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# HARVEST INDEX AND GRAIN SINK SIZE IN WHEAT

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## ABSTRACT

**Identification of high yielding genotype at early stages of varietal development may be realized through evaluation of the genetic system of dry matter accumulation. Usually harvest index (HI) is used as a criterion for this purpose. It was found that harvest index is not applicable in wheat as the relationship between harvest index and plant productivity was linear and that was nonlinear between the genetic system of dry matter accumulation and plant productivity.**

**Key words:** Harvest index, grain sink size, biomass, grain yield, wheat.

Considerable part of the total biological yield cannot be utilized by man as food or industrial raw materials. Therefore, determination of economical and not the biological yield has a great importance.

During the last 20 years, the harvest index (HI) has been taken to be a ratio of grain yield to total aerial biomass. It can be expressed both at the level of an individual plant as well as unit area [1]. Galunova [2] considered HI to be a reliable criterion of a high productive genotype.

Initially, more preference was given to the opinion that a sufficient quantity of assimilates formed as a result of photosynthesis was the decisive factor for crop capacity. However, it is now established that in definite conditions the surplus of assimilation products is accumulated in plants though the crop capacity does not increase correspondingly. According to Pilnev [3] the potential spike productivity is used incompletely, but the actual productivity of a spike increases along with its potential productivity. Lupton [4] also confirmed that maximum dry matter accumulation does not always give high grain yield, whereas excessive vegetative matter can influence economical yield of grain crops negatively.

The history of variety renovation in the USSR for more than half a century showed that increase in grain yield was exclusively attributed by assimilates redistributed from the straw to the spike. This results in higher harvest index and lower plant height in new wheat varieties [5]. Sharma et al. [6] reported that HI negatively correlates to plant height, days to spike formation, and the correlation of HI to biomass yield has been proved to be nonsignificant. However, Valla et al. [7] demonstrated that increase in the productivity of new varieties has been achieved due to an increase in the total biomass yield by 20-23% and 20-30% rise in HI.

However, in spite of the fact that HI could be used as a criterion for evaluating genotype productivity, at the same time it cannot be taken as a criterion for evaluating the distribution level of assimilates from the aerial biomass to the spike since the factor defining the sink size is present in the numerator as well as the denominator. It seems as if the spike itself is reducing the sink size. In case of sink size evaluation, it is not acceptable because grain yield cannot and should not affect the share of grain yield in the total biomass production.

The aim of this contribution is to explain why HI is unacceptable for grain sink size evaluation.

## MATERIALS AND METHODS

The plant materials comprising twelve varieties of spring common and durum wheat (Table 1) were grown at Krasnodar Lukyanenko Agricultural Research Institute, Krasnodar, Russia in 1989. $N_{45}P_{60}K_{30}$ were used as presowing application. The seeding rate

**Table 1. Characteristics of 12 varieties of common wheat and durum wheat**

| Genotype | Variety | Origin | Year of release |
|---|---|---|---|
| **Common wheat** | | | |
| Salyut | Erythrospermum | Krasnodar | 1975 |
| Vector | Lutescens | Krasnodar | 1985 |
| Jupateco | Erythrospermum | CIMMYT | 1973 |
| Zoryan | Erythrospermum | Krasnodar | 1990 |
| Budimir | Erythrospermum | Krasnodar | 1987 |
| Spectr BC-5 | Erythrospermum | Krasnodar | 1981 |
| Opal | Lutescens | Germany | 1971 |
| Krestyanka | Lutescens | USSR | 1986 |
| **Durum wheat** | | | |
| Krasnodarskaya-362 | Leucurum | Kasnodar | 1952 |
| Leucurum 692 h 29/11 | Leucurum | Krasnodar | 1987 |
| Zheleznyar | Hordeiforme | Krasnodar | 1987 |
| Kharkovskaya-17 | Hordeiforme | Kharkov | 1986 |

was 7 million seeds per hectare. Narrow-row sowing with 7.5 cm row spacing was practised. Experiments were carried out in leached chernozem soils. The plants were sown in randomized blocks. The samples taken consisted of 60 plants from each genotype.

Observations recorded on the following traits were evaluated: grain yield/plant, aerial nongrain biomass yield/plant, and total biomass yield/plant. Harvest index was calculated as the ratio of grain yield to total aerial biomass yield and sink size as grain yield to aerial nongrain biomass yield.

## RESULTS AND DISCUSSION

Unacceptability of HI use for sink size evaluation may be demonstrated through simulation. Let us assume that the total aerial biomass of some wheat varieties is similar and equal to 180 units (in ideal conditions it is close to reality) and grain yield varies from 20 to 60 units. In this case HI ranges from 0.11 to 0.33 whereas the grain yield to aerial nongrain biomass yield ratio varies from 0.12 to 0.5 (Fig. 1).

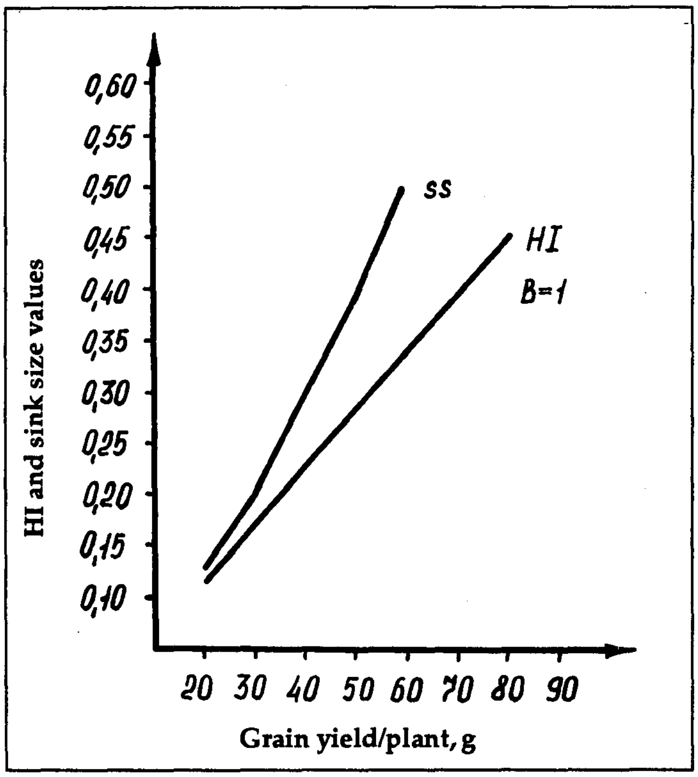


**Fig. 1. Model analysis of harvest index (HI) and sink size (SS) in relation to plant productivity HI—harvest index, SS — sink size, b—coefficient of regression.**

Hence, a coefficient of regression for HI to grain yield is equal to 1. This relationship is linear. However, the relationship of grain yield to aerial nongrain biomass yield as a criterion of interaction between grain sink size of a variety and grain yield proves nonlinear (Fig. 1).

The effect of sink size of a variety increases significantly with increase in its yield when compared to harvest index.

Results on grain sink size and HI showed that the coefficient of variation for harvest index ($CV_{HI}$ = 7.15%) was much lower than that for grain sink size ($CV_{SS}$ = 12.11%).

Figure 2 demonstrates that the range of variation and absolute values for HI are considerably lower than that of the sink size.

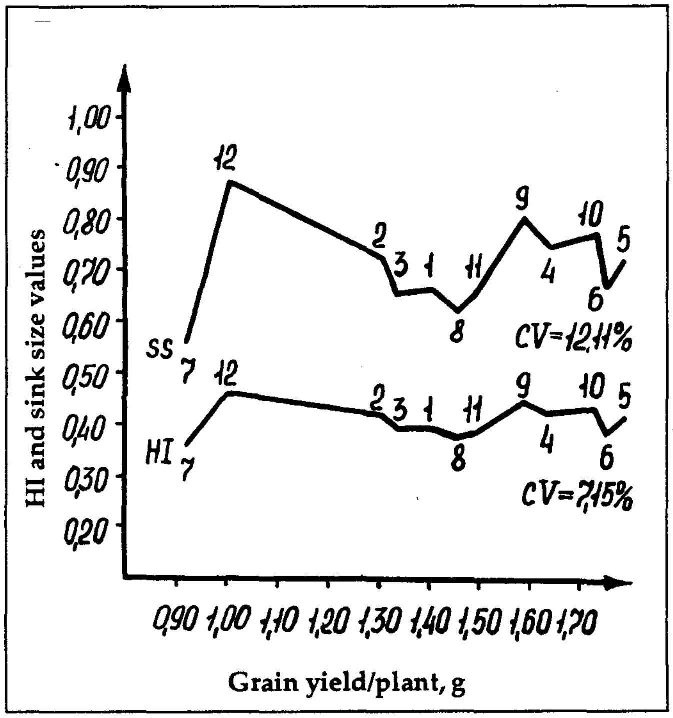


Fig. 2. **Analysis of harvest index (HI) and sink size (SS) in relation to plant productivity in different varieties of spring wheat. Varieties: 1) Salyut, 2) Vector, 3) Jupateco, 4) Zoryan, 5) Budimir, 6) Opal, 7) Krestyanka, 8) Krasnodarskaya-362, 9) Leucurum 692 h 29/11, 10) Zheleznyar, 1) Kharkovskaya-17 and 12) Spetr BC-5. HI—harvest index, SS—sink size, and CV—coefficient of variation.**

Changes in the relationship between grain yield and intensity of assimilate distribution from the aerial biomass of the plant into the grain makes the value of grain sink size more informative.

While evaluating genetic system of dry matter accumulation, the relationship between grain yield and aerial nongrain biomass yield was assumed according to Dragavstsev and

Ostrikov [8], i.e. aerial nongrain biomass yield represents the background for grain yield variation. In this case, their relationship is considered linear and there is assumed that aerial nongrain biomass yield does not manifest genetic dispersion. Grain yield is considered as a breeding trait and aerial nongrain biomass yield as a background trait.

However, it is shown in the simulation (Fig. 1) that the relationship between grain sink size and grain yield was not linear. The results of many other experiments proved that the aerial nongrain biomass yield do show genetic variation. Hence, the ratio of grain yield to aerial nongrain biomass yield is genetically specific and characterizes intensity of genetic system of dry matter accumulation better than considering the value of HI.

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