https://doi.org/10.29321/MAJ.10.A03951

# Studies on growth in Sorghum as affected by different doses of nitrogen and phosphate and varying row spacings

*by*

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**Synopsis :** A field experiment was conducted during the *khariff* season of 1959—'60 at Rafi Ahmad Kidwai Agriculture Institute Farm, Sehore (M. P.) to study the effects of three levels of nitrogen (0, 10 & 20 lb. N/acre), two levels of phosphate (0 & 15 lb. $P_2O_5$/acre) both singly and in combination with three spacings (12", 18" & 24") in rows on the growth of *jowar* crop. The results indicated that higher doses of nitrogen increased the number of leaves and girth of the plants and phosphorus had no effect on the growth of *jowar*.

**Introduction :** Various factors affect the growth of the plant and a change in the intensity of any one of them will influence the development of the plant in different ways. Each factor plays a specific role in the development of the plant. It may change its rate and habit of growth. The ultimate yield of the crop is also greatly influenced by these factors.

Besides other growth factors, supply of nutrients plays an important role. Spacing is intimately connected with the supply of light as well as the root development and plant growth. Generally, the most appropriate spacing is one which enables the plants to take the best advantage of the various growth factors. Too close or too wide spacings are not desirable.

Several workers (Watson 1952, Baver 1956) have not only established the relationship between the growth and the various growth factors but also the ultimate yield of the crop as related to these factors. *Jowar* is one of the most widely grown food-grain crops of the country. Therefore keeping the above facts in view it was considered worthwhile to study the growth in *jowar* crop as affected by different doses of nitrogen and phosphate with varying row spacings. The experiment was conducted in 1959–'60 at Rafi Ahmed Kidwai Agricultural Institue Farm, Sehore, M. P.

**Review of Literature :** Waterman and Ruhnke (1925) observed that in the absence of nitrogen, plants do not grow normally, while an abundance of nitrogen produces luxurient vegetative growth. Miller (1938) stated that height was significantly increased by increasing the dose of nitrogen at all

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* Received on 24—10—1962.

stages of observation. Amount of nitrogen in the soil affects all phases of leaf growth, leaf number and leaf area (Watson 1947). Kulesev and Lapecvic (1951) reported that in sorghum and other cereals growth increment during the days preceding flowering was considerably greater than the increment during the subsequent days. With the completion of flowering, growth ceased. Raheja and Misra (1955) found no influence on the germination of the wheat seed under fertilization. They also reported that the maximum increase in the number of leaves occurred upto 56 days. Thereafter the successive appearance of leaves slowed down and they began to dry up after about 100 days. This period coincides with that of grain formation in the crop. Singh found that application of increasing levels of nitrogen increased the height, number of leaves and girth of the stem in *jowar* plants.

Reitz and Myers (1944) noted an increase in average height due to phosphate application. The increase ranged from a fraction of an inch to three inches. Watson (1948) reported that phosphorus application increases the leaf area in cereals, mainly by increasing tillering.

Kostling (1930) in wheat noted that increased spacing per plant produced greater stooling and stronger culms, more resistant to lodging and better development of kernels.

**Materials and Methods:** The present investigation was carried out to study the growth in *jowar* as affected by different doses of N and P with varying row spacings at Rafi Ahmad Kidwai Agricultural Institute Farm, Sehore, M. P. The farm has the typical black cotton soils of Malwa tract. Following were the factors :—

| | | |
|---|---|---|
| Nitrogen | 1. No nitrogen | No |
| | 2. 10 lb. N/acre | $N_1$ |
| | 3. 20 lb. N/acre | $N_2$ |
| Phosphorus | 1. No phosphorus | Po |
| | 2. 15 lb. $P_2O_5$ / acre | $P_1$ |
| Row spacings | 1. 12″ spacing | $S_1$ |
| | 2. 18″ spacing | $S_2$ |
| | 3. 24″ spacing | $S_3$ |

The experiment was laid out in split plot design with four replications. Nitrogen was supplied through ammonium sulphate which was evenly broadcast before sowing. Phosphorus was supplied through superphosphate which was drilled along with seed at the time of sowing. Crop was sown on 10th July, 1959 at a seed rate of 5·5 kgm. per acre. Weeding and thinning were done when the crop was about a month old. A uniform distance of 9″

between the plants in rows was maintained. Observations on the following growth characters viz., (a) germination, (b) growth in height of the plant, (c) number of leaves on the plant and (d) thickness of the stem of the plant were recorded.

Since it was not possible to study all the individual plants of the experimental plots at the successive stages of growth, five plants at random in each plot from different rows growing in the net plot area only were marked and tagged. Plants in the border rows were avoided. These tagged plants were used for studying the various characters at different intervals. The first observation in the growth characters except germination was started after 30 days of sowing while the subsequent ones were taken at 15 days interval.

**Results and Discussion :** The results of the investigations carried out are reported and discussed below

(a) *Germination :* Germination started after three days of sowing in all the treatments. The seedlings continued to come up upto seven days. There was no marked difference in the rate of germination in the treatments. This is in agreement with the findings of Raheja and Misra (1955) who have also reported no effect on the germination of wheat weed by fertilization. This may be attributed to the fact that the seed for germination and early growth meets its nutrients requirements from its stored food material and therefore the addition of plant nutrients through fertilizers did not have any effect on the germination. For germination and initial stage of growth, the seed requires proper environmental conditions, i.e. temperature, air and water which were equally available to all the treatments.

(b) *Growth in height of the plant :* The observations show that in all the treatments upto 45 days after sowing, height increased slowly but afterwards the rate of growth rapidly increased. After 120 days of age there was slight increase in the height. Beyond 135 days, there was no increase in height of plants. This period coincides with grain formation in the crop.

Slow increase in height upto 45 days after sowing may be attributed to small size and less number of the leaves. During 45 to 120 days growth period plants were developing more and producing larger sized leaves for manufacturing greater amount of food, resulting in cell division and finally rapid growth in height.

The slow rate of growth after 120 days may be due to the reason that plants advanced towards reproductive phase. The food material which was being utilized by the plants for their growth till now, was diverted at

this stage towards fruit formation. Hence, the rate of growth was slow after 120 days and it stopped completely after 135 days when all the food material was utilized in grain formation. Similar findings have been reported by Kulesev and Lapecvic (1951).

The data for the final height of the plants were statistically analysed and are given in the following tables :—

TABLE No. 1 (A)

*Average height of plants (in cms.) under different treatments.*

| | $S_1P_0$ | $S_1P_1$ | $S_2P_0$ | $S_2P_1$ | $S_3P_0$ | $S_3P_1$ | Mean |
|---|---|---|---|---|---|---|---|
| $N_0$ | 173·30 | 179·40 | 188·53 | 185·53 | 185·53 | 184·25 | 180·79 |
| $N_1$ | 176·57 | 182·20 | 182·45 | 186·90 | 184·72 | 170·75 | 181·69 |
| $N_2$ | 185·05 | 190·20 | 184·95 | 197·60 | 195·17 | 190·99 | 190·76 |
| | 178·65 | 184·17 | 182·35 | 189·01 | 188·15 | 184·66 | |

TABLE No. 1 (B)

| | $N_0$ | $N_1$ | $N_2$ | Mean |
|---|---|---|---|---|
| $S_1$ | 176·37 | 179·38 | 188·48 | 181·41 |
| $S_2$ | 181·10 | 184·67 | 191·27 | 185·68 |
| $S_3$ | 184·90 | 181·73 | 192·58 | 186·40 |
| | 180·79 | 181·93 | 190·78 | |

TABLE No. 1 (C)

| | $S_1$ | $S_2$ | $S_3$ | Mean |
|---|---|---|---|---|
| $P_0$ | 178·65 | 182·35 | 188·95 | 183·05 |
| $P_1$ | 184·70 | 181·01 | 184·66 | 185·95 |
| | 181·41 | 185·68 | 186·40 | |

C. D. for different comparisons :

1. For main treatments = 13·248
2. For sub-treatments = 6·67
3. For levels of nitrogen to a fixed main treatment = 16·26

The statistical analysis reveals that the main effects of spacing and phosphorus are insignificant. The effect of nitrogen is significant. The table No. 1 (B) reveals that highest dose of nitrogen (20 lb.) has a marked

effect on the height of plants. There is no marked difference between the average of $N_0$ and $N_1$ but the effect of $N_2$ is significantly better than that of either $N_1$ or $N_0$. This is in conformity with the findings of Miller (1938) and Singh (1954) who have reported the increased growth in height by increasing doses of nitrogen.

Though the effect of spacing is insignificant, yet the averages show that with the increase in spacing there is increase in the height of plants also. The difference is marked in case of $S_3$ and $S_2$ over $S_1$. $S_2$ and $S_3$ are of the same order. This may be attributed to the fact that increase in spacing decreased competition between plants for the nutrients, moisture, air and light and this has affected the height of plants.

Phosphorus did not show any significant effect and has increased the height slightly over control. Reitz and Myers (1944) noted an increase in height due to phosphate application.

(c) *Number of leaves on the plant :* The observations reveal that in all the treatments the rate of increase in the number of leaves per plant was slow upto 60 days after sowing but it increased rapidly afterwards upto 120 days after which the rate was again slow. The leaf formation stopped after 135 days.

The above trend of increase in the number of leaves per plant is directly related to the increase in height. In the present investigation, the period of maximum growth of leaves coincides with the maximum growth period of height and increase in the number of leaves stopped as the height ceased to increase.

The data on the final average number of leaves per plant were statistically analysed. The effect of nitrogen is highly significant for this character. The effects of phosphorus and spacing are insignificant whereas the interaction NS is significant. The results are summarised in the following tables :

TABLE No. 2 (A)

*Average number of leaves per plant under different treatments.*

| | $S_1P_0$ | $S_1P_1$ | $S_2P_0$ | $S_2P_1$ | $S_3P_0$ | $S_3P_1$ | Mean |
|---|---|---|---|---|---|---|---|
| $N_0$ | 11·00 | 11·20 | 11·80 | 11·00 | 12·05 | 12·25 | 11·55 |
| $N_1$ | 11·45 | 11·80 | 12·32 | 11·75 | 12·20 | 12·57 | 12·01 |
| $N_2$ | 12·25 | 12·15 | 13·50 | 12·55 | 13·17 | 13·67 | 12·88 |
| | 11·56 | 11·71 | 12·54 | 11·76 | 12·47 | 12·83 | |

TABLE No. 2 (B)

| | $N_0$ | $N_1$ | $N_2$ | Mean |
|---|---|---|---|---|
| $S_1$ | 11·10 | 11·62 | 12·00 | 11·64 |
| $S_2$ | 11·40 | 12·04 | 13·02 | 12·15 |
| $S_3$ | 12·50 | 12·38 | 13·42 | 12·66 |
| | 11·55 | 12·01 | 12·88 | |

C. D. for different comparisons :

1. For main treatments = 1·12
2. For sub-treatments = 0·084
3. For levels of nitrogen for a fixed main treatment = 0·243
4. For two spacing means = 0·79

It is evident from the table No. 2 (B) that the maximum number of leaves per plant was produced by the highest dose of nitrogen i.e., 20 lb. followed by 10 lb. N. and no nitrogen and the differences are statistically significant. The results are in conformity with the findings of Waterman and Ruhnke (1925), Watson (1947) and Singh (1954).

Summary table No. 2 (B) further reveals the significance of interaction NS due to the changing behaviour of 24" spacing with 10 and 20 lb. of nitrogen.

(d) *Thickness of the stem of the plant :* The observations reveal that in all the treatments the increase in the thickness was marked upto 120 days after sowing. After it, there was only a slight increase and after 135 days there was no increase in the thickness of the plant. The increase in the thickness of the plant coincides with that of the number of leaves. It may, thus be concluded that the increasing number of leaves promoted the increase in girth as a result of metabolic activities. The leaves manufactured food at increasing rates which increased the girth of the plant. The increase in girth of the plant also stopped like height and leaves after 135 days when all the food material was diverted towards grain formation.

The data for the final average thickness per plant were statistically analysed and are given in the following tables :—

TABLE No. 3 (A)

*Average thickness per plant under different treatments ( in cm. )*

| | $S_1 P_0$ | $S_1 P_1$ | $S_2 P_0$ | $S_2 P_1$ | $S_3 P_0$ | $S_3 P_1$ | Mean |
|---|---|---|---|---|---|---|---|
| $N_0$ | 0·91 | 1·00 | 1·04 | 0·98 | 1·05 | 1·00 | 1·00 |
| $N_1$ | 0·90 | 1·28 | 1·03 | 1·04 | 1·11 | 1·27 | 1·11 |
| $N_2$ | 1·29 | 1·02 | 1·00 | 1·66 | 1·90 | 2·13 | 1·50 |
| | 1·03 | 1·10 | 1·02 | 1·22 | 1·35 | 1·46 | |

TABLE NO. 3 (B)

| | $N_0$ | $N_1$ | $N_2$ | Mean |
|---|---|---|---|---|
| $S_1$ | 0·96 | 1·10 | 1·16 | 1·07 |
| $S_2$ | 1·01 | 1·04 | 1·33 | 1·12 |
| $S_3$ | 1·03 | 1·19 | 2·02 | 1·41 |
| | 1·00 | 1·11 | 1·50 | |

TABLE NO. 3 (C)

| | $N_0$ | $N_1$ | $N_2$ | Mean |
|---|---|---|---|---|
| $P_0$ | 1·00 | 1·02 | 1·40 | 1·14 |
| $P_1$ | 1·00 | 1·20 | 1·60 | 1·26 |
| | 1·00 | 1·11 | 1·50 | |

C.D. for different comparisons :

1. For main treatments = 0·076
2. For sub-treatments = 0·014
3. For comparing any two spacing means = 0·053
4. For comparing any two levels of N for a given spacing = 0·548
5. For two main treatments for a given level of N = 0·209

The above tables reveal that the effects of spacing and nitrogen are highly significant for this character. The interaction NS is also significant. Phosphorus and the other interaction are not significant.

The results indicate that nitrogen has given a high response to this character. The highest dose of nitrogen i.e., 20 lb. N is statistically superior to 10 lb. N which in turn is statistically superior to no nitrogen. Thus, there is an upward trend in the response with increasing levels of nitrogen. The girth of the stem increased as the level of nitrogen increased. The results are in agreement with the findings of Singh (1954) who has also reported increase in girth with increasing levels of nitrogen.

The increase in the girth of plants due to increasing levels of nitrogen may be attributed to the formation of bigger cells resulting from the stimulated activities of meristematic tissues by the application of nitrogen.

Table 3 (B) reveals that there is maximum girth in $S_3$ i.e., 24" spacing which is significantly superior to $S_2$ or $S_1$. Difference between $S_2$ and $S_1$ is not significant. The findings are supported by the results of Kostling (1930) who had noted that increased spacing per plant produced stronger culms in wheat.

Wider spacing of 24" produced thicker plants because they got maximum space for development and produced more number of leaves, and leaves, the factories of food synthesis, are responsible for increase in girth due to more synthesis of food material.

Table 3 (B) further reveals that interaction NS is significant. The increase in girth in 24" spacing with 20 lb. of nitrogen is more in proportion to 10 lb. and no nitrogen. This may be due to more available nutrient to the plants and less competition amongst them for light, moisture and free air.

1. There was no effect of fertilizers and varying spacings on germination and it was uniform in all the treatments.
2. Increasing levels of nitrogen increased the height of plants. 20 lb. N gave the maximum height. Phosphorus and spacing had no significant effect.
3. Application of nitrogen increased the number of leaves. There was no significant difference in the number of leaves per plant due to different levels of phosphorus and varying spacings in rows.
4. Increasing doses of nitrogen increased the girth of the plant. Similarly the girth increased with the increase in spacings also. Phosphorus did not affect the girth of the plants.

**Acknowledgement:** The authors are grateful to Dr. R. S. Bhatt, Principal for providing facilities and Shri V. J. Shrikhande, Senior Lecturer in Statistics for helping in statistical analysis of data.

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