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# Detopping in Maize: A Review

S. Rajkumara[1], Vinita[1], R.M. Kachapur[2], B.G. Shivakumar[3]

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## ABSTRACT

The scope of increasing the cultivated area under forages is rather limited, because of mounting pressure on need for food and commercial crops, but there is a large demand for green and dry fodder from livestock industry. Hence, fodder production has to be increased per unit area per unit time. By practicing the de-topping in commercial grain maize we can increase the fodder production, quality and it also reduces the deficit of fodder to some extent. Reviews indicated that by de-topping of maize, there may be slight reduction in grain yield of maize but by doing it at right stage/time and at right plant height it gives highest net returns than no de-topped treatments. De-topping at 30 days after silking; removing the top 6 leaves or after physiological maturity; removing all the leaves above the cob or de-topping above 10$^{th}$ internode gives highest fodder yield and net returns with slight or no reduction in grain yield.


**Key words:** Detopping, Defoliation, Maize.

Livestock industry is an important part of agriculture in India and it is considered as backbone of agriculture as it contributes 25.6 per cent to total agriculture, 4.11 per cent to GDP and 16 per cent to the income of small house hold. It provides essentials dietary requirements like meat and milk to millions of people in the country and it also supports allied enterprises like fibre production, fertilizer/compost preparation, fuel requirements in rural areas etc. Good quality fodder is the cheapest source of energy for livestock. Therefore, regular and adequate supply of nutritious fodder is essential to meet the demand of dairy industry in the country. The success of this industry depends on the availability of high quality fodder throughout the year.

The present fodder resources in the country can meet only 45 to 50 per cent of the requirement and the magnitude of fodder deficit vary from state to state. At present, the country faces a net deficit of 61.1 per cent green fodder, 21.9 per cent dry crop residues and 64 per cent feeds as concentrates (Chaudhary *et al*., 2012). The 19$^{th}$ Livestock Census (2012) has placed the country's total livestock population at 512 million and only 4.2 to 4.4 per cent of the country's cropped area is devoted for fodder crops. Therefore, there is a need to increase the fodder crop production in India to meet the livestock demand.

Amongst the various annual fodder crops maize (*Zea mays* L.), sorghum (*Sorghum bicolor* L.), pearl millet (*Pennisetum glaucum*), cluster bean (*Cyamopsis tetragonoloba*) and cowpea (*Vigna unguiculata*) are grown in *kharif* season. Maize has an edge over other cultivated fodder crops due to its high production potential, wider adaptability, quick growing nature, succulency, palatability and excellent fodder quality. It is free from toxicants and can be safely fed to animals at any stage of crop growth. Its fodder contains about 8.62 to 10.32 per cent crude protein, 29.92 to 31.38 per cent crude fiber, 1.27 to 1.35 per cent ether extractable fats (EEF) and 8.45 to 9.24 per cent total ash (TA) (Ibrahim *et al*., 2012).Use of high yielding varieties/ hybrids along with improved agronomic practices are helpful in boosting the forage yield. Among the several agronomic practices, de-topping is one of the practices, followed by maize growers.

De-topping refers to nipping or the removal of terminal portion of the plant. It helps to improve the yield through greater functioning of remaining leaves by, arresting unnecessary growth, decreasing mutual shading of leaves, enhancing light interception, nutrient uptake and decreasing competition between the top portion of plant and cob for available plant nutrients by diverting plant nutrients to the reproductive part which aids in better source-sink relationship and better cob development (Esechie and Al-Alawi, 2002). De-topping is necessary to get more green fodder to animals or quick green fodder in case of emergency without sacrificing the grain yield. It increases the green fodder availability which in turn increases the milk yield of milch animals and also avoids lodging problem in case of excessive vegetative growth in fertile soils. Farmers are practicing de-topping in maize based inter cropping system to avoid the shading effect of maize leaves and to increase the light penetration and nutrient availability to inter crop. In hybrid seed production it is practiced to avoid the effect of self pollination, in seed production plots. There is a possibility

[1]Department of Agronomy, University of Agricultural Sciences, Dharwad-580 005, Karnataka, India.
[2]Maize Breeder, AICMIP, MARS, University of Agricultural Sciences, Dharwad-580 005, Karnataka, India.
[3]ICAR- Indian Grassland and Fodder Research Institute. Southern Regional Research Station, Dharwad-580 005, Karnataka, India.

**Corresponding Author:** S. Rajkumara, Department of Agronomy, University of Agricultural Sciences, Dharwad-580 005, Karnataka, India. Email: rajkumaruasd@gmail.com

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of mixing of pollen from same plant leading to inbreeding depression, as maize is a cross pollinating crop. Therefore, to avoid this problem de-topping is practiced. Because of all these reasons de-topping became one of the most economical ways of increasing the yield.

## Stage and method of de-topping

Stage and method of de-topping greatly influences the fodder yield and grain yield of maize. Ideal stage selection is important to attain the balance between fodder and grain production. Tasseling and silking are the two important phenological stages in maize crop considered for removal of top leaves. Removing the tassel alone or detopping did not affect the green fodder yield. Silking stage is also an ideal stage for de-topping (Saha, *et al*., 2001). De-topping either at 20 or 30 days after silking is better for getting higher grain yield over 10 days after silking. Similarly defoliation at 10 days after silking was optimum in comparison to silk initiation or 50% silking stage in African Tall fodder maize variety (Umashankara, 2007). In a defoliation intensity and defoliation time field experiment in Iran, maize hybrid was not affected by stage/time of defoliation (Emam *et al*., 2013). In another experiment at Mandya, Karnataka it was found that de-topping by removing top two leaves at 20 days after silking was better (Amulya, 2018). Removal of top leaves had more detrimental effect than removal of lower leaves below the ear/cob (Umashankara, 2007). De-topping at 47, 50, 52-55 DAS resulted in similar effect in baby corn. It was better than detassling in getting higher green cob yield (Rathika, 2014). This stage also coincides with the 9, 10 and 11$^{th}$ inter node development of maize plants. In maize and finger millet relay intercropping system during monsoon, de-topping is done when the outer husk of the ear turns brown, just before maturity to get green fodder and to reduce the shading effect of maize to intercropped finger millet (Subedi, 1996). Greater reduction in dry matter yield/m$^2$ was noticed in early de-topping treatments indicating higher loss of photosynthetic capacity.

## Effect of de-topping on growth parameters

De-topping at different stages and heights reduced the plant height, number of leaves and leaf area index (Bhargavi, 2017). The decrease in plant height might be due to the termination of apical dominance (Brar *et al*., 2000). Lesser number of leaves in de-topped treatment was due to removal of tops and gradual senescence of older leaves. While de-topping, removing of either 3 or 4 leaves had a greater impact on leaf area index than removal of 1 and 2 leaves because of the difference in size of leaves. Leaves nearest to ear were larger than those farther from the ear (Dwyer and Stewart, 1986; Keating and Wafula, 1992). Roy and Biswas (1992) conducted an experiment in Bangladesh on de-topping of maize and reported that de-topping treatments made the plants shorter depending on the severity of de-topping, which could be due to the breakage of apical dominance (Muleba, 1980 and Paterniani, 1981). De-topping at 20 and 30 days after silking produced on par dry matter accumulation while greater reductions were noticed with early de-topping at 10 days after silking. This might be due to defoliation treatments imposed when the number of grains had been established and reduced the source/sink ratio. This further resulted in a sharp decrease in stem soluble carbohydrates resulting in lesser dry matter (Westgate and Boyer, 1985). Dry matter production was not affected or slightly affected by de-topping of top 2 and 4 leaves, whereas more reduction in dry matter was observed with de-topping of top 6 leaves (Bhargavi, 2017). This reduction in dry matter might be due to loss of photosynthetic area as there were no leaves above the cob when de-topped up to 6 top leaves (Barimavandi *et al*., 2010).

## Grain yield

De-topping significantly affected the grain yield of maize depending on the method and time. Maize grain yield was higher when de-topping was done at 30 days after silking and de-topping of top 2 leaves when compared to early stage with more leaves removal (Bhargavi, 2017). De-topping after two weeks of anthesis did not have any adverse effect on grain yield. Reduction in grain yield was observed as increase in removal of number of leaves above the cob. There is a direct relationship between number of leaves removed and grain yield (Tilahun, 1993). Degree of yield reduction in de-topped treatment compared to non de-topped treatment was directly proportional to percent of leaf area destroyed. The loss of leaf area resulted in loss of photosynthetic area and reduced the assimilate availability to grain (Walpole and Morgan, 1970). The reduction in yield is also due to reduced rate of dry matter accumulation in the grains (Hanway, 1969). Higher number of grains per cob and higher grain yield were observed in de-topping treatment that left three leaves above the cob than de-topping retaining 1 and 2 leaves above the cob (Roy and Biswas, 1992). Reduction in yield was observed when leaves were removed in early reproductive phase (Afarinesh, 2005 and Borras and Otegui, 2001). Higher harvest index was recorded when plants are de-topped just above the cob. Due to removal of considerable portion of the plant after silking and increased light penetration to the lower layer of canopy would enhance the photosynthetic activity of remaining leaves (Duncan *et al*., 1967). De-topping at 30 days after silking had no effect on yield because dry matter production in the grains was almost complete by then (Subedi, 1996). De-topping beyond 10th inter node was significantly superior and produced highest cob yield compared to de-topping beyond 9th inter node (Rathika, 2014). The reason for higher production of cob yield in de-topped treatment might be due to greater functioning of remaining leaves by arresting unnecessary growth, decreased mutual shading of leaves, higher light interception leading to increased photosynthesis and diverting plant nutrients to the reproductive part which aids in better source-sink relationship and better cob development (Esechie and Al-Alawi, 2002). There was no significant reduction in grain yield in some cases also due to equal number of grain rows

in both de-topped and non de-topped treatments (Shivakumar, 2018) and higher test weight when only two leaves were removed instead of four leaves (Srisailam, 2010). Use of different hybrids responded differently to de-topping. Greater reduction in grain yield was noticed in short season hybrid over full season hybrid (Mishra and Kler, 2003).

### Fodder yield

Green fodder yield is significantly influenced by the stage and method of harvesting in maize. Maize crop could successfully be de-topped for fodder with little or no adverse effect on grain yield. Fodder yield increased with increased plant density and among the de-topping treatments the highest fodder yield was obtained when the plants were de-topped just above the cob (Roy and Biswas, 1992). De-topping at 10, 20 or 30 days after silking produced on par green fodder yield in maize at Hyderabad in DHM-117 (Bhargavi *et al*., 2017). Similar trend was noticed in stover yield at harvest in the same experiment. This may be due to reduced dry matter accumulation in maize plant at the later stages of the crop. Higher fodder yield was obtained by maintaining apical ear with removal of sub apical ears and leaves below apical ear leaf with reduction in grain yield of 1.33 to 2% (Ahmed *et al*., 2007). Irrespective of stages of de-topping, removal of top 6 leaves produced more green fodder yield (Bhargavi, 2017). De-topping was observed to be better in terms of total fodder yield and supply of fodder in earlier period i e., green fodder at 55 days and dry fodder at harvest (Gaurkar and Bharad, 1998). Maximum amount of forage yield was resulted when plants were de-topped leaving only one leaf above the ear (Emran *et al*., 2014; Emam and Taddayon, 1999) and de-topping at 10 days after silking. In another study, the green fodder yield was numerically higher under de-tasseling alone, but not statistically with other de-topping treatments (Rathika, 2014). De-topping at 30 days after 50% silking produced higher fodder yield. De-topping after physiological maturity of the crop will provide fodder in emergency and also increase the grain yield of maize (Subedi, 1996). Higher fodder yield could be obtained from de-topping treatment where no leaf was left above the cob, so that de-topping could be practiced successfully for fodder with very little or no adverse effect on grain yield (Roy and Biswas, 1992). Higher fodder yield was recorded with complete cutting of leaves above the cob immediately after pollination (Afarinesh, 2002).

### Fodder quality

Maize is an excellent green fodder in terms of quality when it is harvested for fodder at 55-65 days after sowing. This fodder contains 8-11% crude protein and 52-68% in vitro dry matter digestibility (Gupta *et al*., 2004). Most of the de-topping treatments coincide with this stage. Topping beyond 10$^{th}$ internode recorded higher crude protein (7.30 and 6.98%), crude fibre (40.88 and 42.58%) and NFE content (42.88 and 42.58%) followed by topping beyond 9th internode during two successive years (Rathika, 2014). De-tasseling + removal of top two leaves at 100 DAS recorded the highest crude protein (12.70%) and oil (6.10%) due to more physiological and biochemical reactions like chlorophyll content, photosynthetic rate and nitrate reductase activity while removal of top 2 leaves at 80 DAS resulted in highest starch content in grains (67.5 %) as compared to other treatments and control (Srisailam, 2010). The enhancement in fodder quality could be attributed to increase physiological and biochemical reaction leading to increased nutrient uptake which ultimately improved the fodder quality of baby corn (Teyker *et al*., 1991). De-topping beyond 10$^{th}$ inter node registered higher NPK uptake (Rathika, 2013). The increased uptake of nutrients is possibly due to higher photosynthetic rate and nitrate reductase activity leading to better uptake of N by the crop.

### Economics

Higher gross returns, net returns and B:C ratio were recorded with de-topping of top six leaves at 30 days after silking (Bhargavi, 2017). De-topping and application of 150 kg N/ ha recorded higher net returns and B:C ratio in fodder maize variety “African Tall” (Shivakumar, 2018).

## CONCLUSION

De-topping of maize significantly increased green fodder yield with little or no reduction in stover yield and grain yield. Grain yield produced by de-topping treatment was on par with control (no de-topping). De-topping after 20 or 30 days after silking or after physiological maturity of the crop provided green fodder when it was in short supply and also increased the grain yield of maize.

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