ISSN NO. 2320-5407

Journal homepage: http://www.journalijar.com

INTERNATIONAL JOURNAL OF ADVANCED RESEARCH

RESEARCH ARTICLE

((Early production of Okra (*Abelmoschus esculentus* L.) fruits under Siwa oasis conditions))

Ghodia, R.H.A.; S.S. Gomaa and M.A.M. Elsagan

Department of plant production, Desert Research Center, El-Mataria, Ciaro, Egypt.

Manuscript Info

Manuscript History:

Received: 14 October 2015
Final Accepted: 22 November 2015
Published Online: December 2015

Key words:

Okra, Transplanting date, Early production, Transplants age

Corresponding Author

Ghodia

Abstract

The experiment was conducted at the Experimental Research Station of Siwa Oasis, Desert Research Center in 2014 and 2015 growing seasons to study the effect of three transplanting dates (mid of February, first of March and mid of March) and three transplants ages (2 Weeks, 4 weeks and 6 weeks) on growth and yield of okra plants under Siwa conditions. The results indicated that late transplanting on mid of March enhanced transplants survival ratio and increased plant height, leaf number, plant fresh weight 45 days after transplanting and total yield followed by transplanting on fist of March, while early transplanting date on mid of February produced the lowest values in this respect. On other hand early transplanting on mid of February increased early yield compared with other transplanting dates. Six weeks transplants age produced the highest transplants survival ratio, vegetative growth 45 days after transplanting and early yield, however, four weeks transplanting age also enhanced vegetative growth and produced the highest total yield compared with two weeks transplants age which produced the lowest transplant survival ratio, vegetative growth, total and early yield in both growing seasons.

INTRODUCTION

Okra (*Abelmoschus esculentus* L. Moench) is an important vegetable crop in tropical and subtropical parts of the world **(Tindall, 1986).** Okra for the fresh market can be planted as soon as soil temperatures rise above the base temperature of 60 °F (15 °C) and the optimum soil temperature for germination is 75 to 90 °F (24 to 32 °C) **(Maynard and Hochmuth, 1997)**. Okra is sensitive to chilling temperatures and grows poorly below 15^{o}C, which climatically constrains its production (**Marsh, 1992b)** and the increases in okra yields were associated with increases in air heat unit, soil heat unit and light intensity **(Sharaiha and Hadidi, 2007).** So, Many researchers found that okra plant height, earlier flowering, larger leaf area, greater pod length, pod diameter, number of pods per plant, pod weight and total yield significantly affected by sowing dates **(Iremiren and Okiy,1986; Usman; 2001 and Oyolu, 2002 and Ezeakunne, 2004)**

Generally, using transplants enables growers to extend the season, increase the percentage of early harvested fruits, reduce the time to harvest in cold areas, enables to produce long maturing crops in moderate areas and reduce the crop production cost **(Orzolek, 1996).** Okra transplants can advance earliness by as much as 21 day **(Khan *et al*., 1990)**. The use of plastic mulch, drip irrigation, and transplants can increase marketable yields of okra compared to bare ground **(Khan *et al*., 1991; William, 1999)**.

The age of vegetable transplants depends on crop, variety, climate, transplant vigor, and stress tolerance, a wide range of plant ages will produce acceptable crop yields providing that the plant has not become totally reproductive

at time of transplanting into the field **(Orzolek, 1996)**. The optimum physiological plant age at transplanting four tomato is 4 to 7 weeks **(Varina and Orzolek, 1993)**, 2 to 4 weeks for muskmelon **(Ne Smith, 1994)**, 10 to 21 days for summer squash **(Ne Smith, 1992)**, transplanting the African eggplant *Solanum macrocarpon* at the appropriate age (6 week-old) resulted in higher quality leaf production, taller plants, wider crop canopies, broader leaves and adequate root development **(Gaveh *et al.*, 2011).** Also **Harmon *et al*., (1991)** on eggplant found that significant differences were observed in the early yields of eggplants as a result of transplant age or root cell size treatments. Optimal transplant age was between 35 and 49 days, with transplants of less than 35 days producing minimal early yields.

Okra transplants should be 3 to 4 weeks old and have about three to four leaves, okra transplants 5 wks old have superiority survival ratio, total and marketable yield, as well as total and marketable number of pods than 9 wks old of transplants **(Khan *et al*., 1991).** Also, larger cell sizes and older transplants should be favored for late fall plantings or when poor weather conditions are anticipated in the spring **(Jones *et al*., 1991).** Earlier planting for fresh-market of okra is desired, since the intention is to market okra yield early when the price is normally highest, while for processed okra, maximum yield rather than earlier production is the prime consideration, and later planting dates are the rule **(William, 1999).** So, the objective of our study was produce earlier okra crop by determine the optimum transplanting date and transplants age under Siwa oasis weather conditions.

Materials and Methods

The experiment was conducted at the Experimental Research Station of Siwa oasis, Desert Research Center in 2014 and 2015 growing seasons. The GPS (Global Positioning System) of the experimental site is at 29.12_N Latitude and 25.29_ Longitude with an elevation of 18 meter blew the mean sea level. The experiment was conducted in split plot design with three replicates. Main treatments consisted of three transplanting dates (mid of February, first of March and mid of March) and three Transplants ages (2 Weeks, 4 weeks and 6 weeks) were arranged in sub-treatments. Okra seeds of Baladi cultivar were sowing from January 1st. at March 1st. with 15 days intervals between sowing dates. Okra seeds were sowing in plastic pots 5cm diameter X 7 cm depth, filled with 1:1 (v/v) mixture of peatmoss and vermiculite (the recommended transplants production media for protected cultivation) and the pots were placed under protection system at transplanting date, then transplanted in open field in rows 1 meter width, 30cm apart under drip irrigation system and the plot area was 10.5 m^2. In both growing seasons, all agriculture practices were performed according to the recommendation of the Egyptian Ministry of Agriculture.

Data recorded

Vegetative growth

Five randomly selected plants were sampled from each plot 45 days after transplanting in both seasons and plant length (cm), leaves number and plant fresh weight (g) were recorded. Also transplants survival ratio was calculated 15 days after transplanting and number of days from transplanting at harvest beginning was counted.

Yield and its component

Marketable fruits 3 – 6 cm long were harvested at 3 - 5 day intervals during the growing season **(March, 1992a)**, counted and weighed to record total number of pods per plot, average fruit weight and total yield per plot. The early yield per plot was determined as weights of all pods harvested during April and May months in both seasons. Ten okra pods (3 to 6 cm length) were collected randomly from each treatment during early harvesting period as sub-samples for fruits elements contents, and then samples were oven-dried at 65 C° until constant weight. Dry matter percent were determined then 0.1 g of the dry samples was taken and digested using a mixture of sulphuric acid and hydrogen peroxide as described by **Thomas *et al*., (1976)**. Phosphorus content was measured spectrophotometrically using the ascorbic acid method as described by **A.O.A.C.,(2005)**. Potassium was measured by flame photometer as described by **Page *et al*., (1982)**

Statistical analysis

Data were subjected to statistical analysis by M-STAT C **(Russel, 1991).** The differences among means were performed using least significant difference (LSD) at 5% level.

Table 1 Maximum and minimum monthly temperature during 2014 and 2015 growing seasons

Temp.	2014							2015						
	Feb.	Mar	Apr	May	June	July	Agu	Feb	Mar	Apr	May	June	July	Agu
Max.	22.4	26.1	30.1	33.8	36.8	38.4	38.3	20.1	24.6	28.7	33.6	34.9	38.5	39.2
Min.	8.2	11.5	14.5	18.6	21.4	23.5	23.6	7.0	11.8	12.9	18.7	21.2	23.3	25.7
Mean	15.9	18.8	22.3	26.2	29.1	30.9	31.0	13.6	18.2	20.8	26.1	28.1	30.9	32.4

Results and discussion

Transplants survival ratio and vegetative growth:

The influence of transplanting dates, transplants age and their interactions on transplants survival ratio, plant height, leaf number and plant fresh weight are presented in table (2). Transplants survival ratio significantly affected by transplanting dates and transplants age, while interaction effect was not significant in both seasons. Transplanting on mid of March produced the highest significant transplant survival ratio followed by transplanting on first of March compared with mid of February in both seasons. Concerning of transplants ages, six and four weeks transplants ages in the first season and six weeks in the second season produced the highest transplants survival ratio compared with two weeks transplants age which produced the lowest transplants survival ratio in both seasons.

Table (2) Effect of transplanting date, transplants age and their interaction on Transplants survival ratio, plant height, leaf number and plant fresh weight 45 days after transplanting.

Characters		Transplants survival ratio		Plant height (cm)		Leaf number		Plant fresh weight (g)	
Treatments		**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Feb.Med..		73.02	75.66	47.18	46.81	7.82	5.48	187.79	150.64
Mar. St.		82.54	81.48	56.20	49.52	8.56	7.44	211.20	167.40
Mar. Med.		89.95	84.66	63.10	56.03	8.95	8.39	217.13	189.48
L.S.D. at 0.5		**3.79**	**4.57**	**1.62**	**2.68**	**0.24**	**0.53**	**10.32**	**11.77**
Transplants Age									
Two weeks		73.02	70.37	33.44	36.73	6.64	6.45	166.95	128.90
Four weeks		86.24	82.01	50.73	55.81	9.14	8.39	212.12	184.29
Six weeks		86.24	89.42	56.27	59.82	9.56	9.17	237.05	194.34
L.S.D. at 0.05		**3.19**	**3.05**	**1.68**	**1.73**	**0.58**	**0.43**	**8.07**	**7.74**
Interaction									
Feb. Med..	Two weeks	63.49	65.08	34.44	33.44	5.68	5.48	152.94	117.93
	Four weeks	79.37	77.78	52.55	50.73	8.46	7.44	185.12	158.25
	Six weeks	76.19	84.13	54.56	56.27	9.33	8.39	225.30	175.75
Mar. St.	Two weeks	73.02	69.84	40.89	36.42	6.56	6.61	171.72	126.67
	Four weeks	87.30	82.54	63.70	53.17	9.49	8.63	220.47	182.60
	Six weeks	87.30	92.06	64.0	58.97	9.61	9.33	241.43	192.93
Mar. Med.	Two weeks	82.54	76.19	44.34	40.33	7.67	7.27	176.21	142.11
	Four weeks	92.06	85.71	74.07	63.54	9.46	9.08	230.78	212.01
	Six weeks	95.24	92.06	70.88	64.21	9.73	9.78	244.41	214.34
L.S.D. at 0.5		**NS**	**NS**	**2.90**	**3.00**	**NS**	**NS**	**NS**	**NS**

Okra plant height, leaf number and plant fresh weight 45 days after transplanting significantly affected by transplanting dates and transplants ages in both seasons, while interaction effects was not significant except plant height in both seasons. Transplanting on mid of March produced highest plant, highest leaf number and heaviest plants, followed by transplanting on first of March, while transplanting on mid of February produced the lowest values in this respect. Regarding of transplants ages, data in Table (2) showed that six weeks transplants age produced the highest values of plant height, leaf number and plant fresh weight in both seasons, followed by four weeks, while two weeks transplants age produced the lowest significant plant height, leaf number and plant fresh weight in both seasons. Moreover, two weeks transplants age transplanted on mid of February produced the lowest plant height compared with four and six weeks transplants age which transplanted on mid of March in the first and second seasons respectively. It may be concluded from the forgoing results that the superior effect of later planting dates on growth characters such as, plant height, leaf number and plant fresh weight might be due to the favorable temperature degrees prevailed during this stage. These results agreed with **(Marsh, 1992b; Sharaiha and Hadidi, 2007).**

Yield and its component:

Data in table (3) showed that transplanting dates, transplants age and their interaction affected significantly on days from transplanting at harvest, early yield, total yield and total pods number per plot in both seasons. Days from transplanting at harvest increased on mid February transplanting date followed by first of March, while this period decreased significantly when transplanting date was delayed on mid of March in both seasons. Moreover, early transplanting date (mid of February) produced the highest early yield followed by first of March then mid of March in both seasons. on the contrary, late transplanting dates (first and mid of March) produced the highest significant total yield and highest total number of pods per plant compared with early transplanting date (mid of February) which produced the lowest values.

Table (3) Effect of transplanting date, transplants age and their interaction on Days from transplanting at harvest, Early yield (kg/plot), Total yield (kg/plot) and Total pod number /plot.

Characters		Days from transplanting at harvest		Early yield (kg/plot)		Total yield (kg/plot)		Total pod number /plot	
Treatments		**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Feb.Med..		54.33	56.56	7.65	7.32	10.112	10.196	824.06	826.43
Mar. St.		49.00	52.00	6.13	5.68	12.367	10.974	1001.65	894.33
Mar. Med.		41.33	43.44	5.15	4.68	11.872	11.267	949.75	918.57
L.S.D. at 0.5		**0.76**	**1.11**	**0.14**	**0.15**	**0.933**	**0.488**	**85.59**	**46.28**
Transplants Age									
Two weeks		56.22	58.00	5.02	4.81	10.635	9.549	870.22	775.06
Four weeks		47.00	49.89	6.53	6.07	12.580	11.721	1023.86	957.55
Six weeks		41.44	44.11	7.38	6.82	11.136	11.167	881.38	906.72
L.S.D. at 0.05		**0.77**	**0.74**	**0.11**	**0.11**	**0.687**	**0.183**	**59.40**	**16.71**
Interaction									
Feb. Med..	Two weeks	61.00	62.33	6.61	6.40	9.290	9.105	770.65	740.48
	Four weeks	53.67	56.67	7.72	7.25	10.454	10.513	855.69	862.93
	Six weeks	48.33	50.67	8.65	8.34	10.593	10.970	845.83	875.88
Mar. St.	Two weeks	56.00	58.67	4.82	4.55	11.787	9.390	969.36	768.07
	Four weeks	48.33	51.00	6.35	5.85	13.844	11.925	1128.39	967.41
	Six weeks	42.67	46.33	7.25	6.65	11.468	11.607	907.21	947.52
Mar. Med.	Two weeks	51.67	53.00	3.65	3.45	10.827	10.153	870.65	816.64
	Four weeks	39.00	42.00	5.55	5.11	13.442	12.726	1087.51	1042.30
	Six weeks	33.33	35.33	6.25	5.52	11.374	10.924	891.10	896.78
L.S.D. at 0.5		**1.33**	**1.28**	**0.19**	**0.19**	**1.190**	**0.317**	**102.89**	**98.95**

Concerning transplants age, two weeks transplants age increased number of days from transplanting at harvest followed by four weeks compared with six weeks transplants age in both seasons. On the other hand, six weeks transplants age significantly produced the highest early yield, followed by four weeks age compared with two weeks transplants age. Similar results were found by (**Jones *et al*., 1991; Khan *et al*., 1991)**. Moreover, four weeks transplants age produced the highest significant total yield and total pods number per plot followed by six weeks compared with two weeks transplants age which gave the lowest yield and pods number per plot in both seasons. All interaction effects were significant , the most pronounced interaction effects when two weeks transplants age increased number of days from transplanting at harvest and decreased early yield when transplanted on mid of February and mid of March compared with six weeks transplants age when transplanted on mid of March and mid of February respectively. On other hand, four weeks transplants age significantly increased total yield and total number of pods per plot when transplanted on first or mid of March compared with two weeks transplants age when transplanted on mid of March in both seasons.

Okra transplanted on mid of February took a significant more days to first harvest compared with transplanting on first and mid of March. This might be as a result of inability of okra transplanted early to accumulate enough thermal units to induce early pods due to a lower temperature recorded during this period. Moreover, early transplanting on mid of February produced early yield since the harvesting began early by (10 to 12) and (18 to 20) days compared with first and mid of March in both seasons. similar results were obtained by **(Iremiren and Okiy,1986; Usman; 2001 and Oyolu, 2002 and Ezeakunne, 2004; Sharaiha and Hadidi, 2007).** Concerning of total yield and its component, later transplanting dates first and mid of March have superiority compared with early transplanting date. This may be due the exuberant vegetative growth of the plants transplanted later during March (relatively hotter) compared to those transplanted later during February. Similar results fond by **(William, 1999)** who reported that earlier planting for fresh-market of okra is desired, since the intention is to market okra yield early when the price is normally highest, while for processed okra, maximum yield rather than earlier production is the prime consideration, and later planting dates are the rule**.**

Average pod weight and chemical contents:

Data presented in Table (4) showed that transplanting on mid of March significantly increased average pod weight compared with other transplanting dates. Also, six weeks transplants age gave the heaviest pod weight compared with other transplants ages in the first season, while all studied factors and their interaction was not significant in second season.

Transplanting on mid of February or first of March significantly increased pods dry matter percent compared with transplanting on mid of March in both seasons. Six weeks transplants age produced the highest pod dry matter percent followed by four weeks, while two weeks transplants age gave the lowest value. Concerning of okra pods phosphorus and potassium content, data in Table (4) showed that there is no significant effect the effect of transplanting dates on phosphorus in the second season and potassium in both seasons, since late transplanting on mid of March slightly enhanced okra pod phosphorus and potassium content followed by first of March, while mid of February gave the lowest value in this respect.

Table (4) Effect of transplanting date, transplants age and their interaction on Average pod weight (g), Pods dry matter percent, Phosphorus pod content (%) and Potassium pod content (%).

Characters		Average pod weight (g)		Pods dry matter percent		Phosphorus pod content (%)		Potassium pod content (%)	
Treatments		**2014**	**2015**	**2014**	**2015**	**2014**	**2015**	**2014**	**2015**
Feb.Med..		12.27	12.33	12.15	12.51	0.532	0.515	2.13	2.24
Mar. St.		12.36	12.27	11.97	12.38	0.535	0.517	2.21	2.35
Mar. Med.		12.52	12.28	11.52	11.78	0.538	0.529	2.28	2.42
L.S.D. at 0.5		**0.13**	**NS**	**0.19**	**0.23**	**NS**	**0.010**	**0.07**	**0.08**
Transplants Age									
Two weeks		12.22	12.32	11.71	12.00	0.530	0.516	2.19	2.32
Four weeks		12.29	12.24	11.81	12.24	0.537	0.521	2.21	2.34
Six weeks		12.64	12.32	12.10	12.42	0.538	0.522	2.21	2.35
L.S.D. at 0.05		**0.16**	**NS**	**0.09**	**0.21**	**NS**	**NS**	**NS**	**NS**
Interaction									
Feb. Med..	Two weeks	12.05	12.30	11.96	12.31	0.525	0.510	2.13	2.23
	Four weeks	12.22	12.18	12.12	12.53	0.532	0.516	2.15	2.25
	Six weeks	12.52	12.52	12.38	12.67	0.538	0.519	2.11	2.24
Mar. St.	Two weeks	12.16	12.23	11.88	12.17	0.529	0.512	2.20	2.35
	Four weeks	12.27	12.33	11.89	12.48	0.540	0.520	2.21	2.35
	Six weeks	12.65	12.26	12.10	12.48	0.537	0.517	2.22	2.36
Mar. Med.	Two weeks	12.44	12.44	11.31	11.52	0.536	0.527	2.25	2.39
	Four weeks	12.37	12.21	11.43	11.70	0.538	0.528	2.28	2.41
	Six weeks	12.74	12.19	11.82	12.11	0.540	0.531	2.31	2.45
L.S.D. at 0.5		**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**	**NS**

References

A.O.A.C. Association of Official Analytical Chemists-International, 2005. Official Methods of Analysis. 18th edn., eds.W. Hortwitz, G. W. Latimer, AOAC-Int. Suite 500, 481 North Frederick Avenue, Gaithersburg, Maryland, USA.

Ezeakunne, C.O., 2004. Large scale fruit and vegetable production in Nigeria. Extension Bulletin, Ahmadu Bello University, Zaria, 8pp.

Gaveh ,E.A.; Timpo,G.M.; Agodzo,S.K. and Shin, D. H. 2011. Effect of irrigation, transplant age and season on growth, yield and irrigation water use efficiency of the African eggplant. Horticulture, Environment, and Biotechnology. (52) 1 : 13-28

Harmon, R.; L. A. Weston and T. Jones, 1991. Effect of root cell size and transplant age on yield of transplanted eggplant. HortScience (26) no. 6 689

Iremiren G.O. and Okiy, D.A. 1986. Effect of sowing dates on the growth, yield and quality of okra in Southern Nigeria. Journal of Agricultural Science 106 (1): 21 – 26.

Jones, R.T., L. A. Weston and R. Harmon, 1991. Effect of root cell size and transplant age on cole crop yields. HortScience June 1991 vol. 26 no. 6 688

Khan, V.A., C. Stevens, J.Y. Lu, E.G. Rhoden, M.A. Wilson, M.K. Kabwe, and Z. Haung. 1991. The influence of age of transplants, clear and black plastic mulch and VisPore row cover on okra yields, p.146–148. In: J. Brown (ed.). Proc. 23rd Natl. Agr. Plastics Congr. (c. f. Hort. Sci. 26 (5) 487.)

Khan, V.A., C. Stevens, and J.E. Brown.1990. Early response of transplanted okra grown under VisPore row cover and two types of polyethylene mulch, p. 28–32. In:P.A. Dube and K. Stewart (eds.). Proc.22nd Natl. Agr. Plastics Congr.

Marsh, L., 1992a. fruiting characteristics of okra HortScience November 1992vol. 27 (11) 1172.

Marsh, L., 1992b. Emergence and Seedling Growth of Okra Genotypes at Low Temperatures. HORTSCIENCE 27(12):1310-1312.

Maynard, D.N. and G.J. Hochmuth. 1997. Knotts handbook for vegetable growers.4th ed. Wiley, New York.

Ne Smith, D.S.1992. transplant age influences establishment and growth of 'Dixie' summer squash. Proc.Natl. Symp. Stand Establishment of Horticultural crops, Ft. Mayers, Fla.101:265-277.

Ne Smith, D.S.1994. Transplant age has little influence on yield of muskmelon (Cucumis melo L.) HortScience 29 : 916.

Orzolek, M. D. 1996. Stand Establishment in Plasticulture Systems. Hort Technology, July-Sept, 6 (3) 181-185.

Oyolu C, 2002. Variability in photoperiodic response of okra (Hibiscus esculentus L.) Acta Horticulture 52: 207-215.

Page, A.L., R.H. Miller and D.R. Keeney, 1982. Methods of soil analysis-chemical and microbiology properties, SSSA Inc., Mad., WI., USA.

Russell, D. F., (1991). In " MSTATC, Directory crop soil science Department" Michigan Universty.USA.

Sharaiha, R.K. and N.A. Hadidi, 2007. Environmental impact on yield of pea and okra grown under intercropping. Seria agronomie, (50): 313-323.

Thomas, R.L., R.W. Sheard and J.R. Moyer, 1976.Comparison of conventional and automated procedures for nitrogen, phosphorus and potassium analysis of plant materials using a single digestion. Agron. J., 59: 240-243.

Tindall H.D. 1986. Vegetables in the Tropics, 1st edition, Macmillan Publishers, Hong kong, pp. 25-327.

Usman, S.D. 2001. Seed production and quality of okra as affected by sowing time. Seed Research 29 (1): 47-51.

Verina, C.S. and M.D. Orzolek, 1993. Tomato transplant age: A review. HortTechnology. 3:313-316.

William J. L. Jr. 1999. Okra a Versatile Vegetable Crop. hortechnology, April–June (2) 179-184.