Turkish Journal of Range and Forage Science, 2022, 3(2): 36-40
doi: 10.51801/turkjrfs.1092563

Research

Turkish Journal of Range and Forage Science

https://dergipark.org.tr/tr/pub/turkjrfs

Silage Quality of Corn Grown at Different Weed Densities

Onur İLERİ[1] **Emre KARA**[2] **Şule ERKOVAN**[1] **Mustafa SÜRMEN**[2]
Halil İbrahim ERKOVAN[1*] **Ali KOÇ**[1]

[1]Eskişehir Osmangazi University, Faculty of Agriculture, Department of Field Crops, Eskişehir, Türkiye

[2]Aydın Adnan Menderes University, Faculty of Agriculture, Department of Field Crops, Aydın, Türkiye

A R T I C L E I N F O

Received *24/03/2022*
Accepted *25/07/2022*

Keywords:

Corn silage
Fleig score
Silage quality
Weed density

A B S T R A C T

Quality of silage corn is assessed over dry matter ratio, dry matter intake, crude protein, energy, and mineral contents. In this study, the effects of different weed densities on the silage quality of corn were investigated in the 2019 and 2020 years. Silage pH, Fleig score, dry matter ratio, crude protein, NDF, and ADF contents were assumed as silage quality parameters. The experiment was established in randomized block design. Silage pH, Fleig score, dry matter ratio did not present significant variations between the years but crude protein, NDF, and ADF contents significantly varied. Weed density significantly affected NDF content only. Although weed density did not have a significant effect on the silage quality of corn, cultivation should be carried out weed-free for high yielding.

1. Introduction

Silage corn is an important roughage source and cultivated for its high energy, fiber, crude protein, and mineral content. Silage feeding could reduce feeding costs and increase nutritive value without affecting the performance and physiology of the animals. But silage quality is affected by many factors as plant density, maturity, moisture, silage conditions, etc. (Satter and Reisi, 2012). Besides the genetic factors, the growing environment and some physical characteristics as to leaf, stem, and cob ratios also could have significant effects on the nutritive value of the silage (Khan et al., 2012; Ileri et al., 2018). Some physical factors as particle size and cob ratio could affect the aerobic stability of the silage, and thereby the nutritive value because particle size could raise silage pH by increasing the consumption of soluble carbohydrates (Silva et al., 2015). High-quality silage could not be expected from the plants, which exposed a strong competition for nutrition, light, and water in earlier development stages, because silage corn could not reach silage maturity under these conditions.

Weeds strongly compete with silage corn for nutrition, light, and water, especially in the early stages of the corn. This competition causes a significant decrease in the silage yield of corn. Besides, cobs, which are significant carbohydrate sources, could not develop, and consequently carbohydrate content of silage material decreases. Under low carbohydrate conditions, silage fermentation is delayed and quality is decreased. Heuze et al (2017) also indicated that any decrement in dry matter ratio might increase silage quality proportionally, but decrease totaly. For example, crude protein and digestibility ratios decrease when the dry matter ratio increase (Heuze et al., 2017). Weed competition decreases silage yield, dry matter ratio, and cob ratio of the corn, and thereby decreases the nutritive value of the silage. In addition to poor nutritive value, the

*Correspondence author: erkovan@ogu.edu.tr

fermentation period is prolonged and silage might be spoiled. Inoculants could be useful to avoid the spoilage of silage but they increase the costs. Yield loss, a decrease in silage quality, and additional costs due to weed competition might reach intolerable levels for growers. Shresta et al (2019) recorded a yield loss between 20-80% due to weed competition. Low yield, carbohydrate, nutritive value, and losses during ensilage limit silage production.

In this study, silage corn grown under different weed densities were ensilaged separately and silage pH, Fleig score, dry matter ratio, crude protein, NDF, and ADF contents were investigated. It was aimed to determine the effect of weed density on the silage quality of corn.

2. Materials and Methods

The research was carried out in the experimental station of Eskişehir Osmangazi University, Faculty of Agriculture during the main crop season of 2019 and 2020 years. Simpatico was used as the corn cultivar and ensilaged after growing in different weed densities as 0, 2, 4, 6, 8, 10, 12, 14 weeds m^{-2}. Weed numbers for per meter square were controlled by hand remowing. Weed species were identified as *Chenopodium album*, *Amaranthus blitoides*, *Amaranthus hybridus*, *Solanum nigrum*, and *Xanthium strumarium* in the plots. In every plot, 70 kg ha^{-1} N and 180 kg ha^{-1} P_2O_5 were applied while sowing. Additional fertilization was carried out using 70 kg ha^{-1} N both during the 4-6 leaf stages and 6-8 stages. Plants were irrigated once a week for 15 hours using drip irrigation that has a 1.9 l h^{-1} flow rate. Harvest was carried out when corns reached to dough stage in weed-free plots for both years. Harvested plants were mechanically processed and ensilaged. All samples were subjected to the same mechanical process to interrupt the effect of particle size and any inoculant was not used. After filling, silage bags were vacuumed and strapped to avoid air intake of the bags. The experiment was conducted due to a randomized complete blocks design with 6 replications.

Silage bags were opened and investigated after 8 weeks of the fermentation period. Silage pH was determined using a digital pH meter from the extracts of 25 g of samples, which were kept in 250 ml of distilled water for 30 minutes and filtered. Another 500 g samples from each bag were oven-dried at 70 ºC until reached constant weight and the dry matter ratio was calculated by dividing dry and fresh samples. Fleig score was calculated using the formula suggested by Kilic (1986), which was given below;

$$\text{Fleig Score} = 220 + (2 \times \% \text{ DM} - 15) - 40 \times \text{pH}$$

Dry samples were grounded to pass through a 2 mm sieve and CP, NDF, ADF contents were determined using FT-NIR (Fourier Transform Near-Infrared, Bruker MPA) spectroscopy. To validate the results of FT-NIR spectroscopy, randomly selected 20 samples were analyzed using the Dumas method for CP content, and using Ankom Fiber Analyzer for NDF and ADF contents. Dumas and Ankom Fiber Analyzer results had a significant correlation ($r \geq 0.9$, $P \leq 0.01$) with FT-NIR results. Therefore, FT-NIR results were used in the statistical analyses.

All data were subjected to analysis of variance using SAS statistical software (SAS Institute, 2011). Means were compared using Bonferroni/Dunn multiple comparison test.

3. Results and Discussion

Silage pH of corns, which were grown at different weed densities, did not vary significantly between years and among weed densities but year × weed density interaction was significant ($p<0.001$) (Table 1). The mean silage pH was 4.32 and it was measured as 4.32 in 2019, and 4.33 in 2020 (Table 1). Silage pH of weed densities varied between 4.15-4.66 (Table 1). In 2019, pH was similar among weed densities but it was significantly higher in the second year at 14 weeds m^{-2} density (Figure 1). This difference caused a significant year × weed density interaction.

The mean Fleig score was 92.6 and the variation between years and among weed densities, and year × weed density interaction was not statically significant (Table 1). Fleig score was 93.44 in the first year and 91.94 in the second year of the study (Table 1). Even the variation among the weed densities was statically not significant, it was numerically higher in weed-free plots (Table 1).

The dry matter ratio was 30.51% in 2019 and 30.03% in 2020 and this variation between the years was not statically significant (Table 1). The dry matter ratio changed between 34.4 – 26.31% depend on weed density and it was numerically higher in weed-free plots but the effect of weed densities on the dry matter ratio was not statistically significant (Table 1).

Crude protein content significantly varied (p<0.001) between years but weed densities and year × weed density interaction were not statically significant (Table 1). Crude protein content was 7.25% in 2019 but it significantly increased to 10.23% in 2020 (Table 1). A slight increment was observed in crude protein content as the weed densities increased but this variation was not significant (Table 1).

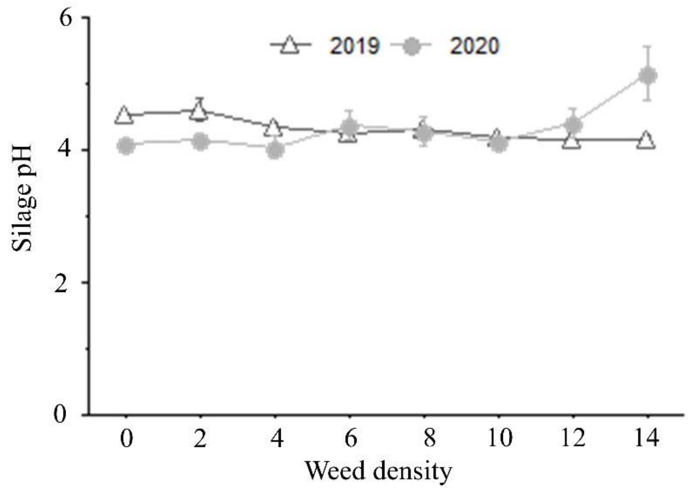

Figure 1. Silage pH at different weed densities and years

Table 1. Means and ANOVA results of the examined silage characteristics

	pH	Fleig Score	Dry Matter (%)	Crude Protein (%)	NDF (%)	ADF(%)
Year (Y)						
2019	4.32	93.44	30.51	7.25 B	31.85 A	17.36 A
2020	4.33	91.94	30.03	10.23 A	27.59 B	15.39 B
Weed Density (W)						
0	4.32	101.21	34.44	8.54	30.71 b	17.08
2	4.37	94.12	31.99	8.47	30.02 b	16.88
4	4.19	94.77	28.62	8.71	29.81 b	15.22
6	4.31	100.60	34.00	8.71	25.42 d	16.31
8	4.30	91.06	29.06	8.45	28.99 b	14.99
10	4.15	91.68	26.31	8.66	28.27 c	16.57
12	4.28	93.67	29.87	9.06	32.71 a	17.35
14	4.66	74.40	27.87	9.29	31.81 a	16.60
Average	4.32	92.69	30.27	8.74	29.72	16.38
Y	ns	ns	ns	**	**	**
W	ns	ns	ns	ns	*	ns
YxW	**	ns	ns	ns	ns	ns

ns: non significant, *: P≤0,05, **: P≤0,01

NDF content, which is an indicator of dry matter intake, significantly varied between years (p<0.001) and among the weed densities (p<0.05) but year × weed density interaction was not statically significant (Table 1). It was determined as 31.85 % in the first year and in decreased to 27.59 % in the second year (Table 1). NDF content decreased as the weed density increased up to 6 weeds m^{-2} but then, an unstable increase was recorded (Table 1).

Mean ADF content was 16.38% and it varied significantly (p<0.001) between the years (Table 1). In the first year, ADF content was 17.36 % and it decreased to 15.39 % in the second year. Variation among the weed densities and year × weed density interaction was not statically significant. (Table 1).

Silage pH is important for avoiding silage spoilage and thereby, it has significant effects on silage quality. Silage pH ranged between 4.15-4.66 in our study and it did not significantly change between years and among weed densities. Other researchers also recorded similar pH values for the silage corn that have 25-35% dry matter ratio (Carvalho et al., 2006; Geren, 2001; Abdelqader et al., 2009; Azevedo et al., 2011; Silva et al., 2015; Heuze et al., 2017). Cob ratio of the corns decreased evidently as the weed density increased (unpresented data) and the higher pH values were expected based on the decreased carbohydrate content of the silage material due to decreased cob ratios. This pH increment was recorded only in the second year of the study, which might be the reason for the significant year × weed density interaction.

Fleig score is a quality parameter for silage and calculated using silage pH and dry matter content. In the study, the Fleig score of the silage did not present a significant variation between years and among weed densities but Fleig score for 14 weeds m^{-2} density was in good class while the others were in very good class (McDonald et al., 1991).

A higher dry matter ratio is expected for the silage, which is prepared using the silage material grown in weed-free conditions considering other weed densities. In the study, the dry matter ratio did not cause a significant variation on the dry matter content of the silage but a numerical increment was recorded as the weed density decreased. Other researchers also determined similar results (Nedunzhiyan et al., 1997; Özer ve ark., 2001; Vazin, 2012; Tursun ve ark., 2016).

Silage crude protein content was significantly affected by yearly variations and it was higher in the second year. This is possibly due to the higher leaf ratio of the silage material in the second year (unpresented data) because researchers stated that leaf ratio has a significant impact on the crude protein ratio of the silage (Turgut et al., 2005; Ileri et al., 2018; İleri et al., 2020). Weed density did not have a significant effect on the crude protein content of the silage. Other research findings showed that crude protein content of the silage corn, which contains 25-30 % dry matter, could range between 4.9 – 9.8 % (Carvalho et al., 2006; Geren, 2001; Abdelqader et al., 2009; Azevedo et al., 2011; Silva et al., 2015; Heuze et al., 2017) and out findings of crude protein content (8.45 – 9.29 %) were consistent with the literature.

NDF and ADF contents of the silage showed a significant variation between years. Yearly variations are very common for agricultural production due to climatic differences, especially in recent years. This variation in NDF and ADF contents of the silage is possibly affected by the NDF and ADF contents of the silage material grown at field conditions in 2019 and 2020. Other researchers revealed the significant relations between silage and silage material in terms of NDF and ADF contents (Turgut et al., 2005; Ileri et al., 2018; İleri et al., 2020). Our findings of NDF and ADF contents were lower than other results (Carvalho et al., 2006; Geren, 2001; Abdelqader et al., 2009; Azevedo et al., 2011; Silva et al., 2015; Heuze et al., 2017).

4. Conclusion

Plant materials and their growth conditions significantly affect the physical and quality characteristics of corn silage. In this study, silage pH, Fleig score, and dry matter ratio are not affected from years but crude protein content was higher in the second year, while NDF and ADF contents were lower. Weed density had a significant effect only on silage NDF content. Although weed density did not significantly affect the silage characteristics in this study, it is important for high silage yield.

In conclusion, the result of present study showed that silage quality is also affected negatively by weed invasion. Hence, weed control practices positively contribute to silage quality as is in yield.

Conflict of Interest

There is no conflict of interest among the authors.

Credit authorship contribution statement

All authors equally contributed to the manuscript.

Acknowledgment

Thanks to the Eskisehir Osmangazi University, Faculty of Agriculture for the support.

References

Abdelqader, M.M., Hippen, A.R., Kalscheur, K.F., Schingoethe, D.J. and Garcia, A.D. 2009. Isolipidic additions of fat from corn germ, corn distillers grains, or corn oil in dairy cow diets. J. Dairy Sci. 92: 5523-5533.

Azevedo, J.A.G., Valadares Filho, S.C., Pina, D.S., Valadares, R.F.D., Detmann, E., Paulino, M.F., Diniz, L.L. and Fernandes, H.J. 2011. Intake, total digestibility, microbial protein production, and the nitrogen balance in ruminant diets based on agricultural and agro-industrial by-products. Arq. Bras. Med. Vet. Zootec. 63: (1), 114-123

Carvalho, L.P.F., Cabrita, A.R.J. Dewhurst, R.J. Vicente, T.E.J., Lopes, Z.M.C. and Fonseca. A.J.M. 2006. Evaluation of palm kernel meal and corn distillers grains in corn silage-based diets for lactating dairy cows. J. Dairy Sci. 89: (7), 2705-2715.

Geren, H. 2001. Effect of sowing dates on silage characteristics of different maize cultivars grown as second crop under Bornova conditions. J Agric F Ege University. 38: (2-3), 47-54.

Heuze, V., Tran, G., Edouard, N. and Lebas. F. 2017. Maize silage. Feedipedia, a programme by INRAE, CIRAD, AFZ and FAO, https://feedipedia.org/node/13883, (Accessed February, 2022).

Ileri, O., Budakli Carpici, E., Erbeyi, B., Avci, S. and Koc. A. 2018. Effect of sowing methods on silage yield and quality of some corn cultivars grown in second crop season under irrigated condition of central Anatolia, Turkey. Turkish Journal of Field Crops. 23: (1), 72-79.

İleri, O., Erkovan, S., Erkovan, H.İ. and Koç. A. 2020. Silage quality of second forage pea at different plant densities and cereal mixtures. Turkish Journal of Range and Forage Science. 1: (2), 35 – 45.

Khan, N.A., Tewoldebrhan, T.A. Zom, R.L.G. Cone, J.W. and Hendriks., W.H. 2012. Effect of corn silage harvest maturity and concentrate type on milk fatty acid composition of dairy cows. Journal of Dairy Science. 95: 1472-1483.

Kilic, A. 1986. Silo Feed. Bilgehan Publications.

McDonald, P., Henderson, A.R. and Heron., S.J.E. 1991. The Biochemistry of Silage, 2nd Edition, Chalcombe Publications, Printed in Great Britain by Cambrian Printers Ltd.

Nedunzhiyan, M., Varma, S.P. and Ray., R.C. 1997. Estimation of critical period of crop- weed competition in Sweet Potato (*Ipomoea batatas* L.). Advences in Horticultural Science. 12: (2), 101-104.

Özer, Z., Kadıoğlu, İ., Önen, H. and Tursun., N. 2001. Herboloji (Yabancı Ot Bilimi). Gaziosmanpaşa Üniv. Ziraat Fak. Yay. No: 20. Kitaplar Serisi, No: 10.

SAS Institute Inc. 2011. Base SAS 9.3 Procedures Guide, NC.

Satter, L.D. and Reis., R.B. 2012. Milk production under confinement conditions. US. Dairy Forage Research Center, USDA-ARS and Dairy Science Department. University of Wisconsin, Madison, Wisconsin, USA.

Shrestha, J., Timsina, K.P., Subedi, S., Pokhrel, D. and Chaudhary., A. 2019. Sustainable weed management in Maize (*Zea mays* L.) production: A review in perspective of Southern Asia. Turkish Journal of Weed Science. 22: (1), 133-143.

Silva, M.S.J., Jobim, C.C., Poppi, E.C., Tres, T.T. and Osmari., M.P. 2015. Production technology and quality of corn silage for feeding dairy cattle in Southern Brazil. Revista Brasileira de Zootecnia. 44: (9), 303-313.

Turgut, I., Duman, A., Bilgili, U. and Acikgoz., E. 2005. Alternate row spacing and plant density effects on forage and dry matter yield of corn hybrids (*Zea mays* L.). Journal of Agronomy and Crop Science. 191: (2), 146-151.

Tursun, N., Sakınmaz, M.S. and Kantarcı., Z. 2016. Corn varieties influenced the critical period for weed control in corn. Tarla Bitkileri Merkez Araştırma Enstitüsü Dergisi. 25: (Özel sayı-1), 58-63 (In Turkish with an abstract in English).

Vazin, F. 2012. The effect of Pigweed Redroot (*Amaranthus retoflexus*) weed competition and its economic thresholds in corn (*Zea mays* L.). Planta Daninha, Viçosa MG. 30: (3), 477-485.