RELATIVE CONTRIBUTION OF PRE AND POST ANTHESIS DRY MATTER TO PRODUCTIVITY: AN ANALYSIS IN SUNFLOWER

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ASTRACT

Stored dry matter (Pre-anthesis) and current assimilation (Post-anthesis) are the two major sources of assimilates for seed development. Analysis of the relative contribution of these sources and the constraints thereof is critical in improving crop productivity.

In this paper, we attempt to analyse the contribution of pre- and post -anthesis dry matter to the productivity of a few sunflower genotypes following a simple physiological approach.

Our results suggest that genotypes which translocate dry matter both from pre and post-anthesis stages, on an average yield more than the genotypes in which there is only post-anthesis contribution. In the latter genotypes, the lack of pre-anthesis contribution is more due to unavailability of stored dry matter than due to the inability of the genotypes to translocate the resources. Productivity in sunflower can hence be increased by encouraging a higher pre-anthesis storage of dry matter.

We conclude that selection for high pre-anthesis storage dry matter coupled with active current assimilation during seed development could contribute significantly towards the improvement of productivity in sunflower.

Key Words: Sunflower, Pre-anthesis dry matter (PDM), Pre- and Post anthesis DM contribution.

INTRODUCTION

Seed development in any crop is dependent upon the translocation of assimilates contributed by the stroed reserves and that from current assimilation. The relative extent to which these two sources contribute to the total biomass accumulated in seed determines the final productivity of the crop. Identification of the relative contribution and developing strategies to improve them could increase the productivity of crops.

In sunflower, a determinate oilseed crop, productivity is generally low. Earlier work in this direction have shown that this could arise due to poor assimilation in this species. In addition, the poor productivity is also attributed to frequent moisture stress that has prevalant during monsoon season in most parts of the India. Sadras et al. (1993) showed that under moisture stress, the contribution of pre-anthesis dry matter to the seed development is relatively high. They argued that sunflower adopts an opportunistic strategy to accumulate high dry matter during pre-anthesis period and translocating them to seed particularly under end season moisture stress.

In this study we have examined the genotypic variation in the contribution of pre and post-anthesis dry matter partitioning to productivity and discuss the possible approaches to improve productivity of sunflower.

MATERIAL AND METHODS

A field experiment was conducted during the rainy season of 1994 at the University of Agricultural Sciences, Bangalore on red loamy soils (pH 6.5). Nine sunflower germplasm lines of similar duration (105 days) were sown in three replicates in completely randomised block design in plots of size 3 x 3m. Crop was raised following all the recommended practices for sunflower cultivation.

Observations on above ground total dry matter (TDM) through its individual components (lamina, stem + petiole and thalamus + seed) were recorded at ray floret stage and at crop maturity. Leaf area at ray floret stage was measured using non-destructive technique (Nanja Reddy et al., 1995).

The contribution of dry matter present in the vegetative parts at pre-anthesis to the capitulum (thalamus + seed) and to seed were computed after modififying the method suggested by Gallagher et al. (1976).

(a) The per cent pre-anthesis dry matter (PDM) contribution to head (Total):

$$= \frac{\text{L + S at ray floret stage} \; - \; \text{L + S at harvest}}{\text{Capitulum weight at harvest} \; - \; \text{Capitulum weight at ray floret stage}} \times 100$$

(b) Per cent PDM to seed:

$$\frac{\text{L + S + C at ray floret stage} \; - \; \text{L + S + Thalamus at harvest}}{\text{Seed yield}} \times 100$$

wherein, L,S and C are leaf, stem and capitulum dry weights respectively

(c) Per cent contribution to thalamus:

(a) - (b)

(d) The per cent contribution to seed yield during post-anthesis stage:

100- (b)

RESULSTS AND DISCUSSION

While the total dry matter (TDM) at ray floret stage was highly positivley correlated to seed yield ($r = 0.81$ $P < 0.05$), the post-anthesis TDM was not ($r= 0.23$, $P> 0.05$). This indicates that in sunflower there should be a significant contrtibution of dry matter from the pre-anthesis reserves. We anlaysed for this prediction by classifying the genotypes into two groups that is, high and low pre-anthesis dry matter (PDM) types (more and less than the genotypic average of 327 $g.m^{-2}$ respectively). Wide variation of nearly four to five fold was seen for all the parameters studied excepting the harvest index (Table 1). Significant genotypic variation existed for all the parameters studied (Table 2). Among the two groups, dry matter (DM) at any given stage and seed yield differed significantly. Seed yield of high PDM types was 43 per cent more compared to low PDM types. The TDM at harvest was also high in high PDM types but, the TDM after anthesis was less by 56 per cent. Harvest index and leaf area did not differ significantly. This clearly indicates that genotypes producing high PDM would yield more.

In studying the contribution of PDM towards seed yield, the high PDM types showed higher contribution (52 %) than the low PDM types (Table 3). Similarly, Hall <u>et</u> <u>al</u>. (1989) showed that 27 per cent of seed yield in sunflower was contributed from pre-anthesis stored soluble carbohydrates based on carbon labelling study. Seed yield derived from both pre- and post-anthesis DM (in high PDM types) was significanlty more compared to the genotypes in which seed yield comes solely from post-anthesis (current photosynthates). This suggests that, pre-anthesis translocation is mainly dependent on the amount of DM accumulated at the time of anthesis. Correlation analysis within a genotype group showed that, seed yield is significantly and positively related to the DM produced at any given crop growth stage including post-anthesis phase in both high and low PDM types. This suggests the importance of post-anthesis dry matter during seed filling period towards grain yield. Therefore, maintenance of higher LAD during seed filling phase should be an important trait for higher productivity. A positive significant relationship between HI and seed yield was observed in low PDM types. However, no such relationship was observed in high PDM types indicating that, current photosynthates are locked up in vegetative plant parts probably because of low sink demand. Therefore, in general, genotypes should be selected for high DM at anthesis and also for maintenance of higher LAD during post-anthesis period. If, pre-anthesis biomass accumulation is more, it leads to increased sink number. These sinks may draw stored carbohydrates due to high sink demand resulting in high seed yield.

However, the DM at anthesis would certainly be dependent on canopy photosynthesis which inturn is a function of canopy size and average assimilation rate per unit leaf area (Gimenez et al., 1994). In the present study, the positive significant relationship between LAI and TDM at ray floret stage in both high and low PDM types (Table 4) clearly suggests that, the high LAI types can be selected to obtain high biomass at anthesis. The importance of LAI may be further emphasized since, photosynthetic rate, one of the component of canopy photosynthesis was found to be already high in sunflower (Connor and Sadrass, 1992). Additionally, LAI is shown to have positive relationship with seed yield also (Steer et al., 1988; Nanja Reddy et al., 1994).

Our results show that, genotypes capable of producing high DM during pre- anthesis are probably better yielders. High TDM at anthesis would lead to remobilization of stored carbohydrates from the stem to seed, such a character is most useful during end season stress. Breeding and selection of genotypes with high biomass at anthesis and high post-anthesis LAD would improve the seed yield of sunflower substantially. .PA

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Table 1. Range and mean for a few growth and yield parameters in sunflower lines

Character	Range	Mean
LAI at ray floret stage	1.65 - 3.74	2.87
TDM at ray floret stage	110 - 590	327.00
TDM produced during post-anthesis period	60 - 177	117.00
TDM at harvest	271 - 661	450.00
HI	0.20 - 0.31	0.24
Seed yield	60 - 148	107.30

TDM and seed yield are in $g.m^{-2}$

Table 2. Seed yield and associated parameters in sunflower genotypes with high and low pre-anthesis (PDM) accumulation capacity.

Genotype	Seed yield	TDM at				LAI
		ray floret stage	harvest	post anthesis	Harvest index	at ray floret stage
High PDM types						
Acc 1253	139	415	488	73	0.28	3.12
Acc 1279	112	459	519	60	0.22	3.38
Acc 121	116	399	460	61	0.25	2.85
Acc 1568	148	590	661	71	0.22	3.74
Mean	129	466	532	69	0.24	3.27
Low PDM types						
Acc 1633	93	267	444	177	0.21	3.00
Acc 159	60	110	271	100	0.22	2.01
Acc 1250	67	201	331	130	0.20	1.68
Acc 99	118	224	384	160	0.31	3.21
Acc 1539	113	275	494	220	0.23	2.82
Mean	90	215	385	157	0.23	2.54
CD (P< 0.05)						
Genotypes	12.6	54	44	23.3	0.02	0.27
Groups					NS	NS

TDM and seed yield are in $g.m^{-2}$

Table 3. Contribution of pre-anthesis biomass to capitulum and seed weight in sunflower germplasm lines.

Genotype	Pre-anthesis (%)			Post-anthesis (%)
	Thalamus	Seed	Capitulum	Seed
High PDM types				
Acc 1253	8.0	47.5	55.1	52.5
Acc 1279	8.7	37.5	46.2	62.5
Acc 121	5.7	47.4	53.1	52.6
Acc 1568	4.7	52.0	56.7	48.0
Low PDM types				
Acc 1633	-	-	0	100.0
Acc 159	-	-	0	100.0
Acc 1250	-	-	0	100.0
Acc 99	-	-	0	100.0
Acc 1539	-	-	0	100.0

Table 4. Correlation co-efficients among yield and related parameters in high and low pre-anthesis DM accumulation types of sunflower germplasm lines.

	Seed yield contributed from Pre-anthesis (High PDM)		Post-anthesis (Low PDM)	
Seed yield Vs				
HI	0.29	NS	0.66	**
TDM at ray floret stage	0.66	*	0.63	**
TDM at harvest	0.70	**	0.80	**
TDM after anthesis	0.65	*	0.82	**
LAI and TDM at ray floret stage	0.54	**	0.54	**

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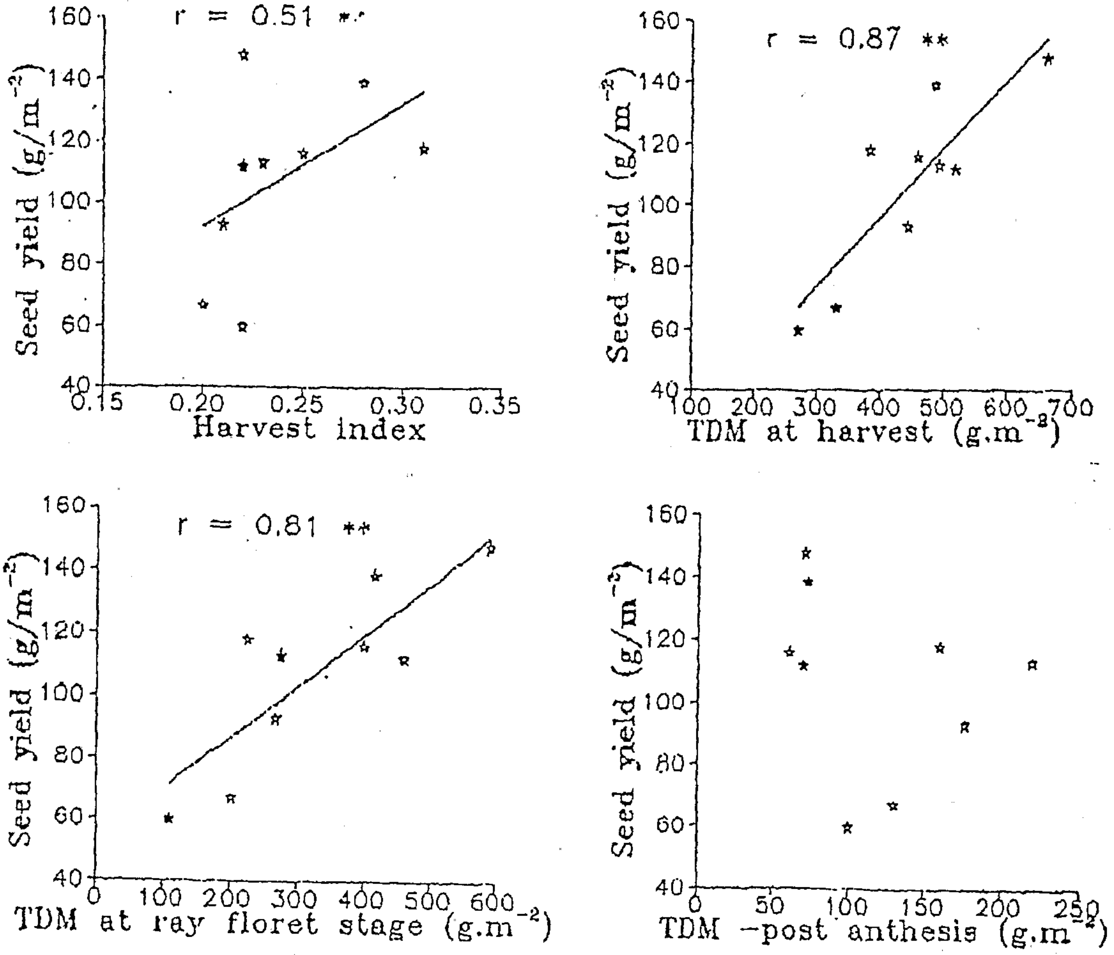

Fig. 1 Relationship between seed yield and HI and TDM at various stages