Technological variants adapted to drought conditions for fodder crops utilized in swine feeding in the ecological conditions of Cojocna, Cluj County, Romania

[1]Nicuşor Sima, [2]Rodica Sima

[1] University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Faculty of Animal Sciences and Biotechnologies, Cluj-Napoca, Romania; [2] University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Faculty of Horticulture, Cluj-Napoca, Romania. Corresponding author: R. Sima, rodiganea@yahoo.com

Abstract. The choice of a mixed structure of fodder crops, including annual and perennial species, becomes a necessity for Romanian farmers due to the droughty periods recorded during the vegetation period of fodder plants. The choice of some species with good adaptability at drought and high forage yields in such climatic conditions has no less importance. Moreover, the application of a proper fertilization influences both the reaction of species at climatic conditions and the level of obtained yields. This study aims to find species/crops and fertilization levels which can provide good forage yields in drought conditions. In this respect six crops represented by two mixtures as oat + peas (control – C1) and triticale + pea (C2), respectively by four pure crops as rape (C3), millet (C4), sorghum x Sudan grass hybrid (C5) and sweet sorghum (C6), on three levels of fertilization (N_0P_0 kg·ha^{-1} – F1, $N_{60}P_{70}$ kg·ha^{-1} – F2 and $N_{120}P_{70}$ kg·ha^{-1} – F3), were studied. The study was undertaken in 2011 when the rainfall level during sowing-harvesting period (March-July months) was with 362.65 mm lower than in 2010 and with 184 mm lower than in 2009, respectively. Sweet sorghum and sorghum x Sudan grass hybrid fertilized with $N_{60}P_{70}$ kg·ha^{-1} and $N_{120}P_{70}$ kg·ha^{-1} doses were revealed with significant high dry matter yield among the studied crops and experimental variants (crop x fertilization). Among the mixtures of annual grasses and legumes taken into the study and which can be used in pig farming within experimental area, in a descending order, considering the obtained yields, the following variants can be recommended for farmers: triticale + peas fertilized with $N_{120}P_{70}$ kg·ha^{-1} dose and unfertilized oat + peas.

Key Words: C4 and C3 type of fodder species, yield, oats and peas mixture, triticale and peas mixture, pig feeding.

Introduction. The lack of new information concerning the yield performance, in drought conditions of Transylvania, of some annual drought resistant fodder species, which can be used by small farmers in the feeding of ruminants and pigs – breeding sows determines the rare usage and on small areas of such species. However, the advantages of using of these species for forage production (grains, fresh matter – FM, hay, silage) in drought conditions are frequently mentioned (Moga et al 1996; Vântu et al 2004; Dragomir 2005; Durst & Wittman 2010; Sima et al 2011a, 2011b). Moreover, many researches proved the higher efficiency of C4 type of species in water use efficiency and nitrogen utilization in high temperatures and drought conditions (sweet sorghum, sorghum x Sudan grass hybrid and millet) in comparison with C3 type of plants (Zhao et al 2005; Farineau & Morot-Gaudry 2006; Condon et al 2006). Thus, at UASVM Cluj-Napoca, in the frame of Didactical and Experimental Station (DES) Cojocna, researches on the technological inputs of some fodder crops such as sweet sorghum and sorghum x Sudan grass hybrid beside traditional used crops in area, such as oat + peas, triticale + peas, spring rape and, were performed.

Material and Method. The study was performed in the experimental field of DES Cojocna, on a luvic phaeozem soil. Six annual fodder crops (C) recommended for fresh matter production and represented by two mixtures as oat + peas (as control, C1) and triticale + pea (C2), respectively by four pure crops as rape (C3), millet (C4), sorghum x Sudan grass hybrid (C5) and sweet sorghum (C6), were taken into the study. Three levels of fertilization (N_0P_0 kg·ha^{-1} – F1, $N_{60}P_{70}$ kg·ha^{-1} – F2 and $N_{120}P_{70}$ kg·ha^{-1} – F3) were studied and fertilizers were applied immediately after sowing of each crop. The experiment was organized according to the subdivided plots method in three replications. The crops were sown in 2011 in the beginning of April (C1, C2 and C3) and in the end of April (C4, C5 and C6), respectively. The harvest was simultaneously done in the beginning of July (beginning of flowering for peas and mean height of 60 cm for sorghum x Sudan grass hybrid). For sorghum x Sudan grass hybrid the second cutting was harvested at the and of August. The yield was determined by weighing of the harvest obtained from the each variant surface. Samples of 200 g of fresh matter were collected in order to determine the dry matter (DM) yield. DM was determined by drying of samples in a drying oven, at a 60°C, for 48 h. The obtained data were statistically analyzed by ANOVA and Duncan test.

Results and Discussion. The influence of crop on the yield obtained at the first cutting, DM yield (t·ha^{-1}) (Table 1) revealed that only C6 (sweet sorghum) recorded a very significant yield increase (2.52 DM t·ha^{-1}) in comparison with control – C1 (oats + peas). The resistance of this species and its good reaction at fertilization was also observed by Almodares et al (2009). All of the other crops recorded yield differences as compared with control. Thus, insignificant yield decreases (0.17 t·ha^{-1} and 0.14 t·ha^{-1}) were obtained for C2 (pea + triticale) and C3 (rape) while very significant yield decreases (0.66 t·ha^{-1} and 0.67 t·ha^{-1}) were obtained for C4 (millet) and C5 (sorghum x Sudan grass hybrid).

Table 1

The influence of crop on the DM yield (t·ha^{-1})

Crop	*DM yield (t·ha^{-1})*	*Yield %*	*Differences +/- (t·ha^{-1})*	*Significance*
C1	2.18	100.00	0.00	Control
C2	2.01	92.00	-0.17	-
C3	2.04	93.60	-0.14	-
C4	1.52	69.80	-0.66	000
C5	1.51	69.10	-0.67	000
C6	4.70	215.80	2.52	***

LSD (p 5%) 0.27; LSD (p 1%) 0.39; LSD (p 0.1%) 0.56.
C1-C6 are the studied crops.

Analyzing the influence of fertilization on the yield obtained at the first cutting (Table 2) it was observed that both fertilization doses ($N_{60}P_{70}$ and $N_{120}P_{70}$ kg·ha^{-1}) determined very significant yield increases in comparison with control. The yield difference obtained between the two fertilization levels was also significant.

Table 2

The influence of fertilization on the DM yield (t·ha^{-1})

Fertilization	*DM yield (t·ha^{-1})*	*Yield %*	*Differences +/- (t·ha^{-1})*	*Significance*
F1	1.71	100.00	0.00	Control
F2	2.26	132.10	0.55	***
F3	3.01	176.40	1.30	***

LSD (p 5%) 0.09; LSD (p 1%) 0.12; LSD (p 0.1%) 0.17.
F1-F3 are the fertilization levels.

Another aim of this research, beside to establish fodder species/crops which can provide high yields in drought conditions, it was also to establish some recommended fertilization levels in order to obtain high yields. Thus, the yield of each crop was analyzed according to the three levels of fertilization considering as control the unfertilized crop. Yield differences in comparison with control were revealed for oat + peas (C1) and triticale + peas (C2) fertilized with $N_{60}P_{70}$ kg·ha^{-1} (Table 3). It has to be mentioned that if at C1 the yield decrease was insignificant at C2 it was distinct significant.

Table 3

The influence of fertilization and crop interaction on the DM yield (t·ha^{-1})

Fertilization/Crop	*DM yield (t·ha^{-1})*	*Yield %*	*Differences +/- (t·ha^{-1})*	*Significance*
F1C1	2.44	100.00	0.00	Control
F2C1	2.32	95.0	-0.12	-
F3C1	1.77	72.6	-0.67	000
F1C2	1.85	100.00	0.00	Control
F2C2	1.51	81.60	-0.34	00
F3C2	2.66	144.20	0.82	***
F1C3	1.39	100.00	0.00	Control
F2C3	1.69	121.60	0.30	*
F3C3	3.04	218.50	1.65	***
F1C4	0.96	100.00	0.00	Control
F2C4	1.48	154.00	0.52	***
F3C4	2.11	219.40	1.15	***
F1C5	1.14	100.00	0.00	Control
F2C5	1.66	145.70	0.52	***
F3C5	1.72	151.60	0.59	***
F1C6	2.47	100.00	0.00	Control
F2C6	4.88	197.70	2.41	***
F3C6	6.76	274.10	4.29	***

LSD (p 5%) 0.22; LSD (p 1%) 0.31; LSD (p 0.1%) 0.41.
C1-C6 represents the studied crops; F1-F3 are the fertilization levels.

Fertilization with $N_{120}P_{70}$ kg·ha^{-1} determined different variations of yield of the two variants. Thus, at C1 fertilization with maximum dose determined very significant yield decreases (0.67 t·ha^{-1}) while at C2 very significant yield increase in comparison with control.

For all of the other crops both fertilization doses determined yield increases. If for C4, C5 and C6 very significant yield increases were recorded for both doses of fertilization for C3 only $N_{120}P_{70}$ kg·ha^{-1} dose determined very significant yield increase (Table 3). The efficient utilization of P and K in case of sweet sorghum was also reported in other researches. Thus, Ayub et al (1999) recorded yield difference of 3.31 t·ha^{-1} between the unfertilized and the fertilized with $N_{50}P_{50}$ kg·ha^{-1} variants.

The rainfall level during sowing-harvesting period (March-July months) of 2011 was with 362.65 mm lower than in 2010 and with 184 mm lower than in 2009, respectively (Sima et al 2012, Table 4). In order to make a right estimation of obtained yields considering the weather conditions of 2011, a droughty year, the yields were analyzed taking into consideration the yield of C5 (sorghum x Sudan grass hybrid) obtained at 1st and 2nd cuttings (3.44 t·ha^{-1} DM).

Table 4

Comparative weather conditions (temperatures and rainfall) at sowing and harvesting time for the studied crops (2009, 2010 and 2011 in Cojocna, Cluj County, Romania), adaptation after Sima et al (2012)

Month/year 2009/2010/2011	*Average monthly temperature (°C)*	*Rainfall (mm)*	*Average monthly temperature (°C)*	*Rainfall (mm)*	*Average monthly temperature (°C)*	*Rainfall (mm)*
March - June	4.30	247.25	6.85	426.10	4.75	63.45
April	13.13		11.30		10.23	
May	16.21		17.21		15.07	
June	18.47		21.24		19.24	
July	20.25		23.10		20.25	
August	21.40		21.44		20.23	

The new statistical analysis of data revealed for sorghum x Sudan grass hybrid a complete different situation than that obtained at 1st cutting (Table 5).

Table 5

The influence of crop on the DM yield (t·ha^{-1})

Crop	*DM yield (t·ha^{-1})*	*Yield %*	*Differences +/- (t·ha^{-1})*	*Significance*
C1	2.18	100.00	0.00	Control
C2	2.01	92.00	-0.17	-
C3	2.04	93.60	-0.14	-
C4	1.52	69.80	-0.66	000
C5	3.44	158.00	1.26	***
C6	4.70	215.80	2.52	***

LSD (p 5%) 0.30; LSD (p 1%) 0.43; LSD (p 0.1%) 0.63.
C1-C6 represents the studied crops.

Considering the influence of crop on the obtained yields of fodder crops, the total yield (1st and 2nd cuttings) of C5 revealed very significant increase in comparison with control. For all of the other crops the yield differences compared with control are similar with those reported and commented at 1st cutting and they have the same statistical significations.

Analyzing the influence of fertilization and crop interaction on the obtained yields of fodder crops through Duncan test, significant differences among the yields of the same crop for the three levels of fertilization they were observed (Table 6).

Table 6

The influence of fertilization on DM yields (t·ha^{-1})

Fertilization (F)	*DM yield (t·ha^{-1})*	*Fertilization (F)*	*DM yield (t·ha^{-1})*
F1C4	0.96 A	F1C1	2.44 GH
F1C3	1.39 B	F1C6	2.47 GH
F2C4	1.48 BC	F1C5	2.58 GH
F2C2	1.51 BC	F3C2	2.66 H
F2C3	1.69 BCD	F3C3	3.04 I
F3C1	1.77 CD	F2C5	3.34 J
F1C2	1.85 DE	F3C5	4.40 K
F3C4	2.11 EF	F2C6	4.88 L
F2C1	2.32 FG	F3C6	6.76 M

Values followed by the same letters do not significantly differ at P≤0.05, according to the Duncan's test.
C1-C6 are the studied crops; F1-F3 are the fertilization levels.

Other researches on sweet sorghum (Ayub et al 1999; Mahmud et al 2003) indicated also significant increases of biomass yields alongside the increase of N used dose, associated with qualitative changes of forage. Almodares et al (2009) reported that the increase of N fertilization dose from 50 to 100, 150, and 200 kg·ha^{-1} determined corresponding significant yield increases and also significant increase of protein brute content of forage. The doubling of N fertilization dose, from 50 to 100 kg·ha^{-1}, which is near by the fertilization doses studied in this experiment ($N_{60}P_{70}$ kg·ha^{-1} and $N_{120}P_{70}$ kg·ha^{-1}) determined a significant quantitative and qualitative improving of forage. Moreover, the fresh matter yield increased from 55.50 t·ha^{-1} to 59.10 t·ha^{-1}, crude protein content increased from 4.30% to 5.40% while cellulose content decreased from 35.89% to 33.10%.

Conclusions. Among the mixtures of annual grasses and legumes (C3 type of species) taken into the study, and which can be used in pig feeding within the studied area, in a descending order, considering the obtained yields, the following variants can be recommended: triticale + peas fertilized with $N_{120}P_{70}$ kg·ha^{-1} dose (F3C2), oat + peas unfertilized (F1C1) and fertilized with $N_{60}P_{70}$ kg·ha^{-1} dose (F2C1).

Among the studied crops for ruminants feeding, in drought conditions, sweet sorghum and Sorghum x Sudan grass hybrid (C4 type of species) can be recommended. Sweet sorghum revealed the highest yield regardless the fertilization dose applied. Sorghum x Sudan grass hybrid can be recommended when is fertilized with $N_{60}P_{70}$ kg·ha^{-1} and $N_{120}P_{70}$ kg·ha^{-1} and two cuttings are ingathered because this type of crop management revealed significant yield increases in comparison with the mixtures of annual grasses and legumes taken into the study.

Acknowledgements. This work was supported by the National Council for Higher Education Scientific Research (CNCSIS), the Executive Unit for the Financing of Higher Education and Academic Scientific Research (UEFISCSU), Romania, project PNII-IDEI, nr. 1107, CNCSIS code 1488/2008.

References

Almodares A., Jafarinia M., Hadi M. R., 2009 The effects of nitrogen fertilizer on chemical compositions in corn and sweet sorghum. American-Eurasian J Agric & Environ. Sci 6(4):441-446.

Ayub M., Tanveer A., Mahmud K., Ali A., Azam M., 1999 Effect of nitrogen and phosphorus on the fodder yield and quality of two sorghum cultivars (*Sorghum bicolor* L.). Pak J Biol Sci 2:247-250.

Condon A. G., Farquhar G. H., Rebetzeke G. J., Richards R. A., 2006 Drought adaptation in cereals. In: The application of carbon isotope discrimination in cereal improvement for water-limited environments. Ribaut J.-M. (ed), pp. 171-219, Food Product Press.

Dragomir N., 2005 Pajişti şi plante furajere. Editura Eurobit, Timişoara, Cap. X: p. 248-281, Cap. 15: p. 426-430.

Durst L., Wittman M., 2010 Nutriţia animalelor. Editura Ceres, Bucureşti, pp. 160-239.

Farineau J., Morot-Gaudry J.-F., 2006 La photosynthèse. Processus physiques, moléculaires et physiologiques. Metabolismes de types C4 et CAM. Collection Synthèses, INRA Paris, pp. 293-314.

Moga I., Schitea M., Mateias M. C., 1996 Plante furajere. Editura Ceres, Bucureşti, Cap. V: p. 283-301, Cap. VII: p. 327-338.

Mahmud K., Ahmad I., Ayub M., 2003 Effect of nitrogen and phosphorus on the fodder yield and quality of two sorghum cultivars (*Sorghum bicolor* L.). Int J Agri Biol 5(1):61-63.

Sima N., Sima R., Mihai G., Pleşa D., Sabo M., 2011a Yield and fodder quality of some annual plants cultivated for fresh matter. Bulletin UASVM Cluj-Napoca, Animal Husbandry and Biotechnology 68(1-2): 435.

Sima N., Sima R., Mihai G., Sabo M., Pleşa D., Peţ I., Bărbos A., 2011b Research concerning the using of Sorghum x Sudan Grass Hybrid (*Sorghum bicolor* (L.) Moench × Sorghum sudanense (Piper) Stapf.) in the fodder plant assortment for fresh matter production in Transylvania. Scientific Papers: Animal Science and Biotechnologies, USAMV Timisoara, 44(2):251-254.
Sima N., Mihai G., Sima R., Rusu T., Georgescu B., Plesa D., 2012 Annual and perennial fodder crops for fresh matter production assessment in actual climate conditions from Transylvania. Bulletin UASVM, Cluj-Napoca, Animal Science and Biotechnologies 69(1-2):192-197.
Vîntu V., Moisuc A., Motcă G., Rotar I., 2004 Cultura pajiştilor şi a plantelor furajere. Cap. X: p. 365 -386, Cap. XII: p. 439 – 453, Cap. XIV: p. 487-490. Editura "Ion Ionescu de la Brad" Iaşi.
Zhao D., Reddya K. R., Kakania V. G., Reddy V. R., 2005 Nitrogen deficiency effects on plant growth, leaf photosynthesis, and hyperspectral reflectance properties of sorghum. Europ J Agronomy 22:391–403.

Received: 11 April 2016. Accepted: 29 May 2016. Published online: 07 June 2016.
Authors:
Nicuşor Sima, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Faculty of Animal Science and Biotechnologies, Romania, Cluj-Napoca, Calea Manastur, no. 3-5, 400372, e-mail: flaviusima@yahoo.com
Rodica Sima, University of Agricultural Sciences and Veterinary Medicine Cluj-Napoca, Faculty of Horticulture, Romania, Cluj-Napoca, Calea Manastur, no. 3-5, 400372, e-mail: rodiganea@yahoo.com

How to cite this article:
Sima N., Sima R., 2016 Technological variants adapted to drought conditions for fodder crops utilized in swine feeding in the ecological conditions of Cojocna, Cluj County, Romania. Porc Res 6(1):10-15.