

## INFLUENCE OF LEAF EXCISION ON PHOTOSYNTHESIS, SEED SETTING AND YIELD IN OKRA

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### SUMMARY

A study was carried out to determine the changes in photosynthesis and yield components associated with excision of leaves at different positions (odd and even nodes) in okra (*Abelmoschus esculentum* L. cv. Arka Anamika) plant. A higher sink/source ratio increased the photosynthetic rate and the leaf area of the remaining leaves. However, there was a reduction of 19-20% in fruit dry weight per plant where leaves were excised. The abortion of seeds was 15% in lower, 34% in middle and 49% in upper fruits when odd leaves were removed, while it was 17% in lower, 49% in middle and 54% in upper fruits when even leaves were removed. Though the involvement of compensatory mechanism and change in phyllotaxic relationship helped in maintaining fruit growth, seed abortion was at a higher magnitude in plants where leaves were excised, indicating insufficient photoassimilates for seed development and thus causing their abortion.

**Key words:** Fruit yield, leaf excision, okra, photosynthesis, seed abortion.

### INTRODUCTION

Leaf ontogeny and/or sink demand for assimilates influence the leaf photosynthesis. The effect of source strength on dry matter partitioning, though is indirect via the formation of new sink organs, plays an important role in a crop like okra (*Abelmoschus esculentum* L.) where the fruits are used for vegetable as well as seed production. Earlier studies (Perkins *et al.* 1952, Akoroda 1986) indicated that allowing fruits to mature on the plant for seed production resulted in alternate bearing or 'fruiting waves' reducing fruit yield per plant by 60 to 70% in okra. Regular fruit removal brought about a significant change in the partitioning of assimilates which varied with cultivars and their ontogenic stages (Bhatt and Srinivasa Rao 1997). However, in seeding okra (crop left for seed production) the pattern of dry matter partitioning to reproductive sink is influenced both by the developing sink and its affect on

the leaf photosynthesis. The present study was conducted to understand the changes in photosynthesis, seed setting and fruit yield associated with excision of leaves (source alteration) at even and odd positions in the plant in seeding okra.

### MATERIALS AND METHODS

The uniform plants of okra (*Abelmoschus esculentum* L. cv. Arka Anamika) were grown in the plastic pots (14" dia) containing garden soil and farm yard manure (3:1 v/v). Recommended package of practices were followed for growing the crop (Chadha 2001). Special care was taken to protect the plants from leaf minor attack by spraying with neem (*Azadiricta indica* L.) kernel extract (40 g/lit.) at 10 days intervals. One plant was allowed to grow in each pot. Environmental data e.g. temperature, irradiance, relative humidity and rainfall were also recorded during the

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study. The average photosynthetically active radiation (PAR) varied from 1400 to 1800  $\mu\text{mol m}^{-2} \text{s}^{-1}$  and the minimum and maximum temperature between 20-22°C and 30-32°C respectively. The relative humidity ranged from 60 to 75%.

The source was altered by excising the leaves. Plants were divided into three groups: T1 = control (no defoliation), T2 = odd leaves removed and T3 = even leaves removed. All the treatments were given at the time of fruit set. Observations were recorded on photosynthetic rate and stomatal conductance using portable photosynthetic system (ADC model LCA-3, UK). Parkinson leaf chamber (area 6.2  $\text{cm}^2$ ) was used. Flow rate of 400 ml/min was maintained during the photosynthetic observations. Leaf area was measured using LI-3000 leaf area meter. The plant parts were separated and dried in an oven at 80°C till constant weight for recording dry matter. Observations were also recorded on fruit yield, number of filled and aborted seeds per fruit. Data were analyzed statistically (Panse and Sukhatme 1967).

## RESULTS AND DISCUSSION

A reduction of 42% in total leaf area per plant was observed in the plants where odd leaves were excised (T2) and 38% where even leaves were excised (T3) (Table 1). A compensatory mechanism in defoliated plants led to an increase of 11% in leaf area when odd leaves were excised and 49% in the plants when even leaves were

**Table 1.** Leaf area ( $\text{cm}^2$ ) at individual node as affected by source manipulation in okra.

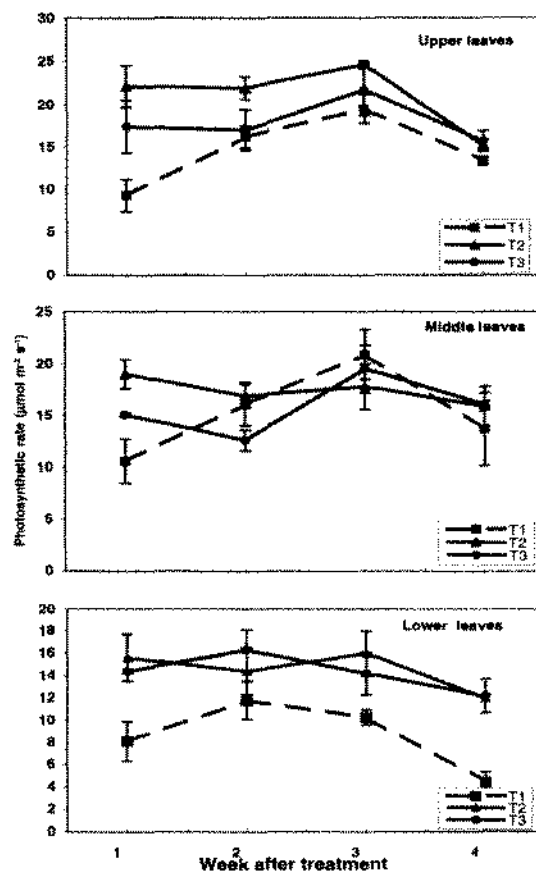
Leaf No.	Treatments		
	T1	T2	T3
1	160.28	-	163.86
2	225.64	297.10	-
3	267.84	-	347.01
4	425.28	394.11	-
5	377.20	-	418.28
6	297.63	355.17	-
7	220.53	-	393.42
8	167.05	196.60	-
Total leaf area	2141.45	1242.98	1322.37

CD at 5% P = 188.7

T1 = control, T2 = odd leaves excised, T3 = even leaves excised

removed but it appears this was not sufficient for full canopy development in treated plants.

Photosynthetic rate of lower, middle and upper leaves of control and treated plants is shown in Fig. 1. In general, the upper leaves had the highest rate of photosynthesis compared to the middle and lower leaves. In all the leaves, the photosynthetic rate was considerably higher upto three weeks after treatment compared to the control plants except for the middle leaves where no particular trend was observed. The difference in photosynthesis rate in upper and middle leaves between control and treated plants was not significant after 3rd week of treatment. The stomatal conductance was higher in the upper leaves of treated plants compared to the control plants (Fig. 2). However, no set pattern was observed in stomatal conductance in middle and lower leaves though the stomatal conductance was higher for first two weeks in treated plants compared to control plants.



**Fig. 1.** Photosynthetic rate as affected by leaf excision (T1=control, T2=odd leaves excised, T3=even leaves excised)

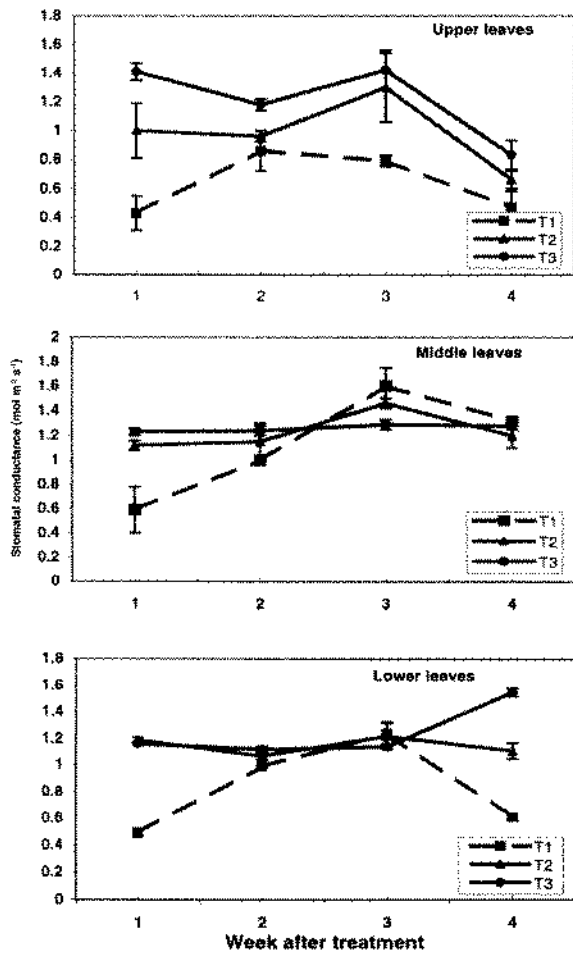


Fig. 2. Stomatal conductance as affected by leaf excision (T1=control, T2=odd leaves excised, T3=even leaves excised)

Leaf excision (even leaves or odd leaves) reduced the fruit yield per plant by 19% to 20% (Table 2). Although

Table 2. Yield components as affected by the source alteration in okra.

Yield components	Treatments			CD at 5% P
	T1	T2	T3	
Fruit weight (g plant <sup>-1</sup> )	85.83	68.81	69.20	7.36
Total seed no. (g plant <sup>-1</sup> )	692.00	545.00	578.00	NS
Total seed wt. (g plant <sup>-1</sup> )	48.32	38.91	39.80	NS
No. of filled seeds (g plant <sup>-1</sup> )	602.00	410.00	437.00	58.72

T1 = control, T2 = odd leaves excised, T3 = even leaves excised

considerable difference was found in total seed number, a significant difference was observed in number of filled seeds between control and treated plants. Number of filled seeds per plant was 32% less when odd leaves excised and 27% less when even leaves were excised. The seed number was found to be relatively more in the middle fruits both in the odd leaves and even leaves excised plants (Fig. 3a). There was a gradual increase in the number of seed abortion in ascending order of fruit position on plants (Fig. 3b). The maximum seed abortion of 49% to 54% was found in the upper fruits, followed by middle (34 to 49%) and lower fruits (15 to 17%) in treated plants. There was no significant difference in seed abortion caused by odd and even leaf excision on lower and upper node fruits but the highest percentage of seed abortion in middle node fruits was found in the plants where even leaves were removed. The effect of source alteration was more on the upper fruits in both the treatments.

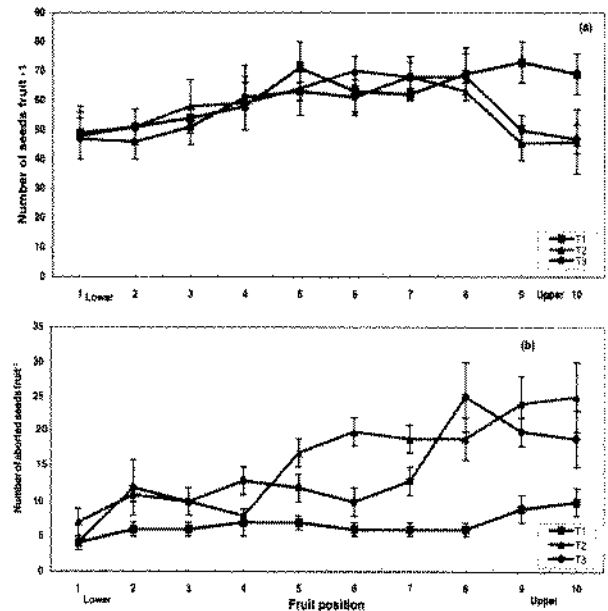


Fig. 3. Seed number (a) and seed abortion (b) as affected by leaf excision (T1=control, T2=odd leaves excised, T3=even leaves excised)

Generally, okra has no lateral branches. The increase in the leaf area of remaining leaves in response to leaf excision depends upon the position of the leaves removed from the plant. The proper development and formation of plant canopy plays an important role in growth and productivity of vegetable crops. The source alteration

irrespective of positions does not compensate the leaf area to a significant extent. The high sink-source ratio increased the photosynthetic rates in the remaining leaves by 38 to 166% in T2 and 38 to 170% in T3 indicating the involvement of an effective compensatory mechanism which helps in withstanding the defoliation in okra. In other vegetable crops also such findings were reported (Wolk *et al.* 1983, Bhatt and Srinivasa Rao 1993). However, the stage of plant growth at which source is manipulated is also important in relation to yield (Wolk *et al.* 1983). The actual mechanism which causes an increase in photosynthesis is not known, it may be due to stimulation of stomatal opening as indicated by the relatively higher stomatal conductance in source altered leaves (Fig. 2). This supports the earlier findings by Chen and Lia (1991) on soybean.

The competition for assimilates among developing fruits increases with each new additional fruit set in seed plants of okra (Akoroda 1986). Source strength exerts coarse control but not fine control over dry matter partitioning (Farrar 1992). The pattern of assimilates distribution provides an explanation for pod and seed abortion (Jeuffroy and Warenbourg 1991). Middle and lower pods appear to be priority sinks having the mobilizing ability and getting their requirement of photosynthate despite fluctuations in supply caused by source alteration at odd and even positions. In the present study in the absence of the subtending leaf after defoliation, the maintenance of the fruit growth indicates a change in phyllotaxic relationship between the pod and leaves and thus the pods receive assimilates from other leaves when it is deprived of subtending leaf. Bhatt and Srinivasa Rao (1993) found that although the subtending leaf supplies 26% radiocarbon to the pod, the immediately upper and lower leaves supply 25 and 10% carbon respectively to developing fruit in okra. It indicates that the pod of okra is not exclusively depending upon the subtending leaf. However, a reduction of 19 to 20% in fruit dry mass per plant was found in the source altered plants. The seed number was reduced by 10 to 21% and seed weight by 8 to 19%. A gradual increase in the number of seed abortion in relation to ascending fruit position caused the reduction in seed weight per pod. The maximum seed abortion was found in the upper fruits (49% in odd and 54% in even leaves excision) followed by middle (34% in odd and 49% in even leaves excision) and lower fruits (15% in odd and

17% in even leaves excision) in source altered plants. This indicates insufficient photoassimilates availability to the seeds irrespective of leaf positions and thus causing the seed abortion in spite of involvement of compensatory mechanism. The study indicated that though the involvement of compensatory mechanism and change in phyllotaxic relationship helped in maintaining the pod growth in source modified plants at odd and even positions, the seed abortion was of higher magnitude in these plants indicating insufficient photoassimilates to the seed and thus causing the seed abortion.

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