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RESPONSE OF SELECTED YIELD ATTRIBUTES OF COTTON (GOSSYPIUM HIRSUTUM L) TO VARIED ENVIRONMENTS AND SOWING ROW POSITIONS

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Abstract

Understanding the impact of different microenvironments (sowing direction and sowing dates) and row locations on yield and yield component of Coker 310 cultivar were studied. in split plot design using randomized complete block design (RCBD) and three replications was applied at two succession growing seasons of 2021 and 2022 at Grdarasha Research station, College of Agriculture Engineering Science, Salahaddin University, Erbil-Iraq.

The results showed that, there was significant differences for the two growing seasons on yield and its components for the different sowing dates (12 and 27, April), in addition, early sowing date possessed superiority over the delayed sowing date in bolls per plant, net ginning outturn lint index and seed cotton yield during both growing seasons. Meanwhile, the delayed sowing date was superior crop in seed index and seeds per boll during both growing seasons. Regarding sowing directions, data showed that the East-West orientation was superior in boll weight, seeds per boll, seed index and bolls per plant on the other hand in the N-S was superior in net ginning outturn and seed cotton yield in the first growing season. Meanwhile, the boll weight, bolls per plant, seed index, lint index, net ginning

outturn and seed cotton yield were obtained when using N-S direction in the second growing season. Meanwhile, highest seed cotton yield produced from North-South direction in the two growing seasons (2842.93 Kg. ha^{-1} and 2210.39Kg. ha^{-1}). Moreover, the statistical analysis observed to significant effect of row positions the highest values was obtained from lateral and central rows (1-3-5-7-9-11-12) for both seasons. These findings suggest that early sowing with a north-south row direction in Coker 310 cotton production might improve productivity.

Keywords: Cotton, Microenvironments, Row positions, Yield, Yield component.

استجابة بعض صفات مكونات الحاصل وحاصل القطن (*Gossypium hirsutum* L.) للبيئات المتنوعة ومواقع صفوف الزراعة

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الخلاصة

تم اجراء هذا البحث لفهم استجابة صنف القطن كوكر 310 لبيئات ومواقع خطوط زراعة مختلفة بتصميم القطاعات العشوائية الكاملة بقطع منشقة لمرة واحدة في حقل كردةرةش التابع لكلية علوم الهندسة الزراعية/ جامعة صلاح الدين لموسمي النمو المتتالين 2021 و2022. حيث شغلت البيئات الالواح الرئيسية ومواقع خطوط الزراعة الألواح الثانوية. اختلفت البيات الدقيقة في مكوناتها (مواعيد الزراعة واتجاهات الزراعة) واختلفت خطوط الزراعة الثلاثة عشر في مواقعها النسبية من مجاورة للخط المركزي (رقم 7) وخطوط متباعدة عنه متجهة نحو اليمين واليسار من 1 الى 13.

أظهرت النتائج اختلافات معنوية فيما بين موعدي الزراعة، المبكر (12 نيسان) والمتأخر (27 نيسان) في معدلات بعض صفات الحاصل ومكوناته حيث تفوق الموعد المبكر في عدد الجوز في النبات الواحد ونسبة تصافي الحلج ودليل الوبر وحاصل القطن الزهر، بينما تفوق الموعد المتأخر في دليل البذور وعدد البذور في الجوزة الواحدة خلال كلتي السنتين. كما تفوق اتجاه الزراعة (شرق–غرب) في وزن الجوزة وعدد بذور الجوزة ودليل البذور وعدد بذور النبات الواحد على الزراعة في الاتجاه (شمال– جنوب) في تصافي الحلج وحاصل القطن الزهر في السنة الأولى، في حين تفوقت الزراعة باتجاه (شمال– جنوب) خلال السنة الثانية في صفات وزن الجوزة وعدد الجوزات

في النبات ودليل البذور، كما تفوق هذا الاتجاه أيضا وخلال موسمي الزراعة في اعلى انتاج من بذور القطن وبمعدلات حاصل 2842.93 كغم هكتار$^{-1}$ خلال 2021 و2210.39 كغم هكتار$^{-1}$ خلال 2022. هذا بالإضافة الى التأثير المعنوي لمواقع خطوط الزراعة حيث تم الحصول على اعلى حاصل من خطوط الزراعة الطرفية (1-3-11-12) وخطوط الزراعة المركزية (5-7-9) ولكلا الموسمين. تشير هذه النتائج الى ان الزراعة المبكرة في اتجاه الصف الشمالي – الجنوبي في انتاج القطن Coker 310 قد تؤدي الى تحسين الانتاجية.

كلمات مفتاحية: القطن، البيئات المختلفة، خطوط الزراعة، الحاصل ومكونات الحاصل.

Introduction

Cotton (*Gossypium hirsutum* L.) is a tropical shrub that grows annually and belongs to the Malvaceae family. It is an important industrial crop cultivated across the world and is used for both fiber and oil seed production. (3). Cotton fibers are very useful since they include 90–95% cellulose as well as waxes, pectin, organic acids, and inorganic materials. Due to its exceptional physical properties, this species serves as the primary natural fiber source globally (11). The fibers are used as row materials in the textile industry and make about 35% of the weight of the cotton seeds. The remaining 65 percent of the seed cotton consists of seeds that are used for oil extraction, containing an oil content of 18–26%, which varies depending on the cultivar, field management, and environmental conditions. Moreover, after the extraction process, the cotton cake that remains is utilized as fodder due to its high protein content of 32–36% (28). Approximately 25 million tons of cotton are produced worldwide annually (20).

Microclimatic modifications can be achieved through various practices, including changes in sowing date, row orientation, and the adoption of appropriate cropping systems (21). According to various authors (19 and 27), sowing date is a critical agronomic factor that influences not only the growth and yield components of cotton but also the quality of its fibers. The optimal sowing date is essential for achieving uniform stand establishment, promoting growth, and enhancing seed cotton yield (25). Early sowing can lead to increased bloom production and a higher number of bolls per plant, resulting in greater boll weight (15 and 22). On the other hand, delayed sowing has been found to significantly reduce lint yield and result in lower boll weight (1 and 22). Different sowing dates during two years significantly affected cotton yield and yield components, with the highest lint yield achieved from an early sowing date (29). Furthermore, the sowing dates also have a significant impact on other factors such as GOT (%), bolls per plant, boll weight, seed index, and overall cotton yield (24). The row direction of crops plays a crucial role not only in influencing crop yield but also in preserving soil water by reducing evaporation. However, the impact of row direction on crop yield varies depending on the specific farming system and the cultivars of the crops (10). Scientists were varied in preferring north-south as compared with east-west row directions. In the north-south row direction, growing plants are subjected to the highest light interception compared to the east-west (1). (5) found that in terms of direction of sowing, maximum fruit weight, number of seeds per fruit, seed weight per fruit, and seed yield were higher in the east-west direction than in the north-south direction. Row orientation on seed and forage yield of grass sorghum was experimented

with by (23), where 4 sowing directions were tried: east-west, north-south, north-eastern, and north-western. Results showed that maximum and minimum seed yield, 1000 seed weight and number of tillers were obtained when using the north-south direction rather than the east-west orientation. The seed cotton yield significantly increased when the crop was sown on April 30th, with yields of 3203 and 3370 kg ha^{-1} recorded at both locations. Additionally, adopting an east-west row orientation further improved yields, with 3038 and 3085 kg ha^{-1} recorded at both locations (13).

The primary aim of this research was to assess the impact of row direction, sowing row positions on cotton performance and examine how sowing dates affect the responses of cotton crops.

Materials and Methods

Study area**:** The experiment was conducted at the Girdarasha Agriculture Research Station. Belongs to the Department of Field Crops and Medicinal Plants / college of Agriculture Engineering Sciences at the University of Salahaddin in Erbil, Kurdistan in Erbil (Latitude: 36° 4' N and Longitude: 44° 2' Elevation 415 Meters above sea level) two growing seasons 2020-2021 and 2021-2022.

The experiment design: Experiment was organized in a Randomized Complete Block design (RCBD) with a split-plot arrangement and three replications: The main plot (A) consisted of four microenvironment levels, including; east-west first sowing date 12 April (E1), north-south first sowing date 12 April (E2), east-west second sowing date 27 April (E3) and north-south second sowing date 27 April (E4) as shown in table 1. The sub plot (B) included thirteen sowing rows (used also as row positions). The American type cotton cultivar sown in this study was Coker 310, released and recorded in Iraq), The experiment was repeated in two consecutive growing seasons of the years 2020– 2021 and 2021–2022 the microenvironments were allotted to main plots, and the sowing rows was allotted to a subplot. The main plot area of 8.40m x 5.25m. Subplot size was 5.25m x 0.70m, contained 21 plants interspaced by 0.7 meters between rows and 0.25m between plants, so that each plant occupied 0.175 m^{-2}.

Table 1: defining the four studied environments (main plots).

SOWING ROW ORIENTATION	SOWING DATE	
	12 April	27 April
EAST-WEST	E1	E3
NORTH- SOUTH	E2	E4

Soil preparation and water management: Field experiment soil was prepared for cultivation by ploughing with two perpendicular directions by using mold board plow. The soil was well softened by rotavator and leveled then rows established. To insure proper spacing and seed depth sowing, dibbling process was practiced where seeds inserted manually into the soil using wood sticks labelled to not insert more than 3cm depth to achieve plant density of 57143 plants ha^{-1} (about 25 kg seeds ha^{-1}) DAP fertilizer (45% P_2O_5) applied once with the rate (240Kg.ha^{-1}) and Urea (46% N) with two doses rated (160 Kg ha^{-1}). The First dose was applied at planting and the second dose was after thinning equally quantum (6). The plots were drip-irrigated and maintained well-watered throughout the growing season. The first pick was conducted

on 1st September 2021, while for the second-year, first pick was conducted on 2 September 2022. The second pick was conducted on 2 October (one-month interval) for both years 2021 and 2022.

Soil Sampling: Prior to the setting of the experiment, soil samples were randomly collected from the land at a depth of 0 to 30 cm. After that, the sample was transported to the lab. Following air drying, the soil was sieved using a 2 mm size of pore sieve. The chemical and physical characteristics of the soil for the both years are displayed in Table 2.

Table 2: Physicochemical properties of the soil sample for the location of experiments 2021 and 2022.

Physicochemical properties		Average value 2021	Average value 2022
Particles size distribution (Kg-1)	Sand	25.5	31.0
	Silt	42	37.3
	Clay	32.8	31.7
	Texture	Clay loam	Clay loam
PH		7.2	7.83
EC(MICRO SIMRNS CM^{-1})		0.48	0.5
O.M (G KG^{-1})		1.8	1.14
$CaCO_3$(g Kg^{-1})		304	312

Meteorological Data Collection The meteorological during the summer growing seasons of 2021 and 2022 in Grdarasha is displayed in Figure 1. The Ainkawa Research Station provided the data.

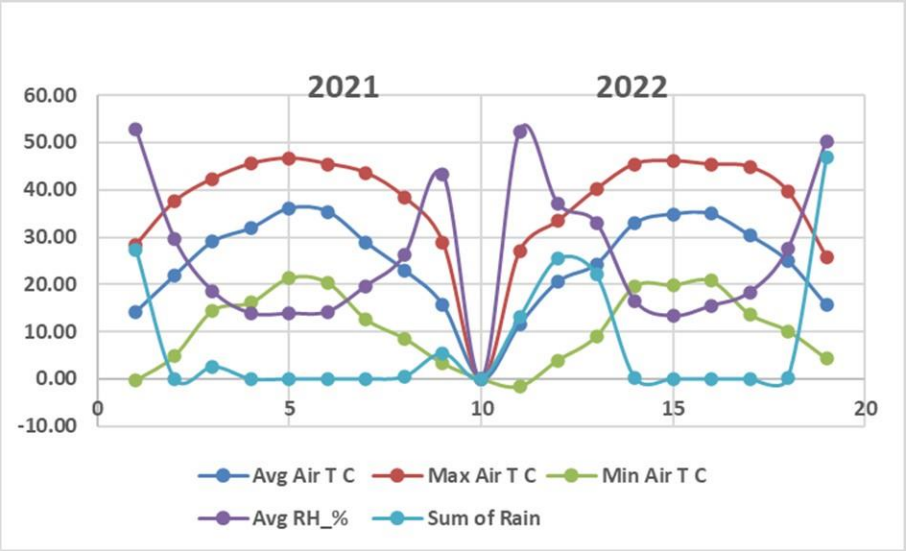

Fig. 1: Meteorological data during both years (2021 and 2022) Erbil Agricultural Research center.

Studied parameters:

1- Average boll weight (g): Using five bolls from the first pick and five more from the second pick in each row, the mean boll weight was determined by weighing ten full-measured bolls.
2- Number of seeds per boll: Determined by counting the number of seeds in ten completely opened bolls from the plants.

3- Number of bolls per plant. Calculated as the average all of the opened bolls from 7 plants.
4- Seed index (g): Calculated as the weight of 100 seeds in grams by randomly selecting and weighing 100 seeds from each sample after ginning.
5- Lint Index (%): Calculated as the weight of fiber yielded from 100 seeds, using the following formula:

$$\text{Fiber index} = \frac{seed\ index\ x Net\ ginning}{100 - Net\ ginning percentage} \qquad (7 \text{ and } 14)$$

6- Net ginning outturn (%): Net ginning outturn was determined by mixing the cotton yield of the first and second picking and taking a 500-gram sample from each experimental unit, using the following formula:

$$\text{Net ginning outturn} = \frac{Weihth\ of\ lint\ cotton}{Weight\ of\ seed\ cotton} \text{ X } 100 \qquad (7 \text{ and } 14)$$

7- Seed cotton yield: (1^{st} +2^{nd} Kg. ha^{-1})

Statistical analysis: The data for each character were analyzed statistically using SAS (version 2003, SAS, institute Inc. cary, Nc, USA) program. Differences between means were tested using Tukey's method test at a probability level of ($P \leq 0.05$) for all the studied characters according to (17). The analyses of this experiment were unique because the sample size was equal to the size of the population as explained above.

Results and Discussion

Average boll weight: This parameter in the first year was non-significantly influenced by environment, and row positions, but significantly influenced by the interaction of factors. Table 3 the maximum and minimum weight of bolls (4.82g and 3.29g) were recorded from E3 X R6 and E2 X R5, respectively based on the interaction between environments and row positions. These first-year results are consistent with those reported by (12), which demonstrated that alternative sowing dates have little effect on the boll weight per plant. (1) For ear grain weight, the East-West (E-W) row orientation exceeded the North-South (N-S) row orientation. although, in 2022 environment factors was non-significantly influenced boll weight as indicated in table 3 but the row positions and their interaction were significantly influenced boll weight, the maximum and minimum values in row positions were noticed (4.31g and 3.79g) from R1 and R6 treatments, respectively. Significantly, a maximum and minimum average boll weight per plant 4.72g and 3.40g was observed at interaction E2 X R12 and E4 X R9, respectively. These finding are in agreement with the previous research on the effect of row direction on average boll weight (26).

Table 3: Influence of environments and row positions on average boll weight (g plant^{-1}) for cotton plant.

Year	2021				
ROW	Environment				Average row
	E1	E2	E3	E4	
R1	3.99 a-e	3.54 c-e	4.53 a-c	4.66 ab	4.18 a
R2	4.11 a-e	3.36 de	4.41 a-d	4.62 a-c	4.12 a
R3	4.24 a-e	3.79 a-e	4.71 ab	4.50 a-c	4.31 a
R4	4.76 a-b	3.81 a-e	4.59 a-c	4.16 a-e	4.33 a
R5	4.48 a-c	3.29 e	4.60 a-c	4.69 ab	4.27 a
R6	4.46 a-c	3.68 b-e	4.82 a	4.56 a-c	4.38 a
R7	4.20 a-e	4.04 a-e	4.68 ab	4.66 ab	4.39 a
R8	4.40 a-d	4.40 a-d	4.20 a-e	4.36 a-e	4.34 a
R9	4.49 a-c	4.20 a-e	4.47 a-c	4.53a-c	4.42 a
R10	4.76 ab	4.25 a-e	4.32 a-e	4.12a-e	4.36 a
R11	4.22 a-e	4.05 a-e	4.58 a-c	4.27 a-e	4.28 a
R12	4.30 a-e	4.13 a-e	4.34 a-e	4.53 a-c	4.32 a
R13	4.35 a-e	4.45 a-c	4.56 a-c	4.46 a-c	4.45 a
Average environment	4.36 a	3.92 a	4.52 a	4.47 a	
Year	2022				
	Environment				
Row	E1	E2	E3	E4	Average row
R1	4.56 a	4.52 ab	3.86 a-d	4.31 a-d	4.31 a
R2	3.82 a-d	4.48 abc	3.78 a-d	4.27 a-d	4.09 ab
R3	4.45 abc	4.33 a-d	3.74 a-d	4.11 a-d	4.16 ab
R4	4.20 a-d	4.40 a-d	3.94 a-d	4.06 a-d	4.15 ab
R5	4.09 a-d	4.05 a-d	3.70 a-d	3.98 a-d	3.95 ab
R6	4.09 a-d	3.84 a-d	3.75 a-d	3.49 a-d	3.79 b
R7	4.54 ab	4.22 a-d	3.71 a-d	3.75 a-d	4.06 ab
R8	4.53 ab	4.10 a-d	3.69 a-d	3.68 a-d	4.00 ab
R9	4.34 a-d	4.30 a-d	3.79 a-d	3.40 d	3.95 ab
R10	4.26 a-d	4.20 a-d	4.03 a-d	3.46 cd	3.99 ab
R11	4.60 a	4.13 a-d	3.87 a-d	3.80 a-d	4.10 ab
R12	4.41 a-d	4.72 a	3.99 a-d	3.76 a-d	4.22 ab
R13	4.46 abc	4.45 abc	4.02 a-d	3.75 a-d	4.17 ab
Average Environment	4.34 a	4.29 a	3.84 a	3.83 a	

Note: The means with different alphabetic letters differed significantly at (p =0.05) based on multiple range test of tukys.
E1 = E-W date1, E2= N-S date1, E3= E-W date2, E4= N-S Date 2
N=North, S= South, E= East, W= West, Date = Sowing date R= Row position.

Number of seeds per boll: According to the data presented in Table 4 number of seeds boll^{-1} significantly affected by different environments. The largest number of seeds (25.25 and 31.20 seeds boll^{-1}) seen in E3 for each of the two years may be the result of an increase in E3's average boll weight. While the smallest number of seed were (20.68 and 28.92 seeds boll^{-1}) respectively recorded from E2 and E1 for the both years. These results are in line with (5) reported that the east-west row direction had a higher number of seeds per fruit. It appears from the previous results in Table 4, different row positions affected significantly on number of seeds plant-1 the highest values were (24.81 and 32.34 seeds boll^{-1}) were recorded for R7 and R4 for the both

years respectively. while, lowest values 21.55 and 27.97 were observed from R10 and R1 respectively. Significant difference was noticed on number of seeds boll^{-1} due to the combination between environment treatments and row positions, according to the data represents in Table 4 which shows the maximum and minimum mean value (29.27 and 15.87 seeds boll^{-1}) which recorded form the interaction between E4 X R5 and E2 X R6 for the 1st year. On the other hand, the maximum and minimum value for the 2nd year were (34.93 and 26 seeds boll^{-1}) recorded from interaction between E1 X R2 and E1 XR2 and E2 X R3. These findings agree with (1)'s results that there are less seeds per row and ear in a north-south direction than in an east-west one.

Table 4: Influence of environments and row positions on number of seeds per boll for cotton plant.

Year	**2021**				
ROW	Environment				Average row
	E1	E2	E3	E4	
R1	22.07 e-k	20.13 i-m	24.60 b-i	26.30 a-f	23.28 abc
R2	22.27 e-k	19.90 j-m	25.57 a-h	23.63 c-k	22.84 bc
R3	21.87 f-k	20.40 i-m	25.63 a-h	24.23 b-j	23.03 abc
R4	23.37 c-k	19.90 j-m	25.30 a-h	23.70 c-k	23.07 abc
R5	22.97 c-k	19.90 j-m	24.10 b-j	29.27 a	24.06 ab
R6	25.23 a-h	15.87 m	27.53 a-c	25.47 a-h	23.53 ab
R7	23.33 c-k	21.33 h-k	28.43 ab	26.13 a-g	24.81 a
R8	23.83 c-k	22.57 e-k	23.80 c-k	25.67 a-h	23.97 ab
R9	23.63 c-k	19.27 k-m	27.20 a-d	26.50 a-e	24.15 ab
R10	16.57 lm	23.70 e-k	23.50 c-k	23.13 c-k	21.55 c
R11	20.47 i-l	21.30 h-k	27.23 a-d	22.87 d-k	22.97 abc
R12	22.17 e-k	21.67 g-k	21.77 f-k	24.67 b-i	22.57 bc
R13	22.57 e-k	23.90 b-j	23.67 c-k	25.60 a-h	23.93 ab
Average environment	22.33 b	20.68 b	25.26 a	25.17 a	
Year	2022				
	Environment				
Row	E1	E2	E3	E4	Average row
R1	27.13 f-h	26.13 h	30.67 a-h	27.93 d-h	27.97 c
R2	26.00 h	29.87 a-h	34.40 abc	28.73 b-h	29.75 bc
R3	29.20 a-h	26.00 h	29.60 a-h	31.60 a-h	29.10 bc
R4	34.93 a	28.27 d-h	34.67 ab	31.50 a-h	32.34 a
R5	27.73 e-h	29.93 a-h	31.67 a-h	28.67 b-h	29.50 bc
R6	28.87 a-h	26.87 gh	29.40 a-h	28.53 c-h	28.42 bc
R7	27.53 e-h	28.67 b-h	33.47 a-e	31.27 a-h	30.23 abc
R8	28.07 d-h	28.73 b-h	34.00 a-d	27.40 e-h	29.55 bc
R9	27.73 e-h	28.00 d-h	28.73 b-h	28.73 b-h	28.30 bc
R10	30.13 a-h	32.67 a-g	27.60 e-h	31.73 a-h	30.53 ab
R11	29.47 a-h	31.20 a-h	31.47 a-h	30.13 a-h	30.57 ab
R12	29.87 a-h	30.33 a-h	28.93 a-h	33.20 a-f	30.58 ab
R13	29.27 a-h	30.47 a-h	31.00 a-h	28.13 d-h	29.72 bc
Average Environment	28.92 b	29.01 b	31.20 a	29.81 ab	

Note: The means with different alphabetic letters differed significantly at (p =0.05) based on multiple range test of tukys.
E1 = E-W date1, E2= N-S date1, E3= E-W date2, E4= N-S Date 2
N=North, S= South, E= East, W= West, Date = Sowing date, R= Row positions.

Number of bolls per plant: Table 5 clarified that environment affected significantly on the number of boll plant^{-1} in 1st and 2nd years. The highest and lowest values in the 1st season were (12.81 and 10.34) obtained from E1 and E2 and in the 2nd season was 13.79 and 10.26 recorded from E2 and E3 bolls plant^{-1} respectively. increase number of bolls per plant in early sowing date might be due to increase to a relatively longer period of the crop in the field over the cropping season, which maximizes period for the use of growth resources. Table 5 showed that the number of bolls per plant was improved significantly by different row positions, the highest values (13.31 and 15.48 bolls plant^{-1}) were recorded from R1 and R5 for the 1st and 2nd years respectively, while R11 and R2 recorded the lowest values which were (9.45 and 10.38 bolls plant^{-1}) respectively, might be led to lateral row affected by agro-climatic conditions. The two-factor combination (environments and row positions) were also found to be significant on the studied traits, the highest and lowest values were (16.93 and 7.00) and (24.43 and 6.80) bolls plant^{-1} were recorded for (E1 X R1 and E4 X R6) and (E2 X R5 and E3 X R1) for the 1st and 2nd years respectively. These results are in line with (12, 16) reported that the early sowing significant positive impact on the number of bolls per plant. The result in the first year is similar with what was obtained by (5) Significantly higher number of seeds per plant values were obtained in the east-west row direction.

Table 5: Influence of environments and row positions on number of bolls per plant for cotton plant.

Year	2021				
ROW	Environment				Average row
	E1	E2	E3	E4	
R1	16.93 a	9.90 l-s	13.60 d-g	12.80 d-k	13.31 a
R2	13.40 d-h	9.07 p-f	16.47 a-c	9.60 n-t	12.13 bc
R3	14.07 b-f	8.97 p-t	9.30 o-t	11.40 f-p	10.93 d
R4	13.13 d-i	10.30 i-s	11.47 f-p	8.47 q-t	10.84 d
R5	13.60 d-g	8.97 p-t	11.10 g-q	10.67 h-r	11.08 cd
R6	11.60 f-p	9.64 n-t	9.73 m-t	7.00 t	9.49 e
R7	14.47 a-e	10.00 k-s	12.53 d-m	11.53 f-p	12.13 bc
R8	11.67 e-p	9.13 o-t	13.67 c-g	15.00 a-d	12.37 ab
R9	14.13 a-f	11.93 e-o	10.20 j-s	12.93 d-j	12.30 ab
R10	11.80 e-p	10.67 h-r	16.53 ab	11.30 f-q	12.58 ab
R11	7.60 st	9.93 l-s	10.67 h-r	9.60 n-t	9.45 e
R12	12.73 d-l	13.10 d-i	9.13 o-t	11.60 f-p	11.64 bcd
R13	11.40 f-p	12.87 d-j	12.27 d-n	7.93 r-t	11.12 cd
Average environment	12.81 a	10.34 c	12.05 b	10.76 c	
Year	2022				
	Environment				
Row	E1	E2	E3	E4	Average row
R1	15.09 b-f	11.74 g-q	6.80 t	14.42 b-h	12.01 bcd
R2	9.45 o-t	10.88 j-s	8.77 p-t	12.43 d-o	10.38 e
R3	8.67 q-t	12.00 e-p	10.32 l-s	10.67 k-s	10.41 e
R4	9.77 m-t	15.88 bc	8.33 r-t	12.18 d-o	11.54 cde
R5	12.98 c-m	24.43 a	13.00 c-m	11.53 g-r	15.48 a
R6	12.87 c-m	13.88 b-k	8.66 q-t	12.56 d-o	11.99 bcd
R7	14.70 b-g	11.99 e-p	8.88 p-t	11.11 i-s	11.67 cde
R8	14.23 b-i	15.33 bcd	11.33 h-s	9.35 o-t	12.56 bc
R9	11.62 g-r	15.22 b-e	12.78 c-n	10.03 l-t	12.41 bc
R10	14.17 b-j	12.88 c-m	11.32 h-s	8.13 st	11.63 cde
R11	13.21 c-l	12.33 d-o	10.44 l-s	9.57 n-t	11.39 cde
R12	11.95 e-q	10.77 k-s	9.89 m-t	11.22 h-s	10.96 de
R13	16.60 b	11.88 f-q	12.88 c-m	11.55 g-r	13.23 d
Average Environment	12.72 b	13.79 a	10.26 d	11.13 c	

Note: The means with different alphabetic letters differed significantly at (p =0.05) based on multiple range test of tukys.
E1 = E-W date1, E2= N-S date1, E3= E-W date2, E4= N-S Date 2
N=North, S= South, E= East, W= West, Date = Sowing date R= Row positions.

Seed index (weight of 100 seeds g): Seed index is one of the important characters that directly contributed to the yield. As shown in Table 6 seed index in 1st and 2nd years non-significantly influenced by environments, but significantly influenced by row positions in the second year. the highest and lowest value of seed index was 9.75 and 8.21 g for (R4 and R6) respectively for the 2nd year. Weight of the 100 seed were affected significantly by the interaction between environments and row positions. The highest mean values were (10.79 and 10.56 g) respectively founded for the both years from the interaction treatment of E3 X R5 and E4 X R4. In opposing, the lowest values (7.27 and 7.66 g) were founded from interaction treatment of E2 x R5 and E3 x R1

respectively for the both years. These results obtained are similar to those that reported by (23), they found that sunflower grown at Minnesota in EW, NS and 16 other magnetic compass row directions did not differ in 100-achene weight. These finding are in agreement with the previous research on the effect of sowing direction on the seed index (1) found that the highest seed index was produced in an East-West orientation. (26) north-south row orientation significantly higher seed index when compared to the east-west row direction.

Table 6: Influence of environments and row positions on seed index for cotton plant.

Year	**2021**				
ROW	Environment				Average row
	E1	E2	E3	E4	
R1	8.80 ab	8.20 ab	9.39 ab	9.77 ab	9.04 a
R2	8.88 ab	8.59 ab	8.48 ab	9.42 ab	8.85 a
R3	8.65 ab	7.49 b	8.27 ab	9.00 ab	8.36 a
R4	9.29 ab	9.83 ab	8.67 ab	9.21 ab	9.25 a
R5	9.30 ab	7.27 b	10.79 a	8.62 ab	8.99 a
R6	9.07 ab	8.92 ab	8.94 ab	9.55 ab	9.12 a
R7	9.49 ab	9.23 ab	9.42 ab	9.22 ab	9.34 a
R8	8.92 ab	9.00 ab	8.51 ab	9.26 ab	8.92 a
R9	8.94 ab	8.98 ab	9.58 ab	9.88 ab	9.35 a
R10	9.16 ab	9.10 ab	8.77 ab	8.80 ab	8.96 a
R11	8.23 ab	8.53 ab	9.63 ab	9.45 ab	8.96 a
R12	9.86 ab	9.35 ab	9.11 ab	9.58 ab	9.48 a
R13	8.93 ab	9.71 ab	9.09 ab	8.97 ab	9.17 a
Average environment	9.04 a	8.78 a	9.13 a	9.29 a	
Year	2022				
	Environment				
Row	E1	E2	E3	E4	Average row
R1	9.81 ab	9.70 ab	7.66 b	9.53 ab	9.18 ab
R2	9.14 ab	9.24 ab	9.29 ab	9.65 ab	9.33 ab
R3	9.53 ab	9.57 ab	9.38 ab	9.18 ab	9.42 a
R4	8.86 ab	10.22 ab	9.38 ab	10.56 a	9.75 a
R5	8.83 ab	9.26 ab	9.28 ab	8.43 ab	8.95 ab
R6	8.30 ab	8.85 ab	7.82 ab	7.86 ab	8.21 b
R7	8.77 ab	9.47 ab	8.96 ab	8.19 ab	8.85 ab
R8	9.63 ab	9.15 ab	8.17 ab	8.58 ab	8.88 ab
R9	10.23 ab	10.13 ab	9.31 ab	8.48 ab	9.54 a
R10	9.08 ab	8.46 ab	9.80 ab	8.06 ab	8.85 ab
R11	10.13 ab	10.01 ab	9.15 ab	8.18 ab	9.37 a
R12	9.13 ab	10.01 ab	9.13 ab	9.87 ab	9.53 a
R13	9.11 ab	9.44 ab	9.01 ab	7.86 ab	8.85 ab
Average Environment	9.27 a	9.50 a	8.95 a	8.80 a	

Note: The means with different alphabetic letters differed significantly at (p =0.05) based on multiple range test of tukys.
E1 = E-W date1, E2= N-S date1, E3= E-W date2, E4= N-S Date 2
N=North, S= South, E= East, W= West, Date = Sowing date.

Lint index: According to the data presented in Table 7 there were non-significant differences between environments for lint index in the first year as compared to second year that significantly affected by environments the highest value was noticed from the (E1 and E2) (5.38%) while, the lowest lint index 4.74 was recorded from E4 in the second year. increase lint index was due to increase number of fruiting branches and number of bolls per plant. The different row positions significantly affected on lint index. The maximum mean values of lint index (5.35 and 5.49 %) were recorded from R5, R7 and R4 although minimum values 4.66 and 4.69 were observed from R3 and R6 respectively, for both years. The statistical analysis of the data revealed that the interaction between environments and row positions shows that the maximum values (6.09%) was recorded from interaction treatment of E2 X R4) for second year as compared to the first year non-significant effected on the lint index. On the other hand, the lowest value (4.03%) was noted from interaction treatment E3 X R8 in the second year. Our finding is in accordance with a study (30) to find that the early sowing date showed higher lint index as compared to delayed sowing date. The inconsistent in their results may be attributed to the effect many factors such as light, temperature and weeds which are crucial for crop production.

Table 7: Influence of environments and row positions on lint index for cotton plant.

Year	2021				
ROW	Environment				Average row
	E1	E2	E3	E4	
R1	5.09 a	5.12 a	4.74 a	5.42	5.09 ab
R2	4.95 a	5.45 a	4.46 a	5.08a	4.99 ab
R3	4.88 a	4.88 a	4.70 a	4.19 a	4.66 b
R4	4.93 a	4.91 a	4.31 a	5.42 a	4.89 ab
R5	5.22 a	5.44 a	5.36 a	5.40 a	5.35 a
R6	5.36 a	5.59 a	4.63 a	5.00 a	5.15 ab
R7	5.25 a	5.50 a	5.25 a	5.40 a	5.35 a
R8	5.19 a	4.91 a	4.61 a	5.31 a	5.00 ab
R9	4.98 a	5.38 a	5.08 a	5.19 a	5.16 ab
R10	5.65 a	5.37 a	4.76 a	5.04 a	5.20 ab
R11	4.89 a	5.53 a	5.15 a	5.18 a	5.19 ab
R12	5.04 a	5.34 a	4.73 a	5.01 a	5.03 ab
R13	5.21 a	5.12 a	4.69 a	4.51 a	4.88 ab
Average environment	5.13 a	5.27 a	4.80 a	5.09 a	
Year	2022				
	Environment				
Row	E1	E2	E3	E4	Average row
R1	5.62 a-f	4.98 a-g	4.14 e-g	5.41 a-g	5.04 abc
R2	5.31 a-g	4.80 a-g	5.24 a-g	4.90 a-g	5.06 abc
R3	5.54 a-g	5.45 a-g	5.17 a-g	4.69 a-g	5.21 abc
R4	5.38 a-g	6.09 a	5.20 a-g	5.30 a-g	5.49 a
R5	5.33 a-g	5.29 a-g	5.19 a-g	4.77 a-g	5.15 abc
R6	4.68 a-g	5.32 a-g	4.72 a-g	4.04 f-g	4.69 c
R7	5.05 a-g	5.83 abc	4.57 z-g	4.79 a-g	5.06 abc
R8	5.63 a-f	4.98 a-g	4.03 g	4.55 a-g	4.80 bc
R9	5.63 a-e	5.94 ab	4.89 a-g	4.65 a-g	5.28 abc
R10	5.31 a-g	4.79 a-g	4.73 a-g	4.38 b-g	4.80 bc
R11	5.75 a-d	5.65 a-e	4.78 a-g	4.31 c-g	5.13 abc
R12	5.62 a-f	5.34 a-g	5.12 a-g	5.64 a-e	5.43 ab
R13	5.10 a-g	5.43 a-g	4.93 a-g	4.20 d-g	4.91 abc
Average Environment	5.38 a	5.38 a	4.82 b	4.74 b	

Note: The means with different alphabetic letters differed significantly at (p =0.05) based on multiple range test of tukys.
E1 = E-W date1, E2= N-S date1, E3= E-W date2, E4= N-S Date 2
N=North, S= South, E= East, W= West, Date = Sowing date, R= Row positions.

Net ginning out turns: Table 8 showed that the effect of environments and row positions on percentage of net ginning out tern. It was observed that there were significant differences between environments on this trait in both years, the highest values (36.85% and 36.66%) were recorded from E2 and E1 respectively for the both years, while the lowest values (34.82% and 34.93%) were recorded from E3 and E4 respectively for the both years. ginning outturn percentage lower values in delayed sowing due to a shortened fruiting period and delayed maturity as compared to the early sowing date (9). The results in net ginning outturn are in agreement with those of (8) to reported that early sowing date of cotton recorded maximum net ginning outturn

than delayed sowing. The presented data in table 8 reveled that row positions non significantly affected on the ginning out tern percentage in 1st year as compared to 2nd year significantly affected the highest and lowest value was (36.52% and 34.38%) for R5 and R12 respectively. The table also shows the interaction between environments and rows which significantly affected on net ginning out-turn percentage, the highest values were recorded from combination between E2 X R4 and E1 X R12, E2 X R7 for (40.52% and 38.08%) respectively, while the lowest values were recorded from combination between E4 X R12 and E3 X R10 (33.45% and 32.45%) respectively which were during 1st and 2nd years. These results are in agreement with (4) noticed that Early sowing of cotton resulted in significantly higher ginning out turn percentage at. On the other hand, the orientation of the rows, whether East-West or North-South, did not show any significant difference in net ginning percentage in both study regions.

Table 8: Influence of environments and row positions on net ginning out turn percentage for cotton plant.

Year	**2021**				
ROW	Environment				Average row
	E1	E2	E3	E4	
R1	36.62 a-f	36.52 a-f	33.53 c-f	35.27 b-f	35.55 a
R2	35.95 b-f	37.52 a-c	34.45 b-f	33.45 b-f	35.80 a
R3	36.03 b-f	37.43 a-d	36.18 b-f	36.98 d-f	35.78 a
R4	34.58 b-f	40.52 a	33.12 ef	35.37 a-e	36.30 a
R5	35.92 b-f	37.55 a-c	35.45 b-f	35.03 b-f	36.07 a
R6	34.88 b-f	34.03 c-f	35.17 b-f	34.60 b-f	34.78 a
R7	35.52 b-f	38.37 ab	36.52 a-f	36.40 b-f	36.25 a
R8	36.82 a-e	35.23 b-f	35.23 b-f	34.50 b-f	35.92 a
R9	35.72 b-f	37.48 a-c	34.58 b-f	36.40 b-f	35.57 a
R10	37.53 a-c	36.45 b-f	35.22 b-f	35.38 b-f	36.40 a
R11	35.95 b-f	36.43 b-f	34.93 b-f	32.60 b-f	35.68 a
R12	35.53 b-f	36.80 a-e	34.18 c-f	33.45 f	34.78 a
R13	36.82 a-e	34.67 b-f	34.12 c-f	35.27 d-f	34.76 a
Average environment	35.99 ab	36.85 a	34.82 c	35.00 bc	
Year	2022				
	Environment				
Row	E1	E2	E3	E4	Average row
R1	36.32 a-e	33.82 b-e	35.15 a-e	36.30 a-e	35.40 ab
R2	36.78 a-d	34.10 a-e	36.07 a-e	33.70 b-e	35.16 ab
R3	36.75 a-d	36.22 a-e	35.53 a-e	33.75 b-e	35.56 ab
R4	36.83 a-d	37.38 abc	35.70 a-e	33.47 cde	35.85 ab
R5	37.67 ab	36.42 a-e	35.83 a-e	36.17 a-e	36.52 a
R6	36.03 a-e	37.53 abc	37.57 abc	33.93 b-e	36.27 a
R7	36.48 a-e	38.08 a	33.75 b-e	36.87 a-d	36.30 a
R8	37.00 a-d	35.32 a-e	33.02 de	34.63 a-e	34.99 ab
R9	35.48 a-e	36.93 a-d	34.47 a-e	35.40 a-e	35.57 ab
R10	37.03 a-d	36.20 a-e	32.45 e	35.30 a-e	35.25 ab
R11	36.23 a-e	33.53 cde	34.28 a-e	33.45 cde	34.38 b
R12	38.08 a	34.85 a-e	35.88 a-e	36.37 a-e	36.30 a
R13	35.83 a-e	36.47 a-e	35.33 a-e	34.82 a-e	35.61 ab
Average Environment	36.66 a	35.91 a	35.00 b	34.93 b	

Note: The means with different alphabetic letters differed significantly at (p =0.05) based on multiple range test of tukys.
E1 = E-W date1, E2= N-S date1, E3= E-W date2, E4= N-S Date 2
N=North, S= South, E= East, W= West, Date = Sowing date R= Row positions.

Seed cotton yield: Seed cotton yield is the most vital among cotton production, which is directly related to number of bolls per plant. Thus, by focusing on Table 9 seed cotton yield for the first- and second-years significant differences by environments and row positions. Maximum values of seed cotton yield (2842.93 and 2210.39 kg ha^{-1}) were recorded from E2 in the 1st and 2nd years; however, the minimum values (2370.43 and 1527.38 kg ha^{-1}) were recorded from E1 and E4 respectively. increase seed cotton yield was due to increase number of bolls per plant and boll weight. The different row positions significantly affected on seed cotton yield the highest seed cotton yield in the first and second years (3321.03 and 2163.58 kg ha^{-1}) were recorded from R13 and R1 respectively for the both years, on the other hand the lowest seed cotton yield (2245.95 and 1652.18 kg ha^{-1}) were recorded from R5 and R13 respectively in both years. Additionally, interaction of factors E2 X R12 and E1 X R7 was recorded the highest yield of seed cotton yield in which (5010.77 and 2775.79 kg ha^{-1}) respectively in 1st and 2nd years, while the lowest seed cotton yield (1238.39 and 894.57 kg ha^{-1}) was recorded from E2 X R1 and E4 X R11 respectively for the both years. Early sowing of cotton leads to a higher number of branches per plant, increased boll size, greater boll weight, a higher seed index, and a larger number of bolls, all contributing to an overall improvement of yield. On the other hand, delayed sowing cotton exhibits a poor seed cotton yield due to its shorter growth period. These results are in agreement with (2 and 18) found that early sowing produced crops with the highest seed cotton yield on the other hand decrease in seed cotton yield with delayed sowing. These results are in line with (17) found that north-south rows intercepted more light than east-west rows in cotton plant. and those sown in the north-south direction yielded about 11% higher grain yield compared to those sown east-west.

Table 9: Influence of environments and row positions on seed cotton yield (kg. ha^{-1}) for cotton plant.

Year	2021				
ROW	Environment				Average row
	E1	E2	E3	E4	
R1	2146.15 r-w	1238.39 x	2402.34 n-u	3206.86 d-g	2248.44 g
R2	2491.70 l-s	2062.12 t-w	2435.16 m-t	2678.29 i-o	2416.82 fg
R3	2078.23 s-w	2482.57 l-t	2939.92 f-k	2120.22 s-w	2405.23 fg
R4	3156.41 d-h	2684.11 i-o	2570.86 j-r	2159.47 r-w	2642.71 cde
R5	2170.61 q-w	1751.92 w	2242.48 p-u	2818.78 g-n	2245.95 g
R6	2217.44 q-v	2195.95 q-v	2433.58 m-t	3138.64 d-h	2496.40 ef
R7	1798.29 vw	3841.52 b-c	2556.65 k-r	2841.20 f-m	2759.41 cd
R8	2986.42 f-j	2588.33 j-q	2822.57 f-n	2283.24 o-u	2670.14 cde
R9	2875.24 f-l	3250.18 d-f	2950.80 f-k	3455.89 d-e	3133.03 b
R10	2293.33 o-u	2728.76 h-n	2664.00 i-p	3073.01 e-i	2689.78 cd
R11	2059.92 t-w	4039.97 b	3119.48 d-h	1979.02 u-w	2799.60 c
R12	2483.78 l-t	5010.77 a	2243.65 p-u	3545.90 d-c	3321.03 a
R13	2058.08 t-w	3083.48 e-j	2786.18 g-n	2559.10 j-r	2621.71 de
Average environment	2370.43 c	2842.93 a	2628.28 b	2758.43 a	
Year	2022				
	Environment				
Row	E1	E2	E3	E4	Average row
R1	2172.72 c-h	2399.24 a-e	1531.99 n-r	2550.39 abc	2163.58 a
R2	1843.08 g-n	1965.58 f-m	1766.44 i-p	1707.64 k-p	1820.69 bc
R3	1589.40 m-q	2318.57 b-f	1547.00 n-r	2278.32 c-f	1933.32 b
R4	1548.27 n-r	2019.68 e-k	1753.89 j-p	2152.45 c-j	1868.57 bc
R5	1696.83 k-p	2159.45 c-i	1582.20 m-q	1542.45 n-r	1745.23 cd
R6	1207.44 q-t	2453.54 a-d	1611.85 l-p	1670.16 k-p	1735.75 cd
R7	2775.79 a	1422.41 o-s	1668.43 k-p	1379.63 p-s	1811.57 bcd
R8	1868.72 g-n	2155.10 c-j	1997.56 f-l	1383.97 o-s	1851.34 bc
R9	1733.52 k-p	2332.16 b-f	2015.47 e-k	1121.20 st	1800.59 bcd
R10	1835.11 g-n	2183.84 c-h	1783.78 h-o	1174.39 r-t	1744.28 cd
R11	2430.99 a-d	2274.47 c-f	2203.17 c-g	894.57 t	1950.80 b
R12	1610.59 l-p	2364.35 b-f	1594.69 m-q	1039.08 st	1652.18 d
R13	2065.88 d-k	2686.74 ab	1736.80 k-p	961.64 t	1862.77 bc
Average Environment	1875.26 b	2210.39 a	1753.33 b	1527.38 c	

Note: The means with different alphabetic letters differed significantly at (p =0.05) based on multiple range test of tukys.
E1 = E-W date1, E2= N-S date1, E3= E-W date2, E4= N-S Date 2
N=North, S= South, E= East, W= West, Date = Sowing date R= Row positions.

Correlation:

Table 10 shows positive and negative significant correlations at the levels of 0.01 and 0.05 between the studied traits which lead to increases or decreases in the mean values of the reciprocal traits , where as positive correlations were recorded among boll weight and each of seeds per boll (0.663**) , seed index (0.487**) and Seed cotton (0.253*) and negative correlation with Lint index (-0.505) and ginning (-0.258*) in addition to more positive correlation between seed boll^{-1} and Seed index (0.293*) , seed

index and seed cotton (0.258*) and Lint index and ginning (0.470**) , as well as negative correlations occurred among boll weight, lint index (-0.505**) and ginning (-0.258*) and between seeds per boll and lint index (-0.453**) and ginning (-0.283*).

Table 10: The correlation between seven studied characters of cotton.

	Ball weight	Seed ball-1	Ball plant	Seed index	Lint index	Ginning	Seed cotton
Ball weight	1	.663**	.177	.487**	-.505-**	-.258-*	.253*
Seed ball^{-1}	.663**	1	.140	.293*	-.453-**	-.283-*	.188
Ball plant	.177	.140	1	.157	-.101-	-.104-	.050
Seedindex	.487**	.293*	.157	1	-.190-	.176	.258*
Lint index	-.505-**	-.453-**	-.101-	-.190-	1	.470**	-.004-
Ginning outturn	-.258-*	-.283-*	-.104-	.176	.470**	1	.131
Seed cotton	.253*	.188	.050	.258*	-.004-	.131	1

**. Correlation is significant at the 0.01 level (2-tailed).

Conclusions

Generally, the result of present study shows that most of yield and yield components such as number of bolls per plant, ginning out turn percentage and total seed cotton yield increased with early planting date in N-S row orientation (E2). On the other hand, boll weight and seed index non significantly affected by different environments. Also, number of seeds per boll increased by delayed sowing time with E-W row orientation during both years (E3). Likewise, lint index during second year increase yield in early sowing time with E-W and N-S row orientation (E1 and E2). According to the row positions non-significant differences between central rows (R5,6,7) with lateral rows (R1,2,3 and R11,12,13).

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