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Effect of Different Levels of Organic, Mineral Fertilization and Foliar Application with Some Nutrition Elements on Dry Seed Yield of Cowpea Plants

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ABSTRACT

The effective nutrients management is requiring for increase the productivity and development of cowpea crop as suitable agronomic practice. A field experiment was conducted during the two summer seasons of 2018 and 2019 at Sakha Agricultural Research Station Farm, Kafr El-Sheikh Governorate, Egypt on cowpea (*Vigna unguiculata* L.) cv. Kafr El-Sheikh to study the impact of organic and inorganic fertilizers and foliar spray with K, Ca and B and their interactions on vegetative parameters, seed yield and leaf chemical composition as well as protein content and seeds germination percentage. Results indicated that, the highest values of vegetative growth parameters i.e., plant height (cm), No. of branches/plant, plant fresh and dry weights and chemical composition of leaves (N, P, K, Ca and B), as well as the percentage of protein and germination seeds were recorded by fertilized plants with 50% mineral + 50% organic (compost). Cowpea plants were sprayed with 1cm/l potassium sulfate showed better growth performance, higher values of chemical constituents especially N, P and K in leaves than unsprayed plants. Also, the best results on most growth parameters, leaves chemical constituents were resulted when plants were fertilized by 50% mineral as ammonium nitrate (50 kg/fed.) + 50% organic as compost (1.2 or1.3ton/fed.) and sprayed with potassium sulfate at 1cm/l. Therefore, this treatment could be recommended for improving cowpea plants performance under similar condition of this study.

***Keywords*:** Cowpea, compost, foliar application, K, Ca, B, growth and yield

Introduction

Cowpea (*Vigna unguiculata* L.) is one of the most important crops of the family Fabaceae and a major grain legume grown in semi-arid regions. It is a major source of protein, minerals (Dube and Fanadzo, 2013). Cowpea is commonly referred it for seeds which containing 18-34% protein, leaves and green pods are consumed as vegetable and the dried grains are used in many different food preparations. In Egypt, cowpea has been introduced as a promising double purpose forage and seed crop for its green canopy or using it in animal diets as dry seeds as well as it is a primary source of plant protein for humans and animals (Hamd Alla *et al.,* 2014). The excessive use of mineral fertilizers represents the major factor of plant production cost, increase soil salinity, lead to serious health hazards and makes some pollution of agro-ecosystem (Fisher and Richter, 1984).The optimum fertilizer requirements for cowpea plants production can be realized not only with the recommended quantity, but also through using proper sources that are considered one of the most important factors affecting the plant growth. Organic fertilizers such as animal manure, green manure, plant residues and composts have gained motivation in organic farming to boost agricultural production for its important multi various features such as being rich in nutrients, vitamins, growth regulators, free from pathogens and containing immobilized micro flora (El-Gizy, 1994). Moreover, composts play an important role in nutrients solubility and activate physiological and biochemical processes in plants leading to increasing plant growth and nutrients uptake (Sarhan *et al.,* 2011). Fertilizer is a vital input to boost the crop yields. Among the methods of fertilizer application, foliar nutrition is recognized as an important method of fertilization and faster for absorption, since foliar nutrients usually penetrate the leaf cuticle or stomata and enters the cells facilitating easy and rapid utilization of nutrients (Elayaraja and Angayarkanni, 2005). Several investigators reported that, K, Ca and B as foliar applications had an important role in plant growth, yield and its quality. Potassium is an important nutrient for plant growth and physiological functions, including regulation of water and gas exchange in plants, protein synthesis, enzyme activation, photosynthesis and carbohydrate translocation in

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plants (Bednarz and Oosterhuis (1999) and Zekri and Obreza (2009). Calcium, uptake as Ca^{2+}, is an essential element for the growth of the plants and fruit development, and it is important in the resistance of the plants to pathogens due to the protection of the cell wall. Also, it plays an important biochemical functions and supports many metabolic processes, in addition to activating several enzymatic systems, thus contributing to the proper development of plants (El Habbasha and Ibrahim, 2015). Legume crops required more amounts of boron compared to other field crops; boron plays vibrant role in proper development of reproductive organs. The organic fertilizers combined with chemical fertilizers is more suitable to achieve high crop yields (Wijewardana, 1993). Hence, the objective of this work was to study the effect of organic and inorganic fertilizers and foliar spraying with K, Ca and B nutrients and their combination on vegetative growth parameters, seed yield and leaf chemical constituents of cowpea plants in both seasons.

Materials and Methods

This study was carried out during the two summer seasons of 2018 and 2019 at Sakha Agricultural Research Station Farm, Kafr El-Sheikh Governorate, Egypt on cowpea (*Vigna unguiculata* L.) cv. Kafr El-Sheikh to study the effect of organic and inorganic fertilizers and foliar application with nutrients (K, Ca and B) and their combination on vegetative growth parameters, seed yield and leaf chemical constituents. The physical and chemical properties of the experimental soil are given in Table (1).

Table 1: Physical and chemical and properties of experimental soil before conducting the experiments in 2018 and 2019 seasons

Seasons	O.M (%)	Clay (%)	Silt (%)	Sand (%)	Texture class	EC (dS/m)	PH	Available (mg/Kg soil)		
								N	P	K
1st	1.86	42.40	23.97	33.63	Clay	3.75	7.7	25	9.2	651
2nd	2.22	43.22	23.21	33.57	Clay	3.60	7.6	36	12	681

The experimental layout was split-split plots system in a randomized complete blocks design with three replicates. Organic and inorganic fertilizers (Table 2) were randomly distributed in the main plots which were subdivided to three sub-plots, each one contained foliar application, i.e., control (tap water spray), potassium sulfate (48%K_2O) at rate 1cm/l, calcium chelated (10% Ca) at rate 1g/l and boric acid (17% B) at 0.5g/l were sprayed three times to plants at two-week intervals starting after two weeks from sowing date.

Mineral fertilizers, as calcium super phosphate (15.5% P_2O_5) was added with the soil preparing at rate 300 kg/fed., ammonium nitrate (33.5% N) was added in two equal portions after 25 and 40 days from sowing date at rate 100 kg/fed., while potassium sulfate (48 % K_2O) was add at rate 50 kg/fed. after 30 days from sowing date as the 100% recommended mineral fertilizers requirements for cowpea plants according to the recommendation of Ministry of Agriculture and Land reclamation 2018.

Table 2: Description of used treatments in the field experiments within the current study

Treatments Details	
Main plot	**Sub-plot**
1- Control (unfertilized	1- Control (unsprayed)
2- 100% mineral	2- Spray application of potassium sulfate at rate 1cm/l
3- 50% organic + 50% mineral	3- Spray application of calcium chelated at rate 1g/l
4- 100% organic (compost)	4- Spray application boric acid at 0.5g/l

Organic fertilizer (compost) amounts was determined according to its nitrogen content (total nitrogen in compost 1.2 and 1.3 % in both seasons, respectively.

The compost (100% organic) was added with the soil preparing at rate 2.792 and 2.577 ton/fed. This experiment included 16 treatments as a combination between 4 fertilizer sources in main plots, and 4 foliar applications in subplots in both seasons. Cowpea seed were sown in hills at 20 April

during both seasons at 25 cm apart between plants on one side of the ridge. The experimental plot area was 14.4 m2 (3 rows with 8 m in length and 0.6 m in width).

All cultural practices for the commercial cowpea production were done according to the recommendations of the Ministry of Agriculture and land Reclamation.

The following data were recorded 1- Vegetative growth parameters

A random sample of five plants were taken from each plot at the flowering stage (Days after sowing) for measuring the growth parameters, i.e., plant height (cm), No. of branches/plant, plant fresh and dry weights (g) according to Koller (1972).

1. Seed yield and its components

At harvest time, a random sample of five plants from each plot were taken to evaluate seed yield, No. of pods/plant, No. of seed /pods, dry seed yield /plant and seed index (weight of 100 seeds) as well as seed yield /fed.

2. Chemical constituents of leaves

The samples of leaves were randomly taken for estimating chemicals constituents. Nitrogen was determined using the Micro-Kjeldahl method (Piper, 1950). Phosphorus was determined by spectrophotometer (Murphy and Riely, 1962). Potassium was determined according to (Jackson, 1967). Calcium was determined according to Jackson and Ulrich (1959). Meanwhile, boron was determined according to (A.OA.C, 1990).

3. Protein content and seed germination (%)

Crude protein percentage in dry seeds of cowpea was determined according to (A.OA.C, 1990), also 100 seeds were used from each treatment for calculation the germination percentage.

Statistical analysis

Data were tested by analysis of variance according to Little and Hills (1975). Duncan's Multiple Range test was used for comparison among treatments means (Duncan, 1955).

Results and Discussion

1. Vegetative growth parameters

Data presented in Table (3) reveal that the highest values of plant growth parameters (plant height, No. of leaves, No. of branches, plant fresh and dry weights) were produced by plants fertilized with 50% organic + 50% mineral fertilizers treatment followed by 100% mineral, while the lowest values were obtained by control (untreated plants) in both seasons. Improving vegetative growth parameters due to applying of compost plus chemical fertilizers compared to using each alone. This favorable effect can be attributed to that applying mineral N stimulated the rate of decomposition of compost and produced higher humus substances which in turn improve the physical and chemical properties of the soil as well as increase both the exchangeable water soluble of nutrients and their uptake (Cooke, 1972), consequently increased the vegetative growth parameters. In this concern, Mafadi and Gohar (1975) attributed that to NH_4^+ ion adsorbed on the surface of composts and became available to plant uptake. Similarly, Jha *et al.,* (1996) stated that applying chemical fertilizer with organic manures increased both N mineralization and nitrification which in turn improve the access to NH_4-N and result in greater number of viable cells of nitrifying bacteria, especially with chemical fertilization. The superiority of 50% compost + 50% mineral N treatment in improving growth of cowpea plants may be due to that such organic manure is capable as a source of many essential macro and micronutrients to plants (Remington and Frances, 1955) to serve as a good natural soil texture conditioner being rich in organic matter and increase availability and uptake of N, P and K which positively reflected on plant cell elongation and division as well as stimulate photosynthesis and metabolic processes. The obtained results are in accordance with those of El-Mansi *et al.,* (2004) on pea, Ahmed and Elzaawely (2010), Dey *et al.,* (2017), Abd El Lateef *et al., (*2018), Chemutai *et al.,* (2018), Jinendra *et al.,* (2018) on Cowpea and Zeid *et al.,* (2015) on radish plants.

Table 3: Vegetative growth parameters of cowpea plants as affected by different sources of organic, mineral fertilizers and foliar application with K, Ca and B during 2018 and 2019 seasons

Seasons	1st season					2st season				
Treatments	Plant height (cm)	No. of leaves/plant	No. of branches/plant	Fresh weight (g/plant)	dry weight (g/plant)	Plant height (cm)	No. of leaves/plant	No. of branches/plant	Fresh weight (g/plant)	dry weight (g/plant)
Fertilizer sources										
Control (Without fertilizer)	57.38d	16.12d	5.05d	169.17d	25.22d	58.85d	17.58d	5.05c	172.57d	26.54d
100% Mineral	65.29b	19.41b	5.43c	273.34b	38.55b	65.32b	20.55b	5.42b	277.18b	39.95b
50% Mineral + 50% Organic	70.61a	20.75a	5.85a	306.79a	43.53a	71.43a	21.87a	5.83a	310.78a	44.63a
100% Organic	61.62c	17.71c	5.53b	251.53c	34.16c	62.33c	18.50c	5.53b	256.13c	35.05c
L.S.D at 0.05	0.328	0.191	0.064	1.063	0.780	1.342	0.333	0.175	1.550	0.536
Foliar spray										
Control	52.33d	15.09d	4.68d	180.92d	27.54d	53.68d	16.38d	4.64d	184.83d	28.93d
K	69.80a	20.86a	6.50a	290.31a	40.78a	70.47a	22.14a	6.50a	294.64a	41.70a
Ca	67.63b	19.73b	5.80b	275.56b	38.08b	68.37b	20.68b	5.80b	279.88b	39.68b
B	65.15c	18.30c	4.88c	254.04c	35.07c	65.42c	19.29c	4.88c	257.30c	35.86c
L.S.D at 0.05	0.522	0.292	0.103	1.481	0.416	1.357	0.255	0.085	1.735	0.483

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Concerning the effect of foliar application (K, Ca and B), it was found that all growth parameters were increased in the two growing seasons as a result to all foliar treatments compared with the check treatment (control). Results in Table (3) clearly show that the highest significant values of plant height, No. of leaves, No. of branches, plant fresh and dry weights were recorded by spraying plant with potassium (K) following by spraying with Ca, while the check treatment (control) recorded the lowest values of vegetative parameters in both seasons. Regarding the growth enhancing potential of potassium foliar application might be attributed to potassium is an important nutrient for plant meristematic growth and physiological functions, including regulation of water and gas exchange in plants, protein synthesis, enzyme activation, photosynthesis and carbohydrate translocation in plants. Potassium has favorable effects on metabolism of nucleic acids, proteins, vitamins and growth substances (Bednarz and Oosterhuis, 1999). Salami and Saadat (2013) pointed out that K plays an essential role in enzyme activation, protein synthesis, photosynthesis, osmoregulation, stomata movement, energy transfer, phloem transport, cation-anion balance and stress resistance. Potassium is a part of many important regulatory roles in the plant. It is essential in nearly all processes needed to sustain plant growth and reproduction, i.e. photosynthesis, translocation of photosynthesis products, protein synthesis, control of ionic balance, regulation of plant stomata, turgor maintenance, stress tolerance and water use, activation enzymes and many other processes (Cakmak, 2005). In the same tendency Sangakar *et al.,* (2001), Priyadhrshini and Seran (2009) and Chavan *et al.,* (2011) on cowpea.

As for the effect of the interaction, the results presented in Table (4) noticed that the highest values of growth parameters were recorded by the plants were fertilized with 50% organic + 50% mineral and sprayed with potassium (K) followed by the combination of 50% organic + 50% mineral treatment and foliar application by Ca comparing with the other combination treatments in both seasons.

2. Seed yield and its components

Data in Table (5) illustrated the effect of organic and mineral fertilizers on seed yield and its components of cowpea plants; i.e. No. of pods/plant, No. of seed/pods, dry seed yield /plant, seed index (100 seeds weight) as well as dry seed yield (kg/fed.). It can be concluded that, seed yield and its components were significantly increased by addition 50% organic + 50% mineral fertilizers compared with the control in both seasons. This increment in seed yield characteristics may be attributed to the high levels of nutrients in the organic fertilizers that could encourage the vegetative growth (Table, 3) of cowpea plants to go forward and accelerate the photosynthetic rate. The results are in conformity with those obtained by Singh *et al.,* (2010), they noted a significant increase in grain yield (seeds/pod, pod/plant and seed weight) of kabuli chickpea crop with the application of farmyard manure in combined with mineral fertilizers . In the same line, Mahatele *et al.,* (2011) on pigeon pea, Abd El Lateef *et al.,* (2018), Chemutai *et al.,* (2018), Jinendra *et al.,* (2018) on Cowpea. Similar findings were also found by El-Fakhrani, (1997) on broad beans and Gabr, (2000) on snap bean.

Significant differences in seed yield and its components were noticed among foliar treatments and the control (Table 5). Plants were sprayed with potassium (K_2SO_4) showed the highest values of No. of pods/plant (33.11 and 34.13), No. of seed /pod (10.99 and 11.56), dry seed yield /plant (25.22 and 25.67g) as well as dry seed yield /fed. (882.73 and 904.17 kg) while the control plants recorded the lowest values of No. of pods/plant (24.36 and 24.92), No. of seed /pods (9.03 and 9.55), dry seed yield /plant (23.46 and 24.06 g) and dry seed yield /fed. (821.16 and 841.98 kg) in the 2018 and 2019 seasons, respectively. The other treatments showed an intermediate values in most cases in both seasons.

The superiority of potassium sulfate treatment may be due to the active role of potassium in dividing and wideness of meristem cells and the speeded raise in the absorption of nutrients and activation of enzymes effect especially those related with the treatment of energy transformation (Tisdal *et al.,* 1997). The improving effect of potassium on growth due to potassium spraying reflected on the seed yield comparing to check treatment (Mengel and Kirby, 1987). These results are in the same line with those obtained by Zedan (2011), Marschner, (2012), Salim *et al.,* (2014), and JafarUllah *et al.,* (2007) on cowpea plants.

Concerning the effect of combination of the interaction, the statistical analysis for data in Table (6) showed that, a significant effect of fertilization treatments and K, Ca and B spraying was found to exist on the seed yield aspects. Fertilization treatment of 50% mineral + 50% organic combined with

Table 4: Vegetative growth parameters of cowpea plants as affected by the interaction between fertilizer sources (organic and inorganic) and foliar application with K, Ca and B during 2018 and 2019 seasons

Seasons		1st season					2st season				
Treatments		**Plant height (cm)**	**No. of leaves/plant**	**No. of branches /plant**	**Fresh weight (g/plant)**	**dry weight(g/plant)**	**Plant height (cm)**	**No. of leaves/ plant**	**No. of branches /plant**	**Fresh weight (g/plant)**	**dry weight (g/plant)**
Control (Without fertilizer)	**Control**	48.63l	13.57	4.20k	155.40m	24.83l	50.60l	15.03i	4.20i	159.53m	25.73k
	K	63.20g	18.47	6.10d	183.77j	28.17j	63.93f	20.77e	6.10cd	187.23j	29.07ij
	Ca	60.20h	16.87	5.40g	171.33k	24.47l	62.13g	18.00g	5.40f	175.33k	27.63j
	B	57.50i	15.57	4.50j	166.17l	23.40m	58.73h	16.50h	4.50g	168.17l	23.73l
100% Mineral	**Control**	50.63k	15.67	4.50j	172.63k	27.93j	52.43k	17.07h	4.47h	174.23k	29.93i
	K	71.23d	21.73	6.50b	321.97c	44.23c	71.97c	22.80c	6.50b	327.13c	45.43c
	Ca	70.80d	20.60	5.90e	306.90d	42.03d	70.70d	21.67d	5.90de	312.00d	43.23d
	B	68.5e	19.63	4.80i	291.87e	40.00e	66.17e	20.67e	4.80g	295.33e	41.20e
50% Mineral + 50% Organic	**Control**	53.23j	16.57	4.80i	183.67j	30.57i	54.30j	17.83g	4.70h	185.30j	31.70h
	K	78.43a	23.40	7.10a	381.83a	52.47a	78.87a	24.40a	7.10a	387.17a	53.73a
	Ca	76.30b	22.77	6.20cd	357.60b	49.10b	76.87b	23.63b	6.20c	361.90b	50.30b
	B	74.47c	20.27	5.30gh	304.07d	42.00d	75.70b	21.60d	5.30f	308.77d	42.80d
100% Organic	**Control**	56.80i	14.57	5.20h	211.97i	26.83k	57.40i	15.60i	5.20f	220.27i	28.37j
	K	66.33f	19.83	6.30c	273.67f	38.23f	67.10e	20.60e	6.30bc	277.03f	38.60f
	Ca	63.20g	18.70	5.70f	266.40g	36.70g	63.77f	19.40f	5.70e	270.30g	37.53f
	B	60.13h	17.73	4.90i	254.07h	34.87h	61.07g	18.40g	4.90g	256.93h	35.70g
L.S.D at 0.05		1.238	0.693	0.129	3.513	0.986	1.238	0.606	0.202	4.114	1.144

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Table 5: Seed yield and its components of cowpea plants as affected by different sources of organic, mineral fertilizers and foliar application with K, Ca and B during 2018 and 2019 seasons

Seasons	1st season					2st season				
Treatments	No. of pods/plant	No. of seeds/pod	Seed index 100 seeds wt. (g)	Dry seed yield (g/plant)	Dry seed yield (kg/fed.)	No. of pods/plant	No. of seeds/pod	Seed index 100 seeds wt. (g)	Dry seed yield (g/plant)	Dry seed yield (kg/fed.)
Fertilizer sources										
Control	17.05d	8.58d	17.86d	21.75c	761.07d	17.89d	9.10d	18.32d	22.22d	777.01d
100% Mineral	33.07b	10.75b	28.24b	24.32b	851.03b	34.20b	11.33b	28.84b	24.89b	877.10b
50% Mineral + 50% Organic	38.47a	11.43a	29.25a	26.97a	943.88a	39.01a	11.90a	29.86a	27.53a	963.94a
100% Organic	29.47c	9.94c	25.46c	24.21b	821.13c	30.47c	10.59c	26.75c	24.59c	851.70c
L.S.D at 0.05	0.118	0.057	0.082	1.303	3.867	0.410	0.122	0.633	0.149	3.701
Foliar spray										
Control	24.36d	9.03d	21.78d	23.46b	821.16d	24.92d	9.55d	22.31d	24.06d	841.98c
K	33.11a	10.99a	27.98a	25.22a	882.73a	34.13a	11.56a	28.59a	25.67a	904.17a
Ca	31.24b	10.71b	26.03b	24.24ab	848.45b	32.09b	11.24b	27.27b	25.25b	882.73b
B	29.34c	9097c	25.03c	24.32ab	824.78c	30.24c	10.57c	25.61c	24.27c	840.87c
L.S.D at 0.05	0.081	0.092	0.116	1.109	3.104	0.186	0.073	0.496	0.140	2.420

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Table 6: Seed yield and its components of cowpea plants as affected by the interaction between fertilizer sources (organic and inorganic) and foliar application with K, Ca and B during 2018 and 2019 seasons

Treatments	Seasons	1st season					2st season				
		No. of pods /plant	No. of seeds/pod	Seed index 100 seeds wt. (g)	Dry seed yield (g/plant)	Dry seed yield (kg/fed.)	No. of pods/plant	No. of seeds /pod	Seed index 100 seeds wt. (g)	Dry seed yield (g/plant)	Dry seed yield (kg/fed.)
Control (Without fertilizer)	**Control**	15.83o	7.56f	16.52k	21.28c	744.79j	16.46p	7.87g	16.73h	21.72h	760.32i
	K	18.30l	9.33d	19.30h	22.27bc	779.57i	19.27m	9.77e	19.83ef	22.83g	799.05g
	Ca	17.50m	9.26d	18.24i	22.13bc	774.43i	18.31n	9.86e	18.86fg	22.62g	787.97h
	B	16.56n	8.18e	17.38j	21.30c	745.50j	17.50o	8.91f	17.86gh	21.70h	760.72i
100% Mineral	**Control**	27.29j	10.24c	25.16f	24.16bc	845.72f	28.29k	10.83d	25.83d	24.79e	867.54e
	K	37.39d	11.25b	30.18b	25.27	884.57d	38.57d	11.83c	30.84b	25.16e	903.93d
	Ca	35.36e	11.26b	29.29c	24.42bc	854.58e	36.37e	11.81c	29.84bc	25.81d	903.35d
	B	32.22g	10.24c	28.33d	23.41bc	819.23g	33.56g	10.87d	28.83c	23.82f	833.59f
50% Mineral + 50% Organic	**Control**	28.52i	10.13c	25.22f	25.26abc	883.95d	28.75j	10.75d	25.85d	25.84d	904.28d
	K	43.33a	12.16a	32.21a	29.19a	1021.53a	44.15a	12.82a	32.89a	29.81a	1044.63a
	Ca	41.72b	12.14a	30.34b	27.22ab	952.66b	41.93b	12.39b	30.84b	27.75b	971.37b
	B	40.30c	11.27b	29.24c	26.21abc	917.35c	41.21c	11.62c	29.88bc	26.73c	935.48c
100% Organic	**Control**	25.70k	8.19e	20.21g	23.15bc	810.13h	26.17l	8.75f	20.83e	23.88f	835.80f
	K	33.42f	11.22b	30.24b	24.15bc	845.25f	34.52f	11.83c	30.79b	24.86e	869.05e
	Ca	30.39h	10.17c	26.23e	23.20bc	812.12gh	31.76h	10.90d	29.52bc	24.81e	868.23e
	B	28.39i	10.20c	25.16f	26.34abc	817.02gh	29.43i	10.87d	25.86d	24.82e	833.70f
L.S.D at 0.05		0.192	0.217	0.275	2.630	7.360	0.441	0.172	1.177	0.333	5.739

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potassium sulfate at 1cm/l as foliar application had expressively higher seed yield values than the other combinations in both seasons.

3. Chemical constituents in leaves

Chemical constituents (N, P, K, Ca and B) concentrations of cowpea leaves were significant increased by fertilizers sources compared with the control in both seasons. Data presented in Table 7 show that cowpea plants fertilized with 50% mineral + 50% organic recorded the highest contents of N, P, Ca and B in leaves followed by plants received 100% mineral treatment singly compared to control plants which resulted the lowest values. Meanwhile, the highest K% in leaves was obtained by 100% mineral treatment followed by applyingr 50% mineral + 50% organic, 100% organic and finally control treatment. In the same tendency, Ahmed and Elzaawely (2010) and Abd El Lateef *et al.,* (2018) on cowpea, they found that fertilizing plants with organic plants increased macro- and microelements contents in leaves and seeds.

Concerning with the effect of foliar application of K, Ca and B, data in Table (7) showed that foliar application of potassium sulfate treatment was increased leaves N, P and K contents, while foliar application of calcium recorded the highest leaf Ca content. Also, the plants which sprayed with boron produced the highest leaf B content comparing with the control in both seasons. Similarly, Nurzynska-Wierdak *et al.,* (2012) on garden rocket plants. Also, Behairy *et al.,* (2015) on onion, Zyada and Bardisi (2018) on garlic and Zyada *et al.,* (2020) on cowpea, found that potassium spraying increased the contents of N, P and K in leaves.

Generally, the interaction between fertilizers sources and foliar application of K, Ca and B increased the contents of N, P, K, Ca and B in cowpea leaves as compared to control. In addition, the highest percentage of N and P in leaves were obtained from the interaction between 50% mineral + 50% organic and potassium spray in both seasons, with a significant increase compared to untreated cowpea plants. Likewise, Ca and B were increased in leaves with the combination of 50% mineral + 50% organic with Ca spray and 50% mineral + 50% organic with B spray, respectively (Table 8).

4. Protein content in dry seeds and seed germination (%)

As for the effect of fertilizers sources on protein % in dry seeds, data in Table (9) show that, cowpea plants fertilized with 50% mineral + 50% organic treatment gave the highest protein content and the highest seed germination followed by applying 100% mineral, 100% organic and finally control treatment which resulted the lowest values in both seasons. In the same tendency Ahmed and Elzaawely (2010), Abd El Lateef *et al.,* (2018) and Jinendra *et al.,* (2018) on cowpea.

Regarding to the effect of foliar applications, data in Table (9) clearly indicated that spraying K, Ca and B greatly improved the protein content and germination percentage of dry seeds as compared to untreated plants. The highest values in this respect were obtained by spraying cowpea plants with potassium sulfate at 1cm/l followed by plants sprayed with Ca and B in both seasons. In the same line, Zyada *et al.,* (2020) on cowpea, found that application of potassium fertilizer as soil or foliar application was recorded the best treatments for increasing all cowpea growth and seed yield components as well as N, P, K and protein percentage in seeds such as compared with control treatment. About the effect of interaction between foliar application and fertilizer treatments on the percentage of protein and germination seeds of cowpea, data in Table (10) show that there were significant differences among treatments in both seasons. Cowpea plants fertilized with 50% mineral

+ 50% organic and sprayed with potassium sulfate at 1cm/l gave the highest values in this respect followed by plants fertilized with 50% mineral + 50% organic and sprayed with calcium chelated at rate 1g/l in both seasons.

Table 7: Chemical composition in leaves of cowpea plants as affected by different sources of organic, mineral fertilizers and foliar application with K, Ca and B during 2018 and 2019 seasons

Seasons / Treatments	1st season					2st season				
	N%	P%	K%	Ca%	B ppm	N%	P%	K%	Ca%	B ppm
Fertilizer sources										
Control	2.49d	0.674d	1.40d	0.065c	21.78d	2.58d	0.676d	1.41d	0.075d	22.84d
100% Mineral	3.24b	0.735b	1.82a	0.113b	23.00c	3.33b	0.736b	1.83a	0.123c	23.97c
50% Mineral + 50% Organic	3.63a	0.798a	1.72b	0.145a	25.04a	3.73a	0.790a	1.73b	0.155a	26.11a
100% Organic	3.04c	0.698c	1.61c	0.120b	24.18b	3.13c	0.700c	1.63c	0.130b	25.26b
L.S.D at 0.05	0.018	0.001	0.011	0.014	0.145	0.009	0.002	0.002	0.004	0.035
Foliar spray										
Control	3.16a	0.708d	1.58d	0.085d	21.90d	3.26a	0.710d	1.59d	0.095d	22.95d
K	3.18a	0.745a	1.69a	0.120b	23.99b	3.25a	0.747a	1.70a	0.130b	25.06b
Ca	3.11b	0.727b	1.66b	0.140a	23.06c	3.12b	0.729b	1.67b	0.150a	24.06c
B	2.95c	0.715c	1.62c	0.098c	25.06a	3.05c	0.717c	1.63c	0.108c	26.12a
L.S.D at 0.05	0.018	0.001	0.009	0.010	0.124	0.013	0.001	0.011	0.009	0.042

Any values on the same vertical line for the same character having the same letter are not statistically different according to DMRT

Table 8: Chemical composition in leaves of cowpea plants as affected by the interaction between fertilizer sources (organic and inorganic) and foliar application with K, Ca and B during 2018 and 2019 seasons

Treatments	Seasons	1st season					2st season				
		N%	P%	K%	Ca%	B ppm	N%	P%	K%	Ca%	B ppm
Control (Without fertilizer)	Control	2.43i	0.664n	1.33k	0.05h	20.24i	2.53h	0.666n	1.35k	0.06h	21.25l
	K	2.62h	0.682k	1.48h	0.07fgh	22.27g	2.69g	0.684k	1.50h	0.08fgh	23.34j
	Ca	2.47i	0.678l	1.42i	0.08efg	21.27h	2.55h	0.680l	1.44i	0.09efg	22.34k
	B	2.44i	0.670m	1.36j	0.06gh	23.36e	2.53h	0.672m	1.38j	0.07gh	24.43g
100% Mineral	Control	3.06e	0.711h	1.78e	0.08efg	21.32h	3.18d	0.712h	1.79b	0.09efg	22.39k
	K	3.41d	0.761e	1.85a	0.12cd	23.42de	3.49c	0.762e	1.86a	0.13cd	24.49g
	Ca	3.38d	0.742f	1.83a	0.15b	22.74f	3.48c	0.744f	1.84a	0.16b	23.48i
	B	3.09e	0.725g	1.80b	0.10de	24.50c	3.17d	0.727g	1.81b	0.11de	25.54e
50% Mineral + 50% Organic	Control	3.54	0.765d	1.68e	0.12cd	23.46de	3.66b	0.768d	1.69e	0.13cd	24.50g
	K	3.74a	0.811a	1.75c	0.15b	25.56b	3.81a	0.812a	1.76c	0.16b	26.63c
	Ca	3.71a	0.795b	1.72d	0.18a	24.55c	3.82a	0.797b	1.74cd	0.19a	25.62e
	B	3.55c	0.782c	1.71d	0.13bc	26.61a	3.65b	0.783c	1.72d	0.14bc	27.68a
100% Organic	Control	3.61b	0.690j	1.52g	0.09ef	22.57f	3.65b	0.692j	1.54g	0.10ef	23.64h
	K	2.93f	0.725g	1.67e	0.14bc	24.70c	3.01e	0.728g	1.69e	0.15bc	25.77d
	Ca	2.89f	0.695i	1.66e	0.15b	23.69d	3.00e	0.696i	1.67e	0.16b	24.80f
	B	2.73g	0.683k	1.60f	0.10de	25.75b	2.86f	0.685k	1.62f	0.11de	26.82b
L.S.D at 0.05		0.043	0.003	0.020	0.023	0.295	0.031	0.003	0.025	0.021	0.100

Any values on the same vertical line for the same character having the same letter are not statistically different according to DMRT

Table 9: The percentage protein in dry seeds and seed germination of cowpea as affected by different sources of organic, mineral fertilizers and foliar application with K, Ca and B during 2018 and 2019 seasons

Seasons	1st season		2st season	
Treatments	Protein %	Germination ratio (%)	Protein %	Germination ratio (%)
Fertilizer sources				
Control	15.55d	83.97d	16.11d	84.23d
100% Mineral	20.26b	92.25b	20.83b	92.87b
50% Mineral + 50% Organic	22.73a	95.07	23.34a	95.44a
100% Organic	17.49c	90.55c	18.08c	91.01c
L.S.D at 0.05	0.037	0.056	0.067	0.112
Foliar spray				
Control	18.26d	85.71d	18.85d	86.14d
K	19.81a	93.53a	20.34a	93.90a
Ca	19.49b	92.05b	20.07b	92.68b
B	18.46c	90.56c	19.09c	90.84c
L.S.D at 0.05	0.053	0.031	0.073	0.047

Any values on the same vertical line for the same character having the same letter are not statistically different according to DMRT

Table 10: The percentage protein in dry seeds and seed germination of cowpea as affected by the interaction between fertilizer sources (organic and inorganic) and foliar application with K, Ca and B during 2018 and 2019 seasons

Seasons		1st season		2st season	
Treatments		Protein %	Germination ratio (%)	Protein %	Germination ratio (%)
Control (Without fertilizer)	**Control**	15.21m	82.14o	15.84h	82.50p
	K	16.25k	86.27k	16.84g	86.48l
	Ca	15.50l	84.2m	15.89h	84.44n
	B	15.25m	83.27n	15.85h	83.50o
100% Mineral	**Control**	19.23f	87.19j	19.8d6	87.62k
	K	21.30d	95.26d	21.86c	95.58e
	Ca	21.16e	94.26e	21.77c	95.74d
	B	19.33f	92.31g	19.82d	92.56h
50% Mineral + 50% Organic	**Control**	22.13c	88.25i	22.87b	88.71j
	K	23.38a	98.32a	23.81a	98.71a
	Ca	23.19b	97.33b	23.88a	97.79b
	B	22.20c	96.38c	22.81b	96.56c
100% Organic	**Control**	16.48j	85.26l	16.81g	85.75m
	K	18.30g	94.26e	18.86e	94.82f
	Ca	18.10h	92.40f	18.75e	92.76g
	B	17.07i	90.27h	17.88f	90.72i
L.S.D at 0.05		0.125	0.073	0.174	0.112

Any values on the same vertical line for the same character having the same letter are not statistically different according to DMRT

Conclusions

It can be concluded that the best results on growth parameters, leaves chemical composition were resulted when cowpea plants fertilized by 50% mineral as ammonium nitrate (50 kg/fed.) + 50% organic as compost (1.396 or 1.289 ton/fed.) and sprayed with potassium sulfate at 1cm/l thrice to plants at two-week intervals starting after two weeks from sowing date. Therefore, this treatment could be recommended for improving cowpea plants performance under similar condition of this study.

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