*Indian J. Genet.*, 53 (4): 366–371 (1993)

# DYNAMICS OF DRY MATTER ACCUMULATION IN WHEAT

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**(Received: July 25, 1991; accepted: February 15, 1993)**

## ABSTRACT

**Studies on dynamics of grain sink at different ontogenesis phases allows differentiating genotypes considering genetic system of dry matter accumulation. It was found that durum wheat varieties display a high level of grain sink size at all stages of grain development.**

**Key words:** Dry matter accumulation, adaptivity, grain sink, common wheat, durum wheat.

At present the main trend in wheat yield increase is to develop genotypes displaying an intensified flow of assimilates from the vegetative organs of a plant into its grain [1].

Though a direct dependence is not always seen among the vegetative and reproductive parts of a plant, an excess growth in vegetative organs negatively influences the grain yield [2].

Dynamics of dry matter accumulation and the duration of grain forming in wheat mainly depend on temperature, the rate of water supply and the general state of the plant at the time of grain formation. The latter affects the spike size and its barrenness [3].

The sources of flow of assimilates are different at different stages of grain formation. Just after flowering the spikes start getting their assimilates basically from leaves and other chlorophyll containing organs of the plant. Third week onwards there is a drop in the flow from leaves and is mainly performed by the straw of the plant.

The grain filling in wheat is mainly by photosynthesis, flow of mineral salts from the soil and, to some extent, by the assimilates that are already accumulated in the plant. Moreover, the process of accumulation, distribution and redistribution of assimilates in plants during the vegetative and the post-flowering period is rather complicated.

The growth of the straw ceases after 6-8 days of heading, but the upper rachis internodes keep on growing. Increase in the root mass also ceases soon after flowering and at this stage the kernels become the main consumers of assimilates.

Each and every organ of the wheat plant — leaves, stem, chlorophyll containing parts of the spike—play a double role in grain filling. On one hand, they participate in photosynthesis and supply the products to grains and, on the other hand, the unused assimilates at the time of decay of the organs are also sent to the grain to complete its formation.

The aim of our work was to find out the grain sink ability of the spike at different stages of its formation and identification of wheat genotypes possessing high grain sink ability with the help of a system so called "breeding-background traits".

## MATERIALS AND METHODS

The plant material consisted of seven varieties of spring common and durum wheat. The spring common wheat varieties were: Salyut, Jupateco, Zoryan, Budimir and Spectr BC-5; and the spring durum wheat varieties were: Leucurum 692 h29/11 and Zheleznyar. Their characteristics are given in Table 1.

**Table 1. Characteristics of seven varieties of common and durum spring wheat**

| Genotype | Variety | Origin | Year of release |
|---|---|---|---|
| **Common wheat** | | | |
| Salyut | Erythrospermum | Krasnodar | 1975 |
| Jupateco | Erythrospermum | CIMMYT | 1973 |
| Zoryan | Erythrospermum | Krasnodar | 1990 |
| Budimir | Erythrospermum | Krasnodar | 1987 |
| Spectr BC-5 | Erythrospermum | Krasnodar | 1981 |
| **Durum wheat** | | | |
| Leucurum 692 h29/11 | Leucurum | Krasnodar | 1987 |
| Zheleznyar | Hordeiforme | Krasnodar | 1987 |

The studies were carried out at the Wheat Breeding Department of the Krasnodar Lukyanenko Agricultural Research Institute, Krasnodar, Russia, in 1989.

Maize for grain was used as predecessor. No fertilizers were applied at the main tillage. At presowing cultivation $N_{45}P_{60}K_{30}$ were applied. The seeding rate was 7 million seeds per hectare. Narrow-row spacing with 7.5 cm between the rows was practised. Experiments were carried out in leached chernozem soils. The plants were sown in randomized blocks. The samples consisted of 60 plants from each genotype at 5-day intervals after flowering. The spikes were separated from the stems and tied to the plants which were later air dried. The straw and spikes were weighed separately. The theory of background traits was used to interpret the data [4]. This theory explains that background traits are closely correlated with the breeding traits conditioned by environment, although they have zero genetic dispersion [5–7]. By applying the principles of background traits a genotype can be evaluated in general without advancing generations.

The computed data were analysed by the method proposed by Dragavtsev et al. [6]. It is known that the lines of regression commonly used to evaluate quantitative traits cannot give a precise pattern of the contribution from the system of adaptivity and sink effects. Therefore, the authors used the orthogonal regression reported earlier by Kramer [8]. It represents a straight line when the sum of standard deviation of the experimental points along the perpendicular is minimal.

To plot a graph of the orthogonal regression mean values for breeding (spike weight/plant) and background (straw weight/plant) traits, the coefficient of sink : source correlation, and the coefficient of orthogonal regression are to be calculated. Considering the value of breeding and background traits, position of each genotype is found in a two-dimensional system. These four sections form the possible location for each genotype, reflecting their different genotypic character. So, in the system of coordinates, spike weight/plant, straw weight/plant, and the system of sink size (ss) and adaptivity (ad) act in different directions, to the left from the line L are genotypes with large grain sink size, to the right from the line $L_1$ are the genotypes with high adaptivity.

## RESULTS AND DISCUSSION

Dispersion of the cultivars in the two dimensional system of coordinates from flowering to complete grain filling constantly varies and so does the angle of inclination of the orthogonal regression. The maximum value of the angle was observed 25-30 days after flowering. After 5 days of flowering, Zheleznyar showed a big shift to the line of adaptivity and the trend is maintained by this cultivar even after 10 days of flowering, but it does not surpass Budimir. At this moment, the grain sink size of Zheleznyar changes its position from positive to negative. After 15 days of flowering, while Zheleznyar is still approaching its mean value of adaptivity, Budimir has already reached its mean value. Thus the gene activity of the grain sink size of Zheleznyar is characterized to be negative (Fig. 1c). After 5 more days, i.e. 20 days after flowering, these varieties again appear in the zone of high adaptivity, but Jupateco seems to be superior to Zheleznyar and Budimir. So varieties Jupateco and Budimir have positive sink size effect whereas Zheleznyar and Spectr BC-5 have negative sink size effect.

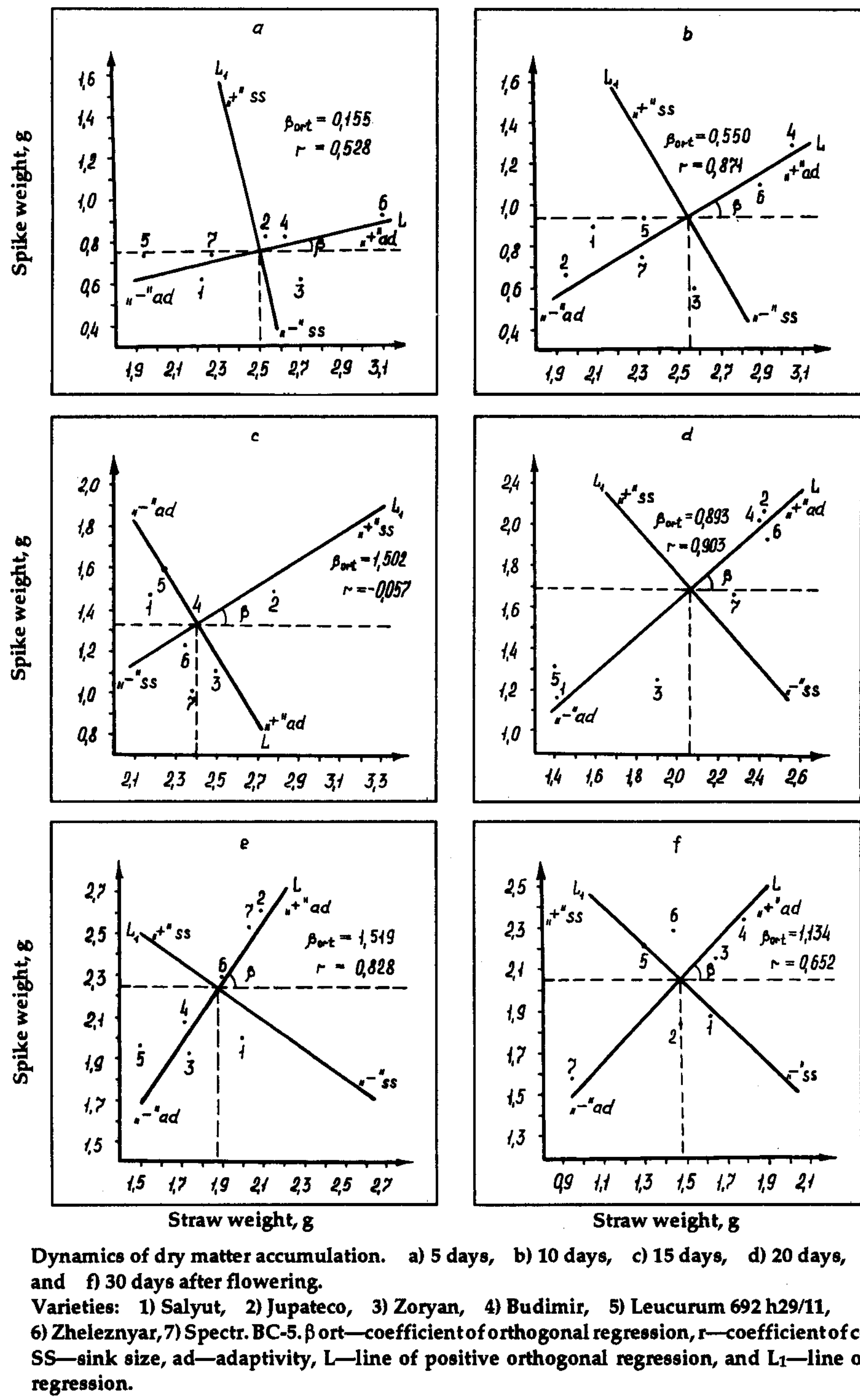

Fig. 1. **Dynamics of dry matter accumulation. a) 5 days, b) 10 days, c) 15 days, d) 20 days, e) 25 days and f) 30 days after flowering.**
**Varieties: 1) Salyut, 2) Jupateco, 3) Zoryan, 4) Budimir, 5) Leucurum 692 h29/11, 6) Zheleznyar, 7) Spectr. BC-5. β ort—coefficient of orthogonal regression, r—coefficient of correlation, SS—sink size, ad—adaptivity, L—line of positive orthogonal regression, and $L_1$—line of negative regression.**

After 25 days of flowering, Jupateco accelerates its adaptivity and sink size effect (Fig. 1e), whereas Zheleznyar and Spectr BC-5 stay in the zone of high adaptivity, but both stay inferior to Jupateco. The above three varieties with high adaptivity possess positive sink size effect, whereas Budimir moved from its zone of high adaptivity to low adaptivity still retaining its positive sink size effect.

By the end of grain filling stage, the position of many varieties possessing high adaptivity and sink size kept on changing. The variety Jupateco shifted to the zone of low adaptivity and low sink size. This fact characterizes its low yield ability in the agroclimatic conditions of Krasnodar.

Variety Spectr BC-5 also shifts to the zone of low adaptivity, but at the same time showing high sink-size effect. Whereas the variety Zheleznyar does not change its position, thus remaining in the zone of high adaptivity and increased positive sink size effect. Leucurum 692 h29/11 possesses high sink size effect and satisfactory adaptivity. It is located exactly along the line of grain sink size (Fig. 1f). Therefore, the above two varieties (Zheleznyar and Leucurum 692 h29/11) can be considered as effective donors. Budimir accompanied by Zoryan once again shifts to the zone of high adaptivity. Though at this moment both varieties possess negative sink size effect. Out of all the varieties, the behaviour of Zoryan is typical and shows the following characters: during the whole period of observation it is thrice positioned in the zone of high adaptivity, i.e. after 5 days of flowering, after 15 days, and at the end of grain formation, and throughout it remained in the negative zone of sink size effect.

Such a position of common and durum wheat varieties relative to the line of orthogonal regression confirms the need for these wheats to be evaluated individually.

The results of this study show that the change in the position of the varieties studied in the system of coordinates at the time of grain filling can be used to explain the activity of physiological processes, which in turn, is useful in the development of a technology for the identification of high productive genotypes.

## CONCLUSIONS

1. The intensity of outflow of food substances from the leaves and stems of the plant into the spike and developing kernels is different for each genotype at different stages of grain formation.

2. The position of the varieties significantly varies depending on the system of genes of grain sink size at different stages of grain development. However, some varieties, like Leucurum 692 h29/11, may occupy a definite position throughout the period of grain formation. Most probably, such varieties can be considered as good donors of grain sink effect.

3. The combined analysis of common and durum wheat varieties in one system of coordinates shows increased activity of the genes for grain sink effect among the varieties of durum wheat.

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