Construction Method Right Angular Association Schematic Partial Incomplete Randomized Block Design

Muhsinil Haq[1], Georgina Maria Tinungki[2], Nirwan[3]

Abstract

Partially Balanced Incomplete Randomized Group Design (RAKTLSP) is a design with v treatments arranged into b groups with each group consisting of k treatments (k<v) and there are treatment pairs that appear together in the same group λ_m times. The purpose of this study is to be able to construct an experimental design plan and to be able to carry out ANOVA preparation, follow-up tests, testing model assumptions from the Right Angular Association scheme Partial Incomplete Randomized Block Design. This study uses the Right Angular association scheme which is a 4-class association scheme used to determine the first, second, third and fourth associations of each treatment. Based on the association formed, the number of treatment pairs that appear in each group will be obtained (λ_m, m=1,…,4). The test that was carried out was an influence test on the treatment because only the treatment was important where the treatment was adjusted (adjusted). The assumptions needed are the assumption of residual normality, equality of variance and independence with the Tukey test as a follow-up test. The data used as an example of application in this study is data in agriculture by observing the effect of the type of hebricide on weeds, which consists of three types of herbicides with 4 dose levels, namely the single herbicide Bentazon 400 $g.L^{-1}$ and MCPA 60 $g.L^{-1}$ (2; 1; 0.5; 0.25; $L.ha^{-1}$), mixed herbicide Bentazon + MCPA 460 $g.L^{-1}$ (2.5; 1.25; 0.625; 0.3215; $L.ha^{-1}$). The results of the Right Angular Association scheme, Partially Balanced Incomplete Randomized Block Design show that the type of herbicide has an effect on the level of damage to weeds. By using this method it can be seen that the recommended hebricide is type J, namely the single active ingredient MCPA 60 $g.L^{-1}$ (1 ; $L.ha^{-1}$).

Key Words: RAKTLSP, Right Angular Association, Tukey's Test, Normality, Equality of Variances, Independence

DOI Number: 10.14704/nq.2022.20.13.NQ88383 **Neuro Quantology 2022; 20(13):3072-3083**

Introduction

Basically, the experimental design is a design that forms the basis for collecting research data. The word design or design implies that the manufacturing process is done on purpose. Researchers carry out a miniature environment that is made in such a way that it becomes ideal and fulfills the expected conditions for further study of the object's behavior. The basic designs commonly used are Completely Randomized Design (CRD) and Completely Randomized Block Design (RAKL). RAL is used when only a few treatment units are used and the experiment is relatively homogeneous. Experiments involving large enough experimental units rarely use RAL, because it is difficult to collect large numbers of homogeneous experimental units. To overcome difficulties in preparing relatively homogeneous experimental units in large numbers, RAKL is used.

According to Stell & Torrie (1991), if the number of treatments in an experiment increases, the number of experimental units also increases. In many cases, this results in a large increase in the experimental error. To overcome the problems that arise due to the increase in treatment, an Incomplete Randomized Design was used.

Corresponding author: Muhsinil Haq
Address: [1,2,3]Department of Statistics, Faculty of Mathematics and Natural Sciences, Hasanuddin University, Jalan Perintis Kemerdekaan KM. 10 Tamalanrea, Makassar 90245, Indonesia.
[1*]muhsinilhaq@gmail.com
Received: 10 October 2022 **Accepted:** 25 October 2022

According to Montgomery (2009), if not all treatments appear in each group, then it is said that the design that contains them is an Incomplete Randomized Block Design (RAKTL). If the number of repetitions of all treatment pairs in RAKTL is the same, it can be stated that the selection process is carried out in a balanced way so that this form of experiment uses a Completely Balanced Randomized Group Design (RAKTLS) (Suwanda, 2011). RAKTLS is not always suitable for experiments because this design requires treatment pairs to appear with the same frequency in a number of groups. To overcome the occurrence of treatment pairs that appear with unequal frequency, a Partially Balanced Incomplete Randomized Group Design (RAKTLSP) was used. To clarify the discussion, examples of applications in agriculture are given using 6 treatments and 6 groups.

Literature Review

Balanced Incomplete Randomized Block Design (RAKTLS)

Incompletely Balanced Randomized Group Design is a design in which the treatment combinations used in each group are selected in a balanced way so that treatment pairs appear in the same number for each group as other treatment pairs (Montgomery, 2009). The treatment pairs that appear together in the same group are λ, with

$$\lambda = \frac{r(k-1)}{v-1}, \quad \lambda \text{ is an integers}$$

Total observations are N = vr = bk, where r is the repetition of treatment, k is the number of treatments in each group and v is the number of treatments and b is the number of groups.

RAKTLS Linear Model

The linear model for RAKTLS according to Toutenburg and Shalabh (2009) is:

$y\,ij = \mu + i + {}_j\beta + \varepsilon_{ij}\tau$ with i = 1, 2, ... b j = 1, 2, ... vwhere y ij is the observation of the i-th group and the j-th treatment, μ is the general average, i is the influence of the $_{i\text{-}th}$ group, $_j$ is the influence of the β j-th treatment, $\varepsilon\tau_{ij}$ is the error component. When a fixed model is used, the assumption is:

$\sum_{i=1}^{b} \beta_i = 0$ and $\sum_{j=1}^{v} \tau_j = 0$

b) $\varepsilon_{ij} \sim NID\ (0, \sigma^2)$

Hypotheses that can be take:

Ho : = $\tau_1\ \tau_2 = \cdots = \tau_v$ (no effect of treatment on the observed response)

H_1 : There is at least one different pair τ j (there is an influence of treatment on the observed response)

Estimated RAKTLS Parameters

The estimation of the parameters of the RAKTLS equation model can be written down by

$\hat{\mu} = \bar{y}_{..}$ $\quad\quad \hat{\beta}_i = \bar{y}_{i.} - \bar{y}_{..}$

$\hat{\tau}_j = \frac{kQ_j}{\lambda v}$ From the estimated parameters are obtained:

$$\hat{y}_{ij} = \hat{\mu} + \hat{\beta}_i + \hat{\tau}_j = \bar{y}_{..} + (\bar{y}_{i.} - \bar{y}_{..}) + \frac{kQ_j}{\lambda v} = \bar{y}_{i.} + \frac{kQ_j}{\lambda v}$$

Where it is the average of $\bar{y}_{..}$ all observations,

$\bar{y}_{i.}$ is the average observation that gets the j-th treatment.

Variance Analysis for RAKTLS

The effect of treatment on RAKTLS was adjusted, because not all treatments appeared in every group. When F_{counts} greater than $F_{(v-1);(bk-b-v+1)}$ then H_0 will be rejected. This means that there is one or more treatments that have a marked effect on the response. The RAKTLS variance analysis table is described as in table 1.

Table 1. Table of Analysis of Variances for RAKTLS

Sources of Variance	Sum of Squares	Free Degrees	Middle Square	F_{Count}
Treatment (customized)	$\frac{k}{\lambda v}\sum_{j=1}^{v} Q_j^2$	v – 1	$\frac{JKP_{(disesuaikan)}}{v-1}$	$\frac{KTP_{(disesuaikan)}}{KTG}$

Group	$\frac{1}{k}\sum_{i=1}^{b} y_{i.}^{2}$ - $\frac{y_{..}^{2}}{N}$	b – 1	$\frac{JKK}{b-1}$	
Error	JKT - JKP$_{(customized)}$ - JKK	VR - V - B + 1	$\frac{JKG}{vr - b - v + 1}$	
Total	$\sum_{i=1}^{b}\sum_{j=1}^{v} y_{ij}^{2}$ - $\frac{y_{..}^{2}}{N}$	VR – 1		

Test assumptions

The basic assumptions that must be met according to Oehlert (2010) are normally distributed residual, similarity of variance and independence with its residuals as follows:

ε_{ij} = y ij - μ - i - $_j\beta$ = $y_{ij}\tau$ - - ($\overline{y_{..}}_{i.}$ $\overline{y}$ -) - $\overline{y_{..}}$ ()

$\frac{kQ_j}{\lambda v}$ = y_{ij} - $\overline{y}_{i.}$ – (), ε $\frac{kQ_j}{\lambda v}$ $_{ij}$ ~ NID (0,σ^2).

Normality tests can be performed using the Kolmogorv-Smirnov test.

The Variance Similarity Test can be performed using the Bartlett test.

Test Independence using Residual Plot *versus the order of the Data.*

Tukey Method Double Comparison Test

The calculation steps on the Tukey test are:

The average of the adjusted treatments (estimated by $\hat{\tau}_j$) is sorted from smallest to largest value.

Calculates the error standard of the adjusted i-th treatment and j-th treatment. According to Montgomery, (2009), the default error value is

= $s_{\overline{y.i}-\overline{y.j}}\sqrt{\frac{k(KTG)}{\lambda v}}$

Calculating HSD values

HSD = $q_{\alpha;v;dbg} * s_{\overline{y.i}-\overline{y.j}}$

where $q_{\alpha;v;}$dbg is the value in the table with treatment, significance level, and error-free degree (dbg).$qv\alpha$

If || > HSD then the treatment pairs differ significantly.$\hat{\tau}_i - \hat{\tau}_j$.

Methods

The steps performed in analyzing data on RAKTLSP are; (1) Specifies the association scheme that will be used to design what treatments will appear in a group; (2) Determine how many treatments and groups to use in the experimental desig; (3) Determine the linear model of the additive as well as the hypothesis to be used; (4) Perform variance analysis using customized treatment; (5) Conducting assumption tests, namely residual normality, sivariant equality and independence. If the three test assumptions are not met, then a transformation is carried out; (6) Conduct further tests if the initial hypothesis is rejected or there is an effect of treatment on the observed response; (7) Drawing conclusions from the results of further tests that have been carried out.

Results and Discussion

Partial Balanced Incomplete Group Randomized Design (RAKTLSP

The treatment with v treatment is said to be partially balanced if the treatment can be arranged or grouped into b groups with each group consisting of k treatments (k<v) where each treatment appears only once per group and there are two treatments that appear together in the same group λ_m times (Toutenburg and Shalabh, 2009). Some pairs appear together as much as λ_1 time, some other pairs appear as much as λ_2 times , some other pairs appear as much as λ_m times. The pairing of treatments that appear with λ m times is said to be associated to m, where the design is said to have an association of m classes (Montgomery, 2006)·

Model Liner RAKTLSP

The additive linear model for the randomized design of partially balanced incomplete groups with b group fruit and v fruit treatment according to Toutenburg and Shalabh (2009) is :

y ij = μ + $_i$ + j β +ε_{ij} with i = 1.2,...,τ b j = 1.2,..., vwhere y ij is the observation of the i-th group and the j-th treatment, μ is the general average, i is the influence of the $_{i\text{-}th}$ group, $_j$ is the influence of the β j-th treatment, $\varepsilon\tau_{ij}$ is the error component. When a fixed model is used, the assumption is:

a) $\sum_{i=1}^{b} \beta_i = 0$ dan $\sum_{j=1}^{v} \tau_j = 0$

b) $\varepsilon_{ij} \sim$ NID ($0,\sigma^2$)

Hypotheses that can be taken :

Ho : = $\tau_1\ \tau_2 = \cdots = \tau$ $_v$ (no effect of treatment on the observed response)

H_1 : There is at least one different pair τ j (there is an influence of treatment on the observed response)

Right Angular Association Scheme

The right-angular method is a design of the PBIB with 4 associations introduced by Tharthare (1963). The construction of RAKTLSP with the Right angular method is as follows:

Determines the number of groups for each treatment (v) and the number of treatments for each group (k), i.e. and $v = 12k = 12$.

where:

v = number of j-th treatments

k = number of i-th groups

Determining the multiplicity $n_1, n_2, n_3, dan\ n_4$.

Here are the values $n_1, n_2, n_3, dan\ n_4$.

$n_1 = s - 1$

$n_2 = s$

$n_3 = s(l - 1)$

$n_4 = 2(l - 1)(l - 2)$

where:

n_m = the number of treatments associated with the m-th

Determining the multiplicity $\lambda_1, \lambda_2, \lambda_3, dan\ \lambda_4$.

where:

λ_m = number of treatment pairs associated to the m-th

Build an experiment table

The preparation of the experimental table using right angels with arm length is In the first association will be selected treatment 1, then treatment 1 does not appear together in the same group or the first association with other treatments $s = 2. (n1 = 1)$.

1 2		5 6	9 10
	3 4	7 8	11 12

According to Hinkelmann & Kempthorne (2005) the general formula of parameters on the association of triangles is :

$n_1 = s - 1 = 2 - 1 = 1$

$n_2 = s = 2$

$n_3 = s(l - 1) = 2(3 - 1) = 4$

$n_4 = 2(3 - 1)(3 - 2) = 4$

$\lambda_1 = 1, \lambda_2 = 2, \lambda_3 = 4, dan\ \lambda_4 = 4$

$$P_1 = \begin{pmatrix} s-2 & 0 & 0 & 0 \\ 0 & s-2 & 0 & 0 \\ 0 & 0 & s(l-1) & 0 \\ 0 & 0 & 0 & s(l-1) \end{pmatrix}$$

$$P_2 = \begin{pmatrix} 0 & s-1 & 0 & 0 \\ s-1 & 0 & 0 & 0 \\ 0 & 0 & 0 & s(l-1) \\ 0 & 0 & s(l-1) & 0 \end{pmatrix}$$

$$P_3 = \begin{pmatrix} 0 & 0 & s-1 & 0 \\ 0 & 0 & 0 & s \\ s-1 & 0 & s(l-2) & 0 \\ 0 & s & 0 & s(l-2) \end{pmatrix}$$

$$P_4 = \begin{pmatrix} 0 & 0 & 0 & s-1 \\ 0 & 0 & s & 0 \\ 0 & s & 0 & s(l-2) \\ s-1 & 0 & s(l-2) & 0 \end{pmatrix}$$

The above value is equal to the value obtained in the previous calculation. So to make it easier to find values, it can be done using the general formula.$n_1, n_2, n_3,\ n_4, p_1, p_2, p_3,\ dan\ p_4$

Compile a table of association classes.

The first step to compile the association class table is to know which one to use, namely and$v, s\ dan\ lv = 2sl = 2x2x3 = 12, s = 2\ l = 3$.

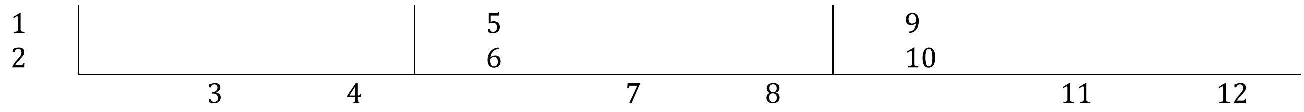
where:

v = multiplicity of treatments

s = the multiplicity of right angles and arms

I = the number of angular positions of the right angle

Furthermore, the treatment is arranged into a 90° angle as follows.



Here is the 4-class association scheme of the 12 treatments shown in 1.

Table 2. Angular Right RAKTLSP Association Scheme1.

Table 2. Angular Right RAKTLSP Association Scheme

Treat	First Association	Second Association	Third Association	Fourth Association
P1	P2	P3, P4	P5, P6, P9, P10	P7, P8, P11, P12
P2	P1	P3, P4	P5, P6, P9, P10	P7, P8, P11, P12
P3	P4	P1, P2	P7, P8, P11, P12	P5, P6, P9, P10
P4	P3	P1, P2	P7, P8, P11, P12	P5, P6, P9, P10
P5	P6	P7, P8	P1, P2, P9, P10	P3, P4, P11, P12
P6	P5	P7, P8	P1, P2, P9, P10	P3, P4, P11, P12
P7	P8	P5, P6	P3, P4, P11, P12	P1, P2, P9, P10
P8	P7	P5, P6	P3, P4, P11, P12	P1, P2, P9, P10
P9	P10	P11, P12	P1, P2, P5, P6	P3, P4, P7, P8
P10	P9	P11, P12	P1, P2, P5, P6	P3, P4, P7, P8
P11	P12	P9, P10	P3, P4, P7, P8	P1, P2, P5, P6
P12	P11	P9, P10	P3, P4, P7, P8	P1, P2, P5, P6

Estimated RAKTLSP Parameters

The estimates of the influence of the j-th treatment according to Das and Giri (1986) for the 2 classes of association are as follows:

$$\hat{\tau}_j = \frac{k\,\{B_2\,Q_j - A_2\,S_1(Q_j)\}}{A_1\,B_2 - A_2\,B_1}, j = 1,2,\dots,v$$

With :

$$A_1 = r(k-1) + \lambda_1 + \lambda_2 + \lambda_3$$

$$A_2 = \lambda_3 - \lambda_2 - \lambda_1$$

$$B_1 = (\lambda_2 - \lambda_1)p_{12}^2 \qquad B_2 = r(k-1) + \lambda_2 + (\lambda_2 - \lambda_1)(p_{11}^1 - p_{11}^2)$$

Description:

$\hat{\tau}_j$ = effect of adjusted treatment, r = repetition of treatment, k = group size

p_{11}^1 = the multiplicity of the two treatments associated symmetrically 1st with the first treatment being at the 1st association and the second treatment being at the lth association

p_{11}^2 = the multiplicity of two treatments associated symmetrically 2nd with the first treatment being at the 1st association and the second treatment being at the 1st association

p_{12}^2 = the multiplicity of the two treatments associated with the 2nd symmetrical with the first treatment being at the 1st association and the second treatment being at the 2nd association

λ_1= the number of treatment partners that appear in the group

λ_2= the number of treatment partners who do not appear in any group

Q j = number of treatments to j adjusted

$S_1(Q_j)$ = the number of treatments to j adjusted at the third and fourth associations

Analysis of Variance for RAKTLSP

Table 3. Variance Analysis for RAKTLSP

Sources of Variance	Sum of Squares	Free Degrees	Middle Square	F Count
Treatment (customized)	$\sum_{j=1}^{v} \hat{\tau}_j Q_j$	V-1	$\frac{JKP_{(disesuaikan)}}{v-1}$	$\frac{KTP_{(disesuaikan)}}{KTG}$
Group	$\sum_{i=1}^{b} \frac{y_{i.}^2}{k} - \frac{Y_{..}^2}{N}$	B-1	$\frac{JKK}{b-1}$	
Error	JKT – JKP(customized) – JKK	VR – V – B + 1	$\frac{JKG}{vr-v-b+1}$	
Total	$\sum_{i=1}^{b}\sum_{j=1}^{v} y_{ij}^2 - \frac{Y_{..}^2}{N}$	VR – 1		

The effect of treatment on RAKTLSP was adjusted, because not all treatments appeared in every group. When F_{counts} greater than $F_{(v-1);(bk-b-v+1)}$ then H_o will be rejected. This means that there are one or more treatments that have a marked effect on the response.

Test the RAKTLSP Assumption

The basic assumptions that must be met according to Oehlert (2010) are normally distributed residual, similarity of variance and independence with its residuals as follows:

$$\varepsilon_{ij} = y_{ij} - \mu - \beta_i - \tau_j = y_{ij} - \overline{y}_{..} - (\overline{y}_{i.} - \overline{y}_{..}) - \frac{k\{B_2 Q_j - A_2 S_1(Q_j)\}}{A_1B_2 - A_2B_1} = y_{ij} - \overline{y}_{i.} - \frac{k\{B_2 Q_j - A_2 S_1(Q_j)\}}{A_1B_2 - A_2B_1}$$

$\varepsilon_{ij} \sim NID(0,\sigma^2)$. The assumption testing is carried out as in RAKTLS.

Double Comparison Test (Tukey Test) for RAKTLSP

The Tukey (*Honest Significant Difference)* test was performed to see which treatment had an influence on the observed response. The steps performed in this test are:

The average of the adjusted treatments (estimated by $\hat{\tau}_j$) is sorted from smallest to largest value.

Calculates the variance values of the i-th and j-th treatments as follows:

$$Var(\hat{\tau}_i - \hat{\tau}_j) = \frac{k(A_2+B_2)\sigma^2}{(A_1B_2 - A_2B_1)} = p_1,$$ if i and j are the third association

$$= \frac{kB_2\sigma^2}{A_1B_2 - A_2B_1} = p_2,$$ if i and j are the fourth association

1. Calculating the misguided standards of the i-th and j-th treatments as follows:

$$SE(1) = \text{standard error of } (\hat{\tau}_i - \hat{\tau}_j) = \sqrt{\frac{k(A_2+B_2)\sigma^2}{(A_1B_2 - A_2B_1)}}$$

$$SE(2) = \text{standard error of } (\hat{\tau}_i - \hat{\tau}_j) = \sqrt{\frac{kB_2\sigma^2}{(A_1B_2 - A_2B_1)}}$$

σ^2 is the value of the middle square of the error.

Calculating HSD values

HSD 1 = $q_{\alpha;v;dbg} * SE_1$

HSD 2 = $q_{\alpha;v;dbg} * SE_2$

If $|\hat{\tau}_i - \hat{\tau}_j|$ > HSD then the treatment pairs differ significantly.$\hat{\tau}_i - \hat{\tau}_j$

Contoh Penerapan RAKTLSP

An experiment was conducted to see the most significant influence among several treatments. There are 12 types of Hebrisides with weed types to see the percentage of weed damage. The research was conducted at the plastic house of the Faculty of Agriculture, Padjadjaran University, Jatinangor District, Sumedang Regency, West Java from June-August 2019. The ingredients used are a single herbicide with active ingredients Bentazon 400 g.L^{-1} and MCPA 60 g.L^{-1}, a mixed herbicide containing the active ingredient Bentazon and MCPA with a concentration of 460 g.L^{-1}. (Umiyati, 2021)

The weeds used consist of 2 types, namely grass group weeds and teki group weeds. The weeds of the grass group are as follows : Ludwigia hyssopifolia, Cynodon dactylon (L.), Eleusine indica(L.), Fimbristylis miliacea, Sphenochlea zeylanica, Imperata cylindrica (L.), Echinochloa crus-galli (L.), Echinochloa colanum (L.), and Panicum repens. Then the weeds of the teki group are as follows : Cyperus iria L and Cyperus bervifolius. Using Hebricide consists of three types of herbicides with 4 dose levels, namely the single herbicide Bentazon 400 g.L^{-1} and MCPA 60 g.L^{-1} (2; 1; 0.5; 0.25; L.ha^{-1}), a mixed herbicide Bentazon + MCPA 460 g.L^{-1} (2.5; 1.25; 0.625; 0.3215; L.ha^{-1}).

Table 4. Angular Right RAKTLSP Association Scheme

Treat	First Association	Second Association	Third Association	Fourth Association
P1	P2	P3, P4	P5, P6, P9, P10	P7, P8, P11, P12
P2	P1	P3, P4	P5, P6, P9, P10	P7, P8, P11, P12
P3	P4	P1, P2	P7, P8, P11, P12	P5, P6, P9, P10
P4	P3	P1, P2	P7, P8, P11, P12	P5, P6, P9, P10
P5	P6	P7, P8	P1, P2, P9, P10	P3, P4, P11, P12
P6	P5	P7, P8	P1, P2, P9, P10	P3, P4, P11, P12
P7	P8	P5, P6	P3, P4, P11, P12	P1, P2, P9, P10
P8	P7	P5, P6	P3, P4, P11, P12	P1, P2, P9, P10
P9	P10	P11, P12	P1, P2, P5, P6	P3, P4, P7, P8
P10	P9	P11, P12	P1, P2, P5, P6	P3, P4, P7, P8
P11	P12	P9, P10	P3, P4, P7, P8	P1, P2, P5, P6
P12	P11	P9, P10	P3, P4, P7, P8	P1, P2, P5, P6

By using $s = 2$, the results are obtained:

$n_1 = s - 1 = 2 - 1 = 1$

$n_2 = s = 2$

$n_3 = s(l - 1) = 2(3 - 1) = 4$

$n_4 = 2(3 - 1)(3 - 2) = 4$

$\lambda_1 = 1, \lambda_2 = 2, \lambda_3 = 4, dan\ \lambda_4 = 4$

$$P_1 = \begin{pmatrix} s-2 & 0 & 0 & 0 \\ 0 & s-2 & 0 & 0 \\ 0 & 0 & s(l-1) & 0 \\ 0 & 0 & 0 & s(l-1) \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 \\ 0 & 0 & 4 & 0 \\ 0 & 0 & 0 & 4 \end{pmatrix}$$

$$P_2 = \begin{pmatrix} 0 & s-1 & 0 & 0 \\ s-1 & 0 & 0 & 0 \\ 0 & 0 & 0 & s(l-1) \\ 0 & 0 & s(l-1) & 0 \end{pmatrix} = \begin{pmatrix} 0 & 1 & 0 & 0 \\ 1 & 0 & 0 & 0 \\ 0 & 0 & 4 & 4 \\ 0 & 0 & 0 & 0 \end{pmatrix}$$

$$P_3 = \begin{pmatrix} 0 & 0 & s-1 & 0 \\ 0 & 0 & 0 & s \\ s-1 & 0 & s(l-2) & 0 \\ 0 & s & 0 & s(l-2) \end{pmatrix} = \begin{pmatrix} 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 0 \\ 1 & 0 & 2 & 0 \\ 0 & 0 & 0 & 2 \end{pmatrix}$$

$$P_4 = \begin{pmatrix} 0 & 0 & 0 & s-1 \\ 0 & 0 & s & 0 \\ 0 & s & 0 & s(l-2) \\ s-1 & 0 & s(l-2) & 0 \end{pmatrix} = \begin{pmatrix} 0 & 0 & 0 & 1 \\ 0 & 0 & 2 & 0 \\ 0 & 2 & 0 & 2 \\ 1 & 0 & 2 & 0 \end{pmatrix}$$

Table 5. RAKTLSP Right Angular with 4 Classes of Association

Ex.	Treatment												$y_{i.}$
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	
A					89,45	45,17	73,87	48,64	87,33	99,49	49,08	77,82	**570,83**
B					66,49	43,96	60,66	21,59	85,90	87,10	48,61	25,11	**439,41**
C					37,34	28,62	57,75	20,15	68,52	69,24	39,81	23,03	**344,45**
D					31,70	28,08	43,98	20,05	35,08	31,81	28,73	20,50	**239,94**
E	34,54	93,43	58,74	85,80					88,99	80,42	66,97	54,62	**563,50**
F	30,88	84,27	55,90	78,62					63,44	77,25	41,19	47,04	**478,59**
G	24,49	59,03	37,83	45,16					46,46	63,14	38,05	44,33	**358,49**
H	26,62	44,57	28,49	23,94					40,22	48,63	31,88	26,14	**270,50**
I	56,44	100,00	32,89	66,50	82,56	68,47	70,26	82,80					**559,92**
J	47,90	67,82	32,85	44,68	81,94	61,13	53,70	76,03					**466,06**
K	29,65	45,74	19,98	15,95	57,69	36,65	34,93	25,92					**266,51**
L	18,52	29,54	19,78	12,23	26,24	20,21	33,78	19,58					**179,87**
$y_{.j}$	**269,04**	**524,40**	**286,46**	**372,88**	**473,41**	**332,28**	**428,93**	**314,75**	**515,93**	**557,07**	**344,32**	**318,58**	**4738,05**

The additive linear model is:

$$y\,ij = \mu + \mathrm{i} + {}_j\beta + \varepsilon_{ij}\tau$$

with i = 1, 2, ... 6 j = 1, 2, ... 6

where y ij is the observation of the i-th group and the j-th treatment, μ is the general average, i is the influence of the $_{i\text{-}th}$ group, $_j$ is the β influence of the j-th treatment, $\varepsilon\tau_{ij}$ is the error component.

Hypothesis:

Ho: $= \tau_1\ \tau_2 = \cdots = \tau\ _6$ (no hebricide type influence on weeds)

H_1: There is at least one different pair τ_j (there is an influence of hebricide type on weeds)

Table 6. ANOVA Table

Sources of Variance	Sum of Squares	Free Degrees	Middle Square	F_{count}	$F_{0.05(11.73)}$
Treatment (customized)	6212,34	11	564,76	2,30	1,92
Group	25842,52	11	2349,32		
Error	17945,80	73	245,83		
Total	82055,52	95			

Assumption of Normality

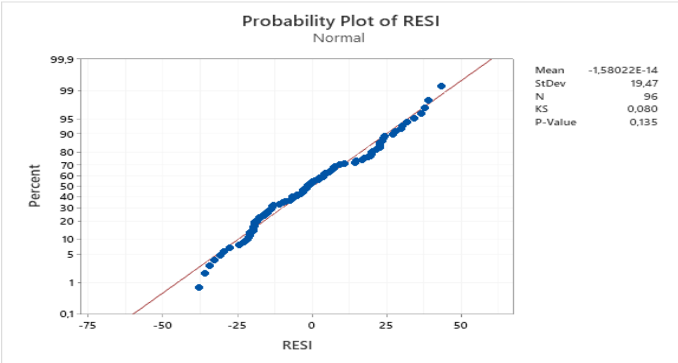


Figure 1. Residual Normality Graph (RAKTLSP)

Based on Figure 1, it shows that the KS value of 0.080 and the p-value of 0.135 were obtained. Where the p-value is less than a significant level of 0.05 in the Kolmogorov-Smirnov table with and which is 0.143 so that H 0α = 5%N = 96 is accepted which means the residual is normally distributed.

Assumption of Variance Similarity

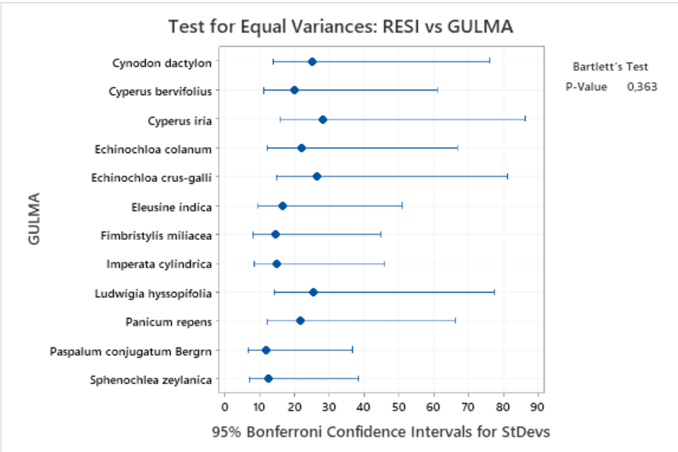


Figure 2. Residual Variance versus Treatment Similarity Graph (RAKTLSP)

Table 7. Variance Similarity Test

Method	TestStatistic	P-Value
Multiple comparisons	—	0,425
Levene	1,21	0,290
Method	**TestStatistic**	**P-Value**
Bartlett	12,00	0,363

Based on Figure 2 and Table 4.7, a Barlett test value of 12.00 was obtained where the value was less than the chisquare value with and free degree = 11 obtained a value of 19.67. As well as a p-value of 0.363 where the value is less than a significant level of 0.05. Thus, it is accepted, which means the variance is the same.$\alpha = 5\% H_0$.

Assumption of Independence

The assumption of independence is fulfilled if the *Residual Plot versus the order of the Data* does not form a certain pattern.

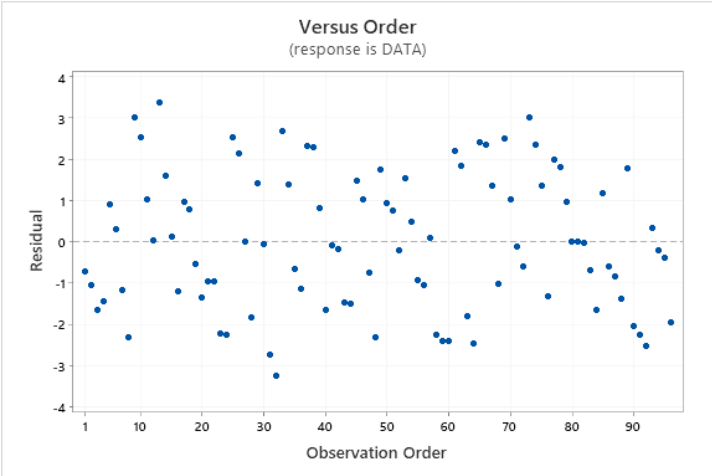


Figure 3. Residual Plot Versus the Order of The Data

From figure 3. shows that randomly spreading plots do not form a specific pattern so that independent assumptions are met.

Based on the assumption test carried out, it is found that all assumptions have been met, then further tests can be carried out. Testing is carried out on customized treatments.

If and is the third association, then :ij

$$P_1 = Var\left(\hat{\tau}_i - \hat{\tau}_j\right) = \frac{k(A_2 + B_2)\sigma^2}{(A_1B_2 - A_2B_1)} = \frac{8(1+135)32{,}56}{18764} = 1{,}89$$

$$SE(1) = \sqrt{\frac{k(A_2 + B_2)\sigma^2}{(A_1B_2 - A_2B_1)}} = \sqrt{1{,}89} = 1{,}37$$

If and is the fourth association, then :jm

$$P_2 = Var\left(\hat{\tau}_j - \hat{\tau}_m\right) = \frac{kB_2\sigma^2}{(A_1B_2 - A_2B_1)} = \frac{8(135)32{,}56}{18764} = 1{,}87$$

$$SE(2) = \sqrt{\frac{kB_2\sigma^2}{(A_1B_2 - A_2B_1)}} = \sqrt{1{,}87} = 1{,}37$$

$$HSD_{\ 1} = q_{0{,}05(12{,}73)} * SE(1) = 4{,}81\ \times 1{,}89 = 9{,}09$$

$$HSD_{\ 2} = q_{0{,}05(12{,}73)} * SE(2) = 4.81 \text{ x } 1{,}87 = 8{,}99$$

By comparing the average of each pair obtained the following results:

A	C	L	H	K	F	D	G	E	I	B	J
-7,18	-6,18	-5,11	-3,94	-3,63	-2,93	-1,20	2,63	5,19	6,24	7,52	8,61

It can be seen that the average comparison of each pair differs significantly because the Value of and > of the treatment value has been adjusted. This means that the types of Treatment A, B, E, D, E, F, G, H, I, J, K and L have the same influence statistically. However, if these results want to be applied, the recommended types of Hebricides are the types of Hebricides J, B, I, E and G, the selection of Hebricide types is adjusted to the percentage of damage to the weeds produced. But statistically, the J vehicle type gives a more lethal percentage of damage to weeds.$HSD_1 HSD_2$.

The investment in the freshwater fishing effort of Lake Tempe in Wajo Regency has investments that support the operation of its business.

Conclusion

The preparation of the experimental plan on the RAKTLSP is based on the association scheme. In the selection of the association scheme it is necessary to pay attention to what class of association to use. Different association schemes will result in different classes of associations. RAKTLSP is more flexible than RAKTLS. However, the analysis of variance on RAKTLSP is more complicated compared to RAKTLS because the analysis on RAKTLSP is based on the association scheme. Preparation of variance analysis in RAKTLSP using adjusted treatment. There are three basic assumptions that must be met, namely residual normality, similarity of variants and independence. The next test that can be used is the Tukey (Honest Significance Difference) test where the comparison value (HSD) used in the RAKTLSP is adjusted based on the associations formed.

References

1. B. Srinivas, N.Ch. Bhatra Charyulu. (2015). "A new method for the construction of Partially balanced n-ary block design". Department of Statistics, University College of Science, Osmania University, Hyderabad-7. ISSN (e): 2319 – 1813 ISSN (p): 2319 – 1805
2. Bose, R. a. (1939). *Partially Balanced Incomplete Block Designs*. Sankya, 307-372.
3. Bose, R., & Connor, W. (1952). *Combinatorial properties of group divisible incomplete block designs*. Journal of Ann. Math. Statist., 367-383.
4. Bose, R., & Shimamoto, T. (1952). *Classification and Analysis of Partially Balanced. Journal of Amer*. Statist., 151-184.
5. Clatworthy, W. (1955). *Partially Balanced Incomplete Block Designs With. Journal of Research of the National Bureau of Standards*, 177-190.
6. Cochran, W., & G. M. Cox. (1957). *Experimental Design*. pp. 127-131.
7. Das, M. N dan Giri N. C. (1986). *Design and Anlysis of Experiments*. New Delhi: Wiley Easternn Limited
8. Dey, Alokey.(2010). *Incomplete Block Designs. Indian statistical Institute*. New Delhi, India
9. Dwivedi, Lokesh. (2011). *Partially Balanced Incomplete Block Designs.* I.A.S.R.I. New Delhi, India
10. Gaspersz, D. I. (1991). *Metode Perancangan Percobaan*. Bandung: Armico.
11. Gomesz A.K dan Gomesz A.A. (2009). *Prosedur Statistik untuk Penelitian Pertanian edisi kedua.* Jakarta: UI-Press.
12. Hinkelmann, K dan Kempthorne, O. (2005). *Design and Analysis of Experiments: Volume 2 Advanced Experimental Design.* New Jersey: Jhon Wiley & Sons.
13. J. Li, Y. Gong, S. Lin and K. Abdel-Ghaffar. (2021). "Balanced Incomplete Block Designs, Partial Geometries, and Their Associated QC-LDPC Codes," *2021 11th International Symposium on Topics in Coding (ISTC)*, 2021, pp. 1-5, doi/10.1109/ISTC49272.2021.9594122.
14. Kelechi, A. C. (2012*). Symmetric and Unsymmetric Balanced Incomplete Block Design: A Comparative Analysis. Internatinal Journal of Statistic and Application*, Vol 2(4), pp 33-39.
15. Kruskal, W., & Wallis, W. A. (1952). *Use of Rank in One-criterion Variance Analysis. Jurnal of the American Statistical Association*, Vol 47(260), pp. 583-621.
16. Lastiyono. 2000. *Masalah Data Hilang dalam Rancangan Blok Acak Lengkap.* Tugas Akhir FMIPA Universitas Gadjah Mada Tahun 2000.
17. Mattjik, A., & I.M., S. (2000). Perancangan Percobaan dengan Aplikasi SAS dan Minitab Jilid I,Edisi Kedua. Bogor: PB-Press.
18. Montgomery, D. C. (1984). Design and Analysis of Experiment. Edisi Kedua. New York: John Wiley and Sons, Inc.
19. Montgomery, D.C. (2006). *"Design and Analysis of Experiment 6th edition".* New York: Jhon Wiley & Sons.
20. Montgomery, D.C. (2009). *Design and Analysis of Experiment* 7th edition. New York: Jhon Wiley & Sons.
21. Nair, K., & Rao, C. (1942). A Note on Partially Balanced Incomplete Block. *Journal of Science and Culture*, 7,, 568-569.
22. Oehlert,G.W. (2010)*. A First Course in Design Analysis of Experiments*. University of Minnesota.
23. Rezgui Imane and Z. Gheribi-Aoulmi. (2013). *"New Construction Method Of Rectangular Partially Balanced Incomplete*

Block Designs And Singular Group Divisible Designs". doi:10.3844/jmssp.2014.45.48 Published Online 10 (1) 2014 (http://www.thescipub.com/jmss.toc)

24. Rida Jabeen, Rashid Ahmed, H.M. Kashif Rasheed, Farrukh Shehzad. (2019). *"Construction of circular strongly partially-balanced repeated measurements designs".* Journal of King Saud University - Science, Volume 31, Issue 3, 2019, Pages 345-351, ISSN 1018-3647, https://doi.org/10.1016/j.jksus.2018.03.014.

25. Rida Jabeen, Rashid Ahmed, Muhammad Sajjad, H.M. Kashif Rashid, Abid Khan. (2019). *"Circular strongly partially-balanced repeated measurement designs in periods of two different sizes using method of cyclic shifts (Rule II)".* Journal of King Saud University - Science, Volume 31, Issue 4, 2019, Pages 519-524, ISSN 1018-3647, https://doi.org/10.1016/j.jksus.2019.02.002.

26. Sharma, V. (n.d.). *Partially Balanced Incomplete Block Design. I.A.S.R.I Library Avenue*, 177-188.

27. Stell, R. G. D., & Torrie J. H., (1980). *Prinsip dan Prosedur Statistika: suatu Pendekatan Biometri*. Jakarta: Gramedia Pustaka Utama

28. Sudjana. (1989). *Desain dan Analisis Eksperimen*. Bandung: Tarsito.

29. Sudjana. (2002). *Metode Statistika*. Bandung: Tarsito.

30. Suswantari. (2014). *Rancangan Acak Kelompok Tak Lengkap*.

31. Suwanda, R. (2011). *Desain Eksperimen untuk Penelitian Ilmiah.* Bandung: Alfabeta.

32. Toutenburg, H dan Shalabh. (2009). *Statistical Analysis of Designed Experiments* 3th edition*.* New York: Springer.

33. Uum Umiyati*, Dedi Widayat, Dani Riswandi dan Reza Amalia. (2021). *"Sifat Campuran Herbisida Berbahan Aktif Bentazon dan MCPA Terhadap Gulma Daun Lebar, Teki dan Rumput".* Agrosains : Jurnal Penelitian Agronomi 23(1): 1-5, 2021. https://jurnal.uns.ac.id/agrosains/article/view/43981. DOI: http://dx.doi.org/10.20961/agsjpa.v23i1.43981

34. Vartak, Manohar N. (1959). *The Non-Existence of Certain PBIB Designs.* University of Bombay. India.

35. Vinayaka & L N, Vinaykumar. (2022). "*Higher associate class partially balanced incomplete block designs using graphs for agricultural experiments".* 10. 967-972. 10.22271/tpi.2021.v10.i12Sn.11252.

36. Widasari, S. (2008). *Rancangan Percobaan.* Jakarta: Karunika, Universitas Terbuka.

37. Yates, F., & Fisher. (1936). *Incomplete Randomized Block. Annals of Eugenics*, 121140.

38. Yitnosumarto. (1991). *Percobaan, Perancangan, Analisis, dan Interpretasinya.* Jakarta: PT Gramedia.