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REPEATED MEASUREMENT OF VARIANCE ANALYSIS PROCEDURES IN AGRICULTURAL RESEARCH THROUGH SPSS 16.0 VERSION

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Abstract

A numerous quantitative data about measurements of some agricultural research, would be meaning significantly after the data were tabulated and analysed in the adequate way. Commonly, the quantitative data should be tabulated and analysed by parametric principles so as to obtain the clear points. Usually, the pooled data achieved were done in repetition of several frequencies. These data gathered were named repeated measure and the data analysis

applied was repeated measurement analysis or Repeated Measurement Analysis of Variance. One advancement of many methods used in this analysis was the efficient in use of time, procedures, and human resources. For instance, when the observation variable only on one variable observed, like measurement of addition of plant height and measured in some times, then only one analysis of variance table would be generated, not more based on measurement frequency. If the data are negative or positive trending, the analysis would not be obstacle, but when the data are fluctuatively pattern, the problems would be present in this condition. This repeated measurement analysis of variance was properly applied in this situation.

Keywords: Assumption, efficient calculation, longitudinal observation, parametric statistics, repeated measurement

Introduction

Repeated measurement analysis of variance, is one kind of data collected from the field- or laboratory- research or observation in quantitative data. Our observation measures variables have been measured in several different times. As a result, we will obtain several groups of data based on times observation as a so-called “Repeated Measurement Anova” (RMA). This technique has been introduced in long time ago by mathematical and statistical scientists such as Steel and Torrie in the 1960s named the “*split-plot in time experiment*”, Huynh and Feldt (1970) in *Journal of American Statistics Association*, 65: 1582-1589, and Litle (1989) in *Journal of HortScience*, 24(1): 37-40. So that the scientists have also been explained as Mead, *et al.*, (1994), Motulsky (1995), Zar (1999), Clewer and Scarisbrick (2001), and also Johnson and Wichern (2007).

In RMA, data observations or measurements have been included the “times” in serial levels that could not be randomized as another treatment (Mead *et al.*, 1994). This means the data observation or measurement have been done as the age of the object increases as or time duration of applied treatments. For instance: observation of weights of some animal husbandry as a response of some diets after for months and measured in different four times, heights of some crop plants based on ages as responses to some nutritions applied for three months and measured in different six times, and so forth.

The uselessness of repeated measurement ANOVA approach is based on three reasons (Suaib, 2011) as explained by Park *et al.* (2009) i.e., the experimental hypothesis needed the repeated measurement in which each sample of a measure was executed in each phase, and this phase was a repeated factor as first reason; especially for the bigger variants in between their samples, the variance error of the estimation from standard ANOVA will be bigger so that each sample could be accommodated to measure this variance, as a result of the error of variance will be lesser as the second reason, and the determining of the small sample could be reached so that, in each individually sampled, should be measured in each condition as the third reason.

One reason that hardly inhibited implementation to thinking about the use of non-repeated measurement (regular ANOVA) in an observation or an experiment was the non-efficient and non-effective ways. The calculation procedures and time-lapse consumption in regular ANOVA would be bigger than in the RMA. The condition of the research measurement results from the data at the inconsistent pattern (trend to increases or decreases), this condition not easily be the too accurate conclusion.

The use of SPSS for Windows Program version 16.0 was based on the simplest used compared to the latest version, also another program, and more easily be obtained with uncharged that could be downloaded in the google, free of charge (SPSS, 1968). In the next explanation, we will shortly elaborate the simple conclusion of each four assumptions test before ANOVA is applied (Gio, 2015).

The normality assumption was met if the test of normality based on the significance score of Kolmogorov-Smirnov was bigger than alpha 0.05, which means the test normality assumption is met. Other than, if the test resulted in less than alpha 0.05, the normality assumption was not met. In this condition, the data must be transformed by arcus sinus, or logarithmic ways, and so on, or by the proper ways, depending on the data distribution patterns, and then ANOVA would be continued.

Analyzing the variance homogeneity assumption will conclude that the homogeneity of variance was met if the test resulted in a bigger than that of alpha score 0.05 of the significance of Levene Statistics. In contrast, if the score is less than alpha 0.05, this means the homogeneity of variance was not met. The data must be transformed by arcus sinus or logarithmic way, and so on, or by the proper ways, depending on the data distribution patterns, then ANOVA would be continued.

The additivity assumption has to be tested by Tukey's test of additivity. If the score of the residual ANOVA with Tukey's test for non-additivity significance was bigger than alpha 0.05, it means the data was additive. Conversely, if the residual score was less than alpha 0.05, this means the additivity data was not met. The data must be transformed by arcus sinus or logarithmic, and so on, or by the proper way, depending on the data distribution patterns, then ANOVA would be continued.

The fourth consideration was the independence assumption, and all data were not correlated if the Durbin-Watson score was also less than an alpha score of 0.05. The data must be transformed by arcus sinus, or logarithmic way, and so on, or by the proper ways, depending on the data distribution patterns before ANOVA would be continued. So, the independent assumption was met if the Durbin-Watson score was less than alpha 0.05.

All of these assumptions or minimally two assumptions (normality assumption and assumption of equality of variances) must be met when we would like to do some ANOVA in the repeated measurement of analysis of variance (Field, 2009) and if they are not met, then the ANOVA results would be violated. The conclusion made would be false as, the conclusion was 95% significant level, in scientific reality, this would be only less than 95% or 80%, etc. It is the scientific viewpoint of the important problem when doing the ANOVA or parametric statistics in research data analyses.

This article will be expressed some experimental data observation on crop plants about the use of some combination fertilizers and weed management and analysed with both regular ANOVA and RMA procedures. The objectives of this article were to give the short phenomena and to give a simple explanation about doing some ANOVA analysis, especially for RMA. It was also explained, discussed, and write up report of some primary and secondary literature as materials discussion in the final version.

Materials and methods

The field experiment was done in the second field laboratory Faculty of Agriculture Halu Oleo University in the second season of 2021. The data gathered were analyzed in two ways, i.e., (i) the regular ANOVA, and (ii) the RMA procedures. The regular ANOVA was followed in all procedures and resulted in some groups of data e.g., the four figures of variable progress, the four data tables of results analyses treatments with the codes of comparisons of each level of treatments, and the four conclusions. In contrast, the RMA procedures generated the four

figures of variable progress, the one data table of results analyses treatment with the codes of comparisons of each level of treatments, and the one conclusion.

As we know that this experiment was more quantitative in viewpoint and parametric model based on analytical data in solving the problems so that before advanced analysis, the four assumptions of ANOVA in common, plus one assumption of RMA, must be verified firstly. Only if all the assumptions are met, the above should be continued by using SPSS 16.0 version.

Starting Program and Input Data Preparation

Firstly, we open the menu of the SPSS program and click **variable view** in under left hands corner of the screen, then write in the first line and the first column was **treatment name**, the second column was **data kinds** (*string* or *numeric*), the third column was **width** (*the character numbers of words or phrases*), the fourth column was **decimal** (*the number of the score after a full stop*), the fifth column of the **label** (*the flag of treatment*), the sixth columns was **values** (*none*), the seventh column of **missing** (*none*), the eighth columns aligned, (*left, mid, right*), and the ninth column was a **measure** (*nominal, ordinal, scale*). In the second line, click all of each column was the same attributes as the same way as the first line with a **variable view**, etc.

Secondly, click the **data variable** and click every column to choose the proper alternatives based on its column as same as in the **variable view**. The number of column that has to be filled depends on the building structure of the research. The simple research is a simple structure, but the advanced research would be a more complicated structure.

Input Data Procedures

Soon after both **variable view** and **data variable** were already opened, all the data research was written down to each column properly. Put the scores of all measures in a precision way to serve the accuracy of the result in one aspect. Incorrect input of the data measurements then continuously analyzed, would be biased the research result in another aspect.

Assumptions Test of RMA Procedures

Firstly, open the screening program, choose the data file of the research, and began to analyze after the data screen was opened. For analyzing the **Normal Data Distribution** assumption, click **analyze** menu, then **descriptive statistics**, and click **explore**. The new screen would appear, then drag all the treatment names to **Label Cases by**, then click **Dependent List**.

Click **OK**, the other new screen would appear. Click **Plots**, then **Continuous**, and the new screen would appear. Next, click **Factor levels together**, tick the **Normality plots with tests**, then click **Continue**, and at the end click **OK**. Some results and tables would appear, but the most important one was the **Test of Normality** which composed both **Kolmogorov-Smirnov** and **Shapiro-Wilk** significance scores.

For analyzing the **Variance Homogeneity** assumption, open the file data as same as above, and in the sequence order, click **Analyze**, **Compare Mean**, and **One-Way ANOVA**, and the new screen would appear. Drag all the treatment names into the **Dependent List** window, then click the *treatment name* into the **Factor**, then **Option**. After that, tick the windows of the **Homogeneity of variance test**, **Continue**, and click **OK**. The **Test of Homogeneity of Variances** table will appear which consists of **Levene Statistics**, the homogeneity of variances could be read the significant scores.

In analyzing of **Additivity** assumption, reopen again the data as same as above, and in the same procedures was clicked the **Analyze**, **Scale**, and **Reliability analysis** in the sequence order. The other new screen appeared, and dragged all treatments into the item window, then click the **Statistics**, and tick the **Tukey's test additivity**. Click **Continue** and **OK**, the final test would be seen in a table about **Anova with Tukey's Test for Non-additivity**. Pay attention to scores of **Residual Non-additivity** of **F-value** and **Significance**.

The last stage of the assumption procedures was analyzing the **Independence** assumption. We again use the same data as seen above, click **Analyze** and **Regression** in the sequence order, then **Linear**. The other new window was appeared and drag the *name of the treatment* into the **Dependent** window, and *all the treatments* tested in the **Independent(s)** window. Click the **Statistics** button, tick **Model fit**, **Estimates**, **Durbin-Watson**, **Continue**, and **OK**, in the order sequences. The final screen will appear as a **Model Summary** table and the expression of **Durbin-Watson** would be the attention scores.

Common Anova Data Analyzing Procedures

Open the screen data program as same as above, click **Analyze**, then **General Linear Model**, and then **One-Way ANOVA**. Click **Continue** and **Oke**.

RMA Data Analyzing Procedures

Open the screen data program as same as above, click **Analyze**, then **General Linear Model**, and then **Repeat Measurement**. Name the **Within-Subject** variable by putting the name into the **Within-Subject Factor Name**. Then put the number of **Levels of the Within-subject**

variable into the number of **Levels**. In this case, the number **Levels** will be 4 (four), then click **Add**, and then **Define**. Move the **Between-Subject** variable from the left box to the **Between-Subject Factor(s)** box on the right. Then move the **Within-Subjects** variables from the left box to the **Within-Subjects Variable** box on the right. Then click **Option**, if we like to display another result analysis like means, interaction effect, homogeneity assumptions, etc. It is the final procedure of Repeated Measurement Anova.

These two-factor experiments proposed here were arranged in Completely Randomized Design (CRD) with four treatments such as the use of full completely fertilization combinations (NPK) like the ratio of NPK e.g., 1:1:1; 1:0.5:1; 1:0.5:0.5, and 2:1:1 (w/w/w), and three replications. All treatments consisted of 12 plots as experimental units, and each plot was in 625 plants, 1 plant per hill e.g., 75 cm between rows and 25 cm between plants in the row. The height of the plant measurements was done in four times. To judge the best treatment was tested with the Tukey t-test (Honestly Significance Difference, HSD) at 5% of the significance level (Steel and Torrie, 1960).

Results

The data gathered in this experiment were presented in Table 1, in which the condition varied according to the results of measurements. Based on these data, showed that likely to trend in increasing scores according to the age of the plants. If these data are directly analyzed by ANOVA in common without verification with those some assumptions, the results were expressed in the Tables 2 until 5, respectively. These tables were showed all four of ANOVA tables of each time measurements. Each table is expressing their data characteristics about the developments and the changes of their heights according to the plant growth ages. By those procedures of this ANOVA tables were generated four tables based on the number of measurement frequency.

Table 1. Data measurement of some observation of mays height (cm) as responses to four levels of fertilizer combination and two levels of weed management

No.	Factor*		Measurement Frequency (cm)			
	First	Second	1	2	3	4
1	1	5	22.74	40.23	77.48	98.30
2	1	5	38.20	30.35	63.34	96.02

3	1	5	24.30	39.63	74.93	91.71
4	1	6	28.87	38.87	74.59	95.37
5	1	6	25.20	35.61	69.77	95.18
6	1	6	33.30	42.62	76.18	96.65
7	2	5	22.71	38.11	64.78	85.50
8	2	5	28.73	36.65	72.02	92.30
9	2	5	27.83	39.58	64.78	83.89
10	2	6	32.10	38.43	72.02	95.76
11	2	6	36.69	40.50	73.83	95.37
12	2	6	35.02	42.63	74.59	95.91
13	3	5	25.39	38.62	70.95	94.26
14	3	5	27.73	40.19	77.68	95.37
15	3	5	29.86	41.71	79.51	98.21
16	3	6	33.03	40.00	76.73	96.02
17	3	6	26.16	36.17	71.93	97.87
18	3	6	22.28	37.53	64.78	90.78
19	4	5	26.83	38.51	67.33	88.35
20	4	5	35.65	46.17	75.29	91.90
21	4	5	36.07	41.62	74.59	90.87
22	4	6	31.44	41.57	74.20	90.78
23	4	6	31.26	40.95	73.89	94.26
24	4	6	30.64	36.36	68.65	91.90

Note: *Code of first factor combination of fertilizer (N=nitrogen, P=phosphorus, and K=potassium) i.e., 1) = 1:1:1; 2) = 1:0.5:1; 3) = 1:0.5:0.5; 4) = 2:1:1, and the second factor of weed management, i.e., 5) = weeding by hands, and 6) = weeding by tractor.

Table 2. ANOVA of plant height on the first observation

Item	Sum of Squares	Df	Mean Square	F	Sig.
Between Groups	177.928	7	25.418	1.219	.348
Within Groups	333.739	16	20.859		
Total	511.667	23			

Table 3. ANOVA of plant height on the second observation

Item	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	60.609	7	8.658	.881	.543
Within Groups	157.284	16	9.830		
Total	217.893	23			

Table 4. ANOVA of plant height on the third observation

Item	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	133.335	7	19.048	.882	.542
Within Groups	345.569	16	21.598		
Total	478.905	23			

Table 5. ANOVA of plant height on the fourth observation

Item	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	214.570	7	30.653	4.378	.007
Within Groups	112.020	16	7.001		
Total	326.591	23			

By the RMA procedures, the first action that have to do was to verify of all parametric assumptions of data characteristics i.e., those respect assumptions like the normality, the variances homogeneity, the independent assumption, and the additivity of the data. The normality assumption as the first consideration indicated that the scores of Saphiro-Wilk's test was significance in some treatment as expressed in Table 6. The second assumption was the homogeneity of variances in which the Levene test of three data measurements were met i.e., the data scores of significances less than 0.05 of the apha's value i.e., the fourth measurement (Table 7). The third assumption was the independent of variable. According to ANOVA with test of independent was the score of Durbin-Watson test. The value of this test was more than the score of F-table i.e., 0.46 (Table 8). This value was more than the value of alpha score of 0.05. Lastly, the fourth assumption was the additivity of the data. This assumption was violated because the Tukey's test especially to the residual non-additifity of significant level was 6.928 that more than F-table i.e., 0.010 (Table 9).

Table 6. ANOVA with test of normality

	Kolmogorov-Smirnov ^a			Saphiro-Wilk		
	Statistic	Df	Sig.	Statistic	df	Sig.
Measure-1	.080	24	.200	.965	24	.550
Measure-2	.102	24	.200	.950	24	.275
Measure-3	.178	24	.049	.929	24	.093
Measure-4	.178	24	.048	.908	24	.032

a. Lilliefors Significance Correction

*. This is a lower bound of the true significance.

Table 7. Test of homogeneity of variances

	Levene Statistic	df1	df2	Sig.
Measure-1	3.233	7	16	.025
Measure-2	1.840	7	16	.148
Measure-3	1.706	7	16	.178
Measure-4	2.941	7	16	.035

Table 8. ANOVA with test of independent variable

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.434 ^a	.189	.018	11.329	.406

a. Predictors: (Constant), Measure-4, Measure-2, Measure-1, Measure-3

b. Dependent Variable: 15, 16, 25, 26, 35, 36, 45, 46

Table 9. ANOVA with Tukey's test for nonadditivity

		Sum of Square	df	Mean Square	F	Sig.
Between People		1,310.103	23	56.961		
Within People	Between items	77,870.293	4	19,467.573	554	.000
	Residual Nonadditivity	228.584	1	228.584	6.928	.010

		Balance	3,002.368	91	32.993		
		Total	3,230.952	92	35.119		
	Total		81,101.245	96	844.805		
Total			82,411.348	119	692.532		
Grand Mean = 53,0251							
a. Tukey's estimate of power to which observations must be raised to achieve additivity = 1,869.							

In the next analysis of Figure 3 shows that by graphical representation of mays growth development during four times of measurements, pointed the gradual increasing according to the growing phase. This indicated that from early to the last measurement, all treatments were sincronously increased based on the plant growth. Some generated tables have the very important informations that could be pointed like table of the Multivariate tests (Table 10). This table was explained the significant effects of some factors and interaction of factors and treatments.

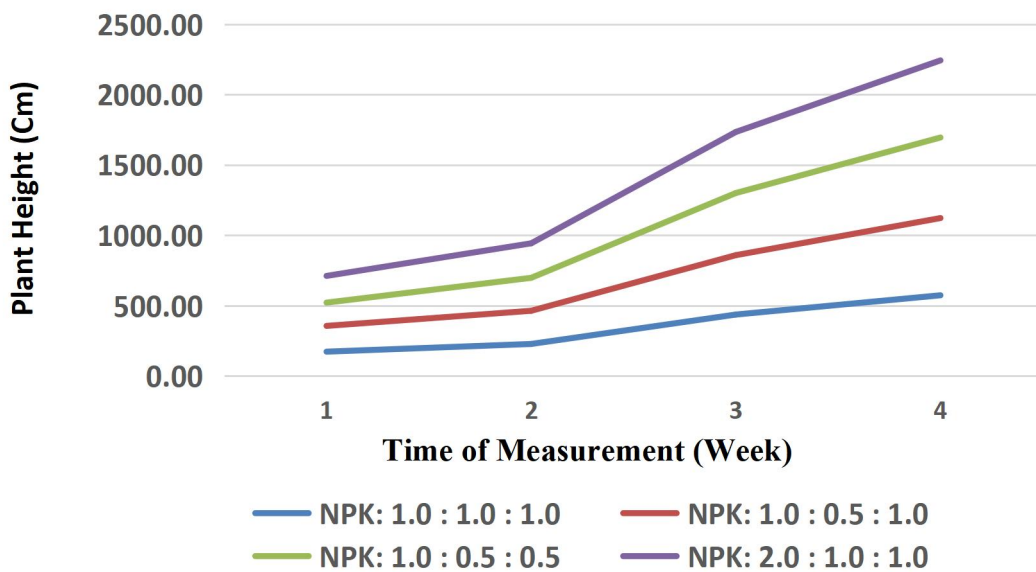


Figure 3. Graphical representation of mays growth development during four times of observation

Table 10. ANOVA with multivariate tests^c

	Effect	Value	F	Hypothesis df	Error df	Sig.
Factor-1	Pillai's Trace	.998	2.632E3 ^a	3.000	14.000	0.000
	Wilks' Lambda	.002	2.632E3 ^a	3.000	14.000	0.000
	Hotelling's Trace	563.997	2.632E3 ^a	3.000	14.000	0.000

	Roy's Largest Root	563.997	2.632E3 ^a	3.000	14.000	0.000
Factor-1*Treatment	Pillai's Trace	.974	1.099	21.000	48.000	.381
	Wilks' Lambda	.237	1.262	21.000	40.751	.256
	Hotelling's Trace	2.387	1.440	21.000	38.000	.161
	Roy's Largest Root	2.027	4.663 ^b	7.000	16.000	.005

a. Exact statistic

b. The statistic is an upper bound on F that yields a lower bound on the significance level.

Design: Intercept + Treatment

Within Subjects Design: factor1

Table 11. ANOVA with Mauchly's test of Sphericity^b

Measure: MEASURE-1

Within Subjects Effects	Mauchly's W	Approx. Chi-Square	Df	Sig.	Epsilon ^a		
					Greenhouse-Geisser	Huynh-Feldt	Lower-bound
Factor-1	.481	10.782	5	.056	.664	1.000	.333

Tests the null hypothesis that the error covariance matrix of the orthonormalized transformed dependent variables is proportional to an identity matrix.

a. May be used to adjust the degrees of freedom for the averaged tests of significance. Corrected tests are displayed in the Tests of Within-Subjects Effects table.

b. Design: Intercept + Treatment Within Subjects Design: factor1

Table 12. ANOVA with multivariate tests^c

Measure: MEASURE-1

Source		Type III Sum of Squares	df	Mean Square	F	Sig.
Factor-1	Sphericity Assumed	62.648.911	3	20.882.970	1.976E3	0.000
	Greenhouse-Geisser	62.648.911	1.991	31.479.847	1.976E3	0.000
	Huynh-Feldt	62.648.911	3.000	20.882.970	1.976E3	0.000
	Lower-bound	62.648.911	1.000	62.648.911	1.976E3	0.000
Factor-1*Treatment	Sphericity Assumed	285.762	21	13.608	1.287	.231

	Greenhouse-Geisser	285.762	13.935	20.507	1.287	.268
	Huynh-Feldt	285.762	21.000	13.608	1.287	.231
	Lower-bound	285.762	7.000	40.823	1.287	.317
Error (Factor-1)	Sphericity Assumed	507.407	48	10.571		
	Greenhouse-Geisser	507.407	31.851	15.931		
	Huynh-Feldt	507.407	48.000	10.571		
	Lower-bound	507.407	16.000	31.713		

Table 13. ANOVA with test of within subjects contrasts

Measure: MEASURE-1

Source	Factor-1	Type III Sum of Squares	Df	Mean Square	F	Sig.
Factor-1	Linier	60.362.046	1	60.362.046	6.202E3	.000
	Quadratic	805.679	1	805.679	46.086	.000
	Qubic	1.481.186	1	1.481.186	329.292	.000
Factor-1*Treatment	Linier	211.197	7	30.171	3.100	.029
	Quadratic	54.977	7	7.854	.449	.856
	Qubic	19.587	7	2.798	.622	.731
Error (Factor-1)	Linier	155.722	16	9.733		
	Quadratic	279.715	16	17.482		
	Qubic	71.969	16	4.498		

Table 14. ANOVA with test of between subject effects

Measure: MEASURE-1

Transformed Variable: Average

Source	Type III Sum of Squares	Df	Main Square	F	Sig.
Intercept	330.294.517	1	330.294.517	1.198E4	.000
Treatment	300.680	7	42.954	1.558	.218
Error	441.206	16	27.575		

The Maulchy's test of spericity (Table 11), explained the significant score of measures i.e., 0.56, and this value indicate more than alpha score i.e., of 0.05. The ANOVA table of multivariate test (Table 12), which elucidate the significant level of some factors and interaction between some factors and treatments. in the respect of test of Within Subjects Contrast (Table 13), and test of Between Subject, Effects (Table 14) were explaine the difference within and between treatments. The within subject effect was non significant for all factors and interaction between factors and treatments, only linier model was significant but non-significance for quadratic and cubic distributions.

Finally, the ANOVA test of within subject effects indicating the 0.000 of significant for intercept, but the non-significance effect was presence in between treatments.

Discussions

As expressed in the early explanation in this research results, for analyzing the data, the format of programs and data composition are shown in the Figure 1 and 2, whereas the data observation measurements were indicated in Table 1. These expressions were arranged based on the guides of this program (SPSS, 1968). As proposed by Park and Ki (2009) that the use of RMA procedures must be confirmed the arrangement of the observation mainly in serial times of measurements. If the times of observation were included in these whole projects, the using of RMA was the appropriates choices (Litle, 1989; Mead, *et al.* 1994; Park and Ki, 2009).

	Name	Type	Width	Decimals	Label	Values	Missing	Columns	Align	Measure
1	Treatment	Numeric	8	2	15, 16, 25, 26, 35, 36, 45, 46	None	None	8	Right	Scale
2	Height	Numeric	8	2	Measure-1	None	None	8	Right	Scale
3	Height1	Numeric	8	2	Measure-2	None	None	8	Right	Scale
4	Height2	Numeric	8	2	Measure-3	None	None	8	Right	Scale
5	Height3	Numeric	8	2	Measure-4	None	None	8	Right	Scale
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Figure 1. Variable view of research observation

	Treatment	Height	Height1	Height2	Height3	var	var	var	var	var	var	var	var	var
1	15.00	22.74	40.23	77.48	98.30									
2	15.00	38.20	30.95	63.34	96.02									
3	15.00	24.30	39.63	74.93	91.71									
4	16.00	26.87	38.87	74.59	95.37									
5	16.00	25.20	35.61	69.77	95.18									
6	16.00	33.30	42.62	76.18	96.65									
7	25.00	22.71	38.11	64.78	85.50									
8	25.00	26.73	36.65	72.02	92.30									
9	25.00	27.83	39.58	64.78	83.89									
10	26.00	32.10	38.43	72.02	95.76									
11	26.00	36.69	40.50	73.89	95.37									
12	26.00	35.02	42.63	74.59	95.91									
13	35.00	25.39	38.62	70.95	94.26									
14	35.00	27.73	40.19	77.68	95.37									
15	35.00	29.86	41.71	79.51	98.21									
16	35.00	33.03	40.00	76.73	96.02									
17	36.00	26.16	36.17	71.93	97.87									
18	36.00	22.28	37.53	64.78	90.78									
19	45.00	26.83	38.51	67.33	88.35									
20	45.00	35.65	46.17	75.29	91.90									
21	45.00	36.07	41.62	74.59	90.87									
22	46.00	31.44	41.57	74.20	90.78									

Figure 2. Data view of research observation

Inspection of the four or two more valuable assumptions before using the analysis of variance is the most proposed in the parametrical statistics like on the special case of this project. Because the validity or adequate results were depending upon the assumptions were holding (Garsd *et al.*, 1995). Violation from one or more of these assumptions resulted in the inadequate of conclusions results. One or more solving problems that must be choiced in this situation was transforming the data by arcus sinus or logarithmic or another kind of transformation based on data distribution patterns (Delacre, *et al.*, 2019).

The four points of growth measures of plants height suggested that the test of normality data distribution indicating that the only treatment of fourth was significantly different (0.032) by Saphiro-Wilk test. This means that the Ho hypothesis was rejected i.e., there was no measures was different. In this situation, some times will be happened in some measures, but the adequate analysis must go on (Field, 2009).

The equality of variances also showed that there are two measures that the values of Levene's statistics were more than alpha 0.05 value i.e., measure-1 and measure-2. These means that only two measures were had the same values of variances. This condition would be considering on the uses of other techniques like any properly transformation or using one technique of non-parametrical statistics (Kvam and Vidakovic, 2007).

The independent variable test of Durbin-Watson showed that the value of 0.406 indicate that the model of the independents was accepted. It means that all treatments were not inter related

on each other, whether in between or within groups of treatments. As a consequence, the unmet of assumption would be an obstacle in the detection of significant differences in between and within treatments (Stevens, 2002). The continuous violation will affect on the increase of type-1 error, i. e., the treatment effect is not true (Dean and Voss (1999).

Another consideration was the additivity of the Tukey's test for non-additivity of residual of significance. Based on Table 9, the significance of residual non-additivity by Tukey's test was 0.010, means that some variables should not be dependent on one another (Bevans, 2021). By within and between subject effects the significance of all the factors were met, but interaction between factors and treatments was significant in linear pattern (Table 13). These means that within subject contrasts were significantly different in which all factors were different with others. In case of difference between subject the ANOVA showed that the intercept of factors and treatments were significantly different.

Conclusion

In the regular ANOVA or commonly practiced the table generated were more than the RMA, and each table must be completed of the separation of difference of all treatments. Then, the other information of some analysis aspects would be added and the analysis result could be more. Some added results analysis like figure for progress measurement, and the indicators of several notes were more proposed. But, in the RMA procedure, only one ANOVA was generated on each variable and one table of summary result. In this connection, the RMA procedure was efficiently than the regular ANOVA.

Consideration of the efficient and effective ways in data analysis of some results from the agricultural observations or measurements, the choice of RMA was more adequately than the others.

Significance statement

This study reports the procedures of Repeated Measurement of ANOVA by using of SPSS version 16.0 in data analysis of some Agricultural field research in longitudinal research. Results generated here produced the simple and efficient way rather than others. The results presented give indication the appropriate use of some repeated measurement of variance.

Author's contribution

SUAIB, S., DARWIS, S., TAUFIK, M. and SUAIB, N.R.A., were designed and performed the experiments, and also wrote manuscript. SUHARJO, MAKMUR, J.A., and SUAIB, N.F., were performed data analysis, and SUAIB, S., DARWIS, D., and TAUFIK, M., were designed and reviewed the manuscript.

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