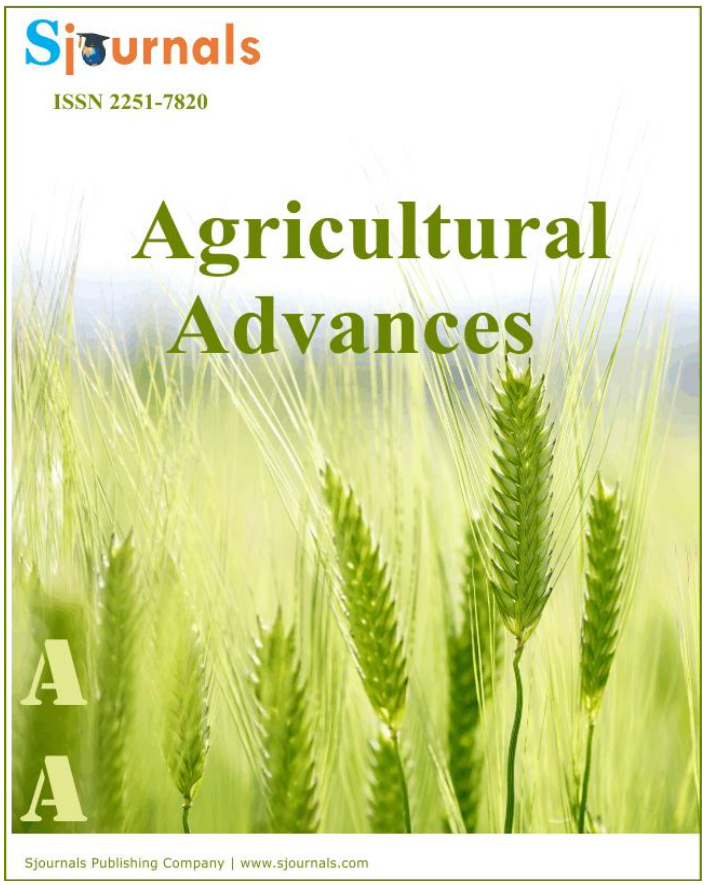

Sjournals
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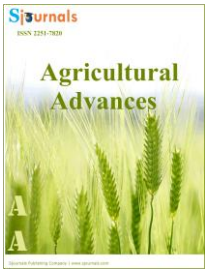
Agricultural Advances (2018) 7(3) 469-473
ISSN 2251-7820
doi: 10.14196/aa.v7i3.2507



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Original article

Effects of nitrogen fertilizer and corn cultivars on corn silage yield

Masoud Mohseni[a,*], Mohammad Hossein Haddadi[a], Maryam Yousefnezhad[b]
[a]*Scientific Member of Agronomy and Horticulture Crops Research Department, Mazandaran Agricultural and Natural Resources Research and Education Center, AREEO, Sari, Iran.*
[b]*M.Sc. Student at Islamic Azad University, Branch of Ghaemshahr, Iran.*

*Corresponding author: mohseni1337@yahoo.com

ARTICLE INFO

Article history,
Received 13 February 2018
Accepted 14 March 2018
Available online 21 March 2018
iThenticate screening 15 February 2018
English editing 12 March 2018
Quality control 19 March 2018

Keywords,
Corn silage
Corn cultivar
Nitrogen fertilizer
Forage yield

ABSTRACT

A split plot experiment using the randomized complete block design with three replications was carried out at the Gharakheil Agronomic Research Station of Iran in the crop year 2014 to evaluate the effects of nitrogen fertilizer and cultivar on forage corn yield and yield components. The main-plot factor included three corn cultivars (SC704, SC677 and SC400) and the sub-plot factor, four application rates of urea (100, 200, 300 and 400 kg/ha). Analysis of the data showed that the effects of cultivar and rate of urea application and their mutual effects on most of the studied traits were significant (α=5%). The mean comparison, using the Least Significant Range (LSR) test indicated the maximum forage and dry matter yields (40.95 and 12.90 t/ha, respectively) were obtained in the treatment of SC704 and urea at 200 kg/ha.

1. Introduction

Corn is an important and valuable cereal for tropical and temperate regions of the world and it ranks third with respect to world production after wheat and rice (FAO, 2014). Considering the importance of, and the role played by, forage corn in livestock nutrition, breeding and introducing high yielding cultivars compatible to

different regions for obtaining maximum yield and for utilizing the maximum potentials of cultivars are important goals. Moreover, application of nitrogen fertilizer as an important agronomic input can increase yield and research has shown various corn hybrids react differently to various rates of nitrogen fertilizer application (Bundy and Cater, 1988).

Subedi et al. (2006) stated there was an exponential relationship between corn grain yield and increased rates of nitrogen application. They reported maximum corn grain yield was achieved with the application of nitrogen at 225 kg/ha, while corn silage yield increased linearly when nitrogen fertilizer application rate was raised from 150 to 225 kg/ha and remained constant at higher rates of application. Babnik et al. (2002) studied the effects of nitrogen fertilizer on corn yield and concluded dry matter yield increased linearly when rate of nitrogen application was raised up to 250 kg/ha. Cox and Cherny (2001) and Shapiro and Wortmann (2006) studied the effects of rates of applying 0-250 kg/ha of nitrogen fertilizer in two separate experiments and stated that maximum dry matter yield was obtained when nitrogen fertilizer was applied at 150 kg/ha. According to research carried out by Budakli-Karpici et al. (2010), raising nitrogen application rate from zero to 400 kg/ha increased plant height, stem diameter, dry matter yield and weight and number of leaves, but reduced the percentage ratios of cob weight and stem weight to total forage. Our research intended to determine the best cultivar with respect to yield, the best rate of nitrogen application to achieve maximum yield in corn silage, the mutual effects of nitrogen and cultivar on yield and yield components of forage yield used for corn silage and the traits that had the greatest effect on forage yield.

2. Materials and methods

An experiment was carried out at the Gharakheil Agronomic Research Station (with latitude of 36˚27 north, longitude of 52˚53 east and altitude of 14 m), which is affiliated to the Agriculture and Natural Resources Research Center of Mazandaran Province in the crop year 2014. This research was conducted in the split plot arrangement using the randomized complete block design with three replications. The main-plot factor included three cultivars of silage cultivars (SC704, SC677 and AC400) and the sub-plot factor four rates of urea (100, 200, 300 and 400 kg/ha).

Seeds were planted on 22 October 2014 in 36 plots, each with 4-planted rows. The distance between adjacent rows was 0.75 m, between adjacent seeds on each row 0.16 m, between adjacent plots 1.5 m and between replications 2 m. The rate of nitrogen application was recommended based on soil nitrogen content, the estimated fresh forage yield (40 t/ha) and the nitrogen removed from the soil (200 kg/ha). Moreover, potassium sulfate was applied at 150 kg/ha before planting. For each treatment, half of the nitrogen fertilizer was applied at planting time and the rest by top dressing at the 8-10 leaf stage. Sprinkle irrigation was carried out five times during the growing season at 10-14 intervals depending on weather conditions, and timely weed and pest control operations were performed. At full maturity, 10 plants were selected in each plot to measure the various traits. Moreover, in measuring forage yield, the two border rows in each plot were omitted and the two middle rows were harvested for final evaluation. The evaluated traits were plant height, stem diameter, leaf weight, stem weight and cob weight. Plant parts were dried 72 hours in an oven at 70˚C. Analysis of variance (ANOVA) was performed using the method introduced by Steel and Torri (1980) employing MSTAT-C and the comparison of the means test was carried out using Duncan's Least Significant Range (LSR) Test at the 5% statistical significance level.

3. Results and discussion

Results of ANOVA are presented in Table 1. There were significant differences between the cultivars with respect to plant height and leaf, stem, cob and forage dry weights. The mutual effects of the two factors (cultivar and fertilizer application) were not significant, which shows that the studied cultivars exhibited similar patterns of response to the fertilizer and that the effect of each cultivar could be studied separately. The comparison of the means test using Duncan's method indicated plant height increased when higher rates of the fertilizer were applied. This result is compatible with those found by Persad and Singh (1990) and Gardner and Bax (1990).

Table 1
Results of ANOVA related to the evaluated traits.

	Sources of variation						
Mean of squares	**Replication**	**Cultivar**	**Error a**	**Urea application rate**	**Cultivar × urea application**	**Error b**	**Coefficient of variation**
Degree of freedom	2	2	4	3	6	18	
Plant height (cm)	452.625 ns	3065.030**	114.708	27.630 ns	222.337 ns	177.453	7.83
Stem diameter (cm)	0.014 ns	0.034 ns	0.200	0.153 ns	0.167 ns	0.119	20.2
Leaf fresh weight (t/ha)	2.160 ns	0.886 ns	1.197**	11.086**	7.341	1.441	19.07
Stem fresh weight (t/ha)	35.390 ns	81.137 *	10.473	37.212*	53.990**	13.446	21.32
Cob fresh weight (t/ha)	11.327 ns	93.628**	5.010	7.518 ns	5.655 ns	6.720	16.41
Leaf dry weight (t/ha)	0.096 ns	6.895*	1.005	0.841 ns	1.038 ns	1.856	20.77
Stem dry weight (t/hs)	1.241 ns	7.444**	0.280	0.666 ns	0.234 ns	0.720	18.70
Cob dry weight (t/ha)	0.706 ns	11.550*	1.862	4.131 ns	3.116*	1.575	16.17
Forage fresh weight (t/ha)	105.557 ns	355.532*	31.175	127.335*	73.283 ns	29.496	14.96
Forage dry weight (t/ha)	2.860 ns	70.901**	2.587	1.379 ns	7.868 ns	5.188	17.54

The symbols *, ** and ns stand for significant at the 5% level, significant at the 1% level and not significant, respectively.

Table 2
Comparison of the means of the studied traits using Duncan's method.

	Factors						
	Cultivar			Rate of urea application (kg/ha)			
Mean of squares	**SC647**	**SC704**	**SC400**	**100**	**200**	**300**	**400**
Plant height (cm)	182.9 a	175.3 a	152.2 b	168.70 b	168.7 b	171.1 a	172.2 a
Stem diameter (cm)	1.57 a	1.49 a	1.59 a	1.46 a	1.74 a	1.45 a	1.52 a
Leaf fresh weight (t/ha)	6.289 a	6.569 a	6.026 a	5.514 b	7.941 a	5.842 b	5.881 b
Stem fresh weight (t/ha)	14.78 ab	16.92 a	11.75 b	11.80 b	16.22 a	14.02 ab	15.89 a
Cob fresh weight (t/ha)	16.21 a	18.35 a	12.82 b	14.82 b	16.81 a	15.80 ab	15.85 ab
Leaf dry weight (t/ha)	2.13 ab	2.845 a	1.330 b	1.872 a	2.540 a	1.913 a	2.089 a
Stem dry weight (t/ha)	2.858 b	3.500 a	1.933 c	2.536 a	3.111 a	2.559 a	2.850 a
Cob dry weight (t/ha)	5.688 b	7.354 a	5.623 b	5.036 b	7.25 a	6.15 ab	6.45 ab
Forage fresh weight (t/ha)	37.28 ab	41.84 a	30.59 b	32.10 b	40.95 a	35.65 ab	36.60 ab
Forage dry weight (t/ha)	10.68 b	13.70 a	8.89 b	9.44 b	12.90 a	10.62 b	11.39 a

Means in each column with at least one letter in common are not significantly different at the 5% level of probability in Duncan's method.

Table 3
Regression coefficients between the evaluated traits.

	Cob height	Plant height	Stem diameter	Total fresh weight	Cob fresh weight	Stem fresh weight	Leaf fresh weight	Cob length	Cob diameter	No. of seed rows	No. of seeds/ row	Plant dry weight	Cob dry weight	Stem dry weight
Plant height	0.86**													
Stem diameter	-0.18 ns	-0.17ns												
Total fresh weight	0.14 ns	0.19 ns	0.29 ns											
Cob fresh weight	0.23 ns	0.35*	-0.12 ns	0.76**										
Stem fresh weight	0.09 ns	0.08 ns	0.41*	0.87**	0.44**									
Leaf fresh weight	-0.01ns	-0.03ns	0.36*	0.76**	0.41*	0.64**								
Cob diameter	0.24 ns	0.37*	-0.10 ns	0.49**	0.70**	0.23 ns	0.24 ns							
No. of rows of grains	0.26 ns	0.37*	0.01 ns	0.37*	0.45**	0.24 ns	0.12 ns	0.62**						
No. of grains/row	0.13 ns	0.13 ns	-0.14 ns	0.24 ns	0.27 ns	0.23 ns	0.08 ns	0.40*	0.45**					
Plant dry weight	0.12 ns	0.26 ns	0.13 ns	0.64**	0.73**	0.40*	0.40*	0.76**	0.35*	0.21 ns				
Cob dry weight	0.26 ns	0.41*	-0.07 ns	0.64**	0.83**	0.39*	0.30 ns	0.64**	0.56**	0.25 ns	0.50**			
Cob dry weight	0.02 ns	0.14 ns	-0.03 ns	0.59**	0.73**	0.40*	0.31 ns	0.55**	0.60**	0.30 ns	0.50**	0.83**		
Stem dry weight	0.53**	0.51**	0.05 ns	0.57**	0.69**	0.38*	0.31 ns	0.70**	0.45**	0.34*	0.55**	0.67**	0.42*	
Leaf dry weight	0.16 ns	0.37*	-0.17 ns	0.28 ns	0.44**	0.09 ns	0.07 ns	0.22 ns	0.17 ns	-0.05ns	0.10 ns	0.70**	0.32 ns	0.22 ns

*and ** Respectively indicates the existence of a statistical significant correlation in level 1% and 5% +and_: positive and negative correlation coefficient.

Moreover, Fallah and Tadayyon (2009) stated that nitrogen application had significant effects on leaf and stem fresh weights and results obtained in this experiment confirm their claim. Cultivars and urea rates of application had identical effects on stem diameter, which contradicts reports by Shapiro and Wortmann (2006).

Results of the comparison of the means test using Duncan's method in Table 2 show that the cultivar SC704 enjoyed the maximum values for all the studied traits and had the largest fresh and dry forage yields (41800 and 13700 kg/ha, respectively). These results confirm the findings of Genter and Camper (1973) and Tohidinezhad et al. (2008). Cultivar SC677 ranked second in forage production. Comparison of the various rates of urea application showed that the maximum yields of fresh and dry forage (40900 and 12900 kg/ha) were obtained at the rate of 200 kg/ha.

Raising the rate of urea application increased plant height by 3.5 cm, but this increase did not have positive effects on yield. For a more accurate examination, the regression coefficients between the evaluated traits were determined (Table 3), which indicated leaf and stem weights and cob weight, length and diameter, played the greatest role in determining yield. This conclusion conforms to reports by Chockan (1997), Khalilimahalleh et al. (2004) and Girardian et al. (1987). Moreover, higher rates of urea application (300 and 400 kg/ha) did not increase fresh and dry forage yields.

The cultivar SC704 at urea application rates of 200, 300 and 400 kg/ha produced the same maximum forage yield. Therefore, considering economic and environmental issues, we recommend this cultivar be used at urea application rate of 200 kg/ha.

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How to cite this article: Mohseni, M., Haddadi, M.H., Yousefnezhad, M., 2018. Effects of nitrogen fertilizer and corn cultivars on corn silage yield. Agricultural Advances, 7(3), 469-473.