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# EFFECT OF CUTTING MANAGEMENT AND NITROGEN LEVELS ON SILAGE QUALITY AND YIELD OF FORAGE MAIZE

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**SUMMARY**

The present experiment was conducted at Post Graduate Institute Instructional Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra) during summer season of 2020 to evaluate the effect of cutting management and nitrogen levels on quality of forage maize and silage. The experiment was laid out in Factorial Randomized Block Design with three replications and fifteen treatment combinations, consisted of three cutting managements *i.e*. cutting at 60 (before flowering), 75 (50 % flowering) and 90 (after fertilization) days after sowing and five nitrogen levels *i.e*. absolute control, 75 % RDN, 100 % RDN, 125 % RDN and 150 % RDN. The silage prepared from maize forage cut at 60 DAS recorded significantly higher per cent crude protein (9.47 %), *in vitro* dry matter digestibility (68.56 %) and the lowest crude fibre (27.34 %). The silage prepared from application of 150 % RDN recorded significantly higher crude protein (9.44 %), *in vitro* dry matter digestibility (68.57 %) with the lowest crude fibre (29.07%). As the harvesting interval and application of nitrogen levels increases, there was increase in pH of silage. Cutting of forage maize at 90 DAS recorded significantly higher green forage, dry matter, crude protein, crude fibre yield, whereas higher per cent crude fibre with lower per cent crude protein and IVDMD. The application of 150 % RDN recorded significantly higher green forage, dry matter, crude protein, crude fibre yield, whereas higher per cent crude protein and IVDMD with lower per cent of crude fibre in forage maize.

**Key words :** Maize, crude protein, crude fibre, *in vitro* dry matter digestibility, nitrogen levels, cutting management

Although India has a larger livestock population, the milk productivity is very low as compared to world average and much below than the developed countries. Lack of proper quality and quantity of forage is one of the key constraints of productive livestock population in the country. Lack of green forage availability to livestock adversely affects the productivity and reproductive performance. For the sustainable dairy farming, the quality green fodder should be fed regularly to the dairy animals (Naik *et. al.,* 2015). Forage maize contains high concentrations of soluble sugars, which makes it most suitable for preservation as silage. Maize is one of the most important and valuable forage crops for the livestock and it is used wherever maize can grow, from tropical to temperate regions. Forage maize is a consistent source of palatable forage for all classes of ruminants, including dairy cattle, beef cattle, sheep and goat. Maize silage serves as a high energy forage feed for dairy cows. Maize silage contains about 25-35% dry matter. Maize silage is relatively poor in protein content (8-10% of DM) and rich in fibre (15-27% of DM) with highly variable starch content (18-37% of DM).

Maize silage has become one of the most used ingredients in the dairy industry. Its high energy content, coupled with its effective fiber, make corn silage excellent feed for dairy industry. Silage is the product which is formed by the fermentation of green forage crops under anaerobic conditions. The important goal of silage making of forage crops is to preserve as much as the nutrients in the original forage crop as possible. Traditional maize is usually harvested at milk ripe or wax stages for producing high-quality silage (Wang *et al.* 2018). In practice, delayed harvest reduced feed value of corn stalk (Cai *et al.* 2020). Silage making is followed mostly to improve the preservation of original nutrients for feeding of livestock under forage shortage time. Silage can be kept under storage for three years without deteriorating the nutrient content. Palatability of silage is more as compare to fodder and it can be fed at any time.

Therefore, in this study, effects of cutting management and nitrogen levels on silage quality and yield of forage maize under summer condition were studied.

## MATERIALS AND METHODS

A field experiment was conducted at Post Graduate Institute Instructional Farm, Mahatma Phule Krishi Vidyapeeth, Rahuri, Dist. Ahmednagar (Maharashtra) during summer, 2020. The experiment was laid out in a factorial randomized block design with three replications and fifteen treatment combinations consist three cutting management *i.e.* cutting at 60 DAS (days after sowing), 75 DAS and 90 DAS and five nitrogen levels *i.e.* absolute control, 75 % RDN (recommended dose of nitrogen), 100 % RDN, 125 % RDN and 150 % RDN. The forage maize cultivar, African tall was used as for the experimental purpose. The soil of experimental field was clay in texture with a pH of 8.47, organic carbon 0.61 per cent, low in available nitrogen (170.56 kg/ha), medium in available phosphorus (28 kg/ha) and very high in available potassium (510 kg/ha). The recommended fertilizer dose of forage maize was 100:50:40 kg NPK per hecatre. The Full dose of $P_2O_5$, $K_2O$ and half dose of N were applied as basal dose at the time of sowing. The nitrogen, phosphorus and potassium were applied through urea, single super phosphate and murite of potash, respectively. Forage maize was harvested as per the treatments *i.e.* 60, 75 and 90 DAS. The green forage yield of maize was recorded at the time three cutting management treatments. Plastic silo bags of 25 kg capacity were used for ensiling of forage maize. The harvested maize plants were dried to reduce moisture content to an optimum level of 35% and chopped in to small pieces of 1-2 inch. After thorough mixing, chopped forage was filled in silo bags and bags were tightly tied. These silo bags were kept under cool, dry place for 45 days. Samples were analyzed for flavour and pH. The crude protein and crude fibre contents were estimated according to standard method (A.O.A.C, 2005), while *in vitro* dry matter digestibility was carried out by Tilley and Terry (1963) method using goat rumen liquor.

## RESULTS AND DISCUSSION

The data on flavour, nutritional quality and yield attributes of maize green forage and silage prepared from it as influenced by cutting management and nitrogen levels is depicted in Table 1, 2 and 3, respectively.

### Flavour

The flavour of maize silage was varied according to the cutting management and nitrogen levels (Table 1). Although differences observed in the flavour, all flavours were in acceptable range of light acidic, medium acidic to strong acidic. Similar results were reported by Amodu *et al.* (2014).

### pH

The pH of forage maize silage was non-significantly influenced but there were differences in pH according to the cutting management and nitrogen levels (Table 2). The pH values of the silages prepared for all treatments were in the acceptable range of 3.5 to 4.2 (excellent quality). Delayed harvesting restricted the reduction of pH value, because high dry matter and low moisture contents in corn stalks inhibited the silage fermentation. In general, the pH required for successful ensiling was lower than 4.2. Similar results were recorded by Guo *et al.* (2021).

### Crude protein

Statistically significant variation in crude protein contents were recorded by cutting management and nitrogen levels (Table 2). In all cutting management and nitrogen levels treatments, slightly higher per cent crude protein was recorded in silage than green forage. Cutting of forage maize at 60 DAS recorded higher

TABLE 1

Flavour of forage maize silage as affected by different interaction combination between cutting management and nitrogen levels

| Cutting Management | Nitrogen levels | | | | |
|---|---|---|---|---|---|
| | $N_1$ | $N_2$ | $N_3$ | $N_4$ | $N_5$ |
| $C_1$ | Medium acidic | Medium acidic | Medium acidic | Light acidic | Light acidic |
| $C_2$ | Strong acidic | Strong acidic | Strong acidic | Medium acidic | Medium acidic |
| $C_3$ | Strong acidic | Strong acidic | Strong acidic | Strong acidic | Strong acidic |

per cent crude protein in both forage and silage (9.06 and 9.47 %, respectively), while the lowest was recorded in 90 DAS (7.78 and 8.07 %, respectively). As the cutting interval increased, reduction in per cent crude protein in both forage and silage was observed. Among the different nitrogen levels, 150 % RDN recorded significantly higher crude protein content in green forage and silage (9.08 and 9.44 %, respectively) than other treatments. It was obvious that crude protein content was increased with increase in level of nitrogen application. Similar results were reported by Souza *et. al.* (2019), Dhillon and Sidhu (2020) and Guo *et al.* (2021).

## Crude fibre

Crude fibre content in green forage and silage was observed highest when forage maize was harvested at 90 DAS (34.42 and 33.88 %, respectively) and lowest per cent fibre was recorded at 60 DAS (28.93 and 27.34 %, respectively) (Table 2). The increase in crude fibre content with development of growing stage, it may be due to increased concentration of cell walls constituents within stem and leaves as well as decreased soluble proportion of the cell content. Similar result was reported by Amodu *et al.* (2014). The crude fibre content was found significantly higher in absolute control (34.17 and 31.14 %, respectively) in both forage and silage. In both factors of cutting management and nitrogen levels, per cent crude fibre was decreased in silage as compared to green forage. These findings are in consistent with those of Pal and Sharma *et al.* (2015) and Chaudhary *et al.* (2016).

## *In vitro* dry matter digestibility

The cutting of maize forage at 60 DAS recorded significantly higher *in vitro* dry matter digestibility in green forage as well as silage prepared from it (65.96 and 68.56 %, respectively) as compared to 90 DAS (65.05 and 66.65 %, respectively) (Table 2). Souza *et. al.,* (2019) reported that in the milky stage, there was significantly higher IVDMD of corn silage as compared to hard dough stage. Among the different nitrogen levels, 150 % RDN recorded significantly higher IVDMD in forage and silage of maize (65.83 and 68.57 %, respectively). In both factors of cutting management and nitrogen levels, IVDMD was observed higher in silage as compared to forage. Uzun *et al.* (2020) reported that as rate of nitrogen increases, it increases the digestibility of silage

TABLE 2
Nutritional quality of maize green forage and silage as influenced by different treatments of cutting management and nitrogen levels

| Treatments | Forage quality (%) | | | Silage quality (%) | | | pH |
|---|---|---|---|---|---|---|---|
| | Crude protein | Crude fibre | IVDMD | Crude protein | Crude fibre | IVDMD | |
| **Cutting management (3)** | | | | | | | |
| $C_1$–Cutting at 60 DAS | 9.06 | 28.93 | 65.96 | 9.47 | 27.34 | 68.56 | 3.97 |
| $C_2$–Cutting at 75 DAS | 8.28 | 31.83 | 65.15 | 8.72 | 29.36 | 67.92 | 4.04 |
| $C_3$–Cutting at 90 DAS | 7.78 | 34.42 | 65.05 | 8.07 | 33.88 | 66.65 | 4.07 |
| S. E. m± | 0.05 | 0.13 | 0.02 | 0.01 | 0.10 | 0.01 | 0.05 |
| C. D. at 5% | 0.16 | 0.39 | 0.07 | 0.04 | 0.30 | 0.03 | NS |
| **Nitrogen levels (5)** | | | | | | | |
| $N_1$–Absolute control | 7.71 | 34.17 | 64.82 | 7.77 | 31.14 | 66.68 | 3.95 |
| $N_2$–75 % RDN | 7.97 | 32.22 | 65.23 | 8.45 | 30.77 | 67.38 | 3.91 |
| $N_3$–100 % RDN | 8.33 | 31.71 | 65.43 | 8.84 | 30.19 | 67.73 | 4.05 |
| $N_4$–125 % RDN | 8.77 | 31.04 | 65.62 | 9.28 | 29.80 | 68.18 | 4.10 |
| $N_5$–150 % RDN | 9.08 | 29.48 | 65.83 | 9.44 | 29.07 | 68.57 | 4.12 |
| S. E. m± | 0.06 | 0.17 | 0.02 | 0.02 | 0.13 | 0.02 | 0.06 |
| C. D. at 5% | 0.19 | 0.52 | 0.06 | 0.07 | 0.40 | 0.06 | NS |
| **Interaction (C×N)** | | | | | | | |
| S. E. m± | 0.10 | 0.30 | 0.04 | 0.03 | 0.21 | 0.03 | 0.06 |
| C. D. at 5% | 0.31 | 0.92 | 0.13 | 0.09 | 0.64 | 0.09 | NS |
| General Mean | 8.37 | 32.31 | 65.39 | 8.75 | 30.19 | 67.71 | 4.03 |

RDN : Recommended dose of nitrogen, DAS: Days after sowing.

of forage maize. Chaudhary *et al.* (2016) reported that there was small loss of nutrients in silage as compared to green forage, but preparation of silage significantly improved the digestibility. Their correlation data were also showed per cent crude protein was positively related to IVDMD but negatively associated with fibre components (CF, NDF and ADF).

**Yield attributes**

**Green forage and dry matter yield**

The highest yield of green forage and dry matter was recorded at 90 DAS (544.49 q/ha and 124 q/ha, respectively) due to cutting management (Table 3). While, significantly lowest yield of green forage and dry matter was recorded cutting at 60 DAS (480.59 q/ha and 98.90 q/ha, respectively). Among the five nitrogen levels, application of 150 % RDN recorded significantly higher yield of green forage and dry matter (619.76 q/ha and 136.66 q/ha, respectively). However, application of 125 % RDN was found at par (598.44 q/ha) in case of green forage yield. The absolute control recorded the lowest yield of green forage and dry matter due to cutting management and nitrogen levels. Similar trend of results were reported by Tahira *et al.* (2018), Sharma *et al.* (2016) and Pathan *et al.* (2020).

**Crude protein and crude fibre yield**

Crude protein and crude fibre yield was observed highest when forage maize was harvested at 90 DAS (9.71 q/ha and 41.92 q/ha, respectively) and it was at par with cutting at 75 DAS (9.36 q/ha) in case of crude protein yield (Table 3). The lowest yield of crude protein and crude fibre was recorded at 60 DAS (8.94 q/ha and 28.07 q/ha, respectively). Among the different nitrogen levels, the application of 150 % RDN recorded significantly the highest yield of crude protein and crude fibre (12.20 q/ha and 40.48 q/ha, respectively) and yield of crude fibre was found at par with application of 125 % RDN (40.26 q/ha). However, the lowest crude protein and crude fibre yield was recorded in absolute control (5.03 q/ha and 22.92 q/ha, respectively). Results are in corroboration with the research findings of Kumar *et al.* (2017).

## CONCLUSION

On the basis of the results, it could be concluded that silage prepared by cutting of forage maize at 60 DAS (before flowering) found appropriate for achieving the higher per cent crude protein and IVDMD with lower per cent crude fibre. The application of 150 % RDN found better for higher per cent crude protein and IVDMD with lower per cent

TABLE 3
Yield parameters of forage maize as influenced by cutting management and nitrogen levels

| Treatments | Yield (q/ha) | | | |
|---|---|---|---|---|
| | Green forage | Dry matter yield | Crude protein | Crude fibre |
| **Cutting management (3)** | | | | |
| $C_1$–Cutting at 60 DAS | 480.59 | 98.90 | 8.94 | 28.07 |
| $C_2$–Cutting at 75 DAS | 514.67 | 111.39 | 9.36 | 34.93 |
| $C_3$–Cutting at 90 DAS | 544.49 | 124.00 | 9.71 | 41.92 |
| S. E. m± | 6.75 | 1.16 | 0.12 | 0.33 |
| C. D. at 5% | 19.55 | 3.49 | 0.36 | 1.01 |
| **Nitrogen levels (5)** | | | | |
| $N_1$–Absolute control | 307.14 | 65.96 | 5.03 | 22.91 |
| $N_2$–75 % RDN | 485.56 | 103.93 | 8.25 | 33.63 |
| $N_3$–100 % RDN | 555.35 | 119.25 | 9.86 | 37.58 |
| $N_4$–125 % RDN | 598.44 | 131.36 | 11.32 | 40.26 |
| $N_5$–150 % RDN | 619.76 | 136.66 | 12.20 | 40.48 |
| S. E. m± | 8.71 | 1.50 | 0.15 | 0.43 |
| C. D. at 5% | 25.24 | 4.55 | 0.45 | 1.29 |
| **Interaction (C×N)** | | | | |
| S. E. m± | 11.50 | 2.60 | 0.26 | 0.74 |
| C. D. at 5% | 34.52 | 7.83 | 0.78 | 2.25 |
| General Mean | 513.25 | 111.43 | 9.33 | 34.97 |

crude fibre. As the harvesting interval and application of nitrogen levels increases, there was a increase in silage pH. The flavour of silage was in acceptable range of light acidic to strong acidic. Cutting of forage maize at 90 (after flowering) DAS found significantly higher in green forage, dry matter, crude protein, crude fibre yield with higher per cent crude fibre and lower per cent crude protein and IVDMD. The application of 150 % RDN found higher in green forage, dry matter, crude protein, crude fibre yields, with higher per cent crude protein and IVDMD and lower per cent of crude fibre in forage maize *cv*. African tall under summer season.

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