The Effect of Harvest Time and Fertilizer Application on Okra Pod and Seed Characteristics in Relation to Sowing Date

Ghadir Mohammadi[1]*E.M.Khah[1]and Majid Gheytouli[1]
[1]University of Thessaly, School of Agricultural Science, Crop Production and Rural Environment, Volos, Greece.
Correspondence: Ghadir Mohammadi, University of Thessaly, School of Agricultural Science, Crop Production and Rural Environment, Volos, Greece.
*Corresponding author: gmohammadi@uth.gr

Abstract

The aim of the present study was to examine the effect of nitrogen application rate and harvest time on yield components of four cultivars of okra (*Abelmoschus esculentus* L.) such as seed characteristics and pod production, in relation to sowing date. Seeds of four okra cultivars, namely cv. 'Boyatiou', cv. 'Veloudo', cv. 'Clemsson' and cv. 'Pylaias', were sown in the field. The experimental treatments were three fertilizer levels (F1, F2 and F3), four harvest times (T1, T2, T3 and T4) and two sowing dates (S1 and S2). Results showed that there was significant difference for seed germination of the four cultivars, regardless of fertilizer level, and sowing date. The presence of hardseedness (% of hard seeds) was higher for cv. 'Boyatiou' and 'Veloudo' than cv. 'Pylaias' and 'Clemson', especially at 50 DAA (days after flowering), whereas for cv. 'Boyatiou' higher fertilizer levels (F2 and F3) reduced the % percent of hard seeds in sowing date S1. Regarding mean pod length there was significant effect of harvesting time, sowing date and fertilizer level, but no specific trend was observed. Mean weight of 100 seeds, was lower when delayed harvesting and F3 fertilizer level were applied, for both sowing dates.

***Keywords*: *Abemoleschus esculentus* L., Fertilizer, Germination, Hardseedness, Okra.**

Introduction

Okra [*Abelmoschus esculentus* (L.) Moench] is one of the world's oldest cultivated crops, with India, Nigeria, Sudan, Iraq and Cote d'Ivoire being the most important okra-producing countries. The pod and seed production of the plant are affected by climatic factors and various agronomic practices such as fertilizer, application and planting density (Pandey and Dubey, 1996). Sowing date has a significant effect on okra seed production and yield components as it was previously reported by Sing *et al.* (1986). Regarding the occurrence of hardseedness, it is being affected mainly by harvesting time, with delayed harvest resulting in higher percentages of hardseedness, mostly due to the deposition or development of hard cuticle or impermeable cell layer of the seed coat during the later stages of seed development (El Balla *et al.*, 2011).

The objective of the present study was to determine the effect of harvesting time and nitrogen application rate in relation to sowing date on pod and seed characteristics of four different cultivars of okra.

Material and Methods

Plant material and experimental conditions

The experiment was carried out at the experimental farm of the University of Thessaly, Greece throughout the growing season of 2016. Seeds of four okra cultivars were sown in seeding trays then transplanted at 21st of May (S1) and 10th of June (S2).

The experimental treatments were as follows:

a) four different cultivars of okra, cv. 'Clemson', 'Boyatiou', 'Veloudo' and 'Pylaias'.
b) two sowing dates, 21st of May (S1) and 10th of June (S2), 2016.
c) three fertilizer levels, F_1 (control):150 mg L^{-1} N, 150 mg L^{-1} P and150 mg L^{-1} K,
F_2: 300 mg L^{-1} N, 150 mg L^{-1} P and 150 mg L^{-1} K,
F_3: 450 mg L^{-1} N, 150 mg L^{-1} P, 150 mg L^{-1} K.

Control stock solution (F1) was prepared by adding 65.7 gr of N, 43.2 gr of P and 44.1 gr of K (Solid fertilizer), whereas F2 and F3 were prepared by adding 67.5 and 131.5 of N respectively to control solution. Each stock solution was dissolved in water at a final volume of

150 L. Fertilization was applied manually at regular intervals according to climate conditions with doses of 0.5 L per plant. Immediately after anthesis each flower was recorded and tagged on a daily basis, regarding date of flowering, position on the plant etc.

Harvesting was carried out according to the following schedule, at:

T_1= 30 DAA (days after anthesis), T_2= 35 DAA, T_3= 40 DAA, T_4= 50 DAA.

Measurements

Throughout the experiment the following data were recorded:

Mean seed germination, Total flower induction per plant, Number of pod set per plant, Pod length, Pod diameter, Average number of seeds per pod, 100 seed weight.

Results

Mean Germination

In both sowing dates effect of harvesting time on seed germination for all nitirogen application rates showed a significant difference between the cultivars. Among all cultivars, cv. 'Boyatiou' was the most susceptible to hardseededness occurrence, especially when low nitrogen application rates were applied (F_1) and late harvest was implemented (50 DAA) (Table 2).

Mean Pod Length

Except cv. 'Boyatiou' in second sowing time, harvesting time and nitrogen application rate had a significant effect for all cultivars tested in this experiment. However different trends were observed depending on cultivar (Table 3).

Mean Pod Diameter:

In both sowing dates, delay in harvest resulted in narrower pods for all cultivars tested in the present study and regardless of nitrogen application rate.

Mean Number of Seeds per Pod

The mean number of seeds per pod in both sowing dates was significantly affected by both harvesting time and fertilizer level, depending on the cultivar. More specifically, for cv. 'Boyatiou' and 'Veloudo', early to mid-early harvest (30 to 35 DAA) resulted in higher number of seeds per pod, especially when high nitrogen application rates were applied (F_3 level).

Mean 100 seed weight:

Regarding mean weight of 100 seeds in both sowing dates, it was significantly higher when mid to late harvest (40 to 50 DAA) was applied, except for the lower application rate (F_1 level) for cv. 'Veloudo' and Pylaias' and middle application rate (F_2 level) for cv. 'Boyatiou' and 'Clemson'.

Discussion

Between the cultivars studied in the present study, cv. 'Boyatiou' presented the highest percentage of hardseeds, especially when pods were harvested at 50 DAA, regardless of sowing date and fertilizer rate, whereas seeds of cv. 'Clemson' were not affected by the occurrence of hard seeds. In addition, for cv. 'Boyatiou' and 'Veloudo', harvest at 35 and 40 DAA, resulted in an increase in germination rate and consequently in a lower percentage of hard seeds, whereas for cv. 'Pylaias' and 'Clemson' late harvest (40 and 50 DAA) increased germination rate.

Regarding the effect of sowing date on the occurrence of hardseedness, the first sowing date resulted in higher percentage of hard seeds for cv. 'Boyatiou', 'Veloudo' and Pylaias', especially when low nitrogen rates were applied (F1 level), whereas cv. 'Clemson' was not affected by sowing date. According to Passam *et al.* (1998) the percentage of hardseedness in cv. 'Boyatiou' was also particularly high during periods of very high temperatures (July-August).

Conclusion

In conclusion, seed yield and quality was significantly affected by nitrogen application rate, time of harvest and sowing time. Increased nitrogen application rate resulted in higher germination rates for all the cultivars studied. In addition, for cultivars with high frequency of hardseedness such as cv. 'Boyatiou' and 'Veloudo' harvest at 35 to 40 DAA increased germination rate and decreased the percentage of hard seeds. Late sowing decreased the occurrence of hardseedness, especially when combined with low nitrogen application rates.

References

El Balla M. M. A., Saidahmed A. I and Makkawi M. 2011. Effect of moisture content and maturity on hardseededness and germination in okra (*Abelmoschus esculentus* L. Moench). International Journal of Plant Physiology and Biochemistry Vol. 3(6), pp. 102-107.

H.C. Passam, K. Akoumiankis and A. Sarigiannidi. 1998. The effect of time of sowing on the production of okra (*Hibiscus esculentus* L.) seed in the Mediterranean region. Plant varieties and seeds. 11, 145-150.

Pandey, V.B. and R.P. Dueby, 1996. Effect of nitrogen, phosphorus and intra row spacing's on quality chemical composition of okra. Indian J. Hort., 53: 141–4.

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

Table 2. Pod and seed development in relation to the time of harvest, for the 1st sowing and the first level of fertilizer (F_1).

Cultivar (C)	Time from pod set to harvest (days) (T)	Mean pod length (cm)	Mean pod diameter (cm)	Mean seed number per pod	Mean 100 seed weight (g)	Mean germination (%)
Boyiatiou	30 (T1)	16.9a	2.6a	76a	38a	36.6b
	35 (T2)	16.5a	2bc	74.5a	34ab	43.8ab
	40 (T3)	18.4a	2.2b	61.1b	19.7b	58.3a
	50 (T4)	17.4a	1.8c	62.4b	19.3b	30.4b
LSD		2.2	0.4	5.3	16.2	16.1
Veloudo	30 (T1)	22.1a	2.1b	52.2b	36.1a	40.5b
	35 (T2)	23.1a	2.5a	74.3a	41.3a	64a
	40 (T3)	22.1a	2.1b	57.1b	29a	64.6a
	50 (T4)	19.4b	1.9c	53.0b	33.4a	55.8ab
LSD		2.0	0.2	12.4	15.4	16.0
Pylias	30 (T1)	16.8c	2.3a	86.8a	34.9a	49.1c
	35 (T2)	18.6b	2.3a	86.5a	35a	57.6b
	40 (T3)	19.3b	2.1b	65.5b	24.7a	78.8a
	50 (T4)	21a	1.9c	62.3b	24.1a	74.1a
LSD		1.7	0.1	18.4	15.5	7.7
Clemson	30 (T1)	16a	1.7a	102.0a	37.7ab	56.5b
	35 (T2)	15.5bc	1.5b	100.5a	41.7a	62.2b
	40 (T3)	15.7ab	1.2c	67.5b	22bc	88.5a
	50 (T4)	15.2c	1.1d	81.1b	20.1c	91.6a
LSD		0.4	0.08	15.6	16.1	7.2
C x T						
(C x T1)		*	*	*	ns	*
(C x T2)		*	*	*	*	*
(C x T3)		*	*	*	*	*
(C x T4)		*	*	*	*	*

Mean separation by LSD test. Mean values in the same column followed by different letters differ significantly at P = 0.05.

*: statistically significant ($p<0.05$); ns: not significant.

Table 3. Pod and seed development in relation to the time of harvest, for the 2nd sowing and the first level of fertilizer (F_1).

Cultivar (C)	Time from pod set to harvest (days) (T)	Mean pod length (cm)	Mean pod diameter (cm)	Mean seed number per pod	Mean 100 seed weight (g)	Mean germination (%)
Boyiatiou	30 (T1)	18a	2.4a	69.6ab	37.2a	38.8c
	35 (T2)	18a	2c	58b	29.4b	48.4b
	40 (T3)	17.3a	2c	85.6a	25.5bc	63a
	50 (T4)	18.3a	2.2b	64b	20.9c	40.5c
LSD		1.1	0.2	19.8	5.0	2.9
Veloudo	30 (T1)	24a	2.6a	84a	45.5a	43.6c
	35 (T2)	20.9b	2bc	64.3b	38b	51.2b
	40 (T3)	21.1b	2.2b	59.3bc	44.6a	70.8a
	50 (T4)	20.1b	1.7c	58.6c	24.1c	51.8b
LSD		2.8	0.4	14	6.0	4.1
Pylias	30 (T1)	20.5a	2.2a	77a	46.8a	52.4d
	35 (T2)	16.6b	1.6c	65b	30b	61c
	40 (T3)	18.7ab	1.9b	70.6ab	35.4b	85.4a
	50 (T4)	19.4a	1.7c	64.6b	23.7c	78.2b
LSD		2.6	0.2	11.5	6.2	3.1
Clemson	30 (T1)	17a	1.8a	92.3b	37.2a	48c
	35 (T2)	15.2b	1.4c	92b	30.2b	56.4b
	40 (T3)	16.4a	1.5b	107a	29.6b	87.1a
	50 (T4)	16.8a	1.3d	86.3b	21.1c	85.1a
LSD		0.8	0.1	12.6	3.6	7.8
C x T						
(C x T1)		*	*	*	*	*
(C x T2)		*	*	*	*	*
(C x T3)		*	*	*	*	*
(C x T4)		*	*	*	ns	*

Mean separation by LSD test. Mean values in the same column followed by different letters differ significantly at P = 0.05.

*: statistically significant ($p<0.05$); ns: not significant.