International Journal of Statistics and Applied Mathematics

ISSN: 2456-1452
Maths 2024; SP-9(1): 38-42

https://www.mathsjournal.com
Received: 14-10-2023
Accepted: 13-11-2023

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Integrated approach to enhanching cowpea yield, quality and nutrient composition using foliar supplements

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DOI: https://dx.doi.org/10.22271/maths.2024.v9.i1Sa.1543

Abstract
An agronomic study on cowpea yield, quality and nutrient composition impacted by foliar supplements was carried out in a field experiment at the College Farm, NM College of Agriculture, Navsari Agricultural University, Navsari, during the 2021 *kharif* season. The experimental plot's soil had a clayey texture and an alkaline reaction. Eight treatment were tested in this experiment using a Randomized Block Design with three replications. The results revealed that the T_3 - foliar spray of 2% urea at 35 and 50 DAS significantly influenced all the cowpea yield and yield parameters, including pod length, number of pods/plant, number of seeds/pod, and seed and haulm yield. It was statistically at par with T_4 (foliar spray of Pulse Wonder fertilizer at 5 kg/ha) and T_2 (foliar spray of 1% Novel). Protein content was significantly influenced by foliar spray of 2% of Urea at 35 and 50 DAS and it was found statistically at par with T_4 and T_2. Significant increased N content in seed and haulm were shown under foliar spray of 2% Urea. While Fe and Zn content found significantly highest under T_5 (Foliar spray of chealated micronutrient Fe and Zn at 0.5% at 35 and 50 DAS). T_3 recorded the highest net return of 46659 ₹/ha and greatest B: C ratio (2.97), which was followed by treatments T_4 (2.71) and T_2 (2.64). Based on the results of a year-long experiment, it can be concluded that full doses of RDF (20:40:00 NPK kg/ha) should be used to grow *kharif* cowpea, along with foliar sprays of 2% urea or 5% Pulse Wonder fertilizer or 1% Novel (Nauroji organic product) at 35 and 50 DAS to increase yield and financial returns.

Keywords: Foliar spray of urea, panchagavya, pulse wonder fertilizer, novel (Nauroji organic product)

Introduction
Among various pulse crops cowpea is an important food legume and grown over an area of 0.5 million ha. It is adopted to wide range of soils, rainfall situations and fits as crop in multiple and intercropping systems. Cowpea also has ability to withstand drought, which make it suitable for drought-prone areas with low rainfall. An age old practice of mixed cropping of cowpea for vegetable purpose with widely spaced crop such as cotton, pigeon pea, maize, sorghum, pearl millet, sunflower, castor and plantation crops or its cultivation in cropping systems.

All pulse crops require healthy root systems to maximize growth and yield. Healthy nodulation of pulse roots is important to maximize the nitrogen fixation. In pulses such as chickpea and cowpea up to flowering stage the number of nodules per plant increases but in post-flowering stage there is sudden decline in number of nodules due to disintegration. Foliar application of water-soluble fertilizers may be a very good option under this situation to enhance the yield of pulse crops under reduced cost of cultivation. Positive effect of supplying legume plants with supplementary nitrogen or a balanced dose of nutrients particularly at pre-flowering stage was found to have beneficial effect on increasing seed yield.

Foliar application is regarded as a preferred solution when quick supply of nutrients is hindered or the soil conditions are not conducive for the absorption of nutrients. Foliar spray technique helps the nutrients to reach the site of food synthesis directly, leading no wastage and quick supply of food and thereby reduce the requirement of fertilizers. Foliar nutrition can hasten the growth of a crop suddenly.

It is also known that active nodulation of pulse crop stops after 45 to 50 DAS and at that time, the positive effect of supplying legume plants with supplementary nitrogen was found to have beneficial effects on enhancing growth and increasing seed yield by quick supply of nitrogen. Palta *et al.* (2005) [12] and Zeidan (2003) [21] concluded that foliar application of urea at 50% flowering increased the yield and seed protein. In legumes, leaf senescence starts earlier before completion of maturity which break the source to sink relation, thereby reduces the yield. Nitrogen spray have been found to delay leaf senescence and improve yield. Application of nutrients via foliage, in addition to recommended dose of fertilizers (RDF) and plant growth regulators (PGRs) at critical growth stages is a unique and easy way to increase the pulse productivity by curbing the barriers encountered during flowering and pod setting. PGRs like NAA, IBA, salicylic acid, brassinosteriods etc. are effective for foliar application. Providing nutrients as wells as PGRs are known to enhance the yield by 15-25% compared to soil nutrition alone (Pooja and Ameena, 2021) [13].

Materials and Methods

The present study entitled "Integrated approach to enhanching cowpea yield, quality and nutrient composition using foliar supplements" was conducted at the College Farm, N. M. College of Agriculture, Navsari Agricultural University, Navsari in *kharif* season 2021. The experiment was laid out in a Randomized Block Design (RBD) with eight treatments in three replications. The details of treatments are T_1:Foliar spray of Panchagavya (3%), T_2: Foliar spray of Novel (Nauroji organic product) (1%), T_3: Foliar spray of Urea (2%), T_4:Foliar spray of Pulse Wonder fertilizer (5 Kg/ha), T_5: Foliar spray of chelated micronutrients (Fe, Zn) (0.5%), T_6: Foliar spray of NAA (40 ppm), T_7:Foliar spray of Salicylic Acid (1%), T_8:Control. The details of experiment are given below.

Table 1: Treatment details

Treatments	
T_1	Foliar spray of Panchagavya (3%)
T_2	Foliar spray of Novel (Nauroji organic product) (1%)
T_3	Foliar spray of Urea (2%)
T_4	Foliar spray of Pulse Wonder fertilizer (5 Kg/ha)
T_5	Foliar spray of chelated micronutrients (Fe, Zn) (0.5%)
T_6	Foliar spray of NAA (40 ppm)
T_7	Foliar spray of Salicylic Acid (1%)
T_8	Control

Note: RDF (20:40:00 NPK kg/ha) is common in each of the treatments.

Results and Discussion

1. Impact of PGRs, organic and inorganic foliar sources of foliar nutrients on yield parameters

A. Length of Pod (cm): The mean pod length as influenced by different treatments of foliar application is furnished in Table 2. The application of treatment T_3 (foliar spray of 2% urea) significantly increased the length of pod of cowpea (15.95 cm) which was remains at par with the T_4 (15.67 cm), T_2 (15.51 cm), and T_1 (13.96 cm) treatments. While, lower length of pod (12.30 cm) at harvest time was recorded with the application of T_8 treatment.

B. Number of Pods/plants: Data presented in Table 2. Showed significant effect of different foliar treatments on number of pods/plant recorded at 60 DAS and at harvest. Significantly higher number of pods/plant (27.53) were noted under treatment T_3 but it was remained at par with the treatments T_4 (26.02) and T_2 (24.93). The application of T_3 increased the number of pods/plant of cowpea 40.17% over control. The lowest number of pods/plant (19.64) was recorded under treatment T_8 at harvest time.

Optimum availability of all nutrients at crop growth might have caused efficient translocation of photosynthates from source to sink. Decreased the flower drop due to prolonged assimilatory activity of leaves might be another possible reason for higher number of pods/plant. The foliar application at the different stage might have been effectively absorbed and trans located to the pods resulting in more number of pods/plant. The results are in closely related with Das and Jana (2015) [5] in different crops like greengram, chickpea and blackgram, Choudhary and Yadav (2011) [3] and Singhal *et al.* (2015) [18] in cowpea.

C. Number of Seeds/pod: Mean data presented in Table 2. Indicated that different foliar treatments significantly influenced number of seeds/pod in cowpea. The application of treatment T_3 (foliar spray of 2% urea) significantly increased the number of seeds/pod of cowpea (13.95) which was remains at par with the T_4 (13.42) and T_2 (13.32) treatments. The application of T_3 increased the number of seeds/pod of cowpea 47.77% over control.

Increased all the yield attributing characters as effect of foliar spray of 2% urea, 1% Novel and Pulse Wonder fertilizer might be due to the application of nutrients at flowering and reproductive stage which helped in more translocation of photosynthates to the developing pods and also helped in better filling of pods. Pronounced growth of plant tissue, formation of amino acid, synthesis of proteins and vitamins and their favourable effects causes by different foliar treatments might have led to increase all above yield parameters. Similar finding were also reported by Reddy *et al.* (2005) [15], Balaji *et al.* (2019) [1] and Reddy *et al.* (2020) [14] in black gram.

Table 2: Impact of different treatments on yield parameters

Treatments		Length of pod (cm)	Number of pods/plant	Number of seeds/pod
T_1	Foliar spray of Panchagavya (3%)	13.96	23.42	11.50
T_2	Foliar spray of Novel (Nauroji organic product) (1%)	15.51	24.93	13.32
T_3	Foliar spray of Urea (2%)	15.95	27.53	13.95
T_4	Foliar spray of Pulse Wonder fertilizer (5 Kg/ha)	15.67	26.02	13.42
T_5	Foliar spray of chelated micronutrients (Fe, Zn) (0.5%)	13.50	23.35	11.48
T_6	Foliar spray of NAA (40 ppm)	13.33	22.56	11.27
T_7	Foliar spray of Salicylic Acid (1%)	13.16	22.24	11.39
T_8	Control	12.30	19.64	9.44
S.E.M ±		0.79	1.42	0.82
CD at 5%		2.25	4.05	2.33
CV(%)		9.66	10.38	11.84

2. Impact of PGRs, organic and inorganic source of foliar nutrients on nutrient composition of cowpea

N, P, K, Fe and Zn content in cowpea

A. Nitrogen content (%): A perusal of data in Table 3. Indicated that significantly the highest nitrogen content in seed was recorded with treatment T_3 (3.60%) but remained at par with treatment T_2, T_4, T_1, T_5 and T_6. The lower nitrogen content in seed was registered under control (T_8) (3.12%).

While in case of haulm, significantly higher nitrogen content in haulm was recorded with treatment T_3 (1.16%) but remained at par with T_2 and T_4. The lower nitrogen content in haulm registered under control T_8 (1.01%).

Improvement in N content of seed and haulm might be due to higher uptake of nutrient by plant under different foliar spray of Urea, Novel, Pulse wonder and Panchagavya. Similar findings were also reported by Beulah and Ghosh (2020) [2] in black gram and by Sakpal (2019) [17] in cowpea.

B. Phosphorus content (%): Data presented in Table 3. Indicated that P content in seed as well as haulm was found non-significant.

C. Potassium content (%): Data presented in Table 3. Indicated that K content in seed and haulm were non-significant under different treatments.

D. Iron content (mg/kg): Data presented in Table 3. Indicated that Fe content in seed (71.47 mg/kg) and haulm (144.73 mg/kg) were found significantly the highest under T_5 (Foliar spray of chelated micronutrients (Fe, Zn) at 0.5%. While lower Fe content was found under T_8 (control). Similar result was found by Salih (2013) [16].

Higher concentration of Fe in the leaves as compared to grain might be due to the presence of non-heme proteins and presence of Fe storage proteins such as phytoferritin, which have high binding capacity for Fe. Low phloem mobility of Fe could be another reason for relatively higher share of Fe in the shoots as compared to grain at maturity, (Pal *et al.*, 2019).

E. Zinc content (mg/kg): Data presented in Table 3. Indicated that Zn content in seed (37.77 mg/kg) and haulm (30.27 mg/kg) were found significantly highest under T_5 (Foliar spray of chelated micronutrients (Fe, Zn) at 0.5%. While lower Zn content found under T_8 (control).

Iron has many essential roles in plant growth and development, including chlorophyll synthesis, thylakoid synthesis and chloroplast development. Zinc is an essential element for plants that act as a metal component of various enzymes or as a functional, structural or regulatory cofactor and for protein synthesis, photosynthesis, the synthesis of auxin, cell division, and sexual fertilization. Iron and Zinc foliar fertilization at flowering and pod set stage significantly increased the Fe and Zn concentrations in shoots and seeds (Ekhtiari and Kobraee, 2018) [7].

Table 3: Effects of different treatments on nutrient composition of cowpea

Treatments		Nutrient content									
		N (%)		P (%)		K (%)		Fe (mg/kg)		Zn (mg/kg)	
		Seed	Haulm	Seed	Haulm	Seed	Haulm	Seed	haulm	Seed	Haulm
T_1	Foliar spray of Panchagavya (3%)	3.45	1.03	0.40	0.22	1.22	1.55	64.23	125.97	33.67	26.47
T_2	Foliar spray of Novel (Nauroji organic product) (1%)	3.52	1.10	0.42	0.23	1.25	1.59	63.57	125.13	31.83	24.63
T_3	Foliar spray of Urea (2%)	3.60	1.16	0.44	0.25	1.24	1.60	64.40	125.93	32.17	25.47
T_4	Foliar spray of Pulse wonder fertilizer (5 Kg/ha)	3.47	1.09	0.42	0.24	1.24	1.60	65.88	132.73	33.27	26.10
T_5	Foliar spray of chelated micronutrients (Fe, Zn) (0.5%)	3.40	1.05	0.43	0.22	1.22	1.57	71.47	144.73	37.77	30.27
T_6	Foliar spray of NAA (40 ppm)	3.39	1.06	0.41	0.23	1.19	1.53	63.20	121.93	32.03	24.53
T_7	Foliar spray of Salicylic Acid (1%)	3.26	1.06	0.42	0.23	1.16	1.54	62.57	121.47	29.80	21.87
T_8	Control	3.12	1.01	0.41	0.22	1.14	1.50	60.30	121.07	29.20	21.70
S.E.M ±		0.08	0.03	0.02	0.01	0.05	0.06	1.89	4.05	1.40	1.01
CD at 5%		0.23	0.07	NS	NS	NS	NS	5.37	11.52	3.99	2.87
CV (%)		4.15	4.20	6.22	6.09	7.09	6.24	5.07	5.50	7.49	6.94

3. Impact of PGRs, organic and inorganic source of foliar nutrients on quality of cowpea

A. Crude Protein Content (%): The magnitude of the protein content of cowpea seed tabulated in Table 4. indicated that different foliar treatments improve protein content significantly. However, treatment T_3 (foliar spray of 2% Urea) contributed to higher protein content (22.50%). It was statistically at par with treatment T_2, T_4, T_1, T_5 and T_6. The application of T_3 increased the protein content of cowpea 15.38% over control. Whereas, the lowest protein content (19.50%) was registered under control (T_8).

Improvement in crude protein content and crude protein yield might be attributed to higher uptake of nutrient during growth period which increased photosynthesis, synthesis of protoplasm and protein for higher rate of mitosis. The higher crude protein content was found with application of 2% of urea which might be due to foliar treatments of nitrogen could improve the photosynthetic activity and enzymes carbohydrate transformation, (Singhal *et al.* 2016) [19]. Similar finding was also reported by Venktesh and Basu (2011) [20] in chickpea and Beulah and Ghosh (2020) [2] in black gram.

B. Crude Protein Yield (kg/ha): Significantly highest crude protein yield of cowpea (232.50 kg/ha) was recorded under treatment of T_3 which remained at par with T_4 (213.71 kg/ha) and T_2 (210.78 kg/ha). The lowest crude protein yield (149.65 kg/ha) was recorded under T_8.

Table 4: Effects of different treatments on quality of cowpea

Treatments		Crude protein content (%)	Crude protein yield (kg/ha)
T_1	Foliar spray of Panchagavya (3%)	21.58	183.48
T_2	Foliar spray of Novel (Nauroji organic product) (1%)	21.98	210.78
T_3	Foliar spray of Urea (2%)	22.50	232.50
T_4	Foliar spray of Pulse wonder fertilizer (5 Kg/ha)	21.71	213.71
T_5	Foliar spray of chelated micronutrients (Fe, Zn) (0.5%)	21.23	185.82
T_6	Foliar spray of NAA (40 ppm)	21.20	177.45
T_7	Foliar spray of Salicylic Acid (1%)	20.36	160.88
T_8	Control	19.50	149.65
S.E.M ±		0.51	11.50
CD at 5%		1.45	32.74
CV(%)		4.15	10.53

4. Impact of PGRs, organic and inorganic source of foliar nutrients on yield and economic parameters

The seed yield and haulm yield of cowpea significantly affected by different foliar treatments on cowpea are presented in Table 5.

Significantly higher seed yield (1149 kg/ha) was recorded with treatment T_3 (foliar spray of 2% urea) but, it was statistically at par with the treatment T_4 (1092.33 kg/ha) and T_2 (1062.67 kg/ha). Treatment T_8 (control) was found inferior with respect to seed yield (853.33 kg/ha). The increased in seed yield was to the tune of 34.64% by T_3 treatment over control.

An appraisal of data (Table 5.) showed that haulm yield of cowpea was significantly higher (2588 kg/ha) was recorded with treatment T_3 (foliar spray of 2% urea) but, it was statistically at par with treatment T_4 (2462.67 kg/ha) and T_2 (2303.67 kg/ha). Treatment T_8 (control) was found lowest with respect to haulm yield (1916.33 kg/ha). There is 35.04% haulm yield increase by T_3 treatment over control.

The increase in seed and haulm yields due to application of foliar spray of urea, pulse wonder and novel might be due to concomitant increase in number of pods/plant, number of seeds/pod, test weight of seed and plant growth characters *viz*., as plant height, number of branches/plant, and number of nodules/plant. The increase in these attributes increased the seed and haulm yields.

Increasing the total seed yield may due to the increased nutrient supply and reduced nutrient losses. Spraying of either 2% urea, Pulse wonder fertilizer and Novel helped in quick absorption of nitrogen, phosphorous and micronutrients, at the time of where the nutrients demand is at the peak due to foliar spray at 35 DAS and 50 DAS of the crop. Hence, it reduced the flower drop and ultimately enhanced the pod setting and resulted in higher seed yield. The results are corroborating with the findings of Choudhary and Yadav (2011) [3] in cowpea who revealed that foliar spray of 2% urea at branching and flowering stages recorded significantly higher growth and yield parameters and yield over other treatments. Kumar *et al.* (2008) [10], Karthikeyan *et al.* (2017) [8] and Balaji *et al.* (2019) [1] observed similar result in blackgram and Singhal *et al.* (2015) [18] observed similarly result in cowpea crop.

The haulm yield enhancement due to the different treatments might be due to continuous supply of nutrients which in turn increased the leaf area and dry matter production resulting in higher haulm yield. This was also attributed due to the higher nutrient uptake throughout the crop growth period. The higher haulm yield may be due to the beneficial effect of nitrogen on morpho-physiological characters, which influenced growth attributes such as plant height and number of branches/plant. Das and Jana (2015) [5] in pulses and Kavitha *et al.* (2019) [9] in cowpea also found that significantly higher yield attribute like pod length, pods/plant and seeds/pod. The results are in line with findings of Choudhary and Yadav (2011) [3], Singhal *et al.* (2015) [18] and Dey *et al.* (2017) [6] in cowpea.

Net Return

Scrutiny of data revealed that maximum net return of ₹46659/ha was realized with T_3 (Foliar spay of 2% Urea) followed by the treatment T_4 (₹42215/ha) and T_2 (₹40162/ha). The lowest net returns of ₹28583/ha was achieved under T_8 (control).

BCR

An appraisal of data showed that maximum BCR of 2.97 was obtained with the T_3 (Foliar spay of 2% Urea), followed by the treatment T_4 (2.71) and T_2 (2.64). The lowest BCR of 2.14 was accrued under T_5.

Table 5: Impact of different treatments on yield and economic parameters

Treatments		Seed yield (kg/ha)	Haulm yield (kg/ha)	Net income (₹/ha)	BCR
T_1	Foliar spray of Panchagavya (3%)	947.00	2158.67	32828	2.30
T_2	Foliar spray of Novel (Nauroji organic product) (1%)	1062.67	2303.67	40162	2.64
T_3	Foliar spray of Urea (2%)	1149.00	2588.00	46659	2.97
T_4	Foliar spray of Pulse wonder fertilizer (5 Kg/ha)	1092.33	2462.67	42215	2.71
T_5	Foliar spray of chelated micronutrients (Fe, Zn) (0.5%)	976.67	2110.67	31597	2.14
T_6	Foliar spray of NAA (40 ppm)	930.33	2052.00	32892	2.38
T_7	Foliar spray of Salicylic Acid (1%)	878.00	1959.67	29153	2.19
T_8	Control	853.33	1916.33	28583	2.21
S.E.M ±		58.95	122.13		
CD at 5%		167.78	347.61		
CV(%)		10.35	9.64		

Conclusion

From the results of one-year experimentation, it can be concluded that *kharif* cowpea crop should be fertilized with application of RDF (20:40:00 NPK kg/ha) along with foliar spray of 2% Urea or 5 kg/ha Pulse Wonder fertilizer or Novel

1% (Nauroji Organic product) at 35 and 50 DAS to obtain higher yield and monetary returns.

Author's contribution

Sachin Dodiya formulated the theory and conducted the calculations. Sachin Dodiya validated the analytical techniques. Under the guidance of Dr. Rahul Pisal. The results were collectively deliberated by all authors, and each played a role in shaping the final manuscript.

References

1. Balaji P, Kumar SR, Srinivasan G, Kancheti M. Effect of foliar nutrition on yield maximization strategies for irrigated blackgram cv. ADT 3. J Pharmacogn Phytochem. 2019;8(3):2884-2886.
2. Beulah ED, Ghosh G. Effect of foliar nutrition and plant growth regulators on growth of blackgram (*Vigna mungo* L.). J Pharmacogn Phytochem. 2020;9(3):1754-1756.
3. Choudhary GL, Yadav LR. Effect of fertility levels and foliar nutrition on cowpea productivity. J Food Legumes. 2011;24(1):67-68.
4. Darade GA, Gosavi SV, Elumle P. Effect of foliar nutrition on growth and yield of blackgram (*Vigna mungo* (L). Hepper). J Pharmacogn Phytochem. 2019;8(4):2494-2496.
5. Das SK, Jana K. Effect of foliar spray of water-soluble fertilizer at pre-flowering stage on yield of pulses. Agric Sci Digest. 2015;35(4):275-279.
6. Dey S, Prasad S, Tiwari P, Sharma P. Effect of urea, KCl, zinc placement and spray on growth of cowpea. J Pharmacogn Phytochem. 2017;1:971-973.
7. Ekhtiari S, Kobraee S. Response of yield and yield components of chickpea to Fe foliar fertilization. Int J Modern Agri. 2018;7(4):58-66.
8. Karthikeyan A, Vanathi J, Babu S, Ravikumar C. Studies on the effect of foliar application of organic and inorganic nutrients on the phenotypic enhancement of blackgram CV. VAMBAN-6 A. Plant Archieves. 2017;20:1161-1164.
9. Kavitha MP, Balakumbahan R, Prabukumar G. Effect of foliar spray and fertilizer levels on growth and yield of vegetable cowpea [*Vigna unguiculata* (L.) Walp.]. Indian J Agric Res. 2019;53(6):745-748.
10. Kumar GS, Muthukrishnan P, Ramasamy S, Chandaragiri KK. Effect of organic and inorganic foliar spray on growth and yield of blackgram (*Vigna mungo* L.). Madras Agril J. 2008;95(1-6):57-60.
11. Pal V, Singh G, Dhaliwal SS. Yield enhancement and biofortification of chickpea (*Cicer arietinum* L.) grain with iron and zinc through foliar application of ferrous sulfate and urea. J Plant Nutrition. 2019;15(42):1789–1802.
12. Palta JA, Nandwal AS, Kumari S, Turner NC. Foliar nitrogen applications increase the seed yield and protein content in chickpea (*Cicer arietinum* L.) subject to terminal drought. Australian J Agric Res. 2005;56(2):105-112.
13. Pooja AP, Ameena M. Nutrient and PGR-based foliar feeding for yield maximization in pulses: A review. Agric Reviews. 2021;42(1):1-10.
14. Reddy AS, Rao PV, Ramana MV. Effect of foliar nutrition on growth and yield attributes of blackgram (*Vigna mungo* (L.) Hepper). Chem Sci Rev Lett. 2020;9(33):73-76.
15. Reddy MM, Padmaja B, Rao LJ, Radhakrishna KV. Effect of foliar spray of urea on N uptake and yield of urdbean (*Vigna mungo* L.). Indian J Dryland Agril Dev. 2005;20(2):151-154.
16. Salih HO. Effect of foliar fertilization of Fe, B and Zn on nutrient concentration and seed protein of Cowpea (*Vigna unguiculata* L.). J Agric Vet Sci. 2013;6(3):42-46.
17. Sakpal VM, Jagtap DN, Upadhyay L, Pinjari SS, Dhekale SS, More SS, Jadhav MS, Rajemahadik VA, Bodake PS. Response of cowpea (*Vigna unguiculata* L.) to foliar application of different organic sources and levels of fertilizer. Chem Sci Rev Lett; c2019.
18. Singhal V, Patel GG, Kumar U, Saini LK. Effect of foliar application of water-soluble fertilizers on growth, yield, and economics of vegetable cowpea production. Int Quarterly J Env Sci. 2015;7:79-83.
19. Singhal V, Patel GG, Kumar U, Kumar T, Painkra B. Effect of the efficacy of foliar application of water-soluble fertilizers in vegetable cowpea. Res Env Life Sci. 2016;9(12):1478-1481.
20. Venkatesh MS, Basu PS. Effect of foliar application of urea on growth, yield and quality of chickpea under rainfed conditions. J Food Legumes. 2011;24(2):110-112.
21. Zeidan MS. Effect of sowing dates and urea foliar application on growth and seed yield of determinate faba bean (*Vicia faba* L.) under Egyptian conditions. Egypt J Agron. 2003;24:93-102.