Effect of different planting method and plant density on yield and morphological traits of fodder maize in two planting dates

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Abstract: Effect of different planting methods, plant density and planting dates on yield, yield components and morphological traits of fodder maize studied during 2011 growth season. KSC704 variety of fodder maize planted in rural district of Abravan at south east of Mashhad. Main plots belonged to three levels of planting method (P1: Furrow planting, P2: ridge planting and P3: double rows of planting on ridge). Sub plots belonged to three levels of plant density (D1: 90,000; D2: 110,000 and D3: 130,000 plant.ha). A split plot experiment conducted base on randomized complete design with three replications and two planting dates (early April, and early June). Combined analysis of variance conducted. Results showed that plant height, tassel length, leaf area, ear length, and fodder dry weight and ASI duration affected by planting date. Quality index improved by furrow planting. The highest forage yield produced by P1 (50.75 t.ha) and D3 (50.58 t.ha). Forage yield significantly correlated by ear weight (r^2=0.71**). Stepwise regression model accounted for more than 43 percent of forage yield variance. Stem weight, ear weight and leaf area was three variables which enter the regression model. The first principal component contains stem weight, leaf weight and ear weight.

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Key words: forage yield, quality index, correlation, stepwise regression, principal component

Introduction

Cereal supplies the food of more than 70 percent of world density. Maize (*Zea mays* L.) is one of the three most important cereal crop species (after wheat and rice), which is grew for grain and fodder purposes. In Iran, maize production developed in recent years because of its high adoption to environmental conditions, releasing new hybrid varieties and prompting mechanized farming.

Common corn planting methods in Khorasan province are ridge planting, double rows on ridge and furrow planting. Furrow planting is a perfect method for regions with drought or saline stress risk (Khavari khorasani, 2008). Khalili Torghabe (2009) investigates the effect of planting methods and nitrogen fertilizer on sweet corn yield and yield components. Results showed that furrow planting produced higher yield and biological weight in sweet corn. Mazaheri et al (2001) reported that, double rows on ridge enhance water use efficiency by reducing evaporation area. Applying double rows on ridge, resulted in water use improvement and reducing side effects of saline soils. Amin allah et al (2011) showed that double rows on ridge enhanced corn yield by reducing weed total dry matter. Rafeei et al (2003) showed that double rows ridge planting increasing yield at least 30% more than ridge planting.

Prine (1964) reported that competing for light is the most limiting effect of plant density on plant yield. Haidargholinezhad et al (2003) showed the best quality of SC704 hybrid forage gained by plant density of 78,000 and 104,000 plants ha-1. Saberi et al (2001) investigated the effect of three planting methods (ridge planting, double rows by 15 and 20 cm distance) and four plant densities (70,000; 80,000; 90,000 and 100,000 plants ha-1) on yield of fodder maize.

Planting date is an important factor in farming which has significant impact on crop growth and development and its yield and yield components (Cukan and Mosavat, 2000). Olnes et al (1990) showed that in maize, there is a positive correlation between planting date and grain yield.

Abdel Rahman et al (2001) reported that proper planting date improve plant efficiency in applying environmental factors. There are several researches which indicated the effect of planning date on maize yield and phonological traits (Swanson and Wilhelm, 1996; Nielson et al, 2002). Some researchers reported lower maize yield by later planting dates (Norwood, 2001; Lauer et al, 1999). Maize yield significantly affect by plant density. Selecting accurate planting density results in higher yield and dry matter accumulation in maize (Norwood, 2001; Widdicombe and Thelen, 2002).

Materials and methods

The experiment carried out at Abravan rural district of Mashhad during 2011 and 2012 growing season. The site is located at 40 km of Mashhad south east with 36° 30′ E latitude and 60° 30′ N longitude and 985 m above see surface which is a cold-arid region with 170 mm precipitation per year. Soil EC was 16.5 dsm^{-2}which is characteristic of saline soils. The field plowed by autumn at 2010 and then prepared and sowed by April and June. There were four rows with 70 cm distance in each plot. Plot area was 10*0.7 m^2. Split plot design base on complete randomized blocks with three replications was conducted in two planting dates separately. Planting patterns (P1: Furrow planting, P2: ridge planting and P3: double rows of planting on ridge) belonged to main plots. Sub plots belonged to three levels of plant density (D1:90,000; D2:110,000 and D3:130,000 plant.ha). All morphological and yield component traits measured on 10 randomly selected plants of each plot. Yield was measured in 7 m2 for each treatment.

Data gained from two planting dates combined and analyzed using the SAS (Ver.9.1) and Significance of differences between means was conducted using Duncan's multiple range test.

Results and discussions

Morphological traits

Plant height

There was significant difference between two planting dates in respect of plant height. Higher plants belonged to April planting date with mean of 174 cm height (table 1). Effect of planting method was significant on plant height ($p<0.01$). Furrow planting produced higher plants rather than ridge planting. Reducing height is one of plant strategies in resisting against salinity. Planting maize on ridges resulted in height reduction because of saline stress. The data showed that plant height was not affected by plant density (table). Sidat and Hashemi Dezfuli (2000) reported that plant density and planting pattern did not affect corn height. Plant height did not increase by high plant density because of high competition between plants for soil water and nutrition elements. Interaction between treatments had not significant effect on plant height (table 2).

Tassel length

Tassel length reduced by delay planting (table 2). Planting method and plant density had not significant effect on tassel length (table 1). Nasr-allah Hosseini (2009) reported that tassel length dose not affected by planting method. Chukan (2012) declared that tassel length is more control by genetic rather environment.

Stem diameter

Planting method showed a significant effect on stem diameter ($p<0.01$). Double rows on ridge resulted in thin stems. There was not a significant difference between D1 and D1 in respect of stem diameter. Stem diameter also affected by planting density ($p<0.01$) and interaction between planting date and plant density ($p<0.05$). D1 in both planting dates produced higher stem diameter rather than other treatments (fig1).

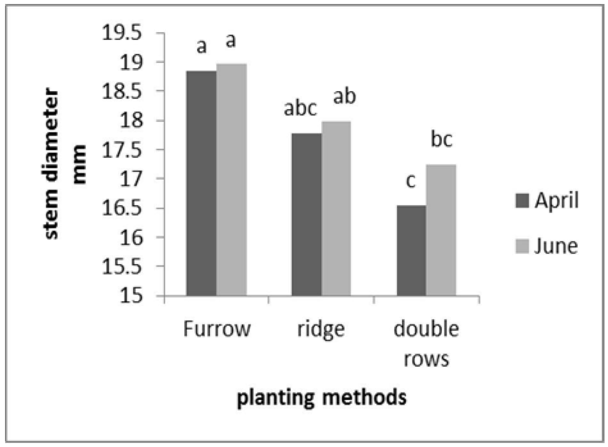

Fig1: interaction between planting date and planting method on stem diameter

Stem weight

Effect of planting method and plant density was significant on stem weight. Stem weight was higher in furrow planting method. Higher plant density results in lower stem weight (table). Higher water and nutrition availability at furrow planting, results in better assimilate accumulation in stems and producing heavy stems. Higher plant density results in more competition between plants and producing lower stem weight. There was a significant correlation between stem weight and forage yield (r^2=0.66**). Result was in agreement with Fatemi et al (2008). Stem weight was the first variable enters to regression model. The proportion of stem weight in forage yield variance was more than 34 percent (table).

Leaves number

Effect of planting method and interaction between planting method and plant density was significant on leaves number per plant (table). Furrow planting at D2 plant density level produced the highest leaves number (fig 2). Furrow planting decreases salinity effects and results in higher leaf production per plant. Very high plant densities results in high competition between plants and reduces leaf number by reducing light interception to canopy. There was not significant difference between plant density levels ad double rows planting method in respect of leaves number (fig 2). Williams et al (1965) reported the same result about relation between plant density and leaf number in corn.

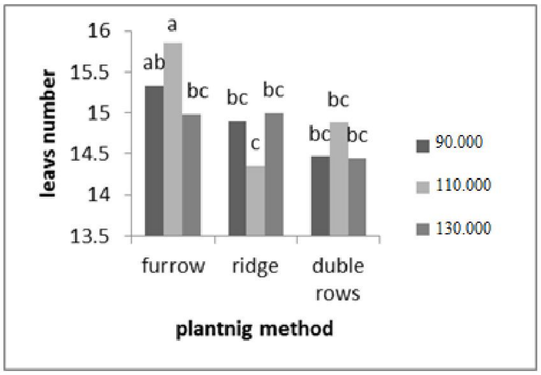

Fig2: interaction between plant density and planting method on leaves number

Leaf weight

Leaf weight significantly affected by planting method and plant density ($p<0.01$). Double rows on ridge and 130,000 plant density make an decrease in leaf weight of maize (table 1). There was not a significant difference between furrow planting and ridge planting in respect of leaf weight. Both D3 and P3 treatments results in low light interception to the canopy and thus decreases leaf weight. Leaf weight is an effective trait in producing fodder yield and enhances fodder quality. Karlen and Bregh (1985) reported the same results in maize.

Leaf area

Planting date and method had significant effect on leaf area of maize. Delay cropping results in lower leaf area (table 1). Furrow planting produced highest leaf area by mean of 365 cm^2 per plant. Leaf area declined at double rows on ridge because of higher competition between plants. Redman et al (2005) reported the same results. Leaf area was the third variable enters to regression model. Leaf area plus with ear weight and leaf weight controlled more than 43 percent of yield variations (table 2).

Agronomic traits

Ear length

Ear length affected by planting date, planting method and interaction between planting date and planting method (table). Double rows at June planting date resulted in lower ear length between all treatments (fig 3). Feizbakhsh et al (1389) reported the same results. Ear length significantly correlated by ear weight (r^2= 0.66**) whereas ear weight correlated by forage yield (r^2=0.55**). Thus fodder yield affected by ear length indirectly.

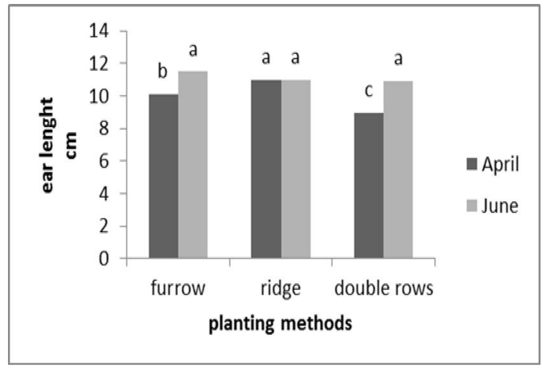

Fig 3: interaction between planting date and planting method on ear length

Ear diameter

Ear diameter did not affected by applied treatments (table 1). Ear diameter was correlated by ear weight (r^2=0.66**) and forage yield (r^2=0.43**)

Ear weight

Ear weight significantly affected by planting method, plant density, and interaction between planting date and planting method (table). There was different between planting methods in different planting dates in respect of ear weight. At April furrow planting produced the highest ear weight, while at June the highest ear weight produced by ridge planting (fig 4). Double rows resulted in lower ear weight at both planting dates. High population enhances plant competition for light, water and nutrients. Higher competition between plants at double row planting method resulted in producing lower ear weight. Fatemi (2008) showed that ear weight reduced significantly by double rows on ridge compared with ridge planting. Ear weight was the second variable enters to regression model. Ear weight plus leaf weight controlled more than 38 percent of forage yield variations (table 3).

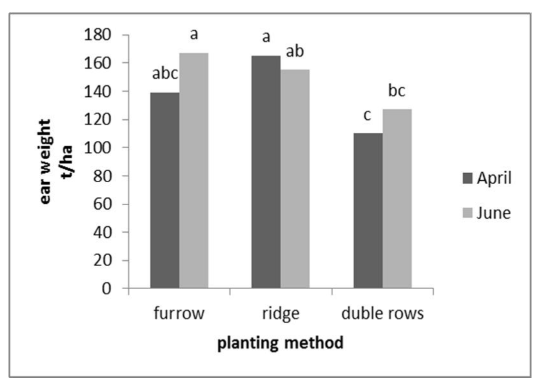

Fig 4: interaction between planting date and planting method on ear weight

Forage yield

Planting method had a significant effect on forage yield (p<0.01) (table). The highest forage yield produced by furrow method by mean of 50.74 t.ha. The lowest forage yield gained by P3treatment (table 1). Forage yield affected by plant density too (p<0.01) (table). Higher plant density results in higher forage yield (table 2).

Forage yield significantly correlated by ear weight (r^2=0.71**) (table 5). Fatemi (2008) showed that ear weight reduced significantly by double rows on ridge compared with ridge planting. Norwood (2001) reported that yield component affected by proper plant density. Hassanzadeh Moghadam and Basafa (2006) and Mazaheri et al (2002) reported that enhancing plant density increased forage yield significantly. High plant densities resulted in better light absorbance by flag leaves which have high photosynthesis efficiency and enhanced forage yield (Tetio-Kagho and Gardner 1988).

Applying criterion of eigenvalue one or more, four principal components (PC) were found to be significant and explained over than 75 percent of variance between 14 variables (table 4). The first PC contains the variation information of three factors: stem weight, leaf weight and ear weight which account for 39 percent of cumulative variances. Plant height, tassel length, leaf area and ASI were variables with high coefficients in second PC (table 4).

Quality index (QI)

Quality index (QI) enhanced furrow planting (p<0.01) (table1). P1 and P3 produced the highest and lowest quality index by mean of 0.28 and 0.20% respectively (table). Planting density, planting date and interaction between treatments had not significant effect on QI (table 1). Leaching salts from soil increases by furrow planting in saline condition. Side effect of salts reduces by furrow planting which results in better water and mineral absorbance and higher ear yield. QI enhanced by higher percent of ear at forage weight. Saadatzadeh et al (2011) reported that reducing ear weight results in lower QI of maize forage. There was a negative correlation between quality index and root lodging (r^2= -0.45**). QI correlated by ear diameter ($r^{2=}$0.42**) and ear weight ($r^{2=}$0.43**) too.

Anthesis silking interval (ASI)

ASI significantly affected by planting date (p<0.05), planting method (p<0.01) and interaction between planting date and planting method (p<0.01) (table 1). ASI duration diminished by planting at June in all planting methods. At April planting date, D3 imposed the longest ASI duration. ASI decreased by furrow planting at April but yet was longer than June planting date (table 2). Cirilo and Andrade (1994) stated that delay cropping accelerate sweet corn development rate and silk appearance. Sarmadnia (1374) declared that silking occurs at high temperatures of July in corn which planted by early April. While corns planted by July produce silks at lower temperatures and thus shows short ASI durations.

ASI negatively correlated by ear weight (r^2=0.50**) and ear length (r^2=0.44**).

Root lodging

Root lodging did not affected by planting density and planting date but furrow planting significantly decreased root lodging (p<0.01) (table 1). Khalili Torghabe (2009) reported the same results. Nodal roots, growth better in furrow planting method, reach the soil level and put in the ground, thus helps stalks better standing (Hassanzadeh,2006). Root lodging negatively correlated by forage yield (r^2=-0.44**)

Table1:Different traits analysis of variance at different planting methods and plant densities levels

Mean of squares

Treatment	Degree of freedom		Ear weight	forage yield		Quality index		Plant height		Leaf area	
Replication	2	1743	ns	82.3	ns	0.01331	ns	3.13	ns	733	**ns**
Planting date (T)	1	1884	ns	129	ns	0.0056	ns	8932	**	48079	**
Error T	2	941	ns	36.6	ns	0.00146	ns	2.231	ns	385	**ns**
Planting method (P)	2	8878	**	762	**	0.0340	**	1084	**	16001	**
T*P	2	1706	*	61.24	ns	0.001568	ns	104	ns	39.98	ns
Error P	8	365	ns	30.35	ns	0.00136	ns	69.72	ns	690	ns
Plant density (D)	2	2042	*	457	**	0.00291	ns	38.58	ns	416	ns
T* D	2	101	ns	3.042	ns	9.0740	ns	4.31	ns	38.39	ns
P*P	4	986	ns	35.52	ns	0.0023	ns	51.097	ns	337	ns
T*D*P	4	735	ns	31.62	ns	0.00164	ns	57.958	ns	476	ns
Residual	24	365	ns	24.16	**ns**	0.0021	**ns**	34.47	**ns**	554	**ns**
CV%		13.25		10.64		19.21		3.63		6.98	

* and **significant at 5% and 1% level respectively ns sot significant

Table 1: continued

	Mean of squares								
Treatment	Degree of freedom	Tassel length		Stem diameter		Stem dry weight		Leaves number	
Replication	2	3.723	ns	1.759	ns	3136	ns	0.8246	ns
Planting date (T)	1	949.62	**	6.203	ns	7954	ns	0.11574	ns
Error T	2	2.6572	ns	4.307	ns	1442	ns	0.3201	ns
Planting method (P)	2	6.2612	ns	35.568	**	14418	**	3.159	**
T*P	2	9.694	ns	3.77	ns	120	ns	0.7412	ns
Error P	8	7.868	ns	0.9911	ns	1054	ns	0.2451	ns
Plant density (D)	2	13.125	ns	13.238	**	4811	**	0.2135	ns
T* D	2	0.7868	ns	1.73195	*	168	ns	0.0901	ns
P*P	4	1.6378	ns	0.82836	ns	492	ns	1.01185	**
T*D*P	4	5.2350	ns	0.9412	ns	588	ns	0.1457	ns
Residual	24	4.2671	ns	0.445	**ns**	662	**ns**	0.2189	**ns**
CV%		7.39		3.69		11.79		3.13	

* and **significant at 5% and 1% level respectively ns sot significant

Table 1 continued

	Mean of squares						
Treatment	Degree of freedom	Leaf number		Ear length		Ear diameter	
Replication	2	57.90	ns	0.91		36.30	ns
Planting date (T)	1	309.36	ns	16.77	**	3.18	ns
Error T	2	153	ns	0.09		4.70	ns
Planting method (P)	2	1185	**	5.70	**	32.01	ns
T*P	2	287	ns	4.62	**	18.98	ns
Error P	8	68.84		0.307		13.17	ns
Plant density (D)	2	434.41	**	1.45		12.08	ns
T* D	2	11.94	ns	0.680		2.27	ns
P*P	4	56.59	ns	2.36		11.34	ns
T*D*P	4	99.46	ns	0.75		16.24	ns
Residual	24	47.15	ns	0.95		7.73	ns
CV%							
		3.13		9.23		7.1	

* and **significant at 5% and 1% level respectively ns sot significant

Table 2: comparison of means using Duncan multiple test

TREATMENT	Leaf area cm^2	Leaves number	Plant height cm	Tassel length Cm	Stem diameter mm	ASI Day	Root lodging %
Early April (T1)	367.159a	14.867a	174.381a	32.122a	17.722b	9.741a	1.00a
Early June (T2)	307.481b	14.959a	148.659b	23.722b	18.411a	6.489b	1.185a
Furrow planting (P1)	365.9a	15.39a	170.4a	28.464a	18.86a	6.928c	0.100b
Ridge planting (P2)	339.8b	14.75b	156.0b	28.000a	18.89a	7.506b	1.561a
Double rows on ridge (P3)	306.4c	14.60b	158.1b	27.300a	16.44b	9.911a	1.744a
90.000 (D1)	339.067a	14.90a	163.078a	28.317a	18.96a	7.739a	1.137a
110.000 (D2)	341.011a	15.03a	161.311a	28.511a	17.99b	8.467a	1.144a
130.000 (D3)	331.883a	14.81a	160.172a	26.939a	17.24c	8.139a	1.130a
T1*P1	395.767a	15.14a	180.50a	32.38 a	19.05 a	7.33 c	0.1 a
T1*P2	371.044a	14.91a	170.53a	31.64a	18.32a	8.44b	1.60a
T1*P3	334.667a	14.54a	172.11a	32.33a	15.80a	13.44a	1.57a
T2*P1	335.933a	15.63a	160.30a	24.54a	18.68a	6.52d	0.10a
T2*P2	308.456a	14.58a	141.50a	24.35a	19.45a	6.57cd	1.52a
T2*P3	278.056a	14.65a	144.18a	22.26a	17.08a	6.38d	1.92a
T1*D1	370.51a	14.9a	175.47a	32.30a	18.83ab	8.89a	1.16a
T1*D2	370.50a	14.9a	174.68a	32.73a	17.79c	10.56a	1.11a
T1*D3	360.47a	14.8a	173.00a	31.33a	16.54d	9.78a	1.0a

T2*D1	307.62a	14.9a	150.69a	24.34a	19.09a	6.59a	1.11a
T2*D2	311.52a	15.1a	147.94a	24.29a	18.20bc	6.38a	1.18a
T3*D3	303.30a	14.8a	147.34a	22.54a	17.94c	6.50a	1.26a
P1*D1	362.05a	15.33ab	169.43a	28.75a	19.65a	6.98a	0.10a
P1*D2	375.16a	15.85a	169.97a	29.35a	19.16a	6.72a	0.10a
P1*D3	360.33a	14.98bc	171.80a	27.30a	17.81a	7.08a	0.10a
P2*D1	350.37a	14.90bcd	159.57a	28.48a	19.90a	6.85a	1.55a
P2*D2	335.33a	14.35d	157.25a	28.90a	18.37a	8.6a	1.55a
P2*D3	333.55a	15.00bc	151.23a	26.61a	18.38a	7.06a	1.58a
P3*D1	304.78a	14.47cd	160.23a	27.71a	17.33a	9.38a	1.75a
P3*D2	312.53a	14.88bcd	156.71a	27.28aa	16.45a	10.08a	1.78a
P3*D3	301.77a	14.45cd	157.48a	26.90a	15.53a	10.27a	1.70a
T1*P1*D1	03.395a	1.15a	17.177a	33.32a	20.20a	3.7a	10.0a
T1*P1*D2	87.395a	4.15a	37.178a	60.32a	10.19a	0.7a	10.0a
T1*P1*D3	40.396a	9.14a	97.185a	23.32a	17.90a	7.7a	10.0a
T1*P2*D1	97.384a	2.15a	67.174a	31.50a	19.76a	0.7a	7.1a
T1*P2*D2	57.364a	3.14a	90.172a	67.33a	17.98a	7.10a	7.1a
T1*P2*D3	60.363a	2.15a	03.164a	77.29a	20.17a	7.7a	5.1a
T1*P3*D1	53.331a	3.14a	57.174a	08.33a	53.16a	3.12a	7.1a
T1*P3*D2	07.351a	9.14a	77.172a	93.31a	30.16a	0.14a	6.1a
T1*P3*D3	40.321a	4.14a	00.169a	00.32a	53.14a	0.14a	4.1a
T2*P1*D1	07.329a	5.15a	70.161a	18.25a	10.19a	6.6a	10.0a
T2*P1*D2	47.354a	3.16a	57.161a	10.26a	23.19a	4.6a	10.0a
T2*P1*D3	27.324a	1.15a	63.157a	38.22a	73.17a	5.6a	10.0a
T2*P2*D1	77.315a	6.14a	47.144a	48.25a	03.20a	7.6a	4.1a
T2*P2*D2	10.306a	4.14a	60.141a	13.24a	76.18a	5.6a	4.1a
T2*P2*D3	50.303a	8.14a	43.138a	48.23a	56.19a	5.6a	7.1a
T2*P3*D1	03.278a	6.14a	90.145a	38.22a	13.18a	4.6a	8.1a
T2*P3*D2	00.274a	8.14a	67.140a	63.22a	60.16a	2.6a	0.2a
T2*P3*D3	13.282	5.14a	97.145a	80.21a	53.16a	5.6a	0.2a
TREATMENT	Leaf area cm^2	Leaves number	Plant height cm	Tassel length Cm	Stem diameter mm	ASI Day	Root lodging %

Table 3: results of stepwise regression regarding forage yield as dependent variable

Step	1	2	3
stem weight	0.131	0.090	0.032
T-Value	5.41	2.99	0.83
P-Value	0.000	0.004	0.409
ear weight	0.082	0.104	
T-Value	2.12	2.70	
P-Value	0.039	0.009	
leaf area	0.064		
T-Value	2.30		
P-Value	0.025		
S	7.04	6.82	6.54
R-Sq	35.98	41.16	46.80
R-Sq(adj)	34.75	38.85	43.61
Mallows C-p	22.5	18.7	14.3

Table 4: Eigen analysis of the Correlation Matrix

PC	Eigenvalue	Cumulative variance
1	5.8532	0.390
2	3.2846	0.609
3	1.2539	0.693
4	1.1229	0.768

Table 5: result of principal component analysis

Variable	PC1	PC2	PC3	PC4
plant height	0.131	0.487	-0.039	0.070
tassel length	0.030	0.500	0.008	0.228
stem diameter	0.274	-0.156	-0.411	0.255
leaf area	0.248	0.385	-0.124	0.027
Leaves number	0.220	0.010	-0.325	-0.462
stem weight	0.333	0.157	-0.005	0.166
leaf weight	0.333	-0.136	-0.125	0.054
ear weight	0.345	-0.152	0.216	0.286
ear diameter	0.283	0.047	0.271	0.201
ear length	0.191	-0.328	0.196	0.309
QI	0.231	0.013	-0.111	0.172
ASI	-0.198	0.370	0.300	0.075
Root lodging	-0.261	-0.111	0.319	0.301

Conclusion

Results showed that forage yield highly affected by stem weight, leaf weight and ear weight. Quality index was higher in treatments with higher ear length. Delay cropping because of lower temperatures, results in short ASI rather than early cropping. Destructive effects of salinity reduced by furrow planting in all plant densities.

References

1. Abdel Rahman, A.M., Magboul E.L.and A.E.Nour.2001.Effects of sowing date and cultivar on the yield and components of muize in nother sudan.Seventh eastern and southern Africa Regional maize Conference 11 th-15 th February.2001.pp.2,5-2.8
2. Chukan, R.2012. maize and its characteristics. 104 pp.
3. Cirilo, A.G., and F.H. Andrade.1994.Sowing date and maize productivity:1:Crop growth and dry matter partitioning. Crop Sci.34: 1039-1043.
4. Fatemi. R. 2008. Effect of different planting methods on fodder maize hybrids in saline condition. Azad University of Mashhad. MSC thesis.
5. Feizbakhsh, M. Mokhtarpour, H. Mosavat, A. Mohajer, M. Shahi, Gh.1389. Effect of planting date and plant population on fodder maize yield and morphological traits. Crop production. E-journal. 3(1):217-224.
6. Haidargholinezhad, M.; Ghadimzadeh, M.; Faiazmoghaddam, A., 2003: The effect of planting density of corn hybrid on the basis of agronomy traits. Iranian Journal of Agricultural Sciences 34(2): 417-425.
7. Hassanzadeh Moghadam, H. 2006. Effect of planting method and plant population on seed and forage yield of maize in saline condition. Agricultural and resources research center of Khorasan Razavi.
8. Karlen, D. and Bregh, D. 1985. Row spacing, plant population and water management effects on corn in the Atlantic coastal plain, Agron.J.77:393-398.
9. Khalili Torghabe, 2009. Effect of planting method and nitrogen fertilizers on eco-physiologic traits of sweet corn variety KSC403. MSc thesis. Azad university of Neyshabour. 46 pp.
10. Khavari khorasani, S. 2008. The Handbook of corn production. Gholami publication.
11. Lauer,G.J. Carter,P.R.Wood M,D.W. Wiersma, R.E Rand and Mlynark, M.T, 1999. Corn hybrid response to planting date in the northern corn belt.Agron.J.91:834-839.
12. Mazaheri, D. askarirad, M. Bankesaz, A. 2002. Effect of planting method and plant density on yield and yield components of two fodder maize hybrids. 7th agronomy symposium.
13. Nasr-allah Hosseini. S.M. Zekri, S. Nabavi kalat S.M. 2009. Effect of salinity on germination of three sweet corn hybrids. The first environmental stress symposium. Birjand. 27-30 January.
14. Nielson, R.L, P. R.Thomison, G.A.Brown, A.L.Halter, J.Wells,and K.L. Wuethrich. 2002;Delayed planting effects on flowering and grain maturation of dent corn.Agron.J.94:549-558.
15. Norwood, C. A. 2001. planting date, hybrid maturity and plant density effect on soil water delpletion and yield of dry land corn.Agron J.93:1034-1042.
16. Olnes,A.,G.R.Beneoif, and Etalf.1990.Effect of planting date on time and rate of nitrogen accumulation by maize. crop.Sci.164:42-53.
17. Rafeei, M.K. Khademi, H. Sabzi, V. Khani, R.M. 2003. Effect of planting method ad plant density on morphological characteristics of maize.
18. Redman, R.E. M.Q.Qi M.Belyk.2005. Growth of sorghum varieties in response to soil salinity. Can.J.Plant sci.94:797-799.
19. Saberi, A.R, Mazaheri, D, Heydary Sharifabad, H. 2001. Determining the best planting pattern and plant density in Mazie var three way cross 647. Proceeding of 8th congress of agronomy and plant breeding.
20. Sarmadnia, Gh. 1374. Effect of planting date on yield and yield components of three maize varieties at Isfahan. Iranian Journal of Agricultural Science. 26 (4): 15-17.
21. Siadat S.A, Hasemi-Dezfouli SA, 2000. Effect of plant density and planting pattern of grain yield and yield components of corn (Zea mays L.) hybrid KSC 704. Agric Sci. J 9: 39-48.
22. Swanson, S.p., and W.W.Wilhelm.1996. Planting date and residue effects on growth, Partitioning, and Yield of corn Agronomy.J.88:88:205.210.
23. Widdicombe,W.D.and Thelen,K D.2002. Row width and plant density effect on corn grain production in the northern corbelt. Agron.j.94:1020-1023.
24. Williams, W.A.,R.S. Loomis and C.R. Lepley. 1965. Vegetative growth of corn as affected by population density productivity in relation to interception of solar radiation. SCI. 5:211-214.

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