Effect of foliar application of organic and inorganic nutrients on quality parameters

Treatments	Crude Fiber (%)	Protein (%)	Iron (ppm)	Zinc (ppm)
T ₁ : Control (No spray)	12.33	20.69	182.39	52.57
T ₂ : <i>Panchagavya</i> (2%)	12.39	21.91	191.90	55.22
T ₃ : <i>Panchagavya</i> (3%)	12.46	22.38	197.29	56.85
T ₄ : Novel plus organic liquid nutrients (0.5%)	12.72	23.91	219.34	60.45
T ₅ : Novel plus organic liquid nutrients (1%)	12.76	24.04	220.12	62.76
T ₆ : Novel plus organic liquid nutrients (1.5%)	12.59	22.70	210.94	58.69
T ₇ : Micronutrient grade IV (0.5%)	12.52	22.59	209.30	58.57
T ₈ : Micronutrient grade IV (1%)	12.62	23.32	214.43	59.30
T ₉ : Micronutrient grade IV (1.5%)	12.70	23.47	216.63	59.92
S.Em. (±)	0.18	0.55	6.93	1.55
C.D. at 0.05%	NS	1.64	20.77	4.64
C.V. %	2.50	4.17	5.80	4.60

3.3 Effect of Foliar Application of Organic and Inorganic Nutrients on Quality Parameters

Foliar application of organic and inorganic nutrients exhibited profound results for protein content (Table 4). The highest protein content (24.04%), Fe content (220.12 ppm) and Zn content (962.76 ppm) in pods were noted with 1% Novel plus organic liquid nutrients (T₅). The enhancement of quality contents supposedly attributed to higher uptake of nitrogen during growth period which upscaled photosynthesis, synthesis of protoplasm and protein for higher rate of mitosis. Application of 1 % Novel plus organic liquid nutrients accelerate the availability of elements & hormones, which could lead to enhanced metabolic activities and carbohydrate transformation of enzymes which ultimately enhances the quality characters of the pods. Similar effect was noted by Singhal et al. [15]. Additionally, boosts in Fe and Zn content might have contributed to the increased the capacity of plant to utilize ample amount of nutrients supplied through Novel plus organic liquid nutrients and better translocation of available

micronutrients already available in Novel plus organic liquid nutrients [11]. El-affifi et al. [25]; Fouda et al. [26] estimated the same effect in cowpea by foliar fertilization.

4. CONCLUSIONS

Based on the study findings it can be concluded that foliar application of nutrients has significant effect on growth and productivity of vegetable cowpea. Novel plus (1%) organic liquid nutrient (NOVEL) developed and patented by Navsari Agricultural University, Navsari (Gujarat), India is recommended to the farming community for application at 30 and 60 days after sowing.

ACKNOWLEDGEMENT

Authors are thankful to Regional Horticulture Research Station, ACHF, NAU, Navsari, Gujarat, India for providing land and variety for carryout the experiment. We also thankful to Soil and Chemistry laboratory, NAU, Navsari, Gujarat, India for providing facilities to perform laboratory analysis.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

- Salih HO. Effect of foliar fertilization of Fe, B and Zn on nutrient concentration and seed protein of cowpea (*Vigna Unguiculata*). J Agri Vet Sci. 2013; 6(3):42–46.
- Nijjar GS. Nutrition of fruit trees. Edited by MRS. Usha Raj Kumar. kalyani publishers, New Delhi. 1985;173-270.
- Dehnavard SM, Souri K, Mardanlu S. Tomato growth responses to foliar application of ammonium sulfate in hydroponic culture. J Plant Nutr. 2017; 40(3):315–323.
- Hallock DL. Relative effectiveness of several Mn sources on virginia-type peanuts. Agron J. 1979;71(4):685–688.
- Eisa GSA, Ali TB. Impact spraying of some microelements on growth, yield, nitrogenase activity and anatomical features of cowpea plants. World J Agric Sci. 2014;10(2):57–67.
- Garcia AL, Madrid R, Gimeno V. The effects of amino acids fertilization incorporated to the nutrient solution on mineral composition and growth in tomato seedlings. Span J Agric Res. 2011; 9(3):852–861.
- Aslani M, Souri MK. Growth and quality of green bean (*Phaseolus vulgaris* L.) under foliar application of organic-chelate fertilizers. Open Agric. 2018;3(1): 146–154.
- Elwell WT, Gridley JAF. Atomic absorption spectrophotometry. Volume 6 in International Series of Monographs on Analytical Chemistry, 2nd edn. Pergamon press Ltd., London; 1967. Available:<https://doi.org/10.1016/C2013-0-02027-0>
- Maynard AJ. Methods in food analysis. Academic Press, New York. 1970;176.
- Kalariya VD, Bhanderi DR and Patel NK. Effect of foliar application of micronutrients, Novel organic liquid fertilizer and sea weed extract on yield of okra [*Abelmoschus esculentus* (L.) Moench]. Int J Chem Studies. 2018^a; 6(3):1834–1836.
- Anonymous. Effect of pseudostem sap and vermiwash on fruit setting in mango cv. Kesar. In: 2012 8th AGRESO Report, Soil and Water management Research Unit, NAU, Navsari. 2012;108-112.
- Anonymous. Effect of enriched banana pseudostem sap (injection) at pre flowering stage on production and quality of banana var. Grand Naine. 10th AGRESO Report, Soil and Water management Research Unit, NAU, Navsari. 2014;115-128.
- Desai SA, Patel B, Naik PR. Effect of plant growth enhancers on growth and flowering of tuberose cv. Prajwal. Int J Chem Studies. 2018;6(6):1076–1079.
- Manani NP. Integrated nutrient management in cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.], Thesis (M.Sc. Horti.), Navsari Agricultural University, Navsari. 2019;69.
- Singhal V, Patel GG, Patel DH. Effect of foliar application of water soluble fertilizers on growth, yield and economics of vegetable cowpea production. Int Quart J Env Sci Spl. 2015;7:79–83.
- Kalariya VD, Bhanderi DR and Tank RV. Response of foliar application of micronutrients, Novel organic liquid fertilizer and sea weed extract on growth of okra [*Abelmoschus esculentus* (L.) Moench]. Int J Chem Studies. 2018^b; 6(3):1228–1230.
- Patel HB, Shah AK, Barvaliya SA. Response of green gram (*Vigna radiata* L.) to different level of phosphorus and organic liquid fertilizer. Int J Curr Microbiol App Sci. 2017;6(10):3443-3451.
- Deore G, Limaye A, Shinde BM, et al. Effect of Novel organic liquid fertilizer on growth and yield in chilli (*Capsicum annum* L.). Asian J Exp Bio Sci Spl. 2010;15-19.
- Mehta VS, Padhiar BV, and Kumar V. Influence of foliar application of water soluble fertilizers on growth, yield and quality attributes of garlic (*Allium sativum* L.) Var. Gujarat garlic-3 in Southern Gujarat (India). Int J Curr Microbiol App Sci. 2017;6(10):3211–3225.
- Shah SB. Response of sweet potato (*Ipomoea batatas* L.) to fertilizer levels and Novel organic liquid nutrients. Thesis (M.Sc. Horti.), Navsari Agricultural University, Navsari. 2019;87-92.
- Patel SJ, Desai LJ and Keraliy SJ. Cabbage (*Brassica oleracea* var. capitata L.) yield, nutrients uptake and soil available nutrients as influenced by nitrogen and foliar nutrients application

- under south Gujarat condition. Int J Pure App Biosci. 2018; 6(2):1222–1225.
22. El Sayed Hamed EA, Amen El-Sh A, El-Morsy AH. Effects of foliar spraying with microelements and different fertilizer sources on quality and yield of *Pisum sativum*. Int Res J Agri Sci Soil Sci. 2012; 2(1):17–24.
23. Patil TD, Kolambe BN. Effect of rates of castor cake and banana pseudostem sap on the nutrient concentration, uptake and yield of organic garlic (*Allium sativum* L.) (cv. GG 2). Asian J Soil Sci. 2014; 8(2):264–269.
24. Salunkhe JR, Patel AM, Patil RG. Effect of banana pseudostem sap as liquid fertilizer in onion. Indian J Agric Res. 2013; 47(3):258–262.
25. EL-Afifi ST, Zaghloul MM, EL-Saady WA. Effect of different levels of NPK fertilizers with the foliar application of iron, zinc and boron on vegetative growth and yield of cowpea. J Plant Prod. 2016;7(12): 1245–1254.
26. Fouda KF, Abd-Elhamied AS. Integrated effect of foliar fertilization of Fe, Zn and rates of P fertilization on growth and yield of cowpea. J Soil Sci and Agric Eng. 2017; 8(12):733-740.

© 2023 Savaliya et al.; This is an Open Access article distributed under the terms of the Creative Commons Attribution License (<http://creativecommons.org/licenses/by/4.0>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

Peer-review history:

The peer review history for this paper can be accessed here:
<https://www.sdiarticle5.com/review-history/104258>