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Mineral Nitrogen Fertilization of Sweet Corn in Central Transylvania I. In Conventional Agricultural System

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Abstract. Five Romanian sweet corn hybrids (Prima, Dulcin, Estival, Deliciul verii and T145) 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 and the prevalence of G or G x E effects in the total value of P_i. Quite expectedly, the highest ear yields were recorded in all tested hybrids, when N_{100} and N_{150} were applied. Fertilization with N_{50} had no significant effects on ear yield in either hybrid. Prima cv. reacted very poorly to increasing rates on mineral N, most probably due to its earliness. Dulcin and Estival were classified as most stable and high yielding hybrids in all experimental environments while Prima showed the lowest stability of its rather poor ear yield.

Keywords: sweet corn, cob yield, stability index (P_i), classification of hybrids

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, either as organic and/or mineral compounds. Thus a rather natural answer arises: how far should one go with mineral N fertilization of the existing sweet corn hybrids? 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, a superiority index (P_i) was computed for each sweet corn hybrid, illustrating the stability of their cob yields, with and without husks. 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). Table 1 shows the yield performances of the tested sweet corn hybrids grown on different levels of mineral N fertilization.

As it has been expected, Prima cv. registered the poorest yields most probably due to it's earliness which does not allow the plant to use the additional mineral fertilization. Only on N_{100} and N_{150} this genotype has an unhusked ear yield which differs from that of N_0 slightly above the limits of $P_{1\%}$.

The highest ear yield were noticed in semiearly and semilate hybrids (27.51 – 30.70 t/ha unhusked ear and 24.88 – 26.34 t/ha husked ear) with the last rate of additional mineral N fertilization (N_{150}). It is worth mentioning the fact that in T-145 cv. (semilate) the increase of additional mineral N, from N_{100} to N_{150}, was not accompanied by a significant increase of unhusked cob yield. These results might suggest that for certain sweet corn genotypes, the fertilization with high and very high rates of additional mineral N might not be economically efficient since the yield increase is far from being significant as compared with yield obtained with moderate rates of N.

The ear yield without husks followed rather closely the pattern described for unhusked ear yield. Again significant yield increases were noted only beginning with moderate rate of N (N_{100}) while on N_{150} the yields were very significantly higher than those registered with N_0.

There can be concluded that for sweet corn, the conventional practices of mineral N fertilization should consider as really efficient only high rates of additional mineral N (N_{150} and over). The low input practices of N fertilization are far from rewarding the farmer with significant yield increases in comparison with no mineral N application.

Tab. 1

Effect of genotype and level of mineral N fertilization upon cob yield (t/ha) in a series of experiments performed in Turda, Morau and Jucu (2008-2010)

Hybrid	Rate of mineral N fertilization	Cob 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_{50}	18.11	12.61
Dulcin		22.17	17.18
Estival		22.92	18.27
Deliciul verii		25.95	20.63
T-145		23.50*	20.12
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 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 conventional 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	37.1	17.7	19.5	32.5	15.7	16.8
Dulcin	3.1	0.4	2.7	2.8	0.2	2.5
Estival	1.4	0.2	1.2	1.5	0.6	0.9
Deliciul verii	11.3	4.9	6.5	8.1	3.1	4.9
T-145	14.6	5.8	8.8	9.8	4.1	5.7

As it can be seen in table 2, Dulcin 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 much poorer that of Dulcin and Estival. Furthermore, the share of G and G x E effects in the total value of P_i is much favorable in Dulcin and Estival [G x E = (3-6) G] than in Deliciul verii $G \infty$ G x E). This means that Dulcin and Estival cv. based their yield stability mainly on their ecological plasticity and less on specific genetic effects implied in cob yield in sweet corn.

CONCLUSIONS

Early genotypes register poor ear yields, most probably due to their short vegetative period which does not allow the plants to use the additional mineral N fertilization. Such genotypes are not recommended for conventional practices of sweet corn fertilization.

For semiearly and semilate sweet corn hybrids, the conventional practices of mineral N fertilization should consider as really efficient only high rates of additional mineral N (N_{150} a).

For certain semiearly sweet corn genotypes, the fertilization with high and very high rates of additional mineral N might not be economically efficient since the yield increase is far from being significant as compared with yield obtained with low rates of mineral N.

The organic and low input practices of N fertilization are far from the levels attained with high and very high rates of additional fertilization with mineral N.

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