Response of sorghum varieties to the ratoon cultivation
1- Growth characteristics

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Abstract: Previous studies that sorghum ratoon differs in its performance when compared with the plants resulted from direct seeding and differed varieties, therefore, a field trial was conducted in spring and fall seasons of 2017 at the field of Field Crop- College of Agriculture- University of AL-Anbar (a Hernative site- Abu-Graib) to investigate the response of five sorghum varieties (Inqath, Lilo, Ishtar, Boohooth 70 and Caffier) to the ratoon cultivation. Results indicated that cultivation pattern affected most studied characters significantly. Plants of ratoon gave the highest values of number of days to the 75% flowering, number of tillers, green forage yield and less concentration of HCN (66.15 day, 21.40 tiller m⁻², 8.75 t ha⁻¹ and 54.64%), respectively compared with the direct seeding method. However, plants of direct seeding gave the highest averages of plant higher and leaf area (191.36 cm and 4910 cm²), respectively. Varieties were significantly different in their performance for all studied characters. Boohooth 70 was superior in number of days to the 75% flowering, plant height, leaf area, number of tillers, green forage yield and dry forage yield (59.75 days, 240.8 cm, 4554 cm², 19.00 tiller m⁻², 12.73 t ha⁻¹ and 55.10%), respectively. However, Caffier gave the lowest concentration of HCN (58.67%).

Key words: Cultivation pattern, green forage, hydrocyanic acid (HCN) and apical dormancy.

1. Introduction
Ratoon cultivation has many advantages among, in addition, its less i.e. economic method as no need to repeat sowing which requires seed bed preparation (ploughing, levelling and seeding e. t. c.) which adds more costs (10). It reduces the life cycle of crop by 25 days and gives more afresh and dry green forages due to the high tillering compared with the direct seeding method (6). Also, plants of ratoon method are strong competitive to the weeds. The regrowth of essential buds requires food storage in the roots and stems to supply the buds with the nutritive essential for growth (12). Ratoon method depends upon an active
physiology in the harvested stems which enables transferring water, stored carbohydrates and nutritive elements to the buds and tillers being ready to be enhanced for growth. This depends upon the transportation tissues which supports buds (7). It also depends upon enhanced buds after cutting and removing the apical dominance of the main stem, plant tissue age and the variety (8). Many studies referred to the superiority of ratoon plants compared with the plants of direct seeding method in number of heads, grain weight, grain yield and harvest index (5). Also, it was found that sorghum varieties were different in their performance in terms of growth characters and grain yield. (13) found significant varietal differences in the number of days to the 50% flowering, plant height and leaf area. In the light of above advantages, ratoon cultivation might be exploited to develop the sorghum cultivation by testing the capabilities of some varieties which highly responsive to such kind of cultivation by comparing them with the direct seeding method.

2. Materials and Methods

A field trial was carried out during the spring and fall seasons of 2017. At a field belongs to the Department of Crop Sciences, College of Agricultural-University of AL-Anbar (a Hernative site- Abu-Graib). The objective was to investigate the response of sorghum varieties (Inqath, Lilo, Ishtar, Boohooth 70 and Caffier) to the ratoon cultivation. Treatments were distributed according to randomized complete block design (RCBD) in the arrangement of split-split plot with three replicates. Ratoon cultivation (spring ratoon-fall) and direct seeding occupied the main plots while the varieties occupied the sub-plots. Seeds of varieties in both seasons were sown by plant population density 133300 plant ha⁻¹. All soil preparation (ploughing, evening e. t. c.) were performed, then, divided into experimental 3 × 2.5 m to give six rows, 50 cm between them and 15 cm between hills. Three seeds were sown in the each hill, then, thinned to single plant at two stages, the first after emergence and the second stage after 10 days. Urea fertilized (46 % N) was applied with 200 Kg N. ha⁻¹ at three stages; the first was after complete field emergence, the second at 4-6 leaves stage, and the third at beginning of flowering. All phosphorous fertilizer was added before sowing with 100 Kg P ha⁻¹. The sowing date in spring season was on 28/3/2017. Plants were cut at 7-10 cm height at the maturation to protect the new buds, then, left for the next fall season to obtain the sorghum ratoon. Seeds of sorghum were sown after completion of cutting ratoon plants, then, irrigated at the same time on 18/7/2017. Hand weeding was performed as necessary.

the following characteristics: Number of days from sowing to the 75% flowering was calculated by recording visually 75% flowering of plants in the middle of two rows for each experimental units. Plant height was measured after full flowering for five plants randomly chosen from middle rows from the soil surface to the top of head. Leaf area and number of tillers m² were calculated from the average of emerged tillers m² in each treatment. Grains forage yield was determined from harvesting plants in 1m² at full maturity, then, result transferred to the t ha⁻¹. Hydrocyanic acid (HCN%) was also measured.

Data were statistically analyzed according to the ANOVA analysis by using Genstat program and least significant difference (L.S.D.) at 0.05 probability (14).

3. Results and Discussion

3.1. Number of days from sowing to the 75% flowering

Results in Table (1) showed significant superiority of the ratoon cultivation in recording the less average of Number of days from sowing to the 75% flowering (66.15 day), compared with direct seeding which gave the highest average of this character (80.10 day). This result was confirmed by (11) that ratoon plants were early in growth and harvest by ten days (as an average) compared with the plants of direct seeding. Table (1), also showed significant differences between varieties, where Boohooth 70 was superior in giving 59.75 days to reach 75% flowering compared with 82.75 days for Ishtar variety. This may be due to the different genetic make up of these varieties which was reflected in different response to the dominant environmental condition during the growing season. There were significant differences for the interaction of study factors, where plants of Boohooth 70 resulted from direct seeding were superior (52.67 day) compared with 89.33 days of Ishtar cultivars resulted from direct seeding.
Table 1. Effect of sorghum varieties and cultivation method on number of day to 75% flowering, height plant and leaf area

| Cultivars | cultivation method | Plant height (cm) | Leaf area (cm²) |
|-----------|--------------------|-------------------|-----------------|
|           | Seeding            | ratoon            | Seeding         | ratoon         |
| Inqath    | 86.33              | 69.28             | 156.7           | 129.3          |
| Lilo      | 86.00              | 67.11             | 148.3           | 130.3          |
| Ishtar    | 89.33              | 76.17             | 161.7           | 154.7          |
| Bohooth70 | 52.67              | 56.38             | 287.6           | 194.1          |
| Caffier   | 76.17              | 61.83             | 202.6           | 173.2          |
| LSD 0.05  | 2.33               | 1.70              | 7.2             | 5.4            |
| Average   | 4910               | 4014              | 191.36          | 156.33         |
| LSD 0.05  | 1.85               | 5.1               | 80.10           | 70             |

3.2. Plant height (cm)
Results of Table (1) showed that direct seeding gave the highest average of plant height (191.36 cm) compared with (156.00 cm) for ratoon plants. This may be attributed to the earliness of ratoon plants reach 75% flowering and their short life cycle compared varietal differences. This results were in accordance with (3) who found significant reduction in the plant height of direct seeding compared with the plants resulted from ratoon plants.

Booooth 70 record the highest average of plant height (240.8 cm) compared with 139.3 cm for Lilo variety. This varietal differences may be due to the differences of linkage capability between height genes and maturity gens (2). The interaction between study factors was significant (Table 1), where plants of Booooth 70 resulted from direct seeding recorder the highest average of plant height (287.60 cm) compared with 129.3 and 130.3 cm for Inqath and Lilo from ratoon method, respectively with no significant differences between them.

3.3. Leaf area (cm²)
Plants of direct seeding gave the highest value of leaf area (4910 cm²) compared with 4014 cm² for ratoon method (Table 1). The reason for the superiority of direct seeding cultivation plants over ratoon plants may be due to the increase in the number of tillers in ratoon plants (Table 1), which caused an increase in competition between tillers for nutrients, water and light, which negatively affected on the leaf area of ratoon plants. Also, there varietal differences where Booooth 70 gave the highest average (5445cm²) compared with 4130 cm² for Caffier. This may be due to the different genetic –make up for varieties besides the highest plant height of Booooth 70 which was positively reflected in increased number and area of leaves. This varietal differences may be due to the different genetic make-up of cultivars (9). The interaction was significant. Plants of Booooth 70 resulted from direct seeding gave the highest average (6118 cm²) compared with 3655 cm² for Caffier and Ishtar plants resulted from ratoon method with no significant differences between them.

3.4. Number of tillers (tiller m⁻²)
It is clear from Table (2), that there was significant effect of cultivation method. Ratoon method recorded the highest number of tillers (21.40 tiller m⁻²) compared with 12.47 tiller m⁻² for direct seeding. The superiority of ratoon plants is due to the end of apical dominance as a result of cutting the main stem and stimulating lateral buds to grow. This result was in agreement with the findings of (15) where ratoon plants produced more tillers in comparison with the direct seeding.

As expected, varieties were significantly differ in their tiller number per square meter. Booooth 70 recorded the highest number (19.00 tiller m⁻²) compared with 15.00 and 15.50 tiller m⁻² for Inqath and Lilo respectively with no significant differences between them. This may be due to the different varietal genenic-make up. This results were in accordance with the findings of (6) who reported varietal differences between sorghum cultivars in number of tillers. Concerning the interaction, Inqath of Booooth 70 resulted
from ratoon gave the highest average (25.00 tiller m\(^{-2}\)) compared with 11.67 tiller m\(^{-2}\) for Lilo plants resulted from direct seeding with no significant differences with other varieties grown by direct seeding.

### 3.5. Green forage yield (t ha\(^{-1}\))

Results of Table (2) referred to significant effect of cultivation method. Ratoon method recorded the highest average (8.75 t ha\(^{-1}\)) compared with 6.22 t ha\(^{-1}\) for direct seeding method. This may be due to the highest number of tiller m\(^{-2}\) (Table 2). This result was in agreement with the finding of (1 and 6). There were significant differences between varieties. Plants of Bohooth 70 gave the highest average (12.73 t ha\(^{-1}\)) compared with 5.51 and 5.32 t ha\(^{-1}\) for Inqath and Lilo with no significant differences between them. The superiority of Bohooth 70 plants was due to the highest values of plants height, leaf area and tiller number m\(^{-2}\) (Table 1 and 2) which was reflected in higher green forage yield. This result was in agreement with (1). For interaction, there was significant interaction between study factors. Plants of Bohooth 70 resulted from ratoon gave the highest average (15.00 t ha\(^{-1}\)) compared with 4.33 and 4.28 t ha\(^{-1}\) for Inqath and Lilo resulted from direct seeding.

### 3.6. HCN %

Results of Table (2) showed significant effect of cultivation pattern. Ratoon method recorded the lowest concentration HCN (54.64 %) compared with 76.97 % for direct seed pattern. This result was in agreement with the findings of (6) who found significant reduction in the HCN% of ratoon plants compared with the plants resulted from direct seeding. Concerning varieties, there were significant differences between them, where Caffier gave the lowest percentage (58.67 %) compared with 72.96 % for Lilo plants. This may be due to the genetic characteristics of these varieties. This result was in agreement with (4) they findings of where significant differences were found in the HCN concentration in three sorghum cultivars. Also, results revealed that there was significant effect of the interaction. Plants of Caffier resulted from ratoon recorded the lowest percentage (42.39%) compared with 82.45% for Lilo plants resulted from direct seeding.

| Table 2. Effect of sorghum varieties and cultivation method on number of tillers, forage yield and HCN concentration |
|---------------------------------------------------------------|
| Cultivar       | Cultivation method | number of tillers (tiller m\(^{-2}\)) | forage yield (t ha\(^{-1}\)) | HCN % |
|                | Seeding           | Ratoon                      | average               | Seeding | Ratoon | average               | Seeding | Ratoon | average               |
| Inqath         | 12.00             | 18.00                      | 15.00                 | 4.33    | 6.69   | 5.51                 | 75.38   | 63.71   | 69.54                 |
| Lilo           | 11.67             | 19.33                      | 15.50                 | 4.28    | 6.36   | 5.32                 | 82.54   | 63.38   | 72.96                 |
| Ishtar         | 13.00             | 22.33                      | 17.67                 | 4.95    | 6.90   | 5.92                 | 79.79   | 53.79   | 66.79                 |
| Bohooth70      | 13.00             | 25.00                      | 19.00                 | 10.46   | 15.00  | 12.73                | 72.19   | 49.94   | 61.07                 |
| Caffier        | 12.67             | 22.33                      | 17.50                 | 7.10    | 8.79   | 7.95                 | 74.94   | 42.39   | 58.67                 |

**LSD 0.05** 1.59 1.25 0.50 0.32 2.53 1.99

**Average** 12.47 21.40 6.22 8.75 76.97 54.64

**LSD 0.05** 0.28 0.56 0.47

### 4. Conclusions

Growing sorghum plants by ratoon method may be the best as it was superior in the most characters, besides it requires less costs as it need not repetition of cultivation which adds more costs compared with direct seeding method. Also, there were significant differences between sorghum varieties with the superiority of Bohooth 70 variety.

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