PLANNED COMPARISONS OF DIFFERENT GROUPS USING CONTRAST COEFFICIENTS AND LOCAL AND MUTANT AZERBAIJAN COTTON VARIETIES SAMPLE

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ABSTRACT

Comparisons using ANOVA and multiple range tests are nonplanned comparisons. Alternatively, comparisons of means that researcher directly interest in, can be compared with contrast coefficients. The aim of the study is to present a possibility that researcher would be focused on the hypothesis interested, directly.

In this study, fiber fineness (mic) data obtained form totally four cotton varieties consisting of one local nonmutant hirsutum (*Maraş-92*), three mutants consisting of one barbadense (*Ağdaş-21*) and two hirsutum (*Ağdaş-3*, *Ağdaş-17*) species were used as a numerical sample.

Hypothesis are as below:

a) Ho: Mean of local nonmutant variety and mean of mutant Azerbaijan varieties are similar.
b) Ho: Mean of mutant barbadense variety and mean of mutant hirsutum varieties are similar.
c) Ho: Means of mutant hirsutum varieties are similar.

As a result; in terms of fiber fineness, they are found out that mean of local nonmutant variety and mean of mutant Azerbaijan varieties are similar (P>0.05), mean of mutant barbadense variety and mean of mutant hirsutum varieties are not similar (P<0.05) and means of mutant hirsutum varieties are similar (P>0.05).

Keywords: Contrast, anova, mutant, cotton, planned comparisons

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INTRODUCTION

Analysis of variance (ANOVA) is a statistical method for comparing the means of two or more groups. When F value is found to be statistically significant, a need for a further investigation to find the source of the difference emerges. A classical way for this investigation is multiple comparisons which fall into unplanned category (Efe et al., 2000; Shavelson, 2016). As an alternative, planned (priori) comparisons are used to compare specific differences between group means based on focused hypotheses. For planned comparisons, researcher may have prior information in order to build the hypothesis of interest. (Shavelson, 2016; Karpinski, 2011). Contrast analysis is a method of planned comparisons. Planning contrasts saves time by preventing unnecessary comparisons (Laija, 1997; Davis, 2010; Sundström, 2010).

When planned comparisons are decided, it should be determined if it will be orthogonal or not (Thompson, 1990). And then, contrast coefficients are set for testing the hypothesis (Abdi, 2009; Abdi and Williams, 2010).

In this study, the effect of cotton varieties on fiber fineness (mic) is investigated by using orthogonal contrasts. For this purpose, an unmutated local variety belonging in *hirsutum* species and three mutant

Azerbaijan varieties one of which belonging to *barbadense* and two of which belonging to *hirsutum* species are used.

MATERIAL AND METHOD

Material

In this study, a part of the data obtained from a research conducted in Department of Field Crops, Faculty of Agriculture, Kahramanmaraş Sütçü İmam University is used in applications with permission (Efe et al., 2004; Mustafayev et al., 2005). Varieties are: a local Kahramanmaraş cotton Maraş92, three Azerbaijan cottons Agdaş-3, Agdaş-17 and Agdaş-21. Study is conducted as completely randomized design with three replicates. Data on fiber fineness (mic) are given in Table 1.

Table 1. Fiber fineness (mic) data

Replicates	*Maraş-92 (local, hirsutum)*	*Ağdaş-21 (Azerbaycan, barbadense)*	*Ağdaş-3 (Azerbaycan, hirsutum)*	*Ağdaş-17 (Azerbaycan, hirsutum türü)*
1	4.32	4.01	4.45	5.17
2	4.58	4.21	4.61	4.87
3	4.21	4.17	4.61	4.16
Mean	**4.37**	**4.13**	**4.56**	**4.73**
Std. Dev.	0.19	0.11	0.09	0.51

Method

Sum of squares for a contrast is as below (Rosenthal and Rosnow, 1985; Rosnow et al., 2000; Abdi, 2009):

$$SS_{ContrastEstimation} = SS_{\psi_a} = \frac{n \times L^2}{\sum c_{a,i}{}^2} \quad (1)$$

where;

$$L = \sum_{a=1}^{k} M_{a.} \times C_a = \sum_{a=1}^{k} M_{a.} \times c_{a,i} = M_{1.}c_{1,i} + M_{2.}c_{2,i} + ... + M_{k.}c_{k,i} \quad (1.a)$$

and,

$M_{a.}$: means of conditions (or groups)

$c_{a,i}$: i^{th} contrast coefficient in a^{th} group.

n: number of observations in each group

i: contrast row number (i.e. for C_2 row, i=2)

L: contrasted (weighted) sum of the means .(Rosethal and Rosnow, 1985; Rosnow et al., 2000; Çanga and Efe, 2017)

2.2.1. Building Orthogonal Contrasts

A way to test whether two contrasts are linearly independent (orthogonal) is to show that correlation coefficients between each set of contrast coefficients equal to zero. On the other hand, checking orthogonality is possible without calculating correlation coefficients. Two contrasts are orthogonal if and only if:

$$\sum_{a=1}^{A} c_{a,i} \times c_{a,j} = 0 \quad (2)$$

where $c_{a,1}$, $c_{a,2}$ are first and second contrast row coefficients (Rosnow et al., 2000; Abdi, 2009).

If scalar product of two vectors is zero, it means that these two vectors are orthogonal which indicates zero correlation under the assumption of normality. Therefore, when there is no correlation, there is independency between contrasts (Abdi, 2009).
Orthogonal contrasts are linear combinations divided into two categories as group comparisons and trend analyses. In this study, group comparisons using orthogonal contrasts are considered. There are 3 contrast rows for 4 groups. Hypotheses are:

1) Null hypothesis stating that "mean of local variety and mean of all three mutant Azerbaijan varieties are equal" is expressed by contrast coefficients $C_1=\{3, -1, -1, -1\}$ as:
$$H_{0,1}: \psi_1 = 3\mu_{M92} - 1\mu_{Ağ21} - 1\mu_{Ağ3} - 1\mu_{Ağ17}$$

2) Null hypothesis stating that "between Azerbaijan varieties, mean of mutant *barbadense* variety and mean of two mutant *hirsutum* varieties are equal" is expressed by contrast coefficients $C_2=\{0, 2, -1, -1\}$ as:
$$H_{0,2}: \psi_2 = 0\mu_{kont.} + 2\mu_{Ağ21} - 1\mu_{Ağ3} - 1\mu_{Ağ17}$$

3) Null hypothesis stating that "means of two mutant *hirsutum* varieties are equal" is expressed by contrast coefficients $C_3=\{0, 0, 1, -1\}$ as:
$$H_{0,3}: \psi_3 = 0\mu_{M92} + 0\mu_{Ağ21} + 1\mu_{Ağ3} - 1\mu_{Ağ17}$$

These three hypotheses mean three planned comparisons (Chatham, 1999). Sum of squares of varieties (groups) is divided into three components each of which having 1 degree of freedom. Contrast coefficients for these three planned comparisons are given in Table 2.

Table 2. Orthogonal coefficients for three comparisons

Comparisons	Maraş-92 (local, hirsutum)	Ağdaş-21 (Azerbaijan, barbadense)	Ağdaş-3 (Azerbaijan, hirsutum1)	Ağdaş-17 (Azerbaijan, hirsutu2)
Local variety vs. mutant Azerbaijani varieties	3	-1	-1	-1
Mutant barbedense vs. mutant hirsutum	0	2	-1	-1
Mutant hirsutum1 vs. mutant hirsutum2	0	0	1	-1

RESULTS AND DISCUSSION

Classical ANOVA table for the fiber fineness data is given in Table 3.

Table 3. ANOVA results for fiber fineness

SV	DF	SS	MS	F
Between varieties	3	0.60	0.20	2.48
Within varieties	8	0.65	0.08	
Total	11	1.25		

If scalar product of two vectors is zero, it means that these two vectors are orthogonal. Orthogonality can be shown for C_1, C_2, C_3 as below (Çelik and Yılmaz, 2015):
$C_1 \perp C_2$ = 3*0+ (-1)* 2+(-1)* 1+(-1)* (-1)+ (-1)* (-1) =0
$C_1 \perp C_3$ = 3*0+ (-1)* 0+(-1)* 1+ (-1)* (-1) =0
$C_2 \perp C_3$ = 0*0+ 2*0+(-1)*1+ (-1)*1+(-1)*(-1) =0
With the three hypotheses mentioned previously, sum of squares of each varieties are divided into three components with 1 degree of freedom. When comparisons are nonorthogonal, sume of square of one comparison may include sum of square for another. In such situations, results of the tests cannot be determined clearly.
Contrast coefficients and calculations for the fiber fineness data are given in Table 4.

Table 4. Contrast coefficients and calculations of contrast sum of squares

	Maraş-92 (local, hirsutum)	*Ağdaş-21 (Azerbaijan, barbadense)*	*Ağdaş-3 (Azerbaijan, hirsutum1)*	*Adaş-17 (Azerbaijan, hirsutum2)*		
$M_{a.}$	4.37	4.13	4.56	4.73		
					$\sum Ci$	$\sum Ci^2$
C_1	3	-1	-1	-1	0	12
C_2	0	2	-1	-1	0	6
C_3	0	0	1	-1	0	2
					$L=\sum M_{a.}\times C_i$	$L^2=(\sum M_{a.}\times C_i)^2$
$M_{a.}\times C_1$	13.11	-4.13	-4.56	-4.73	-0.31	0.096
$M_{a.}\times C_2$	0	8.26	-4.56	-4.73	-1.03	1.060
$M_{a.}\times C_3$	0	0	4.56	-4.73	-0.18	0.032

$$SS_{Contrast1}=SS_{\psi_1}=\frac{n\times L^2}{\sum c_{a,i}^{\ 2}}=\frac{3\times 0.096}{12}=0.02$$

$$SS_{Contrast2}=SS_{\psi_2}=\frac{n\times L^2}{\sum c_{a,i}^{\ 2}}=\frac{3\times 1.06}{6}=0.53$$

$$SS_{Contrast3}=KT_{\psi_3}=\frac{n\times L^2}{\sum c_{a,i}^{\ 2}}=\frac{3\times 0.032}{2}=0.05$$

And notice that

$SS_{Varieties}= SS_{Contrast1} + SS_{Contrast2} + SS_{Contrast3}$

Values are provided in Table 5.

Table 5. ANOVA table with contrasts

SV	DF	SS	MS	F
BETWEEN VARIETIES	**3**	**0.60**	**0.20**	**2.47**
$\psi_1=3\mu_{M92}-1\mu_{Ağ21}-1\mu_{Ağ3}-1\mu_{Ağ17}$ (Unmutated local variety vs. mutant Azerbaijani varieties)	1	0.02	0.02	0.30
$\psi_2=0\mu_{M92}+2\mu_{Ağ21}-1\mu_{Ağ3}-1\mu_{Ağ17}$ (Barbadense vs. mutant hirsutum varieties)	1	0.53	0.53	6.53*
$\psi_3=0\mu_{M92}+0\mu_{Ağ21}+1\mu_{Ağ3}-1\mu_{Ağ17}$ (Mutant hirsutum1 vs. mutant hirsutum2)	1	0.05	0.05	0.58
WITHIN VARIETIES (Error)	**8**	**0.65**	**0.08**	
TOTAL	**11**	**1.25**		

*Statistically different at 0.05 significance level

Orthogonality of comparisons guarantees the source variations to be uncorrelated (Kwon, 1996). In this research, with planned comparisons of the groups using orthogonal coefficients, interpretation is made more clear (Çelik ve Yılmaz, 2015).

Findings in Table 5 indicates that the means of local variety and mutant varieties are similar ($p>0.05$), whereas the means of mutant barbadense and mutant hirsutum varieties differentiate ($p<0.05$) in terms of fiber fineness.

CONCLUSION

In this research, the use of contrasts when comparing orthogonal groups in one way completely randomized designs is studied. As a quantitative variable, fiber fineness (mic) which is a characteristic that measure the quality of the fiber is used.

In terms of fiber fineness, the means of mutant barbadense and mutant hirsutum varieties are found to be different ($p<0.05$), while the means of local variety and mutant varieties are similar ($p>0.05$). In addition, means of the two Azerbaijani mutant hirsutum varieties are also decided to be indifferent.

As a summary, orthogonal comparisons enable the researcher to focus only on the hypotheses that is of interest.

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