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Mineral Nitrogen Fertilization of Sweet Corn in Central Transylvania II. In Organic Agricultural System

Mirela Irina CORDEA[1)], Marin ARDELEAN[1)], Voichita HAS[2)], Agnes BORS[1)], Lucia MIHALESCU[3)]

[1)] University of Agricultural Sciences and Veterinary Medicine, Faculty of Horticulture, 3-5 Mănăştur Street, 400372, Cluj-Napoca, Romania; mcordea@usamvcluj.ro
[2)]Agricultural Research and Development Station Turda, 27 Agriculturii Street. 401100 Turda
[3)]Northern University, Baia Mare, Romania

Abstract. Five Romanian sweet corn hybrids (Prima, Dulcin, Estival, Deliciul verii and T-145) were tested in three years (2008-2010) in three locations of Central Transylvania with obviously different soil and climatic conditions. The experiments were organized in a split-plot design in which, on a general level of organic fertilization (40 t/ha manure), four levels of mineral N fertilization were applied: N_0, N_{50}, N_{100} and N_{150}. Ear yield (with and without husk) was registered each year and location and a superiority index (P_i) was computed according to the procedure suggested by Lin and Binns (1988). The shares of G and G x E effects in the total value of P_i were also computed and thus the tested hybrids were classified on the basis of their yield stability expressed by P_i index, ear yield level in the organic agricultural system and the prevalence of G or G x E effects in the total value of P_i. Quite expectedly, the poorest ear yields were recorded, in all tested hybrids, when no mineral N was applied. Fertilization with N_{100} and N_{150} had significant and very significant effects on ear yield in all semiearly and semilate hybrids. Prima cv. reacted very poorly to increasing rates on mineral N, most probably due to its earliness. Deliciul verii and Estival were classified as most stable and high yielding hybrids under organic N fertilization practices while Prima showed the lowest stability of its rather poor ear yield.

Keywords: organic system, sweet corn, cob yield, stability index (P_i)

INTRODUCTION

As it is well known, sweet corn needs high quantities of nitrogen for its vegetative and generative development (Salardini *et al.*, 1992). Most of farmers agree upon the fact that high and profitable yields in sweet corn are possible only by supplying the crop with important quantities of nitrogen. In organic agriculture this can be done exclusively by applying huge quantities of manure or other organic fertilizer. Since, so far, there have not been created sweet corn hybrids for organic agriculture a rather natural answer arises: are the existing Romania sweet corn hybrids adapted to organic practices of N fertilization? To this question the present paper tries to give an answer based on results obtained in rigorous field experiments carried out in Central Transylvania, Romania.

MATERIALS AND METHODS

Five Romanian sweet corn hybrids (Prima, Estival, Deliciul verii, Dulcin and T-145) released by the Agricultural Research Station, Turda, Romania, were tested in three years (2008-2010) in three locations of Central Transylvania (Turda, Jucu and Morău, all three in Cluj County), with obviously different soil and climatic condition.

The experiments were organized in a split plot design (Ardelean *et al.*, 2007) in which, on a general level of organic fertilization (40 t/ha manure), four levels of mineral N fertilization were applied (kg/ha, active matter): N_0, typical for organic technologies; N_{50}, corresponding to the low-input (sustainable) system; N_{100} and N_{150} customary with conventional system of agriculture. The specific technologies of weed and pest control were applied in each agricultural system.

Based on cob yield data registered for hybrids in locations × years × cropping system, comparisons were made between performances of the tested hybrids in organic and conventional agricultural systems and a superiority index (P_i) was computed for each sweet corn hybrid, illustrating the stability of their cob yields, with and without husks under organic fertilization practices. Lin and Binns' (1988) procedure and formula were used to compute P_i.

$$P_i = \left[n(\overline{X}_i - \overline{M})^2 + \sum_{j=1}^{q} (X_{ij} - \overline{X}_{i.} - M_j + \overline{M})^2 \right] / 2n \text{, in which:}$$

$\overline{X}_i$ = mean yield of i^{th} cultivar in n environments; $\overline{M}$ = mean of maximum yields in n environments; M_j = maximum yield of all cultivars in the j^{th} environment; $\overline{X}_{ij}$ = yield of i^{th} cultivar in the the j^{th} environment; $\overline{X}_{i.}$ = mean yield of all cultivars in all environments;
n = number of environments.

P_i is the measure of deviation of performances of a certain genotype from the maximum value of the studied character (i.e. cob yield) across all environments. Thus, the cultivar with the lowest P_i value will be considered the most stable one, the most adapted to the various environments in which the experiment has been carried out. The authors consider that the first part of the above formula is quantifying the contribution of genotype (G) while the second part is indicating the share of G × E to the total value of P_i. On this basis the shares of genotypic (G) and G × E effects in the total value of P_i have been evaluated.

RESULTS AND DISCUSSION

As a vegetable, sweet corn can yield as high as 35-40 t/ha unhusked ears (Ardelean *et al.*, 2010; Haş, 2002; Hemphill and Hart, 1992) under conventional fertilization practices. When organic technologies of fertilization are used, it is expectable to meet more or less reduction of ear yield. Table 1 shows the yield performances of the tested sweet corn hybrids grown on different levels of N fertilization, specific for organic and conventional systems of agriculture.

As it has been expected, Prima cv. registered the poorest yields, both under organic and conventional fertilization practices, most probably due to it's earliness which does not allow the plant to use the additional mineral fertilization. These results might, together with those published by Haş (2002) suggest that, for organic fertilization technologies early sweet corn hybrids are recommendable, on condition that the difference in selling price covers the loss in ear yield.

Under organic agricultural practices, the highest ear yields were noticed in semiearly and semilate hybrids (19.22 – 23.35 t/ha unhusked ear and 16.33 – 18.17 t/ha husked ear). It is worth emphasizing the rather high unhusked ear yield of Deliciul verii cv., which proves that, among the recently released Romanian sweet corn hybrids it is possible to find genotypes which are capable of producing rather high ear yields.

Tab. 1

Effect of genotype and level of mineral N fertilization specific to organic and conventional agricultural practices upon ear yield (t/ha) in a series of experiments performed in Turda, Morău and Jucu (2008-2010)

Hybrid	Rate of mineral N fertilization	Ear yield (t/ha)	
		With husks	Without husks
Prima	N_0 control	16.55	11.97
Dulcin		20.03	16.33
Estival		21.05	17.34
Deliciul verii		23.35	18.17
T-145		19.22	17.94
Prima	N_{100}	20.28*	14.88**
Dulcin		25.37**	19.77*
Estival		25.53**	20.47*
Deliciul verii		27.29*	22.94**
T-145		25.75***	21.32*
Prima	N_{150}	20.31*	16.83**
Dulcin		26.93***	22.91***
Estival		27.94***	24.90***
Deliciul verii		30.90***	26.34***
T-145		27.51**	24.88***
$LSD_{5\%}$=		3.34	2.83
$LSD_{1\%}$=		4.45	3.78
$LSD_{0.1\%}$=		5.79	4.92

The ear yield without husks followed rather closely the pattern described for unhusked ear yield. Again, with no mineral N fertilization, significant yield increases were noted for Deliciul verii cv. There can be concluded that, for sweet corn, the conventional plant breeding has produced genotypes which are good performers under organic agricultural practices and, consequently, an organic breeding program is, for the time being, unnecessary. Most probably a solution like that proposed by Almekinders and Hardon (2006) would be more appropriate.

The classification of the tested hybrids on the bases of their yield stability illustrated by the P_i values is shown in table 2.

Tab. 2

Index of superiority (P_i) for cob yield (t/ha) under organic agricultural practice for five sweet corn hybrids (mean of Turda, Morau, Jucu, 2008-2010)

Hybrid	With husks			Without husks		
	P_i	G effects	G × E effects	P_i	G effects	G × E effects
Prima	35.3	25.4	9.8	34.4	26.6	7.8
Dulcin	16.2	8.4	7.8	18.6	12.9	5.7
Estival	8.6	4.7	3.9	17.4	9.4	8.0
Deliciul verii	10.7	0.2	10.5	13.0	6.3	6.7
T-145	16.1	12.1	4.0	18.5	11.7	6.8

As it can be seen in table 2, Deliciul verii and Estival cv. were best classified on the basis of their P_i values, (yield stability) in spite of the fact that they are not the best yielding genotypes. Deliciul verii cv. is most obviously the best yielding hybrid but the stability of its yield across locations and years is poorer than that of Estival, for unhusked ear yield. For husked ear yield, Deliciul verii cv. ranks first both as yield level and yield stability.

CONCLUSIONS

The ear yields (with and without husks) under organic practices of N fertilization are very significantly lower, in all tested sweet corn hybrids, than the yield levels attained with high and very high rates of additional fertilization with mineral N.

Under organic agricultural practices, the highest ear yields were noticed in Deliciul verii cv., which proves that, among the recently released Romanian sweet corn hybrids, it is possible to find genotypes which are capable of producing rather high ear yields even with no additional mineral N fertilization.

Early genotypes (i.e. Prima cv.) register poor ear yields both under organic and conventional agricultural technologies most probably due to their short vegetative period which does not allow the plants to use the organic and additional mineral N fertilization.

Early genotypes are not recommended for conventional practices of sweet corn fertilization but, for organic fertilization technologies early sweet corn hybrids are recommendable, on condition that the difference in selling price covers the loss in ear yield.

There can be concluded that, for sweet corn, the conventional plant breeding has produced genotypes which are good performers under organic agricultural practices and, consequently, the development of an organic breeding program for sweet corn, in Romania, is, for the time being, not economically justified.

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