# RESPONSE OF SOYBEAN TO NITROGEN, PHOSPHORUS AND POTASSIUM
## II- YIELD, YIELD COMPONENTS AND SEED CHEMICAL CONTENT

BY

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## ABSTRACT

This study was carried out to determine the effect of the combination of three N levels (0, 40 and 80 kg N/fad.), three P levels (0, 16 and 32 kg $P_2O_5$/fad.) and two K-levels (0, 48 kg $K_2O$/fad.) on the yield, yield components and chemical analysis of soybean, clark cultivar. Nitrogen application significantly increased plant height, number of pods/plant, weight of pods/plant, 100-seed weight, seed yield/fad., protein yield/fad. and oil yield/fad. The maximum seed yield was obtained by applying 80 kg N/fad. On the other hand N, protein and oil contents in seeds of soybean were not significantly affected by applying N fertilizer levels. Nitrogen application significantly decreased P% and K%. Seed yield/fad. increased significantly by increasing phosphorus fertilizer rates up to 32 kg $P_2O_5$/fad. in one season only. Whereas, the yield components and chemical analysis in seeds of soybean were not significantly affected by P or K application.

## INTRODUCTION

Yield of soybean was very closely correlated with the amount of nitrogen accumulated by the plant throughout the life cycle. Sharaf (1980); Ali (1981) and Hassanein (1987), found that nitrogen fertilizer increased significantly plant height, number of pods/plant, weight of pods, seeds/plant, seed index, yield of seeds and percentage of protein and oil in seeds of soybean. Nitrogen utilization decreased oil content and increased protein percentage, but this effect did not reach the significant level (Taira et al., 1979 and Ali, 1981).

Sharaf (1980), reported that application of P-significantly increased the number of pods/plant, 100-seed weight, seed yield/fad., oil percentage and decreased crude protein percentage. On the other hand, El-Sherbeeny et al., (1981)

and Bassiem (1983), found that increasing phosphorus fertilizer from 10 to 40 kg $P_2O_5$/fad. did not exert a significant effect on 100-seed weight, weight of pods, seeds/plant, number of pods/plant and seed yield/fad. Whereas El-Deepah (1985), showed that phosphorus fertilization caused increases in number of pods/plant, oil and protein yield/fad in the first season, but weight of 100-seeds was not significantly affected by P fertilizer. Hassanein (1987), found that N, P protein and oil contents in soybean seeds were not significantly affected due to application of phosphorus.

Carson and Shubeck (1974) and Webb and Westerman (1979), indicated that K-application had no significant effect on yield and its components. While, Bharat et al., (1986), concluded that K-application increased seed yield of soybean. On the contrary, Rizk et al. (1986), reported that there was significant reduction in number of pods/plant and economic yield with application of the higher rates of K.

This study was carried out to determine the effect of N, P and K fertilizer levels on seed yield, yield components and chemical content in seeds of soybean.

## MATERIALS AND METHODS

The material and methods of this work were previously described in the first paper of this series (El-Deepah and Salwau, 1989). At harvesting, 10 plants were taken at random from each plot and the following data were recorded: plant height (cm), number of branches/plant, number of pods/plant, weight of pods/plant and 100-seed weight. Seed yield (kg)/fad was estimated from the whole.

Dried mature seeds were ground into a very fine powder for the determination of oil content by using Soxhlet apparatus on dry weight basis as described by Sorenson (1947). Protein was determined as the total nitrogen by microkjeldahl method according to A.O.A.C. (1955) and then multiplied by 6.25 (Tripathi et al., 1971) to obtained the protein content of seeds. Oil and protein yield per fad. were also calculated.

Phosphorus concentration was determined in the acid digest according to the method described by John (1970), through colorimetric determination with ascorbic acid.

Potassium concentration was determined by using flamephotometer according to Brown and Lilleland (1946). Total P and K uptake/fad. were also calculated.

## RESULTS AND DISCUSSION

### I- Effect of N-fertilizer:

#### I.1- Plant height:

Table (1) nitrogen showed a significant effect on the height of soybean plants in the two successive seasons. The height of soybean plants significantly increased over the control plants by increasing N-levels up to 80 and 40 kg/fad. in first and second season, respectively. These results might be attributed to the effect of N in accelerating early vegetative growth (Stamp, 1971). Similar results were obtained by El-kady et al., (1982) and Baza (1985).

#### I.2- Yield components:

Results in table (1) indicate clearly that yield component characters, i.e., number of branches/plant, number of pods/plant, weight of pods/plant and 100-seed weight significantly increased as N level increased up to 80 kg/fad. These results are expected since N fertilizer increased the seed filling (Basistyi and Lopatkina, 1974) and yield of lateral branches (Svoboda and Hruska, 1982).

#### I.3- Seed, oil and protein yield per faddan:

Results presented in table (1) show that seed yield significantly increased as nitrogen level increased up to 80 kg N/fad. Percentage of increases were 68 and 122% in 1985 season and 50 and 97% in 1986 season for 40 and 80 kg N/fad., respectively. These results might be attributed to the significant effect of nitrogen on number of pods/plant, weight of pods/plant and weight of 100 seeds and are in agreement with those obtained by Sharaf (1980), Ali (1981) and Hassanein (1987).

Regarding to oil and protein yield/fad., the results in Table (2) show that there was a significant increase in oil yield/fad. and protein yield/fad. with application of N-fertilizers up to 80 kg/fad. The significant increases in oil yield and protein yield/fad. may be due to the increase in seed yield/faddan. These results are in good agreement with those obtained by Hassanein (1987).

#### I.4- Chemical analysis:

The data in table (2) show that there were no significant differences in nitrogen, protein and oil contents due to different nitrogen fertilizers doses. These results are in agreement with the results reported by Taira et al., (1979) and Ali (1981).

Table (1): Effect of N-fertilizer on soybean yield and yield components in 1985 and 1986 seasons.

| N-levels | Plant height (cm) | No. of branches per plant | No. of pods per plant | Weight of pods/plant (gm) | 100-seed weight (gm) | Seed yield | |
|---|---|---|---|---|---|---|---|
| | | | | | | Kg/fad. | Relative |
| Kg N/fad. | | | | First Season | | | |
| 00 | 91.6 | 2.6 | 58.3 | 37.5 | 16.96 | 725.6 | 100.0 |
| 40 | 94.5 | 3.2 | 72.8 | 45.3 | 17.29 | 1217.5 | 167.8 |
| 80 | 98.8 | 3.6 | 82.6 | 57.1 | 17.48 | 1609.6 | 221.8 |
| L.S.D. at 5% | 5.1 | 0.3 | 10.7 | 5.9 | 0.25 | 103.8 | |
| | | | | Second Season | | | |
| 00 | 84.9 | 1.5 | 29.6 | 14.2 | 12.52 | 558.0 | 100.0 |
| 40 | 103.6 | 1.7 | 40.3 | 19.4 | 12.48 | 839.7 | 150.5 |
| 80 | 107.2 | 2.2 | 48.2 | 25.1 | 13.83 | 1100.1 | 197.2 |
| L.S.D. at 5% | 8.1 | N.S | 8.2 | 2.2 | 0.78 | 168.4 | |

Table (2): Effect of N-fertilizer on chemical contents of soybean seeds (1986 season).

| N-levels | N % | Protein % | Protein yield (kg)/fad. | P % | P-uptake Kg/fad. | K % | K-uptake Kg/fad. | Oil % | Oil yield (kg)/fad. |
|---|---|---|---|---|---|---|---|---|---|
| Kg N/fad. | | | | | | | | | |
| 00 | 4.55 | 28.44 | 177.7 | 0.96 | 6.0 | 1.32 | 8.2 | 26.9 | 165.8 |
| 40 | 4.30 | 26.92 | 236.6 | 0.89 | 7.7 | 1.26 | 10.9 | 26.5 | 231.8 |
| 80 | 4.59 | 28.70 | 349.9 | 0.84 | 10.2 | 1.24 | 14.4 | 26.0 | 308.0 |
| L.S.D. at 5% | N.S. | N.S. | 77.2 | 0.08 | 2.1 | 0.09 | 2.9 | N.S. | 63.4 |

On the other hand P and K% were significantly decreased by increasing N level up to 80 kg N/fad., but the total P and K uptake/fad. were increased by increasing nitrogen fertilization. These results may be due to the increase in the seed yield/fad.

**II- Effect of P-fertilizer:**

**II.1- Plant height:**

Results in table (3) show that application of P had no significant effect on plant height of soybean plant at harvesting stage. These results were true in both seasons. Similar trend was also obtained by Hammam (1986).

**II.2- Yield components:**

The effects of P-fertilizer on the number of branches/plant, number of pods/plant, weight of pods/plant and 100-seed weight were similar to that of plant height in the two successive seasons (table 3).

**II.3- Seed, oil and protein yield per faddan:**

The effect of P on the yield of seeds/fad. show seasonal variation (table 3). In 1985 season, seed yield significantly increased as the P levels increased up 16 kg $P_2O_5$/fad. However, increasing P levels from 16 to 32 kg/fad. did not show significant increase in seed yield. On the other hand, P-fertilizer had no significant effect on yield of seeds in the second season (Table 3). Similar results were obtained by El-Sherbeeny et al., (1981) and Bassiem (1983). On the other hand Sharaf (1980) and El-Deepah (1985), reported that application of P significantly increased seed yield/fad.

Table (4) shows that the differences between the averages of protein and oil yield/fad. were not significant due to phosphorus fertilizer. These characters decreased insignificantly by increasing P-levels. Such result might be due to the adequacy of available phosphorus required for soybean in the experimental farm.

**II.4- Chemical analysis:**

Results in table (4) indicate that there were no significance differences in N, protein, oil, P, K contnet as well as P and K uptake due to different P fertilizer levels.

Table (3): Effect of P-fertilizer on soybean yield and yield components in 1985 and 1986 seasons.

| N-levels | Plant height (cm) | No. of branches per plant | No. of pods per plant | Weight of pods/plant (gm) | 100-seed weight (gm) | Seed yield | |
|---|---|---|---|---|---|---|---|
| | | | | | | Kg/fad. | Relative |
| Kg N/fad. | | | | First Season | | | |
| 00 | 93.7 | 3.1 | 66.5 | 44.9 | 17.12 | 1037.9 | 100.0 |
| 16 | 95.7 | 3.1 | 73.5 | 47.0 | 17.27 | 1207.8 | 116.4 |
| 32 | 95.4 | 3.2 | 73.7 | 48.0 | 17.33 | 1307.0 | 125.9 |
| L.S.D. at 5% | N.S. | N.S. | N.S. | N.S. | N.S. | 103.8 | |
| | | | | Second Season | | | |
| 00 | 97.7 | 2.0 | 35.1 | 17.8 | 12.61 | 864.1 | 100.0 |
| 16 | 99.9 | 1.7 | 39.2 | 19.7 | 12.97 | 797.3 | 92.3 |
| 32 | 98.1 | 1.8 | 43.9 | 21.2 | 13.25 | 836.4 | 96.8 |
| L.S.D. at 5% | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | |

Table (4): Effect of P-fertilizer on chemical contents of soybean seeds (1986 season).

| N-levels | N % | Protein % | Protein yield (kg)/fad. | P % | P-uptake Kg/fad. | K % | K-uptake Kg/fad. | Oil % | Oil yield (kg)/fad. |
|---|---|---|---|---|---|---|---|---|---|
| Kg N/fad. | | | | | | | | | |
| 00 | 4.64 | 29.0 | 273.0 | 0.96 | 8.8 | 1.28 | 11.8 | 27.4 | 255.4 |
| 16 | 4.43 | 27.8 | 246.4 | 0.87 | 7.4 | 1.27 | 10.8 | 25.7 | 215.2 |
| 32 | 4.37 | 27.3 | 244.7 | 0.87 | 7.7 | 1.28 | 10.9 | 26.1 | 235.1 |
| L.S.D. at 5% | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. |

Table (5): Effect of K-fertilizer on soybean yield and yield components in 1985 and 1986 seasons.

| N-levels | Plant height (cm) | No. of branches per plant | No. of pods per plant | Weight of pods/plant (gm) | 100-seed weight (gm) | Seed yield | |
|---|---|---|---|---|---|---|---|
| | | | | | | Kg/fad. | Relative |
| Kg N/fad. | | | | First Season | | | |
| 00 | 95.3 | 3.1 | 71.0 | 46.9 | 17.24 | 1166.8 | 100.0 |
| 48 | 94.6 | 3.1 | 71.4 | 46.4 | 17.24 | 1201.6 | 102.9 |
| L.S.D. at 5% | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | |
| | | | | Second Season | | | |
| 00 | 99.3 | 1.8 | 38.2 | 18.5 | 12.81 | 822.6 | 100.0 |
| 48 | 97.7 | 1.8 | 40.6 | 20.6 | 13.07 | 842.7 | 102.4 |
| L.S.D. at 5% | N.S. | N.S. | N.S. | N.S. | N.S. | N.S. | |

Table (6): Effect of K-fertilizer on chemical contents of soybean seeds (1986 season).

| N-levels | N % | Protein % | Protein yield (kg)/fad. | P % | P-uptake Kg/fad. | K % | K-uptake Kg/fad. | Oil % | Oil yield (kg)/fad. |
|---|---|---|---|---|---|---|---|---|---|
| Kg N/fad. | | | | | | | | | |
| 00 | 4.54 | 28.3 | 260.3 | 0.91 | 8.3 | 1.29 | 11.4 | 26.9 | 242.9 |
| 48 | 4.42 | 27.7 | 249.1 | 0.88 | 7.7 | 1.26 | 10.9 | 26.1 | 227.5 |
| L.S.D. at 5% | N.S. | N.S. | N.S. | N.S. | N.S | N.S. | N.S. | N.S. | N.S. |

Table (7): Effect of nitrogen and phosphorus interaction on seed yield of soybean per fad. in 1985 and 1986 seasons.

| Seasons | 1985 | | | 1986 | | |
|---|---|---|---|---|---|---|
| N-levels | Kg N/fad. | | | Kg N/fad. | | |
| | 00 | 40 | 80 | 00 | 40 | 80 |
| P-levels Kg $P_2O_5$/fad. | | | | | | |
| 00 | 727.8 | 1024.6 | 1361.3 | 624.7 | 832.4 | 1136.6 |
| 16 | 707.3 | 1236.8 | 1679.3 | 538.1 | 804.1 | 1049.8 |
| 32 | 741.6 | 1391.1 | 1788.3 | 511.2 | 884.3 | 1113.9 |
| L.S.D. at 5% | | 179.8 | | | N.S. | |

Table (8): Effect of nitrogen and phosphorus interaction on potassium percentage of soybean seeds in 1986 season.

| Treatments | Kg N/fad. | | |
|---|---|---|---|
| | 00 | 40 | 80 |
| Kg $P_2O_5$/fad. | | | |
| 00 | 1.45 | 1.22 | 1.29 |
| 16 | 1.24 | 1.33 | 1.21 |
| 32 | 1.15 | 1.24 | 1.20 |
| L.S.D. at 5% | | 0.16 | |

Table (9): Effect of nitrogen, phosphorus and potassium interaction on oil percentage of soybean seeds in 1986 season.

| Kg $P_2O_5$/fad. | 00 | | 16 | | 32 | |
|---|---|---|---|---|---|---|
| Kg $K_2O$/fad. | 00 | 48 | 00 | 40 | 00 | 48 |
| Kg N/fad. | | | | | | |
| 00 | 30.2 | 26.8 | 24.3 | 27.3 | 27.7 | 25.2 |
| 40 | 26.8 | 27.8 | 25.2 | 26.5 | 27.5 | 25.5 |
| 80 | 26.8 | 25.7 | 28.5 | 22.3 | 25.2 | 27.5 |
| L.S.D. at 5% | | | 3.06 | | | |

**III- Effect of K-fertilizer:**

**III.1- Yield and yield components:**

Results presented in Table (5) show that the effect of K-fertilizer on plant height, number of branches/plant, number of pods/plant, weight of pods, 100-seed weight and seed yield/fad. were similar to the effect of P-application on all previous characters. These results are in agreement with those obtained by Webb and Westerman (1979).

The data in table (6) show that there were no significant differences in protein and oil yields/fed. due to different potassium fertilizer rates.

**III.2- Chemical analysis:**

Results in table (6) show that application of potassium had no significant effect on N, protein, oil P, K contents P as well as K uptake/fad.

**IV- Effect of the interactions:**

The effect of the interaction between nitrogen and phosphorus fertilization on seed yield/fad. was significant in one season out of two (table 7). The maximum values of seed yield/fad. were 1788.30 kg and 1113.87 kg/fad., obtained from adding 80 kg N/fad. with 32 kg $P_2O_5$/fad. in 1985 and 1986 seasons, respectively. It was clear that these doses resulted in increasing the yield components of soybean plant.

The data in table (8) show that NxP interaction significantly affected the percentages of K in soybean seeds in 1986 season. The highest value of K% was 1.45%, obtained without application of N and P, whereas, the lowest one was 1.15%, obtained with zero N + 32 kg $P_2O_5$/fad.

The highest value of oil percentage was 30.17%, obtained without application of N, P and K, whereas the lowest value 24.33%, obtained from zero N + 16 kg $P_2O_5$/fad. + zero $K_2O$ (table 9).

The other interactions had no effect on the yield, yield components and chemical content of the seeds.

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