



Response of Three Varieties of Cowpea (*Vigna sinensis* L.) to Different levels of potassium fertilizer under southern region conditions of Iraq

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Abstract: A field experiment was conducted during autumn season 2018 at Al Salam district, Maysan governorate. The aim was to evaluate some growth properties and grain yield of three varieties of cowpea, *Vigna sinensis* L. (Local, Patton Boa and Atta E) grown under different levels of potassium sulphate (0, 43, 86 and 129 kg h⁻¹). The experimental design was applied according to the random complete block design in a split arrangement (Split Plots in RCBD). In on hand, the results showed a significant differences between the varieties. The local variety significantly gave highest plant length, leaf area, pods number, seeds number pod⁻¹ and grain yield and which were 60.75cm, 2936.81cm², 39.60 pod. plant⁻¹, 7.69 seed pod⁻¹, 99.93 g and 4.16 t. h⁻¹ respectively. While the varieties Baton Boa gave highest weight of 100 seeds and gave 37.58 g. In other hand, as compare to the control, the addition of potassium up to 129 kg. h⁻¹ lead to significant increase in plant length, leaf area, pods plant⁻¹, seeds number pod⁻¹ and grain yield plant⁻¹ and total grain yield which were 53.33 cm, 3455.91 cm², 51.61 pod. plant⁻¹, 8.76 seed. pod⁻¹, 125.93 g. and 5.25 T.h⁻¹ respectively. Whereas, the control treatment (K₀) gave the highest weight of 100 seeds (45.11 g). The Interaction between varieties and potassium had a significant effect on almost growth and yield characteristics.

Keywords: Cowpea, Varieties, Potassium fertilizer.

Introduction

Cowpea *Vigna sinensis* L. is one of the most important legume crops. It is grow vigorously at a hot weather in Africa. Thereafter, it is spread from Africa to Asia and other areas (Khan *et al.*, 2010; Agbogidi & Egho, 2012). Cowpea is one of the most important legumes plants, it is consider a cheapest plant protein sources in the world. The protein content of

cowpea seeds range between 22-33 % while, the carbohydrates range (56.53-57.36)%, in

addition cowpea used to improve sustain soil fertility through high ability to fixed nitrogen in the soil. The total cultivated area of legumes in Iraq reached to 54.000 dounams in 2013. While, the cultivated area of cowpea crop reached to 47.750 dounams with a total productivity of 74.500 thousand tons

(Ministry of Planning, Central Statistical Organization Iraq, 2013). Potassium is a major nutrient necessary for field crops production, it comes in third degree after nitrogen and phosphorus. It plays a significant role in improving quantity and quality of agricultural production (IPI, 2000), Potassium plays a remarkable role in transpiration, stomatal opening and closing and osmoregulation (Cakmak, 2005). It is important to study the performance of cowpea varieties in order to support efforts that caused on developed high quality traits and economic returns (IPI, 2001). The produce of high-yield genotypes alone is not sufficient to improve cowpea productivity because production capacity and genotype are based on physiological processes that are governed by genetic factors and environmental conditions, thus adapting and optimizing the derived genetic structures depends on genetic differences, environmental, climatic and soil conditions (Kamdi; 2001; Lesly, 2005; Aremu *et al.*, 2007). The cowpea crop, did not receive the attention of researchers, especially in the southern region in addition there is rare study on this crop. Therefore this study was conducted to determine the suitable varieties for environmental conditions in the southern region in terms of quantitative and qualitative characteristics as well as determine the best level of potassium fertilizer which gives the highest yield and the best quality of cowpea.

Materials & Methods

A field experiment was conducted in Al Salam area, Maysan province during the autumn growing season 2018. The experiment included two factors: The first factor is three varieties of cowpea, local (control), Patton Boa (the origin is Holland) and ATT A (the origin is USA), which they were symbolized by V1, V2 and V3 respectively. The second factor is four levels of potassium in form of potassium sulphate 0, 43, 86 and 129 kg. h⁻¹, which they were symbolized by K0, K1, K2 and K3 respectively. The treatments replicated three time in random complete block design with split plot design. Potassium were main plots, while the varieties cowpea were sub-plots. Each sub-plot contain 5 rows of 4 m long and 60 cm distance between the rows. Soil was prepared by two orthogonal tillage and then the soil was levelled. Nitrogen fertilizer was added to the soil in form of urea (40% N) at 80 kg h⁻¹. Phosphate fertilizer was added to the soil in form of triple superphosphate (21% P) at 80 kg. h⁻¹ (Ali, 2012). While, Potassium sulphate was added to the experimental units at three equal timing, the first one before planting, the second one after four weeks of planting and the third one at flowering stage. Random five samples were taken from the field to determine some physical and chemical properties, (shown in Table 1).

Table (1): Some physical and chemical traits of the soil before sowing

Adjective	the value
Sand	350 g kg ⁻¹
Silt	230 g kg ⁻¹
Clay	420 g kg ⁻¹
E.C	4.9 dsm ⁻¹
pH	7.16
Organic matter	3.0 g kg ⁻¹
Total nitrogen	45 mg kg ⁻¹

Available phosphorus	45.9 mg kg ⁻¹
Available Potassium	60 mg kg ⁻¹

Some growth and yield traits were measured, plant height leaf area were determined by the average of 10 plants harvesting from the centre of each plot at the beginning of flowering stage except total leaf area of plant were determined at 50% using leaf area meter (CI-202 Portable Laser). At maturity stage, the average of pods number plant.t⁻¹, seed number pod-1, weight of 100 seed and grain yield plant-1 were measured from 10 plants harvesting from the central rows of each plot. Grain yield have been measured from the grain yield of the all the plants grown in middle lines. Data were analyzed by using SPSS program. The experimental design was applied according to the random complete block design in a split arrangement (Split Plots in RCBD) The means of traits were tested by using least significant differences (L.S.D.) at probability level 0.05 (Al-Rawai & Khalaf Allah,1980).

Results & Discussion

Plant height (cm)

The results of Tables (2 and 9) showed that, there is a significant differences between the varieties, potassium fertilizer levels and their interaction. The local variety (V1) produced highest average of plant height of 60.75 cm, while the variety Natun Boa (V3) gave the lowest average of 36.58 cm. This differences

in plant height may be because the differences between varieties in response to the surrounding environmental conditions due to varying of their genetic capacity and extent their interaction with environmental conditions. (Al-Othman & Ibrahim, 2009). This result is consistent with Abayomi & Abidoeye (2009), Al-Tahfi *et al.* (2014). The results of table (2) indicated that potassium fertilizer level k3 gave the highest rate of plant height of 53.33 cm, While k0 gave the lowest rate of plant height of 39.78 cm. This results indicated that there was a clear response to potassium fertilization, may be this attributed to the low of available potassium in soil (see table 1) and to the importance of potassium to the plants throw their attributes in process of cells wall division and expansion as well as the fact that potassium is the basis of physiological functions in plant and metabolic processes. This finding is consistent with the findings of Zeda (2011) which found that potassium levels had a significant effect on plant height of cowpea. It is also noted (Table 2) that the Verity V1 under the treatment of potassium K3 produced V1K3 the highest rate of plant length of 72.67 cm, while the Verity V1 under the treatment of potassium K0 produced the lowest rate of plant height of 35.00 cm.

Table (2): Response of cowpea varieties to potassium fertilizer levels and their interactions in (cm). plant length.

Potassium levels	Varieties			means (K)
	V1	V2	V3	
K0	47.33	37.00	35.00	39.78
K1	55.00	41.00	36.67	44.22
K2	68.00	39.33	36.30	47.88
K3	72.67	49.00	38.33	53.33
means (V)	60.75	41.58	36.58	

L.S.D_{0.05} for Potassium=1.90, L.S.D_{0.05} for varieties =1.49, L.S.D_{0.05} for interaction=2.99.

leaf area cm²

The results of tables (3 and 9) indicated that there is a significant differences between the varieties, potassium fertilizer levels and their interaction in leaf area. The local variety (V1) gave the highest mean of leaf area of 2936 cm² compared to V3 which gave the lowest average of 2511 cm². The reason for the superiority of the local variety may be due to its superiority in the length of the plant and the number of leaves per plant which is reflected positively in increase leaf area. This finding is in agreement with Hassan *et al.* (2015) which indicated that the varieties of cowpea differ significantly in the leaf area. The results of table (3) indicated that the level of potassium fertilizer level k3 gave the

highest average of the leaf area reached to 3455 cm² compared to the control k0 which gave the lowest average of leaf area of 2058 cm². The addition of potassium lead to increased leaf area because of the role of potassium in increasing the number and leaves of the plant and activation of the enzymatic systems, which ultimately increases the growth characteristics, including the leaf area. The results of table (3) revealed that the interaction of varieties and potassium levels have significant effect on leaf area. The variety V1 under potassium K3 highest average of the leaf area 3884 cm², while the variety of V3 under K0 treatment produced less average of leaf area 1899 cm², this is due to the effect of single factors.

Table (3): Response of cowpea varieties to potassium fertilizer levels and their interaction in leaf area (cm²).

Potassium levels	Varieties			means (K)
	V1	V2	V3	
K0	2197.90	2076.39	1899.77	2058.02
K1	2525.35	2430.78	2289.58	2415.23
K2	3139.47	2954.61	2757.19	2950.42
K3	3884.52	3385.24	3097.98	3455.91
means (V)	2936.81	2711.76	2511.13	

L.S.D_{0.05}for Potassium=66.68, L.S.D_{0.05}for varieties =46.77, L.S.D_{0.05} for interaction=93.54.

Pods number per plant

The results of tables (4 and 9) showed that the varieties, potassium levels and their interaction have significant affected pods number plant⁻¹. The local variety V1 gave the highest rate of pods number .plant⁻¹ of 39.60. Whereas the variety V3 produced the lowest average of pods number .plant⁻¹of 31.62. This may be due to their deferent in genetic ability to exploit the surrounding environmental conditions. and use them in photosynthesis, which helped to increase the transfer

of processed of food from source to sink which lead to increase the proportion of flowers and thus led to increase the number of pods plant. This finding is consistent with Khan *et al.* (2010), Hassan *et al.* (2015) and Rajab & Khader 2017 found that cowpea varieties significantly differed in pods number .plant⁻¹. The results of table (3) showed that the addition of potassium fertilizer lead to increased pods number. plant⁻¹. The potassium level of K3 gave the highest pods

number.plant⁻¹ of 51.22. While the control average of pods number .plant⁻¹ reached to 21.44. This trained of response maybe due to the role of potassium in activating the effectiveness of some special hormones responsible on increasing flowering, and then pod numbers in plant, in addition to the positive role of potassium in increasing the efficiency of carbonization and regulating the transfer the products of photosynthesis to the

potassium level (K0) gave the lowest new sites at reproductive stage. These results were consist with Zedan (2011). For the interaction, the results of table (3) revealed that, the local cultivars V1 under potassium level K3 produced the highest pods number. plant⁻¹ of 55.73. Whereas, the verity V3 under potassium level of V0 has the lowest pods number plant⁻¹ of 16.00. This response is due to the effect of single factors.

Table (4): Response of cowpea varieties to potassium fertilizer levels and their interaction on pods number .plant⁻¹.

Potassium levels	Varieties			means (K)
	V1	V2	V3	
K0	25.73	22.60	16.00	21.44
K1	34.33	30.40	26.60	30.44
K2	42.60	40.33	36.33	39.76
K3	55.73	50.40	47.53	51.22
means (V)	39.60	35.93	31.62	

L.S.D_{0.05} for Potassium=0.89, L.S.D_{0.05} for varieties =0.71, L.S.D_{0.05} for interaction=1.42.

Seeds number in a pod (seed.pod⁻¹)

The results of tables (5 and 9) exhibited that, there are significant effect for varieties, potassium fertilizer levels and their interaction in seeds .pod⁻¹. The local variety (V1) gave the highest number of seeds pod⁻¹ of 7.69, while the Baton Boa (V3) recorded the lowest seeds. pod⁻¹ reached to 6.85 seeds. pod⁻¹. These differences may be due to the high genetic susceptibility of the local variety to exploit the surrounding environmental conditions and use it in the process of photosynthesis, which helped to increase the growth and increase flowers, pollination and fertilization by regulating the growth and variety of plant hormones in the reproductive stage so thus increase the number of seeds

pod⁻¹. This result was consistent with the findings of Hassan *et al.* (2015), Kahraman, (2017) and Rajab and Khader, (2017). They found that cowpea varieties differed in the number of seeds in pods. The results of table (5) showed that the level of potassium k3 gave the highest seeds.pod⁻¹ of 8.76, while the control treatment of potassium (k0) gave the lowest average of seeds pod⁻¹ of 6.01.

Potassium contributed in regulation of transfer metabolites to the new evolutionary sites in the reproductive stage of plant, so lead to increase the fertility and nodes number. This result is consistent with the results of some researchers who they found that the addition of potassium resulted in significant increase in the number of seeds per cornea in

cowpea crop (Khan *et al.*, 2010; Mansouri & Shokoohfar, 2015).

Table (5): Response of cowpea varieties to potassium fertilizer levels and their interaction in seeds number. pod⁻¹.

Potassium levels	Varieties			means (K)
	V1	V2	V3	
K0	6.40	6.03	5.60	6.01
K1	7.27	6.93	6.50	6.90
K2	7.60	7.70	7.37	7.56
K3	9.50	8.83	7.93	8.76
means (V)	7.69	7.38	6.85	
L.S.D _{0.05} for Potassium=0.30, L.S.D _{0.05} for varieties =0.71, L.S.D _{0.05} for interaction=0.43				

For the interaction. The variety of V1 under K3 fertilizer level gave the highest seeds pod⁻¹ of 9.50, whereas the variety V3 under non-potassium fertilizer (V3 x K0) gave the lowest seeds. pod⁻¹ of 5.60.

100 seeds weight (g)

The results of tables (6 and 9) displayed that there are significant differences between varieties, potassium levels and their interaction in weight of 100 seeds, The Baton Boa V3 gave the highest rate in the weight of 100 seeds of 37.58 g, while the local variety V1 produced the lowest trait rate weight of 100 seeds of 33.75 g. local variety gave highest seed number. pod⁻¹ (Table 4) this lead to increasing competition between seeds within the pod on nutrients in development and seed falling stage within the pod, which reflect negatively on weight of 100 seeds. This was confirmed by the significant negative correlation between seed number. pod⁻¹ and weight of 100. The result was consistent with Kahraman (2017), who reported a significant difference between cowpea genotypes in the weight of 100 seeds. The results of Table (6) showed significant effect for potassium fertilizer level on weight of 100 seeds. The control treatment (K0) gave

highest seed weight of 100 seeds of 45.11 g compared with the level K3 which gave the lowest rate of 28.00 g. The addition of potassium fertilizer lead to increased seed number. pod⁻¹ (see Table 4) so this lead to increase the compotation between the seeds on the photosynthesis production which reflect negatively on weigh of 100 seed (Table 5). This results was not consistent with Seran (2010) and JafarUllah *et al.* (2012) who they found a significant increase in the weight of 100 seeds when potassium was added. For the interaction, the results of table (5) revealed that, the variety V3 under potassium level K0 gave the highest average of weight of 100 seed of 46.33, while the interaction of V1 with K3 gave the lowest average reached to 26.33g.

Yield of individual plant (g plant⁻¹)

The results of table (7 and 9) revealed that there is significant effect for varieties and potassium fertilizer levels, whereas there is significant effect for their interaction. The variety V1 produced the higher yield reached to 99.93g .plant⁻¹ while the variety V3 produced the lowest yield reached to 79.42g. plant⁻¹. The reason is that, the variety V3 gave

Table (6): Response of cowpea varieties to potassium fertilizer levels and their Interaction on weight of 100 (g).

Potassium levels	Varieties			means (K)
	V1	V2	V3	
K0	43.67	45.33	46.33	45.11
K1	34.33	35.67	39.67	36.56
K2	30.67	36.33	34.67	33.89
K3	26.33	28.00	29.67	28.00
means (V)	33.75	36.33	37.58	

L.S.D_{0.05} for Potassium=2.03, L.S.D_{0.05} for varieties =1.44, L.S.D_{0.05} for interaction=2.87

the highest seeds. pod⁻¹ and seeds number.plant⁻¹ which reflect positively on plant yield (Tables 4 and 5). This results was in agreement with Kahraman (2017). The results of table (7) showed that the addition of potassium lead to increased yield of individual plant. The potassium level of V3 gave the highest yield of plant (125.93 g plant⁻¹). While the control level produced the lowest average reached to 59.27g plant⁻¹.The increased of potassium fertilizer lead to

increased pod number plant⁻¹ and seeds number pod⁻¹ (Tables 4 and 5) which reflect positively in increased the yield of plant. In addition, potassium lead to increased plant yield throw improved translocation of photosynthesis product from leaves to sink. Moreover, Potassium improve enzyme activity specially the enzyme which play role in energy transferred and production of ATP complex.

Table (7): Response of cowpea varieties to potassium fertilizer levels and their interaction in yield of individual plant (g plant⁻¹)

V/k	Varieties			means (K)
	V1	V2	V3	
K0	73.04	62.66	42.12	59.27
K1	86.61	75.92	69.56	77.36
K2	99.95	113.43	93.36	102.25
K3	140.13	125.03	112.64	125.93
means (V)	99.93	94.26	79.42	

L.S.D_{0.05} for Potassium=4.29, L.S.D_{0.05} for varieties =5.97, L.S.D_{0.05} for interaction=n.s

Total grain yield (t. h⁻¹)

The results of tables (8 and 9) presented that, there is significant effect for varieties and potassium fertilizer levels. While the results revealed that there is no significant effect for

their interaction. The variety V1 gave the highest total grain yield reached to 4.16 t. h⁻¹, whereas the variety V3 gave the lowest average of 3.31 t. h⁻¹ (Table 8). The reason is because of the locale variety V1 produced

highest pod number. plant⁻¹, seeds number pod⁻¹ and the yield of individual plant (Tables 4, 5 and 7). The results indicated that the increased potassium fertilization lead to increased total grain yield. The level V3 gave the highest grain yield of 5.25 t.h⁻¹, whereas the control level (V0) gave the lowest grain

yield of 2.47 t.h⁻¹. potassium fertilizer lead to improve pod number .plant⁻¹, seeds number .pod⁻¹ and the grain yield of individual plant (Tables 4, 5 and 7), so the total grain yield have been significantly increased by applied K3 by 12.50% as compared to K0.

Table (8): Response of cowpea varieties to potassium fertilizer levels and their interaction in total yield (t. h⁻¹).

Potassium levels	Varieties			means (K)
	V1	V2	V3	
K0	3.04	2.61	1.75	2.47
K1	3.61	3.16	2.90	3.22
K2	4.16	4.73	3.89	4.26
K3	5.84	5.21	4.69	5.25
means (V)	4.16	3.93	3.31	

L.S.D_{0.05}for Potassium=0.18, L.S.D_{0.05}for varieties =0.25, L.S.D_{0.05} for interaction=n.s

Table (9): Analysis of variance represented by mean square of traits measured.

Sources of variation	df	Plant height	leaf area cm ²	Pods number per plant	Seeds number in a pod (seed.pod ⁻¹)	100 seeds weight (g)	Yield of individual plant (g plant ⁻¹)	Total grain yield (t. ha ⁻¹)
Blook	2	48.08	255009.72	42.76	8.42	29.36	3942.60	6.84
K	3	296.44**	3377296.39**	1464.68*	12.02**	455.19**	7617.61**	13.22**
E(k)	6	2.70 ^{n.s}	3340.98**	0.60 ^{n.s}	0.07 ^{n.s}	3.10 ^{n.s}	13.81**	0.02 ^{n.s}
V	2	1953.75**	544204.96**	191.62**	2.17**	45.86**	1346.59**	2.34**
KxV	6	99.14*	50105.18**	3.15*	0.23*	5.49*	167.28 ^{n.s}	0.29 ^{n.s}
E(V)	16	2.98	2920.33	0.68	0.06	2.75	47.53	0.08
Total	35							

n. s., means No significant differences, * :means significant differences were found at (P <0.05), ** means significant differences were found at (P <0.01).

Conclusion

The local variety significantly defer from other varieties and produced higher grain yield of 5.84 t ha⁻¹, also it is more adaptive for local environment as compared to other varieties. The addition of potassium fertilization lead to increased growth and grain yield, so this revealed the high contribution of potassium in supporting plant growth at deferent growth stages. The high level of potassium gave 5.25 t ha⁻¹.

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