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Yield Performance of Two Locally Adapted and Two Introductions of Common Cowpea in Response to Amended In-Row-Spaces and Planting Dates

Mohamed M. A. Abdalla, M. F Mohamed, A. M. A. Rashwan

Abstract**—**A field experiment was conducted in the Agricultural Research Station, at El-Ghoraieb, Assiut to study dry seed yield performance of two locally adapted cultivars ('Azmerly' and 'Cream 7') and two line introductions (IT81D-1032 and IT82D-812) of common cowpea (*Vigna unguiculata* (L.) Walp) grown at three different within-row spaces (20, 30 and 40 cm) and two planting dates in the summer (April 15th and 30th) and in the fall season (Aug. 12th and 27th) of two successive seasons. The data showed that total dry-seed yield produced by plants grown at 20 cm was greater than at 30 cm in all cvs/lines in both years. Increases in 1000-seed weight were detected in cv 'Azmerly' and line IT82D-812 when they were grown at 30 cm as compared with 20 cm in the summer season. However, in the fall season such increases were found in all cvs/lines. Planting at 40 cm produced seeds of greater weight than planting at 30 cm for all cvs/lines in the fall season and also in cv. Cream 7 and line IT82D-812 in the summer season, while all cvs/lines in the fall Planting on April 15th in the summer and also planting on Aug. 12th in the fall had plants which showed increases in 1000-seed weight and total dry-seed yield. The greatest 1000-seed weight was found in the line IT81D-1032 in the summer season and in the line IT82D-812 in the fall season. The sum up results revealed that 'Azmerly' produced greater dry-seed yield than 'Cream 7' and both of them were superior to the line IT82D-812 and IT81D-1032 in the summer season. In the fall, however, the line IT82D-812 produced greater dry-seed yield than the other cultivars/lines.

Keywords**—**Cowpea, Assiut, fall, planting dates, El-Ghoraieb.

I. Introduction

LEGUMES are second to cereals as major strategic crops for human diet. Cowpeas (*Vigna unguiculata* (L.) Walp) are ancient leguminous plants widely grown nowadays throughout tropics and subtropics but greater in India and Africa. There are five subspecies of *V. unguiculata* of which two are wild. The cultivated common cowpea is subsp. *unguiculata* and both West Africa and India are the modern centers of diversity of cultivars [25]. It is suggested that cultivars reached Europe from Egypt. The common cowpea is grown in Egypt both as vegetable and pulse crops. The common cowpea is favorable to Egyptian consumers especially in form of dry seeds. The seeds have high percentage of protein (20 to 30%) and they are rich in the essential amino acid lysine [25].

Mohamed Abdalla and M. F. Mohamed are with the Department of Horticulture, Faculty of Agriculture, Assiut University, Assiut 71526, Egypt. (e-mail: mmalyabdalla@yahoo.com).

A. M. A. Rashwan is with the Department of Horticulture, Faculty of Agriculture, Qena University. Egypt

As being a tropical plant which is known to be more tolerant to unfavorable soil conditions than other leguminous crops [13], [8]; it would be ideal crop for production in new reclaimed soil in southern Valley. This crop has indeed received considerable attention of researchers in Upper Egypt [1], [11], [7]. Cowpea cultivation may be useful to enhance natural proprieties of such soil. Yield potential of cowpea can be greatly improved via optimizing cultural practices including in-row spaces and plant densities [21] in addition to planting dates [5]. These cultural practices are of renewable interest particularly when new line introductions are manipulated. The objective of the present study was to investigate crop performance of two locally adapted cultivars and two line introductions in response to three different within-row spaces and two planting dates

II. Materials and Methods

The present study was carried out in the Agricultural Research Station of Assiut University at El-Ghorieb (26 Km east of Assiut city).

A. Plant Materials, Studied Treatments, and Experimental Procedures

Two locally adapted cowpea cultivars ('Azmerly' and 'Cream 7') and two line introductions (IT82D-812 and IT81D-1032) were used in this study. Source, testa color, and plant growth habit for the four cowpea cultivars/lines are described in Table I. The experiment was conducted in sand clay loam soil (Table II) during both the summer and fall seasons in 1994 and 1995. Seeds were planted on April 15th and 30th in the summer season and on August 12th and 27th in the fall season. Seed planting was spaced 20 or 30 or 40 cm apart on the eastern side of 3 m long and 60 cm wide rows. These planting date and hill space treatments were arranged in the field as split-split plots in randomized complete-blocks with four replicates. The four cowpea entries were in the main plots. Sub-plots contained the three spacing treatments. Sub-sub-plot treatments were the two planting dates. Each sub-sub plot (10.8 m^2) consisted of six rows. Calcium superphosphate (15.5% P_2O_5) was added at rate of 300 kg/feddan (60 x 70 meter) during soil preparation. Otherwise, all cultural practices were as usual in the production of cowpea.

TABLE I
SOURCE, TESTA COLOR, AND GROWTH HABIT OF THE FOUR COWPEA CULTIVARS/LINES USED IN THE PRESENT STUDY

Cultivar/line	Source	Testa color	Growth habit
IT81D-1032	IITA[1]	Brown	Determinate
IT82D-812	IITA	Light Brown	Indeterminate
Azmerly	EAO[2]	White with black eye	Indeterminate
Cream 7	EAO	Yellowish-White	Determinate

[1] IITA, International Institute of Tropical Agriculture, Ibadan, Nigeria.
[2] EAO, Egyptian Agricultural Organization, Egypt.

TABLE II
MECHANICAL AND CHEMICAL CHARACTERISTICS OF THE SOIL IN THE EXPERIMENTAL SITE AT EL-GHORAIEB RESEARCH STATION, ASSIUT

A- Mechanical analysis		B- Chemical analysis	
Sand	49.92	P (ppm)	3.2
Silt	22.00	pH (1:1)	7.63
Clay	28.08	Ec mmhos/cm	1.54
		Total N (%)	0.031
		Total $CaCO_3$ (%)	8.11

B. Measurements

1. Plant Growth and Development

Data were recorded for the following characters: 1) plant height (cm; from surface of the ground to the tip of the main stem for ten mature plants sampled randomly in each treatment per replicate at the end of the growing season), 2) number of primary branches/plant (using ten randomly sampled flowering plants in each treatment per replicate) and 3) days lapsed from planting to 50% plants developing dry pods (judged based on all plant grow in each treatment per replicate).

2. Pulse/Crop

The following data were recorded: 1) 1000-seed weight (g, seeds were randomly sampled from bulked dry-seeds produced from each treatment per replicate) and 2) total dry-seed yield (kg/feddan, weight of bulked seeds produced in plots (10.8 m^2) of each treatment were used to estimate seed production/feddan).

TABLE III
PLANT HEIGHT (CM) AS AFFECTED BY THREE WITHIN-ROW SPACES AND TWO PLANTING DATES IN FOUR COWPEA CULTIVARS/LINES GROWN DURING THE SUMMER SEASON [1], 1994[2] AND 1995[3].

A

Spacing (S)	Dates (D)	1st year Cultivars/lines (C/L)					2nd year Cultivars/lines (C/L)				
		Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L	Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L
20 cm	15 April	55.74	209.80	178.53	30.26	118.58	56.41	210.63	181.13	30.65	119.70
	30 April	54.16	207.58	176.40	29.09	116.81	54.90	208.38	179.00	29.86	118.03
Mean over all (D)		**54.95**	**208.69**	**177.46**	**29.67**	**117.69**	**55.66**	**209.50**	**180.06**	**30.26**	**118.87**
30 cm	15 April	54.04	180.65	173.73	29.23	109.41	54.63	182.25	177.28	29.78	110.98
	30 April	52.61	179.30	172.28	28.78	108.24	53.61	180.50	175.90	29.43	109.86
Mean over all (D)		**53.32**	**179.98**	**173.00**	**29.00**	**108.83**	**54.12**	**181.38**	**176.59**	**29.60**	**110.42**
40 cm	15 April	51.58	175.10	171.05	28.88	106.65	52.70	176.75	173.50	29.18	108.03
	30 April	50.48	173.25	169.20	28.43	105.34	51.58	175.55	172.30	28.78	107.05
Mean over all (D)		**51.03**	**174.18**	**170.13**	**28.65**	**105.99**	**52.14**	**176.15**	**172.90**	**28.98**	**107.54**
Mean over all (S)	15 April	**53.78**	**188.52**	**174.43**	**29.45**	**111.54**	**54.58**	**189.88**	**177.30**	**29.87**	**112.91**
	30 April	**52.42**	**186.71**	**172.63**	**28.76**	**110.13**	**53.36**	**188.14**	**175.73**	**29.35**	**111.65**
Mean over all (S and D)		**53.10**	**187.61**	**173.53**	**29.11**	**110.84**	**53.97**	**189.01**	**176.52**	**29.61**	**112.28**

B

Spacing (S)	Dates (D)	1st year Cultivars/lines (C/L)					2nd year Cultivars/lines (C/L)				
		Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L	Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L
20 cm	12 August	49.45	62.53	66.80	27.15	51.48	51.21	63.63	68.30	27.85	52.75
	27 August	47.56	60.10	64.55	25.66	49.47	49.90	60.36	66.56	26.33	50.75
Mean over all (D)		48.51	**61.31**	**65.68**	**26.41**	**50.48**	**50.56**	**61.99**	**67.43**	**27.09**	**51.77**
30 cm	12 August	48.50	61.25	63.43	26.46	49.91	49.76	62.50	65.70	27.22	51.29
	27 August	46.75	59.50	61.15	25.34	48.21	47.85	59.53	63.66	26.08	49.28
Mean over all (D)		47.63	**60.43**	**62.29**	**25.90**	**49.06**	**48.80**	**61.01**	**64.68**	**26.65**	**50.29**
40 cm	12 August	48.31	59.38	61.78	26.20	48.92	48.45	60.95	63.28	26.88	49.89
	27 August	46.75	57.83	59.93	25.08	47.39	47.15	58.90	61.73	25.90	48.42
Mean over all (D)		47.53	**58.60**	**60.85**	**25.64**	**48.16**	**47.80**	**59.93**	**62.50**	**26.39**	**49.15**
Mean over all (S)	12 August	48.75	**61.05**	**64.00**	**26.60**	**50.10**	**49.80**	**62.36**	**65.76**	**27.31**	**51.31**
	27 August	47.02	**59.18**	**61.88**	**25.36**	**48.36**	**48.30**	**59.59**	**63.98**	**26.10**	**49.49**
Mean over all (S and D)		47.89	**60.11**	**62.94**	**25.98**	**49.23**	**49.05**	**60.98**	**64.87**	**26.71**	**50.40**

[2] $LSD_{0.05}$ = 0.24, 0.05, 0.33 and 0.16 to compare: 1) planting spaces for each cv., 2) planting dates for each cv., 3) cultivars/lines for each planting space, and 4) cultivars/lines for each planting date, respectively, in 1994.
[3] $LSD_{0.05}$ = 0.19, 0.05, 0.22 and 0.13 to the use for same comparisons as described above for 1994.
[4] Non-significant

3. Statistical Analysis

All data were statistically analyzed following the appropriate procedures of analysis of variance (ANOVA) for the experimental model and design used in the present study. Effects of all factors were considered fixed except replicates. Significance of variance components for the different factors

and their combinations were used to aid mean comparisons as explained by [12].

TABLE IV
NUMBER OF PRIMARY BRANCHES AS AFFECTED BY THREE WITHIN-ROW SPACES AND TWO PLANTING DATES IN FOUR COWPEA CULTIVARS/ LINES GROWN DURING THE SUMMER SEASON [1], 1994[2] AND 1995[3].

A

Spacing (S)	Dates (D)	1st year Cultivars/lines (C/L)					2nd year Cultivars/lines (C/L)				
		Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L	Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L
20 cm	15 April	6.05	6.00	4.50	4.19	5.18	6.10	5.91	4.74	4.18	5.23
	30 April	5.74	5.68	4.29	4.01	4.93	5.86	5.64	4.50	4.03	5.01
Mean over all (D)		5.89	5.84	4.39	4.10	5.06	5.98	5.78	4.62	4.10	5.12
30 cm	15 April	6.75	6.43	5.12	4.39	5.67	6.85	6.49	5.45	4.40	5.80
	30 April	6.45	6.18	4.81	4.24	5.42	6.58	6.14	5.15	4.30	5.54
Mean over all (D)		6.60	6.30	4.97	4.31	5.54	6.71	6.31	5.30	4.35	5.67
40 cm	15 April	7.35	7.34	6.08	4.68	6.36	7.49	7.54	6.25	4.56	6.46
	30 April	7.06	7.08	5.75	4.46	6.09	7.26	7.33	6.03	4.38	6.25
Mean over all (D)		7.21	7.21	5.91	4.57	6.22	7.38	7.43	6.14	4.47	6.35
Mean over all (S)	15 April	6.72	6.59	5.23	4.42	5.74	6.81	6.65	5.48	4.38	5.83
	30 April	6.42	6.31	4.95	4.24	5.48	6.57	6.37	5.23	4.23	5.60
Mean over all (S and D)		6.57	6.45	5.09	4.33	5.61	6.69	6.51	5.35	4.31	5.72

B

Spacing (S)	Dates (D)	1st year Cultivars/lines (C/L)					2nd year Cultivars/lines (C/L)				
		Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L	Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L
20 cm	12 August	4.99	5.17	4.95	3.50	4.65	5.35	5.08	5.25	3.48	4.79
	27 August	4.55	4.46	4.43	3.15	4.15	4.81	4.43	4.65	3.10	4.25
Mean over all (D)		4.77	4.81	4.69	3.33	4.40	5.08	4.75	4.95	3.29	4.52
30 cm	12 August	5.58	5.67	5.63	3.76	5.16	6.20	5.49	6.35	3.69	5.43
	27 August	4.65	4.72	5.03	3.34	4.43	5.59	4.74	5.68	3.25	4.81
Mean over all (D)		5.11	5.19	5.33	3.55	4.80	5.89	5.11	6.01	3.47	5.12
40 cm	12 August	6.29	6.08	6.48	3.89	5.68	6.70	6.23	6.85	3.86	5.91
	27 August	5.29	5.28	6.00	3.45	5.00	6.04	5.23	6.15	3.36	5.19
Mean over all (D)		5.79	5.68	6.24	3.67	5.34	6.37	5.73	6.50	3.61	5.55
Mean over all (S)	12 August	5.62	5.64	5.68	3.72	5.16	6.08	5.60	6.15	3.68	5.38
	27 August	4.83	4.82	5.15	3.31	4.53	5.48	4.80	5.49	3.23	4.75
Mean over all (S and D)		5.22	5.23	5.42	3.51	4.85	5.78	5.20	5.82	3.46	5.07

[2]$LSD_{0.05}$ = 0.24, 0.05, 0.33 and 0.16 to compare: 1) planting spaces for each cv., 2) planting dates for each cv., 3) cultivars/lines for each planting space, and 4) cultivars/lines for each planting date, respectively, in 1994.
[3]$LSD_{0.05}$ = 0.19, 0.05, 0.22 and 0.13 to the use for same comparisons as described above for 1994.
[4]Non-significant

III. RESULTS AND DISCUSSION

Study of crop management is always required whenever manipulating different breeding lines or new cultivars and new cultural environments or technologies. In this context, the present study provides useful information on plant spacing and planting date for production of common cowpea under Assiut conditions. Cowpea is generally recommended to be planted 20 to 30 cm apart within 60 to 70 cm wide rows [13]. There is a wide agreement among researchers on the premise that in-row spacing has a great influence on the cowpea yield [3], [4], [6], [17]-[19]. As indicated here, cowpea yield potential (Table VI) was obviously enhanced with planting at 20 cm compared with 30 cm or 40 cm within-row in all cvs/lines. Results obtained by [23] suggested that yield increases were due to greater number of plants per culture area. Yield per plant eventually decreases, as the plants tend to develop less number of branches [4], [25], [29], and decreased seed weight [25]. These effects can be explained in terms of limitation by increasing competition among plants [19]. The present results, generally, substantiated those findings.

Among the four cvs/lines the local cv 'Azmerly' was on the top for dry-seed production during the summer season (Table VI). It was followed by the local cv 'Creram 7'. Although even closer in-row spaces than 20 cm have been suggested by other workers on common cowpea [16], [18], [21] in different parts of the world, this does not seem to be applicable in production of cowpea cv 'Azmerly'. The cultivar 'Azmerly' tended to produce seeds of less weight when it was grown 20 cm apart compared with 30 cm. Its plants also exhibited tendency towards elongation, decrease in number of primary branches (Table IV), and lateness in pod maturity. Similar effects were indicated by [23]. Changes in cv 'Azmerly' for these measurements although seemed slight, they were significant. They can be expected to decline more sharply when growing at closer spaces than 20 cm comparing with the changes which were observed at 30 cm vs. 20 cm. These growth and yield criterions are of great concern to the convenience of the growers and/or detrimental for acceptability by consumer. Therein lays the reason those closer in-row spaces than 20 cm may not be useful in production of cv. 'Azmerly' under the condition tested in the summer season here.

TABLE V
AVERAGE 1000-SEED WEIGHT AS AFFECTED BY THREE WITHIN-ROW SPACES AND TWO PLANTING DATES IN FOUR COWPEA CULTIVARS/ LINES GROWN DURING THE SUMMER SEASON (1), 1994(2) AND 1995(3)

A

Spacing (S)	Dates (D)	1st year Cultivars/lines (C/L)					2nd year Cultivars/lines (C/L)				
		Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L	Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L
20 cm	15 April	142.63	153.15	145.68	161.23	150.67	142.83	157.98	154.75	161.80	154.34
	30 April	141.39	152.28	144.85	160.38	149.72	141.80	157.10	153.10	161.20	153.30
Mean over all (D)		142.01	152.71	145.26	160.80	150.20	142.31	157.54	153.93	161.50	153.82
30 cm	15 April	143.46	155.18	148.45	162.16	152.31	145.10	160.25	157.98	163.09	156.60
	30 April	142.80	154.18	147.65	161.44	151.52	143.38	159.08	156.27	161.90	155.15
Mean over all (D)		143.13	154.68	148.05	161.80	151.91	144.24	159.66	157.12	162.50	155.88
40 cm	15 April	145.48	156.65	155.20	163.60	155.23	147.88	162.40	161.81	163.93	159.02
	30 April	144.50	155.55	154.00	163.03	154.27	146.79	161.21	160.10	163.23	157.83
Mean over all (D)		144.99	156.10	154.60	163.31	154.75	147.33	161.81	160.96	163.58	158.42
Mean	15 April	143.86	154.99	149.78	162.33	152.74	145.27	160.21	158.18	162.94	156.65
over all (S)	30 April	142.90	154.00	148.83	161.61	151.84	143.99	159.13	156.49	162.11	155.43
Mean over all (S and D)		143.38	154.50	149.30	161.97	152.29	144.63	159.67	157.33	162.53	156.04

B

Spacing (S)	Dates (D)	1st year Cultivars/lines (C/L)					2nd year Cultivars/lines (C/L)				
		Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L	Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L
20 cm	12 August	137.78	143.35	159.45	142.05	145.66	139.98	143.85	160.38	143.28	146.87
	27 August	135.63	139.60	156.95	139.18	142.84	137.05	140.35	157.55	140.28	143.81
Mean over all (D)		136.70	141.48	158.20	140.61	144.25	138.51	142.10	158.96	141.78	145.34
30 cm	12 August	139.23	145.73	164.03	145.25	148.56	142.14	145.79	163.48	145.90	149.33
	27 August	138.30	142.40	160.23	143.13	146.01	139.28	142.48	160.98	142.55	146.32
Mean over all (D)		138.76	144.06	162.13	144.19	147.29	140.71	144.13	162.23	144.23	147.82
40 cm	12 August	141.10	146.98	166.71	147.75	150.63	143.80	147.40	166.18	147.58	151.24
	27 August	139.38	143.08	163.75	145.30	147.88	140.65	143.48	163.48	144.75	148.09
Mean over all (D)		140.24	145.03	165.23	146.53	149.26	142.23	145.44	164.83	146.16	149.66
Mean	12 August	139.37	145.35	163.40	145.02	148.28	141.97	145.68	163.34	145.58	148.28
over all (S)	27 August	137.77	141.69	160.31	142.53	145.58	138.99	142.10	160.67	142.53	145.58
Mean over all (S and D)		138.57	143.52	161.85	143.78	146.93	140.48	143.89	162.00	144.05	146.93

[(2)] $LSD_{0.05}$ = 1.81, 0.16, and 1.82 to compare means for: 1) planting spaces for each cv., 2) planting dates, and 3) cowpea cultivars/lines grown at same or different spaces, respectively, in the summer season, 1994.

[(3)] $LSD_{0.05}$ = 1.72, 0.41, and 2.17 to compare means for : 1) planting spaces for each cv. and planting date, 2) planting dates for each cv. at same within row space, and 3) cultivars/lines grown at similar space for each planting date, respectively, in the summer season, 1995.

[(4)] **Non-significant**

The cv. 'Cream 7' is known as being of limited growth and foliage relative to cv. 'Azmerly' (Table III). As indicated from the data obtained here, it also produces smaller seeds than 'Azmerly' and its seed weight (Table V) did not consistently affected with 20 cm vs. 30 cm planting spaces. This cultivar may be produced at closer spaces than 20 cm within-row but whether or not the closer spaces would affect its seed size cannot be definitely decided in our opinion. It is, however, noticeable that a decrease in number of branches and an increase in stem length occurred for cv 'Cream 7' grown at 20 cm compared to 30 cm apart. Data obtained on the four cvs/lines in the fall season, on the other hand, revealed that the line introduction, IT82D-812 grown at 20 cm apart produced the highest dry-seed yield and it had the greatest seed weight. In addition, its pods matured as early as those of both cvs 'Azmerly' and 'Cream 7'. This line introduction, therefore, may be exploited for pulse crop production under Assiut conditions during the fall season. Testa in the line IT81D-812 is just a little darker than those of 'Cream 7'. Eventually, seeds of color similar to seeds of this line are being sold at commercial food stores in northern regions of the country. The choice if not to grow the line IT82D-812, is the cv. 'Cream 7'. It was either similar to cv. 'Azmerly' or greater in dry-seed yield than it. Growing the line IT82D-812 or cv. 'Cream 7' at intra-row spaces closer than 20 cm during the fall season would not be recommended for same reason discussed elsewhere above. In addition, plants of the line IT82D-812 developed strong foliage and it had semi-prostrate growth in this growing season that may affect its manageability at closer spaces than 20 cm within-row.

The line IT81D-1032 did not show changes in stem length and number of branches at 20 cm within-row compared with 30 cm apart during the summer and the fall in both years of the study. In addition, it produced seeds of the greatly weight and its seeds was not affected during the summer season in both years. This line is interesting for its distinct earliness in pod maturity. Differential genotypic responses to planting spaces have been widely documented [3], [5], [6], [8], [15], [24]. The line introduction IT81D-1032, therefore, may be useful for the current intensive cultivation system and to produce under short season conditions in the summer. Although it had the lowest seed yield in both seasons, it might be gown at closer spaces than 20 cm in-row and produces seed yield competitive to 'Azmerly' and 'Cream 7'. However, its acceptability may be limited as pulse crop of direct use for our local consumers due to its dark-brown testa. Planting date is another major factor affecting cowpea production [1], [2], [5], [9], [10], [25], [26], [27], [31]. The data presented in this study

suggest that all cultivars consistently had increased number of branches, 1000-seed weight, and total dry-seed yield when they were grown on early date in the summer (April, 15th) and in the fall (Aug. 12th). Similar results were reported by [1], [22], [26]-[31]. The reduction occurred in growth and yield measurements for plants grown on late date in the summer (April 30th) and in the fall (Aug. 27th) can be mainly attributed to adverse higher and lower temperatures, respectively, than optimum for normal growth, pod-set, and seed development in cowpea [14], [20]. Some cowpea cultivars may not flower when grown on unsuitable planting dates as they are photoperiod sensitive [30], but all cvs/lines in this study showed normal flowering. In conclusion, it is advisable based on this study to grow cv. 'Azmerly' or 'Cream 7' for production of pulse cowpea crop under Assiut conditions during the summer season while line introduction 'IT82D-812' is proposed for production in the fall season. Planting seeds at 20 cm in-row space on dates close to April 15th in the summer season and Aug. 12th in the fall season are recommended.

TABLE VI
TOTAL DRY-SEED YIELD (KG/FEDDAN) AS AFFECTED BY THREE WITHIN-ROW SPACES AND TWO PLANTING DATES IN FOUR COWPEA CULTIVARS/LINES GROWN DURING THE SUMMER SEASON [1], 1994[2] AND 1995[3]

A

Spacing (S)	Dates (D)	1st year Cultivars/lines (C/L)					2nd year Cultivars/lines (C/L)				
		Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L	Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L
20 cm	15 April	1252.3	1383.66	324.70	719.12	919.94	1280.1	1438.43	434.64	741.99	973.80
	30 April	1221.9	1351.16	302.07	666.16	885.32	1250.9	1379.55	369.37	694.13	923.49
Mean over all (D)		**1237.1**	**1367.41**	**313.39**	**692.64**	**902.63**	**1265.5**	**1408.99**	**402.01**	**718.06**	**948.64**
30 cm	15 April	892.49	988.08	252.57	533.46	666.65	950.01	1027.03	308.04	538.24	705.83
	30 April	863.10	948.60	237.58	492.95	635.56	902.56	991.53	288.05	515.97	674.53
Mean over all (D)		**877.79**	**968.34**	**245.08**	**513.21**	**651.10**	**926.29**	**1009.28**	**298.05**	**527.10**	**690.18**
40 cm	15 April	818.03	870.64	215.59	433.18	584.36	842.14	899.14	275.59	450.54	616.85
	30 April	769.92	847.50	197.55	408.78	555.93	813.81	869.29	250.97	415.27	587.34
Mean over all (D)		**793.98**	**859.07**	**206.57**	**420.98**	**570.10**	**827.98**	**884.21**	**263.28**	**432.91**	**602.10**
Mean	**15 April**	**987.61**	**1080.79**	**264.29**	**561.92**	**723.65**	**1024.1**	**1121.53**	**339.42**	**576.92**	**765.49**
over all (S)	**30 April**	**951.64**	**1049.09**	**245.73**	**522.63**	**692.27**	**989.09**	**1080.12**	**302.80**	**541.79**	**728.45**
Mean over all (S and D)		**969.62**	**1064.94**	**255.01**	**542.28**	**707.96**	**1006.6**	**1100.83**	**321.11**	**559.36**	**746.97**

B

Spacing (S)	Dates (D)	1st year Cultivars/lines (C/L)					2nd year Cultivars/lines (C/L)				
		Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L	Cream 7	Azmerly	IT82D-812	IT81D-1032	Mean overall C/L
20 cm	12 August	603.91	617.96	930.50	528.08	670.11	644.15	628.13	969.14	544.18	696.40
	27 August	529.55	531.00	893.00	486.00	609.89	570.09	541.20	923.10	500.26	633.66
Mean over all (D)		**566.73**	**574.48**	**911.75**	**507.04**	**640.00**	**607.12**	**584.67**	**946.12**	**522.22**	**665.03**
30 cm	12 August	460.60	446.46	678.50	400.50	496.52	465.72	468.18	693.14	408.14	508.80
	27 August	379.42	396.50	636.02	363.00	448.24	413.66	410.09	646.16	372.60	460.63
Mean over all (D)		**429.01**	**421.48**	**657.26**	**381.75**	**472.38**	**439.69**	**439.14**	**669.65**	**390.37**	**484.71**
40 cm	12 August	385.11	390.90	593.42	348.50	429.48	386.58	392.19	601.14	356.16	434.13
	27 August	355.04	325.00	554.05	316.00	387.52	358.62	333.19	569.62	326.67	397.03
Mean over all (D)		**370.08**	**357.95**	**573.74**	**332.25**	**408.50**	**372.60**	**362.69**	**585.38**	**341.64**	**415.58**
Mean	**12 August**	**483.21**	**485.11**	**734.14**	**425.69**	**533.04**	**498.82**	**496.17**	**754.47**	**436.31**	**546.44**
over all (S)	**27 August**	**427.34**	**417.50**	**694.36**	**388.33**	**481.88**	**447.46**	**428.16**	**712.96**	**399.84**	**497.11**
Mean over all (S and D)		**455.27**	**451.30**	**714.29**	**407.01**	**507.46**	**473.00**	**462.16**	**733.72**	**418.08**	**521.78**

[2] **$LSD_{0.05}$** = 21.05, 10.97 and 14.32 to detect significance of mean differences for 1) planting spaces for each cv/line grown on same planting date, 2) planting dates in each cv/line grown at same within-row space, and 3) cvs/lines grown on same date and at same space within-row, respectively, in the summer season, 1994.

[3] **$LSD_{0.05}$** = 34.80, 14.99 and 33.48 in the summer season of 1995 to use for same mean comparisons as indicated above for 1994.

[4] **Non-significant**

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