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FERTILIZATION OF SWEET SORGHUM WITH COMPOST FROM WASTE WOOL

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Abstract

In Romania, wool waste from the felt industry would be suitable for the fertilization with compost sorghum saccharatum. This hypothesis was tested in an experiment at USAMV Bucharest. The experience consists in the fertilization treatments of reddish preluvosol with both the lemon straw directly into the soil and a compost consisting of a mixture of waste wool, bovine and wheat. Experience includes untreated control variant (Mt), compost variant (C) and variant of wool debris embedded directly into soil (L). Experience results showed that variant (L) generated the largest biomass, followed insignificantly by variant (C).

Key words: *waste wool, biomass, compost, sweet sorghum, chlorophyll.*

INTRODUCTION

Agricultural farmers face many problems, one of which is control over the use of organic fertilizers. The result of these problems is the lack of fertilizer with nitrogen easily accessible to crop plants. Organic fertilizers contain organic nitrogen, but they are not assimilated sufficiently quickly to meet the needs of plants during critical periods (Vončina A. et al., 2013; Pang X. N. et al., 2000).

In Romania, it is not known when this plant was brought and cultivated, but the literature mentions that in 1936 "a ha was cultivated in four kinds of land and in all it succeeded" (Popescu I., 1943, quoted by Antohe I., 1991).

Sugar is an agricultural crop that supplies strains to produce syrup, sugar, fuel, litter (for cattle), food ethyl alcohol, starch, building material, agglomerated sheets, paper pulp. Starch can be used as additives, for clotting in the textile industry or alcohol can be produced by fermentation.

Sugar sorghum biomass can be used to feed animals in the form of silo or green cow dairy cows. Cultivated as a fodder plant is produced as a green table with several sews. Sugar beans have uses like corn grains.

The plant is tolerant to soil and climate. Moisture resistance -1/3 to sugar cane and 1/2 to maize, as well as a high CO_2 absorption power of 45 tons of CO_2/ha over the entire vegetation period.

With regard to environmental protection, it can reduce the population's limit: one ha of sugar sorghum can absorb annually from the atmosphere up to 50-55 t of CO_2, compared to deciduous trees that absorb 16 t/ha/year CO_2 (Roman G.V. et al., 2016).

Secondary products, such as wool waste from the felt mill, are mostly deposited in landfills. An alternative to such wastes is their use as organic fertilizers. Scientific literature of specialists mentions that these by-products are richer in organic nitrogen (over 5%) and carbon (30-50%) than manure (Vončina A. et al., 2013; Baker R.A., 1991). The hydrolysed sheep wool improves the growth conditions by the large amount of nitrogen, carbon and phosphorus that it emits during the plant growth process in the soil (Vončina A. et al., 2013; Govi R.S. et al., 1998).

The applied wool has also improved the appearance and growth of plants (Vončina et al., 2013; Nustorova M. et al., 2005).

MATERIALS AND METHODS

The experiment took place in the spring of 2018 on the field of the University of Agronomic Sciences and Veterinary Medicine of Bucharest. Comparing the effects of fertilizers on growth and development of sorghum (*Sorghum saccharatum*) were made on red preluvosol soil. The cut was made at a depth of 0-20 cm. The placement of the experimental field was made on the principle of randomized variants (Figures 1, 2), with three repetitions. The land was relatively homogeneous. In each variation, the lots were fertilized with either compost (C) or sheep wool waste (L), and having non-fertilized soil (Mt) as a control.

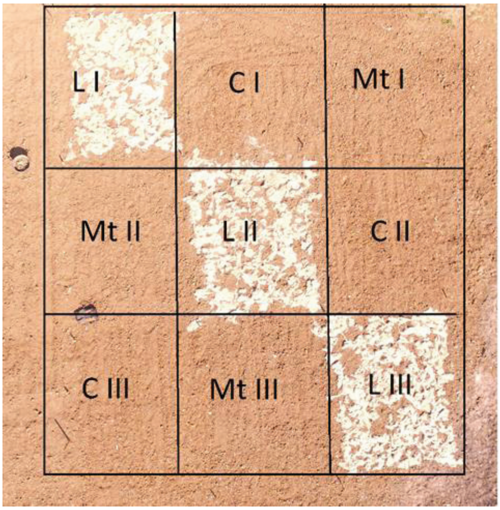

Figure 1. Experimental field placement within the experience

Each variant measured 12 m^2 (3 m x 4 m). Fertilization was performed on May 2, 2018 (Table 1). The wool waste distribution was done manually and uniformly on the test version, and covered with hoeing in the first 10 cm of plowed soil, so as not to be swept by the wind. The compost was spread evenly, using the fork.

In field experiments, research has shown that parcels close to one another on the ground tend to produce more similar to each other than the distant ones.

The square placement was recommended to find out the very small differences between the few variants. Also, the Latin square is very suitable for experiences where there are variations in temperature, brightness, air current and uniformity of watering.

The statistical analysis allows to eliminate both the differences between the blocks and the columns, making it possible to control the influence of soil unevenness as well as other influences, thus achieving a double control.

Figure 2. Experimental ground framing vs. other experiences

Table 1. Experimental treatments, application rates for fertilizers

Treatment	Fertilization	Rate of application (kg)
(M_t)	Unfertilized soil	-
(C)	Compost	15
(L)	Waste wool	10

After fertilization, the soil was processed with a rotary harrow only for the (C) and (Mt) treatments, since variant (L) does not allow mixing with the rotary harrow. Prior to the beginning of the sowing of the sorghum grains, the rows were drawn at a distance of 50 cm on the 3 m side of the parcel. During the year, the prevention and growth of weeds between rows of sucrose sorghum was done manually. Sowing was applied after sowing.

In order to make evident the influence of the experimental factors, the chlophyll concentration of the sorghum leaves was quantitatively determined. Determination was performed on 9 samples (in 3 repetitions) of sorghum (*Sorghum saccharatum*).

Green chlorophyll pigments (chlorophyll a and b) and yellow or carotenoid pigments (carotenes and xanthophylls) are photosynthetic pigments or assimilators.

All organs or tissues of a plant, if green, that is to say if they have chlorophyll, make photosynthesis, but adapted and at the same time specialized to fulfill this function are the leaves.

Chlorophyll a and b are the two main pigments involved in photosynthesis. Chlorophyll a is the primary pigment of photosynthesis, capture of luminous energy and the emission of high energy electrons in the two photosensitive systems. Chlorophyll b is the auxiliary pigment, passing the energy captured in chlorophyll a. Thus, the main difference between chlorophyll a and b is their function in photosynthesis.

The identification and quantification of total carotenoid content was made according to a method adapted from Lichtenthaler and Wellburn (1983).

Thus, 1.0 g of the sample was mixed in the presence of quartz sand. The mojarate was washed several times with 100% acetone, filtered in vacuo and passed quantitatively into a 50 ml volumetric flask containing 10 ml of distilled water.

The obtained acetone extract was spectrophotometrically compared to a 80% acetone blanc at wavelength λ = 470 nm (carotenoids), 646 nm (chlorophyll b), 663 nm (chlorophyll a).

The results wer calculated based on the formulas developed by Lichtenthaler and Wellburn (1983):

Chlorophyll a (μg/ml) = [(12.21 x DO663) - (2.81 x DO646)]

Chlorophyll b (μg/ml) = [(20.13 x DO646) - (5.03 x DO663)]

Carotenes and xanthophylls (μg/ml) = $\frac{(1000 \text{ x DO470}) - (3{,}27\ x\ Ca - 104\ x\ Cb)}{229}$

RESULTS AND DISCUSSIONS

Experience shows that between variants (L) and (C) was used on the basis of the amount of green mass expressed in t/ha (Table 2).

Table 2. Green sweet sorghum (*Sorghum saccharatum*) t/ha

Variants	Product	Meaning
Waste wool (L)	21.9	a
Compost from wool waste (C)	18.8	a
Control (M_t)	11.6	b

Dl 5% = 7.01 t/ha

The greenhouse weight values of the sorghum recorded differences of 21.9 t/ha and 18.8 t/ha compared to the control variant (Mt) (Figures 3 and 4). The variations obtained under the influence of the fertilization mode were statistically assured in all fertilization variants.

Figure 3. Variation of biomass production

Figure 4. Production variation on 20 August 2018

The green biomass obtained from the wool waste variant (L) did not differ as the production of the wool waste compost (C), both of which were marked with the letter a. The green weight difference (Mt) was significantly lower with the letter b, than variants (L) and (C) (Table 3).

Table 3. Influence of compostable (C) and non-compostable wool (L) waste on biomass of sorghum leaf (*Sorghum saccharatum*) on chromic luvisol

Variants	Product	Meaning
(L)	28.83	a
(C)	28.59	a
(M_t)	26.93	b

Dl 5% = 4.75 t/ha

Wool waste is a rich source of nutrients, being composed of keratin proteins that contain abundant nitrogen, carbon and sulfur, playing an essential role in plant nutrition. It has been argued that the use of sheep's wool on the soil has produced beneficial effects on the productivity of several plant species (Górecki R.S., 2010; Zheljazkov V.D. et al., 2008; Zheljazkov V.D., 2005).

Table 4. Influence of treatments applied to sugar sorghum on chlorophyll a content

Variants	Chlorophyll a content (µg/ml)	The difference (µg/ml)	Semnification
Witness	12.47	Mt	-
Waste compost wool	15.59	3.12	-
Wool waste	18.39	5.92	***

$Dl_{5\%}$ = 3.15 µg/ml; $Dl_{1\%}$ = 4.34 µg/ml; $Dl_{0,1\%}$ = 5.98 µg/ml

Tables 4 and 5 present the results of the chlorophyll a analyzes. We note that for the variant treated with wool waste and compost from the wool debris, the chlorophyll does not differ significantly between them (receiving letters a 18.39 and 15.59). This means that the reddish chromic luvisol has been subjected to a more intense phosphorus ion release activity, by statistical differentiation. This differentiation is due to the fertilization conditions and the amount of nutrients (nitrogen, phosphorus).

Table 5. Influence of treatments applied to sugar sorghum culture

Variants	Chlorophyll a content (µg/ml)	Semnification
Witness	18.39	a
Waste compost wool	15.59	a
Wool waste	12.47	b

$Dl_{5\%}$ = 4.46 µg/ml; $Dl_{1\%}$ = 4.67 µg/ml

Table 6. Influence of treatments applied to sugar sorghum on chlorophyll b content

Variants	Chlorophyll b content (µg/ml)	The difference (µg/ml)	Semnification
Witness	3.88	Mt	-
Waste compost wool	6.04	2.16	-
Wool waste	6.83	2.95	***

$Dl_{5\%}$ = 2.21 µg/ml; $Dl_{1\%}$ = 3.04 µg/ml; $Dl_{0,1\%}$ = 4.19 µg/ml

Table 7. Influence of treatments applied to sugar sorghum

Variants	Chlorophyll b content (µg/ml)	Semnification
Witness	6.83	a
Waste compost wool	6.04	a
Wool waste	3.88	b

$Dl_{5\%}$ = 3.12 µg/ml; $Dl_{1\%}$ = 3.27 µg/ml

Tables 6 and 7 present the results of the chlorophyll b analyzes. We find that for the variant treated with wool waste and wool waste compost, chlorophyll b does not differ significantly between each other (receiving letters a 6.83 and 6.04). This means that the soil in reddish chromic luvisol has undergone a more intense phosphorus ion release activity, by statistical differentiation.

Table 8. Influence of applied treatments on carotene and xanthophyll content in sugar sorghum plants

Variants	Content carotenes and xanthophylls (µg/ml)	The difference (µg/ml)	Semnification
Witness	2.95	Mt	-
Waste compost wool	3.06	0,11	-
Wool waste	3.58	0,63	***

$Dl_{5\%}$ = 0.70 µg/ml; $Dl_{1\%}$ = 0.96 µg/ml; $Dl_{0,1\%}$ = 1.33 µg/ml

Table 9. Influence of treatments applied to sugar sorghum culture

Variants	Content carotenes and xanthophylls (µg/ml)	Semnification
Witness	3.58	a
Waste compost wool	3.06	a
Wool waste	2.95	b

$Dl_{5\%}$ = 0.99 µg/ml; $Dl_{1\%}$ = 1.04 µg/ml

Tables 8 and 9 present the results of analyzes of carotene and xanthophyll content. We note that for the wool waste and wort waste compost variants, carotenes and xanthophylls do not differ significantly (by the letter a 3.58 and a 3.06). This means that in the soil the reddish-uptake was carried out a more intense nutrient release activity, marked by the statistical differentiation and the more intense color of the sorghum leaves.

CONCLUSIONS

Sheep's wool is a rich source of nutrients. Lana is composed of protein (keratin) that contains abundant nitrogen, carbon and sulfur, which play an essential role in plant nutrition. It has been argued that the fertilization of soil with sheep's wool caused beneficial effects on the productivity of several plant species (Zheljazkov V.D. et al., 2008; Zheljazkov V.D., 2005).

The results of fertilization research for variants (L) and (C) allow the formulation of a set of conclusions on green biomass and separat (*Sorghum saccharatum*).

The results of this study suggest that with the onset of degradation and degradation of debris, they can provide sufficient nutrients for plants. However, it takes time for wool waste to begin to degrade and release nutrients.

In the agricultural year 2018 from the point of view of the green biomass, the variants (L) and (C) are noted. Following the analysis of the influence of fertilization on the sorghum leaves, the variants (L) and (C) are also compared with the control variant (Mt).

The compost obtained can also be used as a bio-stimulator of soil microbianity and as a plant growth stimulant for trace elements (Fe, Cu, Zn) as a valid alternative to the use of other synthesis substances.

Due to fertilization, the percentage of green meal did not vary significantly between fertilized fertilizer with wool waste and fertilized fertilizer with compost from wool waste, wheat straw and cattle manure.

After harvesting the sugar sorghum plants, wool waste has not completely decomposed into the soil, making the next crop come with a nutrient input.

Sweet sorghum plants for which fertilizer was used with wool waste can see the color of leaves of a darker green, most likely due to the nitrogen that wool waste put at the disposal of plants, resulting in an increase in the content in carotenes and xanthophylls.

It can be concluded that wool waste is a valuable fertilizer in the production of many plant species over several years. Both wool waste and wool waste compost can be valuable as organic fertilizers for sustainable agriculture.

Overall, the amount of wool waste used as a fertilizer for sugar sorghum plants was reduced after harvesting plants, indicating a possibility for a new harvest. Further mineralization of wool wastes is expected, which could provide phyto-available nutrients for further harvesting.

Further research is needed to release nutrients from the collection of wool waste to crop requirements and to determine optimal rates of application of wool waste to different crops. Since wool waste may contain pathogens or chemicals, further research is needed to address the possible concerns of consumers and the general public about the use of waste wool waste as a source of nutrients for crops.

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