*University of Thi-Qar Journal of agricultural research*
*Thi-Qar Journal of agricultural research*
*ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 13, Issue 2 (2024) PP 335-345*
https://jam.utq.edu.iq/index.php/main https://doi.org/10.54174/utjagr.v13i1.323

# Growth and Yield Performances of Five Kenaf (*Hibiscus cannabinus* L.) Varieties Grown Under Sulaimani Condition

[1]Shaee Ghareeb, [2]Rabar Salih, [3]Rawaz Hama Ali

[1,3] Department of Biotechnology and Crop Science, College of Agricultural Enginnering Sciences, University of Sulaimani, Sulaimani, Kurdistan, Iraq, 46001

[2] Department of Field Crops and Medicinal Plants, College of Agricultural Enginnering Sciences, University of Salahaddin, Erbil, Kurdistan, Iraq, 44002

[1]*E- mail: shaee.gharib@univsul.edu.iq.*

[2]*E- mail: rabar.salih@su.edu.krd.*

[3]*E- mail: rawaz.hamaali@univsul.edu.iq*

## Abstract

*Hibiscus* is a large genus of more than 200 species of shrubs, trees, annuals, and perennials from warm-temperate, subtropical, and tropical areas are grown around the world. Seeds of five kenaf varieties were cultivated from Sulaimani, Kurdistan for the first time at spring season in two consecutive years (2022-2023). Which was to investigate their growth and yield performances and to adaptation these varieties with Sulaimani climatic conditions. Results showed that, 4383 *var.* superior on other varieties by having the best growth parameters such leaf number, plant height and stem diameter (239.28 LN Plant$^{-1}$, 314.48 cm and 24.77 mm), respectively. Additionally, the maximum values of total fresh yield, fresh and dry core and bast fibers were also found in the same variety (454.27, 114.70, 43.43, 55.17 and 19.10 t ha$^{-1}$), respectively. Generally, the first year of plant growing was better compared to the second year. The best results of both growth and yield parameters were indicated in the interaction treatment 4383 *var.* in the first year (4383×year1). While, the maximum days for flowering was noted in HC95 *var.* (119.83). In the interaction treatments HC95 and HC2 varieties both in the second year (HC95×year2) and (HC2×year2), needed to (124.33 days) for flowering, which was the highest number of days. That's while, other varieties also performed well, not only about photoperiodism/day of flowering but also for yield and yield components, which were affected by growing seasons. Finally, could concluded that kenaf plants can be cultivated and developed very well in Sulaimani conditions.

***Keywords****: Environmental factors, Sowing time, Varieties, Growth and Yield improvement, Fiber dry matter.*

## I. Introduction

Climate change has a great role in growing seasons of the crops, due to that fact doing more researching are necessary to find the right period for growing plants successfully. On the same time, varieties are also having the significant impact on growth and improving quality properties.

Vayabari *et al*. (2023) stated that nowadays, kenaf has gained significant global attention as a more cost-effective, adaptable, and manageable alternative to other fiber crops. India and China, with nearly 70% of the global kenaf production, have emerged as the leading producers of kenaf plants. While kenaf was traditionally valued for its paper production, it has evolved into a multipurpose crop with

*University of Thi-Qar Journal of agricultural research*
*Thi-Qar Journal of agricultural research*
*ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 13, Issue 2 (2024) PP 335-345*
https://jam.utq.edu.iq/index.php/main https://doi.org/10.54174/utjagr.v13i1.323

diverse industrial applications over the past two decades. The global kenaf market is projected to cross USD 854 million by Jason Thomas (2019). The same source indicated that kenaf is a major crop in Africa and Asia, where it is used for various cordage products such as rope, twine and burlap. In construction, it is used for thermal insulation of walls, floors and roofs and soundproofing solutions, while in furniture, is it used in the manufacturing of medium-density fiberboard (MDF) and other wood composite materials. Globally, the demand for natural fibers such as kenaf is growing at 10 to 15 per cent annually, especially for use in composite material. China, Bangladesh, Thailand and Myanmar contribute 95 percent of global kenaf production which totals three million tons a year.

Kenaf plant population is approximately 400000-600000 plants $ha^{-1}$, it is required to water 780-1200 mm, plants ready for harvesting only 3-5 months after planting date, at that time its dry matter production (stem) will be reached to 17-60 t $ha^{-1}$ (Bañuelos *et al*. 2002, Danalatos, N.G. and Archontoulis, S.V. (2010), Mohd, H. Et al., (2014), Salih, R.F., (2014a), Salih, R.F. (2016) and Salih *et al*.2020).

Kenaf is one of the most important fiber crops globally, its scientific name is (*Hibiscus cannabinus* L.) belongs to family Malvaceae. Kenaf fibers can be used for timber and other biocomposite purposes, moreover growing kenaf plant will caused to conserve environment from pollution through absorption optimal value of carbon dioxide ($CO_2$), additionally cultivation this kind of crop has impact role in agricultural sustainability Salih *ea al*.,(2022). . Ezzadin *et al*., (2022) concluded that leaves and seeds of kenaf plants have various important uses such as food and medicinal applications. Amount of nutritive value in kenaf leaves is too high, which that causes to use as medicinal plants and also as a food source for cooking and forage for animals, Sultan, D.M. and Salih, R.F.(2022). As mentioned earlier kenaf is one of the fiber crops so fiber crops generally have numerous benefits that can be used in textile industries and their plant parts may usefulness in various products such as in food, medicines, cosmetic, animal feed, etc. Furthermore, natural fibers are renewable, economy, environment friendly, low weight, not toxic as compared to synthetic fibers, Ezaddin, N.A. & Salih, R.F.(2023a).

Increasing and enhancing growth, yield and yield components of kenaf plant are depending on growth conditions and also agriculture processing. Salih *et al.* (2020) stated that Kurdistan environment condition was suitable for cultivation kenaf crops, some varieties adapted very well. Olanipekun, S.O. and Togun, A.O.(2020) suggested that, if the purpose of kenaf cultivation is to reach the best quality and quantity of fiber June is the best for sowing, while July is better for seed production, that was based on Ibadan, South Western Nigeria. From the results of Budi, U.S. and Murianingrum, M.(2020) were noted that keanf genotypes, environment, and their interactions had significant effect on the fiber yield. The best growth, fiber yield and quality were noted in Cuba-108 cultivar, it means that kenaf cultivars have significant impact on growth and yield parameters Eifediyi *et al*., (2022), the importance of the kenaf varieties was also confirmed by Sadhineni *et al*.,(2023).

The objective of this present research was to investigate the performances of different kenaf varieties under Sulaimani, Kurdistan condition, and to adaptation these varieties while all of them for the first time sowed in there, additionally to know growing seasons had the impact on growth, yield and yield components or not.

From this present study it is hypothesized that kenaf plants will be well adapted to the environmental of the project site, moreover it is growing well and providing high amount of fiber.

# II. Methods and Materials

University of Thi-Qar Journal of agricultural research
Thi-Qar Journal of agricultural research
ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 13, Issue 2 (2024) PP 335-345
https://jam.utq.edu.iq/index.php/main https://doi.org/10.54174/utjagr.v13i1.323

**Study Site:**

This current investigation was done in the Qlyasan, which is the Research Station of the Biotechnology and Crop Science Department, College of Agricultural Engineering Sciences, University of Sulaimani. Qlyasan is located at the Governorate of Sulaimani in the Northeast of Iraq, on the border with Iran, (Latitude: 35° 34´ 17″ N, Longitude: 45° 22´ 00″ E, and altitude of 757 masl), 2 km northwest of Sulaimani city. "Garmin, GPS map 60 Cx.".

**Soil Analysis:**

Table 1 displays the physical and chemical properties of the soil taken from the experimental site. 0 to 30 cm was the depth of the soil to take the samples randomly in several places of the farm before it was divided into plots. Afterward, the soil was air dried and sieved through a 2 mm pore size sieve, which was in the laboratory. Then, physicochemical parameters were determined.

**Table 1 Physicochemical properties of the soil samples from the study site:**

| **Physicochemical Properties** | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Physical Properties | | | | Chemical Properties | | | | | | |
| **Sand** | **Sily** | **Clay** | **Texture** | **pH** | **ECe** | **O.M.** | **$CaCo_3$** | **N (total)** | **P (available)** | **K (available)** |
| ($g\ kg^{-1}$) | | | | | ($\mu S\ cm^{-1}$) | ($g\ kg^{-1}$) | | (%) | ($Mg.\ kg^{-1}$) | (ppm) |
| 87 | 435 | 457 | Silty Clay (SiC) | 7.59 | 490 | 22.4 | 304.3 | 0.12 | 5.24 | 80 |

**Experimenatl Design:**

Two field experiments were carried out during the spring season 2022 and 2023 in Qlyasan Research Station. The first experiment was done on June 6, 2022, while second experiment was done in June 1, 2023. Seeds of five kenaf varieties were selected as plant material and then planted. Randomized Complete Block Design with three replicates was the field experiment design. The area of each experimental unit was ($1m^2$), and there were four lines within each experimental unit. The distance from one line to the next was 25 cm, while it was just 10 cm between plants, and the distance between experimental units was 1 meter, with 2 meters between blocks. Two to three seeds were planted in each hole. In this current study drip irrigation system was applied, additionally weeds were also controlled manually. Moreover, any pesticide and herbicide was not used, on the same time organic and inorganic fertilizers were not added to the plants, which was to identify its ability for adaptation with environmental of the project site. In the maturity stage growth parameters such as plant height, stem diameter and leaf number were taken according to the previous research Salih *et al.*, (2014b), while date of flowering was calculated at flowering stage. Finally, total fresh yield, fresh and dry fiber yields (core and bast) were determined according to Salih *et al.*, (2023).

Meteorology of the study site in both growing seasons were determined to show its affect the growth and yield characteristics of kenaf plants (Figure 1).

**Statistical Analysis:**

All data were collected from this present study statistically analyzed according to the technique of analysis of variance (ANOVA) for randomized complete block design, (RCBD) using IBM SPSS Statistics Program (20), the mean comparison was fulfilled according to Duncan multiple range test at the level of significant 0.05.

## III. Results and Discussions

**Growth Parameters:**

The highest significance of all growth parameters was recorded between varieties, at the same time year of plant growing was caused to record different results (Table 2). The highest values of leaf number, plant height and stem diameter were found of 4383 var. (V4), by (239.28 LN Plant$^{-1}$, 314.48 cm and 24.77 mm), respectively, while HC2 var. (V3) recorded the smallest values of leaf number and plant height were by (148.35 LN Plant $^{-1}$ and 228.22 cm), respectively, despite that 4202 followed by HC2 varieties recorded the smallest stem diameter.

Growing seasons were also as varieties caused to record different results of all parameters. Generally, plants were growing well in the first year compared to the second year.

Differences of leaf number per plant, plant height and stem diameter may have occurred due to climatic differences in the location of the study, especially average temperature between both years (2022 – 2023), refer to (Figure 1). Results from this present study supported by Salih, R.F *et al.*,(2022) whose stated that sowing time and kenaf varieties significantly affected growth and yield characteristics. Moreover, table 3 displays the impact of interactions (variety × year). These results were evidence to show the impact of growing seasons on the plant growth characteristics. The weather certainly varies from year to year, which causes to change not only plant growth but also amount and quality of crops. So could said that, the results recorded in this present study are really normal, while from this kind of case planting date is more efficiency to confirm that fact about growth characteristics.

Interaction between both factors (variety × year), caused to find the significant differences of all growth parameters (Table 3). The highest values of leaf number, plant height and stem diameter noted in the interaction treatment (4383×year1), were (265.53 LN Plant-1, 341.47 cm and 26.67 mm), respectively followed by (4383×year2) in leaf number (213.03), later plant height and stem diameter were (314.37 cm and 24.70 mm) in the interaction treatment (FH952×year1).

**Yield and Yield Components:**

The highest amount of total fresh yield, fresh and dry core and bast fiber yields found in the 4383 var. (454.27, 114.70, 43.43, 55.17 and 19.10 t ha$^{-1}$), respectively. On the same time, the first year of plant growing June 6, 2022 was better to record the best amount of all yield and yield component parameters (395.25, 113.22, 40.07, 49.42 and 16.97 t ha$^{-1}$), respectively (Table 4).

Interaction between both factors was also significantly affected total fresh yield, fresh and dry matter of core and bast fibers (Table 5). The maximum amount of all parameters were found in the interaction treatment (4383×year1), were by (496.17, 135.63, 47.20, 59.13 and 20.87 t ha$^{-1}$), respectively.

*University of Thi-Qar Journal of agricultural research*
*Thi-Qar Journal of agricultural research*
*ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 13, Issue 2 (2024) PP 335-345*
https://jam.utq.edu.iq/index.php/main https://doi.org/10.54174/utjagr.v13i1.323

Total fresh yield is directly relative to fresh and dry matter of core and bast fibers, likewise yield and yield components are also strongly linked to growth parameters that's why the best amount of yield and components were noted from the plants had healthy growth (Tables 2 and 4). These results in line with Alexopoulou *et al.,* (2000) whose stated that fresh and dry matter yields and yield components were found to be affected by the kenaf varieties. However, five varieties of kenaf were planted in Ibadan Nigeria in 2018 and 2019 planting season. Results indicated that mid-June in South Western Nigeria will give optimum seed yield of high quality, which means that environment had significant affected Adetumbi *et al*., (2022). Likewise, interaction between both factors significantly affected yield and yield components as Ogunniyan *et al.,* (2017) stated that kenaf genotypes and environment affected fiber yield. From the newest study the impact of interaction between environmental factors and varieties on yield of the natural fibers was confirmed, Ezaddin, N.A. and Salih, R.F (2023b) reported that cotton fiber yield was significantly improved by environmental factors and varieties.

**Day of Flowering:**

Figure 2 shows the number of days were requested for plants flowering. Variety and also year of plant growing were significantly affected this field parameter. HC95 needed to (119.83) day for flowering, while 4202 var. needed to (118.17) day. Plants from the first year of growing were only requested to (116.00) day for flowering, while in the second year increased to (121.93) day.

Effect of interaction between variety and year of plant growing on flowering period was recorded in the following figure. The maximum days was found in the interaction treatments (V2Y2 and V3Y2), by almost (124) day. While, the minimum days for flowering was found in the interaction treatment (V3Y1), by (114) days followed by (V2Y1 and V5Y), which was by almost (115) day as can be seen in the (Figure 3).

The case of flowering may belong to difference of average temperature and rainfall especially in the latest months of growing season (Figure 1). While, flowering period is strongly linked to genetic but in the same time environmental factors are also affected this agronomic trail. Ryu *et al*., (2017) confirmed that this field characteristic strongly linked to genotypes and they found a significant correlation between flowering time and dry matter yield of kenaf plants. Additionally, Lee *et al.,* (2021) stated that kenaf varieties significantly affected day of flowering. Similarly, interaction (variety × year) caused to record significant differences of this parameter (Figure 3). These results were evidence to confirm the relationship between varieties and environmental condition on flowering period. Results from this current study is in line with the Vayabari *et al.,* (2023) whose said that photoperiodism has affected flowering stage of kenaf plants, period of flowering also is one of the most important factors effecting fiber production and quality.

# IV. Conclusion

The aim of this study was to develop and improve kenaf plants since it is one of the most important fiber crops ecologically and economically around the world. This current investigation focused on environmental conditions as a main factor since it has a great role on the growing seasons of the crops. As previously mentioned that seeds of five kenaf varieties in the spring season of two different years (2032 and 2023) were planted. Generally, from the outcomes found that both factors variety and year and its interaction (variety × year), were significantly affected all growth, yield and yield component parameters. Additionally, it was proofed that Sulaimani conditions appropriate to cultivate kenaf plants.

*ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 13, Issue 2 (2024) PP 335-345*
https://jam.utq.edu.iq/index.php/main https://doi.org/10.54174/utjagr.v13i1.323

**Table 2 Effect of variety and year of plant growing on growth parameters:**

| Variety | Leaf number plant$^{-1}$ | Plant height (cm) | Stem diameter (mm) |
|---|---|---|---|
| **FH952** | 179.90$^{b}$ | 290.97$^{b}$ | 24.03$^{a}$ |
| **HC95** | 172.15$^{c}$ | 263.73$^{c}$ | 21.77$^{b}$ |
| **HC2** | 148.35$^{e}$ | 228.22$^{e}$ | 20.63$^{c}$ |
| **4383** | 239.28$^{a}$ | 314.48$^{a}$ | 24.77$^{a}$ |
| **4202** | 160.20$^{d}$ | 238.47$^{d}$ | 20.37$^{c}$ |
| **Year** | | | |
| **First year** | 197.88$^{a}$ | 284.02$^{a}$ | 23.99$^{a}$ |
| **Second year** | 162.07$^{b}$ | 250.33$^{b}$ | 20.63$^{b}$ |
| *Means with different alphabetic letters differ significantly at ($p \leq 0.05$). | | | |

**Table 3: Interaction effects (variety × year) on growth parameters:**

| Interaction | Leaf number plant$^{-1}$ | Plant height (cm) | Stem diameter (mm) |
|---|---|---|---|
| **(FH952×year1)** | 197.47$^{c}$ | 314.37$^{b}$ | 24.70$^{b}$ |
| **(FH952×year2)** | 162.33$^{e}$ | 267.57$^{e}$ | 23.37$^{cd}$ |
| **(HC95×year1)** | 185.30$^{d}$ | 276.10$^{d}$ | 23.60$^{c}$ |
| **(HC95×year2)** | 159.00$^{e}$ | 251.37$^{f}$ | 19.93$^{e}$ |
| **(HC2×year1)** | 164.77$^{e}$ | 241.30$^{g}$ | 22.20$^{d}$ |
| **(HC2×year2)** | 131.93$^{g}$ | 215.13$^{i}$ | 19.07$^{e}$ |
| **(4383×year1)** | 265.53$^{a}$ | 341.47$^{a}$ | 26.67$^{a}$ |
| **(4383×year2)** | 213.03$^{b}$ | 287.50$^{c}$ | 22.87$^{cd}$ |
| **(4202×year1)** | 176.33$^{d}$ | 246.87$^{fg}$ | 22.80$^{cd}$ |
| **(4202×year2)** | 144.07$^{f}$ | 230.07$^{h}$ | 17.93$^{f}$ |
| *Means with different alphabetic letters differ significantly at ($p \leq 0.05$). | | | |

*ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 13, Issue 2 (2024) PP 335-345*
*https://jam.utq.edu.iq/index.php/main* *https://doi.org/10.54174/utjagr.v13i1.323*

**Table 4 Effect of variety and year of plant growing on yield parameters ($t\ ha^{-1}$) in kenaf fibers:**

| Variety | Total fresh yield | Fresh core yield | Dry core yield | Fresh bast yield | Dry bast yield |
|---|---|---|---|---|---|
| **FH952** | $402.25^{b}$ | $103.80^{b}$ | $39.67^{b}$ | $48.90^{b}$ | $16.55^{b}$ |
| **HC95** | $364.87^{c}$ | $95.53^{c}$ | $36.23^{c}$ | $44.80^{c}$ | $15.62^{c}$ |
| **HC2** | $312.52^{e}$ | $90.73^{d}$ | $33.28^{e}$ | $42.02^{d}$ | $13.37^{e}$ |
| **4383** | $454.27^{a}$ | $114.70^{a}$ | $43.43^{a}$ | $55.17^{a}$ | $19.10^{a}$ |
| **4202** | $333.45^{d}$ | $94.37^{c}$ | $34.28^{d}$ | $42.90^{d}$ | $14.27^{d}$ |
| **Year** | | | | | |
| **First year** | $395.25^{a}$ | $113.22^{a}$ | $40.07^{a}$ | $49.42^{a}$ | $16.97^{a}$ |
| **Second year** | $351.69^{b}$ | $86.43^{b}$ | $34.69^{b}$ | $44.09^{b}$ | $14.59^{b}$ |
| *Means with different alphabetic letters differ significantly at ($p \leq 0.05$). | | | | | |

**Table 5 Interaction effects (variety × year) on growth parameters of kenaf fibers:**

| Interaction | Total fresh yield | Fresh core yield | Dry core yield | Fresh bast yield | Dry bast yield |
|---|---|---|---|---|---|
| **(FH952×year1)** | $427.37^{b}$ | $118.53^{b}$ | $42.10^{b}$ | $52.77^{b}$ | $17.70^{b}$ |
| **(FH952×year2)** | $377.13^{d}$ | $89.07^{f}$ | $37.23^{d}$ | $45.03^{e}$ | $15.40^{d}$ |
| **(HC95×year1)** | $386.93^{d}$ | $105.87^{c}$ | $37.53^{d}$ | $46.97^{d}$ | $16.63^{c}$ |
| **(HC95×year2)** | $342.80^{e}$ | $85.20^{g}$ | $34.93^{e}$ | $42.63^{fg}$ | $14.60^{de}$ |
| **(HC2×year1)** | $323.07^{f}$ | $99.53^{d}$ | $35.97^{e}$ | $43.87^{ef}$ | $14.33^{e}$ |
| **(HC2×year2)** | $301.97^{g}$ | $81.93^{g}$ | $30.60^{f}$ | $40.17^{h}$ | $12.40^{f}$ |
| **(4383×year1)** | $496.17^{a}$ | $135.63^{a}$ | $47.20^{a}$ | $59.13^{a}$ | $20.87^{a}$ |
| **(4383×year2)** | $412.37^{c}$ | $93.77^{e}$ | $39.67^{c}$ | $51.20^{c}$ | $17.33^{bc}$ |
| **(4202×year1)** | $342.70^{e}$ | $106.53^{c}$ | $37.53^{d}$ | $44.37^{e}$ | $15.30^{d}$ |
| **(4202×year2)** | $324.20^{f}$ | $82.20^{g}$ | $31.03^{f}$ | $41.43^{gh}$ | $13.23^{f}$ |
| *Means with different alphabetic letters differ significantly at ($p \leq 0.05$). | | | | | |

*ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 13, Issue 2 (2024) PP 335-345*

*https://jam.utq.edu.iq/index.php/main* *https://doi.org/10.54174/utjagr.v13i1.323*


**Figure 1: Meteorology of the study site; Average temperature and rainfall for both growing seasons (2022 and 2023).**

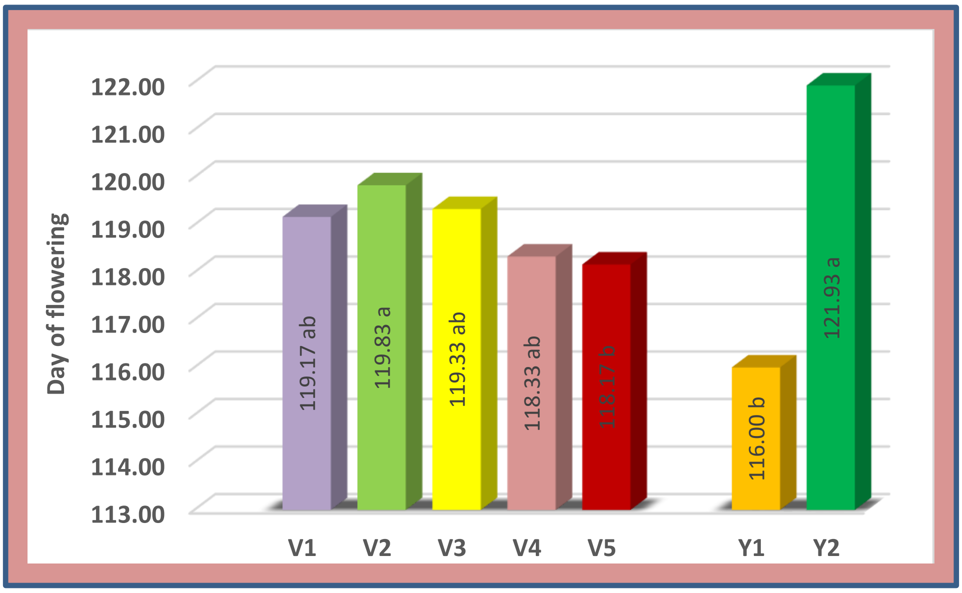
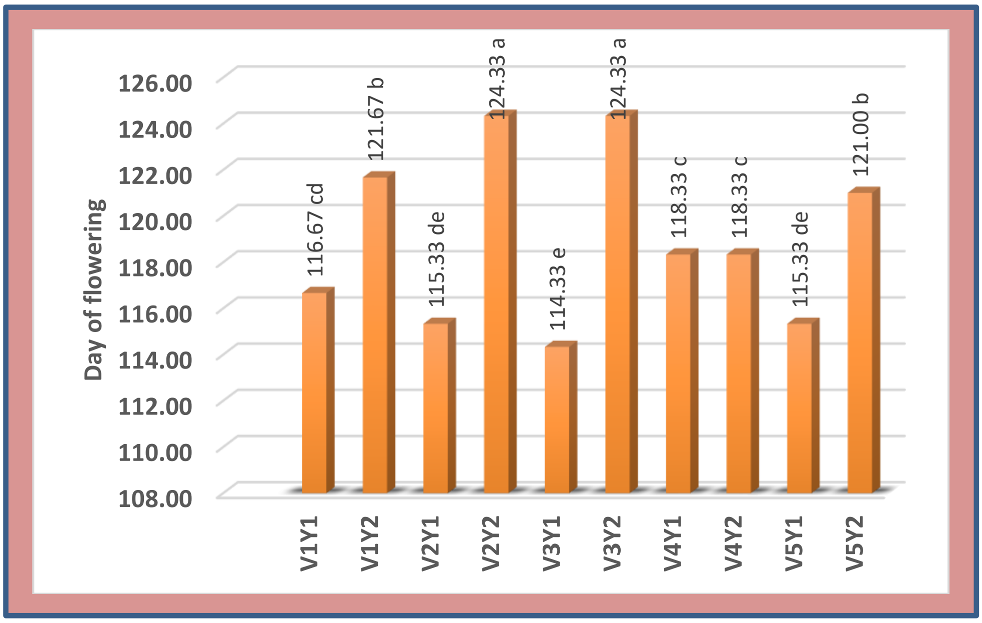
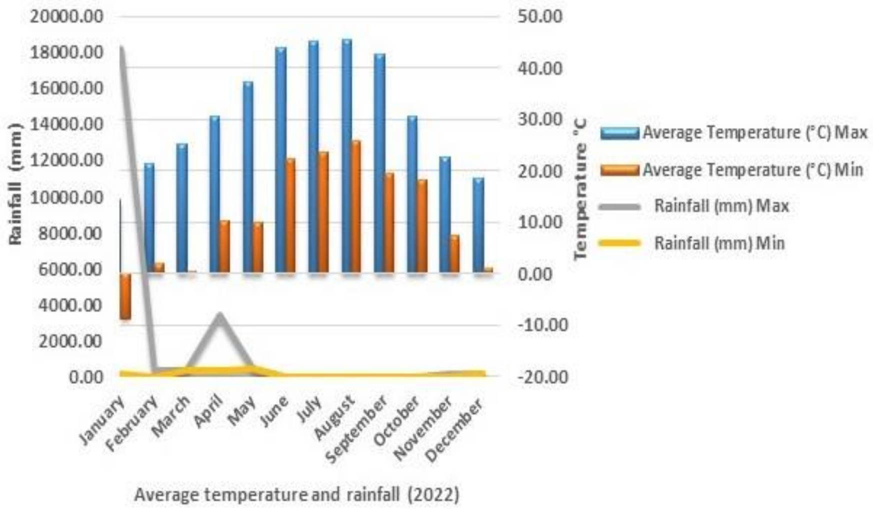


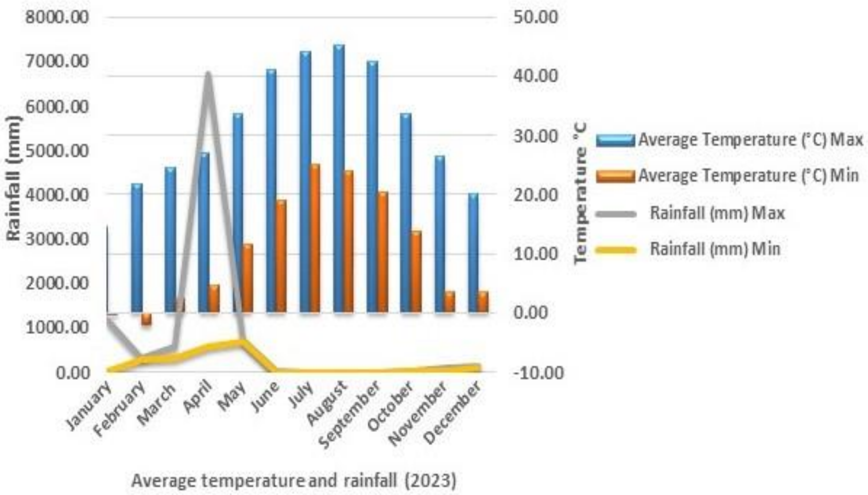

**Figure 2: Response of day of flowering to variety and year of plant growing. V1= FH952, V2= HC95, V3= HC2, V4= 4383, and V5= 4202, Y1= First year and Y2= Second year.**



ISSN Onlin:2708-9347, ISSN Print: 2708-9339 Volume 13, Issue 2 (2024) PP 335-345
https://jam.utq.edu.iq/index.php/main https://doi.org/10.54174/utjagr.v13i1.323

***Figure 3:*** *Interaction effects (variety × year) on day of flowering of kenaf plant.*




## V. Reference

Adetumbi, A.J., Ogunniyan, D., Ajijola, S., Oyegbami, A. & Adeniyan, N. Appropriate Planting Time for Profitable Production of Quality Seed of Kenaf (*Hibiscus canabinus* L.) in South Western Nigeria. *Journal of Agricultural Sciences (Belgrade)*, *67*(**3**), https://doi.org/10.2298/JAS2203253A (2022)

Alexopoulou, E., Christou, M., Mardikis, M. & Chatziathanassiou, A. Growth and yields of kenaf varieties in central Greece. *Industrial Crops and products*, *11*(**2-3**), pp.163-172, https://doi.org/10.1016/S0926-6690(99)00064-3 (2000)

Bañuelos, G.S., Bryla, D.R. & Cook, C.G. Vegetative production of kenaf and canola under irrigation in central California. *Industrial crops and products*, *15*(**3**), pp.237-245, https://doi.org/10.1016/S0926-6690(01)00119-4 (2002)

Budi, U.S. & Murianingrum, M. Yield stability and adaptability of kenaf (*Hibiscus cannabinus* L.) genotypes at different kenaf growing regions in Indonesia. In *IOP Conference Series: Earth and Environmental Science* (Vol. **418**, No. 1, p. 012076). IOP Publishing, doi:10.1088/1755-1315/418/1/012076 (2020)

Danalatos, N.G. & Archontoulis, S.V. Growth and biomass productivity of kenaf (*Hibiscus cannabinus* L.) under different agricultural inputs and management practices in central Greece. *Industrial Crops and Products*, *32*(**3**), pp.231-240, https://doi.org/10.1016/j.indcrop.2010.04.013 (2010)

Eifediyi, E.K., Adetoro, O.G., Ahamefule, H.E., Ogedegbe, F.O. & Isimikalu, T.O. Varieties, poultry manure and fertilizer influence on the growth and fibre quality of kenaf (*Hibiscus cannabinus* L.). *Tropical and Subtropical Agroecosystems*, *25*(**1**), http://dx.doi.org/10.56369/tsaes.3869 (2022)

Ezaddin, N.A. & Salih, R.F. Cultivated Natural Fiber Crops in Iraq and their Uses: A Review. *Passer Journal of Basic and Applied Sciences*, *5*(**1**), pp.191-201, 10.24271/PSR.2023.387490.1265 (2023a)

Ezaddin, N.A. & Salih, R.F. Straw Mulching and Plant Spacing Enhance Yield and Some Quality Traits of Cotton (*Gossypium hirsutum* L.) Varieties. *Preprint*, *Research Square*, pp. 1-29, https://doi.org/10.21203/rs.3.rs-2629632/v2 (2023b)

Ezzadin, N.A., Salih, R.F. & Sultan, D.M. A comprehensive review on Kenaf seeds and leaves for medicine. *Journal of Medicinal Plants*, *10*(**5**), pp.26-33, https://doi.org/10.22271/plants.2022.v10.i5a.1462 (2022)

Jason Thomas. The Asean Post. Kenaf: Nature's little-known wonder, https://theaseanpost.com/article/kenaf-natureslittle-known-wonder (2019)

Lee, I.S., Kang, C.H., Lee, J.J. & Kim, H.J. Development of Kenaf (*Hibiscus cannabinus* L.) Pedigrees with Superior Characteristics through Backcross. *Korean Society of Breeding Science*, *53*(**3**), pp.191-199, https://doi.org/10.9787/KJBS.2021.53.3.191 (2021)

Mohd, H., Arifin, A., Nasima, J., Hazandy, A.H. & Khalil, A. Journey of kenaf in Malaysia: a review. *Scientific Research and Essays*, *9*(**11**), pp.458 470, http://www.academicjournals.org/article/article1402393963_Basri%20et%20al.pdf (2014).

Ogunniyan, D.J., Makinde, S.A. & Omikunle, S.O. Genotypic variability and stability of fibre yield components in kenaf (*Hibiscus cannabinus* L.). *Journal of Agricultural Research and Development*, *16*(**2**), pp.22-35, DOI:10.4314/jard.v16i2.3 (2017)

Olanipekun, S.O. & Togun, A.O. Effect of planting date on the growth, fibre and seed yield of Kenaf (*Hibiscus cannabinus* L) in Ibadan, South western Nigeria. *Journal of Applied Sciences and Environmental Management*, *24*(**10**), pp.1711-1714, 10.4314/jasem.v24i10.2 (2020|)

Ryu, J., Kwon, S.J., Kim, D.G., Lee, M.K., Kim, J.M., Jo, Y.D., Kim, S.H., Jeong, S.W., Kang, K.Y., Kim, S.W. & Kim, J.B. Morphological characteristics, chemical and genetic diversity of kenaf (*Hibiscus cannabinus* L.) genotypes. *Journal of Plant Biotechnology*, *44*(**4**), pp.416-430, https://doi.org/10.5010/JPB.2017.44.4.416 (2017)

Sadhineni, M., Sreelatha, T. & Mitra, S. Performance of kenaf (*Hibiscus cannabinus* L) genotypes under varying fertilizer levels in rainfed agro-ecosystem of north coastal Andhra Pradesh. *Annals of*

*Agricultural Research*, *43*(**4**), pp.457-462, https://epubs.icar.org.in/index.php/AAR/article/view/132233 (2023)

Salih, R.F. & Qader, N.A. Environmental effect on growth and yield parameters of ten kenaf varieties (*Hibiscus cannabinus* L.) in Erbil. *Zanco Journal of Pure and Applied Sciences*, *32*(**4**), pp.169-173, http://dx.doi.org/10.21271/ZJPAS.32.4.20 (2020)

Salih, R.F. Influence of Potassium, Boron and Zinc on Growth, Yield and Fiber Quality of Two Kenaf (*Hibiscus cannabinus* L.) Varieties. *Senate of Univeriti Putra Malaysia*. (2016)

Salih, R.F., Abdan, K. & Wayayok, A. Growth responses of two kenaf varieties (*Hibiscus cannabinus* L.) applied by different levels of potassium, boron and zinc. *Journal of Agricultural Science*, *6*(**9**), pp.37-45, doi:10.5539/jas.v6n9p37 (2014b)

Salih, R.F., Abdan, K., Wayayok, A. & Hashim, N. Effect of Potassium, Boron and Zinc on Nitrogen Content in Bast and Core Fibres for Two Kenaf Varieties (*Hibiscus cannabinus* L.). *International Journal of Development Research*, *4*(**12**), pp.2581-2586, http://www.journalijdr.com (2014a)

Salih, R.F., Hamad, E.M. & Ismail, T.N. Commercial and field factors of selecting kenaf fibers as alternative materials in industrial applications. *Malaysian Journal of Sustainable Agriculture (MJSA)*, *6*(**2**), pp.85-89, http://doi.org/10.26480/mjsa.02.2022.85.89 (2022)

Salih, R.F., Ismail, T.N. & Hamad, E.M. Foliar Application of NPK Improves Growth, Yield and Fiber Morphological Properties of Some Kenaf Varieties. *Passer Journal of Basic and Applied Sciences*, *5*(**1**), pp.183-190, DOI: 10.24271/PSR.2023.387988.1267 (2023)

Salih, R.F., Rahman, K.A., Esmail, A.O., Sultan, D.M. & Wayayok, A. Response of Kenaf (*Hibiscus cannabinus* L.) Varieties to Sowing Date. *ProEnvironment Promediu*, *15*(**50**), http://journals.usamvcluj.ro/index.php/promediu (2022)

Sultan, D.M. & Salih, R.F. Nutritional Value of Different Kenaf Leaves (*Hibiscus cannabinus* L.) Varieties Enhanced by Using Different Concentrations of Humic Acid. *Zanco Journal of Pure and Applied Sciences*, *34*(**5**), pp.186-197., http://dx.doi.org/10.21271/ZJPAS.34.5.17 (2022)

Vayabari, D.A., Ilham, Z., Md Saad, N., Usuldin, S.R.A., Norhisham, D.A., Abd Rahim, M.H. & Wan-Mohtar, W.A.A.Q.I. Cultivation strategies of kenaf (*Hibiscus cannabinus* L.) as a future approach in Malaysian agriculture industry. *Horticulturae*, *9* (**8**), p.925, https://doi.org/10.3390/horticulturae9080925 (2023)