Progressive Agriculture 29 (1): 1-9, 2018 ISSN: 1017 - 8139

Progressive Agriculture
Journal homepage:http://www.banglajol.info/index.php/PA

Source-sink manipulation on yield contributing characters and yield of Sesame *(Sesamum indicum* L.)

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Abstract

Source-sink manipulation may improve light interception into the canopy and reduce the competition between vegetative and reproductive sinks during seed filling period, and may help in achieving higher yield. So, an effort was made to assess the effect of source-sink manipulation on yield contributing characters and yield of sesame. The experiment was laid out in two factors randomized complete block design consisted of two varieties of sesame *viz.*Binatil-3 and Local-Black and five levels of source-sink manipulation *viz.*control (M_0), removal of lower empty leaves, lower empty branches and top of the inflorescence (M_1), removal of top of the inflorescence (M_2), removal of all branches and removal of lower empty leaves (M_3) and lower empty branches (M_4) with three replications. Source-sink manipulations were imposed during capsule development stage (50 days after emergence). Results revealed that the higher number of capsules plant^{-1} (16.17), seeds capsule^{-1} (53.27), maximum 1000-seed weight (2.72 g), higher seed capsule wall ratio (2.52), seed yield plant^{-1} (2.35 g), yield (938.96 kg ha^{-1}) and harvest index (36.40%) were produced by the modern variety Binatil-3 than the traditional variety Local-black. Source-sink manipulation showed positive response to yield attributes compared with control. Maximum seeds capsule^{-1} (57.13), 1000-seed weight (2.92 g), higher seed capsule wall ratio (2.71), seed yield plant^{-1} (2.78 g) and yield (1110.96 kg ha^{-1}) were found from removal of lower empty leaves, lower empty branches and top of the inflorescence (M_1). Yield was increased by 71.77%, 46.88%, 8.52% and 22.45% due to M_1, M_2, M_3 andM_4 manipulation. Although all the source-sink manipulation treatments gave higher yield in their respective variety, the highest (1258.63 kg ha^{-1} and 125.04%) yield was obtained when lower leaves, lower empty branches and top of the inflorescence of the variety Binatil-3 were removed i.e. from V_1M_1 treatment. Therefore, Binatil-3 with removal of lower empty leaves, lower empty branches and top of the inflorescence manipulation was the best treatment in respect of yield and yield contributing characters of sesame.

Key words: Source-sink manipulation, seseame, growth and yield, Binatil-3

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Introduction

Sesame *(Sesamum indicum*L.) is an important oil crop in Bangladesh which can contribute to a large extent in the national economy. Sesame seeds are unusually high in oil, around 50% of the seed weight, compared to 20% seed oil in soybeans. Oilseeds are important in the economy of Bangladesh. They constitute the second most important group of crop next to cereals occupying 4.22% of the total cropped area (BBS, 2009). Among the oilseed crops, sesame contributes about 11.03% of the country's total oilseed production. It is the second largest source of edible oil in Bangladesh (Hossain and Salahuddin, 1994) and is cultivated in over 80 thousands ha of land with a production of 50 thousand tons annually (BBS, 2009). With the increase in population, demand for edible oil has increased greatly, and production of sesame has been raised also (Kaul and Das, 1986). The average yield of this crop is very low. Major reasons of such low yield are inadequate management practices and in appropriate plant stand (Zaman, 1986). Sesame is an indeterminate and photosensitive crop. Vegetative growth and fruit development occur simultaneously, as a result there exists a competition for assimilate among source and sink organs of the plant. Canopy structure of sesame is such that lower branches and leaves overlap one another and develop mutual shading (Ghungarde *et al.,* 1992). Thus removal of lower leaves and top of the inflorescences reduce the competition for assimilate allowing the remaining fruits to develop properly. The production and utilization of photosynthates are in dynamic balance within a plant (Ho, 1992). This balance is achieved by adjusting either the capacity of leaf production (source) or the capacity of utilization of photosynthates by the growing tissues (sinks) (Evans, 1989). There are reports that sink size and its activity are affected by leaf photosynthesis through the amount and rate of supply of photosynthates, the source activity of leaf photosynthesis is affected by sink activity and its size through the amount and rate of accumulation of photosynthate in the sink (Nakatani et al., 1992). Sink capacity depends on the number of pods per unit area, the number of seeds per pod, and the individual seed size in mungbean (AVRDC, 1974). Leaf and branch clipping enhances the reproductive growth in mungbean (Howlader, 1995). Top clipping enhances the seed weight of grass pea (Parvez, 1992). Understanding of the mechanisms of yield formation through manipulation of source-sink relationship may help in designing in plant ideotype or management options for achieving higher yield in sesame. The productivity of sesame may be increased by agronomic manipulation. Source-sink manipulation may improve light interception into the canopy and reduce the competition between vegetative and reproductive sinks during seed filling period, and may help in achieving higher yield. The whole scenario and context clearly reflect that due emphasis must be given to source-sink manipulation of sesame so that the threat to the management practices which reduces yield per unit area can be encountered. Therefore, the present study was undertaken to find out the optimum source-sink manipulation of sesame varieties to study the yield and yield attributes of varieties of sesame and to evaluate the effect of source-sink manipulation on the dry matter production and yield performance of sesame.

Materials and Methods

The experiment was carried out at the experimental field of Agricultural botany, Patuakhali Science and Technology University, Dumki, Patuakhali, Bangladesh during the period of March 2015 to June 2015. The geographical location of experiment was 22.26^0N latitude and 90.22^0E longitude at an elevation of 1.5 m above the sea level (UNDP and FAO, 1988).The experimental field was characterized by subtropical climate. Moderately high temperature and heavy rainfall during the kharif season (April-September) and low rainfall with moderately low temperature during the rabi season (October-March). The experimental field was medium high land with silty clay textured soil belonging to the Ganges Tidal Flood Plain (AEZ 13) in coastal non-saline zone of Bangladesh. Soil pH value was 6.9. The organic matter content was found 0.85%. Deficiency of N is acute and widespread. Status of exchangeable K is almost satisfactory.

Treatments

One modern variety (Binatil-3) and one traditional cultivar (Local-Black) with five levels of source-sink manipulation *viz.*control (M_0), removal of lower empty leaves, lower empty branches and top of the inflorescence (M_1), removal of top of the inflorescence (M_2), removal of all branches and removal of lower empty leaves (M_3) and lower empty branches (M_4) were the treatments variable. The experiment was laid out in two factors RCBD with 3 replications. The size of unit plot was 3 m x 3 m. The total number of treatments was (2 variety × 5 levels of source-sink manipulation) 10 and the number of plots were 30. The treatments were randomly assigned in each replication. Each unit plot and block was separated from each other by 50 cm and 1m, respectively.

Fertilization

Cowdung at the rate of 10 tons per hectare was applied during land preparation. Other fertilizers at the rate of 40 kg N, 65 kg P_2O_5, 60 kg K_2O and 20 kg S per hectare in the form of Urea, Triple Super Phosphate, Muriate of Potash and Gypsum respectively were applied at the time of final land preparation (Source-Fertilizer recommendation guide, FRG, 2012). All plots were given 9 kg, 36g, 59g, 54g and 18g as cowdung, N, P_2O_5, K_2O and S, respectively. All fertilizers were incorporated into the soil as broadcast before sowing of seeds. Additional quantity of 40 kg N per hectare (36g/plot) was top dressed during flower initiation in the form of Urea.

Sowing of seeds and intercultural operation

Seeds were sown on March 07, 2015 in solid lines. Three to five seeds were sown per hill. Missing hills were sown with seeds to maintain desired plant population.The crop was always kept under careful observation. To ensure and maintain the normal growth and development of the crop intercultural operations viz. weeding, thinning, irrigation and drainagewere done at proper time.

Imposition of source-sink manipulation

The source-sink manipulation treatments were imposed by removing the designated source-sink organs with scissors at capsule development stage (50 days after emergence, DAE).

Observation and statistical analysis

The crop was harvested from an area of 1 m^2 from each plot. The data on agronomic parameters and yield components of sampled plants were recorded. The harvested plants were segmented into components such as straw (leaf, branch and stem together) and seed. Data were compiled and tabulated in proper form for statistical analysis. The recorded data on various plant characters were statistically analyzed using 'Analysis of variance technique' with the help of STAR (Statistical Tools for Agricultural research, IRRI,2014) and the mean difference were adjusted by Duncan's Multiple Range Test at 5% level of significance

Results and Discussion

Effect of variety

Variety had no significant effect on number of capsule $plant^{-1}$ (Table 1). The modern variety Binatil-3 produced numerically higher number of capsule $plant^{-1}$ than the traditional variety Local-Black. Binatil-3 produced maximum (16.17) number of capsules $plant^{-1}$ than that of Local-Black (15.54). It was observed that the Binatil-3 produced the higher number of seeds $capsule^{-1}$(53.27) and lower (48.13) number of seeds $capsule^{-1}$was obtained from Local-Black. The variety Binatil-3 had heavier 1000-grain weight (2.72 g) than traditional variety Local-Black (2.44 g). Seed:capsule wall ratio was remarkably affected by variety (Table 1). Binatil-3 had more ratio of seed capsule wall (2.52) compared to Local-Black (2.10). The higher (938.96 kg ha^{-1}) grain yield was recorded from Binatil-3 than Local-Black (735.52 kg ha^{-1}). The grain yield of Binatil-3 was 29.98% greater than that of Local-Black. The greater yield was due to the higher number of capsule $plant^{-1}$, seed $capsule^{-1}$ and heavier 1000- seed weight. The result was in alignment with the findings of Roy *et. al.* (2009) who observed that seed yield of sesame was well correlated with capsules $plant^{-1}$ and seeds $capsule^{-1}$. Harvest index obtained from Binatil-3 was significantly different from that obtained from Local-Black (Table 1). The harvest index of Binatil-3 was 36.40%, which was significantly higher than Local-Black (31.54%). This was because Local-Black had comparatively higher stover yield and lower seed yield than Binatil-3.

Table 1. Effect of variety on yield and yield attributes of Sesame

Variety	Capsule plant^{-1} (no.)	Seed capsule^{-1} (no.)	1000-seed weight (g)	Seed capsule wall ratio	Yield (g plant^{-1})	Yield (t ha^{-1})	Harvest index (%)
Binatil-3	16.17	53.27 a	2.72 a	2.52 a	2.35 a	938.96 a	36.40 a
Local- Black	15.54	48.13 b	2.44 b	2.10 b	1.86 b	735.52 b	31.54 b
$S_{\bar{x}}$	0.61	1.39	0.048	0.039	0.075	30.12	0.791
Level of sig.	NS	**	**	**	**	**	**
CV (%)	7.16	7.66	6.45	5.62	8.21	8.23	6.39

Figures in a column followed by different letters differ significantly, but with common letter (s) do not differ significantly at 5% level of probability by DMRT. * and ** = Significant at 5 and 1%, respectively, NS= Not significant

Effect of source-sink manipulation

Source-sink manipulation had significant effect on number of capsule plant^{-1}. The highest (17.23 capsule plant^{-1}) number of capsule plant^{-1}was obtained from control treatment that was statistically similar with removal of lower leaves, lower empty branches and top of the inflorescence (M_1) (16.58 capsule plant^{-1}) and removal of top of the inflorescence (M_2) (16.52 capsule plant^{-1}) (Table 2). The least number of capsule plant^{-1}(13.78 capsule plant^{-1}) was recorded from the removal of all branches (M_3) which was also statistically similar with removal of lower leaves and lower empty branches (M_4) (14.63 capsule plant^{-1}). Removal of all branches (M_2) reduced the number of capsules per plant by about 22.71%. This reduction might be due to the removal of all branches. The similar trends were observed in soybean by Hintz and Fehr (1990). They observed that defoliation, branch and stem cutoff decreased the number of capsules per unit area over non-manipulation treatment.

Seeds per capsule were influenced significantly due to the source-sink manipulation (Table 2). Maximum number of seeds per capsule (57.13) was obtained from the removal of lower leaves, lower empty branches and top of the inflorescence (M_1 manipulation). Removal of top of the inflorescence (M_2 manipulation), removal of all branches (M_3 manipulation) and removal of lower leaves and lower empty branches (M_4 manipulation) produced statistically similar seeds capsule^{-1} (53.10, 50.78 and 52.05, respectively) and were second in rank. The lowest number of seeds per capsule was obtained from control treatment (40.17).

Source-sink manipulation significantly influenced the weight of 1000-seed (Table 2). The highest (2.92 g) 1000-seed weight was achieved when the lower leaves, lower empty branches and top of the inflorescence were removed (M_1) which was statistically different from other manipulation treatments. The second highest (2.69 g) 1000-seed weight was recorded from the removal of top of the inflorescence (M_2) which was statistically similar with the removal of lower leaves and lower empty branches (M_4) (2.55 g). The minimum 1000-seed weight was registered from control treatment (2.24 g). The results indicate that the removal of lower leaves, unproductive branch and top of the inflorescence increased the dry matter accumulation in reproductive sinks resulting in higher 1000-seed weight because of the reduction in competition for assimilation of dry matter. Similar results were also endorsed in soybean by Hicks and Pandleton (1969). Parvez (1992) also reported that top clipping enhances the seed weight of grass pea.

Seed : capsule wall ratio increased significantly due to the source-sink manipulation (Table 2). All the source-sink manipulation treatments gave relatively higher seed : capsule wall ratio than the control. The highest (2.71) value of seed capsule wall ratio was obtained in the treatments with the removal of the lower leaves, lower empty branches and top of the inflorescence were removed (M_1). This might be due to the better assimilates translocation from the source to the developing seeds. Debranching and partial defoliation might increase the photosynthetic efficiency of the remaining leaves because of high light interception. Murty and Venkateswaralu (1978) reported that the rate of dry matter production is proportional to the amount of radiation intercepted by the plant. The removal of top of the inflorescence (M_2) gave the second higher (2.45) seed capsule wall ratio was statistically similar with the removal of lower leaves and lower empty branches (M_4) (2.37). Control treatment gave the lowest (1.72) seed capsule wall ratio.

Table 2. Effect of source-sink manipulation on yield and yield attributes of Sesame

Source-sink manipulation	Capsule plant^{-1} (no.)	Seed capsule^{-1} (no.)	1000- seed weight (g)	Seeds capsule wall ratio	Yield (g plant^{-1})	Yield (t ha^{-1})	Harvest index (%)
M_0	17.83 a	40.17 c	2.24 d	1.72 d	1.61 d	645.57 d	30.95 d
M_1	16.58 a	57.13 a	2.92 a	2.71 a	2.78 a	1110.96 a	37.34 a
M_2	16.52 a	53.10 b	2.69 b	2.45 b	2.37 b	948.32 b	34.94 ab
M_3	13.78 b	50.78 b	2.49 c	2.37 bc	1.75 cd	700.49 cd	32.20 cd
M_4	14.63 b	52.05 b	2.55 bc	2.29 c	1.95 c	780.89 c	34.44 bc
$S_{\bar{x}}$	0.52	1.59	0.056	0.045	0.089	35.68	0.851
Level of significance	**	**	**	**	**	**	**
CV (%)	7.16	7.66	6.45	5.62	8.21	8.23	6.39

Figures in a column followed by different letters differ significantly, but with common letter (s) do not differ significantly at 5% level of probability by DMRT. ** = Significant at 1%; M_0 = Control, M_1 = Removal of lower empty leaves, lower empty branches and top of the inflorescence, M_2 = Removal of top of the inflorescence, M_3 = Removal of all branches and M_4= Removal of lower empty leaves and lower empty branches.

Different source-sink manipulation practices created a significant variation in grain yield. The maximum (1110.96 kg ha^{-1}) seed yield was registered when the lower leaves, lower empty branches and top of the inflorescence were removed (M_1) (Table 2). Second position (948.32 kg ha^{-1}) was ranked by the removal of top of the inflorescence (M_2). Statistically similar yield was achieved when all branches (M_3) and lower leaves and lower empty branches (M_4 manipulation) were removed (700.49 and 780.89 kg ha^{-1}, respectively). Control treatment gave the lowest (645.57 kg ha^{-1}) seed yield. The yield was increased by 71.77% due to the removal of lower leaves, lower empty branches and top of the inflorescence (M_1 manipulation); 46.88% due to the removal of top of the inflorescence (M_2); 8.52% due to the removal of all branches (M_3) and 22.45% due to the removal of lower leaves and lower empty branches (M_4).The remarkable increase in seed yield of M_1 manipulationmight be attributed to the reduction in competition for assimilate requirements among the sink organs. As the lower empty leaves and lower empty branches played the role of relative sink, the removal of this relative sinks and top of inflorescence enhanced the assimilate supply to the already established capsules. This resulted in an increase in seeds per capsule and 1000-seed weight. Hicks and Pandleton (1969) reported that under ideal growth conditions, some of the lower empty leaves and branches may become parasitic due to mutual shading, during seed development period. At this period of seed development there is a competition for assimilates requirement among the capsules of different positions in the plants, such as newly formed capsules at the top of the inflorescence and relatively developed capsules of the lower position of the plants. Clifford (1979) reported that partial defoliation increases yield in mungbean.

Harvest index was increased significantly with the application of source-sink manipulation. The highest harvest index was found in M_1 manipulation which is significantly different from other manipulation treatments. The highest (37.34%) harvest index was recorded from the removal of lower leaves, lower empty branches and top of the inflorescence (M_1). The lowest (30.95%) value of harvest index was registered in control treatment (Table 2).

Interaction effect of variety and source-sink manipulation

Highly significant variation among the number of capsules per plant between variety and source-sink manipulation was noted. The modern variety Binatil-3 produced higher (18.27 capsules plant^{-1}) number of capsules plant^{-1} at control treatment. Statistically similar number of capsules plant^{-1} was obtained from the variety Binatil-3 and Local-Black when the lower leaves, lower empty branches and top of the inflorescence (M_1), top of the inflorescence (M_2) were removed (Table 3). The traditional variety Local-Black produced lowest (13.10 capsules plant^{-1}) number of capsule plant^{-1} when all branches (M_3) were removed.

Significant variations in seeds per capsule on account of the combination of variety and source-sink manipulation were observed. Where the highest (60.67 seeds capsule^{-1}) number of seeds capsule^{-1} was recorded from the treatment combination of Binatil-3 with removal of lower leaves, lower empty branches and top of the inflorescence (M_1) (Table 3). Statistically similar number of seeds capsule^{-1} was obtained from Binatil-3 when top of the inflorescence (M_2), all branches (M_3) and lower leaves and lower empty branches (M_4) were removed (55.85, 53.23 and 54.43 seeds capsule^{-1}, respectively). The traditional variety Local-Black also gave statistically similar result with removal of lower leaves, lower empty branches and top of the inflorescence (M_1) and top of the inflorescence (M_2) (54.33 and 50.33 seeds capsule^{-1}, respectively). The lowest (38.00 seeds capsule^{-1}) number of seeds capsule^{-1} was produced by the traditional variety local-black in control treatment.

In combination, variety and source-sink manipulation had significant effect on 1000-seed weight. The highest (3.10 g) 1000-seed weight was recorded from the interaction of Binatil-3 x removal of lower leaves, lower empty branches and top of the inflorescence (M_1) and the lowest (2.11 g) was recorded from the traditional variety Local-Black grown in control treatment (M_0) (Table 3).

Source-sink manipulation significantly influenced the seed capsule wall ratio. All the source-sink manipulation treatments gave relatively higher values of seed capsule wall ratio then the control (Table 3). The highest (2.96) value was obtained from Binatil-3 when lower leaves, lower empty branches and top of the inflorescence were manipulated (M_1). The removal of top of the inflorescence of Binatil-3 (V_1M_2) gave second highest value of seed: capsule wall ratio (2.68) that was statistically similar with V_1M_3 and V_1M_4 (2.60 and 2.55, respectively).

The interaction effect of variety and source-sink manipulation was found to be highly significant. The highest yield (1258.63 kg ha^{-1}) was obtained from the treatment combination of Binatil-3 with the removal of lower leaves, lower empty branches and top of the inflorescence (V_1M_1). Second position was ranked by the Binatil-3 when top of the inflorescence was removed (V_1M_2) (1025.76 kg ha^{-1}) which was statistically similar with V_1M_4, V_2M_1 and V_2M_2 (880.74, 870.87 and 603.16 kg ha^{-1}, respectively). The lowest (559.25 kg ha^{-1}) yield was recorded from the traditional variety local-black in control treatment (Table 3).

Table 3. Interaction effects of variety and source-sink manipulation on yield and yield attributes of Sesame

Variety × Source-sink manipulation	**Capsule $plant^{-1}$ (no.)**	**Seed $capsule^{-1}$ (no.)**	**1000- seed weight (g)**	**Seed capsule wall ratio**	**Yield (g $plant^{-1}$)**	**Yield (t ha^{-1})**	**Harvest index (%)**
V_1M_0	18.27 a	42.33 e	2.31 c	1.80 e	1.82 cde	731.89cde	32.95 cd
V_1M_1	16.63 abc	60.67 a	3.10 a	2.96 a	3.15 a	1258.63 a	39.74 a
V_1M_2	16.27 a-d	55.85 b	2.81 b	2.68 b	2.56 b	1025.76 b	37.94 ab
V_1M_3	14.47 cde	53.23 bcd	2.60 bc	2.60 bc	1.99 cd	797.81 cd	34.44 bc
V_1M_4	15.13 b-e	54.43 bc	2.68 b	2.55 bc	2.20 bc	880.74 bc	36.94 ab
V_2M_0	17.40 ab	38.00 e	2.11 d	1.63 e	1.40 f	559.25 f	28.96 e
V_2M_1	16.33 ab	54.33 bc	2.72 b	2.46 c	2.41 b	963.29 b	34.95 bc
V_2M_2	16.77 abc	50.33 bcd	2.57 bc	2.22 d	2.18 bc	870.87 bc	31.97 cde
V_2M_3	13.10 e	48.33 d	2.37 c	2.15 d	1.50 ef	603.16 ef	29.95 de
V_2M_4	14.13 de	49.67 cd	2.42 c	2.03 d	1.70 def	681.05def	31.95 cde
$S_{\bar{x}}$	0.74	1.82	0.079	0.063	0.126	50.45	1.20
Level of significance	*	*	**	**	*	*	**
CV (%)	7.16	7.66	6.45	5.62	8.21	8.23	6.39

Figures in a column followed by different letters differ significantly, but with common letter (s) do not differ significantly at 5% level of probability by DMRT.* and ** = Significant at 5 and 1%, respectively;V_1 = Binatil-3, V_2 = Local-black, M_0 = Control, M_1 = Removal of lower empty leaves, lower emptybranches and top of the inflorescence, M_2 = Removal of top of the inflorescence, M_3 = Removal of all branches and M_4 = Removal of lower empty leaves and lower empty branches.

Large variations for harvest index were observed between the variety and source-sink manipulation.The highest (39.74%) harvest index was found from the removal of lower leaves, lower empty branches top of the inflorescence of variety Binatil-3 (V_1M_1) that was statistically similar when top of the inflorescence (M_2) and lower empty branches (M_4) of Binatil-3 (V_1) were removed (37.94 and 36.94%, respectively) (Table 3). The lowest (28.96%) harvest index was obtained from the traditional variety Local-Black in control treatment (V_2M_0) which was also statistically similar with V_2M_2, V_2M_3 and V_2M_4 (31.97, 29.95 and 31.95%, respectively).

Total dry matter production and distribution

Production of total dry matter was higher in the variety Binatil-3 than the traditional variety Local-Black. Source-sink manipulation had significant effects on the total dry matter production as well as distribution among the vegetative and reproductive parts of the plants (Figure 1).

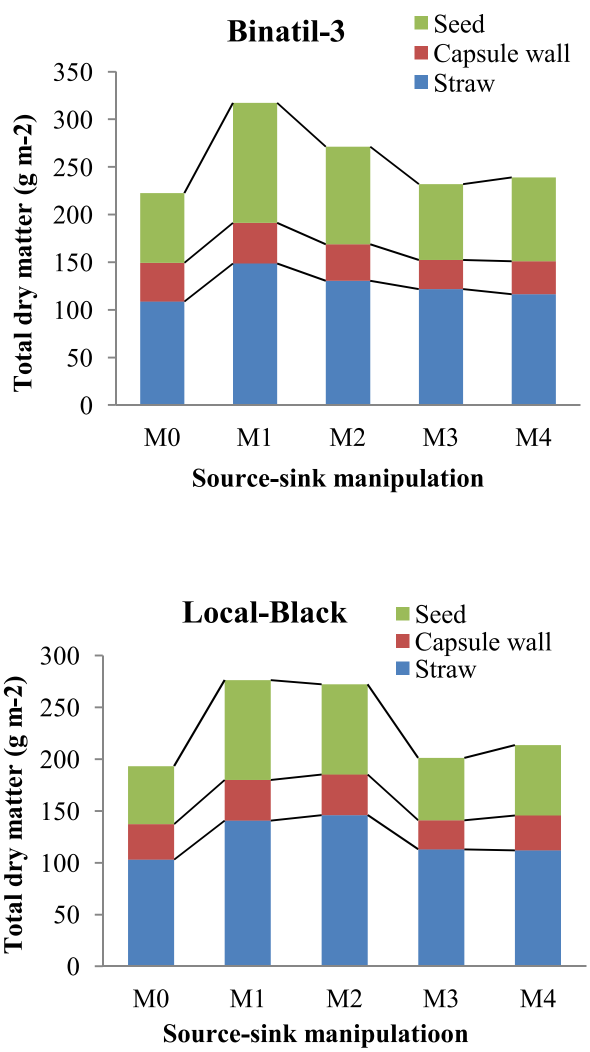

Figure 1. Total dry matter production and its distribution among straw (Stem, branch and leaf), capsule wall and seed in sesame as affected by variety and source-sink manipulation.

All the removal treatments significantly increased the total dry matter production. The variety and source-sink manipulation interacted significantly in respect of total dry matter production in sesame. The highest total dry matter production was recorded when lower leaves, lower empty branches and top of the inflorescence of the variety Binatil-3 were removed i.e. in V_1M_1 treatment and the lowest value of total dry matter production was obtained from Local-black grown in control treatment (V_2M_0). The removal of top of the inflorescence along with the lower leaves, and branches also influenced not only the total dry matter production but also the distribution of dry matter to the harvestable economic parts of the plants which resulted in a high harvest index. This indicates that the removal of vegetative and reproductive sink at later stage diverted photo assimilates to the capsules already formed which led to an increase in seed yield and consequently increased total dry matter. Similar trend in groundnut was reported by Talwar *et. al.* (1992).

Conclusion

Binatil-3 with the removal of lower leaves, lower empty branches and top of the inflorescence (V_1M_1) was the best treatment in respect of yield and yield contributing characters of sesame. Experimental results suggested that under ideal growth conditions in sesame, some of the lower leaves overlap one another and develop mutual shading and become parasitic during seed filling period. Source-sink manipulation may improve light interception into the canopy and result in a greater photosynthetic efficiency and as much as possible, reduces the competition between vegetative and reproductive sinks during seed filling period. These are the reasons why source-sink manipulation at seed development phase increased dry matter accumulation in reproductive sink as compared with control. The increased accumulation of photosynthates to reproductive sink led to an increase in seed yield.

References

AVRDC (Asian Vegetable Research and Development Center) (1974). Mungbean Annual Report for 1973. AVRDC.Shanhua, Tanian, Taiwan.

BBS (Bangladesh Bureau of Statistic) (2009). Statistical Year Book of Bangladesh. Statistics Division, Ministry of planning, Dhaka, Bangladesh.

Clifford PE (1979). Source limitation of sink yield in mungbean. Annals of Botany 43: 397-399.

Evans DH (1989). Effect of sink removal on photosynthesis and senescence in leaves of soybean *(Glycine max* L.)Plant physiol. 61:394-397.

FRG (Fertilizer Recommendation Guide) (2012). Bangladesh Agricultural Research Council Farmgate, Dhaka.

Ghungarde SR, Chavan DA, Alse UN, Yeasgaonkar GV, Pangarkar VN (1992). Effect of planting density and variety on yield of sesame *(Sesamum indicum L.). Indian J. Agro*.37(2) : 385.

Gomez KA, Gomez AA (1984). Duncan's Multiple Range Test In: Statistical Procedures for Agricultural Research. Awiley Interscience publication. John Wiley and Sons. New York., Brisbance. Singapore 139-240.

Hicks DR and Pendleton, JW (1969). Effect of floral bud removal on performance of soybeans. *Crop Sci*. 9: 435-437.

Hintz WR, Fehr (1990). Plant density and defoliation effect on the recovery of soybean injured by stem cut off during Vegetative development. *Agron. J*. 82:57-59.

Ho LC (1992). The possible effects of Sink demand for assimilate on photosynthesis, pp. 729-736.

Hossain MA, Salahuddin ABM (1994). Growth and yield of sesame in relation to population density. *Bangladesh J. of Life Sciences*. vo1. 6(1): 5965.

Howlader MAH (1995). Influence of source-manipulation on photosynthesis and dry matter partitioning in mungbean. M.S in Agronomy. Session 1988-89. Bangladesh Agricultural University, Mymonsingh.

Kaul AX, Das ML (1986). Oilseeds in Bangladesh. Bangladesh-Canada-Agriculture Sector, team, Ministry of Agriculture, The Government of the people's republic of Bangladesh, P. 63.

Murty KS, Venkateswaralu B (1978). Physiological constraints on growth and productivity in rice during kharif season. IRRI, Cuttack. pp: 45-65.

Nakatani H, Koide K, Ishihara K (1992). Effect of ear removal on dry matter production, its partitioning and photosynthesis in rice. Vol. iv : 25-28.

Parvez MM (1992). Effect of clipping at different stages of growth on the performance of grasspea *(Lathyrus sativus L.).* M.S in Agronomy. Session, 1986-87. B.A.U.

Roy N, SMA Mamun, MS Jahan (2009). Yield Performance of Sesame *(Sesamum indicum* L.) Varieties at Varying Levels of Row Spacing, Research Journal of Agriculture and Biological Sciences 5(5): 823-827.

STAR (2014). Biometrics and Breeding Informatics, version 2.0.1 PBGB Division, International Rice Research Institute, Los Baños, Laguna.

Talwar HS, Bhatia DS, Malik CP (1992). Effect of flower and gynophore removal on the biomass partitioning in various vegetative and reproductive parts in groundnut (*Arachis hypogaea* L.) Indian J. Plant Physiol. 2: 125-129.

Zaman SMH (1986). Current status and prospects for rained food grain production in Bangladesh. BRRI Pub. No. 75.p. 56.