CULTIVATION OF MAIZE FOR SILAGE AND FOR ENERGY PURPOSES

Pavlína KOLÁŘOVÁ[1], J. DIVIŠ[1], J.MOUDRÝ Jr.[1], J. BÁRTA[1]

[1] University of South Bohemia, Faculty of Agriculture, České Budějovice; *e-mail: kolaro@zf.jcu.cz*

In years 2003 - 2005 in a location with elevation above 380m experiments testing silage maize hybrids with FAO 200 - Pedro, FAO - Romario, FAO 300 – Chambord started. Used plant density 80 000, 95 000, 110 000 plants.ha^{-1}. Nitrogen fertilizing applied in three steps - basic rate 150 kg N.ha^{-1} and models using additional fertilizing rate of 20 kg N.ha^{-1} in the vegetation phase of 4-5 leaves (solid fertilizer) and Campofort Plus - folial fertilizer. In mentioned location there was no evidence of dry matter content drop with rising FAO number for tested hybrids. Drop in dry matter content with rising plant density was recorded with nitrogen fertilising application and with application of mean rate of nitrogen folial fertilizer. With rising FAO number there was evident rise in dry matter yield. Selected hybrids proved higher dry matter yield with increased plant density. Additional folial fertilizing rate brought dry matter content yield.

The experiment proved very high yield potential of maize hybrids for energy purposes. Higher yield of methane was recorded with maize silage in lover elevations and with Atletico hybrid. In higher elevations there is potential risk of late harvested maize with lower content of dry matter and risk of plant freeze.

***Key words**: silage maize, maize for biogas, hybrids, dry matter content, yield*

Under conditions of the Czech Republic region animal nutrition will be always based on maximal biomass utilization (JAMBOR, 1996). DAMBORSKÝ (1996) considers maize the main fodder crop. Permanent rise of milk production efficiency causes total Czech milk production increase although number of dairy cows has been reduced. Very high dairy cows efficiency - average efficiency in year 2005 reached 6 253,7 l/cow (HRUBÁ, VESELÁ, 2006) has to be based on quality and energy -rich feeding ration.

DIVIŠ (1993) states that hybrid selection for particular conditions is the most important precondition for high yield of cheep and quality energy. During the vegetation season the plants are exposed to stress factors and only the farmer can reduce their affect to minimum using appropriate agricultural practices.

Maize fertilisation and plant density are very important factors. Maize fertilisation is predominantly based on nitrogen fertilisers application. NEVES, REHEUL (2001) state that profitable yield can be reached even when the nitrogen fertilising rates are lowered. Nitrogen fertilising rates depend also on environment protection measures and rising prices of fertilisers. DWYER, COSTA (2003) did not recorded more intensive nitrogen utilisation with rising plant density and higher nitrogen fertilising rates. PRESTEL at al. (2002) warn about great differences between particular hybrids regarding effective nitrogen utilisation. DIVIŠ (2003) considers fertilising rate of 150 kg $N.ha^{-1}$ sufficient to reach a profitable yield of silage maize. JŮZA, BIEDERMANNOVÁ (1992) use in their methodology for silage maize fertilisation the principle of divided application of nitrogen rate.

According to JORDANOVA (1990) plant density is the most important factor influencing biomass production maximisation. NEGOVANOVIČ (1993) states that increase of silage maize plant density by 20% proved no negative affect compared to grain maize production.

With rising plant density over optimal number for given hybrid biomass and dry matter yield slightly rises but the share of corncobs, dry matter content in corncob and biomass decrease HORVÁTH, 1990). These authors both consider optimal plant density for chosen hybrid when under given conditions the profitable yield of biomass is reached and dry matter content amount 27 - 32%.

Maize as a plant with high-production becomes very important plant for biogas production.

The reasons why maize is suitable crop for biogas production:

- high yield potential of hybrids;
- the technology of cultivation and ensilaging is very sophisticated;
- high-quality machinery;
- within the cultivation technology there is possible to respect requirements of environmental protection.

MATERIAL AND METHOD

In a place in elevation 380 m above see level in years 2003 - 2005 there was an experiment established that was aimed to asses maize hybrid reaction to different fertilising application and increasing plant density.

The experiment involved hybrids with increasing FAO number, FAO - Pedro, FAO 250 – Romario, FAO 300 – Chambord. For the experiment was given increasing plant density (80 000, 95 000 and 110 000 $plants.ha^{-1}$ with 0,75m row spacing.

Chosen fertilising methods: 150 kg $N.ha^{-1}$
150+20 kg $N.ha^{-1}$
150 kg N. ha^{-1} Campofort PLUS

Used fertiliser - LAV – (27,5 % N Campofort Plus – folial fertiliser (22 % N, 8 % MgO)

Additional fertilising rate in the phase of 4-5 leaves. Each option repeated 4 times. Pre-emergence herbicide application (Guardien EC – 2,5 $l.ha^{-1}$). Parcel size - 15 m^2. Establishment and harvest were made manually. Yield and dry matter content were determined.

In a place in elevation 380 m and 620 above see level in years 2008 was established an experiment for energy-production maize cultivation with hybrids ATLETICO (FAO 280-300) and LATIZANA (FAO 280-300). Following parameters were monitored - biomass yield, dry matter content and biogas production and maize silage production.

RESULTS AND DISCUSSIONS

Selected hybrids feature different vegetation season length. Within monitored period of time in years 2003 - 2005 the influence of different growth density and fertilising practise brought following results.

There was no difference in dry matter content in biomass monitored for selected hybrids with various vegetation season length. Influence of rising plant density was recorded only for hybrid with FAO 300 when dry matter content in biomass slightly dropped. Folial fertilizer application combined with highest growth density brought dry matter content decrease. However dry matter content in biomass did not decline under low optimal value of dry matter content in biomass - i.e. 27 %.

Conclusions by PODOLÁ, HORVATH (1990), who mention negative influence of growth density rise on dry matter content in cobs and biomass, were not proved.

Dry matter content in cobs differs very slightly in dependence on hybrid, fertilizing and plant density and vary in 57 - 58 %. The fact that dry mater content in cobs decrease in dependence on higher growth density and additional fertilizing rates application was not proved.

There was verified the conclusion by DIVIŠ (2003) who considers fertilising rate of 150 kg N.ha^{-1} sufficient to reach a profitable yield of silage maize. The efficiency of nitrogen fertilizing utilisation varies according to particular hybrid which corresponds to conclusions by PRESTEL at al. (2002). Growth density increase from 80 000 to 110 000 plants.ha^{-1} did not markedly affect silage maize biomass quality, which is consistent with findings by PODOLÁK, HORVATH (1990) who consider as optimal such growth density that provide under given conditions required yield of quality biomass. Recorded dry matter content in cobs approves the possibility to change FAO number to 300 for selected hybrids to fulfil conditions of marginality.

Statistical assessment approved very strong dependence between yield and content of dry matter on year and very low dependence of dry matter content in biomass on plant density.

Yield and dry matter content in cobs variability was also statistically proved with dependence on year but not as strong as for biomass production. On contrary to biomass production statistical assessment proved the dependence of growth density on variability of content and yield of dry mater in cobs.

For environment conditions in elevation 380 m above see level can be used hybrids with FAO number up to 300. Certainty of production volume and profitable yield provide hybrids with FAO number 250 and 300. Choice of hybrids with FAO 200 can be concerned when there are more kinds of hybrids used for ripeness reach and divided harvest of silage maize on large field areas. Plant density between 95 000 and 110 000 plants/ha.$^{-1}$was proven from the production and economic point of view. In the phase of growth establishment one fertilizing rate of 150 kg N.ha^{-1} is considered sufficient. Additional fertilizing in the phase of

4 -5 leaves using solid or folial fertilizer brought profitable yield for hybrids with FAO 250 and 300.

Table 1

Content and yield of dry matter biomass and cobs 2003-2005

growth density (th . ha $^{-1}$)		FAO 200		FAO 250		FAO 300	
		biomass	cobs	biomass	cobs	biomass	cobs
fertilizing 150 N (kg. ha^{-1})							
80	content (%)	27,23	57,70	25,81	57,70	26,85	58,26
	yield (t. ha $^{-1}$)	7,73	6,17	8,51	6,17	9,56	7,52
95	content (%)	29,32	57,61	26,54	58,81	27,18	58,53
	yield (t. ha $^{-1}$)	8,85	6,80	9,37	7,25	10,3	7,73
110	content (%)	27,54	56,72	26,17	57,14	25,89	57,08
	yield (t. ha $^{-1}$)	8,22	6,54	9,32	7,03	9,67	7,53
fertilizing 150 + 20 N (kg. ha^{-1})							
80	content (%)	25,98	57,13	27,83	59,64	28,42	58,76
	yield (t. ha $^{-1}$)	7,98	9,54	9,92	7,28	10,05	7,10
95	content (%)	27,34	58,26	25,74	58,49	26,19	58,08
	yield (t. ha $^{-1}$)	9,10	7,28	9,57	7,55	10,25	7,90
110	content (%)	25,29	56,89	25,52	58,17	25,88	57,06
	yield (t. ha $^{-1}$)	8,35	7,15	9,74	7,91	9,81	8,13
fertilizing 150 N (kg. ha^{-1}) + Campofort Plus							
80	content (%)	28,03	58,81	30,50	60,67	29,35	58,83
	yield (t. ha $^{-1}$)	9,06	7,86	11,41	7,87	11,83	8,47
95	content (%)	27,70	57,69	26,94	58,56	28,29	58,33
	yield (t. ha $^{-1}$)	9,44	7,69	10,42	8,16	12,25	8,95
110	content (%)	26,52	56,51	27,38	57,90	27,50	57,07
	yield (t. ha $^{-1}$)	9,14	7,63	10,50	7,35	11,21	8,87

Experiment results reached in 2008 proved that hybrids for energy purposes can provide high yields of biomass. Required content of dry matter in biomass in elevation 360 m above see level was reached in the middle of September. In elevation 620 m and harvest in early October the required biomass dry matter content recorded only for hybrid ATLETICO (30,8 %). Higher yield of methane from silage maize was reached with hybrid ATLETICO in elevation 380 m (*Table 1*).

CONCLUSIONS

Reached results proved that in elevation 380m above see level hybrids with FAO 300 can be used. These hybrids provide required content of dry matter in biomass for quality maize silage. Growth density rise up to 110 000 plants. ha^{-1} caused only minimal decrease of dry matter content in cobs and biomass. Positive effect on dry matter content and biomass and cobs dry matter yield proved additional nitrogen fertilizing and folial fertilizer Campofort Plus application.

Table 2

Maize for biogas

	380 m a. s. l.		620 m a. s. l.	
	ATLETICO	LATIZANA	ATLETICO	LATIZANA
Yeild of biomass $t.ha^{-1}$	60,2	55,7	65,2	66,1
Dry matter content %	29,4	30,5	30,8	26,5
Yeild of dry matter biomass $t.ha^{-1}$	17,7	17,0	20,1	17,5
Methane yield NL/kg organic coupound	383,4	372,3	362,2	342,3

Results of the year 2008 from 2 sites showed dependence of economic produce of biomass maize for biogas on site. Showed, that is possibility to reach economic production of maize biomass. Hight production hybrids FAO 300 can cause problems with dry matter content in biomass at site with elevation above 620 m.

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