TRANSLOCATION PATTERN OF ASSIMILATES IN INDIAN MUSTARD

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Abstract

The inefficient partitioning of assimilates to the seeds in Indian mustard /B.juncea L. Czern and Coss/ var. RH-30 warranted a study on the translocation pattern of assimilates. The data revealed that: /I/ When either lower, middle or upper leaf on the plant was fed with $^{14}CO_2$, the incorporation of labelled assimilates in the inflorescence was maximum from the middle leaf. /II/ The ^{14}C- assimilates synthesized by the siliquae on the main shoot inflorescence are translocated downward both to other siliquae and to the leaves.

Introduction

In rape plant in addition to leaves, the stem, pedicels and siliqua have the ability to assimilate atmospheric CO_2, though their contribution to seed yield varies /Major, 1975, Major et.al., 1978/, Hozyo et.al./1972/, Scott et.al. /1973 a,b/ and Brar and Thies /1977/ stressed that green walls of the siliquae contribute a substantial amount of photosynthates for their seed development.

From a series of experiments on four different Brassica species /Chhabra and Dhawan, 1982; Chhabra, 1986/ it has been established that under all optium conditions of growth:

a/ The source size is usually surplus and the removal of a part of it /especially the lower-half leaves/ escalated the yield over the undefoliated control,

b/ The sink size in relation to source size is usually surplus or moderate,

c/ The translocation of assimilates is usually a factor limiting the productivity.

These observations therefore suggest the possibility of some physiological constraints in translocation of photosynthates to reproductive sinks. The present paper therefore, attempts to illustrate the translocation pattern of assimilates i.e. from the leaves to the siliqua and vice - versa.

Material and methods

Raising the crop:

The experiments were carried out on field grown crop of B. juncea var. RH-30 raised at the Research Farm, Haryana Agricultural University, Hisar, India. The sowing was done on 23rd Oct., 1984, using a presowing dose of N and P_2O_5@ 80 and 40 kg/ha. Crop was raised in 9 plots and each plot had 2 rows of 4.5 m length. Twenty days after sowing thinning was done to maintain row to row and plant to plant distance of 30 and 15cms, respectively. All the recommended practices were followed to raise a healthy crop.

^{14}C-Translocation studies:

The pattern of translocation of assimilates was studied by feeding $^{14}Co_2$ to the assimilatery components and incorporation of radioactivity was studied in various components listed in Tables 1 and 2.

$^{14}Co_2$ feeding technique:

The selected leaf/inflorescence bearing siliquae was gently inserted in the assimilation chamber made of transparent plexi glasse of 30 cm length, 20cm width and 2.5cm height. Poured a few drops of water in the chamber to maintain humidity. To it, 1 ml of 15 μci $NaH^{14}Co_3$ solution in a vial was attached below. The chamber was sealed with a thin film of vaseline at joining points to avoid leakage and tightened. $^{14}Co_2$ was generated by injecting 2 ml of 2N-Hcl through a hole bearing a cork, just above the vial containing labelled solution. The chamber was detached after one hour of feeding $^{14}Co_2$. After allowing for 20 hours of translocation, the required plant components were prunned. The tissue was extracted in 80% alcohol thrice and the radioactive counts /cpm/ were recorded by making use of Liquid Scin tillation Counter, model LSS-34. The data expressed in Table 1 and 2 denotes net cpm/g dry wt..

Experiment-I: Translocation pattern of assimilates from lower, middle and upper leaf.

The lower most undamaged leaf, the fourth leaf from base and a leaf immediately below the upper-most leaf of 53 day, old plants in three replications each were fed with $^{14}Co_2$ to represent lower, middle and upper leaf respectively. Incorporation of cpm was observed in various plant components as listed in Table 1.

Experiment-II: Translocation pattern of $^{14}Co_2$-assimilates from the siliquae to other siliquae and leaves.

All except only three primary branches from three 120 days old representative plants were prunned in a way that three retained branches were one each at lower, middle and upper position on main shoot. The $^{14}Co_2$ was fed to the apical- half region of the inflorescence bearing siliquae. The siliquae were allowed to incorporate $^{14}Co_2$ and incorporation of radioactivity was studied in the remaining siliquae on the plant at different position and leaves as listed in Table 2.

Results

Experiment-I: Translocation pattern of ^{14}C- assimilates from lower, middle and upper leaf.

I. Lower leaf tagged: Perusal of data presented in Table 1 reveals that twenty hours after feeding lower leaf with $^{14}Co_2$, 20.7 per cent of the total incorporated assimilates were translocated to the inflorescence /buds+flowers/, while only 5.0 per cent to the 3-leaves immediately above the fed leaf and 2.2 per cent to the 3- top leaves. Fed leaf retained 72.1 per cent of the assimilates untranslocated.

II. Middle leaf tagged: Feeding middle leaf resulted in translocation of a higher percentage of assimilates to

the inflorescence, i.e. 33.3 per cent compared to 20.7 per cent when the lower leaf was fed /Table 1/.
The assimilates translocated to the lower-3-leaves and upper-3-leaves were 8.6 and 6.2 per cent respectively. The middle leaf retained lesser counts, i.e. 51.9 per cent compared to 72.1 per cent when the lower leaf was fed.

III. Upper leaf tagged: The upper leaf retained 69.3 per cent of the assimilates untranslocated and translocated 7.5, 2.5 and 20.7 per cent to the 3-leaves immediately below the tagged, 3-lower most leaves and the inflorescence respectively.

Experiment-II: Translocation pattern of $^{14}Co_2$-assimilates from the siliquae to other siliquae and leaves.

$^{14}Co_2$ was fed to the siliquae and distribution observed in components:-

I. Tagged siliquae- On main shoot inflorescence: The siliquae were observed to be photosynthetically active and hence, $^{14}Co_2$ feeding resulted in incorporation of substantial amount of labelled assimilates. Assimilates incorporated by the siliqua wall and the enclosed seeds were at par /Table 2/.

II. Lower untagged siliqua- On the main shoot inflorescence: The labelled assilimates from the $^{14}Co_2$- fed silique were translocated to the lower siliquae on the main shoot inflorescence /Table 2/. But, surprisingly the counts incorporated in the seeds were lesser than in the siliqua wall.

III. Siliquae on lower, middle and upper inflorescence: An interesting observation /Table 2/ was that the labelled assimilates were absolutely not retained by the silique wall on any of the inflorescence /lower, middle or upper/, but some counts were definitely incorporated by the seeds on all these inflorescence.

IV. Leaves: The labelled assimilates from the $^{14}Co_2$- fed siliquae were translocated downward to the other leaves as well and the cpm incorporated by the leaves were either at par or higher than even the seeds.

Discussion

The data presented in Table 1 reveals that when the lower leaf was fed with $^{14}Co_2$, relatively more percentage of assimilates were translocated to the nearby leaves i.e. 3-leaves immediately above the fed leaf, than to the distant leaves i.e. 3-top leaves. This observation collaborates with the earlier hypothesis of Cook and Evans /1976 and 1983/.

When the middle leaf was fed with $^{14}Co_2$, assimilates were translocated to the leaves both above and below the fed leaf. The assimilates translocated to the lower leaves were much greater than translocated to the upper leaves. This suggests and supports our earlier contention that the lower leaves in Brassica serve as "sink leaves" and their removal results in a marked enhancement in seed yield /Chhabra and Dhawan, 1982, Chhabra, 1986/.

The data /Table 1/ further reveals that the assimilates translocated to the inflorescence "per cent of total incorporated/ were more by feeding the middle leaf than by feeding the lower leaf. This suggests relatively higher assimilatory contribution of the middle leaves than the upper leaves.

By feeding the upper leaf, the inflorescence received a relatively lower percentage of total assimilates than when the middle leaf was tagged but nearly it was at par with when the lower leaf was tagged.

The nearly equal percentage of assimilates translocated from $^{14}Co_2$- fed lower and upper leaf and although it seems surprising it can be explained reasonably. Although the upper leaf is photosynthetically more active than the lower leaves which is evident from maximum total incorporation of counts, surprisingly the upper-fed leaf retained a very high percentage of assimilates. This observation suggests that upper fed-leaf being very young although may be a net exporter of assimilates retains a very high amount of assimilates for its development. Earlier defoliation studies /Chhabra, 1986/ have indicated that the upper one-third leave of canopy contributes the maximum assimilates to the seeds followed by middle and lower leaves respectively /Chhabra, 1986/. However, the basic difference in these two observations lies in the fact that the upper leaf selected for $^{14}Co_2$ feeding was extremely very small in size and it does not represent the upper one-third canopy in true sense /Chhabra,1986/.

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Table-1. Translocation pattern of assimilates from lower middle and upper leaves of *B. juncea* Var. RH-30.

Plant part	cpm x 10^{-3}/g dry wt.	Incorporation: per cent of total
	Lower leaf tagged	
Tagged leaf	68061 ± 18772	72.1
3 leaves above tagged leaf	4748 ± 363	5.0
3 top leaves	2062 ± 158	2.2
Inflorescence	19634 ± 5449	20.7
Total	94505	-
	Middle leaf tagged	
Tagged leaf	23848 ± 1826	51.9
Lower -3-leaves	3944 ± 342	8.6
Upper-3-leaves	2859 ± 784	6.2
Inflorescence	15325 ± 2347	33.3
Total	45976	-
	Upper leaf tagged	
Tagged leaf	103429 ± 10632	69.3
3 leaves below tagged leaf	11187 ± 2006	7.5
3 lower most leaves	3731 ± 371	2.5
Inflorescence	30749 ± 1913	20.7
Total	149096	-

Table-2. Translocation pattern of assimilates synthesized by the siliquae in *B. juncea* Var. RH-30.

Plant part	cpm/g dry wt.
Siliqua wall-from tagged siliquae of main shoot (A)	3353 ± 600
Seeds from (A)	3195 ± 187
Siliqua wall-from untagged siliquae of main shoot (B)	444 ± 106
Seeds from (B)	101 ± 33
Siliqua wall-from siliquae on upper branch (C)	0 ± -
Seeds from (C)	185 ± 25
Siliqua wall-from siliquae on middle branch (D)	0 ± -
Seeds from (D)	134 ± 20
Siliquae wall-from siliquae on lower branch (E)	0 ± -
Seeds from (E)	149 ± 19
Middle leaf from lower most primary branch	179 ± 20