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## Yield and Quality of Forage Corn (*Zea mays* L.) as Influenced by Cultivar and Nitrogen Rate

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**Abstract:** The objective of this study was to evaluate the effects of different nitrogen doses on agronomics traits of four corn cultivars (P-3335, P-3394, Arifiye and Frassino). The study was conducted in 1999 and 2000 years at the field of Van Agricultural High School. The experiment was a split plot with three replications. Main plots were assigned to nitrogen levels (0, 80, 160 and 240 kg ha<sup>-1</sup>) and sub-plots were assigned to corn cultivars. In the study, considerable differences were found among both nitrogen levels and corn cultivars. In general, green herbage yield, dry matter yield, crude protein rate, crude protein yield, leaf ratio, ear ratio, ear number per plant, plant height and plant weight increased, but stem ratio decreased with increasing nitrogen level. However, there was no significant difference between 160 and 240 kg ha<sup>-1</sup> nitrogen applications when green herbage yields and traits that affect silage quality are considered. Therefore, optimum rate of nitrogen was 160 kg ha<sup>-1</sup>. Also, Frassino was determined the best cultivars for silage production in Van region because of its high green herbage, dry matter and ear production.

**Key words:** Corn, fertilization, nitrogen, cultivars, yield

### INTRODUCTION

Corn is a plant, which is commonly cultivated in broad area for corn seed production. Corn ranks third, following wheat and rice, in the world production of cereal crops and it is the most important nutriment for human in middle and sought American, Africa and China. It is mostly cultivated in broad area for silage production, in last thirty years. Corn is the most important silage plants in the world because it is the most proper plant for ensiling, it produces abundant amount of green herbage, its silage has high nutriment value and palatable<sup>[1]</sup>.

In Turkey, the annual area devoted to corn is 550.000 ha, which is about 4% of cereal cultivated area and grain production averaged 2 million ton per year. Importance of corn production is increasing year to year because of its importance for silage production as well as grain production. Corn grain production of Turkey is portioned as follow, about 35% used for human nutrient requirement, about 65% used for animal feed<sup>[2]</sup>.

Ranges and pastures of eastern Anatolia are worn-out and they can not produce enough feed for animals. Also, cultivated forages such as alfalfa, sainfoin and vetches insufficient to feed animals. Animal in the region is mostly feed with cereals straw. Therefore, corn cultivation in the region should be developed and spread out and used as silage.

In the study, four doses of nitrogen (0, 80, 160 and 240 kg ha<sup>-1</sup>) were applied to four corn cultivars (P-3394,

P-3335, Arifiye and Frassino). Effects of nitrogen doses on plant height, green herbage and dry matter yield, leaf, stem, ear and crude protein ratio were examined. The purpose of the research was to obtain adequate nitrogen doses for silage corn and to determine the best cultivars in the region.

### MATERIALS AND METHODS

This study was conducted at the field of Van Agricultural High School in 1999 and 2000 years. In 1999-2000 years from May to September, average temperature was pretty similar in both years (19.8 and 20.0°C), total precipitation was 68.6 and 29.1 mm, average% humidity was 55.4 and 47.1% (Table 1).

Soil of research area was slightly alkali and had poor organic matter content. Lime content of soils was middle level and phosphorus levels were pretty low. Besides, potassium level of soil was enough, but salinity ratio of soils was determined as low.

In research, P-3394, P-3335, Arifiye and Frassino cultivars were used and four nitrogen levels (0, 80, 160 and 240 kg ha<sup>-1</sup>) were applied to above four corn cultivars. Experimental design was split plot with three replications and nitrogen levels were assigned to main plots and cultivars were assigned to sub-plots. Nitrogen doses were split up two parts, one half was applied during sowing and the other half was applied when plants become 30-40 cm in height. Besides, 80 kg ha<sup>-1</sup>

Table 1: Climatic values during growing period of silage corn

Months	Average temperature°C		Total precipitation (mm)		Average humidity (%)	
	1999	2000	1999	2000	1999	2000
May	14.9	14.3	41.8	23.9	57.2	53.2
June	20.0	19.4	7.4	3.3	59.3	48.1
July	22.8	25.4	---	0.2	56.3	41.3
August	23.8	22.9	2.2	---	47.8	42.3
September	17.5	17.9	17.2	1.7	56.3	50.5
Average	19.8	20.0	68.6	29.1	55.4	47.1

(Source: Van Meteorology Region Records, 1999-2000)

phosphorous was applied to each parcel. Five rows were established in each parcel with 70 cm row spacing. Planting density was 160.000 seed for per hectare. Plants were harvested during dough stage of kernel. The SPSS<sup>[3]</sup> for Windows program was used for the statistical analysis. Treatment means were separated with Duncan test at  $p < 0.05$ .

## RESULTS AND DISCUSSION

**Green herbage and dry matter yield:** Green herbage yield significantly changed depending on cultivars and nitrogen doses. Arifiye and Frassino cultivars produced greatest amount of green herbage yield (62154 and 64611 kg ha<sup>-1</sup>) and P-3335 followed them. P-3394 cultivars had the lowest green herbage yield. 160 and 240 kg ha<sup>-1</sup> nitrogen doses had greatest amount of green herbage yield in 1999 and 2000 years and there was no significant difference between these nitrogen doses. Control parcels had the lowest green herbage yield. The previous studies demonstrated that the lowest green herbage yields are obtained from the unfertilized plots and nitrogen applications increases yield<sup>[4-6]</sup>.

Frassino cultivars had the greatest dry matter yield (17257 kg ha<sup>-1</sup>) and P-3335 and P-3394 cultivars followed it. Arifiye cultivars had the lowest DM yield. DM yield increased with increasing nitrogen doses. Nitrogen dose (240 kg ha<sup>-1</sup>) had the greatest DM yield and 160 and 80 kg ha<sup>-1</sup> nitrogen doses followed, respectively. Control parcels had the lowest DM yield (Table 2). There are many other studies indicating that green herbage and DM yield of silage corn increases with increasing nitrogen doses<sup>[7-12]</sup>.

**Ratio and yield of crude protein:** P-3394 cultivars had the greatest crude protein rate (6.0%) and Arifiye and P-3335 cultivars followed, respectively. Frassino cultivars had the lowest crude protein rate. Crude protein rates increased with increasing nitrogen rate. Nitrogen rate (240 kg ha<sup>-1</sup>) had the greatest crude protein rate and 160, 80 and 0 kg ha<sup>-1</sup> nitrogen rates followed, respectively.

P-3394 and P-3335 cultivars had higher crude protein yield compared to Arifiye and Frassino cultivars. Besides,

Table 2: Effects of the nitrogen rates on the green herbage and dry matter yield of corn cultivars

Cultivars	Green herbage yield (kg ha <sup>-1</sup> )			Dry matter yield (kg ha <sup>-1</sup> )		
	1999	2000	Average	1999	2000	Average
P-3335	56934b	59434b	58184b	15594ab	16276ab	15935b
P-3394	51613c	53313c	52463c	15494ab	16002ab	15748b
Arifiye	60804ab	63504a	62154a	14148b	14777b	14463c
Frassino	62649a	66574a	64611a	16733a	17781a	17257a
N (kg ha <sup>-1</sup> )						
0	46524c	48999c	47761d	11756d	12379d	12067d
80	55417b	58017b	56717c	14047c	14699c	14373c
160	64018a	66743a	65380a	17334b	18066b	17699b
240	66042a	69067a	67554a	18832a	19692a	19262a
Average	57999	60406		15492	16209	

\*Means with a column followed by a different letter(s) are significantly different at  $p < 0.05$  probability level

crude protein yield increased with increasing nitrogen doses. 240 kg ha<sup>-1</sup> nitrogen dose had the greatest crude protein yield and 160, 80 and 0 kg ha<sup>-1</sup> doses followed, respectively (Table 3). Ippersiel *et al.*<sup>[13]</sup> reported that crude protein yield of forage corn increased with nitrogen fertilization.

**Leaf and stem ratio:** Leaf rate of P-3335 and P-3394 cultivars were found higher than Arifiye and Frassino cultivars. Nitrogen doses (240 kg ha<sup>-1</sup>) had the greatest leaf ratio, but there was no significant difference among 0, 80 and 160 kg ha<sup>-1</sup> doses. A researcher reported that 180 kg ha<sup>-1</sup> nitrogen dose did not affect leaf rate of corn, similarly to our results<sup>[7]</sup>.

Arifiye cultivars had the greatest stem ratio and Frassino cultivars followed it. P-3335 and P-3394 cultivars had the lowest stem ratio. Stem ratio values decreased with increasing nitrogen doses. Control parcels had the highest stem ratio and 240 kg ha<sup>-1</sup> nitrogen dose had the lowest stem ratio (Table 4). A researcher reported that digestibility of leaves is higher than stem; therefore, higher leaf ratio is desired in silages<sup>[14]</sup>.

**Ear ratio and ear number per plant:** P-3335, P-3394 and Frassino cultivars had similar ear ratio, but Arifiye cultivars produced the lowest ear ratio. Besides ear ratio increased with increasing nitrogen dose, but there was no significant difference among 80, 160 and 240 kg ha<sup>-1</sup> nitrogen doses.

Ear number per plant of cultivars was found between 1.12 and 1.26 and there was no significant difference among cultivars. Also, nitrogen application increased ear number for per plant. Nitrogen application (160 and 240 kg ha<sup>-1</sup>) caused to highest ear number for per plant and there was no significant difference between them (Table 5).

**Plant height and plant weight:** Arifiye cultivars had the highest plant height (261.9 cm) and P-3394 cultivars had

**Table 3: Effects of the nitrogen rates on crude protein ratio and yield in corn cultivars**

Cultivars	Crude protein rate (%)			Crude protein yield (kg ha <sup>-1</sup> )		
	1999	2000	Average	1999	2000	Average
	P-3335	5.4c	5.4a	5.4b	862ab	913
P-3394	6.1a	5.9a	6.0a	956a	954	955a
Arifiye	5.7b	5.6a	5.6b	827b	841	833b
Frassino	4.8d	4.9b	4.9c	816b	864	840b
N (kg ha <sup>-1</sup> )						
0	4.5d	4.7c	4.6d	523d	578d	551d
80	5.2c	5.2b	5.2c	725c	770c	748c
160	5.9b	5.8a	5.8b	1003b	1020b	1012b
240	6.4a	6.1a	6.3a	1209a	1204a	1206a
Average	5.5	5.4		865	893	

\*Means with a column followed by a different letter(s) are significantly different at p<0.05 probability level

**Table 4: Effects of the nitrogen rates on leaf and stem ratio of corn cultivars**

Cultivars	Leaf ratio (%)			Stem ratio (%)		
	1999	2000	Average	1999	2000	Average
	P-3335	25.2a	25.7a	25.5a	34.7b	34.0c
P-3394	25.0a	25.5ab	25.3a	34.9b	34.0c	34.4c
Arifiye	24.8a	24.3c	24.6b	44.7a	44.9a	44.8a
Frassino	23.8b	24.8bc	24.3b	37.0b	37.0b	37.0b
N (kg ha <sup>-1</sup> )						
0	24.4b	24.4b	24.4b	40.2	41.1a	40.7a
80	24.6b	24.6b	24.6b	37.9	38.4ab	38.1ab
160	24.2b	24.9b	24.6b	36.9	35.9bc	36.4bc
240	25.6a	26.4a	26.0a	36.3	34.3c	35.3c
Average	24.7 b	25.1a		37.8	37.4	

\*Means with a column followed by a different letter(s) are significantly different at p<0.05 probability level

**Table 5: Effects of the nitrogen rates on ear ratio and ear number per plant of corn cultivars**

Cultivars	Ear ratio (%)			Ear number per plant		
	1999	2000	Average	1999	2000	Average
	P-3335	40.1a	40.3a	40.2a	1.29	1.20
P-3394	40.1a	40.7a	40.4a	1.28	1.16	1.22
Arifiye	30.4b	30.8b	30.6b	1.13	1.12	1.12
Frassino	39.3a	38.2a	38.7a	1.31	1.22	1.26
N (kg ha <sup>-1</sup> )						
0	35.4	34.5b	34.9b	1.09b	1.03c	1.06b
80	37.5	37.0ab	37.2ab	1.23ab	1.13bc	1.18b
160	38.9	39.2a	39.1a	1.34a	1.28a	1.31a
240	38.1	39.3a	38.7a	1.36a	1.25ab	1.30a
Average	37.4	37.5		1.25	1.17	

\*Means with a column followed by a different letter(s) are significantly different at p<0.05 probability level

the lowest plant height (223.8 cm). Plant height values increased depending on increasing nitrogen doses. Nitrogen doses (160 and 240 kg ha<sup>-1</sup>) had greatest plant height and 80 kg ha<sup>-1</sup> dose followed them. Control parcels (no nitrogen) had the lowest plant height values. There are plenty of studies that indicate increasing plant height with increasing nitrogen doses<sup>[7,15-17]</sup>.

Arifiye cultivars had the highest plant weight (785.3 g) and P-3394 cultivars had the lowest plant weight (578.9 g). Plant weight values increased with increasing

**Table 6: Effects of the nitrogen rates on plant height and plant weight of corn cultivars**

Cultivars	Plant height (cm)			Plant weight (g)		
	1999	2000	Average	1999	2000	Average
	P-3335	236.5b	243.0b	239.7b	644.9b	670.3ab
P-3394	226.6c	231.9c	223.8c	568.7b	589.1b	578.9c
Arifiye	261.9a	261.9a	261.9a	826.3a	744.4a	785.3a
Frassino	238.4b	245.6b	241.9b	664.2b	691.3ab	677.7b
N (kg ha <sup>-1</sup> )						
0	224.7c	227.7c	226.2c	488.8c	543.9c	516.3c
80	238.3b	242.0b	240.1b	623.8bc	601.6bc	612.7c
160	249.8ab	255.0a	252.4a	740.4ab	721.6ab	731.0b
240	250.6a	256.9a	253.8a	851.1a	828.0a	839.5a
Average	240.8	245.4		676.0	673.7	

\*Means with a column followed by a different letter(s) are significantly different at p<0.05 probability level

nitrogen application. Nitrogen application (240 kg ha<sup>-1</sup>) produced the highest plant weight while non-fertilized plant having the lowest plant weight (Table 6).

### CONCLUSION

As a result, Frassino was determined the best cultivars for silage production in Van region because of its high green herbage, dry matter and ear production. However, if there is lack of protein for feeding animals, P-3335 and P-3394 cultivars can also be considered for silage production. Because, those cultivars produced high protein yield, leaf and ear ratio which are directly affects silage quality positively. Besides, all of measured component of cultivars were highest with 240 kg ha<sup>-1</sup> nitrogen application, expect stem ratio. However, there was no significant difference between 160 and 240 kg ha<sup>-1</sup> nitrogen application for plant height, green herbage and ear ratio. Therefore, 160 kg ha<sup>-1</sup> nitrogen application will be enough when costs of fertilization are considered.

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