Determination of Yield and Yield Criteria of Different Cotton Lines and Varieties

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Abstract: Cotton (*Gossypium hirsutum* L.) has a economic and strategic importance that provides raw materials to the textile sector. Efforts are being made to increase cotton yield and fiber quality through breeding studies carried out in the world and in Türkiye. It is necessary to determine the yield and yield criteria of the genotypes to be included in the breeding programs and to determine their superiority compared to the control varieties. In this research carried out for this purpose, 165 cotton genotypes were tested to determine yield and yield components. The trial was carried out in 2019 in the experimental area of Siirt University Faculty of Agriculture, Field Crops Department, in 4 blocks according to the Augmented trial design, and 165 genotype materials, including 160 cotton genotypes and 5 control varieties (Stoneville 468, BA 119, BA 440, Edessa, Lima) was used as plant material. In the study, seed cotton yield, plant height, number of monopodial and sympodial branches, number of nodes and number of bolls were examined. Results showed that the highest seed cotton yield were obtained from MNH-786, Dpl-5540-85-subokra and Mex 123 cotton genotypes and that these genotypes showed the highest values than the superior control variety. Deltapine 5816, Stoneville 213 and CIM-70 genotypes were found to be promising for plant height, VH 260, Stoneville 213 and Tamcot Sphinx for sympodial branches, and Deltapine 905, NIAB 777, Tonia and Stoneville 213 genotypes for boll number. The findings showed that there is a wide genetic variability among cotton genotypes in terms of yield and yield component, genotypes with ideal values in terms of desired characteristics can be used as parents in cotton breeding program and new cotton genotypes suitable for the textile sector can be obtained.

Keywords: Cotton, genotype, yield, yield component, textile sector

Farklı pamuk hat ve çeşitlerinin verim ve verim kriterlerinin belirlenmesi

Öz: *Pamuk (Gossypium hirsutum L.), tekstil sektörüne hammadde sağlayan ekonomik ve stratejik öneme sahip bir bitkidir. Dünya'da ve Türkiye'de yürütülen ıslah çalışmaları ile pamuk veriminin ve lif kalitesinin arttırılmasına çalışılmaktadır. Islah programlarında kullanılacak genotiplerin öncelikle verim ve verim komponentlerinin belirlenmesi ve kontrol çeşitlere göre üstünlüklerinin saptanması gerekmektedir. Bu amaçla yürütülen bu araştırmada, 165 adet pamuk genotipi verim ve verim komponentlerinin belirlenmesi bakımından test edilmiştir. Deneme 2019 yılında Siirt Üniversitesi Ziraat Fakültesi Tarla Bitkileri bölümü deneme alanında Augmented deneme desenine göre 4 blok şeklinde yürütülmüş ve 160 adet pamuk genotipi ve 5 adet kontrol çeşit (Stoneville 468, BA 119, BA 440, Edessa ve Lima) olmak üzere 165 adet genotip materyal olarak kullanılmıştır. Çalışmada kütlü pamuk verimi, bitki boyu, odun dalı ve meyve dalı sayısı, boğum sayısı ve koza sayısı özellikleri incelenmiştir. Çalışmada kütlü pamuk verimi bakımından en yüksek değerlerin MNH-786, Dpl-5540-85-subokra ve Mex 123 genotiplerinden elde edildiği ve bu genotiplerin en yüksek kontrol çeşitten daha üstün değerler gösterdikleri belirlenmiştir. Deltapine 5816, Stoneville 213 ve CIM-70 genotiplerinin bitki boyu bakımından, VH 260, Stoneville 213 ve Tamcot Sphinx genotiplerinin meyve dalı sayısı bakımından, Deltapine 905, NIAB 777, Tonia ve Stoneville 213 genotiplerinin ise koza sayısı bakımından daha ümitvar oldukları görülmüştür. Araştırmada elde edilen bulgular incelenen özellikler yönü ile materyalde geniş bir genetik değişkenliğin bulunduğunu, istenen özellikler bakımından ideal değerlere sahip genotiplerin pamuk ıslah çalışmalarında ebeveyn olarak kullanılabileceğini ve tekstil sektörüne uygun yeni pamuk genotiplerinin elde edilebileceğini göstermektedir.*

Anahtar kelimeler: *Pamuk, genotip, verim, verim komponentleri, tekstil sektörü*

INTRODUCTION

Cotton is among the most important and strategic fiber plants. It has different uses and is primarily grown for its fiber. It constitutes one of the important raw materials of the textile sector, the oil rate in the seed and the oil industry, and the protein-rich pulp remaining after the oil is taken, in the feed industry (Kıllı and Gencer, 1999). As an alternative to petroleum, the oil obtained from the cotton seed is used as a raw material in the production of biodiesel in increasing amounts (Özüdogru, 2012).

Today, *Gossypium hirsutum* L. and *Gossypium barbadense* L. species constitute a large part of commercial cotton in the world and our country. *Gossypium hirsutum* L. and *Gossypium barbadense* L. species are of American origin, have tetraploid (2n=4x=52) chromosomes and are grown in hot and humid climate conditions.

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They are known as "Upland", which are the new world cottons, are open bolls and are the most preferred and widely grown species in our country as well as in the world, due to their easier harvest, high fiber yield and quality.

Almost all of the world cotton production (99.5%) is carried out by the 10 largest cotton producing countries, where our country ranks 7th; these are listed as India, China, USA, Brazil, Uzbekistan, Pakistan, Türkiye, Australia, Mexico and Greece. Again, a significant 85% of the world's cotton usage is realized by 8 major cotton consumer countries, where our country ranks 5th, and these countries are listed as China, India, Pakistan, Bangladesh, Türkiye, Vietnam, Brazil and the USA (Anonymus, 2022 a). In Türkiye, cotton seeds are planted on an area of 432.000 ha and a total of 833.000 tons of cotton fiber is obtained from these sown areas (Anonymous, 2022 b).

In the Southeastern Anatolia Region, 1.324.004 tons of seed cotton and 489.880 tons of fiber cotton were produced in an area of 261.989.7 ha where cotton was planted in 2021 (Anonymous, 2022a). The most effective way to increase cotton production is to increase the yield per unit area without sacrificing quality. In our country, it is of great importance to develop cotton lines and varieties with high yield and quality in order to meet the domestic consumption of cotton and to increase the yield obtained from the unit area. The selection of varieties and the use of certified seeds in cotton production are a kind of insurance for the yield and quality to be obtained (Mert, 2009). The sole purpose of the breeding studies; to provide great contributions to both agricultural production and the country's economy by developing new varieties with high efficiency and superior quality in cotton, which is the raw material of the textile industry, which has a great role in the country's economy.

The aim of this study was to determine the yield and yield criteria of different cotton lines and varieties under Siirt ecological conditions and to use promising genotypes as material for future breeding studies.

MATERIAL AND METHODS

The experiment was carried out in Siirt University Faculty of Agriculture, Department of Field Crops application area in 2019 in 4 blocks according to Augmented experimental design. In the experiment, 160 cotton genotypes and 5 control varieties, total 165 genotypes were used as material. Stoneville 468, BA 119, BA 440, Edessa and Lima cotton varieties were used as control varieties. The name of 160 genotypes is given in the Table 1.

Table 1. List of cotton germplasm used in this study

Genotypes			
1-TAM 01 E 22	41-Deltapine 80	81-Helius	121-NIAB-KIRN
2-TAM 94 L 25	42-Deltapine 905	82-Tonia	122-NIA-UFAQ
3-TAM B182-33-ELS	43-Deltapine SR-4	83-Ligur	123-Sadori
4- TAM C 155-22	44- Deltapine SR-5	84-Mehigon	124-Shazbaz
5-TAM C66-26- ELS	45-Deltapine Staple	85-NIAB 111	125-Sindh-1
6-TAM C66-266	46-Dpl-5540-85-subokra	86-NIAB 777	126-Sohni
7-Acala-1064	47-TAMCOT SPHİNX	87-NIAB 78	127-VH 260
8-Acala 1-13-3-1	48-Hopicala Vert	88-NIAB 846	128-Aboriginal 79
9-Acala 1517C	49-AzGR-7711	89-NIAB 874	129-Acala Nakad
10-Acala 1517 D	50- New Mex Acala	90-MNH 493	130-Alba Acala 70
11-Acala 1517 SR2 –vert	51-Mex 122	91-Sivon	131-Rantos
12-Tropikal 225	52-Mex 123	92-Sarbon	132-Samos
13-Acala 1517-70	53-Mex 68	93-Stoneville 474	133-Frego Claster
14-Acala 1517-91	54- Stoneville 213	94-Stoneville 506	134-Nova
15-Acala 29	55- Stoneville 256	95-AZGR-11839	135-AzGR-11835
16-Acala 44	56- Stoneville 2B	96-Sugdiyon-2	136- AzGR-11836
17-Acala-44-WR	57- Stoneville 3	97-Ujchi 2 Uzbek	137- AzGR-11468
18-Acala 442	58- Stoneville-3202	98-AzGR-3775	138- AzGR-11834
19-Acala 51	59- Stoneville 508	99-Zeta 2	139- Ağdaş 7
20-Acala 8	60- Stoneville 618 BBR	100-Ziroatkar-64	140- Ağdaş 6
21-Acala Cluster	61- Stoneville 731 N	101-Ziroatkar-68	141- Ağdaş 17
22-Acala Mexican Lindless	62- Stoneville 108 SR	102-Ziroatkar-81	142-AGC 208
23-Acala Morell	63- Stoneville 504	103-173/994	143-AGC 85
24-Acala N 28-5	64-Tex 1152	104-B557	144-AGC 375
25-Acala Nunn’s	65-Tex 1216	105-BH-118	145-Stoneville 5A
26-Acala Shafter Station	66- Tex 2167	106-CIM-401	146-New Mexico Acala
27-Acala SS-2280	67- Tex 843	107-CIM-240	147-Acala Harper
28-Acala 55-5	68- Tex 2382	108-CIM-506	148- Tex 1412

Table 1 continue. List of cotton germplasm used in this study

Genotypes			
29-Aden	69- Tex 2383	109-CIM-70	149- Viky (ES-20021)
30-Auborn 56	70- Tex 2700	110-CRI5-134	150-Acala Okra
31-Deltapine 120	71-Acala	111-CRI5-342	151-Tex 1416
32-Deltapine 15A	72- Agala Sindou	112-FH 142	152-TAM C155
33-Deltapine 25	73-Arrota- 129	113-Haridost	153-Acala Okra VA2-4
34-Deltapine 26	74- Campu	114-Malmal-MNH-786	154-Bulgar 6396
35-Deltapine 41	75-Cascot L7	115-Marvi	155-Acala SJ1
36-Deltapine 45 Vert	76-Darmi	116-Korina	156-Eva
37-Deltapine 50	77-Deltapine 20	117-MNH-786	157-Acala Tex
38-Deltapine 61	78-Deltapine 50	118-MNH-814	158-Carolina Queen
39-Deltapine 62	79-Deltapine 565	119-MNH-990	159-Mex 106
40-Deltapine 714 GN	80-Deltapine-5816	120-NIAB-111	160-Europa

The field where the experiment was carried out was plowed deep in the autumn and superficially with a cultivator in the spring, and the trial area was made ready for planting by pulling 3 times before planting. Sowing operations were carried out on 16 May 2019 with a trial seeder. Each plot was formed as 1 row with a length of 6 m. The distance between rows was kept constant at 70 cm during planting, and the distance between rows was created by thinning to be 15-20 cm. There is a 2 m gap between the blocks. Soil analyzes were made by taking 0-30 cm deep soil samples from the experimental area and the amount of fertilizer needed by the plant was determined (Table 2). The trial soils were found to be unsalted, slightly limey, slightly acidic, and insufficient in terms of organic matter. Half of the nitrogen needed during planting and all of the phosphorus (8 kg da^{-1} N, 8 kg da^{-1} P_2O_5) were applied to the band in the form of 20-20-0 compound fertilizer, and the second half of the remaining nitrogen (6 kg da^{-1} N) was applied before the first irrigation (about 45 days after sowing) as ammonium nitrate (33%).

Table 2. Main properties of the soil

Dept (cm)	**Texture**			**Electrical Conductivity (EC)**
0-30	Sand 47.99	Clay 43.51	Silt 8.49	0.1
pH	**Lime**			**Organic matter (%)**
6.89	3.01			0.83

*: Siirt University, Science and Technology Application and Research Center, Siirt

All maintenance operations were carried out on time, thinning was done when the plants reached 10-15 cm in height, hand hoeing was done 3 times and machine hoeing was done 2 times during the experiment. Hoeing operations were carried out for both weed control and soil aeration. Weed control and pest control were carried out throughout the plant growth period, and no pesticide control was applied since it was not necessary.

The experiment was irrigated with a drip irrigation system. The water requirement of the plant was taken into consideration during irrigation. Irrigation was started before flowering and ended at 10% boll opening. Harvesting was done manually on 4 October 2019. All data obtained from the experiment were analysed using JMP statistical package program in accordance with the experimental design used.

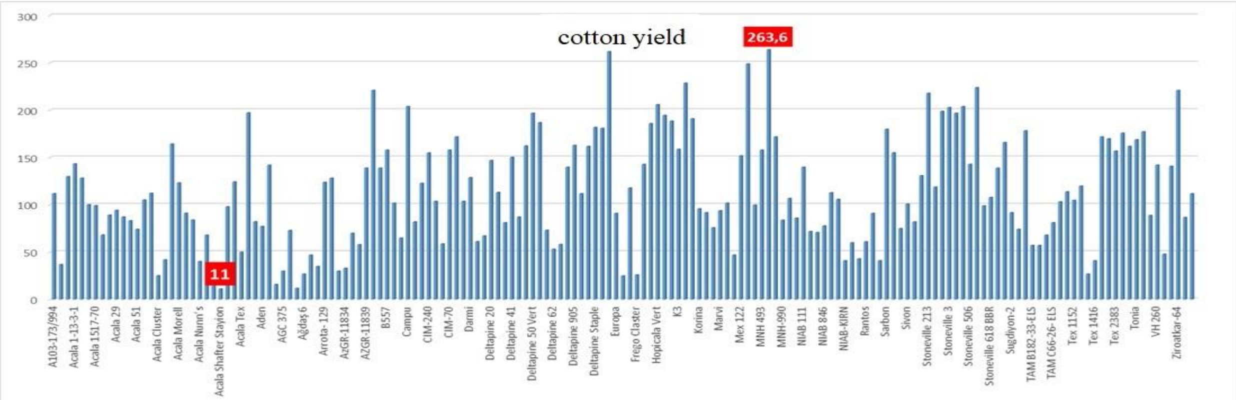
RESULTS AND DISCUSSION

The findings obtained in the research are given in figures in order to facilitate traceability. The values of seed cotton yield of the lines and standard varieties in the experiment are shown in Figure 1. The highest seed cotton yield was observed from MNH-786 (263.60 g/plant), followed by Dpl-5540-85-subocra (261.60 g/plant), Mex 123 (248.60 g/plant), Edessa (Control 4) (228.25 g/plant), Stoneville 508 (223.60 g/plant) and AzGR-3775 (220.60 g/plant). The lowest seed cotton yield was obtained from Acala Shafter Stayion (11.00 g/plant) line. Among the control cultivars, the highest cotton yield was obtained from Edessa control variety (228.25 g/plant) and the lowest cotton yield was obtained from BA 440 (158.50 g/plant) control variety. It was determined that 3 cotton genotypes were superior to the highest control variety Edessa. It is thought that this trait can be improved if genotypes with high yield potential are used as parents in cotton breeding programs.

The main objective of the cotton breeding programs carried out in Türkiye is to increase the seed cotton yield and fiber yield. One of the ways to close the cotton fiber deficit we need is to develop new cotton varieties with high yield and quality. For this reason, new hybrid combinations can be made with genotypes that stand out in terms of yield and fiber quality characteristics and it is possible to combine both characteristics in one genotype.

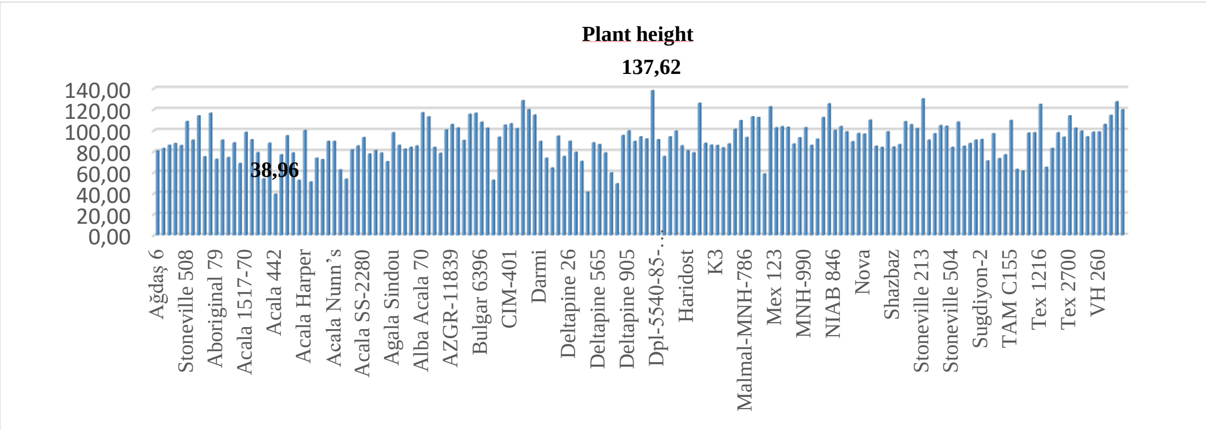
Cotton yield is a quantitative trait and is also affected by environmental factors such as variety, climate and maintenance conditions. It is reported that 70% of the variation in cotton yield is caused by environmental conditions and 30% by crop management systems and variety selection is very important for a successful breeding program (Krieg, 1997; Esbroeck and Bowman, 1998).

Figure 1. Average values of seed cotton yield of genotypes



The plant height values of the lines and standard varieties in the experiment are shown in Figure 2. It was determined that the plant height values of the genotypes in the experiment varied between 38.96 cm and 137.62 cm and the general average of the experiment was 90.99 cm. In terms of plant height, the highest value was obtained from Deltapine 5816 genotype (137.62 cm) and the lowest value was obtained from Acala 442 genotype (38.96 cm). Deltapine 5816 genotype was followed by Stoneville 213 (129.79 cm), CIM-70 (128.12 cm), Ziroatkar-68 (127.12 cm), Hopikola Vert (125.62 cm) and NIAB 78 (125.12 cm) genotypes. The lowest value in terms of this trait was obtained from Acala 442 genotype with 38.96 cm plant height. Among the control varieties, the highest plant height value was obtained from Stoneville 468 (87.50 cm) and the lowest plant height value was obtained from Edessa (83.17 cm) control variety. It is thought that this trait can be improved if genotypes with high plant height are used as parents in breeding studies. Plant height is an important indicator of plant growth and plant height increases under good care conditions, especially under conditions where irrigation and nitrogen are applied more. Plant height shows a significant correlation with seed cotton yield and fiber yield and is known as a yield component. Studies show that there is a significant correlation between plant height and yield (Ahuja et al., 2006). Khalid et al. (2018) reported that plant height was positively correlated with cotton yield. Yunjun et al., 2019, revealed that plant height varied between 58.6 cm and 163.2 cm, short plant height was an important advantage for machine harvesting and early harvesting, and there was a negative correlation between plant height and yield. Salahuddin et al. (2010) reported a positive but not significant correlation between plant height and yield.

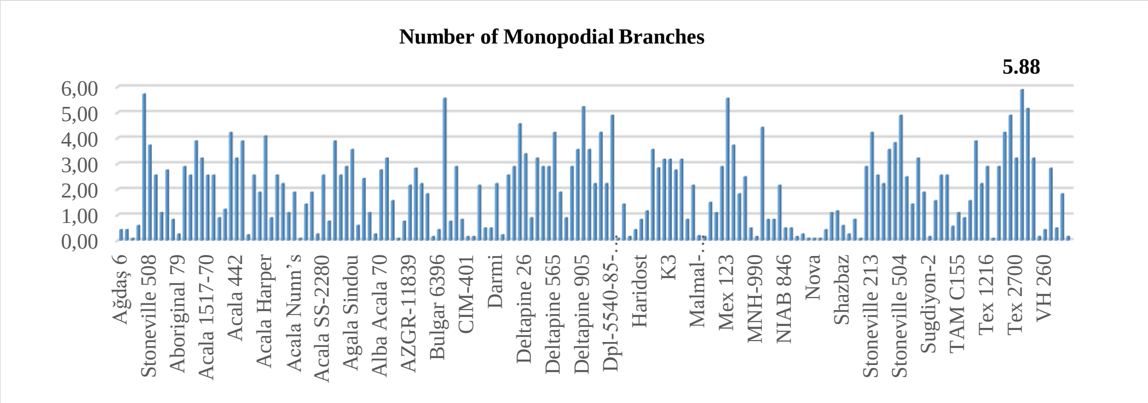
Figure 2. Average plant height values of genotypes



The average values of number of monopodial branches of lines and standard varieties in the experiment are given in Figure 3. It can be seen from Figure 3 that the number of monopodial branches of the lines and standard varieties in the experiment varied between 0.08 and 5.88 number/plant and the general average of the experiment was 1.98. The genotypes showing the highest values in terms of number of monopodial branches were Tex 843 (5.88 number/plant), New Mex Acala (5.72), Campu (5.55), Mex 123 (5.55), Deltapine 905 (5.22) and Tonia (5.15).

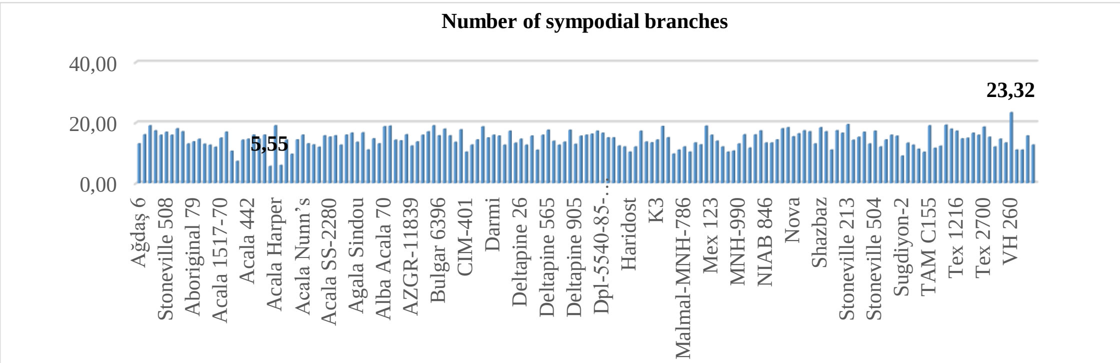
The genotypes with the lowest number of monopodial branches were obtained from Tex 1416, Sohni, Nova, NIA-UFAQ, Rantos, Akala Okra, Europa, AzGR-11835 and AzGR-11468 genotypes with 0.08 monopodial branches/plant. Similar values were obtained among the control cultivars, BA 119, BA 440 and Lima cultivars showed the highest values with 3.17 number/plant, while the lowest value was obtained from Edessa (2.75) and Stoneville 468 (2.83) control cultivars.

Figure 3. Average values of number of monopodial branches of genotypes



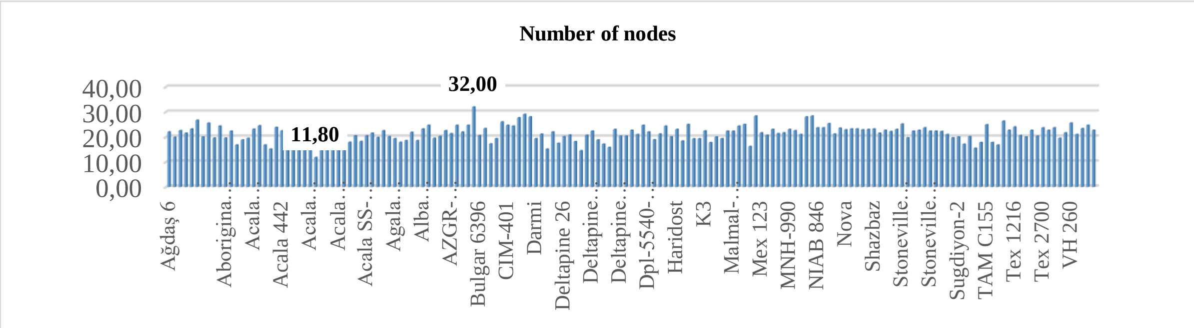
The number of monopodial branches is known as a yield component. It is reported that there is a significant and positive correlation between the number of monopodial branches and yield (Ahuja et al., 2006). They are also important in terms of the number of fruit branches carried on the monopodial branches (Sahito et al., 2015). However, it is also found that there is no significant correlation between the number of monopodial branches in the plant and yield, and there is a positive but not significant correlation with yield (Rauf et al., 2004; Salahuddin et al., 2010). The high number of monopodial branches in the plant increases the vegetative development in the plant and increases the generative development period in the plant (Khokhar et al., 2017). Karademir et al. (2019), in a study conducted with 10 different cotton varieties, reported that the contribution of the number of monopodial branches to yield varied between 11.66% and 30%, and the main contribution to yield was made by fruiting branches and bolls on them at a rate of 70% to 88.34%. Azhar and Rehman (2018) reported that the number of monopodial branches in cotton and its effect on yield was insignificant, this trait is genetically controlled and significantly affected by environmental conditions. Iqbal and Khan (2011), reported that the number of monopodial branches may vary depending on variety, sowing time and plant density. The average values of number of sympodial branches of lines and standard varieties in the experiment are given in Figure 4.

Figure 4. Average the number of sympodial branches belonging to genotypes



It is seen that the lines and standard varieties in the experiment did not show significant difference in terms of the number of sympodial branches and the number of sympodial branches of the genotypes varied between 5.54 and 23.31 number/plant and the general average value of the experiment was 14.54. Among the genotypes, the highest number of sympodial branches was obtained from genotype VH 260 (23.31) and the lowest was obtained from Acala Cluster (5.54) genotype. VH 260 genotype was followed by Stoneville 213 A genotype with 19.34 sympodial branches, Tamcot Sphinx with 19.18 sympodial branches and Acala Harper genotypes with 18.98. The highest value in terms of the number of sympodial branches among the control varieties was obtained from Edessa (18.74 number/plant), while the lowest number of sympodial branches was obtained from BA 119 (13.33 number/plant). In the number of sympodial branches, it is seen that the general average of the experiment was 14.54 number/plant, the average value of the control varieties was 14.97 and the average values of the lines or genotypes were 14.53. In terms of this trait, 9 genotypes with superior values than the highest control variety, which gave the highest value in terms of this trait, were included in the trial, and it seems that it may be appropriate to use these genotypes for the development of this trait. The number of sympodial branches is known to be an effective trait on yield. Some researchers have reported that the number of sympodial branches has a direct and positive effect on yield in cotton (Rahman and Iqbal 2013; Khalid et al., 2018). It is reported that the number of sympodial branches contributes between 70 and 88.34% in the formation of cotton yield and this ratio may vary depending on the varieties (Karademir et al., 2019). Salahuddin et al. (2010) reported that there was a significant and positive correlation between cotton yield and number of fruiting branches (r=0.567) and cotton yield was mainly affected by the number of fruiting branches. It was reported that the number of fruiting branches varies depending on variety, planting time and plant density (Iqbal and Khan, 2011). The average values of number of nodes of lines and standard varieties in the experiment are given in Figure 5.

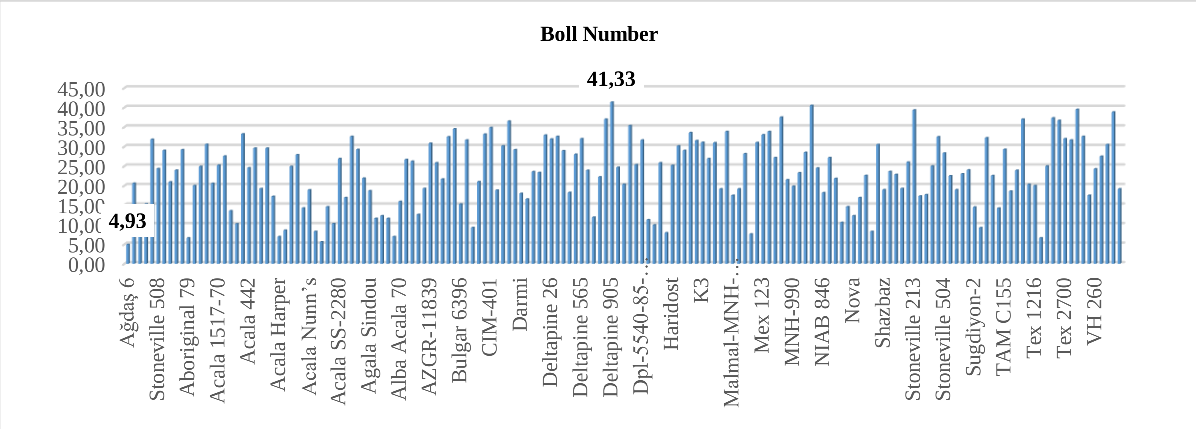
Figure 5. Average number of nodes values of genotypes



It is observed that the number of nodes of the genotypes in the experiment varied between 11.79 and 31.99 number/plant and there was no significant statistical difference between the genotypes and the general average of the experiment was 21.53 number/plant. In terms of number of nodes, the highest value was obtained from BH-118 (31.99 number/plant) and the lowest value was obtained from Acala Mex Lindless (11.79 number/plant) genotype. BH 118 genotype was followed by CRIS-134 (28.99 number/plant), NIAB 78 (28.33 number/plant) and Mex 122 (28.33 number/plant) genotypes with high values. Among the control varieties, the highest value was obtained from BA 440 (22.41 number/plant) and the lowest value was obtained from Edessa (17.74 number/plant). The number of nodes in the plant is known as an important indicator of plant development. Monitoring of plant development in cotton is determined by the number of nodes, and whether there are any stress conditions or overgrowth conditions in the plant can be monitored by examining this feature. The number of nodes can vary depending on the temperature during the pre-flowering period (Guthrie et al., 1993; Reddy et al., 2017). Pettigrew (2003) reported that the number of nodes at the beginning of flowering was 15.1 nodes/plant under irrigated conditions and 14.7 nodes/plant under non-irrigated conditions, and that the number of nodes should be between 22 and 24 in an ideal plant during the advanced development period. The node number values obtained in the study are partially in parallel with the literature findings. The average values of number of bolls of lines and standard varieties in the experiment are given in Figure 6.

It can be observed from Figure 6 that the boll number values of the lines and standard varieties in the experiment varied between 4.93 and 41.33 number/plant and the general average of the experiment was 23.41.

Figure 6. Average number of bolls values of genotypes



The highest values in terms of boll number were obtained from Deltapine 905 (41.33 number/plant), NIAB 777 (40.49), Tonia (39.49), Stoneville 213 (39.33) and Ziroatkar-68 (38.83) genotypes; the lowest values were obtained from Agdas 6 (4.93), Acala Okra VA2-4 (5.6), Aboriginal 79 (6.60) and Tex 1416 (6.60) genotypes. Among the control varieties, Stoneville 468 (33.54) showed the highest value in terms of boll number, while Edessa (26.91) showed the lowest value. It was observed that the control varieties showed values close to each other in terms of the number of bolls.

It is known that sowing time, length of vegetation period, crop management system, climatic conditions such as temperature and rainfall and irrigation affect this trait. It is known that hybridizations with genotypes with high boll number are important in cotton breeding studies. For this purpose, it is thought that it may be appropriate to use Deltapine 905, NIAB 777, Tonia, Stoneville 213 and Ziroatkar-68 genotypes as parents in breeding studies.

It is reported that boll number is the main determinant of fibre yield and cotton boll yield and is used in yield estimations, boll number has a significant and highly positive correlation with yield, and temperature has a significant effect on boll number and boll set (Reddy et al., 1992; Sharma et al., 2015; Sawan, 2017; Khalid et al., 2018). Studies indicate that water stress and high evaporation reduce the number of bolls (Sawan, 2017). Irrigation time and the amount of water given also have a significant effect on the number of bolls (Schaefer et al., 2018). Bozbek (2004) reported that there is a positive and significant relationship between boll number and yield and it is an easy criterion to determine together with other yield factors for selection.

CONCLUSION

The results of this study, in which 165 genotypes obtained from different origins were used, showed that there was a wide genetic variability in the material in terms of yield and yield criteria. In the research MNH-786, DPL-5540-85-subocra, Mex 123, Stoneville 508, AzGR-3775 were found as promising genotypes for seed cotton yield. Deltapine 905, NIAB 777, Tonia, Stoneville 213, Zioatkar 68 genotypes for number of boll and VH 260, Stoneville 213 Z, Tamsot Sphinx and Acala Harper genotypes were shown higher value for number of sympodial branches. By using these genotypes in breeding studies, improvements can be made in yield and yield components.

REFERENCES

Ahuja SL, Dhayal LS, Prakash R (2006) Correlation and Path Coefficient Analysis of Components in *G. hirsutum L*. Hybrids by Usual and Fibre Quality Grouping. Turkish Journal of Agriculture and Forestry, 30, 317-324.

Anonymous (2022a) *National Cotton Council Cotton Sector Report 2022* http://www.upk.org.tr/User_Files/pdf/ulusal-pamuk-konseyi-sektor-raporu2021.pdf [Date of Visit: 08 April 2022].

Anonymous (2022b) Turkish Statistical Institute, Crop Productio Statistics https://biruni.tuik.gov.tr/medas/?kn=92&locale=tr

Azhar MT and Rehman A (2018) Overview on effects of water stress on cotton plants and productivity. In Biochemical, Physiological and Molecular Avenues for Combating Abiotic Stress in Plants. *Elsevier Incorporation*. https://doi.org/10.1016/B978-0-12-813066-7.00016-4 [Visit:15 December 2020].

Bozbek T (2004) Determination of Yield Components and Genetic Correlations in Hybrid Cotton Populations. Nazilli Cotton Research Institute. *Doctorate Project.* Tagem 2004 Development Report. http://www.tagem.gov.tr/ [Visited: 14 December 2020].

Esbroeck GV, Bowman DT (1998) Cotton germplasm diversity and its importance to cultivar development. The Journal of Cotton Science, 2 (3), 121-129.

Guthrie D, Silvertooth J, Stichler C (1993) Monitoring plant vigor. Cotton Physiology Today. Newsletter of the Cotton Physiology Education Program. https://www.cotton.org/tech/physiology/cpt/upload/CPT-June93-v4-5-REPOP.pdf [Visit: 08.02.2021]

Iqbal M and Khan MA (2011) Response of cotton genotypes to planting date and plant spacing. *Frontiers of Agriculture in China*, 5, 262.

Karademir E, Karademir Ç, Kireç A (2019) The Effect of Boll Location and Distribution on Yield in Cotton. *1st International Harran Multidisciplinary Studies Congress*, 08-10 March, 304-312 pp. Şanlıurfa.

Khalid MA, Malik TA, Fatima N, Shaakel A, Karim İ, Arfan M, Merrium A, Khanum, P (2018) Correlation for Economic Traits in Upland Cotton. *Acta Scientific Agriculture,* 2, (10): 59-62.

Khokhar ES, Shakeel A, Maqbool MA, Anwar MW, Tanveer Z, Irfan F, (2017) Genetic Study of Cotton (*Gossypium hirsutum L.)* Genotypes for Different Agronomic, Yield and Quality Traits. *Pakistan Journal of Agricultural Research,* 30 (4), 363-372.

Kıllı F and Gençer O (1999) *Cotton Agriculture in the Turkish World in the 2000s Fibre Technology and Textile 1st Symposium,* 28 September-1 October 1999 Kahramanmaraş, p. 382.

Krieg DR (1997) Genetic and environmental factors affecting productivity of cotton. *Proceedings of the Beltwide Cotton Conference,* 7-10 January, National Cotton Council of America, New Orleans, LA, 2:1347.

Mert M (2009) Fibre Plants. *NOBEL Publications* No: 1446, p.s. 277, Ankara.

Özüdoğru T (2012) Cotton Status and Forecast 2010/2011. *Directorate of Agricultural Economics and Policy Development Publications,* Publication No: 263, Ankara

Pettigrew WT (2003) Physiological consequences of moisture deficit stress in cotton. *Crop Science,* 44(4),1265-1272.

Rahman SA and Iqbal MS (2013). Cause and Effect Estimates for Yield Contributing and Morphological Traits in Upland Cotton (*Gossypium hirsutum* L.). *Journal of Agricultural Researc*h, 51 (4), 393-398.

Rauf S Khan, TM, Sadaqat HA, Khan AI (2004) Correlation and path coefficient analysis of yield components in cotton (*Gossypium hirsutum* L.). *International Journal of Agricultural Biology*, 6(4):686-688.

Reddy KR, Hodges HF, Reddy VR (1992) Temperature Effects on Cotton Fruit Retention. *Agronomy Journal.* 84, 26-30.

Reddy KR, Brand D, Wijewardana C, Gao W (2017) Temperature Effects on Cotton Seedling Emergence, Growth and Development. *Agronomy Journal.* 109 (4), 1379- 1387.

Sahito A, Baloch ZA, Mahar A, Otho SA, Kalhoro SA, Ali A, Kalhoro FA, Soomro RN, Ali F (2015) *American Journal of Plant Sciences,* 6, 1027-1039.

Salahuddin S, Abro S, Rehman A, Iqbal K (2010) Correlation Analysis of Seed Cotton Yield With Some Quantitative Traits in Upland Cotton *(Gossypium hirsutum L.)* Pakistan Journal of Botany, 42(6): 3799-3805.

Sawan ZM (2017) Cotton production and climatic factors: Studying the nature of its relationship by different statistical method. *Cogent Biology,* 3 (1), 1-35.

Schaefer CR, Ritchie GL, Bordovsky JP, Lewis K, Kelly B (2018) Irrigation Timing and Rate Affect Cotton Boll Distribution and Fiber Quality. *Crop Ecology and Physiology,* 110 (3), 922-931.

Sharma B, Mills CI, Snowden C, Ritchi GL (2015) Contribution of Boll Mass and Boll Number to Irrigated Cotton Yield. *Agronomy Journal.* 107:1845–1853.

Yunjun Y, Yanhua D, Zhao H, Li L (2019) Relationships Between Plant Architecture Traits and Cotton Yield Within the Plant Height Range of 80–120 CM Desired for Mechanical Harvesting in the Yellow River Valley of China. Agronomy, 9: 587.