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EFFICIENCY OF SWEET, SUDAN AND BROOM SORGHUM VARIETIES USING AS POLLINATORS FOR HIGH YIELD HYBRIDS BREEDING IN THE STEPPE ZONE OF UKRAINE

NOSOV M.H. – graduate student
orcid.org/0000-0001-6649-905X
State Institution Institute of Grain Crops NAASU

Formulation of the problem. Sorghum is grown in marginal areas where other crops grow poorly, by farmers who are among the world's poorest [6]. African farmers grow several morphological forms or "races" of sorghum including caudatum (originating in eastern Africa), durra (with residual moisture) and Sorghum bicolor, which is broadly distributed [20]. However, Sorghum bicolor is an important coarse grain crop in different countries [21, 13, 17, 1, 19, 7]. Genomic selection is expected to improve selection efficiency and genetic gain in breeding programs [12]. The results suggest that genomic prediction could become an effective tool for predicting the performance of sorghum hybrids based on parental genotypes.

Analysis of recent research and publications. Ten sorghum hybrids were tested at two locations in Pakistan [16]. The following ranges were determined in the investigated traits for grain yield (28.6-52.7 t/ha) and fodder yield (28.7- 45.7 t/ha). F1 hybrid forage sorghums take as advantageous for producing forage as F, grain sorghums are for producing grain [21]. It is possible to develop F, hybrids with high forage yield even when using the dwarf male-sterile lines of grain sorghum as seed parents. Testing of parent lines for general combining ability should be supplemented in hybrid breeding procedures, by evaluation of individual F1 hybrids for specific combining ability [10]. Sorghum has recently been identified as a promising bioenergy feedstock [4, 14, 11]. Heterosis is a key factor considered in hybrid breeding. The degree of heterosis was different among subpopulations even though the parental lines had similar genetic distances from the testers [8].These results suggest that heterosis groups of bioenergy sorghum should be considered for maximizing the performance of F1. It was shown that both general and specific combining ability effects are important but predominance of non-additive genetic variance indicate the presence of Sorghum heterozygosis in the population [15]. Fixed male line exhibited highly significant positive general combining ability effect for total fresh and dry biomass weight [22]. It could be used to develop dual purpose sorghum varieties. Last time sorghum hybrid breeding utilizes the cytoplasmic-nuclear male sterility (CMS) system for seed production and subsequently harnesses heterosis [3]. Since the cost of developing and evaluating inbred and hybrid lines in the CMS system is costly and time-consuming, genomic prediction of parental lines and hybrids is based on genetic data genotype [18]. Success in developing promising hybrids depends on the choice of parents to hybridize and the amount and type of genetic variation present in the base population [9]. In Europe, broomcorns continue to be grown for a unique market [2, 5]. Most recently, various forage accessions have been evaluated for their potential for renewable fuel production. The main objective of this case study was to determine the effectiveness of using sweet, sudanese and broom sorghum as pollinators for obtaining high-yield hybrids in the conditions of the northern part of the steppe zone of Ukraine.

The purpose of research. work on the study and selection of raw material for the creation of highly European hybrids of sorghum crops of bioenergy use with subsequent production of solid fuel.

Material and methods The research was conducted in 2021-2023 at the Sinelnykivo breeding research station of the Institute of Grain Crops of the National Academy of Agrarian Sciences of Ukraine. This station is located in the Dnipropetrovsk region at the northern part of the Steppe zone of Ukraine. Four varieties were used for pollination. Karlykove 45 and Krasen varieties are representatives of broomcorn. Strateya is sudanese sorghum, and Silosne 42 is a sweet sorghum variety. Stratea is the parent component of the sorghum-sudanese hybrid. Krasen is the parent component of Vinnytsia sorghum. Karlykove 45 is the parent component of Vinnytsia sorghum. Silosne 42 is the parent component of sweet sorghum.

Dn5s – the maternal component, a sterile line of grain sorghum and its fixer Dn-5 f, belong to the Nubian subspecies of grain sorghum. Dn13s maternal component sterile line and its fixer Дп–13 f belong to grain Nubian sorghum. Dn 17s sterile line and its sterility fixer Дп–17 f refer to sweet sorghum. Dn 19s sterile line and its sterility fixer Dn–19 f refer to sweet sorghum. SK23s sterile line and its sterility fixer SK-2Z f, belong to the Nubian subspecies of grain sorghum. Dn 37s sterile line and its sterility fixer Dn –37 f refer to African sorghum. Dn 39s sterile line and its sterility fixer Dn– 39 f refer to Kafrske grain sorghum. Medium-ripe, with a growing season of 100–117 days. Dn 71s sterile line and its sterility fixer Dn –71 f – grain sorghum. Niz81s sterile line and its sterility fixer Nizkorosle 81f refers to Kafrske sorghum. Niz93s sterile line and its sterility fixer. Low-growing 93 f refers to Kafrske sorghum. Kafrske early 2 s is a sterile line and its sterility fixer Kafrske forage 186 f refers to Kafrske sorghum. A 326 sterile line and its sterility fixer B326 refer to Kafrske grain sorghum.The area of plots in the nursery for the study of combinatorial ability was 7 m^2, the repetition in the experiment – three times. Harvesting was done manually with subsequent weighing. 3 weighing of 50 g were taken from two non-adjacent repetitions for further drying at a temperature of 100°C to a constant weight to determine the content of dry matter.

Results and discussion. The results of sorghum hybrides fresh biomass estimation for 2023 are shown in Table 1.

The following combinations of parent and pollinating species stood out as the best hybryds: F1 (Nyzkorosle 93s × Karlykove 45) – 71.7 t/ha, F1 (Rannye 776s × Karlykove 45) – 66.4 t/ha; F1 (Dn 71s × Karlykove 45) – 65.6 t/ha, (Dn 19s × Strateya) – 65.5 and Dn 17s × Strateya – 54.6 t/ha. F1(Yefremivske bile 2s × Karlykove 45) – 61.0 t/ha.According to the average values, the following combinations F1(Nyzkorosle 81s × Krasen) – 33.7 t/ha, F1(Dn39s × Silosne 42) – 32.3 t/ha were selested. F1 (A 326 × Strateya) – 33.0 t/ha. It was established that the Karlykove 45 pollinator showed an average result of 53.6 t/ha. Pollinators Krasen and Strateya – 40.9 t/ha, 39.1 t/ha, respectively, Silosne 42 – 28.9 t/ha. The results of the dry biomass estimation for the sorghum hybrids are shown in Table 2.

In terms of dry matter yield of sorghum biomass, the best indicators were: F1 (Nyzkorosle 93s × Karlykove 45) – 45.0 t/ha, F1 (Kafrske feed. 186s × Krasen) – 41.4 t/ha, F1 (Dn71s × Karlykove 45) – 33.3 t/ha, F1 (Dn17s × Strateya) – 32.0 t/ha. The average yield of dry matter ranged from 17.6 t/ha F1(A 326 × Krasen) to 27.4 t/ha, F1(Gaolyan 09-3094c × Krasen). Pollinators Karlykove 45

Table 1

Fresh biomass of the sorghum hybryds, t/ha

Hybryd	Krasen	Strateya	Karlykove 45	Silosne 42
Dn 5s	42,6	21	51,2	21,8
Dn 13s	26,5	31	31,7	32,4
Dn 17s	48,3	54,6	53,9	21,3
Dn 19s	41	65,5	52,8	33,3
Sk 23s	52,3	43	43,5	31,7
Dn 37s	50,2	32,7	41,4	25,9
Dn 39s	31,7	41	61,1	32,3
Dn 71s	41,6	42	65,6	41,5
Nyzkorosle 81s	33,7	35	67,5	24,4
Nyzkorosle 93s	31,3	33,3	71,7	22,4
A158	42,8	41,3	61,6	41,6
Kafrske feed. 186s	51,5	40	52	31,6
Rannye776s	52,4	32	66,4	22,8
A 326	23,4	31,5	22,8	21,3
Gaolyan 09-3094 s	52,6	48,6	51	22,8
Yeferemiv. byle 2s	31,8	41,1	61	31
Gos 11 s	41.4	31	55,3	33,5

Table 2

Dry biomass of the sorghum hybryds, t/ha

Hybryd	Krasen	Strateya	Karlykove 45	Silosne 42
Dn 5s	16,3	12,6	22,5	12,4
Dn 13s	11,3	11,2	12,7	11,9
Dn 17s	21,5	32	13,2	14,3
Dn 19s	18,8	18,6	25,8	15,9
Sk 23s	22,6	17,4	23,5	12,1
Dn 37s	22,9	16,5	18,5	11,7
Dn 39s	13,8	15,5	22,1	12,1
Dn 71s	18,6	13,7	33,3	24,5
Nyzkorosle 81s	9	13,6	45	13,3
Nyzkorosle 93s	18,7	12,1	28,9	13,3
A158	25,8	19,8	23,3	25,4
Kafrske feed. 186s	41,4	14	22,1	11,1
Rannye776s	31,8	13,8	31,3	13,6
A 326	17,6	9,9	13,2	10,3
Gaolyan 09-3094 s	27,4	13,9	12,5	13,2
Yeferemiv. byle 2s	22,9	21,2	21,1	14,1
Gos 11 s	22,2	13,2	17,3	17

(21.3 t/ha) and Krasen (23.1 t/ha) can be singled out by average values.

Conclusion. The following tasks were solved to achieve the goal: to evaluate self-pollinated lines and pollinators according to the combining ability of the yield of green mass, dry matter, to select self-pollinated sorghum lines depending on the directions of use. 17 original kinds of grain and sweet sorghum were studied in the field experiment. The highest yield of fresh biomass was obtained in the combinations: F1 (Nyzkorosle 93s × Karlykove 45) – 71.7 t/ha, F1 (Rannye 776s × Karlykove 45) – 66.4 t/ha; F1 (Dn 71s × Karlykove 45) – 65.6 t/haand (Dn 19s × Strateya) – 65.5, and Dn 17s × Strateya – 54.6 t/ha. The use of sorghum varieties for pollination made it possible to obtain dry biomass in a line by decreasing in the combinations: Nyzkorosle 81c × Karlikove 45 (45.0 t/ha), Kafrske feed. 186s × Krasen (41.4 t/ha), Dn 17s × Stratea (32.0 t/ha) and A158×Silosne 42 (25.4 t/ha).

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Носов М.Г. Ефективність використання сортів цукрового, суданського та віничного сорго в якості запилювачів для селекції високоурожайних гібридів в Степовій зоні України

Мета. Сорго розглядається як стратегічна культура в забезпеченні сировиною біоенергетичної галузі, тому основною метою дослідження було визначення ефективності використання сорго цукрового (Силосне 42), суданського (Стратея) та віничного (Карликове 45 та Красень) в якості запилювачів для отримання високоврожайних гібридів в умовах північної частини Степової зони України. **Методи.** Сортовипробування сорго проводили на Синельниківській селекційно-дослідній станції ДУ Інститут зернових культур НААН України, де вивчалось 68 сортозразків, які мали врожайність зеленої маси у межах 23–79 т/га. Визначали показники врожайності зеленої маси та вмісту сухої речовини. Площа ділянок у розсаднику для дослідження становила 7 м^2, повторність у досліді – триразова. **Результати**. У польовому досліді досліджено 17 вихідних сортів та гібридів зернового та цукрового сорго. У трьох новоствopen гібридів F1(Низькоросле 93с х Карликове 45), F1(Ранні 776с × Карликове 45) та F1(ДН 71с × Карликове 45) найефективнішим запилювачем для забезпечення найвищої врожайності (65,6–71,7 т/га) виявився сорт Карликове 45. Сорго Суданський гібрид Стратея показав ефективність для отримання врожайності 54,6-65,5 т/га у комбінаціях F1(ДН 19с × Стратея) та F1(ДН 17с × Стратея). Сорт Карликове 45 можна рекомендувати як цінний запилювач для створення гібридів, які можуть використовуватись в якості твердого біопалива. За вмістом сухої речовини біомаси сорго найвищі показники отримано у: F1 (Низькоросле 93с × Карликове 45) – 45,0 т/га, F1 (Кафрське корм. 186с × Красень) – 41,4 т/га, F1 (Дн71с × Карликове 45) – 33,3 т/га, F1 (Дн17с × Стратея) – 32,0 т/га. **Висновки.** Визначено, що гібрид біоенергетичного напрямку використання F1(Низькоросле 93с х Карликове 45) є найвищим за показниками врожайності зеленої маси та вмісту сухої речовини. Встановлена цінність сорту Карликове 45, як запилювача при створені гібридів соргових культур для використання у якості твердого біопалива.

Ключові слова: біоенергетика, тверде біопаливо, сорти та гібриди сорго, урожайність, зелена маса, суха речовина.

Nosov M.H. Efficiency of sweet, sudan and broom sorghum varieties using as pollinators for high yield hybrids breeding in the Steppe zone of Ukraine

Purpose. Sorghum is considered a strategic crop in the supply of raw materials for the bioenergy industry, therefore the main goal of the study was to determine the effectiveness of using sugar sorghum (Silosne 42), Sudanese (Strateya) and vine sorghum (Karlykove 45 and Krasen) as pollinators for obtaining high-yielding hybrids in the conditions of the northern part of the Steppe zones of Ukraine. **Methods.** Varietal testing of sorghum was carried out at the Synelnykiv selection and research station of the Institute of Grain Crops of the National Academy of Sciences of Ukraine, where 68 variety samples were studied, which had a yield of green mass in the range of 23–79 t/ha. Indicators of green mass yield and dry matter content were determined. The area of plots in the nursery for research was 7 m^2, the repetition of the experiment was three times. **Results**. In the field experiment, 17 initial varieties and hybrids of grain and sugar sorghum were studied. In the three newly created hybrids F1 (Nyzkorosle 93s x Karlykove 45), F1 (Early 776s × Karlykove 45) and F1 (DN 71s × Karlykove 45), the most effective pollinator to ensure the highest yield (65.6–71.7 t/ha) turned out to be the variety Karlykove 45. Sorghum Sudanese hybrid Stratea showed efficiency for obtaining a yield of 54.6-65.5 t/ha in combinations F1(DN 19s × Stratea) and F1(DN 17s × Stratea). The variety Karlykove 45 can be recommended as a valuable pollinator for creating hybrids that can be used as solid biofuel. According to the dry matter content of sorghum biomass, the highest values were obtained in: F1 (Nyzkorosle 93s × Karlykove 45) – 45.0 t/ha, F1 (Kafrske korm. 186s × Krasen) – 41.4 t/ha, F1 (Dn71s × Karlykove 45) – 33.3 t/ha, F1 (Dn17s × Strategy) – 32.0 t/ha. **Conclusions.** It was determined that the F1 (Nyzkorosle 93s x Karlykove 45) hybrid of the bioenergy direction of use is the highest in terms of the yield of green mass and the content of dry matter. The value of the Karlykove 45 variety as a pollinator in the creation of sorghum hybrids for use as solid biofuel has been established.

Key words: bioenergy, solid biofuel, sorghum varieties and hybrids, yield, green mass, dry matter.