

Influence of Detopping on Fodder, Grain Yield and Economics of Rainfed Maize (*Zea mays* L.)

M. Mohamed Amanullah^{1*}

¹Maize Research Station, Vagarai, Tamilnadu Agricultural University, Tamilnadu, India.

Author's contribution

The sole author designed, analysed, interpreted and prepared the manuscript.

Article Information

DOI: 10.9734/CJAST/2020/v39i3431043

Editor(s):

(1) Dr. Tushar Ranjan, Bihar Agricultural University, India.

Reviewers:

(1) Jose Antonio Valles Romero, Universidad Nacional Autónoma de México, Mexico.

(2) Sana Ullah, Nuclear Institute for Agriculture & Biology, Pakistan.

Complete Peer review History: <http://www.sdiarticle4.com/review-history/61895>

Original Research Article

Received 10 August 2020

Accepted 15 October 2020

Published 13 November 2020

ABSTRACT

Field experiments were conducted at Maize Research Station, Vagarai, Palani Taluk, Tamilnadu during *rabi* 2018-19 and 2019-20 to find out the influence of detopping on green fodder, grain yield and economics of rainfed maize (*Zea mays* L.). The experiments were laid out in a factorial randomized block design with three stages and three heights of detopping. Three stages of detopping viz., D₁-10 days after 50% silking, D₂ -20 days after 50% silking and D₃-30 days after 50% silking were tested with three heights of detopping viz., L₁ - detopping tassel + 2 leaves, L₂ - detopping tassel + 4 leaves and L₃ - detopping tassel + 6 leaves with a control (No detopping) replicated thrice. The results of the experiments revealed that detopping 10 days after 50% silking with tassel + 6 leaves recorded higher green fodder yield. Regarding grain yield, among the days of detopping, detopping 30 days after 50% silking and detopping 20 days after 50% silking recorded higher yield which were comparable with control (no detopping) (6460 kg / ha). Among the number of leaves, detopping tassel + two leaves recorded higher yield followed by tassel + 4 leaves and both were comparable. Among the treatment combinations, higher grain yield was recorded under detopping 20 days after 50% silking with tassel + 4 leaves followed by detopping 30 days after 50% silking with tassel + 4 leaves and detopping 30 days after 50% silking with tassel + 2 leaves. Regarding economics, higher net return and BC ratio were recorded under the treatment combination of detopping 20 days after 50% silking with tassel + 4 leaves followed by control and detopping 30 days after 50% silking with tassel + 4 leaves.

*Corresponding author: E-mail: aman_agron@yahoo.co.in;

Keywords: Detopping; rainfed maize; green fodder; grain yield; economics.

1. INTRODUCTION

Maize (*Zea mays* L.) is the third most important cereal next to rice and wheat, in the world as well in India. During 2017-18, in India, the area under maize was 9.38 million hectares with a production of 28.75 million tonnes and the productivity was 3.06 t ha⁻¹ [1].

It is a versatile crop which has multiple uses and can be grown in diverse environmental conditions and. Besides its use as food, feed and fodder, maize is now gaining increased importance on account of its potential uses in manufacturing of starch, plastic, rayon, textile, adhesive, dyes, resins, boot polish, syrups, ethanol, etc. It has got immense potential and is therefore called as “queen of cereals”. Maize, is an efficient converter of carbon and absorbed nutrients into food since it is a C₄ plant.

Detopping refers to nipping or the removal of terminal portion from the uppermost node to improve the yield through greater functioning of remaining leaves by arresting unnecessary growth, decreasing mutual shading of leaves, enhancing light interception, increasing nutrient uptake, decreasing competition between the tassel and cob for available plant nutrients, diverting plant nutrients to the reproductive part [2]. Maize tassel removal may affect light penetration in the canopy, since the crop is a C₄ plant which needs high light requirement. Tassel removal may increase the seed yield and seed quality. Interaction of defoliation and tassel removal may also affect assimilate distribution between reproductive and vegetative organs. In some places detopping in maize is practiced to avoid lodging problem in fertile soils and especially in areas like coastal districts and areas prone for wind damage. In some other places detopping is practiced for getting green fodder for livestock [3]. With these ideas in view, the present investigation was planned to study the effect of detopping on green fodder, grain yield and economics of maize under rainfed condition.

2. MATERIALS AND METHODS

Field experiments were conducted at Maize Research Station, Vagarai, Palani Taluk, Tamilnadu during *rabi* 2018-19 and 2019-20. The research station is geographically situated at an altitude of 254 m above mean sea level at 10°57' N latitude and 77°56' E longitude and falls under

the Southern Agro-Climatic Zone of Tamilnadu state.

The experiment was laid out in a randomized block design (factorial) replicated thrice. The treatments were three stages of detopping at different days after 50% silking and three heights of detopping with a control (no detopping). The three stages of detopping were (Factor I: Days after 50% silking) D₁- 10 days after 50% silking, D₂- 20 days after 50% silking, D₃- 30 days after 50% silking. And the three heights of detopping are (Factor II: Heights of detopping): L₁- detopping tassel + two leaves, L₂- detopping tassel + four leaves, L₃- detopping tassel + six leaves and Control (No- detopping). The soil of the experimental field was sandy loam in texture with pH: 7.3 Ec: 0.32 dSm⁻¹, Organic carbon: 0.23%, Available N: 257 kg / ha P: 18.4 kg / ha, K: 672 kg / ha.

The maize hybrid Co6 was used for the study. Maize seeds were sown in the field at a spacing 45 cm x 20 cm on ridges on 11th Oct 2018 and 10th Oct 2019. For all the treatments, fertilizer was applied based on the recommended dose of N:P:K (40:20:0 kg ha⁻¹). Herbicide and pesticide were used to control the weeds and pests. The crop reached 50% silking at 50 DAS and the treatments were imposed at 10 days interval from 60 DAS onwards. At every detopping, the green fodder yield was recorded. During the cropping period there was a rainfall of 402.0 mm received in 12 rainy days. Green fodder, grain and stover yield were recorded. Economics *viz.*, gross return, net return and BC ratio were worked out.

3. RESULTS AND DISCUSSION

3.1 Green Fodder Yield

The data on green fodder is presented in Table 1. Among the various days of detopping, detopping 10 days after 50% silking recorded higher green fodder yield (3083 and 3014 kg ha⁻¹ in 2018-19 and 2019-20, respectively) followed by detopping 30 days after 50% silking and detopping 20 days after 50% silking and both were comparable in 2018-19. But in 2019-20, detopping 10 days after 50% silking recorded higher green fodder yield followed by detopping 20 days after 50% silking. Detopping 30 days after 50% silking recorded the least green fodder yield. The findings of Ahmed et al. [3] who

revealed that detopping at 10 days after silking could provide a remarkable amount of fodder (5 to 6 t/ha) lend support to the present finding.

Regarding the number of leaves, detopping tassel + 6 leaves recorded higher green fodder yield (4168 and 4341 kg ha⁻¹ in 2018-19 and 2019-20, respectively) followed by detopping tassel + 4 leaves. The least green fodder yield was obtained under detopping tassel + 2 leaves. This was due to detopping of more number of leaves which led to higher green fodder yield. The results have shown that the maize crop could successfully be detopped for green fodder with little or no adverse effect on grain yield. Among the detopping treatments, the highest fodder yield was obtained when the plants were detopped just above the cob [4].

Among the treatment combinations, detopping 10 days after 50% silking with detopping of 6 leaves recorded higher green fodder yield during both the years. Emran et al. [5] reported that the maximum amount of forage yield was resulted when plants were detopped leaving only one leaf above the ear. In comparison of control vs treatments, higher green fodder yield was noticed at 10 days after silking with detopping up to 6 top leaves. At all stages of detopping with detopping up to 6 top leaves, produced more green fodder yield over other treatments. This finding is in conformity with the present findings.

3.2 Grain Yield

The data on grain yield is presented in Table 2 and the pooled mean of grain yield in Table 3. The difference in grain yield of maize was significant with different stages of detopping. The highest grain yield (6034 and 6318 kg ha⁻¹ in 2018-19 and 2019-20, respectively) was recorded with D₃ (detopping at 30 days after 50% silking) and was comparable with D₂ (detopping at 20 days after 50% silking). The least yield was recorded under D₁ (detopping at 10 days after 50% silking) during both the years. The same trend of result was also evident in the pooled mean of grain yield. The above findings indicate that delay in detopping is associated with increase in grain yield. Reduction of yield as a sequence of leaf removal from maize plant when they were in early reproduction phase has been reported by many researchers [6,7]. Topping at two weeks after anthesis did not have any adverse effect on grain yield [8]. These results are in conformity with the findings of Emam et al.

[9] and Mimbar and Susylowati [10] who reported similar results.

Among the different heights of detopping, higher grain yield was obtained under L₁ (detopping tassel + 2 leaves) and was comparable with L₂ (detopping tassel + 4 leaves) while L₃ (detopping tassel + 6 leaves) recorded the lowest grain yield. The results of the present study indicate a reduction in grain yield as removal of number of leaves above the cob increased beyond 4 leaves. There is a direct relationship between grain yield and the number of leaves removed [11]. In any crop, the degree of yield reduction is directly proportional to the percentage of leaf area destroyed. The loss of functional leaf area results in loss of photosynthetic area of plant and reduce the assimilate availability [12]. The present findings are in accordance with the results of Barimavandi et al. [13] and Safari et al. [14] who reported similar findings.

The interaction effect of different stages and heights of detopping showed that significantly higher grain yield (6341 and 6449 kg ha⁻¹ in 2018-19 and 2019-20, respectively) was recorded under detopping 20 days after 50% silking with tassel + 4 leaves (D₂L₂) and was comparable with detopping 30 days after 50% silking with tassel + 2 leaves (D₃L₁) in 2018-19 and detopping 30 days after 50% silking with tassel + 2 leaves (D₃L₁), detopping 30 days after 50% silking with tassel + 4 leaves (D₃L₂) and detopping 20 days after 50% silking with tassel + 2 leaves (D₂L₁) in 2019-20. Irrespective of number of leaves, early stage of detopping reduced the yield and when six leaves were detopped, the yield reduced drastically. These results are in conformity with the findings of Emam et al. [9], Mimbar and Susylowati [10] and Subedi [15]. When compared with control vs. treatments, higher grain yield (6420 and 6460 kg ha⁻¹ in 2018-19 and 2019-20, respectively) was recorded in control (no detopping). However, comparable grain yield with control was recorded with detopping at 20 days after 50% silking with tassel + 4 leaves, detopping at 20 days after 50% silking with tassel + 2 leaves, detopping at 30 days after 50% silking with tassel + 4 leaves and detopping at 30 days after 50% silking with tassel + 2 leaves in 2018-19 (reduction of yield in percentages were 1.23%, 2.30%, 3.1% and 3.1 %, respectively, in 2018-19) and detopping at 20 days after 50% silking with tassel + 4 leaves, detopping at 30 days after 50% silking with tassel + 2 leaves, detopping at 30 days after 50%

Table 1. Influence of different stages and heights of detopping on green fodder yield of hybrid maize (Kg/ha)

Treatment	2018-19				2019-20			
	L ₁ Tassel + 2 leaves	L ₂ Tassel + 4 leaves	L ₃ Tassel + 6 leaves	Mean	L ₁ Tassel + 2 leaves	L ₂ Tassel + 4 leaves	L ₃ Tassel + 6 leaves	Mean
D ₁ -10 days after 50% silking	1439	3089	4722	3083	1238	3280	4524	3014
D ₂ -20 days after 50% silking	1311	3272	3883	2822	1024	3260	4405	2896
D ₃ . 30 days after 50% silking	1061	2883	3900	2615	1024	2452	4094	2523
Mean	1270	3081	4168		1095	2997	4341	
	SEd			CD (P=0.05)	SEd			CD (P=0.05)
Factor (I)	75			159	96			203
Factor (II)	75			159	96			203
Interaction	130			275	165			351

Table 2. Influence of different stages and heights of detopping on grain yield of hybrid maize (Kg/ha)

Treatment	2018-19				2019-20			
	L ₁ Tassel + 2 leaves	L ₂ Tassel + 4 leaves	L ₃ Tassel + 6 leaves	Mean	L ₁ Tassel + 2 leaves	L ₂ Tassel + 4 leaves	L ₃ Tassel + 6 leaves	Mean
D ₁ -10 days after 50% silking	5624	5710	5157	5497	5921	5588	5147	5552
D ₂ -20 days after 50% silking	6272	6341	5484	6032	6420	6449	5859	6243
D ₃ . 30 days after 50% silking	6220	6221	5661	6034	6444	6423	6087	6318
Mean	6038	6091	5434		6262	6153	5698	
Control (No detopping)	6420				6460			
	SEd			CD (P=0.05)	SEd			CD (P=0.05)
Factor (I)	124			264	136			289
Factor (II)	124			264	136			289
Interaction	218			463	258			542
Control vs treatment	268			583	278			591

Table 3. Influence of different stages and heights of detopping on grain yield of hybrid maize (Kg/ha) (Pooled mean)

Heights of detopping	L₁	L₂	L₃	Mean
Stages of detopping	Tassel + 2 leaves	Tassel + 4 leaves	Tassel + 6 leaves	
D ¹ -10 days after 50% silking	5773	5650	5152	5524
D ² -20 days after 50% silking	6346	6395	5672	6137
D ³ -30 days after 50% silking	6332	6322	5931	6194
Mean	6150	6122	5585	
Control (No detopping)	6440			
	SEd	CD (P=0.05)		
Factor (I)	189	400		
Factor (II)	189	400		
Interaction	327	694		
Control vs. Treatment	310	636		

Table 4. Influence of different stages and heights of detopping on stover yield of hybrid maize (Kg/ha)

Treatment	2018-19				2019-20			
	L₁Tassel + 2 leaves	L₂Tassel + 4 leaves	L₃Tassel + 6 leaves	Mean	L₁Tassel + 2 leaves	L₂Tassel + 4 leaves	L₃Tassel + 6 leaves	Mean
D ₁ -10 days after 50% silking	5958	5593	4473	5341	6138	5864	4695	5566
D ₂ -20 days after 50% silking	5816	5594	4409	5273	6032	5992	4622	5549
D ₃ -30 days after 50% silking	5953	5562	4729	5415	6172	5770	4937	5626
Mean	5909	5583	4537		6114	5875	4751	
Control (No detopping)	6065				6256			
	SEd	CD (P=0.05)		SEd	CD (P=0.05)			
Factor (I)	127	270		142	302			
Factor (II)	127	270		142	302			
Interaction	220	467		270	567			
Control vs treatment	270	587		290	617			

Table 5. Influence of different stages and heights of detopping on economics of rainfed maize

Treatment	2018- 2019				2019-20			
	Cost of cultivation (Rs.)	Gross return (Rs.)	Net return (Rs.)	BCR	Cost of cultivation (Rs.)	Gross return (Rs.)	Net return (Rs.)	BCR
D ₁ L ₁	39150	78825	39675	2.01	39150	100529	61379	2.57
D ₁ L ₂	38400	88620	50220	2.31	38400	99556	61156	2.59
D ₁ L ₃	38400	83406	45006	2.17	38400	94652	56252	2.46
D ₂ L ₁	39150	93207	54057	2.38	39150	107989	68839	2.76
D ₂ L ₂	38400	97788	59388	2.55	38400	113352	74952	2.95
D ₂ L ₃	38400	86358	47958	2.25	38400	105746	67346	2.75
D ₃ L ₁	39150	92072	52922	2.35	39150	108443	69293	2.77
D ₃ L ₂	38400	95353	56953	2.48	38400	111047	72647	2.89
D ₃ L ₃	38400	89029	50629	2.32	38400	107144	68744	2.79
Control	36400	92073	55673	2.53	36400	106744	70344	2.93

(Data not analysed statistically)

silking with tassel + 4 leaves and detopping at 20 days after 50% silking with tassel + 2 leaves in 2019-20 (reduction in yield in percentages were 0.17% and 0.25%, 0.57% and 0.62%, respectively).

3.3 Stover Yield

The data on stover yield is presented in Table 4. Stover yield declined with number of leaves removal during detopping. In comparison of control vs treatments, control (no detopping) recorded higher stover yield and was significantly superior over all other detopped treatments. On the other hand, the least stover yield was recorded when maize was detopped at 20 days after 50% silking with tassel + 6 leaves. In general, lower stover yield was obtained in all stages of detopping when detopping was done with tassel + 6 leaves. This is obvious, as there will be reduction in the stover yield as already a part of leaves is removed by detopping in all the treatments except control. Similar finding reported by Manju Bhargavi et al. [16] is in support of the present result.

3.4 Economics

Higher net return and BC ratio (Rs. 59,388 and 2.55 in 2018-19 and 74,952 and 2.95 in 2019-20, respectively) were recorded under the treatment combination of detopping 20 days after 50 % silking along with tassel + 4 leaves followed by control (Rs. 55,673 and 2.53 in 2018-19 and 70,344 and 2.93 in 2019-20, respectively) and detopping 30 days after 50 % silking with tassel + 4 leaves (Rs. 56,953 and 2.48 in 2018-19 and 72,647 and 2.89 in 2019-20, respectively). Hence, without reduction in yield and production

of green fodder, the stage of detopping at 20 days after 50% silking with 4 leaves was found to be economical to obtain higher gross returns, net returns and B:C ratio.

The findings of Manju Bhargavi et al. [17] who reported that without reduction in yield and production of green fodder, the stage of detopping at 20 days after silking up to 4 leaves was found to be economical is in support of the present finding.

4. CONCLUSION

Early stage of detopping caused a decrease in grain yield compared to later stage of detopping. However, higher green fodder yield was obtained from detopping tassel + 6 leaves, but detopping tassel + 6 leaves at early stages had negative effect on yield. Detopping 30 days after 50% silking and detopping 20 days after 50% silking recorded higher yield which were comparable with control (no detopping). Among the number of leaves, detopping tassel + two leaves recorded higher yield followed by tassel + 4 leaves and both were comparable. The highest net return B:C ratio were obtained by detopping at 20 days after 50% silking with tassel + 4 leaves and detopping at 30 days after 50% silking with tassel + 4 leaves. Hence, without reduction in yield and production of green fodder, detopping at 20 days after silking with tassel + 4 leaves was found to be economical to obtain higher gross returns, net returns and B:C ratio.

COMPETING INTERESTS

Author has declared that no competing interests exist.

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