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Sorghum dry biomass yield for solid bio-fuel production affected by different N-fertilization rates

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Introduction

The interest of new energy sources environmental friendly has increased and development of new technologies are the main reasons for using biofuels. Bioenergy production from biomass has an increased interest during the last decades. One of the crops that attracted worldwide attention during the last fifteen years is sorghum.

The aim of this study was to identify the efficient nitrogen fertilizer application rates for sustainable energy sorghum cultivation in a soil characterized from the downward movement of calcium carbonate from the surface horizons due to leaching with focuses on improvement of dry biomass production yield.

Materials &Methods

Two field experiments were established for the study in the main agricultural plain of Greece (Thessaly; Velestino area) to evaluate the effect of different nitrogen fertilization levels on two new hybrids (H1: EJ7281 and H2: ES5200) of energy sorghum yield in 2017.

Sowing took place on the 20th of June (due to the fact that there was a pea cultivation in the field which was incorporated as green manure).

Five different nitrogen fertilization levels were applied under 4 replications (blocks) for each tested hybrid. Plot size was 20 m^2 (5 m width x 4 m length), while the total plots per crop were 20 (5 N-fertilization levels x 4 blocks).

Final biomass yield measured on final samplings (end of October for both hybrids), where the whole aerial biomass were cut 8-10 cm above ground. The samples were weighed in the field and then a sub-sample was taken for further laboratory measurements and air drying. Thereafter, the dry sub-samples were weighted.

Results

Fertilization	Total Dry Weight (t ha^{-1})	Dry Stem Weight (t ha^{-1})	Dry Leaves Weight (t ha^{-1})	Seed Weight (kg ha^{-1})
0	22.24	17.71	3.60	931
70	35.31	29.66	4.24	1414
140	31.55	25.42	4.31	1822
210	34.77	28.77	4.46	1534
280	29.10	23.54	4.22	1341
$LSD_{0.05}$	ns	9.072	ns	491.5
CV (%)	22.3	23.5	21.1	22.7

Effects of different N-fertilization levels (0, 70, 140, 210, 280 kg N ha^{-1}) biomass and seed yield of sorghum hybrid 1 (H1: EJ7281).

Fertilization (kg N ha^{-1})	Total Dry Weight (t ha^{-1})	Dry Stem Weight (t ha^{-1})	Dry Leaves Weight (t ha^{-1})	Seed Weight (kg ha^{-1})
0	25.98	19.88	5.27	830
70	24.17	18.51	5.08	580
140	25.28	19.41	5.25	620
210	29.26	23.01	5.67	580
280	37.44	29.28	7.17	990
$LSD_{0.05}$	ns	ns	ns	ns
CV (%)	22.3	23.5	21.1	22.7

Effects of different N-fertilization levels (0, 70, 140, 210, 280 kg N ha^{-1}) biomass and seed yield of sorghum hybrid 2 (H2: ES5200).

There were not found statistical significant effects of nitrogen fertilization on total dry biomass yield for both tested sorghum hybrids. Total dry yield was fluctuated between 22.2 to 37.5 t ha^{-1}, with the higher dry yield corresponding to the hybrid 2 under the higher N-fertilization level, while the lower corresponded to the hybrid 1 without fertilization. Hybrid 1 had a negative effect of N-supply above the 210 kg N ha^{-1}, while hybrid 2 followed the principle the higher the nitrogen supply, the higher yield can be obtained.

In both hybrids, sorghum accumulated a high amount of biomass in stems, while the stem/total biomass ratio was rather constant in each hybrid. Hybrid 1 produced higher stem yield than hybrid 2, which was affected from nitrogen fertilization. This ratio achieved the 81.6 and 77.5 % for the first (H1) and the second hybrid (H2), respectively. In the case of leaves the second hybrid (H2) had a higher percentage of leaf biomass (20.1 vs. 13.8 %) than the first (H1). Hybrid 1 produced double seed yield of hybrid 1 (1400 vs. 720 kg ha^{-1}), which can be used as animal feed.

The tested sorghum hybrids shown that high dry biomass yield can be produced even under low nitrogen fertilization or even without fertilization when pea cultivation is the previous one and has been used as green manure.

A general conclusion could be that sorghum, should be taken seriously into consideration in land use planning producing high dry biomass yields for solid biofuels, but further investigation of the gross calorific value and the ash content is needed.