Original Research Article

Exogenous application of organic and inorganic nutrients and its impact on agronomical traits, yield and quality of vegetable cowpea[*Vigna unguiculata* (L.) Walp]

Abstract

Background: The study was performed on heavy black soil at Regional Horticulture Research Station, Navsari Agricultural University, Navsari, Gujarat (India) with an objective to analyse the effect of foliar application of organic and inorganic nutrients on plant phenological growth, yield and quality of cowpea.

Method: The experiment was laid out under randomized complete block design having nine treatments.

Results: The results showed that amongst phenological parameters, application of 1 % Novel plus organic liquid nutrients (NOVEL) (T_5) 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 increasedleaf area (162.14 cm^2). Substantial effect of foliar application of 1 % Novel plus organic liquid nutrients (NOVEL) (T_5) 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). Although, number of pods per cluster, average pod length and average pod weight were found non-significant. Also, 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. Use of these parameters it can be indicated that Novel Plus organic liquid nutrient can play a major role in upscaling the agronomical traits in plants with sustaining soil fertility by reduction in use of inorganic nutrient applications.

Keywords

Novel organic liquid nutrient (NOVEL), foliar spray,*Vigna unguiculata* (L.) Walp, growth, yield, Fe and Zn content.

1. INTRODUCTION

Cowpea [*Vigna unguiculata* (L.) Walp.] being a 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 leads 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 boost the immunity of the bodySalih (2013).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 Nijjar (1985). However, routine practices of using extravagant chemical fertilizers, their amounts and method of application have led to loss of nutrients in soil and water resulted in the process of eutrophication. 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 applicationDehnavard et al.(2017). 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 (1979) observed that foliar application of nutrient is better than soil application for increasing yield. Legume crops required not only adequate macronutrient but also micronutrients for increasing the bacterial activity of nodules. Eisa and Ali (2014) 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. There are numerous studies indicates the better plant growth and yield with application of

organic source of nutrients as compared to inorganic fertilizers Garcia et. al.(2011); Aslani and Souri(2018). A very few studieson the effect of foliar sprays of inorganic nutrients and organic nutrients (Such as NOVEL) was done on the cowpea to check its feasibility for production and quality during summer in this region. Therefore, the present study on foliar application of inorganic and organic nutrients were evaluated and compare for crop 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, having well drainage as well as good water holding capacity. The experiment was carried out on cowpea var. "Gujarat Dantiwada Vegetable Cowpea 2" (GDVC 2) which was released in 2012 from SDAU, Sardarkrushinagar, Dantiwada (Gujarat). The experimental field was thoroughly prepared by ploughing and harrowing followed by Land levelling with the help of wooden plank. The seeds were planted at a distance of 45 cm between two rows and 30 cm between plants in main field during as per the randomised block. Basal dose of manure and fertilizer as per the recommendation dose (20:40:00 kg ha^{-1}) were incorporated in soil during land preparation. A common irrigation was applied at the time of planting in all treatments by furrow methods and subsequently irrigation was appliedy as and when needed. All other crop cultivation practices were followed as per the requirement. This experiment was sketched under RBD design having three replications and 9 treatments viz., Control (T_1), 2 % *Panchagavya*(An organic solution made from cow dung, cow urine, cow butter, cow curd and cow milk) (T_2), 3 % *Panchagavya* (T_3), 0.5 % Novel plus organic liquid nutrients (T_4), 1 % Novel plus organic liquid nutrients (T_5), 1.5 % Novel plus organic liquid nutrients (T_6), 0.5 % Micronutrient grade IV (T_7), 1 % Micronutrient grade IV (T_8) and 1.5 % Micronutrient grade IV (T_9). The foliar application of these treatments were applied atat 30 days after sowing (DAS) and second spray at 60 DAS.The observations were recorded at the intervals of 60 and 90 DAS viz., plant height (cm) and number of leaves per plant. Whereas other growth parameters such as leaf area and number of primary branches per plant were recorded at the time of final harvest. At the time of each picking no. of clusters per plant, no., of pods per cluster and no. of pods per plant were counted and average value was worked out. Pod length and pod weight were calculated at 3rd and 6th picking and average was worked out. While, pod yield per plot and pod yield per hectare were recorded with total six pickings. Quality parameters such as crude fibre content (%), protein content (%), iron (Fe) content (ppm) and zinc content (ppm) were measured at the time of 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 analyzed of the product is depicted in Table.1 (Champaneri *et al.*, 2021)

Table 1 Nutritional composition of Novel plus organic liquid nutrients

Content	Mean
N	0.071 %
P	0.016 %
K	0.158 %
Na	0.059 %
Ca	0.026 %
Mg	0.147 %
S	0.015 %
Fe	742.0 ppm
Mn	11.53 ppm
Zn	2.30 ppm
Cu	0.26 ppm
Ureas activity	63-81 U/ml/min
Gibberrellic acid	110.2-205.0 mg/l
Cytokinin	137.8-244.3 mg/l

2.2.Weather and climate of experimental site:

Distribution of temperatures and relative humidity in analysed years of researches was amassed described as such during the experimental period from March 2019 to June 2019. During the growing season maximum temperature (39.4°C) and minimum temperature (28.2°C) was recorded as it is the hot summer season in the region. Relative humidity ~~was~~seems to be mild (73.10%) with a maximum sunshine hour of (10.8 h) during peak crop growth stage.

2.3.Statistical analysis:

The data pertaining to different parameters were analysed using Indo-Stat statistical software. The ANOVA test was performed and the significance of difference between mean values was determined using Turkey's (CD=0.05) test.

2.4.Estimation of Fe and Zn content:

Fe and Zn content of the pods were estimated at the final harvest by following the diacid mixture method of Elwell and Gridley, 1967. The dried, digested and filtrate samples were analysed using atomic absorption spectrophotometry.

2.5.Estimation of protein content:

At the final harvest the nitrogen content of pods were analysed using Kjedahl method**.** Further protein content (%) in pod was calculated using multiplication factor 6.25 Anonymous(1960).

2.6.Estimation of crude fibre content:

Crude fibre content (%)from the pods were estimated at the final harvest by taking pods of five tagged plants from each treatment. Two grams of sample was extracted with ether or petroleum ether to remove fat and boil 2 g of dried sample with 200 ml of H_2SO_4 for 30 minutes and then filtered through muslin cloth and washed with boiling water until washing are 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 H_2SO_4, there 50 ml portion of water and 25 ml alcohol. The residue was removed and transferred to pre-weighted petri plate (W_1, g). Then the residue was dried for 2 hours at 130 ± 2°C, cool in a desiccator and weighed (W_2, g). Ignited for 30 minutes at 600 ± 15°C, and cooled in a desiccator and reweighed (W_3, g) Maynard(1970).

$$\text{Crude Fibre (\%)} = \frac{\text{Loss in weight on ignition } (W2-W1)x(W3-W1)}{\text{Weight of original sample (g)}} \text{ x } 100$$

3 RESULTS AND DISCUSSION

3.1.Effect of foliar application of organic and inorganic nutrients on growth parameter of vegetable cowpea:

Foliar application of nutrients have significantly influenced the plant growth characters (Table 2). The result revealed that foliar application of 1 % Novel plus organic liquid nutrients (T_5) 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 excelled in leaf area noted (162.14 cm^2) 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. Another reason for proliferation in growth characters 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 enhances 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 $H_2PO_4^-$, K *etc.* These findings are in concurrence with the results reported by Kalariya et al. (2018[a]) in okra, Anonymous (2012 and 2014) in banana, and Desai Supal et al.(2018).

Comment [BI(RA1]: Meaning?

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

Treatments	Plant height (cm)		Number of leaves per plant		Leaf area (cm^2)	No. of primary branches per plant
	60 DAS	90 DAS	60 DAS	90 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)*

Formatted: French (France)

Formatted: French (France)

Formatted: French (France)

3.2. Effect of foliar application of organic and inorganic nutrients on yield parameters of vegetable cowpea:

The Data depicted in Table 3 showed that 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 (T_5). The number of pods per cluster (4.81), average pod length (15.52 cm) and average pod weight (2.48) were also recorded higher with a 1% foliar spray of Novel plus organic liquid nutrient, although the results were non-significant. The number of clusters per plant is closely associated with growth components like plant height, leaf area and number of leaves per plant. The result of present investigation is also corroborated with the findings of Manani (2019) 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 Singhal et al.(2015). The similar findings were observed by Kalariya et al. (2018[b]) in okra, Patel et al. (2017) in green gram and Deoreet al. (2010) 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 Singhal et al. (2015); Mehta et. al. (2017).The results are in accordance with the finding of Shah (2019) in sweet potato, Patel et al. (2018) in cabbage, Patil and Kolambe (2014) in garlic, Salunkhe et al. (2013) in onion and Deore et al. (2010) in chilli.

Table 3:Effect of foliar application of organic and inorganic nutrients on yield parameters of cowpea:

Treatments	Number of clusters per	Number of pods	Number of pods per plant	Average pod length (cm)	Average pod weight (g)	Total pod yield(kg $plot^{-1}$)

		plant	per cluster				
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
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

Formatted: French (France)

Formatted: French (France)

Formatted: French (France)

3.3. Effect of foliar application of organic and inorganic nutrients on quality parameter of vegetable cowpea:

Foliar application of organic and inorganic nutrients exhibited profound results for protein content of pod (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 (T_5). 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. (2015). In addition, boosts in Fe and Zn content might be possible with the increased capacity of plant to utilize ample amount of nutrient supplied through Novel plus organic liquid nutrients and another reason could be a better translocation of available micronutrients already available in Novel plus organic liquid nutrientsAnonymous(2012). El-affifi et al. (2016); Fouda et al. (2017) have estimated the same effect in cowpea by foliar fertilization.

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

Treatments		Crude fiber content (%)	Protein content (%)	Iron content (ppm)	Zinc content (ppm)
T_1 :	Control (No spray)	12.33	20.69	182.39	52.57
T_2 :	*Panchagavya* (2 %)	12.39	21.91	191.90	55.22
T_3 :	*Panchagavya* (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

Formatted: French (France)

Formatted: French (France)

Formatted: French (France)

C.D. at 5 %	NS	1.64	20.77	4.64
C.V. %	2.50	4.17	5.80	4.60

4. CONCLUSIONS

Based on the study findings, conducted during the summer season, it can be concluded that foliar application of nutrients have significant effect of crop production traits. Thus, securing higher growth, yield and quality traits of cowpea cv. GDVC-2, crop can be foliar sprayed with 1% Novel plus organic liquid nutrient (NOVEL) developed and patented by Navsari Agricultural University, Navsari (Gujarat), India at 30 and 60 days after sowing along with recommended dose of fertilizers.

REFERENCES:

AOAC (1960) Official methods of analysis. Association of official agricultural Chemistry, 10th edn. Washington, D. C.

Anonymous (2012) Effect of pseudostem sap and vermiwash on fruit setting in mango cv. Kesar. In: 2012 8th AGRESCO Report, Soil and Water management Research Unit, NAU, Navsari. pp 108-112.

Anonymous (2014) Effect of enriched banana pseudostem sap (injection) at pre flowering stage on production and quality of banana var. Grand Naine. 10th AGRESCO Report (pp. 115-128), Soil and Water management Research Unit, NAU, Navsari.

Aslani M, Souri MK (2018) Growth and quality of green bean (*Phaseolus vulgaris* L.) under foliar application of organic-chelate fertilizers. Open Agric 3(1):146–154.

Champaneri DD, Patel NK, Desai CS, Desai DH. Efficacy of Novel organic liquid nutrient and Novel Plus organic liquid nutrient on quantitative traits of Indian bean [*Lablab purpureus* (L.) Sweet]. International Journal of Plant & Soil Science. 2021;33(17):105-115.

Dehnavard SM, Souri K, Mardanlu S (2017) Tomato growth responses to foliar application of ammonium sulfate in hydroponic culture. J Plant Nutr 40(3):315–323.

Deore G, Limaye A, Shinde BM et al (2010) Effect of Novel organic liquid fertilizer on growth and yield in chilli (*Capsicum annuum* L.). Asian J Exp Bio Sci Spl 15-19.

Desai SA, Patel B, Naik PR (2018) Effect of plant growth enhancers on growth and flowering of tuberose cv. Prajwal. Int J Chem Studies6(6):1076–1079.

Eisa GSA, Ali TB (2014) Impact Spraying of Some Microelements on Growth, Yield, Nitrogenase Activity and Anatomical Features of Cowpea Plants .World J Agric Sci 10(2):57–67.

ElSayed Hameda EA, Amen El-Sh A, El-Morsy AH et al (2012). Effects of foliar spraying with microelements and different fertilizer sources on quality and yield of *Pisum sativum*. Int Res J Agri Sci Soil Sci2(1):17–24.

Elwell WT, Gridley JAF (1967) Atomic absorption spectrophotometry.Volume 6 in International Series of Monographs on Analytical Chemistry, 2nd edn. Pergamon press Ltd., London, https://doi.org/10.1016/C2013-0-02027-0

EL-Afifi ST, Zaghloul MM, EL-Saady WA et al (2016) 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 Prod7(12):1245–1254.

Fouda KF, Abd-Elhamied, AS (2017) 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 8(12):733-740.

Garcia AL, Madrid R, Gimeno V (2011) The effects of amino acids fertilization incorporated to the nutrient solution on mineral composition and growth in tomato seedlings. Span J Agric Res 9(3):852–861.

Hallock DL (1979) Relative effectiveness of several Mn sources on virginia-type peanuts. Agron J71(4):685–688.

Formatted: Spanish (Spain, International

Kalariya VD, Bhanderi DR, Patel NK et al (2018[a]) 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 Studies6(3):1834–1836.

Kalariya VD, Bhanderi DR, Tank RV et al (2018[b]) 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 Studies6(3):1228–1230.

Manani, N. P. (2019) Integrated nutrient management in cluster bean [*Cyamopsis tetragonoloba* (L.) Taub.], Thesis (M.Sc. Horti.), Navsari Agricultural University, Navsari. pp 69.

Maynard AJ (1970) "*Methods in Food Analysis".* Academic Press, New York, pp 176.

Mehta VS, Padhiar BV, Kumar V (2017) 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 Sci6(10):3211–3225.

Nijjar GS (1985) Nutrition of Fruit Trees. Edited by MRS. Usha Raj Kumar. kalyani publishers, New Delhi. pp. 173- 270.

Patel HB, Shah AK, Barvaliya SA et al (2017) Response of green gram (*Vigna radiata* L.) to different level of phosphorus and organic liquid fertilizer. Int J Curr Microbiol App Sci 6(10):3443-3451.

Patel SJ, Desai LJ, Keraliy SJ et al (2018) 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 6(2):1222–1225.

Patil TD, Kolambe BN (2014) 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 Sci8(2):264–269.

Salih HO (2013) Effect of foliar fertilization of Fe, B and Zn on nutrient concentration and seed protein of cowpea (*Vigna Unguiculata*). J Agri Vet Sci 6(3):42–46.

Salunkhe JR, Patel AM, Patil RG et al (2013) Effect of banana pseudostem sap as liquid fertilizer in onion. Indian J Agric Res 47(3):258–262.

Shah SB (2019) Response of sweet potato (*Ipomoea batatas* L.) to fertilizer levels and Novel organic liquid nutrients. Thesis (M.Sc. Horti.), Navsari Agricultural University, Navsari. pp 87-92.

Singhal V, Patel GG, Patel DH et al (2015) Effect of foliar application of water soluble fertilizers on growth, yield and economics of vegetable cowpea production. Int Quart J Env Sci Spl7:79–83.