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Seed Yield and Quality of Okra (*Abelmoschus esculentus* (L.) Moench) as Influenced by Sowing Dates, Harvest Date and Pod Position

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ABSTRACT

Seed production and quality of okra were obviously influenced by sowing date, harvest date and pod position on the mother plant. The aim of the present study was to determine the effect of sowing dates (1^{st} March, 1^{st} April and 1^{st} May), harvest dates (30 , 40 and 50 days after anthesis (DAA)) and pod position on plant (lower, middle and upper) on seed yield and quality of okra (Balady cv.). Two field experiments were carried out during the summer seasons of 2013 and 2014 at Shandaweel Agriculture Research Station, ARC, Sohag Governorate, Egypt. The obtained results indicated that, sowing okra plants on 1^{st} April increased all studied characters compared to other sowing dates of 1^{st} March, or 1^{st} May. Harvesting pods at 40 or 50 days after anthesis gave the maximum germination percentage comparing to early harvest at 30 days after anthesis. Pods at lower or middle positions on the okra plant exhibited the best values in seed yield in terms of seeds number/pod, seeds weight/ pod, 100 seed weight and quality in terms of germination percentage, root and shoot length of seedlings. All possible combinations had significant effect on pod diameter, seed index, germination percentage and shoot in both seasons. The highest values were obtained from pods of plants sown on in 1^{st} April and their pods harvested from lower or middele postions after 40 days after anthesis.It could be recommended from the previous results the highest seed yield and quality was obtained in okra under the condition of this experiment and similar conditions, following planting okra on 1^{st} April and harvest till 8 th pod after 40 days from anthesis.

Keywords: Okra, sowing date, harvesting date, pod position, seed

INTRODUCTION

Okra or ladyfinger (*Abelmoschus esculentus* (L) Moench) is a member of the family Malvaceae and grown widely in tropical and subtropical areas of the world (Kochhar, 1986). In Egypt, it is grown mainly for its pods which are used either, fresh, canned or dried. They are rich in pectin, vitamins, fibers and minerals.

Seed is the prime factor that determines the quantitative and qualitative characteristics of the crop that is going to be harvested later on. Therefore; more attention should be directed toward increasing seed yield with good quality. Successful production of okra seed is conditional to certain agricultural practices.

Many factors which influence okra seed emergence, growth, yield and seed quality, among which sowing date is an important factor where growers start cultivation okra from January onwards as an off-season crop. Although it is a warm season crop it requires high day and night temperatures for best production. Okra seeds can only germinate in relatively warm soils, no germination occurs below 16°C. A monthly average temperature between 21 to 30°C is considered appropriate for growth, flowering and pod development (Tindall, 1983; Nonnecke, 1989). Sowing date has a great impact on seed yield and quality of okra, (Singh *et al.* , 1986; Hossain *et al.* , 1999; Yadav and Dhankar 2001; Moniruzzaman *et al.* , 2007; El-Waraky 2014). Due to the ongoing change in agroclimatic conditions, periodic evaluation of planting dates is of urgent need.

Harvesting date is one of the factors affecting both seed yield and quality. Seed must be harvested when seed reaches its best quality. Some physiological markers have been used in order to identify the time of the occurrence of maximum seed quality. One of which is a hypothesis that suggests coincidence of maximum seed quality with the end of the seed filling period (Harrington, 1972). This was supported by the results in soybean (Tekrony *et al.* , 1980), pea, chickpea and lupin (Ellis *et al.* , 1987). In some other species however, the best quality may not be obtained until some times afterwards (Kameswara *et al.* , 1991). In tomato, Demir and Eilis (1992) reported that mass maturity (end of the seed-filling period) occurred 41 and 39 days after anthesis in the first and second trusses, respectively. Their results also revealed that the ability of seeds to germinate was not detected until after mass maturity and that the onset of germinability occurred 35, 45 and 55 days after anthesis in the first, second and third trusses respectively. In general, seeds germinated more rapidly the later they were harvested and when first dried. Mugnisjah and Nakamura (1984) reported that early harvest may result in poor germination and vigour in soybeans. There have been few detailed studies on seed development of okra. Konwar and Saimbhi (1987) reported maximum germination of okra seeds 35 days after anthesis, Further delay increased damaged and reduced germination percentage. Demir (1994) reported that Maximum seed quality assessed by germination, emergence and rapid ageing test was recorded 52 days after anthesis.

Pod position on mother plant plays an important role on fruit size, seed production and quality. The common practice in okra seed production fields is the harvesting of fruits from all positions at the end of the season. Thomas *et al.* (1979) stated that the position at which celery seed is produced on the plant can markedly affect its size, germination characteristics and size of the ensuing seedling and concluded that the highest percentage seed germination and seedling emergence were obtained from seeds produced on primary umbels (first formed seeds). A similar result was also recorded in tomato by Dias *et al.* (2006). Fruit size is also known to vary with position on mother-plant. Ho and Hewit (1986) reported that during rapid growth in tomato, both the rates of maximum growth and of starch accumulation of proximal fruits are higher than those of distal fruits. However, when the assimilate supply is abundant, the proximal fruit could gain more weight than the distal ones. Yadav and Dhankar (2007) indicated that higher seed yield and germination percentage were recorded from okra pods harvested at the lower position on the plant. Hedau *et al.* (2010) reported that maximum germination and vigour was exhibited by the seeds obtained from fruits positioned at middle nodes, closely followed by seeds collected from the lower portion of the plant. However, seeds obtained from the upper fruits showed poor seed yield and quality.

Therefore, the objective of this study was to investigate the effects of both sowing, harvest dates and pod position on okra seed yield and quality.

MATERIALS AND METHODS

The present study was carried out during the summer seasons of 2013 and 2014 years at Shandaweel Agriculture Research Station, ARC, Sohag Governorate, Egypt. Climate characteristics of experimental location 2013-2014 are shown in Table (1).

Table 1. Climate characteristics of experimental location during 2013-2014 .

Month	Temperature (°C) Maximum 2013	Temperature (°C) Minimum 2013	Average humidity (%) 2013	Temperature (°C) Maximum 2014	Temperature (°C) Minimum 2014	Average humidity (%) 2014
March	26.5	7.8	48	24.6	9.1	65
April	33.1	14.3	46	32.9	15.1	60
May	34.8	16.7	41	35.8	19.6	63
Jun.	37.3	20.5	41	37.8	20.9	62
July.	38.2	20.4	43	38.1	21.9	65
Aug.	36.8	20.7	50	36.6	20.3	66
Sep	33.5	17.5	51	34.8	17.5	68
Average	34.3	16.8	45.7	34.4	17.8	64.1

The experimental land was prepared and shaped to ridges 75 cm apart, each experimental plot was 3 x 3.5 m and contained 4 ridges.

The studied factors were :-

1- Sowing dates (1st March, 1st April and 1st May),

2-Harvesting dates (30, 40 and 50 days after anthesis (DAA))

3-Pod position on mother plant (lower (1st to 3rd), middle (4th to 8th) and upper (9th to 12th)).

A split- split plot system in randomized blocks design with three replicates was used. Sowing dates assigned in the main plots, harvest dates were randomly distributed in sub-plot and pod position were allocated in sub sub-plots.

Seeds of okra (Balady cv.) were sown at 1st March, 1st April and 1st May in both seasons in hills at 30 cm apart on one side of the ridge. Growing plants were thinned at one plant per hill after three weeks from planting, The normal cultural practices known for commercial okra production and pods were collected at three harvesting dates (harvesting pods at 30 , 40 and 50 days after anthesis (DAA). Each individual crop of okra was divided in 3 different parts and pods tagged as a pod of lower (1st to 3rd), middle (4th to 8th), upper (9th to 12th) part of the main stem on plant.

Five plants were tagged in each plot randomly to study seed and pod characteristics and the following data were recorded, pod diameter, pod length, seeds number/pod, seeds weight/ pod and 100 seed weight (seed index).

Seed germination was conducted using 400 seeds (four replications of 100 seeds) per each treatment (ISTA, 2011). Seeds sterilized by Mankuzeb fungicide and were placed on double layered Wathman No.1 filter paper moistened with distilled water in sterilized Petri dishes. At final, all Petri dishes were placed in a germinator at 25°C for 21 days and the number of germinated seeds was counted every 2 days and removed; in the case of moisture deficiency distilled water was added. Germination percentage was calculated by following formula (ISTA, 2009):

$$\text{Germination \%} = \frac{\text{Number of germinated seeds}}{\text{Total number of sown seeds}} \times 100$$

Root and shoot lengths in cm were measured at the end of germination experiment.

All obtained data were subjected to the statistical analysis and treatments means were compared using the LSD test according to Snedecor and Cochran (1981).

RESULTS AND DISCUSSION

Pod diameter (cm)

Data in Table (2) reveals that the maximum pod diameter (2.27 and 2.34 cm) was produced by plants sown on 1st April, in the first and second seasons, respectively. Whereas, minimum pod diameter (1.95 and 2.06 cm) were produced by plants sown on 1st May, in the first and second seasons, respectively. This result is in conformity with that of Moniruzzaman *et al.* ,(2007) they reported that the maximum fruit diameter was recorded from sowing 15 April. Data in same table also shows that pod diameter of okra plant was significantly influenced by harvest date in both seasons. The highest diameter of pod was observed by pods harvested at 40 days after anthesis, while, the lowest pod diameter was observed from pods which were harvested at 50 days after anthesis, in both seasons. This result was disagree with that obtained by Ibrahim and Oladiran (2004) who reported insignificant increases in fruit diameter in all positions between 14 and 56 DAA.

Pod diameter was significantly influenced by pod position in both seasons. The highest values were observed with pods obtained from middle and lower positions, while the lowest values were obtained from upper position, in both seasons. All possible combinations had significant effects on pod diameter in both seasons. The highest values (2.86 and 2.72 cm) were obtained from pods collected 40 days after anthesis in middle position of the plants which were sown on 1st April in the first and second seasons, respectively.

Table 2. Effect of both sowing and harvest dates as well as pod position on pod diameter during 2013 and 2014 seasons.

Seasons		2013				2014			
Sowing date (A)	Harvest date (B)	Fruit position (C) Lower	Middle	Upper	Mean	Fruit position (C) Lower	Middle	Upper	Mean
	30 DAA	2.13	1.88	1.80	1.94	2.12	2.19	2.10	2.14
1st March	40 DAA	2.48	2.78	2.18	2.48	2.46	2.68	2.22	2.45
	50 DAA	2.07	2.25	1.91	2.08	2.04	2.14	2.67	2.08
Mean		2.23	2.30	1.96	2.16	2.71	2.34	2.13	2.22
	30 DAA	2.00	2.05	1.97	2.01	2.30	2.52	2.12	2.31
1st April	40 DAA	2.60	2.86	2.31	2.59	2.55	2.72	2.07	2.45
	50 DAA	2.27	2.41	2.00	2.23	2.38	2.40	2.00	2.26
Mean		2.29	2.44	2.09	2.27	2.41	2.55	2.06	2.34
	30 DAA	2.05	2.00	1.96	2.00	2.66	2.10	1.83	2.21
1st May	40 DAA	2.17	2.23	2.17	2.21	2.08	2.11	2.05	2.08
	50 DAA	1.56	1.80	1.58	1.65	1.98	1.99	1.73	1.90
Mean		1.93	2.03	1.90	1.95	2.24	2.07	1.87	2.06
	30 DAA	2.06	1.98	1.91	1.98	2.36	2.27	2.02	2.22
B x C	40 DAA	2.42	2.64	2.22	2.43	2.36	2.50	2.11	2.33
	50 DAA	1.97	2.15	1.83	1.98	2.13	2.18	1.93	2.08
Mean		2.15	2.26	1.99		2.29	2.32	2.02	
LSD	**A**		**0.085**				**0.117**		
	B		**0.102**				**1.627**		
	AB		**0.177**				**0.282**		
	C		**0.122**				**0.215**		
	AC		**0.211**				**0.373**		
	BC		**0.211**				**0.373**		
	ABC		**0.366**				**0.645**		

Dry pod length

Data illustrated in Table (3) reveals that sowing date at 1st April significantly increased dry pod length as compared with other two sowing dates in the two experimental seasons.This increment in pod length may be due to the effect of prevailing environmenntal conditions on flowering, polination and subsequent pod development at this date (Table,1). Differences in dry pod length due to different dates of sowings were also reported by several workers, such as Hossain *et al.* ,(2003) and Muhammad *et al.* , (2015). There was significant increase in dry pod length at 40 days after anthesis as compared with the other harvest dates. Dry pod length was significantly influenced by fruits position in both seasons. The highest values (10.37 and 9.51cm) was observed with pods obtained from middle pods in the first and second seasons, respectively, while the lowest values were obtained from upper pods, in both seasons. All possible combinations had significant effect on dry pod length in both seasons. The highest values (12 and 11.87 cm.) were obtained from pods collected at 40 days after anthesis in middle position of the plants which were sown on 1st April in the first and second season, respectively.

Table 3. Effect of both sowing and harvest dates as well as pod position on dry pod length during the 2013 and 2014 seasons.

Seasons		2013				2014			
Sowing date (A)	Harvest Date (B)	Fruit position (C) Lower	Middle	Upper	Mean	Fruit position (C) Lower	Middle	Upper	Mean
	30 DAA	8.70	9.67	8.22	8.86	9.18	6.67	8.00	7.95
1st March	40 DAA	10.75	11.40	10.10	10.75	9.83	10.05	9.16	9.68
	50 DAA	9.13	11.02	9.10	9.75	8.50	9.10	7.83	8.48
Mean		9.53	10.70	9.14	9.78	9.17	8.61	8.33	8.70
	30 DAA	9.30	10.05	8.40	9.25	9.57	10.00	8.87	9.48
1st April	40 DAA	11.66	12.00	11.33	11.66	11.55	11.87	10.00	11.14
	50 DAA	11.50	10.82	10.00	10.77	9.13	9.57	8.30	8.98
Mean		10.82	10.96	9.91	10.56	10.08	10.46	9.06	9.87
	30 DAA	8.56	9.00	8.14	8.56	9.11	9.43	7.90	8.81
1st May	40 DAA	10.00	9.77	8.70	9.49	9.29	9.87	8.81	9.32
	50 DAA	8.22	9.60	7.40	8.41	8.31	9.00	7.10	8.14
Mean		8.93	9.51	8.08	8,82	8.90	9.43	7.94	8.76
	30 DAA	8.85	9.57	8.25	8.89	9.29	8.70	8.26	8.75
B x C	40 DAA	10.80	11.06	10.04	10.63	10.22	10.61	9.32	10.05
	50 DAA	9.62	10.48	8.83	9.64	8.64	9.21	7.74	8.53
Mean		9.76	10.37	9.04		9.39	9.51	8.44	
LSD	**A**		**0.447**			**0.225**			
	B		**0.437**			**0.385**			
	AB		**0.757**			**0.667**			
	C		**0.495**			**0.529**			
	AC		**0.858**			**0.916**			
	BC		**0.858**			**0.916**			
	ABC		**1.486**			**1.587**			

Seed number/pod

Data in Table (4) shows that the significant highest number of seed per pod was recorded following sowing on 1st April. The significant lowest values (60.91 and 62,49) for seed number/pod was observed on 1st May sowing in the first and second seasons, respectively . This result is in conformity with that of Hossain *et al.* ,(1999) and Moniruzzaman *et al.* , (2007).

Concerning the results of this study, it was found that in 2013 season seed number/pod was significantly increased from 65.91 at 50 days after anthesis to 69.61 at 40 days after anthesis, while in the 2014 season it increased from 63.95 at 50 days after anthesis to 69.43 at 40 days after anthesis. These results are in harmony with those mentioned by Ibrahim and Oladiran,(2011).

Pod position on the mother plant had significant influence on seed number per pod. The higher values of seed per pod were recorded in pods harvested at the middle position of the plant, compared with those of pods harvested from upper part. These results were in accordance with those found by Ghadir *et al.* ,(2012).

As for the interaction between sowing and harvesting dates, data in the same table revealed that number of seeds per pod was significantly influenced by the interaction between sowing and harvesting dates in both seasons. The highest number of seed per pod were recorded from plants which sown on 1st April when harvested at 40 days after anthesis. A similar result was recorded by Yadav and Dhankar , (2001). The interaction between harvesting times and pod position had a clear significant effect on seed number/pod. The higher values (71.17and 74.75) of seed number/pod were recorded from pods harvested 40 days after anthesis from the middle position of the plants, compared with those of upper position pods harvested at 30 and 50 days after anthesis in the first and second seasons, respectively. These results disagree with those found by Hedau *et al.* ,(2010) they reported that the harvesting stage and its interaction with fruit position were insignificant with respect to number of seeds / pod.

Table 4. Effect of both sowing and harvest dates as well as pod position on seed number/pod during 2013 and 2014 seasons.

Seasons		2013				2014			
Sowing date (A)	Harvest Date (B)	Fruit position (C) Lower	Middle	Upper	Mean	Fruit position (C) Lower	Middle	Upper	Mean
	30 DAA	65.75	69.17	64.25	66.39	65.74	66.29	60.69	64.24
1st March	40 DAA	71.20	69.00	67.33	69.18	68.90	74.66	62.68	68.95
	50 DAA	65.69	66.21	65.00	65.63	66.93	63.75	58.05	62.91
Mean		67.55	68.13	65.53	67.07	67.19	68.23	60.47	65.31
	30 DAA	73.00	70.00	63.75	68.92	73.18	72.00	65.90	70.36
1st April	40 DAA	69.27	74.66	72.00	71.98	78.00	80.69	68.32	75.67
	50 DAA	72.50	70.39	72.00	71.63	67.30	72.50	60.90	66.90
Mean		71.59	71.68	69.25	70.84	72.83	75.06	65.04	70.98
	30 DAA	65.07	65.74	58.73	63.18	63.93	66.07	54.73	61.58
1st May	40 DAA	66.90	69.84	66.33	67.69	65.00	68.90	57.69	63.86
	50 DAA	60.83	62.85	57.68	60.45	70.18	62.21	53.70	62.03
Mean		64.27	66.14	60.91	63.77	66.37	65.73	55.37	62.49
	30 DAA	67.94	68.30	62.24	66.16	67.62	68.12	60.44	65.39
B x C	40 DAA	69.12	71.17	68.55	69.61	70.63	74.75	62.91	69.43
	50 DAA	66.34	66.48	64.89	65.91	68.14	66.15	57.55	63.95
Mean		67.80	68.65	65.23		68.81	69.67	60.31	
LSD	**A**		**2.341**			**2.764**			
	B		**1.744**			**2.320**			
	AB		**3.021**			**4.018**			
	C		**2.751**			**2.458**			
	AC		**4.765**			**1.483**			
	BC		**4.765**			**4.257**			
	ABC		**8.254**			**7.374**			

Seed weight /pod

Data in Table (5) reveals that the heaviest seed weight /pod was recorded in case of sowing okra plants on 1st April. Significantly, the lowest values (4.43 and 4.09 g) of seed weight /pod were observed on 1st May sowing in the first and second seasons, respectively. Seed weight from different harvesting dates was increased with prolonged time of harvest since the weight of seeds was increased until 40 days after anthesis and after that it was reduced. As for the pod position, it was found that seed weight per pod was significantly influenced by pod position in both seasons. The maximum weight of seed was exhibited by the seeds obtained from pods at middle nodes, closely followed by seeds collected from the lower portion of the plant. However, seeds obtained from the upper pods were of minimum seed weight. These results are in accordance with those found by Hedau *et al.* ,(2010) who reported that the pods from the lower and middle positions produced the best quality seeds. As for the interaction between sowing and harvesting dates, data in the same table revealed that seeds weight/pod was significantly influenced by the interaction between sowing date and harvesting stage in both seasons. The heaviest seed weight/pod (6.03 and 5.33 g) was obtained from plants sown on 1st April and pods harvested 40 days after anthesis, in the first and second seasons, respectively. The interaction between harvesting dates and pod position showed significant effect with respect to seeds weight/pod. The highest values (5.85 and 5.27 g) of seeds weight /pod were recorded from pods harvested 40 days after anthesis from the middle position in the first and second seasons, respectively, compared with those of pods harvested at 50 days after anthesis from the upper position. This result is in agreement with the view expressed by Oladiran and Agunbiade (2000) who reported that seed weight declined with later harvests in tomato.

Table 5. Effect of both sowing and harvest dates as well as pod position on seed weight /pod during 2013 and 2014 seasons.

Seasons Sowing date (A)	Harvestdate (B)	2013 Fruit position (C) Lower	Middle	Upper	Mean	2014 Fruit position (C) Lower	Middle	Upper	Mean
	30 DAA	5.10	5.17	4.70	4.99	4.76	4.98	4.16	4.63
1st March	40 DAA	5.80	6.00	5.35	5.72	5.00	5.44	4.24	4.89
	50 DAA	5.00	5.00	4.30	4.77	4.46	4.75	4.00	4.40
Mean		5.30	5.39	4.78	5.16	4.74	5.06	4.13	4.64
	30 DAA	5.22	5.18	4.90	5.10	5.37	4.79	4.45	4.87
1st April	40 DAA	6.01	6.19	5,88	6.03	5.72	5.80	4.46	5.33
	50 DAA	5.85	5.71	5.00	5.52	5.14	4.65	4.12	4.64
Mean		5.69	5.69	5.26	5.55	5.41	4.08	4.34	4.95
	30 DAA	4.15	4.22	4.00	4.12	4.16	4.50	3.72	4.13
1st May	40 DAA	4.80	5.35	4.63	4.93	4.41	4.58	3.81	4.27
	50 DAA	4.15	4.53	4.08	4.25	3.95	4.05	3.64	3.88
Mean		4.37	4.70	4.24	4.43	4.17	4.37	3.72	4.09
	30 DAA	4.82	4.86	4.53	4.74	4.76	4.76	4.11	4.54
B x C	40 DAA	5.54	5.85	5.29	5.56	5.04	5.27	4.17	4.83
	50 DAA	5.00	5.08	4.46	4.85	4.52	4.48	3.92	4.31
Mean		5.12	5.26	4.76		4.77	4.84	4.07	
LSD	**A**		**0.311**			**0.762**			
	B		**0.224**			**0.305**			
	AB		**0.388**			**0.527**			
	C		**0.233**			**0.354**			
	AC		**0.404**			**0.613**			
	BC		**0.404**			**0.613**			
	ABC		**0.699**			**1.061**			

100 seed weight

Data in Table (6) shows the effect of sowing, harvest dates and pod position on 100 seed weight; weight of 100 seed was significantly influenced by sowing dates in both seasons. Maximum 100 seeds weight was obtained from seeds produced at sowing okra plant on 1st April; on the other hand, minimum 100 seed weight was obtained from seeds of okra plants sown on 1st May, in both seasons. These results are in accordance with those found by Muhammad *et.al.* (2015).

Table 6. Effect of both sowing and harvest dates as well as pod position on 100 seed weight during 2013 and 2014 seasons.

Seasons Sowing date (A)	Harvest date (B)	2013 Fruit position (C) Lower	Middle	Upper	Mean	2014 Fruit position (C) Lower	Middle	Upper	Mean
	30 DAA	5.00	4.95	4.80	4.91	5.93	6.00	5.28	5.74
1st March	40 DAA	6.00	6.27	5.91	6.06	6.40	6.53	5.60	6.18
	50 DAA	5.71	5.84	5.22	5.43	5.73	6.31	5.17	5.74
Mean		5.57	5.53	5.31	5.47	6.02	6.28	5.35	5.88
	30 DAA	5.07	5.33	5.11	5.17	6.52	6.43	5.36	6.10
1st April	40 DAA	6.08	6.80	6.33	6.40	6.48	7.00	5.30	6.26
	50 DAA	5.60	5.62	5.30	5.50	5.87	5,83	5.07	5.59
Mean		5.58	5.91	5.58	5,69	6.29	6.42	5.24	5.99
	30 DAA	4.27	4.85	4.76	4.62	4.50	4.73	4.27	4.50
1st May	40 DAA	5.25	5.18	5.10	5.17	4.76	4.60	4.47	4.61
	50 DAA	5.00	4.90	4.80	4.90	4.53	4.40	4.02	4.32
Mean		4.84	4.97	4.88	4.90	4.61	4.58	4.25	4.48
	30 DAA	4.78	5.04	4.89	4.90	5.65	5.72	4.97	5.45
B x C	40 DAA	5.77	6.08	5.78	5.88	5.88	6.04	5.12	5.68
	50 DAA	5.83	5.30	5.10	5.28	5.37	5.51	4,75	5.22
Mean		5.33	5.47	5.25		5,64	5.76	4.95	
LSD	**A**		**0.754**			**0.316**			
	B		**0.495**			**0.339**			
	AB		**0.858**			**0.588**			
	C		**NS**			**0.324**			
	AC		**0.673**			**0.561**			
	BC		**0.673**			**0.561**			
	ABC		**1.165**			**0.971**			

Seed germination

Regarding harvest dates, results given in Table (6) indicates that an increase in 100 seed weight was recorded up till 40 days after anthesis. The same general trend was reported by Oladiran and Agunbiade (2000) who reported that seed weight declined with later harvest in pepper.

Pods position on mother plant had insignificant effect on the 100 seed weight during the first season The same general trend were reported by Ibrahim and

Oladiran (2011) who reported that position did not affect 100 seed weight generally. However, in the second season position pods in the plant had a significant effect on the 100 seed weight. Pods in middle and lower parts of the plant produced a higher 100 seed weight than those of the upper part. As to the interaction between sowing and harvesting dates, data in the same table revealed that 100 seed weight was significantly influenced by the interaction between sowing and harvesting dates in both seasons. The higher values (6.40 and 6.26 g.) of 100 seed weight were recorded from plants sown on 1st April and harvested at 40 days after anthesis, in the first and second seasons, respectively. The interaction between harvesting dates and pod position gave raise to significant effect on 100 seed weight. The higher values (6.08 and 6.04 g.) of 100 seed weight were recorded from pods harvested from the middle position of the plant at 40 days after anthesis, compared with those of pods harvested at 30 and 50 days after anthesis in the middle position of the plant, in the first and second seasons, respectively. The same general trend was reported by Ibrahim and Oladiran (2011) they recommended that for the production of quality seed, fruits should be harvested at about 42 DAA from the first five positions on the mother- plant.

Data in Table (7) reveals that seed germination of okra was significantly influenced by sowing dates in both seasons. Maximum germination (71.1 and 73.1 %) was recorded from seeds of okra plants sown on 1st April , while, significantly minimum germination (53.1 and 57.3 %) was recorded when seeds were sown on 1st May in the first and second seasons, respectively. . These results are in accordance with those found by Muhammad *et al* (2001) who revealed that the maximum germination percentage was observed when seeds sown on either April 15 or May 5. Regarding harvest date, results in Table (7) indicated that germination percentage increased with increased pod age. With mean germination percentage of 57.3, 63.5, and 63.6 % from pods harvested in 2013 at 50, 40 and 30 days after anthesis, respectively, and in 2014 mean percentage germination of 63.5, 71.5 and 65.4 % from pods harvested at 50, 40 and 30 days after anthesis, respectively. The same result was reported by (Eweter, (1980) and Konwar and Saimbhi1987) who reported that the highest seed germination was recorded when the pods were harvested at 35 days after anthesis and Neupane *et al.* ,1991who reported that the highest seed germination was recorded when the pods were harvested at 40 days after anthesis. Delay in harvesting reduced germination percentage. These results are in accordance with those found by Berchie *et al.* , (2004).

Table 7. Effect of both sowing and harvest dates as well as pod position on seed germination during 2013 and 2014 seasons.

Seasons		2013				2014			
Sowing date (A)	Harvest date (B)	Fruit position (C)			Mean	Fruit position (C)			Mean
		Lower	Middle	Upper		Lower	Middle	Upper	
	30 DAA	62.60	61.10	60.20	61.30	66.90	70.00	63.10	66.67
1st March	40 DAA	61.87	63.60	57.60	60.84	81.80	79.30	70.00	77.03
	50 DAA	63.60	57.60	57.30	59.50	66.93	68.10	63.03	66.02
Mean		62.51	60.76	58.36	60.54	71.88	72.47	65.38	69.91
	30 DAA	76.60	76.40	70.30	74.43	74.30	73.30	71.00	72.87
1st April	40 DAA	77.60	76.30	73.30	75.73	81.70	77.70	72.67	77.36
	50 DAA	62.60	62.30	64.30	63.06	65.00	78.80	63.10	68.97
Mean		72.26	71.66	69.30	71.07	73.67	76.60	68.97	73.06
	30 DAA	56.00	55.00	54.00	55.00	56.30	55.40	54.60	56.43
1st May	40 DAA	56.00	56.30	49.30	53.87	63.60	60.60	55.70	59.97
	50 DAA	50.60	53.00	47.30	50.30	69.30	57.30	49.50	55.37
Mean		54.20	54.76	50.20	53.05	60.73	57.77	53.27	57.26
	30 DAA	65.06	64.16	61.50	63.57	66.83	66.22	62.90	65.32
B x C	40 DAA	64.97	65.40	60.06	63.48	75.70	72.53	66.12	71.45
	50 DAA	58.93	57.63	56.30	57.62	63.74	68.07	58.54	63.45
Mean		62.99	62.40	59.28		68.76	68.94	62.52	
LSD	**A**		**2.939**			**2.516**			
	B		**1.991**			**3.162**			
	AB		**3.449**			**5.477**			
	C		**2.528**			**3.507**			
	AC		**4.379**			**6.074**			
	BC		**4.379**			**6.074**			
	ABC		**7.584**			**10.512**			

Root length (cm)

Seeds from different parts of plant showed different germination potential, in 2013 season higher values of seeds germination were recorded in lower position pods compared to those of pods harvested from the upper position while, in 2014 pods harvested from the middle part of the plant showed higher germination percentage. The same result was reported by Yadav and Dhankar , (2001). As to the interaction between sowing and harvesting dates, data in table 7 revealed that seed germination was significantly influenced in both seasons. The higher values of seed germination were recorded from seeds sown on 1st April when pods was harvested at 40 days after anthesis, compared to those of plants sown in 1st May when the pods harvested at 50 days after anthesis. A similar result was recorded by Yadav and Dhankar,(2001).The interaction between harvesting dates and pod position appeared significant with respect to seed germination. In 2013 season, higher values of seed germination were recorded in pods harvested in the middle position of the plants after

40 days from anthesis, compared to those of pods harvested from the lower position of the plant collected after 50 days from anthesis while, In 2014 season pods harvested after 40 days from anthesis in the lower position showed higher germination percentage , compared with those of pods harvested from the upper position which were collected after 50 days from anthesis. Differences in seed germination were also reported by several workers due to different harvest times and pod position Nakagawa *et al.* ,(1994) and Ghadir *et al.* (2013) who reported that harvesting seeds at 40 DAA and collected from the middle part of the plant could be a useful means for reducing the occurrence of hardseedness and increasing germination percentage of okra seeds.

Data recorded in Table (8) shows that the longest root length (4.96 and 4.54 cm) was produced by seeds obtained from okra plants which were sown on 1st March, in the first and second seasons, respectively. However, the shortest root length (3.65 and 3.67 cm) was produced by seeds obtained from okra plants sown on 1st May, in the first and second seasons, respectively. These results are in line with those reported by Ishratnaz *et al.* ,(2009). As for the harvest dates, it was found that root length was significantly influenced by harvest dates in both seasons. The highest values for root length were recorded from 40 days after anthesis, while the lowest values were observed from 50 days after anthesis. These results were true in both seasons. Data from different positions showed differences in root length, in 2013 season pods in middle part of the plant meanwhile, in 2014 season seeds from the pods in lower part of the plant showed higher root length. These findings are in agreement with those obtained by Hedau *et al.* (2010) who indicated that reasonably good seedling length was observed with seeds obtained from lower and middle pods. With respect to the interaction between sowing and harvesting dates, data in Table (8) revealed that root length was significantly influenced by interaction in both seasons. The higher values (5.44 and 5.00 cm) of root length were recorded from plants sown on 1st March and harvested at 40 days after anthesis in the first and second seasons, respectively. A similar result was recorded by Yadav and Dhankar, (2001). The interaction between harvesting dates and pod position was significant with respect to root length. The higher value (5.35 cm) of root length was recorded from pods harvested at 40 days after anthesis from the middle position in the first season, while in the second season the higher value (4.75 cm) was obtained from pods harvested at 40 days after anthesis from the middle position. The lowest values in both seasons were obtained from pods harvested at 50 days after anthesis from the upper position.

Table 8. Effect of both sowing and harvest dates as well as pod position on root length (cm) during 2013 and 2014 seasons.

Seasons		2013				2014			
Sowing date (A)	Harvest date (B)	Fruit position (C) Lower	Middle	Upper	Mean	Fruit position (C) Lower	Middle	Upper	Mean
	30 DAA	4.89	5.00	4.53	4.81	4.39	4.51	4.28	4.93
1st March	40 DAA	5.33	6.35	4.65	5.44	5.50	5.11	4.39	5.00
	50 DAA	4.75	4.99	4.20	4.65	4.19	4.31	4.17	4.22
Mean		4.99	5.45	4.46	4.96	4.69	4.64	4.28	4.54
	30 DAA	4.54	4.97	4.48	4.66	4.44	4.54	4.20	4.39
1st April	40 DAA	5.44	5.70	4.67	5.27	5.03	4.74	4.10	4.62
	50 DAA	4.76	4.98	4.33	4.69	4.51	4.48	3.66	4.22
Mean		4.91	5.22	4.49	4.87	4.66	4.59	3.98	4.41
	30 DAA	3.76	3.98	3.30	3.68	3.92	366	3.33	3.64
1st May	40 DAA	3.96	4.00	3.66	3.87	3.96	4.39	3.51	3.95
	50 DAA	3.30	3.71	3.22	3.41	3.72	3.31	3.27	3.43
Mean		3.67	3.90	3.39	3.65	3.87	3.79	3.37	3.67
	30 DAA	4.40	4.65	4.10	4.38	4.25	4,.24	3.94	4.14
B x C	40 DAA	4.91	5.35	4.33	4.86	4.83	4.75	4.00	4.58
	50 DAA	4.27	4.56	3.92	4.25	4.14	4.03	3.700	3.96
Mean		4.53	4.85	4.12		4.41	4.34	3.88	
LSD	**A**		**0.32**			**0.256**			
	B		**0.29**			**0.244**			
	AB		**0.50**			**0.422**			
	C		**0.24**			**0.300**			
	AC		**0.42**			**0.522**			
	BC		**0.42**			**0.522**			
	ABC		**0.73**			**0.900**			

Shoot length (cm)

Data in Table (9) reveals that shoot length of okra was significantly affected by sowing date in both seasons. The plants grown on 1st April gave the tallest shoots, as compared with the plants grown on 1st May in both seasons. The results revealed that shoot length of okra plants was significantly influenced by harvest date, 40 days after anthesis, gave the highest values. The lowest values were observed from pod harvested at 50 days after anthesis, in both seasons. Shoot length was significantly influenced by pod position in both seasons. The highest values (5.11 and 4.93 cm) were observed with pods obtained from middle and lower positions, respectively, while the lowest values were obtained from upper pods, in both seasons. All possible combinations had significant effect on this character in both seasons. The highest values (6.62 and 5.62 cm) were obtained from the pods collected at 40 days after anthesis in middle position of the plants sown on 1st April in the first and second seasons.

Table 9. Effect of both sowing and harvest dates as well as pod position on shoot length during 2013 and 2014 seasons.

Seasons		2013				2014			
Sowing date (A)	Harvest date (B)	Fruit position (C) Lower	Middle	Upper	Mean	Fruit position (C) Lower	Middle	Upper	Mean
	30 DAA	4.85	4.90	4.40	4.71	5.01	5.09	4.15	4.75
1st March	40 DAA	4.15	5.00	4.44	4.86	5.15	5.44	4.50	5.03
	50 DAA	4,57	4.46	4.12	4.38	4.22	5.34	4.21	4.59
Mean		4.86	4.79	4.32	4.65	4.79	5.29	4.29	4.79
	30 DAA	6.00	5.98	4.62	5.53	5.16	5.57	4.87	5.20
1st April	40 DAA	6.38	6.95	5.50	6.43	5.83	5.62	4.90	5.45
	50 DAA	5.15	5.37	4.25	4.91	4.68	4.46	4.19	4.44
Mean		5.99	6.10	4.79	5.63	5.23	5.22	4.65	5.03
	30 DAA	4,44	4.61	4.00	4.35	4.50	4.30	4.00	4.28
1st May	40 DAA	4.44	4.70	4.24	4.46	4.61	4.65	4.01	4.42
	50 DAA	3.84	3.92	3.18	3.65	4.19	3.90	3.70	3.93
Mean		4.24	4.10	3.81	4.15	4.43	4.28	3.91	4.21
	30 DAA	5.11	5.16	4.34	4.87	4.89	4.99	4.35	4.74
B x C	40 DAA	5.47	5.55	4.73	5.25	5.21	5.24	4.47	4.97
	50 DAA	4.52	4.58	3.85	4.32	4.36	4.57	4.03	4.32
Mean		5.03	5.11	4.31		4.82	4.93	4.28	
LSD	**A**		**0.445**			**0.589**			
	B		**0.190**			**0.500**			
	AB		**0.330**			**0.867**			
	C		**0.359**			**0.246**			
	AC		**0.621**			**0.426**			
	BC		**0.621**			**0.426**			
	ABC		**1.076**			**0.738**			

REFERENCES

Berchie J.N., A.Djetror and C.K. Osei (2004). Effect of pod maturation on vegtative groth, fruit yield and seed germination of okra (*Abelmoschus esculentus L. Moench)*. Agricultural and Food Science Journal of Ghana, 3 :227-235.

Demir, I. 1994. Development of seed quality during seed development in okra. Acta Hort. 362:125-132

Demir I. and R.H. Ellis (1992). Changes in seed quality during seed development and maturation in tomato. Seed Science Research, 2:81-87.

Dias, D.C.F.S., F.P. Ribeiro, L.A.S. Dias, D.J.H. Silva and D.S. Vidigal (2006) Tomato seed quality in relation to fruit maturation and post-harvest storage. Seed Sci. Technol., 34:691-699.

El-Waraky, Y.B. (2014). Effect of sowing date, plant density and phosphorus fertilization on seed yield of okra. Alex. J. Agric. Res., 59 (1): 27 41

Eweter F.K., (1980). Quality seed production in okra (*Abelmoschus esculentus L. Moench)*. Veget Hot Humid Trop 5:39-44.

Ghadir M., E.M. Khah, M. Ghitouli, A. Shirkhani, G .Shabani and M. Jabellou (2012). Improvement of okra (Abelmoschus esculentus L. Moench) hardseedness by using micro element fertilizer.Annal of Biological Research, 3 (5): 2153-2161.

Ghadir M., , E. M. Khah , S. A. Petropoulos, G.Yarsiand and A Vlasakoudis (2013). Effect of fertilizer and drying methods on seed germination of okra (*Abelmoschus esculentus* L.) cultivars at different harvesting times. Journal of Agricultural Science; 5 (4):201-214.

Harrington, J.F., 1972. Seed storage and longevity in: Seed Biology (T.T. Kozlowski) Vol. III. Academic Press, New York., 145-245.

Hedau N.K., S. Gyanendra, V. Mahajan, S.R.K. Singh and G. Anita (2010). Seed quality and vigourin relation to nodal position and harvesting stage of okra under mid hill of North- Western Himalayas. Indian Journal of Horticulture. 67:251-253.

Ho L.C, and J.D. Hewit (1986). Fruit Development: J.G. Atherton and J. Rudich (Eds.).The tomato crop. Chapman Hall, New York pp. 201-239.

Hossain A. B. M., M. Justus and A.Wahab (2003). Comparative studies on the effect of sowing dates and spacing on the growth and yield of okra in different years. Journal of Biological Sciences 3 (12):1173-1180.

Hossain M. D., M. A. Salam, M. S. Islam and M.A.T. Masud (1999).Yield and quality of okra seed as influenced by time of sowing and plant spacing. Bangladesh J. Seed Sci. Tech. 3 (1-2): 83-87.

Ibrahim H. and J. A. Oladiran (2011). Effect of fruit age and position on mother plant on fruit growth and seed quality in okra (Abelmoschus esculentus L. Moench).International Journal of Science and Nature , 2: (3):587-592.

Ishratnaz H. A., M. Ahmad, A. Hussain and M. Tahir (2009). Effect of various dates and cultivars on the management of okra root rot under natural field conditions. Sarhad J. Agric. 25 (2): 251-260.

ISTA (2011). International Rules for Seed Testing. Seed Science and Technology, 39:1-333.

Kameswara R. N., R. S. Appa, M.H. Mengersha, and R.H. Ellis (1991) Longevity of pearl millet (*Peninisetum Glaucum R.Br*) seeds harvested at different stages of maturity. Annals of Applied Biology, 24: 225-234.

Kochhar S.L. (1986). Tropical Crops. A text book of economic botany. Macmillan Indian Ltd., pp. 263-264.

Konwar J.S. and M.S. Saimbhi (1987). Pod maturity and seed quality in okra (*Abelmoschus esculentus L. Moench*) . Punjab Hort J. 27(3/ 4):234-238.

Moniruzzaman M., M. Z. Uddin and A.K. Choudhury (2007). Response of okra seed crop to sowing time and plant spacing in south eastern hilly region of Bangladesh. Bangladesh J. Agril. Res. 32(3): 393-402.

Mugnisjah W.O. and S. Nakamura (1984). Vigour of soyabean seed production from different harvest dates and phosphorus fertilizer application. Seed Science and Technology, 12: 483-491.

Muhammad A.,M. A. Anjum and S.Hussain (2001).Effect of different sowing dates and various doses of fertilizers on juvenility and productivity of okra. Pak. J.Agri. Sci. 38 (1-2): 29-32.

Muhammad S., A. Rehman A. A. Malik, M. S. Khan and Zakaria (2015). Effect of sowing dates on the yield and seed production of okra cultivars in Mansehra. Journal of Biology, Agriculture and Healthcare .5(9); 9-15.

Nakagawa J., A.C.W. Zanin and J. W. Setubal (1994).Effect of harvesting methods and fruit position in plant on hard seed occurrence in okra (*Abelmoschus esculentus L. Moench*). Sci. Agric. 51(3): 490-494

Neupane P.R., A.J. Ghimire and R. Khanala (1991). Seed research on summer vegetable crops (sweet pepper and okra) at PAC.Tech Pap Pakhribas Agril Cent 144:12.

Nonnecke I.L.(1989). Vegetable Production. Van Nostrand Reinhold AVI Publishing, pp. 608-609.

Oladiran J,A. and S.A . Agunbiade (2000).Germination and seedling development from pepper (*Capsicum annuum L,*) seeds following storage in different packaging materials, Seed Science and Technology. 28: 413-419.

Singh K.P., Y.S. Malik and M.L. Pandita.,(1986). Effects of planting dates and spacing on seed production of okra (*Abelmoschus esculentus* (L). Moench. Haryana J. Hort. Sci. 15(3-4): 267-271.

Snedecor, G.W. and W.G. Cochran (1981). Statistical Methods. Seventh Ed. Iowa State Univ. Press, Ames, Iowa, USA.

TeKrony, D.M., D.B. Egli and A.D. Philips (1980). Effect of field weathering and the viability and vigour of soyabean seed. Agronomy Journal, 72: 749 – 753.

Thomas J.F., N.L. Biddington and O. D.F. Toole (1979). Relationship between position on parent and dormancy characteristics of seeds of three cultivars of celery (Apium gradvedus). Seed Science and Technology, 26: 309 - 318.

Tindall H.D.(1983). Vegetables in the Tropics. McMillan AVI., pp. 325-327.

Yadav S.K. and B.S. Dhankar (2001). Seed production and quality of okra (*Abelmoschus esculentus (L.) Moench)* as influenced by sowing time and position of fruit on plant. Seed Res. 29(1): 47-51.

تأثر محصول البذور وجودته فى الباميا بتاريخ الزراعة والحصاد ووضع القرون على النبات

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يتأثر بوضوح إنتاج التقاوى و جودتها فى محصول الباميا بالعديد من العوامل التى من أهمها ميعادى الزراعة و الحصاد و كذلك وضع القرون على النبات الأم و لذلك أجريت هذه الدراسة بهدف دراسة تأتير ٣ مواعيد للزراعة (أول مارس- أول أبريل- أول مايو) و ٣ مواعيد للحصاد (حصاد القرون بعد ٣٠- ٤٠ – ٥٠ يوم من تفتح الأزهار) و كذلك ٣ أوضاع للقرون على النبات الأم (المنطقة السفلى – المنطقة الوسطى – المنطقة العليا) و ذلك على محصول البذور و جودته فى صنف الباميا البلدى.أجريت تجربتين حقليتين خلال الموسم الصيفى لعامى ٢٠١٣ م و ٢٠١٤ م بمحطة البحوث الزراعية بشندويل التابعة لمركز البحوث الزراعية – محافظة سوهاج – جمهورية مصر العربية و كانت أهم نتائج هذه الدراسة هى :- إزدادت جميع الصفات تحت الدراسة معنويا عندما تمت زراعة بذور الباميا فى الأول من أبريل مقارنة بميعادى الزراعة الأخرين (الأول من مارس – الأول من مايو). كما أظهرت النتائج أن حصاد قرون الباميا بعد ٤٠ أو ٥٠ يوم من تفتح الأزهار أعطى أعلى نسبة إنبات فى البذور الناتجة مقارنة بالحصاد بعد ٣٠ يوم من تفتح الأزهار.أعطت القرون المحصودة من المنطقة السفلى أو الوسطى على النبات أعلى القيم سواء فى محصول البذور (عدد البذور فى القرن – وزن البذور فى القرن- وزن ١٠٠ بذرة) أو جودته (نسبة الإنبات – طول البادرة- طول الجذير). أيضا أوضحت النتائج المتحصل عليها تأثر كلا من قطر القرن ووزن ١٠٠ بذرة و نسبة الإنبات و طول البادرة تأثرا معنوياً بتفاعل جميع العوامل تحت الدراسة ، ولوحظ أن اعلى القيم سجلت من القرون الوسطى أو السفلى التى تم حصادها بعد ٤٠ يوما من تفتح ازهارها على النباتات التى زرعت فى الأول من أبريل.يمكن التوصية من نتائج هذه الدراسة أنه للحصول على أعلى محصول بذرى ذو جودة عالية فى الباميا تحت ظروف منطقة البحث و المناطق المشابهة بالزراعة فى أول أبريل و حصاد القرون حتى نهاية المنطقة الوسطى (القرن الثامن) و ذلك بعد ٤٠ يوم من تفتح الأزهار .