

EFFECT OF SOME AGRICULTURAL TREATMENTS ON SEED PRODUCTION AND QUALITY OF COWPEA

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ABSTRACT

Tow field trials were conducted at Vegetable Research Farm of Horticultural Research Institute, Kaha, Kaluobia Governorate during two successive summer seasons of 2001 and 2002 to study the effect of plant spacing (10, 20 and 30 cm) and foliar application with potassium (0, 1, 2, 3 cm/L) on growth, seed yield and quality of cowpea cultivars i.e. Kafr El-Sheikh (1) and Kaha (1). Obtained results could be summarized as follow:

- 1- Kafr El-Sheikh (1) cv. surpassed Kaha (1) cv. in all measurement growth characters, i.e. plant height, number of branches and leaves, leaf area, fresh and dry weight of plants, also in seed yield and its components expressed as number and weight of pods, number of seeds per pod, 100-seed weight (seed index), seed yield per plant and per feddan, produced 35.2 and 39.6% seed yield more than the other cultivar in the two seasons, respectively and gave the highest values of germination (%), seedling length and protein (%) in dry seed.
- 2- All vegetative growth traits recorded higher values in wider spacing 20 or 30 cm except plant height which was maximum under closer spacing (10 cm). Also, all seed yield components characters were enhanced with increasing plant spacing except seed yield/feddan which was maximum under narrow spacing, as well as, seed quality characters except germination speed recorded higher values under wider spacing compared to closer spacing.
- 3- Spraying cowpea plants with potassium increased plant growth characters, seed yield and its components, germination percentage. seedling length and protein (%) in seed. Using potassium at (2 cm/L) was the most effective treatment for all studied characters.
- 4- Interaction effect of cultivars, plant spacing and potassium were differed for all studied characteristics.

In general, it may be recommended to grow the used cultivars under closer spacing (10 cm) and spraying plants with foliar application of potassium at (2 cm/L) to obtain the highest seed yield/feddan as well as seed quality..

INTRODUCTION

Cowpea (*Vigna unguiculata* L. Walp) is considered to be one of important legume crops grown in summer season in Egypt for its green pods and for dry seed, which seeds represent a cheif source of protein.

The seeds production and seed quality depend on many factors. Some of these factors are the used cultivars, plant spacing and foliar nutrition with potassium.

Cowpea cultivars differ genetically in most of vegetative growth characteristics i.e. plant height, number of leaves and branches, leaf area, fresh and dry weight of plant as well as seed yield and its components, also seed quality i.e. seed germination characters and protein percentage (Remison, 1980, Morsy, 1986, Fayad, 1997, Mohamed *et. al.*, 1999, Fawzia, 2000, Fawzia and Soad, 2000). Metwally *et al*, 1998 pointed out that Kafr el-

Sheikh-1 and Kaha-1 as new cultivars of cowpea where the first Cv. surpassed the two commercial cultivars, i.e. Cream-7 and Dokki 331 for seed index, seed yield and protein percentage in summer seasons, whereas, the second one surpassed these commercial cvs. for seed in fall season.

Many reports showed the importance of plant density through inter and intra-row spacing or number of plants per hill on vegetative growth, seed yield and its components as well as seed quality characteristics. Such reports pointed out that, plant growth in low density recorded higher values of all vegetative growth traits than those of in the closer plant density, except plant height which was maximum under closer plant density. Also, low density increased all yield components, while high density increased seed yield per plot (Abdel-Salam, 1963, Saleh *et al*, 1980, Rajesh *et al*, 1997, Fawzia, 2000 on cowpea, Shafik *et al*, 1988, Abdel Gaid, 1996, Ashmawy *et al*, 1998, El-Set *et al*, 1999, Wafaa, 2000, Mohamed, 2003 on faba bean, Ali and Ebaid, 1991 on soybean, Anisa *et al*, 1995 on common bean, Abd-El-Naby *et al* 1998, El-Gamiely *et al*, 1998 on peas.

Among the essential nutrients needed by the plant is potassium, which plays a highly recognized role in plant life, where an adequate supply of potassium for plant improves the quality and quantity of productivity. The stimulative effects of potassium on plant growth, also the favourable effect on seed yield and quality were reported by Tayo, 1981, Kandagal *et al*, 1990, Shide *et al*, 1991, Shide and Jadhav, 1995, Hassan 1998, El-Shaikh, 1999, Fawzia and Soad, 2000, on cowpea, El-Mansi *et al*, 1991 on broad bean, Hewedy *et al*, 1994, Ramamoorthy *et al*., 1995, Kandeel and El-Maddah, 1997 on phaseolus spp., Annaduari *et al*, 1994 on soybean and El-Habbasha *et al*, 1998 on peas.

This investigation aimed to study the response of growth, seed yield and quality of some cowpea cultivars to different plant spacing and foliar spray with potassium.

MATERIALS AND METHODS

Two field experiments were carried out at Vegetable Research Farm of Horticultural Research Institute, Kaha, Kaluobia Governorate during two successive summer seasons of 2001 and 2002 to study the effect of plant spacing and foliar application with potassium on growth, seed yield and quality of cowpea cultivars i.e. Kafr El-Sheikh-1 and Kaha-1. The soil was loamy clay with PH 7.8. The available content of NPK were 140, 4.5 and 0.6 ppm respectively. Each experiment included 24 treatments, which were the combinations of two cultivars, three treatments of spacings and four concentrations of foliar application with potassium as follows :

A- Cultivars

- 1- Kafr El-Sheikh-1 (cv.1) 2- Kaha-1 (cv.2)

B- Plant spacing

- 1- 10 cm (Sp₁) 2- 20 cm (Sp₂) 3- 30 cm (Sp₃)

C- Potassium

- 1- Spraying with water (Control)(K₀)

- 2- Spraying with 1 cm/L (K₁)
- 3- Spraying with 2 cm/L (K₂)
- 4- Spraying with 3 cm/L (K₃)

The treatments were arranged in a split-split plot design with three replications. Cultivars were assigned to the main plots, plant (hill) spacings were randomly distributed in sub plots, whereas potassium treatments were randomly devoted in the sub-sub plots. Treatments means were compared by Duncan's Multiple Range Test (Duncan, 1955).

Seed of cowpea (*Vigna unguiculata*, L. Walp) were sown on April 19th and 1st of 2001 and 2002, respectively in hills 10, 20 and 30 cm apart on one side of ridge. The plot area was (12 m²) consisted of four ridges, each one of 60 cm width and 5m in length. Foliar spray with potassium as K-lequid (37.5 potassium oxid produced by Kafr El-Zayat company for pesticides and chemicals) was done twice at 45 and 52 days from sowing. The normal practices of cowpea production were followed.

At flowering stage, random samples of 5 plants were taken from the two ridges of each sub-sub plot record the following vegetative growth characteristics (A) :

- 1- Plant height (cm).
- 2- Number of branches per plant.
- 3- Number of leaves per plant.
- 4- Fresh weight per plant (gm).
- 5- Dry weight per plant (gm).
- 6- Leaf area per plant (cm²) was calculated as a relation between area unit and fresh weight of leaves (Koller, 1972) using the following formula :

$$\text{Leaf area in cm}^2 = \frac{\text{Fresh weight of leaves}}{\text{Fresh weight of disks}} \times \text{leaf area of disks in cm}^2$$

At the seed harvest stage the following data were recorded the following seed yield and its components characteristics (B) :

- 1- No. of pods per plant.
- 2- Weight of pod per plant (gm).
- 3- No. of seeds per pod.
- 4- Seed yield per plant (gm).
- 5- Seed index (weight of 100 seed) in gm.
- 6- Seed yield/fed. (ton).

The following data were recorded for seed quality characteristics (C) :

- 1- germination percentage : According to the international Rules of (ISTA), 1993.
- 2- Germination speed (days) was calculated according to Edmond and Drapala (1958) : Mean number of days required for germination

$$= \frac{(G_1 \times N_1) + G_2 \times N_2 + \dots \dots \dots G_x \times N_x}{G_1 + G_2 + \dots \dots \dots G_x}$$

Where :

G = Number of germinated seed in certain day.

N = Number of this certain day.

- 3- Seedling length (cm) was calculated (7) days after germination of the produced seed.

- 4- Total protein percentage in dry seed were determined using micro-kjeldahl method according to the procedure described in A.O.A.C. (1965) and the total protein percentage were calculated by the multiplication of nitrogen values by 6.25.

All data in both seasons were subjected to proper Statistical analysis according to Snedcor and Cochran (1980).

RESULTS AND DISCUSSION

A-Vegetative growth

A.1. Effect of cultivars

The results reported in Table (1) indicate that, there were significant differences between the two cultivars in all growth characteristics. It is also clear that, Kafr El-Seikh-1 cv. was superior than Kaha-1 cv. These results were true in both seasons. The above finding confirmed the results recorded by Remison, (1980), Morsy(1936), Fayad (1997), Metwally *et al* (1998), Mohamed *et al* (1999), Fawzia (2000) and Fawzia and Soad (2000) working on many cowpea cvs, who reported that, variation between cultivars could be attributed to the genetic factors.

A.2. Effect of plant spacing

It is obvious from the same data in Table (1), that all vegetative growth traits; i.e. plant height, number of branchers and leaves per plant, leaf area, fresh and dry weight of plant were significantly affected by plant spacing. Higher values of all growth characteristics were obtained by widening spacing (20 or 30cm) except plant height which was maximum under narrow spacing between plants in both seasons. These results may be explained, as the narrower planting space, the more competition between plants for nutrients, light and water. Wider space for plant gave the chance for more branching and corresponding, more leaves can be born by increasing number of branches per plant (Abd El-Rahman *et al.*, 1983). These results are in harmony with those reported by Abdel El-Salam (1963), Saleh *et al* (1980), Fawzia (2000) on cowpea, Ashmawy *et al* (1998), El-Set *et al* (1999), on faba bean, Abd El-Naby *et al* (1998) and El-Gamiely *et al* (1998) on peas.

A.3. Effect of potassium

The growth characters of cowpea plants were influenced significantly by the foliar potassium application during the two experimental seasons (Table 1). All measurements growth characters, i.e. plant height, number of leaves and branches, leaf area, fresh and dry weight of plant significantly increased with increasing potassium concentration up to 2cm/L. The highest vales were obtained from foliar spray of 2cm/L potassium (K_2), whereas the lowest values were produced from the untreated control plants (K_0). The favourable effect of potassium might be due to, it is playing a vital role for normal cell division, translocation of carbohydrates and reduction of nitrates particularly in meristems (Black, 1960), in addition to, Edmond *et al.* (1977) pointed out that potassium is essential in the metabolic processes of important plant

constituents needed for normal plant growth and development. Hassan (1998), El-Shaikh (1999), Fawzia and Soad (2000) on cowpea, El-Mansi *et al.* (1991) on broad bean, Hewedy *et al.* (1994), Kandeel and El-Maddah (1997) on common bean, came to the same conclusion. On the other hand, El-Habbasha *et al.* (1996) found that, spraying peas with potassium at a concentration of 1.5 cm/L gave the shortest plants.

A.4. Effect of interactions

A.4.1. Effect of cultivars x plant spacing

Data tabulated in Table (2) illustrated that, the interaction between cultivars and plant spacing was significant for all vegetative growth traits. On the other hand, plants of Kafr El-Sheikh-1 cv. growth under wider spacing (30cm) produced more number of branches and leaves per plant, higher fresh and dry weight of plant and more leaf area/plant than the other interaction treatments, while, the tallest plants were obtained from Kafr El-Sheikh-1 cv. growth under close spacing (10cm) in both season. Surpassed Kafr El-Sheikh-1 cv. with wider spacing may be due to the vigours growth of cultivar. Similar results were obtained on cowpea by Fawzia (2000).

A.4.2. Effect of cultivars x potassium

The effect of interaction between cultivars and foliar spraying with potassium (K) on vegetative growth are shown in Table (3). It is evident that, spraying plants of Kafr El-Sheikh-1 cv. with potassium at 2cm/L (K_2) increased all growth characters than the other treatments in both seasons. Similar results were obtained by Fawzia and Soad (2000) on cowpea.

A.4.3. Effect of plant spacing x potassium

The interaction between treatments of plant spacing and that of potassium application as foliar spraying on growth measurements of cowpea plants during two seasons are shown in Table (4). It is clear that, the highest values of number of branches and leaves per plant, leaf area as well as fresh and dry weight of plant were obtained from plants grown under wide spacing (30cm) and spraying by potassium at 2cm/L (K_2). On the other hand, the tallest cowpea plants results with narrow spacing (10cm) and potassium foliar spray at 2cm/L (K_2). These results were true in the two experimental seasons. Similar results were obtained by El-Habbasha *et al.* (1996) on pea.

A.4.4. Effect of cultivars (Cv.) x plant spacing (Sp) x potassium (K)

The interaction effect of Cv. x Sp x K on vegetative growth are shown in Table (5). Data reveal that, plants of Kafr-El-Sheikh-1 cv (cv.1) grown under wider distance i.e. 30cm (Sp_3) with potassium foliar spray at 2cm/L (K_2) enhanced all the characters of plant growth except plant height. On the other hand, the tallest plants with Kafr-El-Sheikh-1 (Cv.1) under close spacing i.e. 10cm (Sp_1) and potassium spraying at 2cm/L (K_2). These results were true in both seasons.

Table (1): Effect of cultivars, plant spacing and foliar spraying with potassium (K) on growth characters of cowpea plants.

Treatments	Plant height (cm)		No. of branches/plant		No. of leaves/plant		Leaf area/plant (cm ²)		Fresh wt. Of plant (gm)		Dry wt. Of plant (gm)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
	Kafr El-Sheikh-1	55.6 a	52.2 a	4.2 a	4.8 a	23.5 a	28.4 a	180.9 a	170.3 a	164.5 a	161.6 a	20.4 a
Kaha-1	36.4 b	37.6 b	3.4 b	4.3 b	21.6 b	24.2 b	140.1 b	136.8 b	146.2 b	140.3 b	11.3 b	15.1 b
10 cm.	48.3 a	46.8 a	3.0 c	3.8 c	18.0 c	22.8 c	148.3 c	141.8 c	115.6 c	117.3 c	10.0 c	15.3 c
20 cm.	45.8 b	45.6 b	4.1 b	4.8 b	23.5 b	25.9 b	157.9 b	151.1 b	163.5 b	147.4 b	16.8 b	23.3 b
30 cm.	43.9 c	42.3 c	4.4 a	5.1 a	26.2 a	30.1 a	175.3 a	167.7 a	186.8 a	188.2 a	20.8 a	26.1 a
K0	42.9 c	39.4 d	3.2 b	4.0 b	18.8 c	22.9 d	149.9 c	143.4 c	119.1 d	117.5 d	12.8 c	17.5 d
K1	44.8 b	44.1 c	3.8 ab	4.6 ab	21.9 b	25.0 c	160.3 b	153.9 b	149.7 c	144.0 c	14.4 c	19.8 c
K2	50.0 a	49.5 a	4.4 a	5.3 a	26.2 a	30.2 a	170.9 a	165.5 a	194.2 a	188.3 a	19.7 a	25.5 a
K3	46.3 b	46.5 b	3.8 ab	4.4 b	23.3 b	27.1 b	160.9 b	151.5 b	158.3 b	154.1 b	16.4 b	23.5 b

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

Table (2): Interaction effect between cultivars and plant spacing on growth characters of cowpea plants.

Treatments	Plant height (cm)		No. of branches/plant		No. of leaves/plant		Leaf area/plant (cm ²)		Fresh wt. Of plant (gm)		Dry wt. Of plant (gm)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
	Kafr El-Sheikh-1	59.1 a	55.1 a	3.1 d	4.0 e	18.5 d	23.4 d	171.2 c	160.2 c	96.8 f	105.0 e	11.4 d
10 cm	55.8 b	53.0 a	4.5 b	5.1 b	25.0 b	28.0 b	178.9 b	170.5 b	178.1 b	151.6 b	22.2 b	30.5 b
20 cm	52.0 c	50.4 b	4.9 a	5.5 a	27.1 a	33.8 a	192.6 a	180.2 a	218.2 a	228.4 a	27.5 a	35.7 a
Kaha-1	37.5 d	40.4 c	2.9 d	3.7 e	17.5 e	22.3 e	125.4 f	123.4 f	134.4 e	129.6 d	8.7 e	12.5 e
10 cm.	35.8 e	38.1 d	3.6 c	4.4 d	22.0 c	23.9 d	136.9 e	131.8 e	149.0 d	143.1 c	11.3 d	16.2 d
20 cm.	35.9 e	34.3 e	3.8 c	4.8 c	25.3 b	26.5 c	158.0 d	155.3 d	155.1 c	148.2 b	14.1 c	16.5 d
30 cm.												

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

Table (3): Interaction effect between cultivars and foliar spacing with potassium (K) on growth characters of cowpea plants.

Treatments	Plant height (cm)		No. of branches/plant		No. of leaves/plant		Leaf area/plant (cm ²)		Fresh wt. Of plant (gm)		Dry wt. Of plant (gm)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
	Kafr El-Sheikh-1											
K0	53.0 c	44.8 c	3.7 ab	4.2 b	20.5 c	25.0 bc	168.4 c	159.5 c	126.8 e	129.1 f	16.4 c	20.8 d
K1	54.2 bc	51.8 b	4.2 ab	4.9 ab	23.5 b	26.8 b	179.6 b	171.0 b	155.2 cd	149.7 cd	19.4 b	25.1 c
K2	59.0 a	57.7 a	4.7 a	5.6 a	26.0 a	31.2 a	192.0 a	184.4 a	212.4 a	207.8 a	25.3 a	35.0 a
K3	56.3 b	54.3 b	4.1 ab	4.8 ab	24.2 ab	30.0 a	183.5 b	166.4 b	163.5 c	159.9 bc	20.2 b	31.5 b
Kaha-1												
K0	32.8 f	34.0 f	2.7 c	3.9 b	17.2 d	23.2 e	131.5 f	127.3 f	111.4 f	105.8 g	9.1 e	14.2 g
K1	35.5 e	36.3 ef	3.4 bc	4.3 b	20.3 c	23.2 d	141.0 e	136.8 e	144.3 d	138.3 ef	9.3 e	14.6 fg
K2	41.0 d	41.3 d	4.1 ab	4.9 ab	26.3 a	29.3 a	149.7 d	146.7 d	176.0 b	168.8 b	14.2 d	16.0 e
K3	36.2 e	38.7 de	3.5 bc	4.1 b	22.5 bc	24.2 cd	138.2 e	136.6 e	153.0 cd	148.4 de	12.6 d	15.5 ef

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

Table (4): Interaction effect between plant spacing and foliar spraying with potassium (K) on growth characters of cowpea plants.

Treatments	Plant height (cm)		No. of branches/plant		No. of leaves/plant		Leaf area/plant (cm ²)		Fresh wt. Of plant (gm)		Dry wt. Of plant (gm)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
	10 cm											
K0	46.0 cde	40.5 f	2.3 d	3.0 d	15.3 h	19.0 g	140.1 e	135.4 e	71.4 h	77.8 g	7.3 i	11.6 i
K1	47.0 cd	44.8 de	3.0 cd	3.6 cd	17.2 gh	20.5 g	146.4 e	141.4 e	109.2 g	108.4 f	8.6 j	13.8 h
K2	52.5 a	53.0 a	3.7 bc	4.7 abc	21.0 ef	27.9 cd	156.6 d	149.4 d	153.7 d	154.8 d	13.3 g	18.8 f
K3	47.8 bc	48.8 bc	3.0 cd	4.0 bcd	18.5 fg	24.0 f	150.1 e	141.1 e	128.1 f	128.1 e	10.9 h	17.1 g
20 cm												
K0	42.8 ef	38.5 f	3.6 bc	4.3 bc	18.8 fg	23.3 f	147.9 e	139.9 e	137.9 ef	125.4 e	14.2 fg	19.6 f
K1	44.3 df	45.5 cde	4.2 abc	4.9 ab	23.0 cde	24.5 ef	157.6 d	150.7 d	161.3 d	143.9 d	15.7 ef	21.3 e
K2	50.5 ab	49.5 b	4.4 abc	5.3 ab	27.3 bc	29.3 bc	166.7 c	161.6 c	193.6 b	173.6 c	19.7 bc	26.7 bcd
K3	45.0 cde	48.8 bc	4.1 abc	4.5 abc	25.0 bcd	26.8 de	159.4 d	152.4 d	161.4 d	146.5 d	17.5 cde	25.9 cd
30 cm												
K0	40.0 f	39.3 f	3.8 abc	4.8 abc	22.5 de	26.5 de	161.9 cd	154.8 cd	148.0 de	149.3 d	16.8 de	21.3 e
K1	43.3 e	42.0 ef	4.3 ab	5.3 ab	25.5 bc	30.0 bc	176.9 b	169.6 b	178.7 c	179.7 bc	19.0 cd	24.6 d
K2	47.0 cd	46.0 bcd	5.0 a	5.7 a	30.3 a	33.5 a	189.3 a	185.6 a	235.3 a	236.4 a	26.2 a	31.1 a
K3	45.5 cde	42.0 ef	4.3 ab	4.8 abc	26.5 b	30.5 b	173.1 b	160.9 c	185.2 bc	187.6 b	21.0 b	27.6 b

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

Table (5): Interaction effect between cultivars (Cv.), plant spacing (Sp) and foliar spraying with potassium (K) on growth characters of cowpea plants.

Cv.	Treatments Sp.	Plant height (cm)		No. of branches/plant		No. of leaves/plant		Leaf area/plant (cm ²)		Fresh wt. Of plant (gm)		Dry wt. Of plant (gm)		
		2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	
Cv. (1)	Sp1	K0	57.0 abc	44.5 hij	2.5 ef	3.0 e	16.5 fg	18.0 g	160.3 h	153.9 hij	62.7 i	78.9 j	7.1 i	11.4 l
		K1	58.5 ab	51.5 cdef	3.0 def	3.7 cde	18.0 efg	20.0 fg	168.4 fg	161.2 efgh	80.9 i	84.7 j	9.5 kl	15.6 hij
		K2	61.0 a	60.5 a	3.7 bcdef	5.0 abcd	20.5 cdef	29.0 bc	182.8 ed	170.4 cde	132.4 fg	138.7 fghi	15.4 ghi	23.8 f
	Sp2	K3	60.0 a	56.0 abc	3.2 cdef	4.2 bcd	19.0 def	26.5 cd	173.2 ef	155.3 ghi	111.3 h	117.6 i	13.5 hij	21.6 g
		K0	53.0 cde	43.0 ijk	4.2 abcde	4.5 abcde	21.0 cde	26.0 cd	169.2 fg	159.7 fgh	150.6 def	131.0 ghi	19.2 ef	24.0 f
		K1	54.0 bcd	54.0 bcde	4.7 abcd	5.3 abcd	25.0 bc	27.0 cd	179.9 de	171.5 cde	177.6 d	147.9 efg	22.1 de	27.2 e
	Sp3	K2	61.0 a	57.5 ab	4.8 abc	5.5 abc	27.0 ab	29.5 bc	188.2 bc	182.9 b	211.5 b	181.8 c	25.7 bc	36.1 c
		K3	55.0 bc	57.0 ab	4.5 abcd	5.0 abcd	27.0 ab	29.5 bc	178.3 de	167.9 def	172.5 c	145.6 efg	21.9 de	34.7 c
		K0	49.0 e	47.0 fghi	4.5 abcd	5.0 abcd	24.0 bc	32.5 ab	175.8 def	164.8 efg	167.0 cd	177.5 cd	23.0 cd	26.9 e
Cv. (2)	Sp1	K1	50.0 de	49.5 efgh	5.0 ab	5.7 ab	27.5 ab	33.5 a	190.4 b	180.2 bc	207.0 b	216.6 b	26.7 b	32.6 d
		K2	55.0 bc	55.0 bcd	5.5 a	6.1 a	30.5 a	35.0 a	205.1 a	199.9 a	293.3 a	302.9 a	34.7 a	45.1 a
		K3	54.0 bcd	50.0 defg	4.7 abcd	5.2 abcd	26.5 ab	34.0 a	198.9 a	175.9 bcd	206.7 b	216.6 b	25.5 bc	38.3 b
	Sp2	K0	35.0 hij	36.5 lmn	2.0 f	3.0 e	14.0 g	20.0 fg	119.8 m	116.8 n	80.0 i	76.6 j	7.5 i	11.7 l
		K1	35.5 ghij	38.0 klm	3.0 def	3.5 de	16.5 fg	21.0 efg	124.3 lm	121.5 mn	137.5 fg	132.2 ghi	7.7 kl	12.0 kl
		K2	44.0 f	45.5 ghij	3.7 bcdef	4.5 abcde	21.5 cde	26.8 cd	130.5 kl	128.4 lm	175.0 c	170.9 cd	11.2 jk	13.7 kl
	Sp3	K3	35.5 ghij	41.5 jkl	2.8 def	3.8 bcde	18.0 efg	21.5 efg	127.0 lm	162.9 lmn	145.0 efg	138.7 fghi	8.2 kl	12.5 kl
		K0	32.5 ij	34.0 mn	3.0 def	4.2 bcde	16.0 fg	20.5 efg	126.5 lm	120.2 mn	125.2 gh	119.8 hi	9.2 kl	15.1 ij
		K1	34.5 hij	36.5 lmn	3.7 bcdef	4.5 abcde	21.0 cde	22.0 ef	135.4 jk	129.9 lm	145.0 efg	140.0 fgh	9.3 kl	15.3 hij
Sp3	K2	40.0 fg	41.5 jkl	4.0 abcde	5.0 abcd	27.5 ab	29.0 bc	145.2 l	140.2 k	175.6 c	165.4 cde	13.6 hij	17.3 h	
	K3	36.0 gh	40.5 jkl	3.7 bcdef	4.0 bcde	23.0 bcd	24.0 de	140.5 ij	136.9 kl	150.3 def	147.4 efg	13.0 ij	17.0 hi	
	K0	31.0 j	31.5 n	3.2 cdef	4.5 abcde	21.0 cde	20.5 efg	148.1 i	144.8 jk	129.0 gh	121.0 hi	10.6 jkl	15.7 hij	
Sp3	K1	36.5 ghi	34.5 mn	3.7 bcdef	5.0 abcd	23.0 bc	26.5 cd	163.3 gh	158.9 fgh	150.0 def	142.8 fg	11.2 jk	16.5 hi	
	K2	39.0 gh	37.0 lmn	4.5 abcd	5.3 abcd	30.0 a	32.0 a	173.4 ef	171.4 cde	175.3 c	170.0 cd	17.0 fg	17.0 hi	
	K3	37.0 ghi	34.0 mn	4.0 abcde	4.3 abcde	26.5 ab	27.0 cd	147.2 i	145.9 jk	167.7 cde	159.1 def	16.7 fgh	16.0 hi	

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

B- Seed yield and its components

B.1. Effect of cultivars

Number and weight of pods per plant, number of seeds per pod, seed index (100-seed weight), seed yield per plant or per fed., influenced significantly by cultivars as shown in Table (6). It is obvious that, Kafr El-Sheikh-1 cv. surpassed the Kaha-1 cv. in all seed yield characters in both seasons. The superiority of Kafr El-Sheikh-1 cv. due to the high number of pods per plant, number of seed per pod and the heaviest seed index. Kafr El-Sheikh-1 produced 35.2 and 39.6 % seed yield per feddan more than the Kaha-1 cultivar in the first and second seasons, respectively.

These results are in agreement with Remison (1980) Morsy (1986), Fayad (1997), Metwally *et al.* (1998), Mohamed *et al.* (1999), Fawzia (2000) and Fawzia & Soad (2000) working on different cultivars of cowpea. They reported that seed yield components were fairly stable with cultivars specifically.

B.2. Effect of plant spacing

Data presented in Table (6) show the effect of plant spacing on dry seed yield and its components expressed as number and weight of pods per plant, number of seeds per pod, seed yield per plant or per feddan. It could be summarized that the all traits except seed yield per feddan increased with increasing plant spacing from 10 to 20 or 30 cm, whereas, the close spacing (10 cm) gave the highest seed yield per feddan. This might be due to the increase of number of plants in unit area.

These results are similar to those reported by Abdel Salam (1963), Saleh *et al.* (1980), Rajesh *et al.* (1997), Fawzia (2000) on cowpea, Shafik *et al.* (1988), Abdel Gaid (1996), Ashmawy *et al.* (1998), Waffa (2000, Mohamed (2003) on broad bean, Ali and Ebaid (1991) on soybean and Anisa *et al.* (1995) on common bean.

B.3. Effect of potassium

Data in Table (6) indicate that, number and weight of pods per plant, number of seeds per pods, seed index (100-seed weight), seed yield per plant and per feddan were significantly increased by using potassium as foliar spray. The maximum increases resulted from plants sprayed with 2.0 cm/L potassium (K_2) compared to the other treatments. This treatment gave the highest dry seed yield of 1.169 and 1.342 ton/fed. in the first and the second seasons, respectively. The increment in dry seed yield might be due to the increases in number and weight of pods per plant, number of seeds/pod and weight of 100 seed (seed index), in addition to the role of potassium in plant metabolism and accumulation of carbohydrates (Hassan, 1998). Similar results were concluded by Tayo (1981), Kandagal *et al.* (1990), Shide *et al.* (1991) Shide and Jadhav (1995), El-Shaikh (1999), Fawzia and Soad (2000) on cowpea, Annaduari *et al.* (1994) on soybean, Hewedy *et al.* (1994) and Ramamoorthy *et al.* (1995) on *Phaseolus* spp.

B.4. Effect of interactions

B.4.1. Effect of cultivars x plant spacing

Data in Table (7) revealed that, seed yield and its components were affected by the interaction between cultivars and plant spacing. The highest number and weight of pods/plant, number of seeds per pod, seed yield/plant and seed index (100-seed weight) were obtained from the Kafr El-Sheikh-1 cv. plants under wide spacing (20 or 30 cm). On the other hand, the cultivar (Kafr El-Sheikh-1) grown under closer space (10 cm) produced the highest seed yield/feddan. Similar trend was observed with morphological traits. In this respect, Jallow (1985) on cowpea, reported that cultivar x plant density reflected highly significant interaction effects on seed yield. Fawzia (2000) on cowpea, found that H.8-9 cv. with low plant density was the superior treatment regarding all seed yield components except seed yield/feddan, while the same cultivar with high density gave the maximum seed yield/fed.

B.4.2. Effect of cultivars x potassium

The effects of interaction between cultivars and foliar application with potassium (K) on seed yield and its components are shown in Table (8). Data reveal that spraying plants of Kafr El-Sheikh-1 cv. with potassium at 2cm/L. (K_2) gave the highest values of seed yield and its components in both seasons. Fawzia and Soad (2000) on cowpea, pointed out that foliar nutrition with potassium-f on IT85D-1010 cv. resulted in the production of the highest total dry yield and its components.

B.4.3. Effect of plant spacing x potassium

The interaction between treatments of plant spacing and that of potassium application as foliar spraying on seed yield and its components of cowpea plants during the two seasons are shown in Table (9), it is obvious that, all seed yield components except seed yield/feddan in wide spaces (20 or 30 cm) combined with potassium at 2 cm/L (K_2) recorded higher values. On the contrary, the lower spacing of 10 cm x potassium at 2 cm/L (K_2) gave the maximum seed yield/fed. In this respect, El-Habbasha *et al.* (1996) on peas, reported that the highest values of number of pod per plant were obtained with dense planting and sprayed by potassium, whereas, wide seeding and using potassium spraying gave the highest number of seeds per pod.

B.4.4. Effect of cultivars (Cv.) x plant spacing (Sp) x potassium (K)

The interaction effect of cultivars x plant spacing x potassium are presented in Table (10). It is clear that, plants of Kafr El-Sheikh-1 (cv.1) grown under wider distance i.e. 30 cm (Sp_3) with potassium foliar spray at 2 cm/L (K_2) recorded the higher values of all seed yield components, except seed yield per feddan. On the contrary, the same cultivar (cv.1) under close spacing of 10 cm (Sp_1) and application of potassium at 2 cm/L (K_2) gave the highest seed yield per feddan. These results were true in the two experimental seasons.

Table (6): Effect of cultivars, plant spacing and foliar spraying with potassium (K) on seed yield and its components of cowpea plants.

Treatments	No. of pods/plant		Wt. of pods/plant (gm)		No. of Seeds/pod		Seed yield/plant (gm)		Seed index (gm)		Seed yield/fed. (Ton)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
	Kafr El-Sheikh-1	19.2 a	18.6 a	27.6 a	27.5 a	9.7 a	9.7 a	32.8 a	32.4 a	17.9 a	18.2 a	1.011 a
Kaha-1	17.9 b	17.8 b	27.3 b	25.0 b	8.0 b	7.9 b	23.7 b	23.4 b	16.7 b	16.3 b	0.748 b	0.755 b
10 cm.	14.1 c	14.8 c	18.5 c	20.6 c	8.2 c	8.3 c	19.3 c	20.4 c	16.8 c	16.3 c	1.097 a	1.183 a
20 cm.	19.8 b	19.3 b	32.6 a	30.9 a	9.0 b	9.0 b	30.2 b	29.9 b	17.2 b	17.3 b	0.858 b	0.857 b
30 cm.	21.6 a	20.5 a	31.4 b	27.3 b	9.4 a	9.2 a	35.3 a	33.5 a	17.8 a	18.2 a	0.684 c	0.673 c
K0	15.4 d	14.4 c	21.8 d	19.5 c	8.3 c	8.2 b	21.4 d	19.2 d	16.6 c	16.7 b	0.644 d	0.587 c
K1	17.8 c	18.2 b	26.7 c	25.3 b	8.7 b	8.7 b	26.3 c	27.6 b	17.1 bc	17.1 b	0.805 c	0.866 b
K2	22.1 a	22.8 a	34.0 a	34.5 a	9.4 a	10.0 a	35.9 a	39.9 a	17.9 a	18.0 a	1.169 a	1.342 a
K3	18.8 b	17.5 b	28.0 b	25.8 b	9.0 b	8.4 b	29.5 b	25.0 c	17.4 ab	17.2 b	0.900 b	0.823 b

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

Table (7): Interaction effect between cultivars and plant spacing on seed yield and its components of cowpea plants.

Treatments	No. of pods/plant		Wt. of pods/plant (gm)		No. of Seeds/pod		Seed yield/plant (gm)		Seed index (gm)		Seed yield/fed. (Ton)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
	Kafr El-Sheikh-1	14.5 e	14.7 f	18.3 f	20.0 f	9.0 c	9.4 b	22.0 e	23.5 e	17.2 bc	16.8 c	1.249 a
10 cm	20.6 c	20.1 b	33.1 a	32.2 a	9.8 b	9.8 a	34.7 b	35.0 b	17.6 b	18.3 b	0.989 b	1.006 b
20 cm	22.4 a	21.2 a	31.5 c	29.5 b	10.3 a	9.9 a	41.9 a	38.8 a	18.8 a	19.5 a	0.796 d	0.808 c
Kaha-1	13.7 f	14.9 e	18.8 e	21.2 e	7.5 f	7.2 e	16.6 f	17.2 f	16.5 d	15.7 d	0.945 c	1.017 b
10 cm.	19.0 d	18.5 d	32.0 b	28.6 c	8.2 e	8.1 d	25.8 d	24.9 d	16.7 cd	16.4 c	0.727 e	0.708 c
20 cm.	20.9 b	19.9 c	31.3 d	25.1 d	8.5 d	8.5 c	28.7 c	28.2 c	16.9 cd	16.9 c	0.573 f	0.539 d
30 cm.												

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

Table (8): Interaction effect between cultivars and foliar spraying with potassium (K) on seed yield and its components of cowpea plants.

Treatments	No. of pods/plant		Wt. of pods/plant (gm)		No. of Seeds/pod		Seed yield/plant (gm)		Seed index (gm)		Seed yield/fed. (Ton)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
	Kafr El-Sheikh-1	16.9 c	14.7 e	22.1 e	20.9 e	8.8 c	9.0 b	26.1 d	22.4 e	17.2 bc	17.9 b	0.777 d
K0	18.4 b	18.4 c	26.8 cd	26.3 c	9.5 b	9.7 ab	30.2 c	32.7 c	17.7 ab	17.9 b	0.918 c	1.033 b
K1	22.3 a	24.3 a	37.7 a	37.7 a	10.3 a	10.6 a	40.8 a	46.1 a	18.6 a	19.0 a	1.306 a	1.593 a
K2	19.0 b	17.0 d	27.9 bc	25.3 c	10.0 ab	9.4 b	34.1 b	28.6 d	17.9 ab	17.9 b	1.043 b	0.905 bc
K3	13.8 d	14.0 e	20.5 f	18.2 f	7.7 e	7.4 c	16.7 f	16.0 f	16.1 d	15.5 d	0.511 e	0.489 e
K0	17.1 c	17.9 cd	26.6 d	24.2 d	8.0 de	7.7 c	22.3 e	22.5 e	16.5 cd	16.3 c	0.692 d	0.699 d
K1	22.0 a	21.3 b	33.4 a	31.2 b	8.5 cd	9.3 b	30.9 c	33.7 b	17.2 bc	17.0 c	1.032 b	1.091 b
K2	18.5 b	17.9 cd	28.0 b	26.3 c	7.9 e	7.3 c	24.8 d	21.4 e	16.9 bcd	16.5 c	0.757 d	0.741 cd
K3												

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

Table (9): Interaction effect between plant spacing and foliar spraying with potassium (K) on seed yield and its components of cowpea plants.

Treatments	No. of pods/plant		Wt. of pods/plant (gm)		No. of Seeds/pod		Seed yield/plant (gm)		Seed index (gm)		Seed yield/fed. (Ton)	
	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002
	10 cm	11.7 g	11.2 f	15.3 i	13.9 j	7.5 e	7.6 f	13.4 g	12.2 h	16.1 c	15.4 e	0.759 fg
K0	13.2 f	14.5 e	17.3 h	19.7 i	8.2 de	8.0 ef	17.1 f	18.8 g	16.7 bc	16.2 de	0.972 cd	1.069 bc
K1	17.7 d	19.0 bc	23.6 g	27.9 e	9.1 abc	9.7 abc	27.9 d	31.7 d	17.6 ab	17.1 bcd	1.588 a	1.807 a
K2	13.9 f	14.5 e	18.0 h	21.0 h	8.2 de	8.0 ef	18.8 f	18.8 g	17.0 abc	16.4 cde	1.070 bc	1.162 b
K3	15.7 e	15.0 e	22.4 g	21.9 gh	8.4 cd	8.4 def	21.7 e	20.8 f	16.6 bc	16.9 bcd	0.617 hi	0.592 e
20 cm	19.2 c	19.6 b	33.3 c	29.7 d	8.5 bcd	9.1 bcde	27.9 d	30.8 d	17.0 abc	17.3 bc	0.781 fg	0.897 cd
K0	23.8 a	24.4 a	40.1 a	41.1 a	9.4 ab	10.3 a	38.9 b	42.9 b	18.0 a	17.9 b	1.110 b	1.222 b
K1	20.6 b	18.2 cd	34.6 c	31.1 c	9.2 ab	8.1 def	32.4 c	25.3 e	17.2 abc	17.2 bcd	0.923 de	0.719 de
K2	18.9 cd	16.9 d	26.2 f	22.9 g	9.0 bc	8.7 cdef	29.3 d	24.7 e	17.4 ab	17.8 b	0.556 i	0.476 e
K3	20.9 b	20.4 b	29.6 e	26.5 f	9.3 ab	9.2 abcd	33.4 c	33.3 c	17.7 ab	18.0 b	0.664 ghi	0.633 e
30 cm	25.0 a	25.0 a	38.5 b	34.4 b	9.9 a	9.9 ab	40.9 a	45.1 a	18.2 a	19.1 a	0.809 ef	0.997 bc
K0	21.8 b	19.8 b	31.4 d	25.5 f	9.5 ab	9.0 bcde	37.2 b	31.0 d	18.1 a	18.0 b	0.708 fgh	0.589 e
K1												
K2												
K3												

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

Table (10): Interaction effect between cultivars (Cv.), plant spacing (Sp) and foliar spraying with potassium (K) on seed yield and its components of cowpea plants.

Cv.	Treatments Sp.	No. of pods/plant		Wt. of pods/plant (gm)		Seeds/pod		Seed yield/plant (gm)		Seed index (gm)		Seed yield/fed. (Ton)		
		2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	2001	2002	
Cv. (1)	Sp1	K0	12.5 jk	10.7 j	14.7 i	13.8 i	8.0 ghi	8.0 cdef	15.7 m	14.3 n	16.3 ef	16.6 fghi	0.892 efg	0.817 fghi
		K1	13.7 ij	15.0 gh	17.9 ijk	21.6 j	8.6 efgh	9.1 bcdef	19.2 i	22.4 jk	17.1 bcdef	16.4 fghi	1.090 cd	1.276 bcd
		K2	17.0 h	20.0 cde	22.2 h	26.1 gh	9.9 abc	10.5 ab	30.6 fg	37.0 cdef	18.2 abcde	17.6 cdefg	1.746 a	2.107 a
	Sp2	K3	14.8 i	13.0 hi	18.2 ij	18.5 k	9.3 bcdef	9.2 bcdef	22.3 k	20.3 l	17.1 bcdef	16.7 efghi	1.269 bc	1.192 bcd
		K0	18.3 fgh	15.7 g	24.7 ghi	24.7 ghi	8.7 defgh	8.9 bcdef	26.5 hij	24.0 ij	16.9 bcdef	18.0 bcdef	0.754 fgh	0.685 hij
		K1	19.7 efg	20.2 cd	32.8 e	32.9 c	9.6 abcde	10.1 abc	31.7 ef	36.8 de	17.4 abcdef	18.2 bcde	0.905 defg	1.087 cdefg
	Sp3	K2	24.3 ab	26.0 a	41.7 a	44.0 a	10.4 ab	11.0 a	44.3 b	49.6 b	18.7 ab	18.8 bcd	1.268 bc	1.413 bc
		K3	20.2 def	18.3 de	32.9 e	31.2 cd	10.3 ab	9.1 bcdef	36.1 d	29.5 f	17.5 abcdef	18.0 bcdef	1.027 de	0.840 efghi
		K0	20.0 def	17.8 ef	26.5 g	24.1 hi	9.8 abcd	9.3 bcdef	36.1 d	29.0 f	18.4 abcd	19.0 bcdef	0.685 hijk	0.551 ij
Cv. (2)	Sp1	K1	21.8 cde	20.0 cde	29.8 f	24.5 ghi	10.2 ab	10.1 abc	39.8 c	38.8 c	18.6 abc	19.2 b	0.760 fghijk	0.737 ghij
		K2	25.6 a	27.0 a	37.2 cd	43.1 a	10.7 a	10.2 abc	47.6 a	51.6 a	19.0 a	20.6 a	0.904 defg	1.259 bcd
		K3	22.0 cd	19.8 cde	32.5 e	26.3 g	10.5 a	9.9 abcd	43.9 b	35.9 e	19.0 a	19.1 bc	0.834 efghi	0.683 hij
	Sp2	K0	10.8 k	11.7 ij	15.9 kl	14.0 i	7.0 i	6.4 h	11.0 n	10.0 o	15.8 f	14.2 j	0.626 jkl	0.568 ij
		K1	12.7 jk	14.0 gh	16.6 jkl	17.7 k	7.0 hi	6.8 gh	15.0 m	15.1 n	16.2 f	15.9 hi	0.853 efghi	0.863 efghi
		K2	18.3 fgh	18.0 def	25.0 g	29.7 de	8.2 fgh	8.9 bcdef	25.1 ij	26.4 gh	17.0 bcdef	16.5 fghi	1.430 b	1.507 b
	Sp3	K3	13.0 ij	16.0 fg	17.7 ijk	23.5 ij	7.0 i	6.7 gh	15.3 m	17.3 m	16.8 bcdef	16.1 gni	0.871 efg	1.131 cdef
		K0	13.0 ij	14.3 gh	19.7 i	19.0 k	8.0 ghi	7.9 fgh	16.8 im	17.5 m	16.2 f	15.8 i	0.480 lm	0.498 ij
		K1	18.6 fgh	19.0 cde	33.8 e	26.5 fg	8.1 ghi	8.0 efgh	24.1 jk	24.8 hi	16.5 def	16.3 ghi	0.656 ikl	0.706 hij
Sp3	K2	23.3 bc	22.8 b	38.4 bc	38.1 b	8.4 fgh	9.5 abcdef	33.4 de	36.2 e	17.3 abcdef	16.9 efghi	0.953 def	1.031 defgh	
	K3	21.0 de	18.0 def	36.2 d	39.9 d	8.1 ghi	7.1 gh	28.7 gh	21.0 kl	16.9 bcdef	16.4 fghi	0.8190 fghij	0.597 ij	
	K0	17.7 gh	16.0 fg	25.8 g	21.6 j	8.1 ghi	8.0 efgh	22.4 k	20.4 l	16.3 ef	16.5 fghi	0.427 m	0.401 j	
Sp3	K1	20.0 def	20.7 c	29.4 f	28.4 ef	8.3 fgh	8.3 defg	27.7 hi	27.7 fg	16.7 cdef	16.7 efghi	0.567 klm	0.528 ij	
	K2	24.3 ab	23.0 b	39.4 b	25.7 gh	9.0 cdefg	9.6 abcde	34.3 de	38.6 ed	17.4 abcdef	17.5 defgh	0.714 ghijk	0.734 ghij	
	K3	21.5 cde	19.7 cde	30.2 f	24.6 ghi	8.5 efgh	8.1 efg	30.5 fg	26.0 gh	17.1 bcdef	16.9 efghi	0.582 klm	0.494 ij	

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

C- Seed quality characteristics

C.1. Effect of cultivars

Data in Table (11) demonstrate clearly that, there were significant differences between the two cultivars in all seed quality characteristics except germination speed which was not significantly influenced by the cultivars in the first season only. Kafr El-Sheikh-1 cv. was surpassed Kaha-1 cv. in germination percentage of the seed produced, seedling length and seed protein percentage in both seasons. In this respect Metwally et al. (1998) on cowpea found that seed protein percentage increased in Kafr El-Sheikh-1 than the other cultivars (Kaha-1, Cream-7 and Dokki 331). Moreover, Fawzia and Soad (2000) pointed out that the IT 85-D-1010 cv. had the highest significant values of seedling vigour and protein content, whereas Dokki 331 cv. surpassed IT 85-D-1010 cv. in germination % and radical length. Similar results on cowpea cultivar were also reported by Fawzia (2000).

C.2. Effect of plant spacing

The results in Table (11) showed that wide spacing between hills i.e. 20 and 30 cm resulted in a significantly higher values for germination percentage, seedling length and protein (%) than those of narrow spacing i.e. 10cm in both season, whereas different plant spacings did not reflect any significant effect on germination speed. Similar results were obtained by Anisa et al. (1995) on climbing bean and Fawzia (2000) on cowpea.

C.3. Effect of potassium

Germination percentage, germination speed, seedling length and protein content as affected by foliar spraying with potassium are given in Table (11). Results show that, all concentrations of potassium had favourable effect on seed quality characters. Spraying with potassium at 2.0 cm/L (K_2) was the most effect treatment in increasing the germination percentage, seedling length, protein percentage in both seasons, whereas the same treatment minimized significantly the number of days for germination i.e. increased the speed of germination in the first season only. The stimulative effect of foliar nutrition with potassium on seed quality was reported by Fawzia and Soad (2000). They found that potassin-f was superior for giving maximum germination percentage and seedling vigour, i.e., radical length, plumule length and enhanced crude protein (%).

C.4. Effect of interactions

C.4.1. Effect of cultivars x plant spacing

As for the combined effect of both cultivars and plant spacing, data in Table (12) indicate that, plants of Kafr El-Sheikh-1 cv. grown under 30 cm in the second season and plants of Kaha-1 cv. grown under spacing of 20 cm in the first one recorded the highest values of germination percentage, whereas the same cultivars under spacing of 30 cm in the first season and the second one respectively minimized significantly the number of days needs for germination i.e. increased the speed of germination. Also, this study clearly shows that Kafr El-Sheikh-1 cv. grown under wider space (20 or 30 cm) gave the tallest seedlings. On the other hand, Kafr El-Sheikh-1 cv. under 30 cm exhibited superior protein content in seeds in both seasons. Similar results were obtained by Fawzia (2000) on cowpea.

Table (11) : Effect of cultivars, plant spacing and foliar spraying with Potassium (K) on seed quality characters of cowpea plants.

Treatments	Germination %		Germination speed (days)		Seedling length (cm)		Protein %	
	2001	2002	2001	2002	2001	2002	2001	2002
Kafir El-Sheikh-1 Kaha-1	95.4 a	90.0 b	3.14 a	3.11 b	36.8 a	35.2 a	21.5 a	20.8 a
	94.3 b	91.6 a	3.10 a	3.16 a	32.4 b	33.1 b	20.4 b	19.8 b
	94.2 b	87.3 c	3.13 a	3.19 a	33.5 c	33.2 b	20.2 c	19.4 c
10 cm	95.1 a	91.6 b	3.11 a	3.16 a	35.5 a	34.6 a	21.0 b	20.2 b
20 cm	95.2 a	93.7 a	3.11 a	3.05 b	34.8 b	34.6 a	21.7 a	21.3 a
30 cm	93.5 c	85.8 d	3.21 a	3.12 ab	32.9 c	32.7 c	19.9 c	19.3 c
K0	94.8 b	91.0 c	3.11 ab	3.19 a	34.0 bc	33.7 bc	20.7 b	20.2 b
K1	96.8 a	94.0 a	3.09 b	3.15 a	36.4 a	36.0 a	22.0 a	21.3 a
K2	94.2 ab	92.5 b	3.07 b	3.07 b	35.1 b	34.2 b	21.2 b	20.3 b
K3								

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

Table (12) : Interaction effect between cultivars and plant spacing on seed quality characters of cowpea plants.

Treatments	Germination %		Germination speed (days)		Seedling length (cm)		Protein %	
	2001	2002	2001	2002	2001	2002	2001	2002
Kafir El-Sheikh-1 10 cm 20 cm 30 cm	93.3 d	84.4 f	3.10 ab	3.18 b	35.2 c	33.6 b	20.9 cd	19.9 c
	94.5 c	91.1 d	3.13 ab	3.09 c	38.2 a	35.9 a	21.4 b	20.8 b
	95.1 b	94.6 a	3.08 b	3.06 cd	37.1 b	36.1 a	22.2 a	21.7 a
Kaha-1 10 cm 20 cm 30 cm	95.1 b	90.1 e	3.16 a	3.20 ab	31.8 e	32.9 b	19.6 e	18.9 d
	95.6 a	92.0 c	3.10 ab	3.23 a	32.7 d	33.2 b	20.6 d	19.7 c
	95.4 ab	92.7 b	3.15 ab	3.04 d	32.6 d	33.1 b	21.1 bc	20.8 b

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

C.4.2. Effect of cultivars x potassium

Data in Table (13) reveal that, growing cowpea plants of Kaha-1 cv. and potassium foliar spray at 2.0 cm/L (K_2) being the most efficient and superior treatment in germination percent. The results also, show that Kafr El-Sheikh-1 cv. combined with potassium at 2.0 cm/L (K_2) gave the tallest seedlings and increased protein (%) in seeds. It is also observed from the same data that foliar nutrition of cowpea plants Kaha-1 cv. with potassium at 0.0 cm/L (K_0) or at 1.0 cm/L (K_1) induced significantly delay in the speed of seed germination in the first and second seasons, respectively.

C.4.3. Effect of plant spacing x potassium

Date of the interaction between plant spacing and foliar spraying with potassium are presented in Table (14). It is clear that, cowpea plants grown under spacing of 20 cm combined with potassium at 2.0 cm/L (K_2) was the most obvious treatment in increasing the germination percentage and gave the tallest seedlings in both seasons. On the other hand, control plants (K_0) grown under closer spacing (10 cm) induced significantly delay in the speed of seed germination. Moreover, plants grown under wider spacing (30 cm) with potassium at 2.0 cm/L (K_2) produced highest value of protein (%) in seeds.

C.4.4. Effect of cultivars (Cv.) x plant spacing (Sp) x potassium (K)

The interaction effect of cultivars x plant spacing x potassium, are presented in Table (15). It is clear that, plants of Kaha-1 (cv. 2) grown under spacing of 30 cm and sprayed with potassium at 2.0 cm/L (K_2) recorded the higher value of germination percentage, whereas, the control plants (K_0) of the same cultivar grown under spacing of 10 cm delayed speed of seed germination. On the other hand, plants of Kafr El-Sheikh-1 (cv. 1) grown under spacing of 30 cm with potassium foliar spray at 2.0 cm/L (K_2) gave the tallest seedlings and increased protein (%) in seeds. These results were true in the two experimental seasons.

Finally, the present investigation recommended the importance of plant spacings and potassium foliar spray to improve growth, seed yield and quality of used cultivars and it can be concluded also that, cowpea cultivars grown at closer spacing (10 cm) and sprayed with potassium at 2 cm/L. gave the highest seed yield/fed.

Table (13) : Interaction effect between cultivars and foliar spraying with potassium (K) on seed quality characters of cowpea plants.

Treatments	Germination %		Germination speed (days)		Seedling length (cm)		Protein %	
	2001	2002	2001	2002	2001	2002	2001	2002
	Kafr El-Sheikh-1							
K0	93.2 ef	87.0 e	3.12 b	3.05 d	34.8 cd	33.8 bc	20.3 cd	19.6 de
K1	94.5 cde	89.3 d	3.12 b	3.12 bcd	36.3 bc	34.7 b	21.1 bc	20.5 bc
K2	96.7 ab	92.7 b	3.08 b	3.22 ab	38.9 a	36.6 a	22.8 a	21.8 a
K3	92.8 f	91.2 c	3.08 b	3.05 d	37.2 b	35.5 ab	21.7 b	21.3 ab
Kaha-1								
K0	93.8 def	84.7 f	3.30 a	3.18 abc	30.9 g	31.6 d	19.5 d	19.0 e
K1	95.2 cd	92.7 b	3.10 b	3.27 a	31.8 fg	32.6 cd	20.4 cd	19.9 cd
K2	97.0 a	95.3 a	3.10 b	3.08 cd	33.9 de	35.3 ab	21.2 bc	20.9 b
K3	95.5 bc	93.8 b	3.05 b	3.08 cd	32.9 ef	33.0 cd	20.6 c	19.4 de

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

Table (14) : Interaction effect between plant spacing and foliar spraying with potassium (K) on seed quality characters of cowpea plants.

Treatments	Germination %		Germination speed (days)		Seedling length (cm)		Protein %	
	2001	2002	2001	2002	2001	2002	2001	2002
	10 cm							
K0	92.8 e	83.3 g	3.35 a	3.33 a	31.9 e	31.6 f	19.4 e	18.5 g
K1	94.0 de	88.0 e	3.10 b	3.15 bc	32.9 de	32.4 ef	20.2 cde	19.3 fg
K2	96.5 abc	90.0 cd	3.00 b	3.23 ab	35.6 abc	35.3 abc	21.3 bc	20.5 cd
K3	93.5 de	87.8 e	3.07 b	3.05 c	33.7 cde	33.7 cdef	20.2 cde	19.4 efg
20 cm								
K0	93.5 de	85.5 f	3.10 b	3.00 c	34.0 cde	33.5 cdef	20.0 de	19.4 efg
K1	95.3 bcd	91.0 c	3.15 b	3.36 a	34.7 bcd	34.1 bcde	20.8 cd	20.4 cde
K2	97.3 a	95.8 a	3.15 b	3.23 ab	37.2 a	36.5 a	22.0 ab	21.2 bc
K3	94.3 de	94.0 b	3.11 b	3.05 c	35.9 abc	34.2 bcde	21.3 bc	20.0 def
30 cm								
K0	94.3 de	88.8 de	3.18 ab	3.03 c	32.8 de	33.0 def	20.5 cde	20.1 cdef
K1	95.3 bcd	94.0 b	3.08 b	3.08 c	34.5 bcd	34.6 abcde	21.3 bc	21.0 bcd
K2	96.8 ab	96.3 a	3.13 b	3.00 c	36.5 ab	36.1 ab	22.8 a	22.4 a
K3	94.8 cd	95.8 a	3.08 b	3.10 bc	35.6 abc	34.9 abcd	22.1 ab	21.6 ab

Means designated by different letters in the same column are significantly at 5% level according to Duncan's Multiple Range Test.

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تأثير بعض المعاملات الزراعية على إنتاج وجودة تقاوى اللوبيا فتحى محمد محمود الأسويطى أقسام بحوث الخضر - معهد بحوث البساتين - مركز البحوث الزراعية

أجريت تجربتان حقليتان بمزرعة الخضر بقها - محافظة القليوبية خلال موسمى ٢٠٠١، ٢٠٠٢. استهدفت دراسة تأثير مسافات الزراعة والرش بالبوتاسيوم على النمو والمحصول البذرى وجودته لصنفى اللوبيا كفر الشيخ (١)، قها (١). وقد تضمنت كل تجربة ثلاث مسافات للزراعة (١٠، ٢٠، ٣٠ سم)، أربعة تركيزات للرش بالبوتاسيوم (صفر، ١، ٢، ٣ سم/لتر) ويمكن إيجاز أهم النتائج فيما يلى:

أولاً: تأثير الأصناف

تفوق الصنف كفر الشيخ (١) على الصنف قها (١) فى جميع صفات النمو خلال موسمى الزراعة متمثلاً فى طول النبات - عدد الأفرع والأوراق - مساحة الورقة - الوزن الطازج والجاف للنبات كذلك فى جميع صفات المحصول البذرى ومكوناته مثل عدد القرون - وزن القرون - عدد البذور فى القرن وزن البذرة - المحصول البذرى للنبات - المحصول البذرى للفدان - وقد بلغت نسبة الزيادة فى محصول الفدان للصنف كفر الشيخ (١) ٣٥,٢، ٣٩,٦% عن الصنف قها (١) فى الموسم الأول والثانى على التوالى. أما صفات جودة البذور المتمثلة فى نسبة وسرعة الإنبات، طول البادرة، محتوى البذور من البروتين فقد تفوق الصنف كفر الشيخ (١) فى جميع الصفات باستثناء سرعة الإنبات فى الموسم الأول فقط.

ثانياً: تأثير مسافات الزراعة

سجلت النباتات المنزرعة فى المسافات الواسعة (٢٠ أو ٣٠ سم) أعلى قيم لكل قياسات النمو الخضرى بإستثناء طول النبات الذى بلغ أقصاه مع المسافات الضيقة (١٠ سم) وقد زاد المحصول البذرى ومكوناته بزيادة مسافات الزراعة بإستثناء محصول البذور للفدان حيث بلغ أقصاه مع المسافات الضيقة (١٠ سم). كذلك أدى إستخدام المسافات الواسعة إلى الحصول على أعلى جودة لصفات البذور (نسبة الإنبات - طول البادرة - محتوى البذور من البروتين) مقارنة بالمسافات الضيقة بإستثناء سرعة الإنبات التى لم تتأثر معنوياً بمسافات الزراعة.

ثالثاً: تأثير البوتاسيوم

أدى الرش بالبوتاسيوم إلى زيادة معنوية فى قياسات النمو فى النبات، كذلك المحصول البذرى ومكوناته بالمقارنة بالكنترول بالإضافة إلى الحصول على أعلى قيم لنسبة الإنبات، طول البادرة ومحتوى البذور من البروتين. وكان الرش بالبوتاسيوم بتركيز ٢ سم/لتر أكثر فاعلية فى زيادة جميع الصفات التى درست.

رابعاً: تأثير التفاعل بين المعاملات

أختلف تأثير التفاعل بين المعاملات بالنسبة لصفات النمو والمحصول البذرى ومكوناته وكذا صفات الجودة للبذور. وللحصول على أعلى محصول بذرى للفدان ينصح بزراعة أصناف اللوبيا المستخدمة على مسافات ضيقة (١٠ سم) مع الرش بالبوتاسيوم بتركيز ٢ سم/لتر.