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SUMMARY

RESPONSE OF SWEET SORGHUM TO APPROPRIATE FERTILIZER REGIMES

Two field experiments were carried out at Mallawi Agricultural Research Station, El-Minia, Egypt during the two successive seasons (1999 and 2000) to study the effect of mineral and biological nitrogen and phosphorus fertilization and potassium on growth characters, yield and its components as well as yield of juice and its technological properties for sweet sorghum c.v. Brands.

Thirty-six fertilization treatments were applied in four replicates. Such treatments were the possible combinations of 3 mineral nitrogen levels (0, 60 and 90kg N/fed);3 phosphorus treatments (0,30kg P_2O_5/fed and Phosphorin inoculation); 2 potassium treatments (0 and 30kg K_2O/ fed)+ 2 biological N treatments (0 and inoculation with *Bacillus polymyxa*).

The lay out of the experimentation was spilt spilt plot design. The 3 mineral nitrogen fertilization were randomly devoted to the main plots; the 3 phosphorus fertilization

treatments were in the sub plots. The two potassium levels (0, 30kg K_2O/fed.) and the two biological nitrogen treatments (0, *Bacillus polymyxa* inoculation) were randomly allocated in the sub sub plots. Each experimental unit was 10.5 m^2 (3.5m x 3m) with an area of 1/400 fed. The following parameters were recorded and studied.

A-Growth behavior:

Four samples of ten plants were labeled at random from each experimental unit during the growth period at 45, 60, 75 and 90 days from planting to study the following plant characters: plant height (cm), stalk diameter (cm), number of inter-nodes/plant, number of leaves/plant and leaf area (cm^2).

B- Forage yield and its components:

Forage yield (ton/fed.), stripped stalks yield (ton/fed.) and total biomass yield (ton/fed.) were determined and recorded.

C-Juice yield and its quality:

Juice extraction percentage, juice yield (ton/fed), syrup extraction percentage, syrup yield (ton/fed), total soluble solids percentage, sucrose percentage, reducing sugar percentage and purity percentage were measured.

Results could be summarized as follows:

A-Growth behavior:

I-Effect of nitrogen fertilization

i-Mineral nitrogen treatments

1- Plant height at 45, 60, 75 and 90 days from planting significantly increased by increasing N level up to 90kg /fed in the two growing seasons. The respective tallest plants were 56.34, 141.3, 187.6 and 249.8 cm in the first season, being 64.24, 158.8, 216.9 and 276.9 in the second season.

2- Increasing N level tended to increase stalk diameter of sorghum plant with prolonging the growing period. The thicker stalks were obtained when using 90kg N/fed. at the four sample dates in the first and second seasons, where the thickest plants were of 1.79, 2.13, 2.85 and 3.18 cm in the subsequent planting dates in the first season; and 2.01, 2.35, 3.17 and 3.52 cm in the second season.

3- Number of inter-nodes/plant at the four dates (45, 60, 75 and 90 days from planting) significantly increased by increasing N level up to 90kg/fed during the two growing seasons, where the greatest number of inter-nodes/plant

was 16.84 and 19.22 in the first and second season, respectively.

4- Increasing N level caused a slight substantial increase in the number of leaves/plant significantly and the highest value was obtained by applying 90kg N/fed at 90 days which was 15.72 and 17.31 in the respective two seasons.

5- Leaf area significantly increased by increasing N level up to 90kg /fed at 45, 60, 75 and 90 days from planting in the first and second season. The respective leaf area/plant was 243.7, 470.5, 519.3 and 571.3 in the first season; and 271.5, 529.5, 573.8 and 633.4 cm^2 in the second one.

ii-Biological nitrogen fertilization (inoculation with *Bacillus polymyxa*)

6- Seed inoculation with *Bacillus polymyxa* significantly increased plant heights slightly at 45, 60, 75 and 90 days from planting in the two growing seasons. Tallest plants were 44.66, 118.0, 164.2 and 234.8 cm in the first season, being 51.15, 135.0, 190.2 and 261.1 cm in the respective four assessing dates in the second one.

7- Seed-inoculation had no significant effect on stalk diameter at the four dates in the first and second season.

8- Inoculation with the applied N fixing bacteria significantly increased number of inter-nodes/plant at 45, 60, 75 and 90 days from planting in the two seasons. Highest number of inter-nodes/plant was 15.82 and 18.02 in the respective two seasons.

9- Inoculation significantly increased number of leaves/plant at the four sampling dates of 45, 60, 75 and 90 days from planting in the two seasons.

10- Nitrogen-fixing bacteria significantly increased leaf area at all of the studied dates from planting in the first and second season. Values of such trait were 223.5, 425.4, 498.7 and 558.8 in the first season, being 248.5, 470.5, 551.0 and 616.5 cm^2 in the second season.

II-Effect of mineral and biological phosphorus fertilization treatments

11- Phosphorus fertilizer treatments had no significant effect on plant height at 45 and 60 days from planting in the first season, and at 45 days in the second season. Whereas, phosphorus significantly increased plant heights at 75 (165.2) and 90 days (237.5) in the first season and at 60 (134.9), 75 (195.0) and 90 days (265.3) in the second season.

12- Any of the applied phosphorus fertilizer treatment did not significantly influence stalk diameter at the four dates of plant growth (45, 60, 75 and 90 days from planting) in the two growing seasons.

13- The applied phosphorus fertilizer treatments had no significant effect on number of inter-nodes/plant at 45, 60, 75 and 90 days from planting in the first season. However, it caused slight significant increase at four sampling dates in the second season.

14- Phosphorus fertilizer treatments did not significantly influence number of leaves/plant at 45 days and 60 days from planting in the first season and at 45 days and 75

days in the second season. On the other hand, phosphorus significantly increased the number of leaves at 75 days (12.50) and at 90 days (13.97) in the first season, and at 60 days (11.80) and 90 days (15.42) in the second season.

15- Leaf area significantly increased by the applied phosphorus treatments at 45, 60, 75 and 90 days from planting in the two growing seasons.

III-Effect of potassium fertilization

16- Potassium fertilizer (30kg K_20/fed) exhibited no significant effect on plant height of sweet sorghum at 45, 60, 75 and 90 days from planting in the two growing seasons.

17- Potassium fertilizer at 30kg K_20/fed did not significantly influence stalk diameter of sweet sorghum plants at the four assessment stages in the two seasons.

18- The effect of potassium fertilizer (30kg K_20/fed) was not significant on the number of inter-nodes/plant at all sampling dates in the two growing seasons.

19- Number of leaves/plant was not significantly affected by potassium fertilization treatments at 45, 60, 75 and 90 days from planting in the first and second seasons.

20-Potassium fertilization treatment of 30kg K_2O/fed did not significantly influence leaf area at all of the studied dates from planting in the two seasons.

B-Forage yield and its components:

I-Effect of nitrogen fertilization

i-Mineral nitrogen treatments

21- The application of N levels up to of 90kg/fed caused substantial increases in forage yield by 64 and 85.3% over the control treatment in the respective two growing seasons.

22- Stripped stalks yield increased by the increase in N application levels. The 90kg N/fed significantly increased stripped stalks yield by 59.1 and 68.8% than the control treatment in the two growing seasons, respectively.

23- Increasing N level caused substantial increases in total biomass yield, which was 60.4 and 72.6% over the control treatment at the highest N rate (90kg/fed) in the two growing seasons, respectively.

ii-Biological nitrogen fertilization (inoculation with *Bacillus polymyxa*)

24- Forage yield significantly increased slightly with N-bacterial inoculation by 5.61 and 5.15% than the control treatment in the two growing seasons, respectively.

25- Seed-inoculation significantly increased stripped stalks yield slightly by 5.06 and 10.03 % over the control in the respective two growing seasons.

26- Total biomass yield increased slightly but significantly with seed- inoculation by 5.21 and 8.66 % than the control treatment in the two respective seasons.

II-Effect of mineral and biological phosphorus fertilization treatments

27- Phosphorin as a biological P treatments caused significant increase in forage yield by 8.8 and 4.4 % compared to the control in the first and second season, respectively.

28- The applied phosphorus fertilizer treatments significantly increased stripped stalks yield and the highest values of stripped stalks were obtained with Phosphorin by 6.6 and 4.8 % than the control treatment in the two growing seasons, respectively.

29- Total biomass yield was significantly increased by 7.2 and 4.7 %, respectively over the control treatment in the two growing seasons, when using Phosphorin treatments.

III-Effect of potassium fertilization

30- The effect of potassium fertilizer at 30kg K_20/fed was not significant on forage yield in the two growing seasons.

31- Potassium fertilizer (30kg K_20/fed) did not significantly influence stripped stalks yield than the control treatment in the two growing seasons.

32- Also, potassium fertilizer had no significant impact on total biomass yield at 30kg K_20/fed in the two seasons.

C-Juice yield and its quality:

I-Effect of nitrogen fertilization

i-Mineral nitrogen treatments

33- Juice extraction percentage of sweet sorghum plants significantly increased by increasing N level up to 90kg N/fed in the two growing seasons, where the respective juice extraction percentage was 39.05 and 43.19% .

34- The application of 90kg N/fed caused significant increase in juice yield by 85.2 and 80.3 % compared to the control in the two growing seasons, respectively.

35- Increasing N level up to 90kg N/fed significantly increased syrup extraction percentage in the two growing seasons, which was 8.38 and 9.35 in the first and second season, respectively.

36- Syrup yield significantly increased substantially by increasing N level up to 90kg/fed with 94.5 and 96.7 % as compared to the control treatment in the two growing seasons, respectively.

37- Total soluble solids percentage of the juice significantly increased by increasing N level up to 90kg N/fed in the two

growing seasons, where the obtained values were 17.88 and 19.98 in the first and second season, respectively .

38- Increasing N level up to 90kg/fed significantly increased sucrose percentage in the two growing seasons. It was 12.39 and 13.84 % in the respective two seasons.

39- Nitrogen level up to 90kg N/fed significantly increased the reducing sugar percentage slightly in the first (3.12%) and second (3.24%) season.

40- The highest N/level of 90kg/fed significantly increased purity percentage in the two growing seasons to be 69.30 and 69.25 % in the first and second season, respectively.

ii- Biological nitrogen fertilization (inoculation with *Bacillus polymyxa*)

41- Inoculation with N-fixing bacteria significantly increased juice extraction percentage of sweet sorghum in the two growing seasons. It was 36.68 and 40.97% in the first and second seasons, respectively, compared to 35.68 and 39.76 % for their controls.

42- Seed-inoculation significantly increased juice yield slightly by 7.7 and 8.5%, compared to their respective control in the first and second season.

43- Syrup extraction percentage of sweet sorghum significantly increased slightly with inoculation in the two growing seasons, which was 7.61 and 8.57 %.

44- Nitrogen bacterial inoculation significantly increased syrup yield of sweet sorghum by 8.44 and 9.19% than the control in the respective two growing seasons.

45- Inoculation significantly increased total soluble solids percentage in the two growing seasons, where the respective obtained values were 17.37 and 19.16 % in the first and second season.

46- No significant effect on sucrose percentage was obtained in the two growing seasons by N-inoculation.

47- Reducing sugar percentage significantly increased by N inoculation in the two growing seasons with respective values of 2.87 and 3.20% compared to their respective control of 2.82 and 3.13%.

48- Nitrogen-bacterial inoculation did not significantly influence the purity percentage of sweet sorghum juice in the two studied seasons.

II- Effect of mineral and biological phosphorus fertilization treatments

49- The applied phosphorus fertilizer treatment as Phosphorin significantly increased juice extraction percentage of sweet sorghum in the two respective seasons, which produced the highest juice extraction percentage of 36.32 and 40.67 %.

50- Phosphorus fertilizer treatments significantly increased juice yield. Highest juice yield was obtained with Phosphorin by 7.4 and 7.1 %, respectively in the first and second season.

51- Phosphorin fertilizer treatments significantly produced the highest syrup extraction percentage which was 7.59 and 8.58 in the successive two seasons compared to their control of 7.30 and 8.17% .

52- All of the applied phosphorus fertilizer treatments significantly increased syrup yield. However, the highest value was obtained with Phosphorin by 1.68 and 1.89 ton/fed. in the two growing seasons, respectively.

53- Phosphorus fertilizer treatments significantly increased total soluble solids percentage and the highest value was obtained with Phosphorin in the two growing seasons, which was 17.4 and 19.33%, respectively

54- Phosphorus fertilizer treatments significantly increased sucrose percentage of sweet sorghum juice and the highest values were obtained with Phosphorin in the first (11.8 %) and second (13.11%) season.

55- Phosphorus fertilizer treatments significantly increased the reducing sugar percentage of sweet sorghum in the two growing seasons as compared to their relevant control with slightly more in favor for Phosphorin treatment.

56- Purity percentage of sweet sorghum juice was significantly increased by any of the applied P fertilizer

treatments in the 2nd season. Whereas, no significant effect was obtained in the 1st season.

III- Effect of potassium fertilization

57- Juice extraction percentage of sweet sorghum was significantly increased by applying potassium fertilizer at 30kg K_2O/fed. in the two growing seasons. The highest juice extraction percentage was 36.37 and 40.63 in the first and second season, respectively.

58- Potassium fertilizer treatment of 30kg K_2O/fed. slightly but significantly increased juice yield by 2.3 and 2.7% than the control in the two growing seasons, respectively.

59- Syrup extraction percentage of sweet sorghum was increased by the application of 30kg K_2O/fed., where the highest value was 7.56 and 8.51% in the respective two successive seasons.

60- Potassium fertilizer treatment (30kg K_2O/fed.) significantly increased syrup yield by 3.16 and 4.49 %

over the control in the two growing seasons, where the respective syrup yield was 1.63 and 1.86 ton/fed.

61- Total soluble solids percentage in the two growing seasons were significantly increased when sweet sorghum was fertilized with 30kg K_2O/fed. It was 17.28 and 19.21%, compared to 17.08 and 18.86 % for their respective control treatments.

62- Sucrose percentage significantly increased by applying potassium fertilizer (30kg K_2O/fed.) in the two growing seasons, which was 11.52 and 12.91 in the first and second season, respectively, being 11.26 and 12.44 % for the relevant control treatment.

63- Reducing sugar percentage of the sweet sorghum juice was not significantly influenced by applying 30kg K_2O/fed. This was true in the two growing seasons.

64- Moreover, purity percentage of sweet sorghum juice was not significantly affected by the application of 30kg K_2O/fed during the two experimental seasons.

IV- Interaction effect of the applied fertilizers treatments

Results of the significant interaction effect in the two growing seasons for the applied fertilization factors on the studied parameters of sweet sorghum are summarized as follows:

65- Plant height was significantly affected by mineral N, Phosphorin and potassium interaction at 75 days from planting in both seasons ,where the tallest plants of sweet sorghum were obtained from using 90kg N x Phosphorin x 30kg K/fed.

66- Number of inter-nodes/plant was significantly influenced by mineral N and Phosphorin in the three stages of growth in the first and second season. The application of 90kg N/fed to the plants inoculated with Phosphorin produced the highest number of inter-nodes/plant.

67- The interactions between mineral nitrogen and bio-nitrogen fertilizer affected the number of leaves/plant only at 60 days from planting of growth in both seasons, whereas leaf number/plant was influenced by mineral N x Phosphorin interaction in the other two growth stages in

both seasons. This treatment (90 kg N/fed x Phosphorin) gave the highest number of leaves/plant.

68- Leaf area/ plant was significantly affected by the interaction between mineral N, K and biological N fertilizer at 45 days of growth. The highest leaf area/ plant was obtained from plants inoculated by *Bacillus polymyxa* and fertilized with 90 kg N x 30 kg K/fed.

69- Juice extraction percentage was significantly influenced by the interaction between all of the studied factors in the successive seasons. Plants inoculated by *Bacillus polymyxa* and fertilized with 90kg N x 30kg P x 30kg K/fed gave the highest value of juice extraction percentage.

70- Syrup yield was significantly affected by the mineral nitrogen and Phosphorin interaction in both seasons. Plants fertilized with 90kg N/fed x Phosphorin produced the highest syrup yield.

71- All of the other studied traits were not significantly affected by the interactions between the studied treatments.