Effect of mineral and organic fertilizers on the growth and development of African millet

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Abstract. African millet is small, about 1000 seeds 5-10 gram and is the best feed for birds. The stalk is superior to all other fodder crops in silage and dry state in terms of its nutritive value and high protein content. Alcohol is extracted from grain and used in the production of beer in the food industry, flour is made from grain and added to wheat flour to make high-quality bread containing various minerals. Another fact is that grain yield is around 0.7-1.2 t/ha, and in some conditions, it reaches 1.8-2.0 t/ha. The root reaches more than 2 meters deep, which ensures drought resistance and wind resistance. The important biological properties of African millet are its high yield, disease resistance, rapid reproduction, high fodder and nutritional properties of the grain, drought resistance, high temperature deficiency resistance, green mass gives an abundant yield. Furthermore, it is less affected by pests and diseases than other cereal crops. African millet “HHVBC tall” and “EEBC” varieties were investigated in eight variants with three iterations according to feeding standards. According to the results, on May 22, 2015, the plant height was 44-45 cm in the EEBC variety and 47-48 cm in the HHVBC tall variety. It was found that when the phenological observations were made on June 20, the average plant height was 130-125 cm in the EEBC variety, whereas it was 95-120 cm in the HHVBC tall variety. It can be seen that the height of EEBC variety compared to HHVBC tall variety was greater.

1 Introduction

Today, 2.6 billion people in the world suffer from the consequences of soil degradation, and there is a decrease in soil fertility due to degradation processes, such as erosion, salinization and desertification [1, 2]. According to the information of the international organization FAO, more than 33% of land has been degraded. Based development of agrotechnical measures aimed at protecting the soil cover from degradation processes, increasing the productivity of irrigated soils is one of the urgent problems [3]. In Uzbekistan, extensive measures are being taken to develop the feed base of livestock and forage crops by introducing agrotechnologies aimed at maintaining and increasing the productivity of degraded irrigated soils, preventing the degradation of irrigated soils and increasing the productivity of agricultural crops [4].

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In fact, African millet was brought to Spain and North Africa in the 14th century and cultivated for its grain. It is later grown as a fodder crop in India, Australia, and the United States. Mowing African millet for silage is carried out mainly during the period of Spike release and milking, the reason is that it was at this time that the highest amount of sugar was collected in the parenchyma of the stem [5].

The important biological properties of African millet are its high yield, disease resistance, rapid reproduction, high fodder and nutritional properties of the grain, drought resistance, high temperature deficiency resistance, green mass gives an abundant yield. Furthermore, it is less affected by pests and diseases than other cereal crops and the stem does not lie down [6]. The average grain yield of African millet ranges from 0.64 to 0.68 t/ha and reaches 1.8-2.0 t/ha in individual areas. Among the annual crops, African millet is well digested by livestock due to its nutritious forage [7].

African millet is small, about 1000 seeds 5-10 gram and is the best feed for birds. The stalk is superior to all other fodder crops in silage and dry state in terms of its nutritive value and high protein content [8]. Alcohol is extracted from grain and used in the production of beer in the food industry, flour is made from grain and added to wheat flour to make high-quality bread containing various minerals. Another fact is that grain yield is around 0.7-1.2 t/ha, and in some conditions, it reaches 1.8-2.0 t/ha. The root reaches more than 2 meters deep, which ensures drought resistance and wind resistance. Vegetation period is 60-115 days depending on the variety. Blueberry stalks can be harvested 3-4 times for silage, whereas 250-320 centners are obtained from a hectare of blue mass [9]. During the long growing season, blueberry increases mass, plant height and stem increase, but grain yield decreases, due to late fertilization and extended irrigation period, grain ripening is prolonged [10]. Due to the high temperature and lack of moisture in July-August, it has a bad effect on the accumulation of reserve substances in the endosperm [11].

The number of experiments in typical gray soils of Tashkent region have been conducted on Sudan Pop I, Raj 171, Raj 171 (W), MC 94 C2, HHVBC tall, ICTP 8203, GB 8735, ICMV 221, ICMS 7704, JBV 2, JBV 3 and Guerninian-4/1 varieties of African millet. According to the results of the experiments, the vegetation period was 96-100 days, the first harvest was on 69-71 days, the wet mass was 65.91 t/ha, and the yield was 10.35-13.21 t/ha [12]. A nutritious porridge is prepared from African millet grain, the grain cooks well for 25-30 minutes, and it is more nutritious than wheat porridge. Clearly, it contains high protein from 10 to 14%, fat 2-4%, starch 70-85%. In production and experimental fields, African millet has high blue mass and high grain yield in many districts. For example, in the collective farm of “United Labor” in the Kuybyshev region, 450 q/ha of blue pulp was collected, in the Engels collective farm, it was 50-60 q/ha of hay (hay), and in the Saratov region, the grain yield was 42 t/ha [13].

Noteworthy, this research aimed at studying the conditions of the irrigated typical gray soils of the Tashkent region towards obtaining abundant and high-quality crops from agricultural crops in the conditions of climate change, and planting and fertilizing African millet in the condition of Uzbekistan.

2 Materials and methods

The research experiments were conducted in 2015-2017 in the conditions of irrigated typical gray soils at the educational experimental station of the Tashkent State Agrarian University, located in the Qibrai district of the Tashkent region (Fig. 1). African millet “NNVBC tall” and “EEVS” varieties were experimented with in eight variants with three iterations according to feeding standards. Conducting field experiments, phenological observations, taking and analyzing soil and plant samples were done based on “Metods of
3 Results and Discussions

African millet NNVBC tall and EEVS varieties were planted in the experimental field on April 13, 2015, which was the first experiment. The first germination started after 2 weeks, and the general germination was observed on May 2-3, which was done after 20 days from the planting date (Fig. 1). The second experiment was done on April 5, 2016, and accordingly, the initial germination started after 12 days, and the total germination was observed on April 24-25. The third one was done on April 1, 2017. It was observed that the first germination started after 2 weeks, and the total germination was observed on April 28-30. Clearly, germination was delayed by 5-10 days due to wet weather conditions this year. Because African millet is a plant belonging to the group of heat-loving plants.

Fig. 1. An appearance of African millet during the growing season

It can be said that African millet is a heat-loving plant, which requires sufficient temperature for its growth. Clearly, the optimum temperature for the growth of millet is 12-13 °C, and germination begins in 10-15 days when the soil temperature is 8 °C, followed by 4-5 days at 15 °C, and 3 days at 20-25 °C.

According to the phenological observations on May 22, 2015, the plant height was 44-45 cm in the EEVS variety and 47-48 cm in the NNVBC tall variety (Table 1). It was found that when the phenological observations were made on June 20, the average plant height was 130-125 cm in the EEVS variety, whereas it was 95-120 cm in the NNVBC tall variety. It can be seen that the height of EEVS variety compared to NNVBC tall variety was greater. Obviously, the variety EEVS is fast-growing and the tall variety NNVBC is medium-growing. It was reported that due to the short vegetation period of the EEVS variety, its fruiting phase began during this period.

The results of phenological observations done in 2016 showed that on May 20, the average plant height was 32.0-40.9 cm in the EEVS variety, and it was 36-45 cm in the NNVBC tall variety. However, when the phenological observations were done on June 15, accordingly, the average plant height was 101.8-132.1 cm in the EEVS variety, and it was 83.4-118.1 cm in the NNVBC tall variety. According to the results of the experiment, the average daily growth of the African millet varieties when observed on May 20 was as follows: “NNVBC tall” averaged 0.71-0.87 cm in 1 day (Fig. 2). In this variety, the height
was higher in the variant where N$_{120}$P$_{85}$K$_{60}$ + 20 t/ha of manure was applied. However, in “EEVS” variety, it was 0.90 cm per day when N$_{90}$P$_{65}$K$_{45}$ + 20 t/ha of manure was used.

**Fig. 2.** An overview of the flowering period of African millet.

**Table 1.** Growth rate of African millet plant during the growing season.

<table>
<thead>
<tr>
<th>#</th>
<th>Variants</th>
<th>22.05.2015</th>
<th>20.06.2015</th>
<th>01.07.2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Control</td>
<td>Height, cm</td>
<td>Duration, cm/day</td>
<td>Growth rate, cm/day</td>
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<tr>
<td>2</td>
<td>N$<em>{60}$P$</em>{45}$K$_{30}$</td>
<td>35.0</td>
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<td>3</td>
<td>N$<em>{90}$P$</em>{65}$K$_{45}$</td>
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<td>39</td>
<td>0.93</td>
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<tr>
<td>4</td>
<td>N$<em>{120}$P$</em>{85}$K$_{60}$</td>
<td>40.0</td>
<td>39</td>
<td>1.02</td>
</tr>
<tr>
<td>5</td>
<td>20 tons of manure</td>
<td>40.1</td>
<td>39</td>
<td>1.02</td>
</tr>
<tr>
<td>6</td>
<td>N$<em>{60}$P$</em>{45}$K$_{30}$ + 20 t/ha of manure</td>
<td>39.8</td>
<td>39</td>
<td>1.02</td>
</tr>
<tr>
<td>7</td>
<td>N$<em>{90}$P$</em>{65}$K$_{45}$ + 20 t/ha of manure</td>
<td>34.3</td>
<td>39</td>
<td>0.87</td>
</tr>
<tr>
<td>8</td>
<td>N$<em>{120}$P$</em>{85}$K$_{60}$ + 20 t/ha of manure</td>
<td>41.8</td>
<td>39</td>
<td>1.07</td>
</tr>
</tbody>
</table>

**HHVBC tall variety**

**EEBC variety**

<table>
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<tr>
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<td>39</td>
<td>0.93</td>
</tr>
<tr>
<td>3</td>
<td>N$<em>{90}$P$</em>{65}$K$_{45}$</td>
<td>40.2</td>
<td>39</td>
<td>1.03</td>
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<tr>
<td>4</td>
<td>N$<em>{120}$P$</em>{85}$K$_{60}$</td>
<td>43.9</td>
<td>39</td>
<td>1.12</td>
</tr>
<tr>
<td>5</td>
<td>20 tons of manure</td>
<td>42.0</td>
<td>39</td>
<td>1.07</td>
</tr>
<tr>
<td>6</td>
<td>N$<em>{60}$P$</em>{45}$K$_{30}$ + 20 t/ha of manure</td>
<td>44.1</td>
<td>39</td>
<td>1.13</td>
</tr>
</tbody>
</table>
According to the 2017 phenological observations, on May 20, the average height of the plant was 25-28 cm in the NNVBC variety, and 28-30 cm in the EEVS variety. The results showed that the average daily growth of the African millet plant when observed on May 20 was the same: “NNVBC tall” averaged 0.39-0.71 cm in the 1st day. It was observed that in this variety, it was higher in the variant when N_{120}P_{85}K_{60}+20t/ha fertilizer was applied. However, it was 0.70 cm per day in the case of application of N_{120}P_{85}K_{60}+20t/ha fertilizer in "EEVS" variety.

The next phenological observations were made on June 12, during which the rutting phase was observed in the EEVS variety of millet. The height of the plant was 91.8 to 128.2 cm in the variety EEVS. The average growth rate of the plant during this period was 3.99 - 5.57 cm per day. In this phase, the superiority of 8 variants was observed. A similar situation was observed in the NNVBC tall variety. In this variety, this phase coincided with flowering. The average growth rate of the plant was 4.10-5.58 cm. Therefore, it can be said that the difference between the varieties of African millet was not observed much. Because the EEVS was faster, the growth rate was observed to be higher in this phase of the growth cycle.

Moreover, when observed on July 10, the plant was in the ripening phase in the EEVS variety. During this period, the average height of the plant at the end of the vegetation period of EEVS variety was 145-195 cm, and the daily growth rate was 5.01-6.74 cm. In the NNVBC tall variety, the flowering phase started, and the average height of the plant was 171-223 cm.

In subsequent phenological observations, only the NNVBC tall variety was observed. Clearly, the ripening phase of the plant was observed, and accordingly, the growth rate of the plant was 15.94-18.24 cm. In general, the growth rate of the African millet plant was observed to be slow at the beginning of the growing season, and was increased sharply by the flowering phase. It was found that mineral and organic fertilizers had a good effect in the variants where both of them were used. In option 6, only 20 t/ha of manure was applied, the growth rate of both cultivars was lower compared to the other variants, and this shows that this plant is not demanding on manure.

On an area of 1 m^2, the number of plant tubers was 8-11 pieces in the NNVBC tall variety, and in the EEVs variety-6-11 pieces. The number of growths on the bushes was 25-55 pieces. In general, the growth rate of EEVS variety of African millet plant was observed to be higher in its fruiting phase. It was reported that it was higher in N_{90}P_{65}K_{45} +20 t/ha of fertilizer and N_{120}P_{85}K_{60}. As the African millet variety "NNVBC tall" is a medium-sized plant, its growth rate accelerated in the middle of the growing season, and at the end of the growing season, it was observed to be 39-68 cm taller than the EEVS variety.

Since the EEVS variety is fast-growing, its vegetation period was 95 days. The length of the shoots on the stem was also observed to be shorter compared to the NNVBC tall variety, that is, it was 24.6-29.9 cm. Long spikes were also observed in this variety in the variant 6 and variant 8. The grain of African millet is round, oval-round or oval-oblong in shape. The color of the grain is pale yellow, yellow-brown, red, gray, brown. The weight of 1000 grains was 5-10 g. The structure of the millet seed is similar to other grains, and it is mainly divided into three parts, such as the endosperm, the pulp and the fruit.
The weight of grain in 1 experimental site (63 m²) was 5.3-13.8 kg according to variants. In general, it was observed during the experiments that high results can be achieved when mineral and organic fertilizers are applied to NNVBC tall and EVVS varieties of African millet. It was observed that African millet showed higher results when mineral fertilizers were applied together than when organic fertilizers were applied alone. It was also expected that the mineral fertilizers themselves would have a positive effect when applied at a high rate, especially in N₁₂₀P₈₅K₆₀. In general, it was observed that the use of mineral and organic fertilizers in increasing the grain yield of African millet had a positive effect on the length of its spikes and the increase in the weight of 1000 grains. In terms of growth rate of African millet plant, sharp differences were observed in "NNVBC tall" and EEVS varieties. According to variants, the growth rate was high in N₉₀P₆₅K₄₅+20 t/ha and N₁₂₀P₈₅K₆₀ variants and in all phases of the plant.

4 Conclusions

African millet NNVBC tall and EEVS varieties were planted in the experimental field on April 13, 2015, which was the first experiment. The first germination started after 2 weeks, and the general germination was observed on May 2-3, which was done after 20 days from the planting date.

It was found that when the phenological observations were made on June 20, the average plant height was 130-125 cm in the EEVS variety, whereas it was 95-120 cm in the NNVBC tall variety. It can be seen that the height of EEVS variety compared to NNVBC tall variety was greater.

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References

5. B.V. Bado, A. Bationo, A. Whitbread, R. Tabo, M.L.S. Manzo, Agriculture, Ecosystems & Environment 335 (2022)