

FIELD PERFORMANCE OF HYBRIDS DEVELOPED FROM DOUBLED HAPLOID MAIZE INBRED LINES

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Introduction

Nowadays, in addition to the need to produce a sufficient quantity of healthy, toxin-free feed and foodstuffs suitable for human consumption, increasing emphasis is placed on the protection of the environment (soil protection, protection of natural and agricultural ecosystems, preservation of biodiversity, etc.) and on questions concerned with profitability. Like crop production and agronomy, plant breeding must also satisfy these new criteria. The life-span of plant varieties and hybrids in general cultivation has now been reduced to 5–6 years, leading to an enormous increase in the number of varieties available each year and acceleration in breeding activities. This increasing speed can only be achieved at a cost, which is reflected in the price of developing new varieties.

In the course of maize breeding, inbred lines are developed as the result of several steps of selection and self-fertilisation. The 6–8-year breeding cycle can be shortened in a number of ways. With the help of a winter generation, for instance, it can be reduced to half. The *in vivo* monoploid method elaborated by Chase (1969), or improved variants of this, can be used to develop doubled haploid (DH) lines, which reduce the breeding process to a single year. A further possibility is anther culture, which is now a routine technique in cereal breeding (Bedő et al., 1996). In the case of maize the starting point for this technique was the use of exotic lines carrying haploid induction ability (Dieu, Beckert, 1986). The agronomic properties of these lines are not favourable under Hungarian climatic conditions (e.g. late flowering, protracted vegetation period, high grain moisture content at harvest, etc.), but genotypes with commercial value proved to be recalcitrant (Brettell et al., 1981; Genovesi, Collins, 1982).

An efficient anther culture system has been evolved in the Cell Biology Department of the Agricultural Research Institute of the Hungarian Academy of Sciences, with which a large number of DH lines can be produced each year. The aim of the present research was to test DH maize lines in the field to determine what role these hybrids could play in the field production of maize for animal and human consumption in the future.

Methods

Twelve DH maize lines were used as parental components in a crossing experiment. The DH lines were developed from combinations of exotic Chinese lines with androgenic ability and recalcitrant inbred lines used in commercial hybrids from Martonvásár. The latter were mostly related to Iodent or to the Hungarian heterosis source Mindszentpusztai Yellow Dent (MYD). The DH maize lines were produced in tissue culture with various proportions of the recalcitrant genotypes (F_1 and BC_1 combinations).

The male testers were sister line crosses (SLC), three belonging to the Iodent (IodSLC), Lancaster (LancSLC) and Iowa Stiff Stalk Synthetic (ISSS SLC) groups, and one unrelated to these (nrSLC). FAO 390 and FAO 450 standards were used in the experiment, which was laid out in a randomised block design in three replications in the experimental nursery of the Agricultural Research Institute of the Hungarian Academy of Sciences. The grain yields ($t\ ha^{-1}$) were expressed in terms of 15 % grain moisture content.

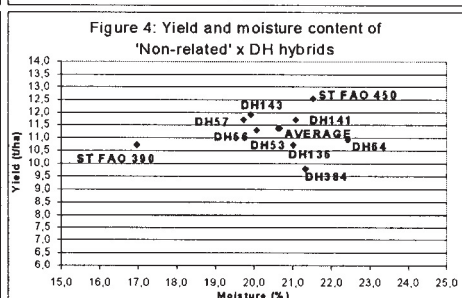
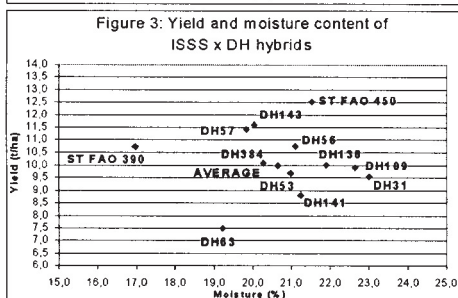
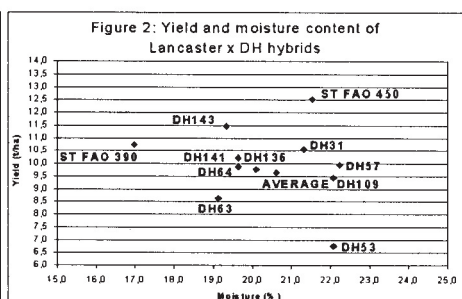
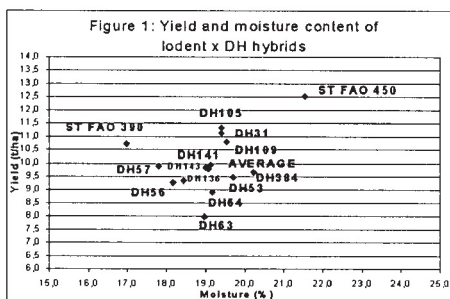
The results were evaluated using single factor analysis of variance, as described by Sváb (1981).

Results and Discussion

The results achieved for hybrids developed using each of the testers on DH lines are presented in Figures 1–4 (only the names of the DH components are given for each point).

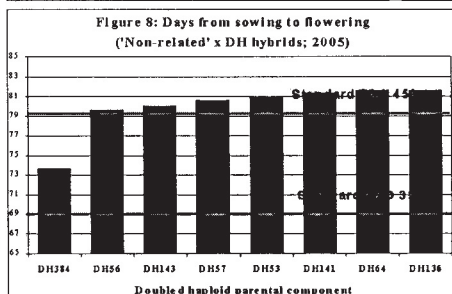
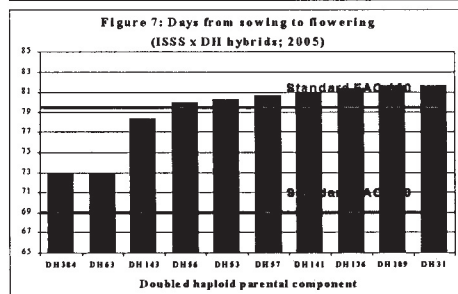
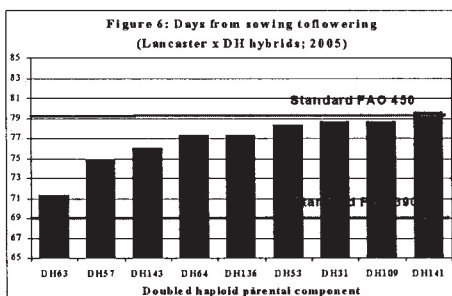
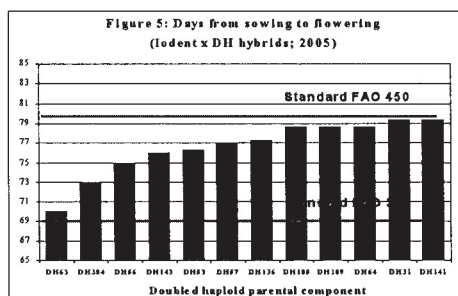
The FAO 450 standard yielded more than hybrids with a DH parental component, but the yields of the DH143 × nrSLC, DH143 × IodSLC, DH64 × ISSS SLC, DH57 × nrSLC and DH141 × nrSLC hybrids did not differ significantly from that of the standard (12.53 t ha⁻¹). The yields of several hybrids exceeded that of the FAO 390 standard (10.73 t ha⁻¹) or were not significantly different. The grand means for the yields of the four crossing series (IodSLC: 9.80 t ha⁻¹; LancSLC: 9.64 t ha⁻¹; ISSS SLC: 10.01 t ha⁻¹; nrSLC: 11.39 t ha⁻¹) differed significantly from each other.

An analysis of the grain moisture values showed that, with two exceptions (DH56 × IodSLC and DH57 × IodSLC), the hybrids exhibited significantly higher values than the FAO 390 standard (16.97 %). Values similar to that of the FAO 450 standard (21.50 %) were recorded for 17 DH hybrids, while the grain moisture contents of 22 hybrids were intermediate to those of the two standards. No significant differences were observed between the grand means of the four crossing series (IodSLC: 19.80 %; LancSLC: 20.61 %; ISSS SLC: 20.65 %; nrSLC: 20.66 %).



LSD_{5%} = 0.96 (yield); LSD_{5%} = 1.36 (moisture)

Yield and grain moisture content do not provide a complete picture of the value of a hybrid without information on the vegetation period of the given combination. One of the parameters used to calculate the vegetation period is the number of days from sowing to flowering. With two exceptions (DH63 × IodSLC and DH63 × LancSLC) the hybrids flowered significantly later than the FAO 390 standard, while the flowering date of 29 hybrids did not differ statistically from that of the FAO 450 standard. Significant differences were observed between the grand means of the four crossing series (IodSLC: 76.61 days; LancSLC: 76.93 days; ISSS SLC: 78.18 days; nrSLC: 79.71 days).



LSD_{5%} = 2.66

Conclusions

It can be seen from the yield figures that doubled haploid lines developed from crosses between Chinese lines of unknown pedigree and lines chiefly related to Iodent exhibited poorer combining ability with Iodent and Lancaster partners, while they combined well when ISSS and nrSLC were the sources of heterosis.

The majority of the hybrids had a greater resemblance to the FAO 490 standard as regards flowering date and vegetation period. Hybrids with later flowering dates and longer vegetation periods gave higher yields, while their grain moisture contents did not differ significantly from those of earlier flowering hybrids.

Most of the hybrids examined did not compare favourably with the yield, grain moisture and flowering data of the standards. Various combinations involving line DH 143, however, had yields close to that of the FAO 450 standard (11.48–11.90 t ha⁻¹) and lower grain moisture content (19.00–20.03 %). In two of these hybrids the number of days to flowering was 76, which is significantly less than for the FAO 450 standard. This suggests that lines developed using the doubled haploid technology could be suitable for the development of competitive hybrids. In addition to approaching or equalling the standard mean for agronomic traits, they can be developed within a single year, considerably accelerating the process of line development.

References

- Bedő, Z., Karsai, I., Láng, L., Vida, Gy. (1996): Bread making quality of doubled haploid lines of wheat. In: Jain, S.M., Sopory, S.K., Veilleux, R.E. (eds.): *In Vitro* Haploid Production in Higher Plants, Vol. 2. Kluwer Academic Publ. pp. 93-109.
- Brettell, R.I.S., Thomas, E., Wernicke, W. (1981): Production of haploid maize plants by anther culture. *Maydica* 26: 101-111.
- Chase, S.S. (1969): Monoploids and monoploid derivatives of maize (*Zea mays* L.). *Bot. Rev.* 35: 117-167.
- Dieu, P., Beckert, M. (1986): Further studies of androgenetic embryo production and plant regeneration from *in vitro* cultured anthers in maize (*Zea mays* L.). *Maydica* 31: 245-259
- Genovesi, A.D., Collins G.B. (1982): *In vitro* production of haploid plants of corn via anther culture. *Crop Sci.* 22: 1137-1144.
- Sváb, J. (1981): Biometrical Methods in Research Work. Mezőgazdasági Kiadó, pp. 113-116. (in Hungarian)
- Kádár, I. (2004): Szennyvíziszap-adagok hatása a növény (*Triticum vulgare* L.)-talaj rendszer néhány mikrobiológiai és biokémiai tulajdonságára (Impact of sludge treatments on some microbiological and biochemical properties of plant (*Triticum vulgare* L.)-soil system. – in Hungarian). *Agrokémia és Talajtan.* 53. 3-4. 331-342 pp
- Svetková, K.; Henselová, M.; Morvová, M. (2005): Effects of a carbonization product as additive on the germination, growth and yield parameters of agricultural crops. *Acta Agron. Hun.* 53. (3). 241-250 pp
- Tanács, L., Matuz, J., Gerő, L., Petróczi, I.M. (2005): Effect of NPK Fertilizers and Fungicides on the Quality of Bread Wheat in Different Years. *Cereal Res. Commun.* 33 (2-3): 627-634 pp