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Qualitative study of corn silage of cattle farms in subtropical conditions of Indo-Gangetic plains

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Abstract

A field investigation programme was carried out under front line demonstrations of silage making in border area of Tarn Taran district of Punjab, India. A total of 21 dairy farmers were selected from three blocks in the district and they were guided about the management of agronomic practices for raising quality corn fodder and ensiling with preparation of silages considered as S_1 to S_{21}. The data was recorded with respect to maize hybrid grown, stage of harvesting (days after sowing), days taken to fill the silo pit and days of ensiling. After the opening of silo pit, representative samples of silage were collected from all dairy farms and quality analysis of these were carried out for attributes such as pH, dry matter, crude protein, NDF, ADF, ADL and ammonia-N. The study showed that corn harvested by using single row maize harvester at milk stage, packed in silo pit within two days and ensiled for minimum 45 days resulted in values of pH, dry matter, crude protein, NDF, ADF, ADL, ammonia-N as % of total N and buffering capacity, which were within the optimum range. Thus, it was concluded that in order to prepare quality silage, the crop should be harvested at milk stage *i.e.*, on an average at 72 days after sowing (DAS). The crop should also be harvested using single row maize harvester to ensure filling of silo pit within two days and fodder should be ensiled for minimum 45 days.

Keywords: Corn silage, Cultivars, Qualitative attributes, Subtropical conditions

Introduction

Continuous supply of quality fodder throughout the year is a key factor for successful dairy farming. In dairy farming, a regular supply of quality fodder is very essential for more production and economic returns (Brar *et al.,* 2016). Shortage of feed and fodder has been identified as one of the major constraints in achieving desired level of livestock productivity (Meena *et al.,* 2018). In most of the Asian countries nutritional requirements of ruminants are mainly met by feeding green fodder and dry forages including post harvest crop residues. Contribution of forage in animal feed is more than 75% and is considered a inexpensive source of nutrients (Sarwar *et al*., 2002). However, inadequate supply of quality fodder has been identified as one of the reasons for poor livestock productivity in India (Anjum *et al*., 2012; Kumar *et al*., 2016). Area under fodder cultivation is decreasing due to ever-increasing demand of cereal grains for human consumption, as well as preference to grow cash crops instead of fodders. Low fodder production leads to fluctuation in availability of fodder which affects the performance of dairy animals. Silage production has been seen to suffice all these factors which can help in sustenance of provision for round the year fodder to dairy sector. So when grains are in milk stage, surplus fodder if conserved as silage, will not only provide nutritionally uniform forage but also spare land for other crop cultivation (Mandal *et al*., 2003). Corn is a major forage source for ruminants around the world (Wei *et al*., 2018). Corn silage is preferred because of its relatively constant nutritive value, high yield and higher water soluble carbohydrates for fermentation to lactic acid (Darby and Lauer, 2002). So silage is an alternate which replace/ fulfil shortage of conventional fodder without any adverse effect on intake, digestibility, milk yield and its composition in dairy animals. Under sub-tropical condition, Brar *et al*. (2016) even recorded an increase in milk yield of Holstein Friesian crossbred dairy animals by 15.5% by feeding silage over green fodder.

Silage is preserved through anaerobic fermentation process in which epiphytic lactic acid bacteria (LBA) convert water-soluble carbohydrates (WSC) into organic acid, mainly lactic acid, which results in decrease in pH.

This inhibits the undesirable microorganisms thus prevent spoilage (Xie *et al.*, 2012). During the process of silage making, improper storage could result in development of detrimental bacteria's resulting reduced quality. So it is important to estimate its quality. There are number of factors which affect the quality of silage *i.e.*, crop used for silage making, variety of crop, stage of harvesting, method of storage and period of ensiling etc. It is very essential to harvest the crop at a proper stage to ensure good yield, quality and ensiling characters of fodder (Kumar *et al.*, 2019). Farmer's knowledge regarding stage of harvesting of crop for silage making is very important as it determines the moisture content of the crop. Dry matter content of silage is important as it indicates the adequacy of wilting. Forages ensiled below 30% DM will produce effluents which can result in a significant loss of nutrients. On the contrary, when forages are too dry, it is difficult to achieve anaerobic conditions and the silage will be more susceptible to heating and mould growth (Chaudhary *et al.*, 2016). Fibre content in forage is also very important. Increased fibre content of forage is associated with decreased digestibility and intake, and subsequently lower animal production. Digestibility of feeds declined with increase in ADF content (Kumar *et al.*, 2016; Chaudhary *et al.*, 2016). Increasing fibre content leads to a reduction in animal production, though ruminants require some dietary fibre for normal rumen function.

Silage pH is influenced by dry matter and sugar content of the fodder ensiled and type of silage fermentation (Kaiser and Piltz, 2004). The preferred lactic acid fermentation will produce silage with a low pH. All forages contain chemical compounds, called buffers which resist changes in pH. There is an increase in risk of poor fermentation when ensiling forages with a high buffering capacity (Piltz and Kaiser, 2004). Ammonia-N (% of total nitrogen) in silage is an important guide to fermentation quality of silage. High ammonia-N is seen in poorly preserved silages and indicates extensive degradation of the forage protein during ensiling process (Kaiser and Piltz, 2004).

As the quality of silage preserved through fermentation process is influenced by number of management factors. Therefore, the present study was carried out with the objectives to evaluate different factors affecting quality of silage prepared at dairy farms with sets of different management practices under subtropical condition of Indo-Gangetic plains in India.

Materials and Methods

Study site: The field investigation programme was carried out under front line demonstrations of silage making in border area of Tarn Taran district of Punjab, India under subtropical conditions. It lies between 31° 72' and 32° 32' North latitude and 74° 29' and 75° 23' in the East longitude. The soils of district Tarn Taran are loamy sand to loamy in texture with slightly to moderately alkaline reaction having low to medium organic carbon status, fairly good in available P and rich in available K. The micronutrients *viz.*, Zn, Fe and Mn varied from low to medium with optimum availability of available Cu (Kumar *et al.*, 2017).

Climatic characteristics: The climate of the district classified as tropical steppe, semi-arid and hot, which is mainly characterized by general dryness except for a short period during south-west monsoon season. During the summer months *i.e.*, from April to June, weather is very hot and dry. The weather becomes humid and cloudy during July to September. The average rainfall of the district is 482.9 mm. The south-west monsoon which contributes 74%, sets in last week of June and withdraws in middle of September. July and August are the rainiest months of the year.

Crop management*:* A total of 21 dairy farmers were selected from three blocks in the district. They were guided about the management of agronomic practices for raising quality corn fodder and ensiling with preparation of silages considered as S_1 to S_{21} (Table 1). The crop was sown during first week of March to first week of April excepting one farm where it was sown in last week of January. Three cultivars of maize were grown *i.e.*, six plots of P1844, eight plots of DOW2244 and seven of P31Y45. Seed rate was kept 20 kg ha^{-1}. Seed was treated with Gaucho (Imidacloprid) 600 FS @ 6 ml per kg seed before sowing. The crop was sown on the ridges 60 cm apart by dibbling seed manually keeping plant to plant distance at 20 cm. A dose of 250 kg of urea ha^{-1} and 125 kg DAP ha^{-1} was applied to the crop. Half dose of urea and whole DAP was applied at time of sowing and remaining half dose of urea was applied when crop was at knee height stage. For control of grassy weeds, 1500 gm Atrazine + 2.5 L Pendimethalin ha^{-1} was applied within 2 days after sowing and for control of *Cyprus rotundus* and broad leaf weeds*,* 1.0 L of 2,4-D (Amine salt) ha^{-1} was applied at 20-25 DAS. Crop was harvested either manually or by using single row maize harvester (SRMH), when the crop was at milk stage *i.e.*, on an average at 72

DAS. SRMH is a tractor driven machine designed to harvest maize and other tall fodders. The machine harvests a single row at a time. Upon cutting the maize, the machine chops it comprehensively and then throws it in to a trailer. This trailer can be hitched to the harvester itself for convenience, resulting in efficient configuration in which a single tractor can work both as a harvester and a transporter.

Table 1. Crop variety grown, harvesting (days after sowing), days to fill the pit and days of ensiling

Silage	Variety	Harvesting (DAS)	Method of harvesting	Days to fill the pit	Days of ensiling
S_1	P-1844	72	SRMH	2	45
S_2	P-1844	72	SRMH	2	45
S_3	Dow 2244	60	SRMH	2	37
S_4	Dow 2244	60	M	3	45
S_5	Dow 2244	60	M	3	41
S_6	Dow 2244	55	SRMH	2	45
S_7	Dow 2244	60	M	4	42
S_8	Dow 2244	60	M	3	40
S_9	Dow 2244	60	SRMH	2	35
S_{10}	Dow 2244	75	M	3	40
S_{11}	P-31Y45	85	SRMH	2	45
S_{12}	P-1844	60	SRMH	2	40
S_{13}	P-1844	60	M	4	50
S_{14}	P-3396	75	SRMH	1	35
S_{15}	P-1844	70	SRMH	5	45
S_{16}	P31Y45	94	SRMH	2	45
S_{17}	P31Y45	98	SRMH	2	55
S_{18}	P31Y45	82	SRMH	2	50
S_{19}	P31Y45	75	M	3	55
S_{20}	P31Y45	70	SRMH	2	50
S_{21}	P31Y45	109	SRMH	2	76
Mean		72		3	46

SRMH: Single row maize harvester; M: Manually

Silage preparation: The silage was prepared in silo pits/ bunkers having varying dimensions. At the bottom of pits/ bunkers, a 6 inch layer of wheat straw was spread and sides of pits/bunkers were covered by polythene sheet. The chopped fodder (2-3 inch in size) was put in the pits/ bunkers layer by layer and pressed properly with the help of tractor. After filling of pits/bunkers, it was covered by polythene sheet and mud in order to create anaerobic conditions. The data was recorded with respect to maize hybrid grown, stage of harvesting (days after sowing), days taken to fill the silo pit and days of ensiling (Table 1). After the opening of silo pit, representative samples of silage were collected from silo pits of all dairy farms and analysed in laboratory for quality analysis.

Chemical analysis: Quality analysis of silage samples were carried out for attributes such as pH, dry matter, crude protein, NDF, ADF, ADL, ammonia-N as % of total N and buffering capacity. The samples were dried in hot air oven at 80° C overnight for dry matter estimation. Dried samples were ground in Willey mill grinder using 2 mm sieve for determination of proximate principles (AOAC, 2000) and cell wall constituents (Robertson and Van Soest, 1981). For preparation of water extract, 25 g of silage sample was taken and 75 ml of water was added to it. Then whole content was blended and strained through muslin cloth. The extract was preserved for further analysis. The total nitrogen (%) and NH_3-N content in fodder was estimated following AOAC (2000). Crude protein (CP) content was worked out by formula CP = %N × 6.25 and expressed in percentage. The pH of the silage was measured using digital pH meter calibrated against standard buffer solution made from pH tablets (BDH).

For measuring buffering capacity (BC), 40 ml of the extract was taken below the probe of pH meter after calibrating it by standard methods. The pH was recorded and 0.1N acid was added to the content to bring down the pH up to 3. Then the content was titrated with 0.1N alkali to reach the pH up to 4, the reading was recorded (initial reading). The alkali was further added slowly drop wise to make the pH up to 6 and the volume of alkali used was recorded (final reading). That volume of alkali was used to calculate the BC in meq/g.

Statistical analysis: Data of chemical composition of silage was subjected to one-way analysis of variance. The means were then compared for significance by Tukey's b-test. All statistical procedures were performed using the statistical packages for the social sciences (SPSS 17.0 for Windows: SPSS Inc, IL USA).

Results and Discussion

Composition of silage

Dry matter: Dry matter content is important criterion for judging the quality of fodder. Dry matter content in the silage samples ranged from 21.2% to 35.3% (Table 2). The maximum dry matter content was recorded in silage S_8 (35.3%), which was significantly higher than all other samples, followed by S_9 (34.2%), S_2 (32.4%), S_{18} (31.3%), S_{21} (30.6%) and S_{15} (30.1%). The rest of samples contained dry matter less than 30.0%. The dry matter content of forage crop increased with advancement of age of crop. In S_2, S_9, S_{15} and S_{18}, the crop was harvested at 72, 60, 70 and 82 DAS. In case of S_{21} the crop was harvested at 109 DAS also recorded the dry matter content within optimum range because in this case the crop was sown in last week of January, when the temperature was low. Growth rate of crop was slow in initial stage and it took more time to reach at milk stage. While in other fields, the crop was sown between first week of March to first week of April when mean minimum and maximum temperature was in range of 13-27°C which is ideal range of maize growth. Chahine *et al.* (2009) reported that 30.0-40.0% dry matter content was optimum for quality corn silage. Chaudhary *et al.* (2016) observed variable dry matter content (22.0-35.5%) of silages prepared from different maize hybrids and composite due to their morphological variation and plant characteristics. Brar *et al.* (2017) also reported the value of dry matter content in silages prepared at farmer's field under different management practices varied between 16.5 to 31.8%.

Crude protein: Crude protein in samples ranged between 8.1 to 11.0 % (Table 2). Maximum crude protein content was recorded in S_4 (11.0%), which was statistically at par with S_3 (10.8%), S_{10} (10.7%) all made from D2244 cultivar of maize and S_{18} (10.9%). In this study the crop was harvested on an average at 72 DAS when the grains were in dent stage or near 2.5 MLS (milk line score). A range of 7.0-9.0% crude protein is optimum for corn silage as reported by Chahine *et al.* (2009). Chaudhary *et al.* (2016) recorded CP content of maize silages of different hybrids in range of 6.1-9.15% due to their differences in maturity. Brar *et al.* (2017) also reported CP content in maize silages prepared at farmer's field was in range of 7.5-8.9%.

Fibres: Fibres (measured by NDF, ADF and ADL) are a strong predictor of forage quality, since it is the poorly digested portion of the cell wall. Neutral detergent fibre (NDF) values are important in ration formulation for the livestock because they reflect the amount of forage the animal can consume (Kumar *et al.*, 2016). Silage S_4 recorded NDF value of 54.7 % which was at par with S_{17} (54.8 %) and significantly lower than rest of samples. All other samples recorded NDF values above 55.0% (Table 2). The optimum range of NDF in corn silage was 35-55 % (Chahine *et al.,* 2009). NDF is an inverse predictor of intake (high NDF values low intake of fodder and vice versa). Significantly lowest value of ADF was recorded in S_{15} (26.6%). The optimum range of ADF in corn silage was 20-33% (Chahine *et al.,* 2009). S_{18} (28.9%), S_{11} (29.2%), S_{21} (29.4%), S_{10} (31.4%), S_{16} (32.2%), S_2 (32.3%) also showed ADF values within the optimum range. While rest of samples recorded ADF above 33.0% (Table 2).

Table 2. Composition (%) of silage samples

Silage	Dry matter	Crude protein	NDF	ADF	ADL
S_1	27.70^{g}±0.03	9.10^{ef}±0.15	67.27^{g}±0.65	37.69^{de}±0.41	4.89^{def}±0.27
S_2	32.42^{l}±0.04	9.32^{ef}±0.09	65.52^{f}±0.67	32.33^{c}±0.59	3.76^{abc}±0.38
S_3	21.22^{a}±0.42	10.77^{kl}±0.14	69.65^{h}±0.64	44.68^{g}±0.64	6.37^{gh}±0.32
S_4	22.66^{b}±0.03	10.99^{l}±0.27	54.70^{a}±0.61	46.94^{h}±0.91	6.96^{hi}±0.25
S_5	25.39^{ef}±0.22	9.45^{fg}±0.13	68.98^{h}±0.94	41.77^{f}±0.78	5.58^{fg}±0.47
S_6	22.27^{ab}±0.70	8.99^{de}±0.30	69.30^{h}±0.46	38.44^{e}±0.68	4.88^{def}±0.32
S_7	25.85^{ef}±0.09	9.41^{fg}±0.03	60.74^{d}±0.64	37.13^{de}±0.52	5.26^{ef}±0.14
S_8	35.25^{n}±0.26	8.73^{cd}±0.03	62.59^{e}±0.36	49.06^{i}±0.79	7.80^{ij}±0.25
S_9	34.23^{m}±0.04	8.10^{a}±0.10	65.39^{f}±0.42	45.65^{gh}±0.71	6.58^{h}±0.30
S_{10}	25.00^{de}±0.55	10.74^{kl}±0.05	56.64^{b}±0.62	31.37^{c}±0.69	3.72^{abc}±0.17
S_{11}	28.28^{g}±0.26	10.35^{ij}±0.05	58.81^{c}±0.54	29.25^{b}±0.58	5.07^{ef}±0.35
S_{12}	23.77^{c}±0.10	9.24^{ef}±0.05	65.34^{f}±0.61	46.57^{h}±0.34	7.75^{ij}±0.26
S_{13}	25.53^{ef}±0.26	9.23^{ef}±0.04	68.37^{gh}±0.52	47.36^{h}±0.58	7.99^{j}±0.10
S_{14}	22.22^{ab}±0.38	10.01^{hi}±0.07	61.30^{de}±0.67	36.53^{d}±0.47	6.65^{h}±0.21
S_{15}	30.05^{hi}±0.36	9.72^{gh}±0.04	62.52^{e}±0.35	26.66^{a}±0.52	3.07^{a}±0.10
S_{16}	26.40^{f}±0.31	10.01^{hi}±0.09	58.10^{bc}±0.38	32.21^{c}±0.40	4.45^{cde}±0.28
S_{17}	25.11^{de}±0.20	8.17^{ab}±0.13	54.82^{a}±0.20	36.96^{de}±0.55	5.49^{fg}±0.51
S_{18}	31.27^{k}±0.82	10.88^{kl}±0.07	56.57^{b}±0.64	28.97^{b}±0.38	3.98^{abcd}±0.24
S_{19}	29.52^{h}±0.32	10.51^{jk}±0.08	64.93^{f}±0.32	35.86^{d}±0.56	4.05^{bcd}±0.37
S_{20}	24.13^{cd}±0.17	10.56^{jk}±0.02	65.47^{f}±0.64	36.08^{d}±0.49	3.84^{abc}±0.25
S_{21}	30.59^{jk}±0.46	8.50^{bc}±0.03	60.88^{de}±0.51	29.45^{b}±0.56	3.42^{ab}±0.31
Mean	27.09±0.51	9.66±0.11	62.76±0.61	37.67±0.87	5.31±0.20

Means with different superscripts in a column differ significantly (P<0.05)

Acid detergent fibre (ADF) values related to the ability of an animal to digest the forage (Kumar *et al*., 2016). High ADF content is an issue for the same reason as like high NDF content. ADF is negatively correlated to digestibility and energy (Chahine *et al.,* 2009; Kumar *et al*., 2016; Chaudhary *et al.,* 2016). ADL is non digestible portion of cell wall, having optimum range of 2.8-4.1% in corn silage. Silage S_{15} showed lower value of ADL i.e. 3.1% which was at par with S_{21} (3.4%), S_{10} (3.7%), S_2 (3.8%), S_{20} (3.8%) and S_{18} (3.9%) (Table 2). While others samples recorded ADL values above optimum range.

Fermentation pattern of silages

p*H:* pH of different silage samples under study was recorded between 3.6 to 4.3 (Table 3) which were within the ideal limits. Roth and Heinrichs (2001) reported the optimum range of pH values for corn silages were in between 3.5 to 4.3. Kaiser and Piltz (2004) reported that when dry matter is low, pH values of well preserved silages are usually in the range of 3.5-4.2. They further stated that if the silage pH exceeds these limits, there is a high probability that the silage had been poorly preserved.

Table 3. Fermentation pattern of silages

Silage	pH	Ammonia-N (% of total N)	Buffering capacity (meq/100g)
S_1	3.7	8.83^{l}±0.15	44.18^{r}±0.02
S_2	3.7	5.95^{b}±0.06	43.20^{q}±0.01
S_3	4.0	7.00^{d}±0.09	39.21^{e}±0.01
S_4	3.7	6.33^{c}±0.15	43.19^{q}±0.03
S_5	3.9	7.30^{efgh}±0.10	41.51^{j}±0.03
S_6	4.0	7.50^{ghij}±0.26	38.06^{d}±0.04
S_7	3.6	7.59^{hij}±0.03	45.52^{t}±0.04
S_8	3.7	4.62^{a}±0.03	45.31^{s}±0.03
S_9	4.3	7.21^{defg}±0.09	35.91^{a}±0.03
S_{10}	3.8	9.03^{l}±0.04	41.35^{i}±0.01
S_{11}	3.8	7.35^{fghi}±0.04	40.62^{h}±0.01
S_{12}	3.8	8.76^{l}±0.04	43.12^{p}±0.01
S_{13}	4.1	8.49^{k}±0.04	36.93^{b}±0.02
S_{14}	4.0	9.05^{l}±0.06	37.85^{c}±0.02
S_{15}	3.8	7.62^{ij}±0.03	41.97^{l}±0.01
S_{16}	3.8	8.42^{k}±0.07	42.80^{n}±0.03
S_{17}	3.9	7.04^{de}±0.11	39.89^{g}±0.02
S_{18}	3.7	7.32^{efgh}±0.05	42.96^{o}±0.02
S_{19}	3.8	6.21^{bc}±0.05	39.51^{f}±0.03
S_{20}	3.8	7.08^{def}±0.02	41.84^{k}±0.03
S_{21}	3.8	7.69^{j}±0.03	42.31^{m}±0.03
Mean	3.8	7.45±0.14	41.30±0.33

Means with different superscripts in a column differ significantly ($P<0.05$)

Buffering capacity: Buffering capacity (BC) in silage is defined as the degree to which forage material resists change in pH. Buffering capacity of forages depend upon crop species and stage of growth. Silage samples showed buffering capacity between 35.9 to 45.5 meq/ 100 g (Table 3). Shaver *et al.* (1985) also recorded buffering capacity of 44.3 to 56.5 meq/100 g in corn silages under two different experiments. Fresh forage with high buffering capacity will require more acid to reduce its pH than forage with low buffering capacity, but silage with higher BC value could exhibit greater aerobic stability (Saijpaul *et al*., 2015). Due to high buffering capacity, the silage resists to rise in pH thus results in keeping acidic conditions which restricts the growth of undesirable microbes.

Ammonia-N (as % of total N): Ammonia-N value of silage samples was recorded in between 4.62 to 9.05 % (Table 3). Wilkinson (1990) reported that silage having ammonia-N (% total silage N) < 5% is excellent, 5-10% is good, 10-15% is moderate and >15 is poor in fermentation quality. If the value of Ammonia-N in silage is high, it indicates the excessive breakdown of protein during ensiling.

Cultivars performance

Cultivar selection is important in order to get maximum yield of quality forage in minimum time. Climatic conditions, especially growing period longevity affect cultivar selection directly (Ileri *et al*., 2018). In this study, three cultivars of maize were grown by the farmer for silage making *i.e*., P1844, DOW2244 and P31Y45. Data was also analysed with respect to cultivars. There was no significant difference among the cultivars with respect to dry matter, crude protein, NDF, ADL, pH, ammonia-N and buffering capacity. In case of ADF, the minimum value was recorded under P31Y45, which was statistically at par with P1844 and significantly lower than DOW2244 (Table 4). It showed that if the crop is managed properly, all cultivars have the ability to produce good quality forage leading to good quality silage.

Conclusion

It was observed that the silage S_2, S_{15}, S_{18} and S_{21} showed the values of almost all quality parameters within the optimum range. In these silages the crop was harvested with single row maize harvester at 72, 70, 82 and 109 days after sowing, respectively. The silo pit was filled within two days and the fodder was ensiled for 45, 45, 50 and 76 days, respectively. So it was concluded that in order to prepare quality silage, crop should be harvested

Table 4. Effect of corn cultivars on composition and fermentation pattern of silage samples

Quality attributes	Cultivar		
	P1844	DOW 2244	P31Y45
Dry matter (%)	26.95^{a} ±1.58	26.49^{a} ±1.89	27.90^{a} ±1.04
Crude Protein (%)	9.44^{a} ±0.14	9.65^{a} ±0.38	9.86^{a} ±0.41
NDF (%)	65.05^{a} ±1.11	63.47^{a} ±2.05	59.94^{a} ±1.53
ADF (%)	37.78^{ab}±3.29	41.88^{b}±2.09	32.68^{a}±1.35
ADL (%)	5.69^{a} ±0.85	5.81^{a} ±0.45	4.33^{a} ±0.28
pH	3.85^{a} ±0.07	3.88^{a} ±0.08	3.80^{a} ±0.02
Ammonia-N (% of total N)	8.07^{a} ±0.49	7.07^{a} ±0.44	7.30^{a} ±0.25
Buffering capacity (meq/100g)	41.37^{a} ±1.28	41.26^{a} ±1.21	41.42^{a} ±0.53

Means with different superscripts in a column differ significantly (P<0.05)

at proper stage, when the nutrient contents are at peak and the crop is at milk stage. However, time taken by crop to reach this stage also depends upon the genetic makeup of the cultivar and time of sowing of crop. Crop should be harvested by using single row maize harvester machine to ensure filling of silo pit within two days. Prolonged filling of pit decreases quality of silage.

References

Anjum, M. I., A. Azim, M. A. Jabbar, M. A. Nadeem and I. H. Mirza. 2012. Effect of low energy followed by high energy based total mixed diets on growth rate, blood haematology and nutrient digestibility in growing buffalo heifers. *Pakistan Journal of Zoology* 44: 399-408.

AOAC. 2000. *Official Methods of Analysis*. 17th edn. The Association of Official Analytical Chemist, Gaithersburg, MD, USA.

Brar, N. S., B. Kumar, P. Singh, A. Kumar and P. Singh. 2017. Quality assessment of silage prepared at farmer's field in Tarn Taran district of Punjab. *Indian Journal of Animal Nutrition* 34: 357-60.

Brar, N. S., P. Singh, A. Kumar, B. Kumar and Sashipal. 2016. Maize silage feeding via-a-vis milk production in crossbred dairy cows in Tarn Taran district of Punjab. *Progressive Research* 11: 269-70.

Chahine, M., T. E. Fife and G. E. Shewmaker. 2009. Target values of corn silage. In: *Proceedings of Idaho Alfalfa and Forage Conference*, Burley, Idaho (February 3-4, 2009). University of Idaho Extension. www.extension.uidaho.edu.

Chaudhary, D. P., A. Kumar, R. Kumar, A. Singode, G. Mukri, R. P. Sah, U. S. Tiwana and B. Kumar. 2016. Evaluation of normal and specialty corn for fodder yield and quality traits. *Range Management and Agroforestry* 37: 79-83.

Darby, H. M. and J. G. Lauer. 2002. Harvest date and hybrid influence on corn forage yield, quality and preservation. *Agronomy Journal* 94: 559-66.

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

Kaiser, A. G. and J. W. Piltz. 2004. Feed testing: assessing silage quality. In: A. G. Kaiser , J. W. Piltz, H. M. Burns and N. W. Griffiths (eds). *Successful Silage*. Dairy Australia and New South Wales, Department of Primary Industries. pp. 312-333.

Kumar, A., N. S. Brar, Sashipal and P. Singh. 2017. Available soil macro and micro-nutrients under rice-wheat cropping system in district Tarn Taran of Punjab, India. *Ecology Environment and Conservation* 23: 202-207.

Kumar, B., N. S. Brar, H. K. Verma, A. Kumar and R. Singh. 2019. Nutritious feed for farm animals during lean period: silage and hay- a review. *Forage Research* 45: 10-22

Kumar, B., S. S. Dhaliwal, S. T. Singh, J. S. Lamba and H. Ram. 2016. Herbage production, nutritional composition and quality of teosinte under Fe fertilization. *International Journal of Agriculture and Biology* 18: 319 29.

Mandal, A. B., S. S. Pual and N. N. Pathak. 2003. *Nutrient Requirements and Feeding of Buffaloes and Cattle*. 1st edn. International Book Distribution Co. Lucknow, India.

Meena, L. R., S. A. Kochewad, V. Kumar, S. Malik, S. Kumar, L. K. Meena, A. L. Meena and A. S. Panwar. 2018. Status of fodder production in the existing farming systems in Muzaffarnagar district of Uttar Pradesh. *Range Management and Agroforestry* 39: 313-318.

Piltz, J. W. and A. G. Kaiser. 2004. Principles of silage preservation. In: A. G. Kaiser , J. W. Piltz, H. M. Burns and N. W. Griffiths (eds). *Successful Silage*. Dairy Australia and New South Wales Department of Primary Industries. pp. 26-56.

Robertson, J. B. and P. J. Van Soest. 1981. The detergent system of analysis and its application to human foods. In: W. P. T. James and O. Theander (eds). *The Analysis of Dietary Fiber in Foods*. Marcel Dekker, New York. pp. 123-158.

Roth, G. W. and A. J. Heinrichs. 2001. Corn silage production and management. *Agronomy facts* 18. Peen State College of Agricultural Sciences Research and Extension Programs. The Pennsylvania State University.

Saijpaul, S., J. S. Lamba, R. S. Grewal and Chandrahas. 2015. Quality evaluation of pearl millet silages using Saccharomyces cerevisiae as silage additive. *Indian Journal of Animal Sciences* 85: 1343–1347.

Sarwar, M., M. A. Khan and Z. Iqbal. 2002. Feed reserves of livestock in Pakistan. *International Journal of Agriculture and Biology* 4: 186-92.

Shaver, R. D., R. A, Erdman, A. M. Oconnor and J. H. Vandersall. 1985. Effects of silage pH on voluntary intake of corn silage and alfalfa hylage. *Journal of Dairy Science* 68: 338-346.

Wei, M., Z. Chen, S. Wei, G. Geng and P. Yan. 2018. Comparison among methods of effective energy evaluation of corn silage for beef cattle. *Asian Australasian Journal of Animal Sciences* 31: 851-858.

Wilkinson, J. M. 1990. *Silage* UK. 6th edition. Chalcombe publications, Marlow, UK. pp. 1-166.

Xie, Z. L., T. F. Zhang, X. Z. Chen, G. D. Li and J. G. Zhang. 2012. Effects of maturity stages on the nutritive composition and silage quality of whole crop wheat. *Asian Australasian Journal of Animal Sciences* 25: 1374-1380.