Response of Safflower to (N.P.K) Fertilizer Combinations and Plants Distribution

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Abstract

To find out the effect of fertilizer levels and of plants distribution on safflower yield, an experiment was conducted in Iraq - Al-Diwaniyah Governorate in the growing season 2020/2021. The experiment included three replicates with 60 experimental units, and it included combinations levels of fertilization\((F,F_1,F_2,F_3)\) which represented the following fertilizer levels\((N_0, P_0, K_0) (N_{140}, P_{80}, K_{60}) (N_{160}, P_{100}, K_{80}) (N_{180}, P_{120}, K_{80})\) in addition to five planting distribution\((D_1,D_2,D_3,D_4,\text{ and } D_5)\) that follows \((30 \times 30, 40 \times 40, 50 \times 50, 60 \times 60 \text{ and } 70 \times 70 \text{ cm})\). The results showed that the fertilization level\((N_{180}, P_{120}, K_{80})\) gave the highest mean of seed weight and head diameter, which amounted to \((23.12 \text{ g } \text{ and } 2.88 \text{ cm})\) respectively. As for the plant distribution\(D_5\), gave the highest of weight of the yield of petals, Head diameter and plant heads number reached to \((2.23 \text{ g, } 2.93 \text{ cm, } 83.14 \text{ head}\) respectively. While the superiority of the treatment\(D_1\) was in In seeds number per head\(44.88 \text{ seed}\). Therefore, plants distribution between plants can be reduced with increased fertilization from NPK in the area.

Keywords: Safflower, Fertilization levels (N.P.K), Plants distribution.

1. Introduction

Safflower plant \(Carthamus tinctorius\) L. is one of the oil crops of the \(Brassicaceae\) family, and its seeds contain a high percentage of healthy oil, which can be used as edible oil. In addition to its importance, it is a winter crop that does not require large amounts of water, it is also a crop resistant to diseases, insects and birds Attack Safflower has other uses in the field of dyes and paint industry because its oil does not require large amounts of water, it is also a crop resistant to diseases, insects and birds. While the superiority of the treatment\(D_1\), gave the highest of weight of the yield of petals, Head diameter and plant heads number reached to \((2.23 \text{ g, } 2.93 \text{ cm, } 83.14 \text{ head})\) respectively. While the superiority of the treatment\(D_1\) was in In seeds number per head\(44.88 \text{ seed}\) respectively. Therefore, plants distribution between plants can be reduced with increased fertilization from NPK in the area.

2. Methods and Materials

A field experiment was conducted in Al-Diwaniyah governorate during the autumn season (2020/2021) in split plot design based on RCBD, with three replications, included four levels of fertilization\((F,F_1,F_2,F_3)\) as \((N_0, P_0, K_0) (N_{140}, P_{80}, K_{60}) (N_{160}, P_{100}, K_{80}) (N_{180}, P_{120}, K_{80})\) respectively, in addition to five planting distances\((D_1,D_2,D_3,D_4,\text{ and } D_5)\) that follows \((30 \times 30, 40 \times 40, 50 \times 50, 60 \times 60 \text{ and } 70 \times 70 \text{ cm})\). The harvesting process was carried out when the plants reached the stage of physiological maturity.
2.1 Properties of Soil

Some laboratory tests were carried out to determine the chemical and physical properties of the soil. (Table 1).

Table 1. The characteristics of the experimental soil and some of its contents soil.

| Soil properties | results | units   |
|-----------------|---------|---------|
| Ec.             | 3.2     | Ds.m⁻¹  |
| OM              | 0.20    | %       |
| N               | 11.41   | mg.kg⁻¹ |
| P               | 9.56    | mg.kg⁻¹ |
| K               | 1.01    | mg.kg⁻¹ |
| Sandy           | 18.5    | %       |
| Silt            | 37.5    | %       |
| Clay            | 44      | %       |
| Soil texture    | Clay    | silt    |
|                 | loam    |         |

2.2 The studied traits: Five plants were taken from the middle lines of each experimental unit

petal yield (g): The petals were collected from five plants.
Diameter of head (cm): - An electronic Vernier device was used to measure the diameter of the head for 10 plants.
Number of head plant: The heads of five plants were collected from the middle lines, and then the average number of plant heads was calculated.
Number of seeds per head: - calculated as means of five plants
Weight of 500 seeds: - 500 seeds were counted and weighed with a sensitive scale.

3. Results and Discussion

3.1 Analysis of variances

The analyses of variance of different quantitative traits are shown in (Table 2). Analysis of variance indicated that fertilization treatment caused significant effect on head diameter (cm), weight of 500 seeds (gm), total seed yield (ton. h⁻¹). Whereas the distance between plants indicated highly significant effects for all the traits accepting weight of 500 seeds (g). However, the interaction between treatment showed significant effect on weight of 500 seeds (gm), total seed yield (ton. h⁻¹).

Table 2. Analysis of variance of some yield and its components

| S.O.V | d.f | petal yield (g) | Diameter of head (cm) | Number of heads per plant (cm) | Number of seeds per head | Wight of 500 seeds (gm) | Total seed yield (ton. h⁻¹) |
|-------|-----|-----------------|-----------------------|-------------------------------|--------------------------|-------------------------|-------------------------------|
| R     | 2   | 0.12258         | 1432                  | 795.2                         | 1.04                     | 0.328                   | 0.3938                        |
| F     | 3   | 0.31599         | 1.8119*               | 1271.5                        | 26.95                    | 3.217*                  | 6.3602*                       |
| Error a| 6  | 0.08477         | 0.1189                | 388.3                         | 120.90                   | 3.034                   | 1.0598                        |
| D     | 4   | 1.16319**       | 0.8777**             | 4693.6**                      | 123.80**                 | 11.807                  | 9.8887**                      |
| F x D | 12  | 0.08838         | 0.1541               | 279.0                         | 21.44                    | 9.482*                  | 1.0169*                       |
| Error b| 32 | 0.06024         | 0.1210                | 199.5                         | 23.39                    | 4.593                   | 0.3863                        |
| Total | 59  |                 |                       |                               |                          |                         |                               |

3.2 Petal yield (g)

The results in Table (3) indicated that the plant distribution between lines and plants effected the weight of the yield of petals, as the yield reached at the distance D₅ (70 x 70) cm, the highest average was 2.23 g, while the lowest average w achieved as when planting with a distance of (30 x 30) cm D₁, which averaged 1.46 g. This result may be due to the increase in the number of heads in D₅, which increased the weight of the petals compared to the agricultural distance D₁, and this was in agreement with [6,7].
Table 3. Shows the effect fertilizer combinations, plants distribution and introduction on petal yield (g).

| Fertilizer N.P.K (kg) | plant distribution (cm) |
|-----------------------|--------------------------|
|                       | D1 | D2 | D3 | D4 | D5 | average |
| F1                    | 1.40 | 1.47 | 1.34 | 1.51 | 2.08 | 1.56 |
| F2                    | 1.30 | 1.63 | 1.34 | 1.90 | 2.37 | 1.71 |
| F3                    | 1.40 | 1.90 | 1.70 | 2.13 | 2.43 | 1.91 |
| F4                    | 1.73 | 1.50 | 1.67 | 1.73 | 2.03 | 1.73 |
| average               | 1.46 | 1.62 | 1.51 | 1.82 | 2.23 |         |

L.s.d 0.05 F = N.S
L.s.d 0.05 D=0.20
L.s.d 0.05 D=N.S × F

3.3 Diameter of head (cm)

The results showed that the average head diameter differed significantly when increasing the levels of NPK fertilizer, whereas the highest average head diameter achieved from the fourth fertilization level F4 reached 2.88 cm, while the F1 treatment gave 2.16 cm Table (4). This difference can be attributed to that increasing the fertilizer combinations caused a significant effect on increasing the vegetative growth, which in turn had increased the size of the head diameter in the stage of flowering growth and the researcher [10] find a similar result. Also, a significant effect of distances was found, as treatment D5 gave the highest mean of 2.93 cm, while the average distance D1 was 2.34 cm. This difference can be attributed to the increase in plant density through reducing the agricultural distance, which led to an increase in competition for plant growth factors, including light, moisture. nutrients [8] found similar results.

Table 4. Shows the effect fertilizer combinations, plants distribution and introduction on Diameter of head (cm).

| Fertilizer N.P.K (kg) | plant distribution (cm) |
|-----------------------|--------------------------|
|                       | D1 | D2 | D3 | D4 | D5 | average |
| F1                    | 1.74 | 2.18 | 2.22 | 2.21 | 2.44 | 2.16 |
| F2                    | 2.16 | 2.37 | 1.97 | 2.78 | 2.96 | 2.45 |
| F3                    | 2.10 | 2.30 | 2.74 | 3.36 | 3.07 | 2.86 |
| F4                    | 2.64 | 2.76 | 2.88 | 2.93 | 3.25 | 2.88 |
| average               | 2.34 | 2.40 | 2.44 | 2.82 | 2.93 |         |

L.s.d 0.05 F =0.31
L.s.d 0.05 D =0.29
L.s.d 0.05 D=N.S × F

3.4 Number of plant heads (cm)

Table (5) indicated that the effect of planting distances on the number of heads per plant was significant and D4 gave the highest number of 83.14 head.plant-1, while the lowest average number of heads was at D1, which gave an average number 37.66 head.plant-1. This result was attributed to the fact that the increase in plant density increased the average number of
heads per unit area, in addition to that treatment D₅ gave the highest number of branches which increased the number of heads, and this was agreed with [9].

Table 5. Shows the effect fertilizer combinations, plants distribution and introduction of heads per plant (head Plant⁻¹).

| Fertilizer N.P.K (kg) | D1  | D2  | D3  | D4  | D5  | average |
|----------------------|-----|-----|-----|-----|-----|---------|
| F1                   | 38.10 | 39.20 | 69.67 | 73.10 | 64.43 | 56.90   |
| F2                   | 29.23 | 45.90 | 50.30 | 72.77 | 78.43 | 55.33   |
| F3                   | 31.57 | 49.87 | 65.10 | 63.47 | 79.90 | 57.98   |
| F4                   | 51.73 | 42.77 | 74.00 | 96.80 | 109.80 | 75.02   |
| average              | 37.66 | 44.43 | 64.77 | 76.53 | 83.14 |         |

L.s.d 0.05 F = N.S
L.s.d 0.05 D = 11.75

3.5 Number of seeds per head

The number of seeds in the head reflects the extent of the success of the pollination and fertilization processes in the flower. The results showed that changing the agricultural distances between plants and lines had a significant effect on the character of the number of seeds in the head, where the level of fertilization D₄ gave the highest of 44.88 seeds per head, which did not differ significantly with D₃ and D₅. In contrast, the lowest average was at the planting distance D₁, which amounted to 36.68 seed head⁻¹. This is due to the fact that increasing plants distribution led to a decrease in the number of days to reach 75% flowering, and this may explain the increase in the period of proliferative growth of the treatment D₅ at the expense of vegetative growth, which reflected period of pollination and fertilization, thus increasing the number of fertile flowers, which led to an increase the number of seeds per head. The researchers Was agreed with [3,10].

Table 6. Shows the effect fertilizer combinations, plants distribution and introduction of seeds per head.( seed head⁻¹).

| Fertilizer N.P.K (kg) | D1  | D2  | D3  | D4  | D5  | average |
|----------------------|-----|-----|-----|-----|-----|---------|
| F1                   | 32.03 | 40.93 | 47.13 | 41.53 | 41.60 | 40.65   |
| F2                   | 35.40 | 42.70 | 42.37 | 44.87 | 43.57 | 41.78   |
| F3                   | 40.57 | 43.83 | 43.23 | 46.50 | 39.33 | 42.69   |
| F4                   | 38.70 | 45.90 | 41.90 | 46.60 | 45.90 | 43.80   |
| average              | 36.68 | 43.34 | 43.66 | 44.88 | 42.60 |         |

L.s.d 0.05 F = N.S
L.s.d 0.05 D = 4.02
L.s.d 0.05 D = N.S × F

3.6 Wight of 500 seeds (gm)

The weight of the seed is an important characteristic of the yield, which expresses the efficiency of the photosynthesis system and the transfer of manufactured materials from the source. The results in Table (7) showed that the effect of NPK fertilization levels had a significant effect on increasing the seed weight, and F₄ gave the highest average than the F₄ fertilizer mixture, which gave an average weight of 23.12 g, which did not differ significantly from the levels of F₃ fertilization compared with
the F1 treatment, which reached the seed weight it has 19.49 g. The reason for this increase may be attributed to the fact that the provision of important and necessary nutrients in ready-made and abundant quantities to the rhizosphere increased the absorption of these elements by the roots and thus increased the total biomass of the plant, which led to an increase in the production of dry matter and its transmission to the seeds [2]. Also, the interaction of fertilization levels and agricultural distance had a significant effect on increasing the weight of the seed, as the results indicated that the interaction of (F4×D5) gave an average weight of 25.20 g, while the lowest average was 18.10 g when the interaction (F1×D1). This results was agreed with [9].

Table 7. Shows the effect fertilizer combinations, plants distribution and introduction on Wight of 500 seeds (gm).

| Fertilizer N.P.K (kg) | plant distribution (cm) |
|----------------------|-------------------------|
|                      | D1  | D2  | D3  | D4  | D5  | average |
| F1                   | 18.10 | 19.43 | 20.17 | 18.07 | 21.70 | 19.49 |
| F2                   | 21.40 | 21.93 | 22.40 | 21.90 | 21.43 | 21.81 |
| F3                   | 23.87 | 22.63 | 23.27 | 24.37 | 20.00 | 22.83 |
| F4                   | 22.27 | 24.07 | 21.50 | 22.57 | 25.20 | 23.12 |
| average              | 21.41 | 22.02 | 21.83 | 21.72 | 22.08 |         |

| L.s.d 0.05 | L.s.d 0.05 | L.s.d 0.05 |
|------------|------------|------------|
| F = 1.29   | D=N.S      | D=2.81×F   |

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