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EFFECT OF DETOPPING, DEFOLIATION AND DEFLOWERING ON PHOTOSYNTHESIS AND YIELD PARAMETERS OF NON-BRANCHING SESAME (*Sesamum indicum* L.)

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ABSTRACT

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A pot experiment was carried out at Bangladesh Institute of Nuclear Agriculture (BINA), Mymensingh, Bangladesh to investigate the influence of detopping, defoliation and deflowering on photosynthetic, yield attributes and yield of non-branching high yielding sesame cv Binatil-1. Separately detopping, defoliation and deflowering were induced at fertilization, after 5, 6, 7 and 8 capsules bearing nodes at base and continued to maturity with a control. Photosynthetic rate, number of capsule, seeds, capsule dry mass and total dry matter plant^{-1} decreased with detopping, defoliation and deflowering but 1000-seed weight was unaffected. Stomatal conductance (Ci) and transpiration rate (E) varied whereas photosynthetic rate (P_N) remained unchanged from fertilization to maturity. Seed yield decreased 68-80, 47-79 and 50-75% with detopping, defoliation and deflowering, respectively. The results suggest that detopping, defoliation and deflowering had no positive effect on the yield improvement of non-branching sesame variety, thrust should be given on the architectural development and yield improvement of branching type sesame varieties. P_N (r = -0.658*) was negatively correlated with vapor pressure deficit (VpdL). Total dry matter (TDM) (r= 0.737**), number of capsule (r=0.659*) and seeds plant^{-1} (r= 0.985**) were positively correlated with seed yield.

***Key words**: deflowering, defoliation, detopping, photosynthesis, sesame yield, stomatal conductance and transpiration*

INTRODUCTION

Sesame (*Sesamum indicum* L.) is an edible oilseed crop grown all over the world for its importance in food, medicine and industries. The sesame has yield potential of around 2.0 t ha^{-1} but low in productivity (815 kg ha^{-1}) and hence has tremendous option for management technologies. Yield is the manifestation of various physiological processes occurring in plants and they are usually modified by management practices. Improvement of sesame yield with clipping at 35 DAS (Kokilavani *et al*. 2007), decrease with defoliation (Tewolde *et al*. 1994), increase in mustard yield with defoliation at 40-85 DAS (Chhabra *et al*. 1996) whereas defoliation in soybean (Banks and Bernardi, 1987) had negative influence on yield. The sesame variety Binatil-1 (developed at BINA through mutation breeding) is non-branching, high yielding (average yield 1300 kg ha^{-1}, maximum 2000 kg ha^{-1}) and asynchronous in capsule maturity. Removal of leaves subtending capsules had relatively little effect and the greatest reduction in seed yield occurred when the growth terminal removed after heavy fruiting (Tewolde *et al*. 1994). The yield of Binatil-1 was expected to be increased more through detopping, defoliation and deflowering. So, the present experiment was carried out to investigate the influence of detopping, defoliation and deflowering at fertilization on photosynthetic, yield attributes and yield of Binatil-1.

MATERIALS AND METHODS

A pot experiment was carried out during February to May 2009 at BINA, Mymensingh, Bangladesh to assess the effect of detopping on photosynthetic, yield attributes and yield of Binatil-1. The following treatments were imposed at capsule bearing nodes at base at fertilization and continued to maturity: (1) Control (2) Detopping after capsule bearing node 5 (3) Defoliation after node 5 (4) Deflowering after node 5 (5) Detopping after node 6 (6) Defoliation after node 6 (7) Deflowering after node 6 (8) Detopping after node 7 (9) Defoliation after node 7 (10) Deflowering after node 7 (11) Detopping after node 8 (12) defoliation after node 8 (13) Deflowering after node 8. The experiment was laid out in a Randomized Complete Block design with three replications. Each pot contained one plant with 12 Kg of soils (Silty loam, organic matter 1.05%, total N 0.07%, available P 14.3 ppm, exchangeable K 0.25 meq. per 100g soil, available S 13.2 and soil pH 6.67). Total number of pots was 39. Recommended doses of fertilizers were applied and other cultural practices were followed as and when required. Photosynthetic and microclimatic parameters were recorded using *Portable Photosynthesis System LI-6400XT, LI-COR Inc.*, Lincoln, NE, USA. Correlations were performed between microclimatic and yield parameters. Statistical analysis was done as per design used with the help of MSTAT computer packages. Duncan's Multiple Range Test (DMRT) compared the means at 5% level of significance.

RESULTS

Results revealed that Control plants showed the highest photosynthetic rate identical to those with defoliation and deflowering after 5 nodes (Table 1). Ci and E were maximum with deflowering after 8 nodes. P_N remained unchanged, whereas Ci and E varied during fertilization to maturity (Table 2). P_N was negatively correlated with

VpdL (Table 3). The control treatment showed the highest number of capsule, seeds, capsule dry mass and seed yield plant^{-1} (Table 4). Number of seeds capsule^{-1} and total dry matte plant^{-1} were identical with several treatments compared to control. Detopping, defoliation and deflowering treatments had no effect on 1000-seed weight. Total dry matter, number of capsule and number of seeds plant^{-1} were positively correlated with seed yield (Table 5). Seed yield decreased 68-80, 47-79 and 50-75% with detopping, defoliation and deflowering, respectively.

DISCUSSION

In this study, Ci and E varied but P_N remained unchanged from fertilization to maturity. These might contribute to high yield and asynchrony of Binatil-1. P_N was negatively correlated with VpdL. The results of Wolfdge *et al*. (1989) lend support to this finding. The control plants showed the highest number of capsule, seeds, capsule dry mass and seed yield plant^{-1}. The results are partially supported by Tewolde *et al*. (1994) who obtained 77-93, 72-89 and 16-34% yield of control with defoliation at the vegetative, flowering and capsule filling stages, respectively and observed that the greatest reduction in seed yield occurred when all leaves were defoliated and the growth terminal removed after heavy fruiting. In branching type sesame plants, the development of auxiliary buds is inhibited normally by Indole Acetic Acid (IAA) produced in the apical meristem. If the source of auxin is removed by excising the apical meristem, the lateral branching gets accelerated. Moreover, under terminal clipping, the utilization of photosynthates by the crop for the production of lateral branches would be higher and this might be the reason for increased number of branches plant^{-1}. But these mechanisms were not effective to produce lateral branches in non-branching/uniculm type sesame mutant variety Binatil-1. In present study, number of seeds capsule^{-1} and total dry matte plant^{-1} were identical with several treatments compared to mustard that number of seeds siliqua^{-1} was unaffected by defoliation. The above results suggest that detopping, defoliation and deflowering had no positive effect on the photosynthetic, yield attributes and yields of non-branching mutant variety Binatil-1.

Table 1. Effect of detopping, defoliation and deflowering on photosynthesis, stomatal conductance, transpiration of sesame variety Binatil-1

Treatment	P_N	Cond	Trmmol	Tleaf^oC	RH_S%	PARi	Ci/Ca	O_2S_µmol	VpdL
Control	23.2 a	0.290 e	3.3 e	34	83	1148	0.52	324	1.15
DTAN5	17.0 ef	0.200 f	2.6 f	35	80	1487	0.48	328	1.42
DFAN5	22.4 ab	0.320 de	4.0 d	35	79	1478	0.53	324	1.30
DFLAN5	21.7 abc	0.310 de	4.1 cd	35	78	1475	0.54	328	1.35
DTAN6	20.1 cd	0.290 e	3.9 d	35	77	1428	0.60	320	1.45
DFAN6	20.2 cd	0.330 de	4.3 cd	35	76	1443	0.59	320	1.44
DFLAN6	18.8 de	0.358 cd	4.6 c	37	75	1347	0.62	324	1.41
DTAN7	18.4 de	0.311 de	4.4 cd	36	74	1342	0.57	322	1.51
DFAN7	16.2 f	0.311 de	4.3 cd	35	75	1335	0.65	324	1.52
DFLAN7	18.7 de	0.326 de	4.6 c	36	74	1372	0.62	322	1.51
DTAN8	20.0 cd	0.400 be	5.4 b	36	73	1397	0.62	321	1.53
DFAN8	21.1 bc	0.405 b	5.6 b	37	72	1419	0.62	321	1.52
DFLAN8	21.2 bc	0.475 a	6.2 a	36	72	1388	0.67	323	1.43

Values having common or without letter(s) in a column do not differ significantly at 5% level by DMRT

Where,
P_N = Photosynthetic rate (µmolCO_2m^{-2}s^{-1})
Cond = Conductance (mmolH_2Om^{-2}s^{-1})
Trmmol = Transpiration rate (mmolH_2Om^{-2}s^{-1})
Tleaf^oC = Temperature of leaf thermocouple (C)
RH_S% = Relative humidity in the sample cell (%)
PARi = Photosynthetic active radiation in-chamber quantum sensor (µmolm^{-2}s^{-1})
Ci/Ca = Intercellular CO_2/Ambient CO_2
CO_2S_µmol = Sample cell CO_2 (µmolCO_2mol^{-1})
VpdL = Vapor pressure deficit based on Leaf temp (KPa)
DTAN = Detopping after node
DFAN = Defoliation after node
DFLAN = Deflowering after node

Table 2. Photosynthesis, stomatal conductance, transpiration and microclimatic parameters of sesame var. Binatil-1 at capsule development to maturity

Days after fertilization	P_N	Cond	Trmmol	Tleaf^oC	RH_S%	PARi	Ci/Ca	CO_2S_µmol	VpdL
0	20.6 a	0.408 b	4.4 c	33	78	1417	0.63	326	1.20
4	20.0 a	0.222 d	2.5 e	37	84	1508	0.52	318	1.24
8	20.4 a	0.458 a	5.6 b	35	76	1245	0.65	322	1.35
12	18.1 b	0.261 c	3.3 d	36	81	1445	0.57	316	1.29
16	17.9 b	0.429 ab	5.7 b	35	75	1519	0.69	333	1.47
20	21.2 a	0.291c	4.2 c	35	71	1545	0.52	320	1.55
24	20.8 a	0.218 d	2.6 e	35	78	1368	0.49	311	1.31
28	20.4 a	0.392 b	6.9 a	38	64	1252	0.62	340	2.00

Values having common or without letter(s) in a column do not differ significantly at 5% level by DMRT

Where,
P_N = Photosynthetic rate ($\mu molCO_2m^{-2}s^{-1}$)
Cond = Conductance ($mmolH_2Om^{-2}s^{-1}$)
Trmmol = Transpiration rate ($mmolH_2Om^{-2}s^{-1}$)
Tleaf^oC = Temperature of leaf thermocouple (C)
RH_S% = Relative humidity in the sample cell (%)
PARi = Photosynthetic active radiation in-chamber quantum sensor ($\mu molm^{-2}s^{-1}$)
Ci/Ca = Intercellular CO_2/Ambient CO_2
CO_2_S = Sample cell CO_2 ($\mu molCO_2mol^{-1}$)
VpdL = Vapor pressure deficit (KPa)

Table 3. Correlation matrix of microclimatic parameters with photosynthetic rate of sesame cv. Binatil-1 at pod development to maturity

	Cond	Trmmol	Tleaf	RH_S	PARi	Ci/Ca	CO_2S	VpdL
Trmmol	0.965 **							
Tleaf	0.514	0.620						
RH_S%	-0.729 **	-0.868 **	-0.770 **					
PARi	-0.361	-0.481	-0.537	0.658 *				
Ci/Ca	0.764 **	0.840 **	0.640 *	-0.851 **	-0.745 **			
CO_2S	-0.471	-0.493	-0.328	0.502	0.380	-0.578 *		
VpdL	0.257	0.487	0.627 *	-0.839 **	-0.564 *	0.622 *	-0.358	
P_N	0.362	0.162	-0.263	-0.280	0.515	-0.201	-0.130	-0.658 *

* = Significant at 5% level, ** = Significant at 1% level, n=13

Where,
P_N = Photosynthetic rate ($\mu molCO_2m^{-2}s^{-1}$)
Cond = Conductance ($mmolH_2Om^{-2}s^{-1}$)
Trmmol = Transpiration rate ($mmolH_2Om^{-2}s^{-1}$)
Tleaf^oC = Temperature of leaf thermocouple (C)
RH_S% = Relative humidity in the sample cell (%)
PARi = Photosynthetic active radiation in-chamber quantum sensor ($\mu molm^{-2}s^{-1}$)
Ci/Ca = Intercellular CO_2/Ambient CO_2
CO_2_S = Sample cell CO_2 ($\mu molCO_2mol^{-1}$)
VpdL = Vapor pressure deficit (KPa)

Table 4. Effect of detopping, defoliation and deflowering on yield and yield attributes of Sesame cv. Binatil-1

Treatment	Capsule plant^{-1}(No.)	Seeds capsule^{-1}(No.)	Seeds plant^{-1}(No.)	1000-seed wt (g)	Seed yield plant^{-1} (g)	Yield decreased over control (%)	TDM plant^{-1} (g)
Control	54 a	47 ab	2625a	3.7	9.6 a	_	39.2 a
DTAN5	10 f	41 abc	447 d	4.4	1.9 e	80	20.0 bc
DFAN5	27 bcd	43 abc	1203 b	4.2	5.0 b	47	20.7 bc
DFLAN5	33 bc	21 c	719 bcd	3.8	2.7 de	71	29.5 ab
DTAN6	12 f	56 a	711 bcd	4.0	2.7 de	71	18.9 ab
DFAN6	37 b	31 bc	1147 bc	4.2	4.7 bc	51	28.8 ab
DFLAN6	23 cde	30 bc	725 bcd	4.2	3.0 cde	68	29.4 ab
DTAN7	16 ef	44 ab	726 bcd	3.9	2.8 de	70	17.7 bc
DFAN7	15 ef	32 bc	511 cd	4.0	2.0 de	79	11.1 c
DFLAN7	28 bcd	31 bc	840 bcd	3.0	2.4 de	75	25.3 b
DTAN8	19 def	46 ab	879 bcd	3.5	3.0 cde	68	19.6 bc
DFAN8	37 b	22 c	803 bcd	3.8	3.0 cde	68	27.3 ab
DFLAN8	28/ bcd	41 abc	1155 bc	3.4	3.8 bcd	50	27.8 ab

Values having common or without letter(s) in a column do not differ significantly at 5% level by DMRT

Where,
DTAN = Detopping after node
DFAN = Defoliation after node
DFLAN = Deflowering after node

Table 5. Correlation matrix of yield attributes with seed yield of sesame cv. Binatil-1

	TDM plant^{-1}	Capsule plant^{-1}	1000-seed wt	Seeds capsule^{-1}	Seeds plant^{-1}
Capsule plant^{-1}	0.793 **				
1000-seed wt	-0.197	0.006			
Seeds capsule^{-1}	-0.165	-0.208	0.004		
Seeds plant^{-1}	0.758**	0.653 *	-0.220	0.291	
Seed yield plant^{-1}	0.737**	0.659 *	-0.057	0.287	0.985 **

* = Significant at 5% level, ** = Significant at 1% level, n-13

CONCLUSION

Detopping, defoliation and deflowering had no positive effect on the photosynthesis and yield improvement of non-branching sesame variety Binatil-1.

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