Agrotechniques in Industrial Crops

Journal Homepage: https://atic.razi.ac.ir

Determination of Value of Cultivation and Use (VCU) of New Cotton Genotypes in Fars Province

Aidin Hamidi*[1], Mohammad Hassan Hekmat[2], Mortaza Arab Salmani[3], Akram Mohajer Abbasi[3]

[1]*Department of Seed and Plant Technology Research Deputy of Seed and Plant Certification and Registration Institute (SPCRI), Agriculture Research, Education and Extension Organization (AREEO), Karaj, Iran*

[2]*Department of Crops and Horticulture Research of Fars province Agriculture and Natural Resources Research and Education Center, Agriculture Research, Education and Extension Organization (AREEO), Darab, Iran*

[3]*Department of Cotton and Fiber Crops Research of Tehran province Agriculture and Natural Resources Research and Education Center, Agriculture Research, Education and Extension Organization (AREEO), Varamin, Iran*

ARTICLE INFO

Original paper

Article history:
Received: x Month 202x
Revised: x Month 202x
Accepted: x Month 202x

Keywords:
Earliness
Fiber quality
Seed cotton yield
Variety registration

ABSTRACT

The research was conducted in order to six new cotton genotypes value of cultivation and use (VCU) determination in Fars province (Darab) during 2020 and 2021. T2, Eram3, Shayan (No. 200), Axial No. 200, S492, and N-SK (B-23) genotypes VCU determinations conducted in comparisons as control cultivars in comparison to Bakhtegan and Golestan common cultivars, seed cotton yield, boll weight, boll number per plant, earliness, 100 cotton seed weight, gin turn out, fibers length, fitness, strength, uniformity, and elasticity evaluated. Results revealed the T2 genotype had the most seed cotton yield (4177.5 kg ha^{-1}), boll number per plant (19.52), earliness (94%), gin turn out (35.83%) and fiber fitness (4.21 Micronair). The Bakhtegan control cultivar had the most100 cotton seed l weight (11.26 g) and boll weight (5.5 g) in 2020, fiber length (28.85 mm), uniformity (86.6%), and elasticity (6.5%). Also, the highest fiber strength (31.8 g tex^{-1}) belonged to the N-SK (B-23) genotype. Therefore, T2 and Eram3 new genotypes have superiority over other new genotypes, and the examined control cultivars in terms of yield and early maturity have the potential for commercialization and introduction as commercial cultivars in Fars province.

DOI: 10.22126/ATIC.2026.11051.1159

© The Author(s) 202x. Published by Razi University

1. Introduction

Upland cotton (*Gossypium hirsutum* L.) is an important fiber crop in world agriculture (Ahmad and Hasanuzzaman, 2020). In the world, the total area harvested, yield and production of cotton were 32.65 million hectares, 811 Kilograms per hectare and 121.57 million 480 lb. bales in Dec 2021/2022, respectively (USDA, 2022). While the total area harvested, production and yield of cotton respectively, were 90925 hectares, 265031 tons and 2982 and 1185 kilograms per hectare in irrigated and dryland cultivation in Iran during the 2020-2021 cropping year. (Ministry of Jihad-e-Agriculture, 2024). Plant breeding is the art and science of changing the genetics of plants for the benefit of humankind. Plant breeding has been practiced for thousands of years, since near the beginning of human civilization (Bradshaw, 2017). Plant breeding can be accomplished through many different techniques, ranging from simply selecting plants with desirable characteristics for propagation to more complex molecular techniques for developing a new variety (Priyadarshan, 2019). A plant variety represents a more precisely defined group of plants, selected from within a species, with a common set of characteristics (UPOV, 1991). The main objective of plant breeding programs is to develop new plant varieties that can enhance farm productivity (Hickey *et al.*, 2019). After a plant variety improvement, the plant variety is legally registered (SPCRI, 2020). In the variety registration system value of cultivation and use

* Corresponding author.
E-mail address: a.hamidi@areeo.ac.ir

(VCU) trials results is the only criterion for which a commercial variety is introduced for cultivation (Mozafari *et al*., 2010). For VCU trials, the variety is tested by adopting a well-planned testing procedure covering suitable field plot techniques and adequate number of replications and experimental design (SPCRI, 2009). The VCU trials are carried out by national plant varieties registration focal point at their adaptive research fields (Mozafari *et al*., 2010).

Performance of value of cultivation and use of the candidate variety is expressed relative to control variety/varieties used as checks. Value of cultivation and use (VCU) trial conduction is mandatory in a national variety testing system for crops in Iran, and has been used as a policy instrument by favoring the release of variety types. In VCU trials, candidate varieties are compared to control cultivars. Widely cultivated and accepted varieties by both the farmers and the industry are used as the control varieties in VCU trials. The national registration committee assesses the candidate varieties for yield, quality, resistance to diseases and economic value and then the ones equivalent to or better than the control cultivars are registered (SPCRI, 2009). The VCU trials are conducted during at least two growing seasons and in at least 3 locations in each growing season. The varieties are grouped according to their performance using several statistical analyses (Mozafari *et al*., 2010).

Gudeta et al. (2023) reported that the highest seed cotton yield (4.35 tons ha^{-1}) was recorded for Deltapine-90 cotton variety. The lint yields obtained from the cotton varieties ranged between 1.02 and 1.70 tons ha^{-1}. Also, Shah and Rasheed (2019) concluded from the results of their experiment on evaluation of different cotton varieties for yield performance collected from public sector of Pakistan, that among all varieties evaluated for different traits, the performance of CEMB-33 is better than others regarding number of bolls plant^{-1} , total bolls weight, total lint weight and ginning turn out %. Shakr et al. (2017) indicated the cultivar Giza 92 gave the highest oil and germination%, while Giza 96 produced the highest radical length, shoot length and seedling dry weight. Giza 88 surpassed all studied cultivars in protein %. Positive significant correlations were found between seed cotton yield and both boll weight and seed index, lint percentage and each (boll weight, seed volume and seed coat), boll weight and seed coat %, seed index and both (seed volume and seedling dry weight), free fatty acid and acid value, protein % and seed coat %, seed volume and seedling dry weight, germination percent and both (shoot length and seedling dry weight), shoot length and seedling dry weight. This study evaluated new cotton genotypes against common cultivars using VCU trials to compare yield components and fiber quality traits.

2. Materials and methods

In order to determine the value of cultivation and use (VCU) of six new upland cotton genotypes: 1- T2, 3-Eram 3, 4-No. 200, Axial No. 200, 5-S492 and 6- N-SK (B-23) compared to two control common commercial cultivars: 1- Bakhtegan and 2- Golestan the VCU trial was carried out in Fars Province the Agricultural and Natural Resources Research Station at Darab field during 2020-2021 cropping year.

2.1. Genotypes descriptions and source of seeds

All six new cotton genotypes in this study were selected in a breeding program for their high yield, early maturity, high fiber quality, and superior tolerance to Verticillium wilt, in comparison to the control cultivars—Bakhtegan (an old, late-maturing cultivar) and Golestan (an early-maturing cultivar). Additionally, the T2 genotype has a compact, clustered plant type. Nucleus (breeder-class) seeds of these six pure lines were provided by the breeder of the Cotton Research Institute at the conclusion of the breeding project at the Darab Agricultural and Natural Resources Research Station in Fars Province.

2.2. The trial site description

The research station is located 250 km from Shiraz, at 29º 47' N latitude, 57º 17' E longitude, and an altitude of 1060 meters above mean sea level. Meteorological data (average temperature, precipitation, and relative humidity) from the Darab station during the trial period are presented in Table 1.

2.3. Experimental design, land preparation and field management

The trial was conducted as a complete randomizes blocks design with 4 blocks (replications) in a field where the land was fallowed in the previous year and the primary tillage operations including deep plowing in the fall season and the secondary tillage operations including plowing with medium depth and disking and the operations of preparing the cultivation bed. Harrowing, leveling and furrowing with a distance of 75 cm was done in early spring. The seed planting distance on the lines was 20 cm and the plant density was equal to 40 thousand plants per hectare. The seed planting depth was uniform. Each plot consisted of 4 planting lines with a length of 12 meters and one meter was removed from the beginning and end of the lines as a margin effect. Then all field management stages were carried out normally during the growth period, and the date of the first irrigation was considered as the planting date, and the usual planting date, which is in the second half of May in the region, was observed. In both years of trials the enough amounts of chemical fertilizers were used based on soil tests and recommendations from the Soil and Water Laboratory of the Agricultural and Natural Resources Research Station of Darab.

Nitrogen was applied as urea in three split applications, while phosphorus (as triple super phosphate) and potassium (as potassium sulfate) were applied to the soil before planting. Thinning was performed to achieve the desired density, depending on the amount of seed sown. For weed control management, pre-planting herbicide Trifluralin was incorporated with the soil at a rate of 2.4 liters per hectare before the last disk and 48 hours before planting. Depending on the density of weeds in the field, hand weeding was performed three times during the critical period. Irrigation was performed at appropriate intervals based on environmental conditions and plant water requirements. Seeds were disinfected immediately before planting with Carboxin Thiram fungicide and imidacloprid insecticide. Irrigation schedules were also arranged based on estimated potential evapotranspiration, measured during both years of the trials using a Class A evaporation pan (Hamidi, 2016).

2.4. Agronomic measurements

The traits evaluated according to the national guidelines for testing value of cultivation and use of cotton cultivars were: 1- seed cotton (total harvested seed cotton weight in two middle rows of each plot as kg per hectare), 2- bolls number, 3- boll weight, 4- 100-seed cotton weight (g), 5-Earliness index (Equation 1), 6- fiber ginn turn out (Equation 2), 7- fiber length, 8- fiber fineness, 9- fiber elasticity, 10- fiber strength and 11- fiber uniformity (SPCRI, 2009).

$$\text{Earliness index (\%)} = [\text{First harvest time seed cotton yield (kg)} / \text{Total harvested seed cotton yield (kg)}] \times 100 \quad (1)$$

$$\text{Fiber gin turnout (\%)} = (\text{Fiber weight} / \text{Fiber weight} + \text{Cotton seed weight}) \times 100 \quad (2)$$

For the number of bolls per plant measurement, 10 plants were randomly selected from each plot two middle rows. Also for the boll weight determination, 20 bolls were randomly picked up from randomly selected 10 plants of two middle rows of each plot and weighed, and then the average weight was recorded as the mean boll weight for each plot.

Table 1. Average temperature and precipitation data of Darab meteorology station during trial conduction months in 2020-2021 years (Fars Province Meteorology Office, 2021; 2022)

Year	Month	Average Temperature (˚C)	Average Precipitation (mm)
2020	21 April-21 May	30.60	0.0
	22 May-21 June	33.60	0.0
	22 June-22 July	33.70	8.6
	23 July-22 August	30.50	0.0
	23 August-22 September	25.30	0.0
	23September-22 October	16.80	0.5
Mean		28.42	1.30
2021	21 April-21 May	31.60	1.5
	22 May-21 June	33.70	1.7
	22 June-22 July	33.50	5.0
	23 July-22 August	30.50	0.0
	23 August-22 September	25.80	0.0
	23September-22 October	18.70	7.3
Mean		24.83	2.21

2.5. Fiber quality testing

Fiber quality determination was conducted in the Cotton Fiber Technology Laboratory of the Agricultural and Natural Resources Research and Education Center of Tehran province at Varamin. Therefore, at first, each plot picked up seed cotton samples ginned by a laboratory automatic 8-saw gin machine and then about 200 g of cotton lint homogenous sample was prepared for each plot as the sample from two harvests. Then, the ginned fiber samples, some technological traits including fiber length (mm), fiber fineness (in micronare=Inch g^{-1}), fiber strength (in g tex^{-1}), fiber uniformity (in percentage) and fiber elasticity (in percentage) were determined by a calibrated HVI (High Volume Instrument) equipment (Hamidi, 2016).

2.6. Data analysis

The data statistical analysis including homogeneity of variances test (Bartlett's test), time-combined analysis of variance and for all means pairs comparisons, means comparisons conducted by Duncan's Multiple Range Test (DMRT) was conducted by SAS software version 9.1.

3. Results and discussion

3.1. Combined analysis

Data combined analysis of variance results showed that the year × genotypes interaction effect was significant for 100-seed cotton weight, gin turn out and fiber strength and fineness. Therefore, studied genotypes and control cultivars had significant differences for those traits in both trial years (Table 2).

Table 2. Time combined analysis of variance (mean square) of new cotton genotypes and control cultivars in value of cultivation and use traits at Fars province VCU trial 2020-2021 years.

S.O.V.	d.f.	100-seed cotton weight	Gin turns out	Fiber fitness index	Fiber strength
Year (Y)	1	32.86^{**}	94.57^{ns}	3.90^{ns}	3.19^{ns}
Block	6	0.80^{ns}	35.76^{ns}	3.18^{ns}	51.98^{ns}
Genotypes (G)	7	3.72^{**}	5.02^{ns}	0.67^{**}	11.52^{**}
Y × G	7	0.66^{**}	16.64^{*}	0.28^{*}	4.05^{**}
Error	42	0.15	2.49	0.10	1.53
C.V. (%)	-	3.94	4.53	6.99	4.80

ns is not significant and * and ** are significant at 5 and 1 percent probability levels, respectively.

3.2. 100-seed weight

Mean comparisons indicated that Bakhtegan control cultivar and Auxial No. 200 new genotypes had the most 100-seed weight (Table 2). The seed cotton yield components include the number of bolls, boll weight, number of seeds per boll, and the weight of fibers and cotton seeds. Seed cotton yield components are influenced by the physiological activity of the plant and its interaction with the environment. The 100-seed weight is one of seed cotton yield attributes and an important criterion for seed cotton yield evaluation. Killi and Beycioglu (2020) investigated the 100-seed weight of 46 cotton genotypes in Turkey, which varied from 9.37 to 13.23 g.

3.3. Fiber strength

Results (Table 3) showed that the highest fiber strength belonged to the genotype n-sk (b-23). Hamidi et al. (2012) observed a significant difference in the strength of cotton fibers in the years of the experiment and declared the difference in environmental conditions as the cause of this difference. Fiber strength is an effective factor in yarn strength, and after length and fineness, it is the most important qualitative indicator of cotton fiber technology. The strong cotton fibers are well spun and do not tear easily during washing, spinning and weaving. Fiber strength is determined in grams per tex unit (g tex^{-1}), the linear density measurement unit, and in grams per 1000 meters of cotton yarn length. Cotton fibers having strength index is less than 24 and more than 30 grams per tex (g tex^{-1}) are weak and strong fibers, respectively, and strength of more than 26 grams per tex (g tex^{-1}) is desirable. The cotton fiber strength is controlled genetically and different genotypes have different fiber strength; of course, weather conditions and plant nutrition also affect it. Ashokkumar and Ravikesavan (2011) stated the significant variation in fiber strength of cotton cultivars and reported the genetic control of cotton fiber strength up to 71% and observed the diversity of cultivars in this regard and determined that cotton fiber strength is controlled by one or a little number of genes. They also observed that the difference in fineness of cotton genotypes was significant. Gin turnout, along with fiber length, strength, and fineness, constitutes the most critical set of quality characteristics in cotton (Mahmood *et al*., 2006).

Table 3. Mean comparison of the studied value of cultivation and fiber technological traits of new cotton genotypes and control cultivars in Fars province (Darab) during 2020-2021 years.

Genotypes	100 seed cotton weight (g)	Gin turn out (%)	Fiber Fitness Index (Micronair-Inch g^{-1})	Fiber Strength (g tex^{-1})
T2	9.08^{*}	35.83^{a}	4.21^{d}	29.18^{b}
Eram3	9.97^{c}	34.17^{ab}	4.73^{ab}	28.91^{b}
Golestan (Ctrl)	9.42^{cd}	35.10^{ab}	5.03^{a}	29.51^{b}
Bakhtegan (Ctrl)	11.26^{a}	35.16^{ab}	4.25^{cd}	31.31^{b}
No. 200	9.81^{c}	35.62^{a}	4.68^{abc}	28.57^{b}
Axial No. 200	11.66^{a}	34.41^{ab}	4.46^{bcd}	29.17^{b}
S492	10.20^{b}	33.86^{b}	4.68^{a}	28.91^{b}
N-SK (b-23)	10.06^{b}	35.15^{ab}	4.32^{d}	31.80^{a}

*Means, followed by at least one letter in common are not significantly different at the 5% of probability level- using Duncan s Multiple Range Test. Ctrl: Control.

3.4. Fiber fineness

T2 and N-SK (b-23) new genotype had the lowest fiber fitness index, respectively 4.2125 and 4.3250 Micronair-Inch g^{-1}. Therefore, they had the most fitted fibers. Aslan et al. (2022) indicated mean value of 11 cotton varieties fiber fineness was 4.42 to 4.63 Micronair-Inch g^{-1}. Fiber fineness is one of the most important quality characteristics for cotton fiber, especially for textile use (Ehsan *et al.*, 2008). Fiber fineness is more affected by environmental factors than fiber length and fiber strength (Mert, 2020). Micronaire, which represents a combined measure of cotton's fineness and maturity, is ideally between 3.5-4.9 micronaire (Inch g^{-1}) for Upland cottons (Alishah, 2009). Fabrics obtained from fibers with this fineness show superiority for softness and shine (Çağırgan and Barut, 2000). According to the study's results and findings, average values of fiber fineness fell within the optimal range for spinning and textile industries consumption, so that between 3.7 and 4.2 micronaire (Inch g^{-1}) fibers having Excellent fiber fineness, fibers having 3.5 and 3.6 or 4.3 and 4.9 micronaire (Inch g^{-1}) are basic fiber fineness (Delhom *et al*., 2020).

3.5. First-year data analysis

The trial first year data analysis of variance in 2020 showed that the studied new cotton genotypes control cultivars had significant differences for all studied traits, except for the boll weight (Table 4).

3.6. Seed cotton yield in the first year

Mean comparisons showed that in 2020, T2 new cotton genotype had the highest seed cotton yield per hectare (41775 kg ha^{-1}) and was in the same statistical group as the Eram3 genotype, and the S492 genotype had the lowest yield per hectare (2450 kg ha^{-1}) (Table 5). Yield is a complex biometrical trait and seed cotton yield is a resultant product of all its component traits, cotton seed weight, boll number, and boll weight. Killi and Beycioglu (2020) indicated, seed cotton yield of 46 cotton genotypes varied from 1574 to 4497 kg ha^{-1}.

Table 4. Variance analysis (mean square) of cultivation and use traits of new cultivars and new genotypes and control cultivars of cotton in Fars province in 2020.

S.O.V.	d.f.	Seed cotton yield	Boll weight	Boll number per plant	Earliness index	Fiber length	Fiber uniformity	Fiber elasticity
Block	3	27808^{ns}	0.78^{ns}	0.84^{ns}	41.76^{ns}	24.30^{ns}	64.75^{ns}	5.77^{ns}
Genotypes	7	1411306^{**}	1.42^{ns}	46.08^{**}	274.20^{**}	4.87^{**}	7.33^{*}	0.17^{*}
Error	21	123442	0.60	5.59	17.03	0.15	2.15	0.04
C.V. (%)	-	10.88	6.05	6.76	1.20	1.40	1.79	3.50

ns is not significant and * and ** are significant at 5 and 1 percent probability levels, respectively.

Table 5. Mean comparison of the studied value of cultivation and use traits of new cotton genotypes and control cultivars in Fars province (Darab) in 2020.

Genotypes	Seed cotton yield (kg ha^{-1})	Boll number per plant	Earliness index (%)	Fiber length (mm)	Fiber uniformity (%)	Fiber elasticity (%)
T2	41775^{a*}	19.52^{a}	94.00^{a}	28.35^{ab}	83.70^{c}	60.07^{b}
Eram3	4001^{a}	16.38^{abc}	89.25^{a}	28.80^{a}	84.92^{abc}	6.32^{ab}
Golestan (Ctrl)	3088^{b}	13.79^{bcd}	78.00^{b}	27.80^{b}	86.25^{ab}	6.00^{b}
Bakhtegan (Ctrl)	3125^{b}	10.13^{de}	70.00^{c}	28.80^{a}	86.80^{a}	6.50^{a}
No. 200	3022^{b}	12.94^{cde}	76.00^{bc}	28.85^{a}	83.40^{c}	6.07^{b}
Axial No. 200	3097^{b}	17.27^{ab}	78.00^{b}	26.10^{c}	83.92^{bc}	6.30^{ab}
S492	2317^{c}	9.70^{e}	76.00^{bc}	28.10^{b}	85.85^{abc}	5.97^{b}
N-SK (b-23)	3000^{b}	17.06^{ab}	72.00^{c}	28.00^{ab}	86.45^{a}	6.45^{a}

*Means, in each column and for each factor, followed by at least one letter in common are not significantly different at the 5% of probability level- using Duncan s Multiple Range Test. Ctrl: Control.

3.7. Boll number per plant in the first year

T2 and S492 new cotton genotypes had the highest and lowest boll number per plant, respectively (Table 5). Because of difference in boll weight of the studied new genotypes and control cultivars was not significant, therefore expected T2 and S492 new cotton genotypes were expected to have the highest and the lowest seed cotton yield. The number of bolls is one of the most important yield factors that make up the seed cotton yield. The variable that has the most participation in fiber performance is the number of knots per unit area. The number of bolls is per unit area (Boquet *et al*., 2004; Wu *et al*., 2005). However, Shahzad et al. (2019) reported the correlation of yield with different traits among cotton cultivars. Among the number of bolls in the plant, there is a great variety. The non-significance of the interaction effect of year × genotypes indicates that the influence of environmental conditions is less and that the traits that are not significantly affected by the interaction effect of year × genotypes are more under genetic control. The difference in the average final boll number per plant of cultivars is probably due to their genetic characteristics in terms of producing the number of reproductive branches, fruiting positions and the ability to transfer materials to the bolls formed for maturity and uniform blooming of the bolls is the fallout of the shell, which is caused by the internal processes regulating the relations between the source and the reservoir, may increase under unfavorable environmental conditions. Due to the genetic difference of the evaluated cultivars and the different response of these cultivars to environmental conditions and stresses, the boll number per plant can also be different (Naderi Arefi and Hamidi, 2014). Killi and Beycioglu (2020) reported that 46 cotton genotypes had 4.37-11.05 bolls per plant.

The components of seed cotton yield include the number of bolls, boll weight, number of seeds per boll, and the weight of fiber and cotton seeds, and these components are under the influence of the physiological activity of the plant and its interaction with the environment, the variable that has the most participation in fiber yield is the number boll per unit area (Boquet *et al*., 2004; Wu *et al*., 2005).

However, Vafayi Tabar and Tajick Khaveh (2012) reported a great diversity among cotton cultivars in terms of seed cotton yield correlation with different traits, including the number of bolls per plant. The non-significant interaction of the year × genotypes effect indicates that the environmental conditions are less influential and more under the genetic control of the traits that were not significantly affected by the interaction effect of year × genotypes. The difference in the number of bolls per plant is probably due to their genetic characteristics in terms of producing the number of reproductive branches, fruiting positions and the ability to transfer assimilates to the bolls formed for ripening and uniform bolls opening. The bolls shedding, which is caused by the internal processes that regulate the relationship between the source and the sinks, may increase under unfavorable environmental conditions. Due to the genetic difference of the evaluated cultivars and the different responses of studied genotypes to environmental conditions and stresses, the number of bolls per plant can also be different (Nadri Arefi and Hamidi, 2014).

3.8. Earliness index in the first year

The T2 new genotype and the Bakhtegan control cultivar were the earliest and the latest maturity genotypes, respectively (Table 5). Hamidi et al. (2022a) also investigated the significant difference in the earliness index of the studied new and control cultivars.

3.9. Fiber length in the first year

No. 200 new genotype had the most fiber length, 28.850 mm, and Bakhtegan control cultivar and Eram3 new genotype fiber length were 28.800mm and fiber length of them with No. 200 new genotype were in the same statistical group (Table 5). Gin turn out, length, strength and fineness of fibers are the most important fiber quality characteristics of cotton (Mahmood *et al*., 2006). Hamidi et al. (2018) observed that there was a significant difference in the length of the fibers of different cotton genotypes.

3.10. Fiber uniformity and elasticity in the first year

Bakhtegan control cultivar fiber uniformity and elasticity were the highest, and N-SK (B-23) new genotype fiber uniformity and elasticity were in the same statistical group (Table 5). The uniformity of fibers depends on environmental conditions (Bradow and Davidonis, 2010). Liakatas et al. (1998) observed that by changing the range of day and night temperature from 16-30°C to 16.5-26°C, the uniformity of fibers increased from 42.5% to 54.3%. Also, Ashokkumar and Ravikesavan (2011) reported the differentiation and diversity of cotton cultivars in terms of fiber uniformity. The significance of the interaction effect of year × genotypes indicates the influence of environmental conditions on the affected traits.

3.11. Second-year data analysis

Analysis of variance of traits data for which the interaction of year × genotypes was not significant in 2021 showed that the studied new genotypes and the control cultivars had no significant difference except in fiber uniformity and elasticity. Also, seed cotton yield, number of bolls per plant, earliness index, and boll weight and fiber length of the studied new genotypes and the control cultivars had significant differences (Table 6).

Table 6. Analysis of variance (mean square) of cultivation and use traits of cotton new genotypes and control cultivars in Fars province in 2021.

S.O.V.	d.f.	Seed cotton yield	Boll weight	Boll number per plant	Earliness index	Fiber length	Fiber uniformity	Fiber elasticity
Block	3	91636[ns]	0.23[ns]	6.28[ns]	0.25[ns]	0.67[ns]	1.41[ns]	0.60[ns]
Genotypes	7	1209420[**]	0.93[*]	41.11[**]	274.20[**]	2.36[*]	7.73[ns]	0.12[ns]
Error	21	210559	0.33	5.39	0.67	0.66	3.59	0.08
C.V. (%)		12.66	11.93	15.66	5.43	2.84	2.25	4.88

ns is not significant and * and ** are significant at 5 and 1 percent probability levels, respectively.

3.12. Seed cotton yield in the second year

Mean comparisons revealed that in 2021, the Eram 3 new genotype had the highest seed cotton yield per hectare (40501 kg ha^{-1}), and T2 new genotype seed cotton yield per hectare (4000 kg ha^{-1}) was in the same statistical group with them, and the S492 genotype had the highest yield per hectare (Table 7). Naderi Arefi and Hamidi (2014) evaluated the cultivation and use value trial of 9 cotton new genotypes and cultivars and found that the Tabladilla cultivar had the highest bolls number per plant and the highest seed cotton yield up to 3847 kg ha^{-1} and the performance of the crop showed a relatively high positive correlation with its components, including the average number of bolls per plant and boll weight.

Table 7. Mean comparison of the studied value of cultivation and use traits of new cotton genotypes and control cultivars in Fars province (Darab) in 2021.

Genotypes	Seed cotton yield (kg ha^{-1})	Boll weight (g)	Boll number per plant	Earliness index (%)	Fiber length (mm)
T2	4200[a*]	4.20[b]	20.45[a]	92.00[a]	28.60[b]
Eram3	4050[a]	5.37[a]	16.00[b]	86.25[a]	29.37[ab]
Golestan (Ctrl)	3220[b]	4.70[ab]	16.47[b]	77.00[b]	28.17[bc]
Bakhtegan (Ctrl)	3312[b]	5.50[a]	11.59[cd]	70.00[c]	28.82[ab]
No. 200	3255[b]	4.99[ab]	15.85[b]	73.00[bc]	30.05[a]
Axial No. 200	3132[b]	5.07[ab]	13.09[bcd]	76.00[bc]	27.55[c]
S492	2450[c]	4.80[ab]	10.17[d]	75.00[bc]	28.60[b]
N-SK(b-23)	3000[b]	4.20[b]	15.00[bc]	70.00[c]	28.22[bc]

*Means, in each column and for each factor, followed by at least one letter in common are not significantly different at the 5% of probability level- using Duncan's Multiple Range Test. Ctrl: Control.

3.13. Boll weight in the second year

Unlike the trial first year results, boll weight difference of the studied new genotypes and control cultivars was significant in accordance with the trial conduction second year results. During 2021, the Bakhtegan control cultivar had the highest boll weight and Eram 3 new genotype boll weight was in the same statistical group. Hamidi et al. (2022a) also investigated a significant difference in the boll weight of the studied new genotypes and the control cultivars' boll weight.

3.14. Boll number per plant in the second year

The highest number of bolls per plant belonged to the T2 new genotype and the S492 new genotype had the lowest number of bolls per plant. Hamidi et al. (2022a) also investigated studied new and control cultivars number of bolls per plant in new and control cultivars, with a significant difference.

3.15. Earliness index in the second year

As the investigated results for earliness index in 2020, results of 2021 revealed that the earliest maturity genotype was T2 new genotype, and Eram3 new genotype also after the T2 new genotype, was the earliest maturity and grouped with the T2 new genotype in the same statistical group. The Bakhtegan control cultivar and N-SK (B-23) new genotype were the latest maturity genotypes (Table 7). Hamidi et al. (2022b) investigated which cultivar was the earliest maturity cultivar in both years of VCU trial conduction.

3.16. Fiber length in the second year

In 2021, the highest and the lowest fiber length belonged to the Golestan control cultivar and the S492 new genotype, respectively. As the first year trial results, in the second year also No. 200 new genotype had the longest fiber and then Eram3 new genotype had the most fiber length and the order of fiber length of other studied new genotypes and control cultivars was Bakhtegan (control cultivar) > T2 = S492 > N-SK (b-23) > Golestan (control cultivar) >Axial No. 200 respectively (Table 7). Fiber length is a genotype-dependent characteristic and previous studies also reported significant differences among fiber lengths of cultivars (Beegum *et al*., 2025).

4. Conclusion

The commonly cultivated 'Bakhtegan' cultivar is late-maturing, creating a need among farmers in Fars province for an early-maturing cotton variety suitable for planting immediately after the harvest of cereal crops (wheat and barley). The Value of Cultivation and Use (VCU) trial conducted in the Darab region demonstrated that the new genotype T2 achieved the highest seed cotton yield, boll number per plant, earliness index, gin turnout, and fiber fineness. The new genotype Eram3 also exhibited high yield and was the second earliest-maturing genotype after T2. In contrast, the control cultivar 'Bakhtegan' showed superiority in 100-seed weight, boll weight, fiber length, uniformity, and elasticity, while the new genotype N-SK (B-23) recorded the highest fiber strength. Overall, the trial results indicate that the T2 and Eram3 genotypes are superior to the other tested genotypes and control cultivars in terms of seed cotton yield, its key components, and earliness. Therefore, T2 and Eram3 are eligible for release as new commercial cultivars and are recommended for cultivation in Fars province and other regions with similar climatic and soil conditions.

Conflict of interests

All authors declare no conflict of interest.

Ethics approval and consent to participate

No humans or animals were used in the present research. The authors have adhered to ethical standards, including avoiding plagiarism, data fabrication, and double publication.

Consent for publications

All authors read and approved the final manuscript for publication.

Availability of data and material

All the data are embedded in the manuscript.

Authors' contributions

All authors had an equal role in study design, work, statistical analysis and manuscript writing.

Informed consent

The authors declare not to use any patients in this research.

Funding/Support

This study was supported by Seed and Plant Certification and Registration Institute (SPCRI), Agriculture Research, Education and Extension Organization (AREEO), Karaj, Iran.

Acknowledgement

This article was achieved based on the material and equipment of Seed and Plant Certification and Registration Institute (SPCRI), that the authors thanks it.

References

Ahmad S., Hasanuzzaman M. 2020. Cotton production and uses. In: Agronomy, Crop Protection and Postharvest Technologies. (Springer Nature Singapore Pte Ltd.). https://doi.org/10.1007/978-981-15-1472-2

Alishah O. 2009. Special Words of Cotton. Ministry of Jihad-e-Agriculture, Research, Education and Extension Organization (ARREO), Extension and Education Deputy, Education Technology Office, Agriculture Education Publication. 269 p. (In Farsi).

Ashokkumar K., Ravikesavan R. 2011. Morphological diversity and per se performance in upland cotton (*Gossypium hirsutum* L.). Journal of Agricultural Science 3(2): 107. https://doi.org/10.5539/jas.v3n2p107

Aslan R., Aygün Y.Z., Mert M. 2022. Yield and fiber quality characteristics of some cotton (*Gossypium hirsutum* L.) cultivars grown in the southeastern Anatolian conditions. Turkish Journal of Field Crops 27(2): 285-292. https://doi.org/10.17557/tjfc.1159916

Beegum S., Hassan M.A., Reddy K.N., Reddy V., Reddy K.R. 2025. Assessing fiber quality variability among modern upland cotton cultivars and incorporating it into the GOSSYM-based fiber quality simulation model. Journal of Cotton Research 8(1): 18. https://doi.org/10.1186/s42397-025-00221-5

Boquet D.J., Hutchinson R.L., Breitenbeck G.A. 2004. Long-term tillage, cover crop, and nitrogen rate effects on cotton: plant growth and yield components. Agronomy Journal 96(5): 1443-1452. https://doi.org/10.2134/agronj2004.1443

Bradow J.M., Davidonis G.H. 2010. Effects of environment on fiber quality. In: Stewart J.M., Oosterhuis D.M., Heitholt J.J., Mauney J.R. (eds.) Physiology of Cotton. Springer, Dordrecht (pp. 229-245). https://doi.org/10.1007/978-90-481-3195-2_21

Bradshaw J.E. 2017. Plant breeding: past, present and future. Euphytica 213(3): 60. https://doi.org/10.1007/s10681-016-1815-y

Çağırgan O., Barut A. 2000. Nazilli Pamuk Araştırma Enstitüsü'ndeki Genetik Stok Pamuk Çeşitlerinin Özellikleri. T.C. Tarım ve Köy İşleri Bakanlığı, Nazilli Pamuk Araştırma Enstitüsü, Publication (No. 58, pp. 18-30), Nazilli, Aydın. (In Turkish).

Delhom C.D., Knowlton J., Martin V.B., Blake C. 2020. The Classification of Cotton. Journal of Cotton Science 24: 189-196. https://www.cotton.org/journal/2020-24/4/upload/JCS24-189.pdf

Ehsan F., Ali A., Nadeem Tahir M.A., Majeed A. 2008. Comparative yield performance of new cultivars of cotton (*Gossypium hirsutum* L.). Pakistan Journal of Life Social Science 6(1): 1-3.

Fars Province Meteorology Office. 2021. Agricultural Meteorology News Bulletin. Fars Province Meteorology Office Scientific Publication. (In Farsi).

Fars Province Meteorology Office. 2022. Agricultural Meteorology News Bulletin. Fars Province Meteorology Office Scientific Publication. (In Farsi).

Gudeta B., Kedisso E.G., Gurmessa D., Tesfaye D., Damtew S., Taye W., Gebre-Egziabher A., Balcha M., Daba T., Workie A., Maredia K. 2023. Adaptability of genetically engineered BT cotton varieties in different growing regions of Ethiopia. Advances in Agriculture 2023(1): 8224053. https://doi.org/10.1155/2023/8224053

Hamidi A. 2016. Evaluation and determination of some new cotton (*Gossypium hirsutum* L.) cultivars value for cultivation and use (VCU). Final Report of Project. Seed and Plant Certification and Registration Institute (SPCRI), Agricultural Research, Education and Extension Organization (AREEO), Ministry of Jihad-e-Agriculture, Karaj, Iran. (In Farsi).

Hamidi A., Alishah O., Rahemi M.R., Mohajer Abbasi A., Jafari Mofid Abadi Y., Hosseipour J., Ghasemi Bezdi K., Jazayeri Noushabadi M.R., Najafian M. 2022a. Evaluation of some quantitative and qualitative characteristics of six newly introduced genotypes of cotton (*Gossypium hirsutum* L.). Iranian Journal of Cotton Research 9(2): 179-201. (In Farsi). https://doi.org/10.22092/IJCR.2022.359154.1184

Hamidi A., Ghasemi Bazdi K., Jafari Y. 2018. Evaluation of morphological characteristics of cotton (*Gossypium hirsutum* L.) new genotypes in Golestan province. Journal of Crop Breeding 10(9): 66-74. (In Farsi). https://doi.org/10.29252/jcb.10.27.66

Hamidi A., Mehravar M., Dinkou F., Noor Ziarat R., Maleki Ziarati H., Safarnejad A., Khelghatibana F., Rahnama K., Monfared Z., Asadi F., Katooli Nejad M.A. 2022b. Evaluation of foreign cotton cultivar quantitate and fiber quality traits in Golestan province. Iranian Journal Cotton Researches 10(2): 95-116. (In Farsi). https://doi.org/10.22092/ijcr.2023.362052.1195

Hamidi A., Naderi Arefi A., Forghani S.R., Vafayi Tabar M., Arab Salmani M., Hakimi M. 2012. Cotton seed production and technology. Seed and Plant Certification and Registration Institute, Karaj, Iran. 648 p. (In Farsi).

Hickey L.T., Hafeez A.N., Robinson H., Jackson S.A., Leal-Bertioli S.C., Tester M., Gao C., Godwin I.D., Hayes B.J., Wulff B.B. 2019. Breeding crops to feed 10 billion. Nature Biotechnology 37(7): 744-754. https://doi.org/10.1038/s41587-019-0152-9

Killi F., Beycioglu T. 2020. Yield, yield components and lint quality traits of some cotton cultivars grown under east mediterranean conditions. International Journal of Environmental & Agriculture Research 6(2): 45-49. https://doi.org/10.5281/zenodo.3692407

Liakatas A., Roussopoulos D., Whittington W.J. 1998. Controlled-temperature effects on cotton yield and fibre properties. The Journal of Agricultural Science 130(4): 463-471. https://doi.org/10.1017/S0021859698005413

Mahmood S., Irfan M., Raheel F., Hussain A. 2006. Characterization of cotton (*Gossypium hirsutum* L.) varieties for growth and productivity traits under water deficit conditions. International Journal of Agriculture and Biology 8(6): 796-800.

Mert M. 2020. Fiber Plants. Nobel Akademik Yayıncılık, Publication No. 1734, 3rd Edition. Ankara, Türkiye. (In Turkish).

Ministry of Jihad-e-Agriculture. 2024. Agriculture statistics, Volume 1. agronomic crops, 2022-2023 years. Statistics, Information and Communication Technology Center, Statistics Deputy of Ministry of Jihad-e-Agriculture. 126 p. (In Farsi).

Mozafari J., Sadeghian S.Y., Mobasser S., Khademi H., Mohammadi S.A. 2010. Principles of plant variety protection. Seed and Plant Certification and Registration Institute (SPCRI), Agricultural Research, Education and Extension Organization (AREEO), Ministry of Jihad-e-Agriculture, Karaj, Iran. (In Farsi).

Naderi Arefi A., Hamidi A. 2014. Seed cotton yield and some related traits in different cultivars of cotton (*Gossypium hirsutum* L.) in Garmsar conditions. Seed and Plant Production 30(4): 401-420. (In Farsi). https://doi.org/10.22092/sppj.2017.110558

Priyadarshan P.M. 2019. Plant Breeding: Classical to Modern. Singapore: Springer Nature Singapore. https://doi.org/10.1007/978-981-13-7095-3

Seed and Plant Certification and Registration Institute (SPCRI). 2020. Act of plant varieties registration, control and certification of seed and plant material of the Islamic Republic of Iran. Agricultural Research, Education and Extension Organization (AREEO), Ministry of Jihad-e-Agriculture, Karaj, Iran. (In Farsi).

Seed and Plant Certification and Registration Institute (SPCRI). 2009. National guideline for testing value for cultivation and use of cotton. Agricultural Research, Education and Extension Organization (AREEO), Ministry of Jihad-e-Agriculture, Karaj, Iran. (In Farsi).

Shah M.A., Rasheed S.M. 2019. Evaluation of different cotton varieties for yield performance collected from public sector. International Journal of Agricultural and Environment Research 5(4): 227-233.

Shahzad K., Li X., Qi T., Guo L., Tang H., Zhang X., Wang H., Zhang M., Zhang B., Qiao X., Xing C. 2019. Genetic analysis of yield and fiber quality traits in upland cotton (*Gossypium hirsutum* L.) cultivated in different ecological regions of China. Journal of Cotton Research 2(1): 14. https://doi.org/10.1186/s42397-019-0031-4

Shakr S.A., Mohamed E.N., Shahein A.M. 2017. Evaluation of some Egyptian cotton cultivars for yield, seed quality and viability characters. Journal of Plant Production 8(8): 837-844. https://doi.org/10.21608/JPP.2017.40876

UPOV. 1991. International Convention for the Protection of New Varieties of Plants (UPOV Convention). International Union for the Protection of New Varieties of Plants. https://www.upov.int/edocs/pubdocs/en/upov_pub_221.pdf

USDA. 2022. Cotton: World Markets and Trade. United States Department of Agriculture, Foreign Agricultural Service, Washington DC. https://www.fas.usda.gov/data/cotton-world-markets-and-trade

Vafayi Tabar M., Tajick Khaveh Z. 2012. Variation in yield and earliness correlation with other quantitative traits of early upland cotton cultivars. Electronic Journal of Cotton Fiber Crop 1: 97-114. (In Farsi).

Wu J., Jenkins J.N., McCarty J.C., Watson C.E. 2005. Comparisons of two statistical models for evaluating boll retention in cotton. Agronomy Journal 97(5): 1291-1294. https://doi.org/10.2134/agronj2004.0216

HOW TO CITE THIS ARTICLE

Hamidi A., Hekmat M.H., Arab Salmani M., Mohajer Abbasi A. 202x. Determination of Value of Cultivation and Use (VCU) of New Cotton Genotypes in Fars Province. *Agrotechniques in Industrial Crops* x(x): xx-xx. 10.22126/ATIC.2026.11051.1159