Research Journal of Environmental and Earth Sciences 6(1): 44-48, 2014
DOI:10.19026/rjees.6.5740
ISSN: 2041-0484; e-ISSN: 2041-0492

Submitted: October 19, 2013 Accepted: November 06, 2013 Published: January 20, 2014

Research Article

Effect of Planting Methods and Plant Density on Yield and Yield Component of Fodder Maize

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Abstract: The purpose of this research is Effect of planting methods and plant density, on yield and yield component of fodder maize. Salinity is a major abiotic factor that limits agricultural crop production. More than 8 million hectare of world fields involved saline soils. Effect of different planting methods and plant density on yield and yield components 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 (Furrow planting, ridge planting and double rows of planting on ridge). Sub plots belonged to three levels of plant density (90,000; 110,000 and 130,000 plant/ha). A split plot experiment conducted base on randomized complete design with three replications. Results showed that different planting methods had significant effect on fodder yield, ear weight, quality index and leaf area index of plants. Furrow planting with 130,000 plant density, produced the highest fodder yield by mean of 56.33 t/ha.

Keywords: Furrow planting, quality index, ridge planting and double rows of planting on ridge

INTRODUCTION

Maize is one of the most important crops for human and animal husbandry (Kuchaki, 1985). More than 150,000 hectare fodder maize field with 49 t/ha of mean yield placed in Iran (FAO, 2009). Prine and Schrode (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} and reported that, increasing in plant density result in higher dry matter yield in corn. There was a 13.7% difference between dry matter yield of corn planted in 32,000 and 47,000 densities. Emam and Tadaion (1999) reported that 11.11 plants m^{-2} produced the highest maize leaf area index and seed and fodder yield. Harvest index reduced at densities higher than 6.66 plants m^{-2}. 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 (Anonymous, 2002). Asghari *et al*. (2006) reported that there is no significant difference between seed yield of ridge planting and double rows on ridge. Saberi (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. Results showed that double rows with 15 cm distance with 90,000 plants ha^{-1} produced the highest yield. Fatemi (2008), reported that planting method has no effect on morphological traits, yield and yield component of maize in saline condition. Rafeei *et al*. (2003) showed that double rows ridge planting increasing yield at least 30% more than ridge planting.

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. The field plowed by autumn at 2010 and then prepared and sowed by April at 2011. There were four rows with 75 cm distance. A split plot design base on complete randomized blocks with three replications was conducted. 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). Studied traits were forage yield, ear weight and forage quality index (the ratio between ear weight to forage yield). Data gained from 10 random ears in each plot

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subjected to analyses of variance by using MINITAB and MSTAT-C programs. Significance of differences between means was conducted using Duncan's multiple range tests.

RESULTS AND DISCUSSION

Forage yield: Planting method had a significant effect on forage yield ($p<0.05$) (Table 1). The highest forage yield produced by P2 by mean of 52.44 t/ha. The lowest forage yield gained by P3treatment by means of 40.23 t/ha (Fig. 1 and Table 2). Forage yield significantly correlated by ear weight ($r^2 = 0.549^{**}$) (Table 3). Fatemi (2008) showed that ear weight reduced significantly by double rows on ridge compared with ridge planting.

Forage yield affected significantly by plant density ($p<0.01$) (Table 1). D3 produced the highest forage yield by mean of 52.6 t/ha (Fig. 2).

Norwood (2001) reported that yield component affected by proper plant density. Hasanzadeh 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 Gardnar, 1988). Interaction between planting method and plant density was not significant on forage yield.

Quality index: Quality Index (QI) was influenced by planting method ($p<0.01$). P1 and P3 produced the highest and lowest quality index by mean of 0.29 and 0.19%, respectively (Fig. 3).

Leaching salts from soil increased by furrow planting in saline condition. Side effect of salts reduces by furrow planting which results in better water and mineral absorbance and higher forage yield. There was a negative correlation between quality index and ASI (Anthesies Silking Interval) ($r^2 = -0.423^*$). Quality index increased by ASI duration reduce (Table 5). QI decreased by increasing plant density. D1 produced the highest QI by mean of 0.25% (Table 4). Saadatzadeh *et al*. (2011) investigated the effect of different plant densities on fodder maize quality and quantity yield. They reported that stalk diameter, leaf weight and ear weight reduced by high plant densities. Reducing ear weight resulted in lowering QI of maize forage. QI did not affected significantly by interaction between planting method and plant density.

Ear weight: Ear weight affected by interaction between planting method and plant density ($p<0.01$) (Table 1). D1×P1 produced the highest ear weight by mean of 204 gr (Fig. 4). Ear weight reduces by salinity and high population enhances plant competition for light, water and nutrients. Thus less plant density in furrow condition resulted in higher ear yield.

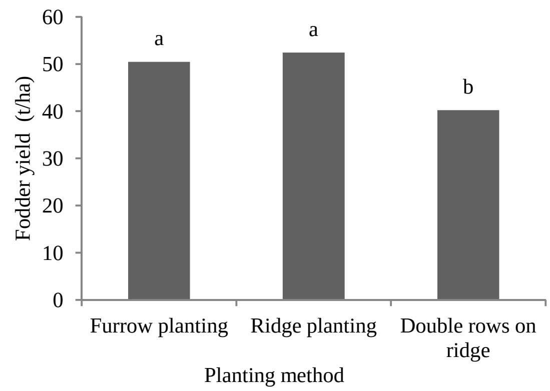

Fig. 1: Effect of different planting methods on forage yield of maize

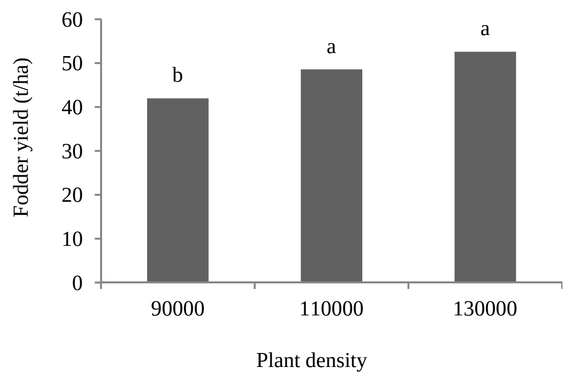

Fig. 2: Effect of different plant populations on forage yield of maize

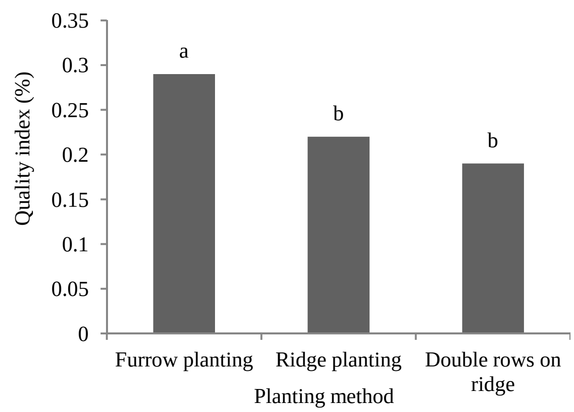

Fig. 3: Effect of different planting methods on forage quality index of maize

Khavari Khorasani (2008) reported that furrow planting enhance ear yield in saline condition. Fatemi (2008) showed that double rows on ridge method reduced ear/biomass percent compared with ridge planting.

Ear weight negatively correlated by ASI ($r^2 = -0.533^{**}$). Short ASI resulted in higher ear weight (Table 5). Duncan (1985) showed that plant population

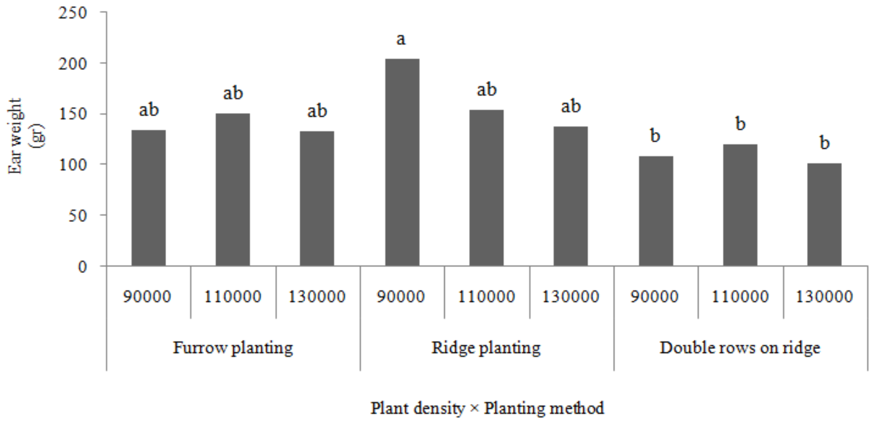

Fig. 4: Interaction between different planting methods and plant densities on ear weight of fodder maize

Table 1: Different traits analysis of variance at different planting methods and plant densities levels

	Mean of squares					
Treatment	Degree of freedom	Ear weight	Fodder yield	Quality index	Plant height	Leaf area
Replication	2	61.2700^{ns}	15.47^{ns}	0.011^{ns}	4.2200^{ns}	553.038^{ns}
Planting method	2	6751.95*	386.62*	0.023**	258.30^{ns}	8501.611*
Main plot error	4	393.760	52.400	0.001	63.71	836.306
Plant density	2	1527.14*	260.02**	0.002^{ns}	14.29^{ns}	302.239^{ns}
Planting method ×plant density	4	1348.22*	34.67^{ns}	0.003^{ns}	87.82^{ns}	409.037^{ns}
Sub plot error	12	384.30	26.51	0.003	42.52	495.540
CV%		14.160	10.79	24.61	3.740	6.06

*and ** significant at 5% and 1% level respectively; ns: not significant

Table 2: Comparison of means using Duncan multiple test

Planting method	Fodder yield (t/ha)	Ear weight (gr)	Quality index (%)	Leaf area (cm)	Plant height (cm)
Furrow planting	50.46a	139.35b	0.29a	395.8a	180.50a
Ridge planting	52.44a	165.31a	0.22b	371.01ab	170.53a
Double rows on ridge	40.23b	110.55c	0.19b	334.7b	172.11a

Means by same letters showed not significant differences

Table 3: Pearson analysis of correlation between measured traits

	Plant height	Ear height	Ear weight	Fodder yield	Quality index	ASI	Leaf area
Plant height	1						
Ear height	0.751**	1					
Ear weight	0.183*	0.061^{ns}	1				
Fodder yield	0.186*	0.076^{ns}	0.549**	1			
Quality index	0.496*	0.225^{ns}	0.361^{ns}	0.290^{ns}	1		
ASI	-0.317^{ns}	-0.106^{ns}	-0.553**	-0.525**	-0.423*	1	
Leaf area	0.560**	0.348^{ns}	0.512**	0.531**	0.586**	-0.742**	1

* and ** significant at 5% and 1% level respectively; ns: not significant

Table 4: Comparison of means using Duncan multiple test

Plant density	Fodder yield (t/ha)	Ear weight (gr)	Quality index (%)	Plant height (cm)	Leaf area (cm^2)
90000	41.96b	149.24a	0.25a	175.46a	370.51a
110000	48.57a	142.02a	0.22a	174.67a	370.50a
130000	52.60a	123.95a	0.23a	173.00a	360.46a

Means by same letters showed not significant differences

Table 5: Comparison of means using Duncan multiple test

Planting method	Plant density	Ear weight (gr)	Fodder yield (t/ha)	Quality index (%)	Plant height (cm)	Leaf area (cm)
Furrow planting	90000	134.33ab	42.48ab	0.28a	177.17a	395.3a
	110000	150.66ab	52.58a	0.26a	177.37a	395.86a
	130000	133.06ab	56.33a	0.32a	185.97a	396.40a
Ridge planting	90000	204.33a	51.12a	0.24a	174.67a	384.96a
	110000	154.53ab	50.30a	0.21a	172.90a	364.56a
	130000	137.06ab	55.9a	0.20a	164.02a	363.60a
Double rows on ridge	90000	109.06b	32.29a	0.22a	174.57a	331.53a
	110000	120.86b	42.82ab	0.20a	172.77a	351.06a
	130000	101.73b	45.58ab	0.14a	169.0a	321.40a

Means by same letters showed not significant differences

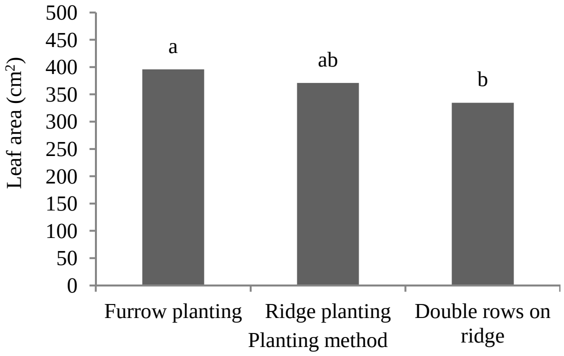

Fig. 5: Effect of different planting methods on leaf area of fodder maize

enhancement resulted in ear weight decrease in each plant because of interplant competition.

Plant height: The data showed that plant height was not affected by planting method and plant population (Table 1). The same result reported by Hassanzadeh (2006) and Fatemi (2008). Correlation analysis showed a positive significant relation between plant height and leaf area (r^2 = 0.560**) tassel length (r^2 = 0.397*), ear height (r^2 = 0.751**) and biomass (r^2 = 0.186*) (Table 5). High plant population results in enhancing plant height and ear height on stalk. Saadatzadeh *et al.* (2011) reported that dense plant population enhances plant height. Siadat and Hasemi-Dezfouli (2000) reported that plant population and planting pattern did not affect corn height.

Leaf area: Furrow planting resulted in the highest leaf area by mean of 395 cm^2 (Fig. 5). The finding was in agreement with Nasr-allah Hosseini (2009). Nasr-allah Hosseini (2009) showed that furrow planting increased leaf area by 12% compared by ridge planting.

Plant density did not significantly affect leaf area (Table 1). Increasing plant population from 7 to 10 plants per m^2 increased leaf area by 50%.

CONCLUSION

Results showed that in Abravan environment, ridge planting by 130,000 populations produce the highest fodder yield. ASI duration significantly affect yield components of fodder maize such as quality index and ear weight. Due to its effect on diminishing salt aggregation in relation to ridge planting, furrow planting prepare semi saline and saline areas for growing crops.

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