Effect of partition foliar applications of organic, biochemical, and chemical fertilizers on some growth characteristics and yield of sorghum

Adawia S Mustafa and Sadam H Cheyed

University of Baghdad, College of Agriculture, Department of Field Crops
Email: saddam.hakeem@coagri.uobaghdad.edu.iq

Abstract. To determine the effect of partition different types of fertilizer (Acadian, Humus and Foliater) on some vegetative traits and seed yield of sorghum var. Inkath. Field experiment was carried out during spring and autumn 2017 in the experimental fields of crop science / college of agricultural engineering sciences, factorial experiment was applied according to RCBD design with three replications. The three types of fertilizers was the first factor and control treatment. The second factor was the partition of the spray into three ways (whole concentration for one spray, half concentration for two sprays and one third concentration for three sprays) at seed initiation stage, beside control treatment (spray with distil water only). The results of the statistical analysis showed that there was a significant effect of the three fertilizers in the studied traits. The plants treated with Acadian gave the highest average leaf area, chlorophyll content, seed per head, grain weight, and plant yield when compared other treatments. The results also showed partition spray to three sprays was superior to other fertilizer treatments in most studied traits. The results indicates that spray with Acadian into three sprays was best treatment in this study.

Keywords: Foliar fertilization, Acadian, Humic acid, growth characters

1. Introduction

Sorghum is one of the most important crops that can be cultivated in a wide range of environmental conditions and tolerate high temperatures and abiotic stresses. This crop gives abundant yield in tropical and semi-arid regions. As well as its importance as fodder crop, which contributes significantly meet the need for green fodder in summer in Iraq (3). The research has confirmed that 85% of the plant needs can be supplied foliar applications. The method of spraying fertilizer is effective in increasing the quantity, improving the quality, vegetative growth of the plant, and reduce the environmental pollution caused by the addition of fertilizer compounds to the soil and the possibility of addressing the lack of major elements in plants instantly by foliar applications of these nutrients on the vegetative parts. One of the most important things in foliar applications is the timing and dosage of spraying to achieve the maximum benefit of foliar fertilizer, which results in increasing the weight or number of seeds by increasing the fertility rate. Organic fertilizers such as Humic acid improve the plant's properties because it contains macro and micro nutrients, cytokine tines, auxins, gebrilines and other plant hormones, as well as its positive role in nutrient uptake and increases the nutrient availability and transport, which accelerates the growth process and improves plant production due to increased photosynthesis in leaves (17and 18). Therefore, this study was designed to
determine the effect of partition foliar applications of three different types of organic, biological and chemical fertilizers, which are sprayed at the stage of the booting, completion of flowering and milking stage in some growth characters and seed yield of sorghum.

2. Materials and Methods

Two field experiments was carried out during the spring and autumn seasons 2017 in the Field of the Department of Field Crops / Faculty of Agriculture / University of Baghdad. A factorial experiment was applied according to the design of the randomized complete block (RCBD). The first factor included foliar fertilizer (Bio fertilizer Acadian) With a concentration of 1500 mg.l⁻¹ and Humus 2000 mg.l⁻¹ and NPK (Foliatral) at a concentration of 600 mg.l⁻¹], in addition to distilled water as control treatments, and the second factor was partition the spray into three applications on the mother plants (booting stage, completion of the flowering, and milky stage), the process of partition the spray on mother plants as follows:

1. Control Treatment : Spraying distilled water three times, first at the booting stage, second at 75% flowering, and third a week after second spray.
2. Full concentration: Spray whole concentration one time at booting stage, and with distilled water in the next two stages.
3. Half of the concentration: Divide the whole concentration into two halves spraying the first half in the booting stage, second half in the stage of 75% flowering, and third sprayed with distilled water only.
4. One-third of the concentration: The whole concentration is divided into three doses, one third at booting stages, one third at 75% flowering, and one third at milky stage).

The soil was well plowed and smoothed and divided according to the experimental design used. The treatments were randomly assigned to the experimental units in each block. The experimental unit was 3x3.5m (6 lines, 3m long). The distance between lines 50 cm and 10 cm between plats. The plant density according to this distribution was 200,000 plants.ha⁻¹, and a distance of 1 m was left between plots as an isolation distance. Fertilizers applications was 436 kg ha⁻¹ of DAP (46% N, P 18%) at planting (Ministry of Agriculture Extension Bulletin, 2006). Nitrogen fertilizer was added as Urea (46% N) for each treatment one month after date of planting (Jeyad et al., 2014) and the other at the beginning of the flowering stage. The plants were sprayed with the three foliar fertilizers using a hand spray and until the full wetting was achieved. The dishwashing liquid was used with a concentration of 1 ml.liter⁻¹ of the spray solution as adhesive and spreading material. Ten plants were taken randomly from the middle lines and measured the following characteristics:

1) Leaf area (cm²): The leaf area was calculated as an average of ten plants by adopting the following formula:

   \[
   \text{Leaf Area (cm}^2\text{)} = \text{length of forth leave (cm)} \times \text{maximum width (cm)} \times 6.18
   \]

2) Relative content of chlorophyll in leaves (SPAD)

   The plant content of chlorophyll was estimated from the leaves by means of a Japanese SPAD502 device, which was established as an indicator of the greenness of the leaves. Three readings were taken for the fourth leaf from the bottom, middle and upper third of leave, and the average chlorophyll was extracted per plant. This method was repeated on the 10 plants in the intermediate lines, the ten reading were averaged.

3) Seed weight (mg): 1000 seeds were taken randomly from the collected plants and took the average weight head in each experimental unit and weighed a thousand grain with a sensitive balance and extracted the average weight of the seed.

4) Number of grains per head (Plant): Ten heads were selected as representative of the experimental unit. The number of grains was calculated as an average grains per head (3).

5) Plant yield (gm): Average plant yield was calculated as an average of ten plants for each experimental unit.
6) Biological yield (gm): was calculated from weight of vegetative parts and seed heads of the average of ten plants

3. Results and Discussion

3.1. Leaf Area (cm$^2$)

The plant parts that produce assimilate are leaves, which is a source, while the parts received for the compounds, such as the seeds and fruits, are the sink. The photosynthesis control both source and sink, beside the mechanism of transmission of the nutrients, in addition to the indexing factor (Harvest index). The increase in leaf area associated with the increase in photosynthetic rate and systematic capacity constant SCC (27). The increase in the seed yield is associated with the increase of the SCC. The leaves contribute the largest proportion of the materials manufactured in the plant, which is an important store for these substances and transported to seeds at the end of the reproductive stage.

The results of the analysis of variance indicate that there are significant differences in the effect of the type of fertilizer and the partition of the spray and the different combinations between the study factors in the spring and autumn seasons for the leaf area. The results indicates that both the Acadian and Humic fertilizers were significantly different from foliatral fertilizer (Table 1) and the control treatment by giving the highest average leaf area (5364 and 5260 cm$^2$) and (3529 and 3559 cm$^2$) for both fertilizers at spring and autumn seasons respectively (Table 2), and that due to the fact that Acadian extract contains the macro and micro nutrients growth regulators and vitamins to improve vegetative growth (18), and foliar application with Humic leads to a significant increase in the average growth of the plant in general and the growth and activity of roots and increase the efficiency and speed of the average carbon photosynthesis and increase in the amount of elements absorbed by the plant from the soil so there was an increase in the average leaf area of the plant (29). These results are consistent with the results of (1) when spraying the plant Ocimum basilicum L. with Humus organic fertilizer has been achieved a significant increase in vegetative growth, especially leaf area.

Partition foliar fertilizers to three sprays was significantly superior to the other spraying treatments by giving the highest average leaf area of the plant for both seasons (5382 and 3567 cm$^2$) respectively (Table 1), and that may be due to the fact that of the limited amount absorbed by the plant in a single spray, whereas the three sprays doubled the opportunity to absorb the fertilizer to three times compared to one spray. The treatment that sprayed with Humic and Acadian three times and Acadian two times exceed other treatments by giving the highest leaf area of 5652, 5468, and 5594 cm$^2$, respectively, and the lowest leaf area of the spray treatment with distilled water with 4153 cm$^2$ in spring season (Table 2).

Table 1: Effect of foliar fertilizers and partition sprays on leaf area (cm$^2$) for spring and autumn seasons for sorghum.

| Partition spray | Foliar treatment |
|-----------------|-----------------|
| Average | Dose | Dose | Full dose | Leaf area (cm$^2$) |
| 5364 | 5468 | 5594 | 5028 | Acadian |
| 5260 | 5652 | 5232 | 4896 | Humic |
| 4979 | 5025 | 5062 | 4851 | Foliatral |
| 205.9 | 356.7 | 5382 | 5296 | LSD$_{0.05}$ |
| | | 4925 | Average partition spray |
| 205.9 | 340.4 | LSD$_{0.05}$ |
| | | 4153 | Average control treatment |
| | | 340.4 | LSD$_{0.05}$ |

**Spring Season**

| Autumn Season |
|----------------|
| Partition spray | Foliar treatment |
| Average | Dose | Dose | Full dose | Leaf area (cm$^2$) |
| 3532 | 3647 | 3505 | 3444 | Acadian |
3.2. The relative content of chlorophyll in leaves (SPAD)

Chlorophyll plays a key role in photosynthesis and is the determining factor for the efficiency of plant photosynthesis (28). The survival of leaves in the plant most likely cause of continued flow of nutrients from source to sink. The results indicates significant differences in the effect of the type of fertilizer and the partition of the spray and the interaction between them (Table 2), for both spring and autumn seasons. The results indicate that the treatment with Acadian fertilizer was superior in SPAD reading of 58.13 SPAD in spring season. In autumn season, the Humic fertilizer significantly exceeded the rest of the fertilizer by giving highest average chlorophyll content in leaves (61.408 SPAD). The Foliatral fertilizer treatment gave the lowest mean for both seasons (55.93 and 58.39 SPAD) respectively, without significantly different from Humic treatment in the spring season. This is due to the fact that both Acadian and Humic fertilizer have elements and compounds that have a positive effect on increasing the leaf content of chlorophyll. This result is in consistence with the findings of (20), that the Acadian and Humic fertilizer increased the content of the chlorophyll in leaves. The reason for this increase is due to the fact that both fertilizers contain growth regulators that have caused an increase in the growth and content of chlorophyll in leaves (25).

The partition spray treatments were significantly higher than the other spraying treatments by giving the highest average chlorophyll content (58.13 and 61.63 SPAD) of the leaf. This is due to the fact that the plant has limited absorptive capacity, the multi-spray system helps the plant to benefit more from the foliar fertilization because it will absorb three times what it absorbs when feeding leaves in one spray because what determines the absorbed amounts of fertilizer is the ability of the leaf to absorb first and period the presence of fertilizer on leaves until the drought second, and not the amount of fertilizer added to the leaves as a single spray. Spraying plants with Acadian fertilizer three times significantly exceeded the other treatments and the control treatment by giving the highest average content of chlorophyll in leaves (61.55 and 63.40 SPAD), followed by the treatment of Humic fertilizer for three sprays, With no significant differences between them for two seasons (Table 3).

### Table 2: Effect of foliar fertilizers and partition sprays on chlorophyll content (SPAD) for spring and autumn seasons for sorghum.

|       | Full dose | Dose | Dose   | Foliar treatment |
|-------|-----------|------|--------|------------------|
|       |           | ½    | 1 x    |                  |
|       |           | x 2  | 1 x 1  |                  |
| Spring Season |          |      |        |                  |
| Average | 58.13 | 61.55 | 57.25 | 55.6  | Acadian         |
|         | 56.67 | 58.00 | 55.70 | 56.32 | Humic           |
|         | 55.93 | 56.35 | 55.55 | 55.90 | Foliatral       |
|         | 1.715 | 2.971 | 56.17 | 55.94 | Average partition spray |
|         |        | 1.715 | 56.5  | 2.829 | Average control treatment |
| Autumn Season |       |      |        |                  |
| Partition spray |    |      |        |                  |
| Average | (1/3 x3) | ½    | 1 x    |                  |
|         |           | x 2  | 1 x 1  |                  |
3.3. Number of grains per head

The number of seeds or grains per plant or the number of fruits is governed by a large number of gene pairs and therefore the impact of the environment is very large, including the growth factors that are represented by fertilization in different forms. There is a maximum limit for the number of seeds obtained by the plant (potential seed number (PSN)) so that all flowers are fertilized to give ripe grains (14). This means that the number of seeds increases or decreases at the critical stages of seed formation according to the availability of growth factors. The results of Table (3), indicates that there are significant differences between the effect of fertilizer type and partition of the spray and their interactions in the number of grains per head of the plant of sorghum for both seasons.

The results revealed that Acadian fertilizer significantly exceeds the rest of the fertilizer by giving the highest average number of grains per head for two seasons (3527 and 3916 grain. head\(^{-1}\)) respectively. What explains the superiority of the Acadian and Humic fertilizers is the containment of balanced combinations of nutrients that have been shown to lead to an increase in the average growth and components of the yield and the quantity and quality of grain in the plant (22). If we follow the results of Tables 1 and 2, we find that the fertilizer Acadian was superior in leaf area And the content chlorophyll in leaves, which certainly means increasing the area of light trap and increase the efficiency of the average photosynthesis, which increases the production of carbohydrate manufactured in the leaves and transfer to the reproductive parts and caused by increasing fertility and the production of more seeds.

The partition spray to three y sprays was significantly superior to the other spray treatments by giving the highest average number of grains per head (3411 grain. head\(^{-1}\)) for the spring season. In the autumn season, the partition to two sprays was significantly higher than the other spray treatments by giving the highest number of grains 3733.6 grain. head\(^{-1}\) (Table 3). The superiority of the partition fertilizer treatment can be explained that the two sprays in this trait, is plant has benefited from partition until the second spray, and the third spray had no significant effect because the number of grains has been determined and completed in the early stages of grain formation.

The treatment of Humic spray at three sprays significantly exceeded the other treatments by giving the highest average number of grains per head (3858 grain. head\(^{-1}\)) for the spring season. In the autumn season, the treatment of Acadian spray at three sprays significantly exceeded the other treatments by giving the highest average number of grains per head (4213 grain. head\(^{-1}\)). The other treatments varied, and the lowest values were 2427 and 2357 grain. head\(^{-1}\) was for control treatment at two seasons respectively (Table 3).

Table 3: Effect of foliar fertilizers and partition sprays on number of grain per head for spring and autumn seasons for sorghum.

| Foliar treatment | Spring Season | Partition spray | Average | Full dose | LSD\(_{0.05}\) |
|------------------|---------------|----------------|---------|-----------|-------------|
|                  | Average      | Dose           |         |           |             |
| Acadian          | 3527          | 3764           | 3580    | 3238      |             |
| Humic            | 3916          | 3858           | 3284    | 3097      |             |
| Foliatral        | 3858          | 3916           | 3527    | 3238      |             |
| LSD\(_{0.05}\)   | 2427          | 2357           | 3527    | 3238      |             |
3.4. Grain weight (mg)

The weight of the grain is the result of a genetically programmed action, in combination with the growth factors. Thus, the weight of the grain is originally linked to the nature of the cultivar with a certain degree of growth input; it expresses the degree of grain filling rate and duration, and its apparent and qualitative density. The results of Table (4) indicate that there are significant differences in the effect of the type of fertilizer and the partition of the spray and the treatment combinations between the fertilizers and partition spray for the two seasons.

Acadian fertilizer was significantly superior in grain weight of both seasons (37.59 and 37.92 mg) respectively with no significantly different from the Humic fertilizer for both seasons (Table 4). Acadian fertilizer was superior because it contains of many nutrients and growth regulators such as iron, copper, zinc, cobalt, molybdeum, manganese and nickel. It also contains auxins, gebrlines, cytokinenes, many vitamins and amino acids (11). Acadian fertilizer increases the plant's ability to increased absorption of mineral nutrients from the soil (26), all these factors eventually led to improved grain weight.

The partition spray treatment was significantly superior to the other spray treatments by giving the highest average grain weight (3.782 mg) for the autumn season (Table 4). Although the weight of the grain or grain is one of the most stable character from one season to another and from treatment to another because it is governed by less number of gene pairs and the additive gene action is the dominant form, but it is influenced by environmental factors, including fertilization in various forms.

The treatment of Acadian fertilizer was significantly higher in three sprays with the highest mean of grain weight (38.15 mg), but did not differ significantly from that of organic fertilizer spraying for three sprays at spring season. The spray treatment of Humic fertilizer was significantly higher in three sprays than other treatments with the highest average grain weight (3.797 g). However, it did not differ significantly from bio fertilizer (Acadian) in three sprays. The other treatments varied, and the lowest values were for mineral fertilizer (NPK) for two sprays (Table 4). The combination between the fertilizer type and partition spray had a clear role in improving the weight of the grain. This is evident by increasing the weight of the grain, which was produced from the mother plants that was previously sprayed with Acadian for three sprays, confirming the role of Acadian and partition the spray in improving the plant yield.
It can be said that the superiority of the treatment of spraying Acadian in improving grain weight was the result of the effect of the treatment by increasing the leaf area (Table 1) and the number of grains per head (Table 3).

Table 4: Effect of foliar fertilizers and partition sprays on seed weight (mg) for spring and autumn seasons for sorghum.

|                  | Spring Season |                  | Autumn Season |                  |
|------------------|---------------|------------------|---------------|------------------|
|                  | Average       | Partition spray  | Foliar treatment | Average partition spray |
|                  | Dose          | Dose            | Full dose     | Dose            | Full dose     |
| Acadian          | 37.59         | 38.15           | 37.2          | 37.42           | 0.897        |
| Humic            | 36.98         | 37.57           | 37.17         | 36.2            | 0.897        |
| Foliatral        | 32.25         | 31.42           | 30.75         | 34.57           | 1.571        |
| LSD0.05          | 35.72         | 35.04           | 36.07         | 36.07           | 1.554        |
| Average partition spray | 1.554        | 0.45            | 0.45          | 2.53            |
| LSD0.05          | 29.35         | 0.79            | 0.79          | 35.83           |
| Average control treatment | 1.571        | 0.81            | 0.81          | 35.83           |
| LSD0.05          | 0.897         | 0.45            | 0.45          | 35.83           |

3.5. Plant Yield (gm)

Grain yield is the most important field character of the variety. It reflects the final outcome of the plant's bioactivities, mainly related to the genetic factor and its interaction with the available growth factors (14). The results revealed significant differences in the effect of fertilizer, splitting spray, and their interaction in the average plant yield of sorghum (Table 5). The results indicate that Acadian fertilizer significantly exceeds other fertilizers and control treatment by giving the highest mean for the two seasons (148.660 and 131.4 gm) respectively, without significantly different from spraying with Humic fertilizer in spring season. The superiority of the spray with Acadian fertilizer as a foliar fertilizer may be due to its containment of the macro and micro-nutrients, growth regulators and vitamins involved in plant nutrition and improvement of growth and plant yield (23 and 18).

Returning to Tables 3 and 4, Acadian fertilizer has increased the number of grains per head and the average seed weight, which positively affected the plant yield. Foliar applications with Humic fertilizer improved the characteristics and average growth and increase the grain yield as well as the increase of the total dry yield compared to the control treatment, which also reflected the increase of the plant yield. The results were agreed with what was found by (8 and 12).

The partitioning to three sprays treatment was significantly superior to the other spray treatments by giving the highest average plant yield (123.6 gm) for the spring season (Table 5). The partition into two sprays treatment was significantly superior to the other spray treatments by giving the highest average plant yield (140.1 gm) for the autumn season (Table 5). The partition of fertilizer and its addition in multi applications may be the reason for the superiority of treatment spray in three sprays, because reduction of losses and of the prolong the availability of nutrients.

The treatment of Acadian fertilizer was significantly higher in three sprays than the rest of the combinations, giving highest mean for both seasons (143.7 and 165.260 gm) respectively. While, the
mineral fertilizer NPK with three sprays gave the lowest plant yield of 82.0 and 82.21 gm for two seasons respectively.

Table 5: Effect of foliar fertilizers and partition sprays on plant seed yield (gm) for spring and autumn seasons for sorghum.

| Foliar treatment | Partition spray | Spring Season |                |                |
|------------------|----------------|---------------|----------------|----------------|
|                  | Average | Dose | Dose | Full dose | Acadian | Humic | Foliatral | LSD<sub>0.05</sub> |
| Acadian          | 131.4   | 143.7 | 133.3 | 117.3 | Acadian | Humic | Foliatral | LSD<sub>0.05</sub> |
| Humic            | 126.5   | 145   | 122.3 | 112.1 |         |       |           |                 |
| Foliatral        | 95.7    | 157.6 | 83.4  | 91.6  |         |       |           |                 |
| LSD<sub>0.05</sub> | 13.77  |       |       |       |         |       |           |                 |
| Average partition spray | 123.6 | 113   | 107   |       | Average partition spray | 7.95 | 71.3 | 13.29 |
| LSD<sub>0.05</sub> |         |       |       |       | LSD<sub>0.05</sub> |       |       |       |
| Average control treatment |       |       |       |       | Average control treatment |       |       |       | 13.29 |

| Autumn Season | Partition spray |                |                |
|---------------|----------------|---------------|----------------|
| Average       | Dose | Dose | Full dose | Foliar treatment | Acadian | Humic | Foliatral | LSD<sub>0.05</sub> |
| Acadian       | 148.66 | 155.26 | 142.58 | 138.16 | Acadian | Humic | Foliatral | LSD<sub>0.05</sub> |
| Humic         | 135.28 | 143.55 | 146.24 | 115.75 |         |       |           |                 |
| Foliatral     | 110.89 | 82.21  | 131.2  | 119.25 |         |       |           |                 |
| LSD<sub>0.05</sub> | 3.378 |       |       |       | LSD<sub>0.05</sub> |       |       |       |
| Average partition spray | 130.44 | 140.01 | 124.38 |       | Average partition spray | 1.95 | |       |
| LSD<sub>0.05</sub> |         |       |       |       | LSD<sub>0.05</sub> |       |       |       |
| Average control treatment |       |       |       |       | Average control treatment |       |       |       | 3.265 |

3.6. Biological yield

The results indicate significant differences in the effect of the fertilizer and the interaction between the fertilizers and partitioning of fertilizers on the total plant dry weight of sorghum (Table 6) in spring season, while in autumn season the significant differences were for type of fertilizers and partitioning of fertilizers. The results revealed that Acadian fertilizer is superior to other fertilizers and the control treatment for spring and autumn seasons by giving the highest average dry weight (154.51 and 247.38 gm) respectively (Table 6). Bio fertilizer increases the chlorophyll content in the leaves, which is positively reflected in prolonging the survival time of the leaves and it is able to intercept the largest amount of light in the early stages which lead to increase average photosynthetic rate and dry matter accumulation in the plant parts, thus increasing the dry weight of the plant (4). In addition, the seaweed extract as a foliar fertilizer containing the major macro and micro nutrients and growth regulators and vitamins which contribute to the plant nutrition and improve the qualities of growth and yield, and this is confirmed by (23 and 18). Acadian can also be used to alter the relationship between the source and sink. The spraying of this fertilizer at important stages such as booting and 75% flowering increases its percentage in flowering, thus increasing the nutrient transfer rate from the source (leaves) to the sink (grain).

The partitioning of spray of the three fertilizers did not have a significant effect on the dry weight at the spring season. Whereas, in autumn season the partitioning to three sprays treatment was significantly higher than the other spraying treatments with the highest mean 235.08 gm (Table 6). The treatment of Acadian fertilizer was significantly higher than other treatments by giving it the highest average dry weight (165.95 gm) for the spring season, while the interaction between the fertilizer type and spray partitioning did not have a significant effect on the dry weight, although the Acadian fertilizer with three sprays exceed other treatments (Table 6). The increase in dry weight of plants treated with seaweed extract Acadian is due to the presence of nutrients, vitamins, growth regulators and other compounds that help to improve plant growth and increase the content and
efficiency of chlorophyll (Table 2), which led to an increase in the amount of dry matter processed to the plant. The increase in dry matter may also be due to positive and high correlation between plant dry weight and leaf area.

### Table 6: Effect of foliar fertilizers and partition sprays on biological yield (gm) for spring and autumn seasons for sorghum.

|                | Spring Season | Autumn Season |
|----------------|---------------|---------------|
|                | Average       | Partition spray | Foliar treatment | Average partition spray | Foliar treatment |
|                | Dose          | Dose           | Full dose | Acadian | Humic | Foliatral | LSD<sub>0.05</sub> | N.S               | Average partition spray |
| Full dose      | 154.51        | 165.95         | 139.23    | 158.34   |       |          |                  | N.S               | 20.96                   |
| 12.1 Dose      | 136.09        | 140.04         | 137.81    | 130.42   |       |          |                  | N.S               | 12.10                  |
| ½ Dose         | 127.80        | 122.67         | 133.19    | 127.65   |       |          |                  | N.S               | 129.95                  |
| (1/3 Dose)     | 142.88        | 136.74         | 138.80    |          |       |          |                  | N.S               | 5.20                    |
| Average        | 247.38        | 249.93         | 247.51    | 244.69   |       |          |                  | N.S               | 227.68                  |
| Partition spray| 235.53        | 238.62         | 236.93    | 231.02   |       |          |                  | N.S               | 20.50                   |
| Full dose      | 210.10        | 216.7          | 206.27    | 207.34   |       |          |                  | N.S               | 216.7                   |
| 5.20           | 235.08        | 230.24         | 227.68    |          |       |          |                  | N.S               | 8.60                    |
| LSD<sub>0.05</sub> | 5.20          | 216.7          |          |          |       |          |                  | 8.60               | 5.20                    |
| Average control treatment | 216.7 |

4. Conclusion

The results of this study indicate that the efficiency of partitioning dose of foliar applications on mother plant for more than one spray of Acadian and Humic fertilizer compared to the mineral fertilizer and control treatment. Acadian fertilizer significantly improved the growth and yield traits of sorghum, where foliar spray resulted in highest leaf area, chlorophyll content, number of grains per plant, highest grain weight and the plant yield, and the biological yield, with no significantly different from the Humic fertilizer in some traits. The results of this study showed the good effect of partitioning the dose of foliar applications to three sprays gave the best results. Therefore, we recommend the spraying of the sorghum plants at booting and beginning of flowering, and milky stage with Acadian (1500 mg.liter<sup>-1</sup>) or Humic (2000 mg.liter<sup>-1</sup>) with partitioning theses doses into three sprays at the above growth stages to improve growth and yield of sorghum.

5. References

[1] Al-Amin, Mazen Mousa Abdel-Rahman. 2010. Effect of date of planting and spraying of Humus on vegetative yield and quantity of volatile oil in sweet basilicum plant <i>cimum basilicum</i> L. Master Thesis, Faculty of Agriculture, University of Kufa, Iraq.

[2] Cheyed, S.S., M.H.Hashem, and S. Qasim. 2014. Optimum first application of urea for some sorghum cultivars. The Iraqi Journal of Agricultural Sciences – 45(2): 151-156.

[3] Khrbeet, H.K., H.A.Salih, and K. Shallal. 2014. Foliar application of boron , grain yield, and yield components of sorghum. The Iraqi Journal of Agricultural Sciences – 45(5): 470-478.

[4] Al-Rawi, A.S. M. 2012. Selection by honey bee for seed weight in sunflower. Master Thesis, College of Agriculture, University of Baghdad.

[5] Elsahookie, M.M. and S. H. Cheyed.2014. Estimating sorghum leaf area by measuring one leaf length . The Iraqi Journal of Agricultural Sciences – 45(1): 1-5.
[6] Al-Amiree, A. A. 2005. Effect of source and levels of potassium and partitioning of applications on the growth and yield of maize. Master Thesis, College of Agriculture, Soil and water science department. University of Baghdad.

[7] Al-Falahi, M.A. and W. M. Al-Rawi. 2003. Criteria for seed yield of the sunflower under the sprinkler system. The Iraqi Journal of Agricultural Sciences – 34(1): 79-82.

[8] Al-Karawi, W.A., and W.A. Al-Rawi. 2016. Effect of foliar applications of organic extract and humic acid application on strawberry production. The Iraqi Journal of Agricultural Sciences – 47(3): 749-756.

[9] Iraqi Ministry of Agriculture. 2006. Guidance in the cultivation and production of sorghum. General Authority for Extension and Agricultural Cooperation - Abu Ghraib. Sorghum Research Project. Guideline No. 19.

[10] Abdel-Mawgoud, A.M.R., N.H.M. EL-Greatly., Y.I. Helmy, and S.M. Singer. 2007. Responses of Tomato Plants to Different Rates of Humic-based Fertilizer and NPK Fertilization. Journal of Applied Sciences Research 3:169-174.

[11] Crouch, I.J. and J. v. Staden. 1992. Effect of seaweed concentrates on the establishment and yield of greenhouse tomato plants. Journal of Applied Phycolgy, 4: 291-296.

[12] Delfine, S., R.Tognetti, E. Desiderio, and A. Alvino. 2005. Effect of foliar application of N and humic acids on growth and yield of durum wheat. Agronomy for Sustainable Development, Springer Verlag/EDP Sciences/INRA 25: 183-191.

[13] Elsahookie, M. M. 2007. Dimensions of SCC theory in maize hybrid-inbred comparison. The Iraqi J. Agric. Sci. 38(1): 128-137.

[14] Elsahookie, M.M. 2007. Seed Growth Relationships. Coll. of Agric., Univ. of Baghdad, Ministry of Higher Edu. & Sci. Res., pp.150.

[15] Elsahookie, M.M.1994. Sunflower Production and Breeding. Ibaa Agric.

[16] Elsahookie, M.M.2004. Approaches of selection and breeding for higher yield crops. The Iraqi J.Agric.SCI.35(1):71-78.

[17] Fartusi, D. J. 2003. The effect of aqueous extracts of some organic wastes on the growth of wheat, Triticum aestivum. M.S. Thesis Department of Soil and Water Science, College of Agriculture, University of Baghdad, Baghdad, Iraq. [Google Scholar].

[18] Kamaladhasan, K. and S.K. Subramanian. 2009. Influence of seaweed liquid fertilizer on legume crop, red gram. J. Basic. Appl. Biol. 3(1&2):21-24.

[19] Karthikeyan, K.O. and M. Shanmugam. 2015. Yield and oil content of peanut (var. TMV-7) and sunflower (var. Co-2) applied with bio-stimulant AQUASAP manufactured from seaweed. African Journal of Agri. Research., 10:25(25), pp. 2537-2543.

[20] Kumari, P.M. a K. Sekar. 2008. Effect of plant growth regulators on chlorophyll and carotenoid content of salinity stressed Okra seedlings. The Asian Journal of Horticulture. 3(1): 54-55.

[21] Neri, D., E.M. Lodolini, M. Luciano., P. Sabatini, and G. Savini. 2002. The Persistence of Humic acid Droplets on Leaf Surface. acta ISHS Acta Horticulturae: International Symposium on Foliar Nutrition of Perennial Fruit Plants. 594:303-314.

[22] Pramanick, B., K. Brahmacari and A. Ghosh. 2013. Effect of seaweed saps on growth and yield improvement of green gram. African Journal of Agricultural Research, 8(13): 1180-1186.

[23] Prasad, K., A.K. Das., M.D. Oza., H. Brahmbhatt., A.K. Siddhanta., R. Meena, and K. Eswaran. 2010. Detection and quantification of some plant growth regulators in a seaweed-based foliar spray employing a mass spectrometric technique sans chromatographic separation. J. Agric. Food Chem. 58:4594-4601.

[24] Ruiz, R. A.and G. A. Maddonni. 2006. Sunflower seed weight and oil concentration under different post flowering source-sink ratios. Crop. Sci. 46:671-680.

[25] Solaimalai., C.Sivakumar., S.Anbumani., T.Suresh., and K. Arulmurugan. 2001. Role of plant growth regulators on rice production- A review. Agriculture Review 22: 33-40.
[26] Sridhar, S. and R. Rengasamy. 2002. Effect of Seaweed liquid fertilizer obtained from Ulva lactuca on the biomass, pigments and protein content of Spirulina platensis. Seaweed Research Utilisation, 24: 145-149.

[27] Subedi, K. D. And B.L. Ma. 2005. Nitrogen uptake and partitioning in stay green and leafy maize hybrids. Crop Sci. 45:746-747.

[28] Williams, E.L., M.J. Hovden., and D.C. Close,. 2003. Strategies of light energy utilization, dissipation and attenuation in six co-occurring alpine

[29] Yildirim, E. 2007. Foliar and soil fertilization of humic acid affect productivity and quality of tomato. Acta Agriculturae Scandinavica Section B-Soil and Plant Science, 57: 182-186.