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# Study of dry matter partitioning into leaf, stem and pod at different oilseed rape cultivars

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## Abstract

Simulation of dry matter partitioning and distribution of crop is an important means of predicting yield .In order to evaluation of leaf and pod partitioning coefficient among 13 spring rapeseed cultivars, an experiment was carried out in 2010 growing season at Agriculture and Natural Resources Research Station of Torogh , Mashhad. Experimental design was Randomized Complete Block with 4 replications. Results revealed that considerable difference was existed among cultivars for leaf partitioning coefficient .In this trail Goldrush with 0.68+0.076 gr/gr and Zarfam with 0.68+0.074 gr/gr had the most and BP18 with 0.22+0.15 gr/gr had the least leaf partitioning coefficient rather than other cultivars respectively .Leaf-stem partitioning figures showed that from onset till cessation of flowering, stems were both more active and bigger sources than leaves for receiving of assimilations. Meanwhile lessening trend of leaf partitioning during flowering period was observable among spring cultivars .significant difference was obtained among varieties regarding partitioning coefficient into pod. Hyolla hybrids represented the most pod partitioning coefficient in comparison with other cultivars. Both yield and harvest index had strong and positive correlation with pod partitioning coefficient in this experiment.

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## Introduction

Rapeseed is a new oilseed crop in Iran and its hectares has been currently expanding also canola production after soybean and palm is the third largest oilseed crop. Undoubtedly cultivation of rapeseed seems to be useful for lessening of imports of vegetative oils in Iran (Arvin, 2009).

Photosynthesis rate define as available carbon fixation in leaf. Regulation of carbon fixation rate in different metabolic pathways defined as a allocation. Vascular bundles formed tube systems that can able to transform photoassimilate into different organs such as young leaves , stems , roots , fruits or seeds. Different distribution of photoassimilate within plant called partitioning (Taiz and Zeiger, 2010).

.according to the yield equation, productivity of crop canopies is analyzed in terms of total incident solar radiation , the proportion of the incident solar radiation that is intercepted by crop canopy , the efficiency of conversion of intercepted radiation into plant dry matter and partitioning of dry matter among various crop components(Echarte *et al.,* 2008).

Staford ( 1996) stated that remobilization from stem did not occur. Also he expressed that dry weight of oilseed rape leaves reduce during growth period and the most leaves dry weight reduction is associated with falling leaves. Leaves transform a bit part of their photoassimilate into pods that are placed in lower parts of canopy (Staford,1996).

Leaves in brassica oilseed rape are fundamental sources of photosynthetic production. In spite of quickly leaves senescence in pod development stage , the leaves photoassimilate form some highlight structure like as number of pod or number of seed per pod .remobilization overall photosynthetic material from leaves to other parts of canopy happen at leaf senescence stage.

After falling leaves, ultimately both stems and pods are important sources of photoassimilate production (Major *et al.*, 1978).

Three methods have been applied to the partitioning of crop dry matter(marcelis,1993): (i) modeling based on source-sink adjustment theory (Minchin *et al.*,1993) ; (ii) function equilibrium theory (Levin and Mooney,1989;hunt *et al.*,1998) and (iii)partitioning coefficient or index theory(singels and bezuidenhout,2002;tang *et al.*,2007a).the source-sink model has been little use because sink ability in absorption of assimilated products is determined by sink intensity (marcelis,1996), and the sink intensity of plant components are quantified by potential growth speed which is difficult to obtain in practice, especially for vegetative organs. Function equilibrium models succeed in simulating dry matter partitioning to shoots and roots by building relationships between shoot (photosynthesis rate) and root vigour (absorption of water and nutrients) but fail to simulate partitioning of the shoots dry matter to other above-ground organs. On the hypothesis that the ratio of growth rate or relative growth rate among different organs is constant or is a function of time, accumulated temperature or plant size at a particular growth stage of the crop , a model based on a partitioning coefficient or index is not as good as the source-sink model in terms of its methodology but is more practical because its parameters are easily measured(Jichuan *et al.*,2012).

In order to determination of leaf partitioning and its importance in construction of plant architecture and earning of pod partitioning and its relationship with final yield and harvest index , this study was carried out.

## Material and methods

*Experimental location characteristics*

The experiment was conducted on 2010 growing season at Agriculture and Natural Resources Research Station of Torogh, Mashhad in East-North of Iran (36˚ N , 59˚ E , 1003 asl and annual rainfall 286 mm). soil texture was silty loam .each experimental plot included 4 planting rows with 6 meter length. Distance of planting on rows was 30cm and planting density was 43 plants per m².

*Experimental design and treatment*

Experimental design was Randomized Complete Blocks with 4 replications. 13 cultivars from rapeseed species were sown at 20 February 2010. Cultivars of Hyolla 401, Hyolla 330, Option 500, Sarigol, RGS003, Zarfam, Echo and Swchotshot were belonged to *B .napus* species. Hysun 110, Rinbow, Goldrush and Parkland were belonged to *B.rapa* species, and BP.18 was a part of *B.juncea* species.

*Data collection*

Leaves, stems and pods were separately taken from three plants of each plots. Sampling of leaves, stems and pods were dried at 70 ·c for 48 hours and next were weighted. Measurement of dry matter was done weekly.

In order to determine of partitioning coefficient for different organs, below formula was applied(Rizzalli *et al.*,2002).

$$PC_i = \frac{\Delta DM_i}{\Delta DM_{tot}}$$

Where $Pc_i$: dry matter distribution coefficient for i organ interval between sampling ; Δ DMi : change of dry matter of singular organ between sampling ; Δ DMtot : change of total shoot dry weight in the desired organ in the interval between sampling.

Finally, relationship between cumulative dry matter for each organ (leaf , stem and pod) versus cumulative dry matter for shoot were calculated and slope of this equation gave the dry matter distribution coefficient.

Harvest index (HI) in each plot at maturity stage were calculated through the following equation (Arvin, 2009)

HI= EY/BY *100

Where EY is seed dry weight and BY is total dry weight.

At maturity stage, final seed yield was calculated from 2 middle rows of each plot and harvested yield level was about 3m² in each plot.

*Statistical analysis*

All data were analyzed statistically using SAS 9.1 package and all graphs were drown using Excel.

**Result and discussion**

*Material partitioning coefficient into leaf and stem*

Distribution coefficient for cumulative leaf dry matter versus cumulative total shoot dry matter was obtained by using regression fit (table 1). Rate of determination coefficient ($R^2$) and coefficient of variation (CV) of leaf was defined. There was considerable difference among cultivars for leaf partitioning coefficient based on rate of ±SE.

**Table 1.** Material partitioning coefficient into leaf , Determination coefficient($R^2$) and Coefficient variation (CV) in spring oilseed rape cultivars.

| CV (%) | Determination coefficient ) $R^2$ | Material partitioning coefficient into leaf gr / gr | Replication | cultivars |
|---|---|---|---|---|
| 22.14 | 0.88 | 0.26±0.098 | 4 | *Hyolla 401* |
| 22.03 | 0.86 | 0.34±0.13 | 4 | *Hyolla 330* |
| 9.86 | 0.99 | 0.45±0.65 | 4 | *Option 500* |
| 10.9 | 0.97 | 0.38±0.071 | 4 | *Sarigol* |
| 4.6 | 0.99 | 0.33±0.028 | 4 | *RG003* |
| 7.9 | 0.98 | 0.68±0.074 | 4 | *Zarfam* |
| 24.5 | 0.29 | 0.34±0.21 | 4 | *Parkland* |
| 5.8 | 0.98 | 0.68±0.076 | 4 | *GoldRush* |
| 13.08 | 0.83 | 0.24±0.71 | 4 | *Echo* |
| 2.69 | 0.99 | 0.3±0.16 | 4 | *Swchotshot* |
| 33.86 | 0.68 | 0.22±0.15 | 4 | *BP18* |
| 11.28 | 0.97 | 0.34±0.059 | 4 | *Rinbow* |
| 14.32 | 0.58 | 0.25±0.0103 | 4 | *Hysun 110* |

Goldrush and Zarfam with 0.68±0.076 and 0.68±0.74 had the most and BP18 with 0.22±0.15 had the least gram leaf dry matter per gram total shoot dry matter respectively at final stage of flowering (table 1).

The highest partitioning coefficient in Goldrush and Zarfam were justifiable because these tow cultivars had winter-spring nature and also placing in spring planting regime leaded to uncompleted vernalization so receiving insufficient of coldness units caused more vegetative growth and production of more leaves for these cultivars rather than others.

Having notable characteristic of Zarfam and Goldrush including high leaf partitioning coefficient , suitable architecture, emergence of early phenological stage and so on , can be predictable if these tow cultivars be placed at appropriate regimes so it can lead to formation more yield.

**Table 2.** Material partitioning coefficient into pod, Determination coefficient($R^2$) , Coefficient variation (CV) and mean comparison of final yield in spring oilseed rape cultivars.

| Mean comparison of yield Kg/ha* | CV (%) | Determination coefficient $R^2$ | Material partitioning coefficient into pod gr / gr | Replication | cultivars |
|---|---|---|---|---|---|
| 1274a | 32.7 | 0.7193 | 0.7475±0.2166 | 4 | *Hyolla 401* |
| 1475a | 33.8 | 0.7552 | 0.709±0.173 | 4 | *Hyolla 330* |
| 464.3e | 48.9 | 0.4722 | 0.258±0.106 | 4 | *Option 500* |
| 526.8de | 57.8 | 0.3594 | 0.299±0.163 | 4 | *Sarigol* |
| 1007b | 49.2 | 0.4691 | 0.411±0.178 | 4 | *RG003* |
| 75.89f | 67.3 | 0.0281 | 0.0048±0.011 | 4 | *Zarfam* |
| 757.4c | 40.2 | 0.6131 | 0.426±0.169 | 4 | *Parkland* |
| 0.0001f | 69.4 | 0.0301 | 0.001±0.0023 | 4 | *GoldRush* |
| 745.5c | 52.3 | 0.3915 | 0.150±0.176 | 4 | *Echo* |
| 495.5e | 58.3 | 0.5896 | 0.316±0.176 | 4 | *Swchotshot* |
| 1277a | 50.1 | 0.6578 | 0.528±0.155 | 4 | *BP18* |
| 928.6bc | 48.5 | 0.363 | 0.357±0.193 | 4 | *Rinbow* |
| 711.3cd | 41.2 | 0.6561 | 0.512±0.161 | 4 | *Hysun 110* |

Note*:column means followed by the same letter are not significantly different at 5% probability level using least significant difference(LSD).

Lower partitioning coefficient for BP18 was due to (Azizi *et al.*,1999) small structure of leaves belong to this species (*Brassica juncea*) rather than two other species( *Brassica napus* and *Brassica rapa*).

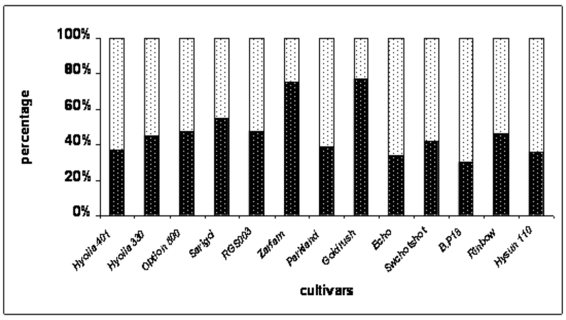


**Fig. 1.** Percentage of dry matter into organ (white part = stem and black part=leaf ) at initiation of flowering.

It's clear that availability of production inputs such as water, solar radiation, nutrition, carbon dioxide, temperature, especially in vegetative period causes production of more vegetative dry matter (Diepenbrock, 2000). We concluded that interval between initiation and cessations of flowering, majority part of photoassimilate were devoted into stems (fig. 1 and 2).

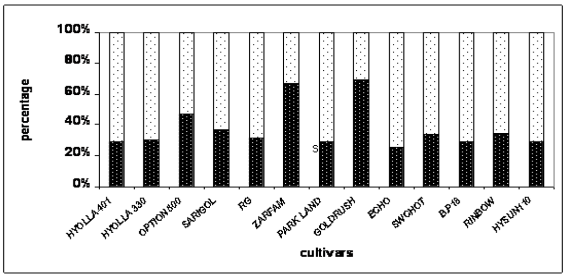


**Fig. 2.** Percentage of dry matter into organ (white part = stem and black part=leaf ) at cessation of flowering.

The reasons of these processes can be explained in this way.

Falling leaves occurred during , especially last of flowering so leaf dry matter contribution ratio to total dry matter decreased so these may be inferred that in this stage , stems had priority for receiving photosynthetic materials than leaves had. On the other hand, lessening trend of partitioning photosynthetic materials into leaves was related to falling leaves physiology (Azizi *et al.*,1999; Diepenbrock,2000).

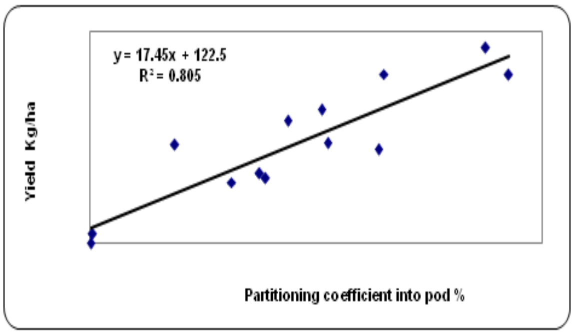


**Fig. 3.** Relationship of partitioning coefficient into pod with Yield.

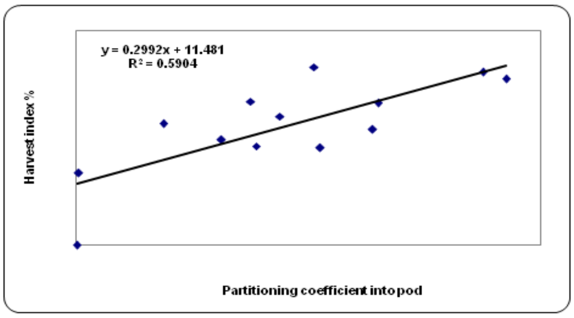


**Fig. 4.** Relationship of partitioning coefficient into pod with Harvest index.

*Material partitioning coefficient into pod*

There was significant difference among varieties regarding pod partitioning coefficient based on rate of±SE. Hayolla401 and Hayolla330 with 0.74759±0.2166 and 0.709±0.1731 had the most and goldrush with 0.001+0.0023 had the least gram leaf dry matter per gram total shoot dry matter respectively at maturity stage (table 2).also results of mean comparison of final seed yield indicated that hayolla330 with mean of 1475 kg/ha and hayolla401 with mean of 1274 kg/ha had the highest final seed yield. goldrush was placed at the lowest rank regarding this trait.seed per pod, number of lateral branch and seed 1000 weight were from yield component in which cause to form more final yield in Hyolla hybrids (Arvin,2009).movment of more photoassimilate from plant sources into pods is the main factor of increasing of material partitioning coefficient into pods( Dipenbrock,2000).

Allocation of more photoassimilate into economic organs can have positive and high correlation with final yield and harvest index(berry and spink,2006). As its was interpreted from fig 3 and 4 , material partitioning coefficient into pod had 80% positive correlation with final yield and had 59% positive correlation with harvest index.

Comprehensive studies in future on leaves , as the main source of capturing and converting of solar radiation and pods as the main economic organ should be done so better understanding of principals of yield formation especially in Brassica oilseed rape can be both useful and helpful for boosting more production per unit land area per unit time.

## References

**Arvin P.** 2009.Study on the physiological and morphological basis of yield differences between spring cultivars species of rapseed. M.Sc. thesis. Islamic Azad University, Bojnourd branch,Iran ( in Persian).

**Azizi M, Soltani A, Khavari S.** 1999.Brassica oilseeds.Jahad Daneshgahi Mashhad Press.230 PP (Translated in Persian).

**Berry MP, Spink JH.** 2006. A physiology analysis of oilseed rape yield, past and future (Review).Journal of Agriculture Science **199,** 381-392.
http://dx.doi.org/10.1017/S0021859606006423

**Diepenbrock W.** 2000. Yield components of winter oilseed rape (*Brassica napus* L.) :A review. Field crops Research **67,** 35-49.

**Echarte L, Rothstein S, Tollenaar M.** 2008.The response of leaf photosynthesis and dry matter accumulation to nitrogen supply in an older and a newer maize hybrid. Crop Science **48,** 656-665. http://dx.doi.org/10.2135/cropsci2007.06.0366

**Jichuan W, Gao S, Yuan J, MA F.** 2012.Simulation of dry matter accumulation, partitioning and yield prediction in processing tomato ( *Lycopersicon esculentum* Mill.).Australian Journal of Crop Science **6,** 93-100.

**Hunt HW, Morgan JA, Read JJ.** 1998. Simulating growth and root-shoot partitioning in prairie grasses under elevated atmospheric CO2 and water stress. Annals of Botany- London **81,** 489-501.

**Levin SA, Mooney HA.** 1989. The dependence of the plant root:shoot ratios on internal nitrogen concentration. Annals of Botany-London. **64,** 71-75.

**Major DJ, Bole JB, Charnetski WA.** 1978. Distribution of photosynthates after $^{14}$ $Co_2$ assimilation by stems‹ leaves and pods of rape plants. Canadian Journal of Plant Science **58,** 783-787.

**Marcelies LFM.** 1993. Simulation of biomass allocation in greenhouse crops (Review).Acta Horticulturae **328,** 49-67.

**Marcelies LFM.** 1996. Sink strength as a determinant of dry matter partitioning in the whole plant. Journal of Experimental Botany **47,** 1281-1291.

**Minchin PEH, Thorpe MR, Farrar JF.** 1993.A simple mechanistic model of phloem transport which explain sink priority. Journal of Experimental Botany. **44,** 947-955.

**Rizzalli RH, Villalobos JF, Orgaz F.** 2002. Radiation interception, radiation use efficiency and dry matter Partitioning in garlic (*Allium sati*Ph.D.Thesis. *vum* L.). European Journal of agronomy **18,** 33-43.

**Staford JA.** 1996. The effects of prochoraz on the growth and yield of oilseed rape. University of Nottingham.

**Singels A, Bezuidenhout CN.** 2002.A new method of simulating dry matter partitioning in the canegro sugarcane model.Field Crop Research **78,** 151-164.

**Tang L, Zhu CH, Wx JU, Cao.** 2007a.Dynamic simulation on shoot dry matter partitioning and yield formation of rapeseed.Chin Journal of Applied Ecology **18,** 526-530.(in Chinese).

**Taiz L, Zeiger E.** 2010. Plant physiology .Fifth Edn. Sinauer Associates publication.690 p.