# INFLUENCE OF FERTILIZATION AND HARVESTING MODE ON THE PRODUCTIVE POTENTIAL IN SORGHUM AND SUDAN GRASS, UNDER CONDITIONS OF NORTH-EASTERN ROMANIA

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*In the last years, climatic conditions were very unfavourable for most fodder crop growing, because of great water and heat stress, in critical vegetation periods. Therefore, the only crops that supported very well this climatic shock, without showing high yield decrease, were sorghum and Sudan grass. The interaction between species, fertilization and harvesting mode has shown that the mean yields obtained by sorghum, used as green mass, were higher than Sudan grass, being comprised between 9.4 and 16.0 t ha$^{-1}$DM., compared to 7.4 – 10.0 t ha$^{-1}$ DM. The highest mean yields of sorghum silo (11.7 t/ha) were obtained at 5 t/ha fertilization with vinasse, while, the highest mean yields of Sudan grass, of 14.6 t ha$^{-1}$ DM, were obtained at the fertilization with 30 t ha$^{-1}$manure.*

***Key words**: sorghum, fertilization, productivity, quality*

An important role in agriculture straitening and, especially, of fodder crops from Romania is played by sorghum and Sudan grass. Sorghum is used for feeding cattle, swine, horses, sheep and poultry, and in many countries, it is used with very good results for producing mixed fodder. Besides sorghum varieties, which are grown for seed production, a special importance has sweet sorghum, cultivated for obtaining sweet substances from stems. Dry sorghum stems or residues resulted from syrup extraction can be also used for making paper and cellulose, as they contain 42% raw cellulose or 30% pure cellulose.

Sudan grass is cultivated more for green mass or silo and has very good results in the warm areas from southern and south-eastern Romania, where is competed by fodder maize. Its usage as green mass is advantageous, because, recovered many times during the vegetation period it supplies the necessary fodder on a longer period.

The results found in the literature show that under conditions of favourable moisture, sorghum reacted positively to nitrogen fertilization, both as concerns the crop and the protein content, because in the dry areas, phosphorus has a favourable effect [1,5].

Nowadays, rates applied worldwide vary between $N_{50-150}P_{36-100}$, according to testing conditions. Sorghum and Sudan grass give very good results on every soil type, show a special resistance to the stress caused by dryness and are sufficiently tolerant to the stress caused by floods [2,3,4].

In this scientific paper, we have followed the role of the two species for supplying constantly the fodder production, even in unfavourable years for fodder, under conditions of the Moldavian Central Plateau. In this scientific paper, we have also followed the influence of fertilization and harvesting mode on increasing productivity in sorghum and Sudan grass.

## MATERIAL AND METHOD

The trial was set up during 2006-2008, in the experimental field situated on the territory of the Ezăreni Farm, within the Didactic Station of Iaşi, on a cambic chernozem with 7-10% slope, loam clayey texture, pH = 6.5-7.1, with a content in mobile phosphorus ($P_{AL}$) of 28-40 ppm and in mobile potassium ($K_{AL}$) of 333-400 ppm, at depth 0-20 cm.

From the climatic conditions point of view, at the Ezăreni Farm there are cold and wet winters, with temperatures of the coldest month of – 3˚C and temperatures of the hottest month of 20-22˚C and the highest amounts of rainfall at the beginning of summer. The mean annual rainfalls have the value of 552.4 mm with an uneven distribution during the year, but there are some cases when the annual rainfall sum is in excess, but because of uneven spreading of rainfalls, the year may be considered dry.

The crop year 2005-2006 was characterized by rich rainfall, the total sum of the interval between October 2005 and September 2006 being of 772.6 mm, with 254.8 mm more than the multiannual mean, while the mean temperature of the same period was of $10.3^0$C, a positive deviation of $0.7\ ^0$C being recorded. The crop year 2006-2007 was characterized by total rainfalls of 427.6 mm, with 90.2 mm less than the multiannual mean, while the mean temperature was of $12.5^0$C, a positive deviation of $3.0\ ^0$C being recorded.

The crop year 2007-2008 was characterized by total rainfalls of 607 mm, with 89.2 mm more than the multiannual mean, while the mean temperature was of $11.0^0$C, a positive deviation of $1.4^0$C being recorded.

The experimental factors were:

Factor A – species cultivated with two phases:

$a_1$ - sorghum;

$a_2$ –Sudan grass.

B Factor– harvesting mode with two phases:

$b_1$ – green mass;

$b_2$ – silo.

C Factor – fertilization with four phases:

$c_1$ – control – unfertilized;

$c_2$ – $N_{60}$+ $N_{30}P_{100}$;

$c_3$ – 5 t $ha^{-1}$ vinasse;

$c_4$ – 30 t $ha^{-1}$ manure.

For fertilization, we have used well-fermented cattle manure, applied in autumn below the ploughed layer, together with phosphorus fertilizers, while in spring, we have applied nitrogen fertilizers and vinasse, at the beginning of vegetation bursting.

For making specific observations, interpretations and analyses, we carried out harvesting on production cycles and experimental variants, in order to determine precisely the DM yield.

Harvesting was done at the specific epoch and maturity for green mass and silo, while the statistical calculation and the interpretation of the obtained results were done by the analysis of variance.

## RESULTS AND DISCUSSIONS

Analysing how the species has influenced the DM mean yield during 2006-2008, we noticed that it had very close values, of 10.9 t $ha^{-1}$ DM in sorghum and of 10.7 t $ha^{-1}$ DM in Sudan grass (*tab. 1*).

Table 1

**Influence of the species on yield (t $ha^{-1}$ DM)**

| Species | 2006 | 2007 | 2008 | Mean | Difference | | Significance |
|---|---|---|---|---|---|---|---|
| | | | | | t $ha^{-1}$ | % | |
| Sorghum | 3.3 | 2.7 | 26.6 | 10.9 | - | 100 | |
| Sudan grass | 8.5 | 5.6 | 17.9 | 10.7 | 0.2 | 98 | 0 |
| LSD 5% = 1.7 t $ha^{-1}$<br>LSD 1 % = 2.8 t $ha^{-1}$<br>LSD 0.1% = 4.5 t $ha^{-1}$ | | | | | | | |

By analysing the influence of the harvesting mode on the mean DM yield, one can see that it was of 10.5 t $ha^{-1}$ DM in case of green mass and of 11.1 t $ha^{-1}$ in case of silo (*tab. 2*).

Table 2

**Influence of the harvesting mode on yield (t $ha^{-1}$ DM)**

| Harvesting mode | 2006 | 2007 | 2008 | Mean | Difference | | Significance |
|---|---|---|---|---|---|---|---|
| | | | | | t $ha^{-1}$ | % | |
| Green mass | 4.0 | 3.2 | 24.3 | 10.5 | - | 100 | |
| Silo | 7.8 | 5.2 | 20.2 | 11.1 | 0.6 | 106 | 0 |
| LSD 5% = 1.7 t $ha^{-1}$<br>LSD 1 % = 2.8 t $ha^{-1}$<br>LSD 0.1% = 4.5 t $ha^{-1}$ | | | | | | | |

Fertilization had a positive influence on the obtained yield (*tab. 3*).

Because of unfavourable climatic conditions, the yields obtained in 2006 and 2007 were very low and quite close each other, compared to 2008, irrespective of the used fertilization level.

Generally, we noticed a higher yield level in the variants where fertilizers were applied in autumn, which may be explained by a higher rainfall level during autumn or winter.

The mean yields, obtained during 2006-2008, were comprised between 9.1 t $ha^{-1}$ DM at the control and 12.4 t $ha^{-1}$ DM at the fertilization with 5 t $ha^{-1}$ vinasse. Yield increases were statistically assured only in the variants fertilized with 5 t $ha^{-1}$ vinasse and 30 t/ha manure, being of 3.3 t/ha DM and, respectively, 2.3 t $ha^{-1}$ DM.

Table 3

**Influence of the fertilization on yield (t ha$^{-1}$ DM)**

| Fertilization rate | 2006 | 2007 | 2008 | Mean | Difference | | Significance |
|---|---|---|---|---|---|---|---|
| | | | | | t ha$^{-1}$ | % | |
| Control – unfertilized | 4.6 | 3.2 | 19.4 | 9.1 | - | 100 | |
| $N_{60}$+ $N_{30}P_{100}$ | 5.6 | 4.1 | 22.1 | 10.6 | 1.5 | 116 | |
| 5 t/ha vinasse | 6.2 | 4.6 | 26.3 | 12.4 | 3.3 | 132 | *** |
| 30 t/ha manure | 7.4 | 4.9 | 21.8 | 11.4 | 2.3 | 125 | * |
| LSD 5% = 1.8 t ha$^{-1}$<br>LSD 1% = 2.4 t ha$^{-1}$<br>LSD 0.1% = 3.2 t ha$^{-1}$ | | | | | | | |

Analysing how the species and the harvesting mode have influenced the DM yield, we noticed that it was higher in both species, at silo harvesting (*tab. 4*).

Table 4

**Influence of species and harvesting mode on yield (t ha$^{-1}$ DM)**

| Species | Harvesting mode | 2006 | 2007 | 2008 | Mean | Difference | | Significance |
|---|---|---|---|---|---|---|---|---|
| | | | | | | t ha$^{-1}$ | % | |
| Sorghum | Green mass | 3.1 | 2.7 | 29.9 | 11.9 | - | 100 | |
| | Silo | 3.5 | 2.7 | 23.3 | 9.8 | -2.1 | 82 | 0 |
| Sudan grass | Green mass | 4.8 | 3.6 | 18.6 | 9.0 | -2.9 | 76 | 0 |
| | Silo | 12.1 | 7.6 | 17.1 | 12.3 | +0.4 | 103 | |
| LSD 5% = 1.7 t ha$^{-1}$<br>LSD 1 % = 2.8 t ha$^{-1}$<br>LSD 0.1% = 4.5 t ha$^{-1}$ | | | | | | | | |

The mean yields of green mass were of 11.9 t ha$^{-1}$ DM in sorghum and of 9.0 t ha$^{-1}$ DM in Sudan grass, while at silo harvesting, they were of 9.8 t ha$^{-1}$ DM in sorghum and 12.3 t ha$^{-1}$ Dm in Sudan grass.

The highest DM mean yields at green mass harvesting, of 11.9 t ha$^{-1}$ DM, were obtained in sorghum, while at silo harvesting, they were of 12.3 t ha$^{-1}$ DM in Sudan grass.

In table 5, we showed the yields obtained after fertilization for the two harvesting modes.

The mean yields were comprised between 8.4 t ha$^{-1}$ DM at the control and 12.6 t ha$^{-1}$ DM at the fertilization with 5 t ha$^{-1}$ vinasse, at green mass harvesting, and between 9.6 t ha$^{-1}$ DM at the control and 12.0 t ha$^{-1}$ DM at the fertilization with 5 t ha$^{-1}$ vinasse, at silo harvesting.

They noticed that in all the fertilized variants, lower DM yields were obtained in 2007, compared to 2006 and 2008, because of much lower rainfall amounts recorded that year.

Table 5

**Influence of fertilization and harvesting mode on yield (t ha$^{-1}$ DM)**

| Harvesting mode | Fertilization rate | 2006 | 2007 | 2008 | Mean | Difference | | Significance |
|---|---|---|---|---|---|---|---|---|
| | | | | | | t ha$^{-1}$ | % | |
| Green mass | Control – unfertilized | 3.2 | 2.3 | 19.7 | 8.4 | - | 100 | |
| | $N_{60}$+ $N_{30}P_{100}$ | 4.0 | 3.2 | 23.0 | 10.1 | 1.7 | 120 | |
| | 5 t/ha vinasse | 4.4 | 3.5 | 30.0 | 12.6 | 4.2 | 150 | *** |
| | 30 t/ha manure | 4.5 | 3.6 | 24.4 | 10.8 | 2.4 | 129 | ** |
| Silo | Control – unfertilized | 5.9 | 4.0 | 19.0 | 9.6 | 1.2 | 114 | |
| | $N_{60}$+ $N_{30}P_{100}$ | 7.2 | 5.0 | 21.1 | 11.1 | 2.7 | 132 | ** |
| | 5 t/ha vinasse | 7.9 | 5.6 | 22.6 | 12.0 | 3.6 | 143 | *** |
| | 30 t/ha manure | 10.2 | 6.2 | 19.2 | 11.9 | 3.5 | 142 | *** |
| LSD 5% = 1.8 t ha$^{-1}$<br>LSD 1% = 2.4 t ha$^{-1}$<br>LSD 0.1% = 3.2 t ha$^{-1}$ | | | | | | | | |

The interaction between species, fertilization and harvesting mode has shown that the mean yields obtained by sorghum harvested for green mass were higher than Sudan grass, being comprised between 9.4 and 16.0 t ha$^{-1}$ DM, compared to 7.4 – 10.0 t ha$^{-1}$ DM (*tab. 6*).

Table 6

**Influence of species, fertilization and harvesting mode on yield (t ha$^{-1}$ DM)**

| Species | Harvesting mode | Fertilization rate | 2006 | 2007 | 2008 | Media | Difference | | Significance |
|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | t ha$^{-1}$ | % | |
| Sorghum | Green mass | Unfertilized | 2.5 | 2.1 | 23.6 | 9.4 | - | 100 | |
| | | $N_{60}$+ $N_{30}P_{100}$ | 3.1 | 2.7 | 26.3 | 10.7 | 1.3 | 114 | |
| | | 5 t/ha vinasse | 3.5 | 2.9 | 41.6 | 16.0 | 6.6 | 170 | *** |
| | | 30 t/ha manure | 3.5 | 3.0 | 28.3 | 11.6 | 2.2 | 123 | |
| | Silo | Unfertilized | 2.7 | 2.2 | 22.4 | 9.1 | -0.3 | 97 | |
| | | $N_{60}$+ $N_{30}P_{100}$ | 3.6 | 2.9 | 23.7 | 10.1 | 0.7 | 107 | |
| | | 5 t/ha vinasse | 2.7 | 2.7 | 29.7 | 11.7 | 2.3 | 124 | |
| | | 30 t/ha manure | 4.8 | 3.1 | 25.4 | 11.1 | 1.9 | 118 | |
| Sudan grass | Green mass | Unfertilized | 3.9 | 2.4 | 15.8 | 7.4 | -2.0 | 79 | |
| | | $N_{60}$+ $N_{30}P_{100}$ | 4.8 | 3.7 | 19.8 | 9.4 | 0 | 100 | |
| | | 5 t/ha vinasse | 5.3 | 4.1 | 18.4 | 9.3 | -0.1 | 99 | |
| | | 30 t/ha manure | 5.4 | 4.1 | 20.5 | 10.0 | 0.6 | 106 | |
| | Silo | Unfertilized | 9.0 | 5.7 | 15.6 | 10.1 | 0.7 | 107 | |
| | | $N_{60}$+ $N_{30}P_{100}$ | 10.7 | 7.1 | 18.4 | 11.6 | 1.2 | 123 | |
| | | 5 t/ha vinasse | 13.2 | 8.5 | 15.6 | 12.4 | 3.0 | 132 | * |
| | | 30 t/ha manure | 15.5 | 9.2 | 19.0 | 14.6 | 5.2 | 155 | ** |
| LSD 5% = 2.9 t ha$^{-1}$<br>LSD 1% = 4.1 t ha$^{-1}$<br>LSD 0.1% = 5.4 t ha$^{-1}$ | | | | | | | | | |

At this harvesting mode, the highest mean yield of 16.0 t ha$^{-1}$ DM was obtained at the fertilization with 5 t ha$^{-1}$ vinasse for sorghum and 10.0 t ha$^{-1}$ DM at the fertilization with 30 t ha$^{-1}$ manure for Sudan grass.

In silo sorghum, the mean obtained yields were comprised between 9.1 t $ha^{-1}$ DM at the control and 11.7 t $ha^{-1}$ DM at the fertilization with 5 t $ha^{-1}$ vinasse, while in Sudan grass for silo, yields were comprised between 10.1 t $ha^{-1}$ DM at the control and 14.6 t $ha^{-1}$ DM at the fertilization with 30 t $ha^{-1}$ manure.

In sorghum, the highest mean yield of 16.0 t $ha^{-1}$ DM was obtained at the fertilization with 5 t $ha^{-1}$ DM, when the crop was harvested for green mass, while in Sudan grass, the highest yield of 14.6 t $ha^{-1}$ DM was obtained at the fertilization with 30 t $ha^{-1}$ manure, when the crop was harvested for silo.

## CONCLUSIONS

In 2006 and 2007, Sudan grass yields were higher than sorghum yields, because the first crop got two harvests, even under unfavourable conditions.

Sorghum achieved lower mean yields than Sudan grass in all the fertilization variants and at both harvesting modes.

The interaction between species, fertilization and harvesting mode shows that mean yields obtained by sorghum harvested for green mass were higher than Sudan grass, being comprised between 9.4 and 16.0 t $ha^{-1}$ DM, compared to 7.4 – 10.0 t $ha^{-1}$ DM.

When used as green mass, the highest mean yield of 16.0 t $ha^{-1}$ DM was obtained at the fertilization with 5 t/ha vinasse for sorghum and 10.0 t $ha^{-1}$ DM at the fertilization with 30 t $ha^{-1}$ manure for Sudan grass.

When used as sorghum silo, the highest mean yields of 11.7 t $ha^{-1}$ DM were obtained at the fertilization with 5 t $ha^{-1}$ vinasse, while in Sudan grass, the highest mean yields of 14.6 t $ha^{-1}$ DM were obtained at the fertilization with 30 t/ha manure.

Higher yields were obtained in the variants fertilized in autumn, which may be explained by the fact that these fertilizers could use water reserves during autumn and winter for reaching soil solution and, implicitly, for using more easily sorghum and Sudan grass the next year.

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