Performance of three soybeans genotypes under different intra and inter row planting arrangements

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Abstract. A field experiment was conducted to evaluate the performance of three genotypes of soybean Iman, Taqa and Lee74 planted on lines with three different spacing 40, 50 and 60 cm and two plant spacings on each row 5 and 10 cm. The experiment was carried out according to the randomize complete block design as a factorial experiment with three replicates to study the number of nodes on the main stem, length of internodes, weight of pods.plant⁻¹, pod weight, number of seeds.plant⁻¹, seed weight.pod⁻¹, weight 1000 seed, seed net weight, seed yield g.plant⁻¹, oil yield, and protein yield. The results showed significant differences between the studied factors of the distances between and within lines, genotypes double interaction and triple interactions in all the studied traits except length of inter nodes (cm) of the genotypes as well as of the double interaction intra row spacing * genotypes. The genotype Iman was superior to the seed yield 41.93 g.plant⁻¹ and distance 60 cm in seed yield 50.62 g.plant⁻¹ and the distance 10 cm between the plants in the seed yield 43.48 g.plant⁻¹.

1. Introduction

Soybean crop Glycine max (L.) Merrill belongs to the legume family leguminaceae, one of the most important legume crops in the world, it is a crop of great economic importance, as the seeds contain 14-24% oil and the proportion of protein about 30-50% is characterized by its high-quality protein for containing all the essential amino acids for humans and animals [1]. It is also beneficial to people with diabetes because of its low starch, and preferred to grow it to improve the properties of the soil and increase fertility through the installation of atmospheric nitrogen in the soil by the rizobacter Rhyzobium japonicum and supply the plant needs for growth [2].

The plant density is important practice in crop management because of its large effect on the growth and yield. Therefore, it is the key to evaluate the stability and productivity of the variety. Studies differed in determining the most suitable plant density to achieve the highest yield of field crops [3], planting density and arrangement are of a great importance due to their effect of the nature
of competition between plants overcome this for elements growth, which is reflected on the physiological processes within the plant that affect the growth and productivity of the crop, to select the plant density that encountered in 95% of the solar radiation falling, which works to increase plant growth and its branches and increase both economic and biological character[4].

One of the methods used to determine the appropriate genotypic is to conduct testing and evaluation experiments under different environmental conditions. The genotype differs in some traits depending on the nature of their genetic make up and their interaction with environmental factors. Therefore, a selection of different genotypes for more superiorty in the field, productivity and quality specifications to be used in subsequent breeding programs for these genotypes to insert them in selection and hybrid programs to improve this crop. This study aimed to evaluate the performance of three genotypes at different distance between lines and plants. The Researchers studied genotypes under different plant densities and found significant differences in most studied traits,[3 ;5 ;6 ;7].

2. Materials and methods
A field experiment was carried out at the experimental station of Kirkuk university during the summer season 2017 from the period 24/5 to 18/11. The experiment was conducted according to the Random Complete Block Design, with three replicate. The experiment includes three factors 3 * 2 * 3. The first factor is represented by three distances between lines 40, 50, and 60 cm. The second factor includes two spaces between plants 5 and 10 cm, and the third factor is three genotypes Iman, Taqa, and Lee74, each experimental unit consisted of four lines along the 3 m line, the distance between one line and another was 40, 50 and 60 cm and one plant and another 5 and 10 cm. Experimental land has been plowed, smoothed, and divided according to the design mentioned above, triple super phosphate were added with the rate of 200 kg.ha⁻¹ in one batch, and urea fertilizer at a rate of 200 kg.ha⁻¹ splitted on two halves in preparation and the other half at flowering [9]. Ten plants were randomly selected for each experimental unit to study the following traits: number of nodes on the main stem, length of internode (cm), the weight of pods.plant⁻¹ g, the weight of pod, number of seeds.plant⁻¹, seed weight.pod⁻¹, weight 1000 seed, seed net weight, seed yield g.plant⁻¹, oil yield kg.ha⁻¹ and protein kg.ha⁻¹. Data analyzed according to the SAS V 9.0 [9], and Duncan Multiple Range at Test a significant level 0.05 according to this test, the averages with similar alphabetic characters are not significantly different [10].

3. Results and discussion
Table (1) shows the analysis of variance of all characteristics of the study factors and shows significant differences at the probability level of 5% and 1% for all studied traits of the distance between lines and plants and genotypes except for the length of internodes of the genotypes showed no significant differences. The interaction was significant of all traits except for the length of internodes of the distance between plants * genotypes showed no significant differences
Table 1. Results of the analysis of variance of the effect of the distances of agriculture between the lines and the plants and the genotypes in the studied traits

| Source of variation | d.f | M.S |
|---------------------|-----|-----|
|                      |     | No. of nodes on the main stem | length of internodes (cm) | weight of pods.plant\(^{-1}\) (g) | pod weight (g) | No of seeds.plant\(^{-1}\) | Seed weight.pod\(^{-1}\) (g) |
| Replication         | 2   | 12.949 | 3.883 | 49.934 | 0.002 | 32.495 | 0.0009 |
| Distance between line (A) | 2   | 25.20** | 2.05** | 692.46** | 0.001** | 6070.22** | 0.04** |
| Distance between plant (B) | 1   | 14.31** | 1.81** | 498.07** | 0.0003** | 108720.90** | 0.01** |
| Genotype (C)        | 2   | 9.63** | 0.09n.s | 1097.55** | 0.03** | 12995.26** | 0.005** |
| A * B               | 2   | 7.07** | 0.37** | 533.31** | 0.0002** | 1612.92** | 0.01** |
| A * C               | 4   | 3.00** | 0.26** | 1207.06** | 0.009** | 3853.27** | 0.01** |
| B * C               | 2   | 2.86** | 0.12n.s | 3650.75** | 0.03** | 13918.16** | 0.06** |
| A * B * C           | 4   | 11.48** | 0.34** | 1531.21** | 0.01** | 7863.19** | 0.03** |
| Error               | 34  | 0.158 | 0.062 | 0.515 | 0.00003 | 0.264 | 0.00001 |

| Source of variation | d.f | M.S |
|---------------------|-----|-----|
|                      |     | weight 1000 seed (g) | seed net weight (%) | seed yield g.plant\(^{-1}\) | Oil yield kg.ha\(^{-1}\) | Protein yield kg.ha\(^{-1}\) |
| Replication         | 2   | 202.032 | 83.826 | 15.908 | 1834.428 | 1589.312 |
| Distance between line (A) | 2   | 13064.59** | 1636.17** | 1563.71** | 24295.14** | 23160.61** |
| Distance between plant (B) | 1   | 4149.63** | 604.58** | 616.10** | 79799.82** | 230628.25** |
| Genotype (C)        | 2   | 4136.44** | 773.93** | 61.25** | 53257.23** | 85908.68** |
| A * B               | 2   | 26.30** | 804.69** | 16.85** | 228.36** | 4099.76** |
| A * C               | 4   | 2192.86** | 1801.73** | 137.71** | 8451.53** | 23438.11** |
| B * C               | 2   | 2588.87** | 4725.52** | 189.87** | 45314.55** | 97245.70** |
| A * B * C           | 4   | 2503.26** | 2211.48** | 199.42** | 6940.89** | 24620.49** |
| Error               | 34  | 3.474 | 3.026 | 0.250 | 0.00001 | 0.00001 |

3.1. Number of nodes on the main stem:

Table (2) shows the effect of the distance between lines and plants and genotype ion the number of nodes on the main stem, where distance of 40 cm was significantly superior on the two distances with an average of 19.31 node for the distance between lines, while the distance between plants was superior for the distance 5 cm which significantly gave 18.85 in other distance node. This may be explained by the fact that agriculture at narrow distances between lines or between plants stimulates plants longitudinally to intercept more light quantities due to lack of space allocated for each plant, thus increasing the elongation of the stem and increased the number of nodes formed on stems, while genotypes Iman showed significant superior to rest genotypes at 19.13 node. This result agrees with [11 ;12 ;13]. Which showed significant differences between soybean varieties in this trait. For the double interactions, superior of 40 cm between lines * 5 cm between plants with an average of 19.97 nodes on all other treatments, while between the distances of planted between lines * genotypes have superior the distance treatment 40 cm at the genotypes of Iman and Taqa a 19.91 and 19.63 respectively. The double interaction of distance between plants * genotypes, the treatment exceeded 5 cm between plants at the genotype Iman at an average of 20.06 nodes on all other treatment. While
triple interaction distance between lines * distance between plants * genotype significantly exceeds the treatment of 40 cm between lines and 5 cm between plants of the genotype Iman with an average of 22.46 node on all other treatments.

Table 2. Effect of distance between lines and plants and genotype in the number of nodes on the main stem

| Distance between line | Distance between plant | Mean distance between the line |
|----------------------|------------------------|------------------------------|
| 5 cm                 | 10 cm                  |                              |
| 40 cm                | 19.97 a                | 18.65 b                      | 19.31 a                      |
| 50 cm                | 18.50 b                | 18.84 b                      | 18.67 b                      |
| 60 cm                | 18.07 c                | 15.96 d                      | 17.02 c                      |

Genotypes

| Genotypes | Distance between line | Mean genotype |
|-----------|----------------------|---------------|
| Iman      | 40 cm                | 19.91 a       |
|           | 50 cm                | 19.13 b       |
|           | 60 cm                | 18.35 cd      |
| Taqa      | 40 cm                | 19.63 a       |
|           | 50 cm                | 18.98 b       |
|           | 60 cm                | 15.93 f       |
| Lee74     | 40 cm                | 18.40 c       |
|           | 50 cm                | 17.90 d       |
|           | 60 cm                | 16.78 e       |

Distance between plant

| Genotypes | Mean distance |
|-----------|---------------|
| Iman      | 5 cm          | 22.46 a       |
|           | 10 cm         | 17.36 g       |
| Taqa      | 5 cm          | 19.60 bc      |
|           | 10 cm         | 18.66 de      |
| Lee74     | 5 cm          | 18.13 ef      |
|           | 10 cm         | 18.56 de      |

Means followed by the same letter are not significantly different

3.2. Length of inter nodes (cm).

Table 3 shows the effect of the distance between lines and plants and genotype in length of inter nodes (cm), the superiority was for treatment of 40 cm and 50 cm for the distance between lines on the other distance, an average of 3.45 and 3.32 respectively. While the distance between plants, for treatment of 5 cm on other distance with an average of 3.37 cm This may be explained by the increased competition between plants in the unit area, resulting in an increase in the height of the plant and the number of nodes on the main stem and thus increase the length of salami i is the distance between two nodes in the narrow distances between lines or between plants, the genotypes did not show any genotype of significant differences, this may be due to the is a non-quantitative and low environmental impact. The interactions between the factors, superior treatment of distance 40 cm between lines and 5 cm between plants significance of all other treatment an average of 3.64 cm, while the double interaction distance between lines * distance between plants, and distance between lines * genotypes has superior significant for distance of 40 cm for two genotypes Iman and Taqa as well as 50 cm for Taqa genotype at averages of 3.45, 3.46 and 3.48 cm respectively, which did not differ significantly on most other treatments. However, double interaction distance between plants * genotypes superior treatment of distance 5 cm for genotype Lee74 an average of 3.51 cm on all other treatments. While triple interaction distance between lines* distance between plants * genotypes, the distance of 40cm between line and 5 cm between plants at genotype Iman at an average of 3.83 cm, which differed from some treatments and did not differ from each other.
Table 3. shows the effect of the distance between lines and plants and genotype in length of internodes (cm)

| Distance between line | Distance between plant | Mean distance between the line |
|----------------------|------------------------|------------------------------|
| 40 cm                | 5 cm                   | 3.64 a                       |
|                      | 10 cm                  | 3.25 b                       |
|                      |                        | 3.45 a                       |
| 50 cm                | 5 cm                   | 3.35 b                       |
|                      | 10 cm                  | 3.28 b                       |
|                      |                        | 3.32 a                       |
| 60 cm                | 5 cm                   | 3.13 b                       |
|                      | 10 cm                  | 2.48 c                       |
|                      |                        | 2.81 b                       |

| Genotypes | Distance between line | Mean genotype |
|-----------|-----------------------|---------------|
| Iman      | 40 cm                 | 3.45 a        |
|           | 50 cm                 | 3.20 ab       |
|           | 60 cm                 | 2.76 c        |
| Taqa      | 40 cm                 | 3.46 a        |
|           | 50 cm                 | 3.48 a        |
|           | 60 cm                 | 2.55 c        |
| Lee 74    | 40 cm                 | 3.43 ab       |
|           | 50 cm                 | 3.28 ab       |
|           | 60 cm                 | 3.11 b        |

Means followed by the same letter are not significantly different.

3.3. Weight of pods.plant\(^{-1}\) (g)

Table 4 shows the effect of the distance between lines and plants and genotype on weight of pods.plant\(^{-1}\) (g), where the treatment of 60 cm of distance between lines was superior over the rest distances with an average of 79.08 g. The distance between plants has significantly superiority 10 cm on other distance at an average of 75.05 g. This may be due to less competition between plants on the environmental factors due to the increase of the area allocated to plants in the unit area and thus increase the efficiency of photosynthesis. This result is similar with finding [14]. As for genotypes, the composition of Lee 74 was superior to the rest of the genotypes with an average of 76.96 g. This result agreed with the results of the [15]. Differences in soybean varieties. The double interactions distance between lines * distance between plants was significantly higher for 60 cm distance between lines with distance 10 cm between plants at an average of 84.96 g. While the double interactions between lines * genotypes was significantly higher at 60 cm between lines for genotype Iman on all interactions at an average of 93.56 g, while double interaction of distance between plants * genotypes, the treatment of the distance 5 cm for genotype Iman, a significant superiority on rest of the treatments an average of 89.28 g. The triple interaction between lines * distance between plants * genotypes has superiority the treatment of the distance between lines 60 cm and distance of 10 cm between plants for genotype Lee 74, an average of 116.00 g on all other treatments.
Table 4. Effect of distance between the line and between plants and genotype in weight of pods plant\(^{-1}\) (g)

| Distance between line | Distance between plant | Mean distance between the line |
|-----------------------|------------------------|-------------------------------|
| 40 cm                 | 5 cm                   | 61.02 e                       |
|                       | 10 cm                  | 73.96 b                       |
|                       |                        | 67.49 c                       |
| 50 cm                 | 5 cm                   | 72.71 c                       |
|                       | 10 cm                  | 66.23 d                       |
|                       |                        | 69.47 b                       |
| 60 cm                 | 5 cm                   | 73.21 c                       |
|                       | 10 cm                  | 84.96 a                       |

Genotypes

| Genotypes | Distance between line | Mean genotype |
|-----------|-----------------------|---------------|
|           | 40 cm                 | 60.03 h        |
|           | 50 cm                 | 74.61 c        |
|           | 60 cm                 | 93.56 a        |
| Iman      | 5 cm                  | 62.66 k        |
|           | 10 cm                 | 43.70 p        |
|           |                       | 76.70 g        |
| Taqa      | 5 cm                  | 70.31 e        |
|           | 10 cm                 | 65.98 g        |
|           |                       | 52.75 i        |
|           |                       | 63.01 c        |
| Lee 74    | 5 cm                  | 72.13 d        |
|           | 10 cm                 | 67.81 f        |
|           |                       | 90.95 b        |
|           |                       | 76.96 a        |

Distance between plant

| Genotypes | Distance between plant | Mean distance between plant |
|-----------|------------------------|----------------------------|
|           | Iman                   | 89.28 a                    |
|           | Taqa                   | 49.68 f                    |
|           | Lee 74                 | 76.34 c                    |
|           |                        | 85.96 b                    |
|           |                        | 75.05 a                    |

Means followed by the same letter are not significantly different.

3.4. Pod weight (g)

Table (5) shows the effect of distance between lines and plants and genotype on pod weight (g), the superiority of distances 40 and 60 cm between lines over other distance, an average of 0.53 g. However, the distance between plants, was significantly superior for distance 10 cm an average of 0.53 g. The genotypes, Lee 74, had an average of 0.55 g over the rest genotypes. This result is agreed with [16]. The double interaction between line * between plants was 40 and 60 cm between lines with distance 10 cm between plants at an average of 0.54 g on rest other treatments, while the double interaction distance between lines * genotypes superior distance of 60 cm for genotype has Iman at an average of 0.60 g on all treatments. While double interaction distance between plants * genotypes superior distance of 5 cm between plant for Iman genotype an average 0.60 g, but triple interaction distance between lines * distance between plants * genotypes have superior treatment distance of 50 cm between lines and 5 cm between plants for Iman genotype with an average of 0.62 on compared with other treatments.
### Table 5. Effect of distance between the line and between plants and genotype in pod weight (g)

| Distance between line | Distance between plant | Mean distance between the line |
|----------------------|------------------------|------------------------------|
| 40 cm                | 5 cm 0.53 b            | 0.53 a                       |
|                      | 10 cm 0.54 a           |                              |
| 50 cm                | 5 cm 0.52 c            | 0.51 c                       |
|                      | 10 cm 0.54 a           | 0.52 b                       |
| 60 cm                | 5 cm 0.53 b            | 0.54 a                       |
|                      | 10 cm 0.54 a           | 0.53 a                       |

| Genotypes          | Distance between line | Mean genotype |
|--------------------|-----------------------|---------------|
| Iman               | 40 cm 0.54 c          | 0.55 a        |
|                    | 50 cm 0.53 d          | 0.57 b        |
|                    | 60 cm 0.54 c          | 0.55 a        |
| Taqa               | 40 cm 0.51 e          | 0.47 b        |
|                    | 50 cm 0.48 f          | 0.43 g        |
|                    | 60 cm 0.54 c          | 0.52 b        |
| Lee 74             | 40 cm 0.54 c          | 0.60 a        |
|                    | 50 cm 0.54 c          | 0.58 b        |
|                    | 60 cm 0.54 c          | 0.57 d        |

**Means followed by the same letter are not significantly different.**

3.5. **Number of seeds.plants⁻¹:**

Table (6) shows the effect of distance between lines and plants and genotype in the number of seeds.plants⁻¹, the distance of 60 cm between lines was superior over on the distances 40 and 50 cm with an average of 305.20 seed.plant⁻¹, the distance between plants 10 cm gave an average of 333.90 seeds.plant⁻¹. This may be due to the less competition between the plants and the ability of these plants to secure the needs of the inside the pods to complete their life cycle and attain the maturity of the mature seed. This result is similar to [14]. The genotype superior Taqa genotype had an average of 318.87 seeds.plants⁻¹ and was similar. These result was in agreement with the found [15; 17; 18; 19]. There are significant differences between the varieties of soybeans in this trait. The double interaction distance between lines * distance between plants has superior the treatment distance of 50 cm between lines with a distance of 10 cm between plants an average of 348.16 seed.plant⁻¹ on all treatment, as for the treatment of distance between lines 60 cm * Taqa genotype gave high mean at 359.85 seed.plant⁻¹. While the distance between plants * genotypes, the treatment showed 10 cm between plants for the genotype of Taqa an average of 380.67 seeds.plants⁻¹. However, triple interaction distance between lines * distance between plants * genotype, the treatment of 60 cm between lines and 10 cm between plants for Taqa genotype has an average energy of 458.06 seed.plant⁻¹ over all other treatments.
Table 6. Effect of distance between the line and between plants and genotype in the number of seeds.plant⁻¹

| Distance between line | Distance between plant | Mean distance between the line |
|-----------------------|------------------------|-------------------------------|
| 40 cm                 | 5 cm                   | 232.16 f                      |
|                       | 10 cm                  | 305.96 c                      |
|                       |                        | 269.06 c                      |
| 50 cm                 | 5 cm                   | 237.50 e                      |
|                       | 10 cm                  | 348.16 a                      |
|                       |                        | 292.83 b                      |
| 60 cm                 | 5 cm                   | 262.82 d                      |
|                       | 10 cm                  | 347.57 b                      |
|                       |                        | 305.20 a                      |

| Genotypes | Distance between line | Mean genotype |
|-----------|-----------------------|---------------|
| Iman      | 40 cm                 | 283.38 e      |
|           | 50 cm                 | 291.45 c      |
|           | 60 cm                 | 269.53 g      |
| Taqa      | 40 cm                 | 274.50 f      |
|           | 50 cm                 | 322.28 b      |
|           | 60 cm                 | 359.85 a      |
| Lee 74    | 40 cm                 | 249.31 i      |
|           | 50 cm                 | 264.76 h      |
|           | 60 cm                 | 286.21 d      |

Means followed by the same letter are not significantly different.

3.6. Seed weight.pod⁻¹ (g)

Table (7) shows the effect of distance between lines and plants and genotype on the seed weight.pod⁻¹ g, with superiority of the treatment 60 cm between lines, an average of 0.36 g over rest distances as the distance between plants has superiority distance 10 cm an average of 0.32 g. This may be due to an increase in the number of seeds at wide distances, which is positively reflected in the increase in the weight of seeds.pod⁻¹ due to the lack of competition between plants on the growth requirements in the unit area. The genotypes Iman was superior giving an average 0.32 g. This result agrees with [16]. The double interaction distance between lines * distance between plants, superior treatment the distance between lines 60 cm with distance 5 and 10 cm between plants was significantly by 0.36 g. The double interaction distance between lines * genotypes showed 60 cm between lines of Taqa genotype at 0.40 g. The double interaction between the distance between plants * genotypes, a distance of 10 cm to Iman genotype was superior an average of 0.41 g. The triple interaction distance between line * distances between plants * genotypes superior the distance of 50 cm between lines with 10 cm between plants of the Iman genotype at an average of 0.58 g.
Table 7. Effect of distance between line, between plants and genotype in seed weight (g).

| Distance between line | Distance between plant | Mean distance between the line |
|----------------------|------------------------|-----------------------------|
|                      | 5 cm                   | 10 cm                       | 40 cm |
| 40 cm                | 0.26 c                 | 0.26 c                      | 0.26 c |
| 50 cm                | 0.24 d                 | 0.35 b                      | 0.29 b |
| 60 cm                | 0.36 a                 | 0.36 a                      | 0.36 a |

| Genotypes | Distance between line | Genotypes | Mean genotype |
|-----------|----------------------|-----------|---------------|
| Iman      | 40 cm                | 0.27 f    | 0.37 b        | 0.33 d | 0.32 a |
| Taqa      | 0.23 h               | 0.26 g    | 0.40 a        |       | 0.30 b |
| Lee 74    | 0.28 e               | 0.26 g    | 0.34 c        |       | 0.29 c |

Means followed by the same letter are not significantly different.

3.7. Weight 1000 seed (g).

Table (8) shows the effect of distance between lines and plants and genotype on weight 1000 seeds (g), the superiority was for the treatment 60 cm between lines an average of 172.80 g over the rest distances this may be due to lack of competition between plants on the necessary nutrients and the composition and fillin of the seeds, which results in an increase in the number of seeds and their weight in the wide distances. The distance between plants, superior distance 5 cm an average of 150.52 g. The genotypes, of Iman genotype superior an average of 150.52 g. This is explained based on the genetic nature of the composition This result agrees with [16;20]. The double interaction between distance between lines * distance between plants, the distance between lines 60 cm with distance between 5 cm an average of 182.63 g, but double interaction between lines * genotypes showed a superior treatment at 60 cm between the lines For genotype Iman, an average of 191.79 g was achieved compared with all other treatments. For double interaction between distances between plants * genotypes, the distance of 5 cm for Iman genotype may be missed at an average of 157.41 g. The triple interaction distance between lines * distance between plants * genotypes superior distance of 60 cm between lines with 5 cm between plants for Iman genotype an average of 200.96 g on all other treatments.
Table 8. Effect of distance between line, between plants and genotype in weight 1000 seed (g)

| Distance between line | Distance between plant | Mean distance between line |
|-----------------------|------------------------|---------------------------|
|                       | 5 cm | 10 cm |                       |
| 40 cm                 | 0.26 c | 0.26 c | 0.26 c |
| 50 cm                 | 0.24 d | 0.35 b | 0.29 b |
| 60 cm                 | 0.36 a | 0.36 a | 0.36 a |

| Genotypes | Distance between line | Mean genotype |
|-----------|-----------------------|---------------|
|           | 40 cm | 50 cm | 60 cm |
| Iman      | 0.27 f | 0.37 b | 0.33 d | 0.32 a |
| Taqa      | 0.23 h | 0.26 g | 0.40 a | 0.30 b |
| Lee 74    | 0.28 e | 0.26 g | 0.34 c | 0.29 c |

Means followed by the same letter are not significantly different.

3.8. seed net weight (%).

Table (9) shows the effect of distance between lines and plants and genotype on the seed net weight (%), where the distance of 60 cm between lines, gave an average of 69.75%, the distance between plants has superior the distance 10 cm 63.74%. This may be explained by the lack of shading of the branches and the lack of competition for light and thus lead to increase the weight of the pod and seeds in the wide distances between lines or between plants and based on this is defined as the ratio between the weight of seeds. While genotypes Taqa of genotype has an average of more Was 66.01% on the two genotypes. The double interaction distance between lines * distance between plants superior 50 cm between lines with 10 cm between plants an average of 71.82% on all treatments, while the interaction of the distance between lines * genotypes superior the treatment distance between lines 60 cm for genotype Taqa an average rate 94.21%. The double interaction distance between plants * genotypes superior the distance treatment is 10 cm for Iman genotype an average of 83.69%. The triple interaction between the distance between lines * distance between plants * genotypes was superior distance between 50 cm with 10 cm between plants for Iman genotype at an average rate of 131.11% on all other treatment.
Table 9. Effect of distance between line, between plants and genotype in seed net weight (%)

| Distance between line | Distance between plant 5 cm | Distance between plant 10 cm | Mean distance between the line |
|-----------------------|-----------------------------|-----------------------------|------------------------------|
| 40 cm                 | 51.18 c                     | 50.20 c                     | 50.69 c                      |
| 50 cm                 | 49.68 c                     | 71.82 a                     | 60.75 b                      |
| 60 cm                 | 70.29 ab                    | 69.21 b                     | 69.75 a                      |

| Genotypes | Distance between line 40 cm | Distance between line 50 cm | Distance between line 60 cm | Mean genotype |
|-----------|----------------------------|-----------------------------|-----------------------------|---------------|
| Iman      | 51.03 e                    | 79.33 b                     | 55.62 d                     | 61.99 b       |
| Taqa      | 48.54 f                    | 55.27 d                     | 94.21 a                     | 66.01 a       |
| Lee 74    | 52.49 e                    | 47.65 f                     | 59.41 c                     | 53.19 c       |

| Distance between plant | Genotypes | Iman | Taqa | Lee 74 | Mean distance between plant |
|------------------------|-----------|------|------|--------|----------------------------|
| 5 cm                   |           | 40.30 e | 75.01 b | 55.84 c | 57.05 b                   |
| 10 cm                  |           | 83.69 a | 57.00 c | 50.54 d | 63.74 a                   |

| Distance between line | Distance between plant 5 cm | Distance between plant 10 cm | Genotypes |
|-----------------------|-----------------------------|-----------------------------|-----------|
| 40 cm                 | 5 cm                         | 47.32 h                     | Iman      |
|                       | 5 cm                         | 61.52 e                     | Taqa      |
|                       | 10 cm                        | 54.75 f                     | Lee 74    |
| 50 cm                 | 5 cm                         | 27.54 k                     |           |
|                       | 5 cm                         | 70.57 c                     |           |
|                       | 10 cm                        | 131.11 a                    |           |
| 60 cm                 | 5 cm                         | 46.05 h                     |           |
|                       | 5 cm                         | 92.94 b                     |           |
|                       | 10 cm                        | 65.19 d                     |           |
|                       | 10 cm                        | 95.47 b                     |           |

Means followed by the same letter are not significantly different

3.9. Seed yield.plant−1 g.
Table (10) shows the effect of distance between lines and plants and genotype on seed yield.plant g, where the distance of 60 cm between lines gave an average of 50.62 g, the distance between plants 10 cm the genotype of Iman 41.48 g. This may be due to a difference in the performance of the genotypes of the distance planted by the genotype or due to its superiority in the characteristics of components of the yield the result agree with [17; 21]. The double interaction distance between lines * distance between plants superior distance of 60 cm between lines at with distance of 10 cm between plants an average of 53.67 g on the rest other treatments, the double interaction distance between lines * distance between plants superior distance treatment 60 cm for genotype of Iman average 51.35 g on the rest of treatments, as well as the double interaction of distance between plants * genotypes superior treatment distance of 10 cm for Iman genotype at an average of 48.90 g on all other treatments. The triple interaction distance between lines * distance between plants * genotypes was superior over the distance of 50 cm with a distance of 5 cm between plants for the genotype of Iman at an average of 720.33g.
Table 10. Effect of distance between line, between plants and genotype in seed yield per plant g

| Distance between line | Distance between plant | Mean distance between the line |
|----------------------|-----------------------|-------------------------------|
|                      | 5 cm                  | 10 cm                         |
| 40 cm                | 30.25 f               | 35.48 d                       |
| 50 cm                | 32.36 e               | 41.30 c                       | 36.83 b                       |
| 60 cm                | 47.57 b               | 53.67 a                       | 50.62 a                       |

Genotypes

| Genotypes | Distance between line | Mean genotype |
|-----------|-----------------------|---------------|
|           | 40 cm                 | 50 cm         | 60 cm         |
| Iman      | 43.96 c               | 51.35 a       | 41.93 a       |
| Taqa      | 34.43 e               | 49.66 b       | 38.25 c       |
| Lee 74    | 32.10 f               | 50.86 a       | 40.14 b       |

Distance between plant

| Genotypes | Mean distance between plant |
|-----------|----------------------------|
| Iman      | 37.60 d                    |
| Taqa      | 42.68 b                    |
| Lee 74    | 43.48 a                    |

Distance between line

| Genotypes | Mean distance between plant |
|-----------|----------------------------|
| Iman      | 406.18 kg.ha⁻¹             |
| Taqa      | 479.52 kg.ha⁻¹             |
| Lee 74    | 487.49 kg.ha⁻¹             |

Means followed by the same letter are not significantly different.

3.10. Oil yield Kg.ha⁻¹.

Table (11) shows the effect of distance between lines and plants and genotype on the oil yield Kg.ha⁻¹. Where the distance treatment 40 cm an average of 370.92 kg. ha⁻¹ on the rest distances. While an recorded average of 370.54 kg.ha⁻¹ on the other distance the genotypes have a superior genotype of Iman an average of 393.67 kg.ha⁻¹. This results agree with [15; 16], which indicated significant differences between the varieties in this trait. The double interaction distance between lines * distance between plants was superior 40 cm between lines with 5 cm between plants averaged 406.18 kg.ha⁻¹ over the rest of the treatments, the double interaction distance between lines * genotypes superior the treatment distance of 40 cm for the genotype of Iman which gave an average of 479.52 kg.ha⁻¹ over the rest of the treatments. The double interaction distance between plants * genotypes was superior the treatment of 5 cm between plants of the genotype Iman at an average of 487.49 kg.ha⁻¹ on the rest of the interactions. The triple interaction distance between lines * distance between plants * genotypes was superior the distance of 40 cm between lines with distance five between plants for Iman genotype an average of 609.63 kg.ha⁻¹ on other treatments.
Table 11 Effect of distance between line, between plants and genotype in oil yield kg.ha\(^{-1}\)

| Distance between line | Distance between plant | Mean distance between the line |
|-----------------------|------------------------|------------------------------|
|                       | 5 cm                   | 10 cm                        |
| 40 cm                 | 406.18 a               | 335.66 c                    | 370.92 a |
| 50 cm                 | 365.27 b               | 289.72 d                    | 327.50 b |
| 60 cm                 | 340.17 c               | 255.59 e                    | 297.88 c |

| Genotypes | Distance between line | Mean genotype |
|-----------|-----------------------|---------------|
|           | 40 cm                 | 50 cm         | 60 cm         |
| Iman      | 479.52 a              | 379.28 b      | 322.22 c      | 393.67 a |
| Taqa      | 322.91 c              | 311.66 d      | 301.59 e      | 312.05 b |
| Lee 74    | 310.33 d              | 291.56 f      | 269.83 g      | 290.57 c |

| Distance between plant | Genotypes | Mean distance between plant |
|------------------------|-----------|----------------------------|
|                       | Iman      | Taqa                       | Lee 74        |
| 5 cm                  | 487.49 a  | 308.06 c                   | 316.08 b      | 370.54 a |
| 10 cm                 | 299.85 d  | 316.05 b                   | 265.07 e      | 293.66 b |

| Distance between line | Distance between plant | Genotypes |
|-----------------------|------------------------|-----------|
|                       | 5 cm                   | Iman      | Taqa | Lee 74 |
| 40 cm                 | 5 cm                   | 609.63 a  | 297.98 gh | 310.93 |
|                       | 10 cm                  | 349.41 d  | 347.84 d | 309.73 f |
| 50 cm                 | 5 cm                   | 465.72 b  | 297.10 gh | 333.00 e |
|                       | 10 cm                  | 292.84 h  | 326.21 e | 250.12 j |
| 60 cm                 | 5 cm                   | 387.12 c  | 329.09 e | 304.30 fg |
|                       | 10 cm                  | 257.31 j  | 274.09 i | 235.37 k |

Means followed by the same letter are not significantly different.

3.11. Protein yield kg.ha\(^{-1}\).

Table (12) shows the effect of distance between lines and plants and genotype on protein yield kg.ha\(^{-1}\), where the distance between lines is 40 cm for the distance between lines an average of 680.29 kg.ha\(^{-1}\). Distance between plant 5 cm with an average of 709.31 kg.ha\(^{-1}\). As well as the genotypes superior to the Iman genotype at an average of 710.88 kg.ha\(^{-1}\) on the rest of the genotype was a reflection of the superiority in the conversion of products of the process of representation of photometric images of different parts of the plant for the benefit of the economic content of the protein concentration in the seeds or the nature of its genotype and this agrees with result [15; 17; 22]. Which indicated significant differences between soybeans in this trait. The double interaction distance between lines superior 40 cm with a distance 5 cm between plants over all the treatments at an average of 735.28 kg.ha\(^{-1}\), while the double distance between lines x distance between plants superior the distance treatment 40 cm 820.11 kg.ha\(^{-1}\) and the interaction distance between plants * genotypes were superior the treatment of 5 cm for the genotype Iman with an average of 843.63 kg.ha\(^{-1}\) over the rest of other treatments. The interaction distance between lines * distance between plants * genotypes superior the distance of 40 cm between lines and distance between 5 cm between plants of the genotype Iman at an average of 1014.70 kg.ha\(^{-1}\).
Table 12. Effect of distance between line, between plants and genotype in protein yield kg ha⁻¹

| Distance between line | Distance between plant | Mean distance between the line |
|-----------------------|------------------------|-------------------------------|
| 40 cm                 | 5 cm                   | 10 cm                         |
| 735.28 a              | 625.30 d               | 680.29 a                      |
| 50 cm                 | 726.69 b               | 560.36 e                      | 643.03 b                      |
| 60 cm                 | 666.97 c               | 550.17 f                      | 608.57 c                      |

| Genotypes | Distance between line | Mean genotype |
|------------|-----------------------|---------------|
| Iman       | 40 cm                 | 820.11 a      |
|            | 50 cm                 | 704.02 b      |
|            | 60 cm                 | 608.50 f      | 710.88 a                      |
| Taqa       | 40 cm                 | 632.52 e      | 660.10 c                      | 648.12 b                      |
|            | 50 cm                 | 573.33 h      | 557.11 i                      | 572.89 c                      |
| Lee 74     | 40 cm                 | 588.25 g      |                            |

Distance between plant

| Genotypes | Distance between plant | Mean distance between plant |
|-----------|------------------------|-----------------------------|
| Iman      | 5 cm                   | 1014.70 a                   |
|           | 10 cm                  | 651.23 i                    | 629.91 gh                     |
| Taqa      | 5 cm                   | 658.90 e                    | 546.58 k                      |
| Lee 74    | 5 cm                   | 556.42 ij                   | 459.06 m                      |

Means followed by the same letter are not significantly different.

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