Journal of Agricultural Sciences
Vol. 64, No. 2, 2019
Pages 133-145

https://doi.org/10.2298/JAS1902133A
UDC: 633.15-154.3:631.559(55)
636.2.085.52:633.15(55)
Original scientific paper

THE EFFECTS OF SEED PRIMING, PLANTING DATE AND DENSITY ON THE SILAGE YIELD OF CORN (*ZEA MAYS* L.) IN SUMMER DELAYED SOWING

Farshid Alipour-Abookheili[1], Hamid-Reza Mobasser[2], Morteza Siavoshi[3*] and Farshid Golmaei[2]

[1]Department of Agronomy, Science and Research Branch,
Islamic Azad University, Tehran, Iran
[2]Department of Agronomy, Qaemshahr Branch,
Islamic Azad University, Qaemshahr, Iran
[3]Department of Agricultural Science, Payame Noor University, Iran

Abstract: To determine the effects of seed priming, date and density of planting on the silage yield of corn ($Ks.c_{704}$ cultivar) in summer delayed planting, an experiment was carried out as a split-split plot in a randomized complete block design with four replications in 2015 and 2016. Treatments were examined including two planting dates (July 27 and August 13) as main plots, two planting densities (7 and 9 plants per m^2) as sub plots and four levels of seed priming (without priming, distilled water, 0.5% KNO_3 and 10% $PEG_{(8000)}$) as sub-sub plots. The results showed maximum of the speed and percentage of seedling emergence at the first year. The number of days decreased from planting date until 8- and 12-leaf stages in seed priming by the distilled water method. The silage yield decreased (26.69%) with the late planting (13 August), but the speed of seedling emergence increased. The planting density (9 plants/m^2) yielded the highest percentage of lignin, speed of seedling emergence, plant height and silage yield. The highest ratio of the ear fresh weight to the total silage weight was obtained by the late planting date (13 August) and seed priming with the PEG method. The maximum value of the silage yield (45,566.41 kg/ha) was produced by the early planting date (27 July) and higher planting density (9 plants/m^2). Thus, to increase seedling emergence speed and to obtain maximum silage yield, early planting date (27 July), higher planting density (9 plants/m^2) and seed priming by the distilled water method are recommended.

Key words: plant density, seed priming, corn silage yield, sowing date.

[*]Corresponding author: e-mail: Morteza_siavoshi@yahoo.com

Introduction

Corn is the most important plant among cereal crops after wheat and rice. Corn cultivation has been increased because of increasing animal husbandry industry in the last several years in Iran (Fathi, 2005). Corn is one of the most suitable crop plants to produce green manure and silage due to high starch in seed and yield of this plant (Khodabandeh, 2000). Corn silage herb will be provided under general conditions easily until energy and herb sustainable quality are obtained (Curran and Posch, 2000). Germination and seedling emergence speed is one of the most important and effective factors to attain maximum yield for most crop plants (Subedy and Ma, 2005). The seed priming treatment can increase the ability and speed of seed germination (Farooq et al., 2006). The seed priming treatment will lower the time between dates until seedling emergence. Because of that, the seeds germinate equally, which will improve the quantity and quality of the yield of the plant (Basra et al., 2004). Murungu et al. (2003) have found that seed priming treatment increased seedling emergence percentage and seedling growth of corn as compared with the witness treatment (without priming). The most common methods for seed priming are hydro-priming and osmo-priming. Regarding the osmo-priming method, seeds will be settled into solutions with low osmotic potential, which include chemical materials such as poly-ethylene glycol (PEG), menthol and chemical fertilizers like urea (Ashraf and Foolad, 2001). Seeds will be also soaked into water and will be dried before completing seed germination within the hydro-priming method. Determination of the suitable planting date for crop plants is important to use the potential of the variety, soil and climate of each region (Estakhr and Dehqanpour, 2010). Sadeghi and Bahrani (2002) have examined the effect of three planting dates (24 April, 4 and 14 May) on silage corn and the maximum silage yield was obtained (13388 kg/ha) on 24 April. The maximum yield for every plant can be influenced by determining the suitable plant density regarding the climate conditions and variety properties (Nourmohammadi et al., 2001). Viddicombe and Thelen (2002) have reported that high planting density (90,000 plants/ha) increased grain yield as compared with low planting density (560,000 plants/ha). The most appropriate plant density to achieve maximum yield (79,040 plant/ha) was also suggested by Bean and Gerik (2000). Therefore, this research was conducted to find out the effect of pre-sowing seed treatment (seed priming), date and density of planting on the corn silage yield of $S.C_{704}$ variety in the summer delayed sowing.

Materials and methods

This experiment was carried out as a split-split plot design in a randomized complete block design with four replications in the Agricultural Research Center of

Qarakheyl - Qaemshahr, Mazandaran province during the two agronomic years (2015 and 2016). The soil of the test site had a clay loamy texture with acidity of 7.1, organic matter of 1.8% and electrical conductivity of 0.26 dS/m. Meteorological data for two years are shown in Table 1. Planting date has been chosen as a main plot at two levels (27 July and 13 August) and planting density has been selected as a sub-plot at two levels (7 and 9 plants per m^2). Seed priming has been also preferred as a sub-sub plot at four levels: control (without priming), distilled water, 0.5% potassium nitrate $(KNO_3)_2$- and 10% poly-ethylene glycol (PEG_{8000}). The experimental field was divided into 4 blocks equal to the number of replications of each treatment combination. Each block was divided into 2 main plots, which were divided further into 2 sub-plots. Each sub-plot was then divided into 4 sub-sub plots. Thus, there were 16 sub-sub plots in each block, which was repeated 4 times. The main plot, sub-plot and sub-sub plot treatments were arranged completely randomly.

Table 1. Meteorological data for two years.

Variable	Minimum temp. (°C)		Maximum temp. (°C)		Evaporation (mm)		Precipitation (mm)	
Year	2015	2016	2015	2016	2015	2016	2015	2016
May	14.6	14	21.8	24	82.0	75	25.3	32
June	20.1	19	28.5	30	159.8	110	1.5	28
July	22.6	22	31.1	34	171.5	128	48.1	9.2
August	23.9	25	32.2	34	170.2	156	31.2	12.2
September	19.9	18	27.8	28	100.7	121	98.6	48
October	15.7	15	25.2	18	78.4	85	143.2	82
November	8.4	14	15.7	16	42.4	82	144.9	95

The plot size was 4.5*6 m^2. In the row, seven plants were cultivated at each plot and the distance between each row was 75 cm. As for seed priming, the selected seeds were combined with provided solution of earlier mentioned materials, during 24 hours. After that, settled seeds were dried under natural conditions and then were cultivated in plots. Regarding the soil test, the amount of chemical fertilizers was added to the soil and other agronomic operations such as care and harvesting operations were done. The measured traits within this research included: phonological traits such as the number of days from the planting date until 8 leaves and the number of days from the planting date until 12 leaves, speed and percentage of seedling emergence and percentage of lignin, plant height, silage yield, yield components such as plant fresh weight, silage yield per surface unit, the ratio of the leaf fresh weight to total silage weight, the ratio of the stem fresh weight to total silage weight and the ratio of the ear fresh weight to total silage weight. To determine the speed of seedling emergence, the number of emerged

coleoptiles from soil surface was counted daily per plot and measured for two weeks. To determine the percentage of seedling emergence, all of emerged coleoptiles were counted 14 days after germination. To determine the rest of morphological characteristics like yield and yield components, 10 plants were chosen per plot and then were measured with general methods. Data were analyzed by using the analysis of variance technique (ANOVA) and Microsoft-MSTAT-C, and the mean differences were calculated by Duncan's test at the probability levels of 5 and 1% (Gomez and Gomez, 1984).

Results and Discussion

Phonological traits

Results showed that the numbers of days from the planting date until 8- and 12-leaf stages were significantly influenced by planting date, year, and interaction effects of experimental factors (Table 2). Table 3 shows that the minimum numbers of days from the planting date until 8- and 12-leaf stages were obtained by early planting (27 July) in the 1st year (2015). Decreasing the numbers of days from the planting date until 8- and 12-leaf stages was caused by increasing the crop growth rate (CGR) and decreasing the plant growth period (PGP) from planting until harvesting stages. This result is not in agreement with earlier works (Khan et al., 2002; Rafiee and Asgharpour, 2009) that have shown that late planting decreased the number of days from the planting date until different stages of growth like 12-leaf and maturing stages. Seed priming with distilled water decreased the number of days from the planting date until 8- and 12-leaf stages (Table 3). Wahid et al. (2008) also found that the seed priming treatment of sunflower decreased the number of days from the planting date until 50% germination and increased the speed of seedling emergence. Plant height was significantly affected by year, planting date and density (Table 2). Table 3 shows that the maximum plant height (241.48, 245.91 and 241.23 cm) for early planting date (27 July) and planting density (9 plants/m^2) were measured in the first year (2015). Rafiee and Asgharpour (2009), Feyzbakhsh and et al. (2010), Atrashi (1998), Hassan (2000) and Bazi et al. (2005) have found the same results.

Germination traits

The percentage of seedling emergence was significantly influenced by year and seed priming and their interaction with planting density (Table 2). This result is in agreement with the earlier study by Abotalebian et al. (2006). Table 3 statistically shows that the percentage of seedling emergence was higher in the 1st year (88.92%) than in the 2nd year (83.22%). The maximum generation (87.80%)

was obtained in control treatment (Table 3) and a higher interaction effect was found between control treatment and planting density (90.97%) (Table 4).

Table 2. Square means of quantitative, qualitative and phonological characteristics of the silage corn $S.C_{704}$ in summer delayed planting.

Source of variation	df	Seedling emergence	Speed of seedling emergence	Planting until the 8-leaf stage	Planting until the 12-leaf stage	Plant height
Replication	3	187.36**	78.52**	44.52**	66.08**	197.95 ^{ns}
Year	1	1040.42**	314.002**	153.13**	56.008*	2150.45**
Error (a)	3	28.18	20.39	29.94	24.78	166.82
Planting date	1	32.11^{ns}	425.23**	488.28**	249.40**	9311.86**
Year*Planting date	1	3.51^{ns}	946.89**	148.78**	4.25 ^{ns}	304.27 ^{ns}
Error (b)	6	36.50	10.96	39.41	47.70	1186.32
Planting density	1	99.60^{ns}	1511.95**	4.50^{ns}	14.67 ^{ns}	1897.67**
Density*Year	1	2.37^{ns}	211.58^{ns}	0.13^{ns}	5.56 ^{ns}	346.03 ^{ns}
Density*Date	1	37.79^{ns}	0.15^{ns}	3.78 ^{ns}	1.53 ^{ns}	583.75 ^{ns}
Year*Density*Date	1	64.48^{ns}	41.93*	0.03 ^{ns}	9.39 ^{ns}	0.11 ^{ns}
Error (c)	12	61.60	18.89	27.55	26.47 ^{ns}	379.71 ^{ns}
Seed priming	3	86.42*	29.56*	20.17 ^{ns}	22.78 ^{ns}	60.97 ^{ns}
Year*Priming	3	8.08^{ns}	3.86^{ns}	1.46 ^{ns}	2.43 ^{ns}	37.18 ^{ns}
Date*Priming	3	60.09^{ns}	9.71^{ns}	0.36 ^{ns}	8.94 ^{ns}	48.11 ^{ns}
Year*Date*Priming	3	5.67^{ns}	0.36^{ns}	6.20 ^{ns}	10.08 ^{ns}	53.68 ^{ns}
Density*Priming	3	88.62*	14.58^{ns}	12.50 ^{ns}	5.95 ^{ns}	37.84 ^{ns}
Year*Density*Priming	3	16.35^{ns}	12.75^{ns}	5.46 ^{ns}	4.74 ^{ns}	176.72 ^{ns}
Date*Density*Priming	3	1.23^{ns}	1.55^{ns}	4.36 ^{ns}	14.008 ^{ns}	47.83 ^{ns}
Year*Date*Density*Priming	3	7.26^{ns}	4.58^{ns}	1.28 ^{ns}	5.54 ^{ns}	133.33 ^{ns}
Error (abc)	72	29.68	7.53	7.92	9.72	233.34
CV%	-	6.33	11.44	6.81	5.35	6.44

ns, * and **; Non-significant, significant and very signicifant at the levels of 5% and 1% respectively.

Seed priming with the PEG method increased the speed and percentage of seedling emergence and the ratio of ear fresh weight to total silage weight and that is why seed priming can be suggested for other crops under dry climate conditions where the speed and percentage of seedling emergence are the most important objectives of all researchers and farmers. As Table 2 shows, planting date and year and their interaction effects influenced the speed of seedling emergence. Feyzbakhsh et al. (2010) have also found that planting date affects the speed of seedling emergence and the rest of plant phonological stages. Planting density and seed priming also significantly affected the speed of seedling emergence. The seed priming treatment of wheat increased the speed and percentage of seedling emergence, tillering and earlier flowering (Harris et al., 2001). Moradi and Yonesi (2009) have shown that seed hydro-priming increased the speed of seedling

emergence. Table 3 shows that the speed of seedling emergence was higher in the 1st year (25.56 seeds/day) than in the 2nd year (22.43 seeds/day). The maximum speed of seedling emergence was also related to planting density of 9 plants/m^2 (27.43 seeds/day). The maximum value of the speed of seedling emergence (30.85 seeds/day) was also attained by interaction effects between year (1st year), early planting date (27 July) and planting density (9 plants/m^2) (Table 4).

Table 3. Mean comparison of simple effects of experimental treatments on quantitative, qualitative and phonological characteristics of the silage corn S.C704 in the summer delayed planting.

Treatment		Seedling emergence percentage (%)	Seedling emergence speed (per day)	No. of days from planting until the 8-leaf stage	No. of days from planting until the 12-leaf stage	Plant height (cm)
Year	2015	88.92	25.56	40.22	57.65	241.48
	2016	83.22	22.43	42.41	58.97	233.28
Planting date	27 July	86.57	22.17	39.36	56.92	245.91
	13 August	85.57	25.82	43.27	59.71	228.85
Planting density	7 plants/m^2	85.19	20.56	41.50	58.65	233.53
	9 plants/m^2	86.96	27.43	41.13	57.97	241.23
Seed priming	Control	87.80	24.61	41.00	57.99	236.74
	Distilled water	86.99	24.98	40.88	57.48	238.52
	PEG	84.12	22.92	42.50	59.47	235.74
	KNO_3	85.39	23.48	40.88	58.31	238.53

The given means per each column with the same letters do not show significant differences statistically ($p<0.05$).

Table 4. Mean comparison of interaction effects of Year*Date, Density*Priming and Year*Date*Density on some agronomic properties of the silage corn $S.C_{704}$ in the summer delayed planting.

Treatment	No. of days from planting until the 8-leaf stage		Treatment	Seedling emergence (%)		Treatment	Seedling emergence speed (per day)	
Year *Date	2015*27J	37.19b	Density *Priming	7 plants/m^2*control	84.62b	Year *Date *Density	2010*27J*7 plants	22.07b
	2015*13A	43.25a		7 plants/m^2*distilled water	87.38ab		2010*27J*9 plants	30.85a
	2016*27J	41.53a		7 plants/m^2*PEG	84.43b		2010*13A*7 plants	21.36b
	2016*13A	43.28a		7 plants/m^2*KNO_3	84.34b		2010*13A*9 plants	27.98a
				9 plants/m^2*control	90.97a		2011*27J*7 plants	15.47c
				9 plants/m^2*distilled water	86.60b		2011*27J*9 plants	20.31b
				9 plants/m^2*PEG	83.81b		2011*13A*7 plants	23.34b
				9 plants/m^2*KNO_3	86.84b		2011*13A*9 plants	30.61a

The given means per each column with the same letters do not show significant differences statistically ($p<0.05$).

Silage corn yield

The fresh weight of plant was significantly influenced by year and planting date (Table 5). Regarding Table 6, the maximum plant fresh weight was observed in the 2nd year (546.79 g) in earlier sowing time (588.02 g). Year, planting date, their interaction effect and planting density significantly increased the ratio of leaf fresh weight and the part of stem fresh weight to total silage weight. Year, planting date, their interaction effect and planting density also significantly increased the ratio of ear fresh weight to total silage weight (Table 5).

Table 5. Square means of quantitative, qualitative and phenological characteristics of the silage corn $S.C_{704}$ in the summer delayed planting.

Source of variation	df	Plant fresh weight	Ratio of leaf fresh weight to total silage weight	Ratio of stem fresh weight to total silage weight	Ratio of ear fresh weight to total silage weight	Silage yield	Lignin
Replication	3	4072.26 ns	2.54**	3.25 ns	8.04 ns	8448561 ns	0.41 ns
Year	1	19128.21*	201.73**	280.73**	2.89 ns	506100 ns	0.84 ns
Error (a)	3	6828.61	4.59	2.07	6.10	78188705	1.82
Planting date	1	635732.7**	331.24**	52.86**	119.85**	3815981661**	2.39 ns
Year*Planting date	1	946.37 ns	281.74**	705.28**	95.81**	47974037 ns	1.15 ns
Error (b)	6	8394.94	3.70	7.40	14.85	54823722	2.82
Planting density	1	4196.20 ns	2.55**	28.03**	47.53**	929491333**	23.47**
Density*Year	1	2367.75 ns	0.56 ns	0.93 ns	2.94 ns	35608540 ns	0.98 ns
Density*Date	1	10112.55 ns	0.01 ns	2.29 ns	1.81 ns	492247906**	1.44 ns
Year*Density*Date	1	905.68 ns	0.22 ns	15.48*	12.39 ns	64535891 ns	1.62 ns
Error (c)	12	8246.43 ns	0.18 ns	3.84 ns	3.80 ns	24109684 ns	2.43
Seed priming	3	736.08 ns	0.18 ns	20.06**	19.18*	22845777 ns	4.19*
Year*Priming	3	401.85 ns	1.82**	3.53 ns	2.38 ns	12430952 ns	4.88*
Date*Priming	3	7295.72 ns	0.51 ns	11.42*	16.009*	19882147 ns	1.12 ns
Year*Date*Priming	3	421.24 ns	0.43 ns	3.91 ns	6.36 ns	6565978 ns	0.91 ns
Density*Priming	3	6919.38 ns	0.12 ns	1.51 ns	1.37 ns	10876537 ns	2.82 ns
Year*Density*Priming	3	1039.28 ns	0.23 ns	1.92 ns	2.85 ns	5075946 ns	1.11 ns
Date*Density*Priming	3	6256.09 ns	0.66*	4.54 ns	5.74 ns	16733197 ns	1.95 ns
Year*Date*Density*Priming	3	7424.81 ns	1.05 ns	5.61 ns	10.17 ns	15976794 ns	2.51 ns
Error (abc)	72	3093.48	0.47	3.60	4.80	31269511	1.49
CV%		10.40	6.59	4.08	5.10	15.77	5.79

ns, * and **: Non-significant, significant and very significant at the levels of 5% and 1%, respectively.

The results showed that the maximum ratios of leaf fresh weight and stem fresh weight to total silage weight were attained in the 1st year (0.12) and in the 2nd year (0.48) respectively. The maximum values of the ratio of leaf fresh weight to total silage weight were attained by the early planting (0.12) and the maximum

values of the ratio of stem fresh weight to total silage weight were also reached by the late planting (0.47) (Table 6). The present studied variety (S.C 704) of the corn plant includes the maximum leaf fresh weight because of its late maturity (Heydar-Qolinezhad Kenari et al., 2003; Genter and Camper, 1973). Planting density (9 plants/m^2) increased the ratio of leaf fresh weight and stem fresh weight to total silage weight at the maximum values of 0.11 and 0.47, respectively. The maximum ratio of ear fresh weight to total silage weight was related to the late planting date (0.44) and planting density of 7 plants/m^2 (0.44) (Table 6). Seed priming significantly affected the ratio of stem fresh weight and ear fresh weight to total silage weight. The interaction effect between seed priming and planting date also affected these characteristics significantly (Table 5). Treatments of the interaction effect between the late planting (13 August) and seed priming attained the maximum ratio of stem fresh weight to total silage weight (0.49) with the KNO_3. This result was obtained on wheat and barley plants by Karaki (1998). The maximum ratio of ear fresh weight to total silage weight (0.46) was achieved by the interaction effect between the late planting date (13 August) and seed priming with the PEG method (Table 8). The maximum ratio of ear fresh weight to total silage weight (0.45) was also obtained by the interaction effect between the late planting date (13 August) and year (1st year) (Table 7). Planting date, plant density and their interaction effect increased silage yield significantly (Table 5).

Table 6. Mean comparison of simple effects of experimental treatments on quantitative, qualitative and phonological characteristics of the silage corn $S.C_{704}$ in the summer delayed planting.

Treatment		Lignin (%)	Plant fresh weight (gr)	Ratio of leaf fresh weight to total silage weight	Ratio of stem fresh weight to total silage weight	Ratio of ear fresh weight to total silage weight	Silage yield (kg/ha)
Year	2015	21.20	522.34	0.12	0.45	0.43	35513.4
	2016	21.04	546.79	0.09	0.48	0.43	35387.7
Planting date	27 July	21.26	588.02	0.12	0.46	0.42	40910.6
	13 August	20.99	481.11	0.09	0.47	0.44	29990.5
Planting density	7 plants/m^2	20.69	528.84	0.10	0.46	0.44	32755.8
	9 plants/m^2	21.55	540.29	0.11	0.47	0.42	38145.3
Seed priming	Control	20.94	537.06	0.11	0.47	0.43	35366
	Distilled water	21.05	534.22	0.10	0.47	0.43	35800
	PEG	21.65	527.99	0.11	0.46	0.44	34324
	KNO_3	20.85	538.98	0.10	0.47	0.42	36313

The given means per each column with the same letters do not show significant differences statistically ($p<0.05$).

The results of the present study are in agreement with Darby and Laure (2002), Mokhtarpour et al. (2008), Feyzbakhsh et al. (2010), Fallah and Tedin (2009) and Dehqanpour and Vahdat (1996). The maximum silage yield was related

to the early planting date (40,910.6 kg/ha) and the planting density of 9 plants/m^2 (38,145.3 kg/ha) (Table 6) and their interaction effects (45,566.41 kg/ha) (Table 7). Fayazbakhsh et al. (2010) found that the highest silage yield (85,000 plants/ha) was achieved with the planting density of 8.5 plants/m^2. In addition, the maximum silage yield was obtained with the planting density of 13 plants /m^2 (Zamaniyan and Najafi, 2002). The results showed that the planting density affected the percentage of lignin significantly at the level of 1%. Seed priming and its interaction effect with year also affected the percentage of lignin at the level of 5% (Table 5). As can be seen in Table 6, the maximum lignin percentage was definite with the planting density of 9 plants/m^2 (21.55%) and seed priming with the PEG method (21.65%). The highest lignin (21.70) was also found by the interaction effect between year (2nd year) and the seed priming PEG method (Table 8).

Table 7. Mean comparison of interaction effects of Year*Date and Date*Density on some agronomic properties of the silage corn $S.C_{704}$ in the summer delayed planting.

	Treatment	Ratio of leaf fresh weight to total silage weight	Ratio of ear fresh weight to total silage weight		Treatment	Silage yield (kg/ha)
Year* Date	2015*27J	0.12a	0.41b	Date* Density	27J*7 plants/m^2	36254.84b
	2015*13A	0.12a	0.45a		27J*9 plants/m^2	45566.41a
	2016*27J	0.12a	0.43b		13A*7 plants/m^2	29256.79c
	2016*13A	0.06b	0.43b		13A*9 plants/m^2	30724.19c

The given means per each column with the same letters do not show significant differences statistically ($p<0.05$).

Table 8. Mean comparison of interaction effects of Year*Priming and Date*Priming and Density*Priming on some agronomic properties of the silage corn $S.C_{704}$ in the summer delayed planting.

	Treatment	Ratio of leaf fresh weight to total silage weight	Lignin (%)		Treatment	Ratio of stem fresh weight to total silage weight	Ratio of ear fresh weight to total silage weight
Year * Priming	2015*control	0.12a	20.61bc	Date * Priming	27J.*control	0.46bc	0.42c
	2015*distilled water	0.12a	21.16abc		27J.*distilled water	0.46bc	0.42c
	2015*PEG	0.12a	21.60a		27J.*PEG	0.45c	0.43bc
	2015*KNO_3	0.11b	21.45ab		27J.*KNO_3	0.46bc	0.42c
	2016*control	0.09d	21.27ab		13A.*control	0.47b	0.44b
	2016*distilled water	0.09d	20.95abc		13A.*distilled water	0.47b	0.44b
	2016*PEG	0.09d	21.70a		13A.*PEG	0.46bc	0.46a
	2016*KNO_3	0.10c	20.25c		13A.*KNO_3	0.49a	0.42c

The given means per each column with the same letters do not show significant differences statistically ($p<0.05$).

Conclusion

Regarding the obtained results of the present study, the maximum percentage of lignin, seedling emergence, plant height, the ratio of leaf fresh weight to total silage weight, the ratio of ear fresh weight to total silage weight and silage yield were attained in the 1st year (2015) which raised crop growth rate (CGR). The maximum values of the percentage of lignin and the percentage of seedling emergence, plant height, plant fresh weight, the ratio of leaf fresh weight to total silage weight and silage yield were achieved with the early planting date (17 July). The number of days with earlier sowing time (17 July) from the planting date until the 8- and 12-leaf stages decreased in the 1st year (2015). On the other hand, the crop plant rate increased, but the plant growth period decreased from planting until harvesting. All of the maximum phonological and morphological characteristics of the corn plant were also attained with the planting density of 9 plants/m^2, except for the ratio of ear fresh weight to total silage weight. The results show that many treatments showed high values in the 1st year (2015) and with the early planting date (17 July) and the planting density of 9 plants/m^2. Therefore, it can be concluded that the early planting date (17 July) and the planting density of 9 plants/m^2 are the best treatment to obtain the maximum silage yield of the corn $S.C_{704}$ variety in the summer delayed sowing. Thus, this treatment can be recommended for farmers who work in moderate climate conditions.

References

Abotalebian, M., Sharifzadeh, F., Jahansoz, R., Ahmadi, A., & Naqavi, M.R. (2006). The effect of Osmo-priming on speed, percentage and basic temperature of germination seedling basic index of 6 varieties of wheat seed. *Scientific Journal, 5* (1), 67-82. (In persian).

Ashraf, M., & Rauf, H. (2001). Inducing salt tolerate in maize (*Zea Mays* L.) Thought seed priming with chloride salts: growth and ion transport at early growth stages. *Acta-Physioliga Plantarum, 23,* 407- 414.

Atrashi, M. (1998). Effects of sowing date and plant density on yield and seed physical and chemical propertie of different hybrids corn. Abstracts *Proceedings of 5th Iranian Congress of Crop Production and Plant Breeding.* 368 pp. (In Persian with English Summary).

Basra, S.M.A., Ashraf, M., Iqbal, N., Khaliq, A., & Ahmad, R. (2004). Physiological and biochemical aspects of pre-sowing heat stress on cottonseed. *Seed Science and Technology, 32,* 765-774.

Bazi, M.T., Nemati, N., Mokhtarpour, H., & Mosavat, S.A. (2005). Effects of tiller removal and plant density on ear yield and forage of sweet corn. Azad Uni. of varamin. (In persian).

Bean, B., & Gerik, T. (2000). Evaluating corn row spacing and plant density in Texas Panhandle, Texas A. and M. University system. *Soil and Crop Science,* 2000-2028.

Curran, B., & Posch, J. (2000). Agronomic management of silage for yield and quality: silage cutting height. Crop in sights, 10 (2). Pioneer Hi-bred International. INC.

Darby, H.M., & Lauer, J.G. (2002). Planting date and hybrid influence on corn forage yield and quality. *Agronomy Journal, 94,* 281-289.

Dehqanpour, Z., & Vahdat, A. (1996). Examination the effect of planting date and density on silage yield of corn S.C 704 in Mash-had. *Agricultural Research Journal Seed* and seedling providing and breeding Institute, *120*, 24-30. (In persian).

Estakhr, A., & Dehqanpour, Z. (2010). Determination of the suitable planting date for new varieties of early maturity of corn at the 2nd cultivation in moderate climate of Fars provience. *Seed and Plant, 2* (2), 169-191. (In persian).

Fallah, S., & Tedin, A. (2009). The effect of plant density and Nitrogen amount on yield and Nitrate and Protein uptake of silage corn. *Electronic Journal of crop plant production, 2* (1), 105-121. (In persian).

Farooq, M., Basra, S.M.A., Tabassum, R. & Afzal, I. (2006). Enhancing the performance of direct seeded fine rice by seed priming. *Plant Production Science, 9*, 446- 456.

Fathi, Q. (2005). Examination of the effect of planting pattern and density on light depreciation coefficient, radiate assimilation on grain yield of corn S.C.402. *Agricultural Sciences and Natural Resources, Special Crop*, 131-143. (In persian).

Feyzbakhsh, M., Mokhtarpour, H., Mosavat, S.A., Mohajer, M., & Shahi, Q. (2010). The effect of planting date and plant density on yield and some morphological traits of maize cv SC704. *Electronic Journal of crop plant production, 3* (1), 217-224. (In persian).

Genter, C., & Camper, H. (1973). Component plant part development in maize as effected by hybrids and population density. *Agronomy Journal, 65*, 669-671.

Gomez, K.A., & Gomez, A.A. (1984). *Statistical procedures for agricultural research* (2nd Edn.). John Wiley sons, New York, Chichester, Bribane, Toronto, Singapore.

Harris, D., Reghuwanshi, B.S., Gangwar, J.S., & Singh, S.C. (2001). Participatory evalution by farmer sofon-farm seed priming in wheat in India, Nepal and Pakistan. *Experimantal Agriculture, 37*, 403-415.

Hassan, A.A. (2000). Effect of plant population density on yield and yield components of eight Egyptian maize hybrids. *Bulletin of Fac. Of Agric. Univ. of Cairo, 51* (1), 1-16.

Heydar-Qolinezhad, Kenari, M., Qadimzadeh, M., & Fayazmoghadam, A. (2003). The effect of planting density on herb quality of hybrid varieties of corn according to agronomic properties. *Iranian Journal of Agricultural Sciences 34* (2), 417-425. (In persian).

Karaki, G.N. (1998). Response of wheat and barley during germination to seed osmo priming at different water potential. *Journal of Agronomy and Crop Science, 181* (4), 229-235.

Khan, N., Qasim, M., Ahmed, F., Khan, R., Khanzada, A., & Khan, B. (2002). Effects of sowing date on yield of maize under Agro climatic condition of Kaghan Valley. *Asian Journal of plant Sciences, 1* (2), 140-147.

Khodabandeh, N. (2000). *Cereals cultivation*. Published by Sepehr, Tehran Uni. P. 537. (In persian).

Mokhtarpour, H., Mosavat, S.A., Feyzbakhsh, M.T., & Saberi, A. (2008). Effect of sowing date and plant density on ear yield of sweet corn in summer sowing. *Electronic Journal of crop plant production, 1*, 101-113.

Moradi, A., & Younesi, O. (2009). Effect of Osmo and hydro-priming on seed parameters of grain sorghum. *Australian Journal of Basic Applied Sciences, 3*, 1696-1700.

Murungu, F.S., Nyamugafata, P., Chiduza, C., Clark, L.J., & Whalley, W.R. (2003). Effects of seed priming aggregate size and soil matric potential on emergence of cotton (*Gossypium hirsutum* L.) and maize (*Zea mays* L.). *Soil and Tillage Research, 74*, 161-168.

Nourmohammadi, Gh., Siyadat, A., & Kashani, A. (2001). *Cereals Cultivation.* 1st Volume. 3rd Edition. Published by Chamran Uni. P. 445. (In persian).

Rafiee, M., & M. Asgharpour, R. (2009). Examination of the effect of planting date and density on the morphological characteristics and yield components of corn S.C 604 in Shirvan. *Quarterly of dynamic agricultural, 6* (1), 23-34. (In persian).

Sadeghi, H., & Bahrani, M.J. (2002). Effects of plant density and nitrogen rates on yield and yield components of corn (*Zea mays* L.). *Iran Journal of Crop Sciences, 3*, 403-412.

Subedi, K.D., & Ma, B.L. (2005). Seed priming does not improve corn Yield in a humid temperate environment. *Agronomy Journal, 97*, 211-218.

Viddicombe, W.D. & Thelen, K. D. (2002). Row width and plant density effects on corn grain production in the Northern Corn Belt. *Agronomy Journal, 94*, 1020-1023.

Wahid, A., A. Noreen., S.M.A. Basra., Gelani, S., & Farooq, M. (2008). Priming induced metabolic changes in sunflower (*Helianthus annuus*) achenes improve germination and seedling growth. Botanical Studies, 49, 343-350.

Zamanian, M., & Najafi, A. (2002). Assessment of row spacing and plant density effect on silage yield and morphological characters of corn (S.C.704). *Seed and Plant Journal of Agricultural Research 23*, 200-214.

Received: August 18, 2018
Accepted: April 18, 2019

UTICAJI POTAPANJA SEMENA, DATUMA SETVE I GUSTINE NA PRINOS SILAŽE KUKURUZA (*ZEA MAYS* L.) U LETNJOJ ODLOŽENOJ SETVI

Farshid Alipour-Abookheili[1], Hamid-Reza Mobasser[2], Morteza Siavoshi[3*] i Farshid Golmaei[2]

[1]Odsek za agronomiju, Ogranak za nauku i istraživanje,
Islamski slobodni univerzitet, Teheran, Iran
[2]Odsek za agronomiju, Ogranak u Kaemšahru,
Islamski slobodni univerzitet, Kaemšahr, Iran
[3]Odsek za poljoprivredne nauke, Univerzitet Pajame Nur, Iran

R e z i m e

Kako bi se utvrdili uticaji potapanja semena, datuma i gustine setve na prinos silaže kukuruza (sorta $Ks.c_{704}$) kod letnje odložene setve, sproveden je eksperiment potpodeljenih parcela u potpuno slučajnom blok dizajnu sa četiri ponavljanja u 2015. i 2016. godini. Tretmani su ispitivani uključujući dva datuma setve (27. jul i 13. avgust) kao glavne parcele, dve gustine setve (7 i 9 biljaka po m^2) kao potparcele i četiri nivoa potapanja semena (bez potapanja, destilovana voda, 0,5% KNO_3 i 10% $PEG_{(8000)}$). Rezultati su pokazali maksimalnu brzinu i procenat nicanja klijanaca u prvoj godini. Broj dana se smanjivao od datuma setve do faza sa 8 i 12 listova kod potapanja semena uz pomoć metode sa destilovanom vodom. Prinos silaže se smanjio (26,69%) u kasnoj setvi (13. avgust), ali se brzina nicanja klijanaca povećala. Gustinom setve (9 biljaka/m^2) postignut je najveći procenat lignina, brzina nicanja klijanaca, visina biljke i prinos silaže. Najveći odnos sveže mase klipa i ukupne mase silaže dobijen je pri kasnom datumu setve (13. avgust) i potapanjem semena PEG metodom. Maksimalna vrednost prinosa silaže (45.566,41 kg/ha) dobijena je pri ranom datumu setve (27. jul) i većoj gustini setve (9 biljaka/m^2). Kako bi se stoga povećala brzina nicanja klijanaca i postigao maksimalni prinos silaže, preporučuju se rani datum setve (27. jul), veća gustina setve (9 biljaka/m^2) i potapanje semena metodom sa destilovanom vodom.

Ključne reči: gustina biljaka, potapanje semena, prinos silaže kukuruza, datum setve.

Primljeno: 18. avgusta 2018.
Odobreno: 18. aprila 2019.

[*]Autor za kontakt: e-mail: Morteza_siavoshi@yahoo.com