

1 **Evaluation of the Effect of Coconut Water Concentration and Planting Media on Growth**
2 **and Post-Harvest Characters of Large Chili Using Multivariate and Non-Parametric**
3 **Analyses**

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12
13 **Abstract.** The urban farming of large chilli plants plays a significant role as a response to
14 agricultural transfer growth mechanisms that rapidly increase land use. This concept requires
15 modern cultivation technologies, using organic fertilization and planting media. Based on the
16 need for precision, multivariate and non-parametric tests both on growth and post-harvest
17 characteristics are commonly employed to evaluate technology effectiveness. Therefore, this
18 study aims to determine the best technology for the combination of planting media and coconut
19 water concentration, using multivariate and non-parametric analyses. Balang Toa village,
20 Binamu district, Jeneponto Regency, Indonesia, at 100 meters above sea level, served as the
21 study location. This study was conducted in two stages from January-May 2020, where the first
22 part combined coconut water at concentrations of 0, 15, 30 and 45% with the planting media that
23 comprises three levels. Meanwhile, the second phase introduced the room and refrigeration

24 temperature conditions. Based on the results of multivariate and non-parametric analyses, an
25 increase was observed in the technology effectiveness, in terms of the parametric and categorical
26 data evaluation, respectively. The diversities of growth and post-harvest characteristics of large
27 chillies were also dominated by coconut water treatment. Furthermore, the best concentration of
28 coconut water in large chilli cultivation in polybags and post-harvest is expected to occur at 15%,
29 with a blend of refrigeration temperature. This value is recommended in the urban farming of
30 large chillies, using organic applications.

31

32 **Key words:** Capsicum annum, Factor analysis, Organic fertilization, Spearman correlation,
33 Urban farming.

34 **Abbreviations** (if any): DFH= Days to First Harvest, FL = Fruit Length, FW= Fruit Weight,
35 FWP= Fruit weight per plant, LA= Leaf area, NF= Number of fruits, NPB= Number of
36 productive branches, PH= Plant height, SD = Stomata density, SOA= Stomata opening area.

37

38 **Introduction**

39 Chili (*Capsicum annum* L.) is a major plant type that easily found in Southeast Asia,
40 including Indonesia. The crop appears rich in capsaicin, flavonoids as well as in vitamins C, A
41 and E (Maksimova et al., 2016; Hamed et al., 2019; Chilczuk et al., 2020; Chilczuk et al., 2021).
42 These contents have a high capacity to protect humans from various diseases by increasing the
43 body's immune system (Hamed et al., 2019). As a consequence, the demand for chili continues to
44 increase alongside the growing population, diverse community needs and the development of
45 industries in need of the plant as a raw material (Saleh et al., 2018; Agustika, 2021). Based on
46 2019 BPS data, the consumption of large chili pepper from 2016-2017 expanded by 1.21%.

47 However, the productivity rate was known to decrease (Nofiyanto et al., 2018; Suryani et al.,
48 2019), which attained 11.06% in 2018 (Suryani et al., 2019). Therefore, the continuous increase
49 in chili production through intensification appears necessary in fulfilling the steady demands. A
50 major intensification technique involves the introduction of organic fertilization.

51 Organic fertilization is an approach closely related to the concept of sustainable agriculture
52 (Ertani et al., 2015; Lin et al., 2019; Beeby et al., 2020; Shah et al., 2021). Commonly applied
53 chemical fertilizers exhibit several side effects on the soil, including the damage to its physical
54 and biological properties (Beeby et al., 2020; Pahalvi et al., 2021). This negative outcome
55 significantly instigates a long term impact on crop productivity. Therefore, the development of
56 sustainable agriculture using organic fertilization serves as an effective solution in overcoming
57 these prevalent challenges (Yadav et al., 2013; Lin et al., 2019; Shah et al., 2021). This concept
58 also supports the expansion of small-scale urban farming systems (Markussen et al., 2014;
59 Schröder et al., 2021), in line with the conversion of agricultural land resources into buildings
60 (Lovell, 2010; Rumanti et al., 2018; Avgoustaki and Xydis, 2020). Similarly, application of
61 urban farming also help to maintain food security. Under this circumstance, the organic
62 fertilizers play a significant role in strengthening urban farming concepts.

63 Organic fertilizer is obtained from the decomposition of organic materials, both in solid and
64 liquid forms (Yadav et al., 2013; Ji et al., 2017; Valenzuela-García et al., 2019; Beeby et al.,
65 2020; Shah et al., 2021). In general, its manufacture is based on the availability of organic matter
66 within the habitable environment or cultivation site (Yadav et al., 2013; Ji et al., 2017). Various
67 natural components in fertilizer production have also been widely reported, such as livestock
68 manure, forage and microorganisms (Ji et al., 2017; Valenzuela-García et al., 2019). These
69 studies observed the significant effect of organic fertilization on plant growth and productivity,

70 including chili (Ji et al., 2017; Valenzuela-García et al., 2019; Liu et al., 2020). Furthermore,
71 fermented coconut water is among the potential organic materials in fertilizer manufacture.

72 The use of coconut water not only affects plant growth, but also provides ecological and
73 economic benefits. In general, coconut water is a major plant product that triggers crop growth
74 (Winarto and Da Silva, 2015). Previous study results showed its content in potassium, minerals
75 such as calcium (Ca), sodium (Na), magnesium (Mg), iron (Fe), cuprum (Cu) and sulfur (S) as
76 well as in sugar and protein. Apart from the mineral richness, coconut water also serves as a
77 PGR source, particularly cytokinins, auxins and gibberellins (Tiwery, 2014; Darmawan et al.,
78 2020), with different concentrations of 34.37 ppm gibberellins; 1.28 ppm auxin/IAA and 28.85
79 ppm cytokinin/zeatin (Ulfa, 2014). The coconut water content is potentially applied as a natural
80 source of nutrients and PGR that are environmentally friendly, cheap and easily obtained (Prando
81 et al., 2014; Lazim et al., 2015; Mintah et al., 2018). Further uses involve the in vitro propagation
82 of plants, as a source of nutrients, PGR and vitamins (D'Souza et al., 2013; Harahap et al., 2020)
83 as well as the propagation of potato cuttings (Ulfa, 2014). These instances indicate that the use of
84 coconut water, specifically in fermented form, appears very important in the support of plant
85 growth and productivity. In addition, the fermentation of coconut water increases soil biological
86 potentials and simplifies the organic molecules presumed difficult to absorb by plants
87 (Darmawan et al., 2020), although tends to trigger a more active plant growth and productivity.

88 The applications of organic fertilizers are more effective under fertilization conditions, based
89 on specific interval and concentration as well as the interaction with the planting media. The
90 planting media is an important element that supports plant growth, with soil as a typical example.
91 This is because the soil contains the main factors for plant growth, such as nutrients, water and
92 air (Bhattacharyya and Pal, 2015). However, its conditions are currently declining due to low

93 available organic matter (Gomiero et al., 2016; Timmis and Ramos, 2021), which affects the
94 physical, biological and chemical quality. As a consequence, farmers tend to combine the soil
95 with other growing media, termed compost, husk charcoal and cocopeat (Gomiero et al., 2016;
96 Syafruddin, 2017; Khaitov et al., 2019). Several kinds of studies on planting media combination
97 have been conducted, including Dalimunthe et.al. (2017), where a blend of compost and husk
98 charcoal potentially increased the vegetative and generative growth of red chili plants. Therefore,
99 study on the effect of combining planting media and coconut water concentration on large chili
100 pepper appears very interesting. This technology needs to be evaluated with precision, in order to
101 demonstrate a positive effect in enhancing crop productivity.

102 The evaluation of a cultivation technology is greatly dependent on the characters of the
103 applied assessment. In general, productivity is the commonly used character (Anshori et al.,
104 2021), although with low effectiveness. This observation was based on the polygenic nature of
105 productivity, where environmental influences appear predominant (Acquaah, 2007; Fellahi et al.,
106 2018). Furthermore, the evaluation does not only focus on the main productivity, but also the
107 secondary related aspect that is fast becoming preferred. This concept has been reported by
108 Abduh et al. (2021) on maize, Farid et al. (2020) as well as Anshori et al. (2019) on wheat and
109 Anshori et al. (2021) on rice plants. As a consequence, the use of the productivity concept in
110 examining the combination of planting media and coconut water concentration on the growth of
111 large chillies appears valid. However, a more effective outcome is possible with the involvement
112 of post-harvest characters. Horticultural crops' quality generally includes post-harvest conditions
113 or fruit phase life, where a faster rate potentially influences the product price. This means the
114 evaluation is not only based on the effectiveness of the growth assessment, but also needs to
115 consider the post-harvest aspect. Therefore, the purpose of this study is to evaluate the best

116 technology for the combination of coconut water concentration and growing media, based on
117 multivariate and non-parametric analyses on the growth and post-harvest characters of chili.

118

119 **Results**

120

121 Based on the analysis of variance results (Table 2), the various coconut concentrations
122 showed a significant effect on almost all growth characters, except for the age of first harvest,
123 productive branches and fruit weight. Conversely, planting media only influenced the density of
124 the stomata, productive branches and brix, while the interaction between the growth media and
125 concentration impacted extensively only on stomatal density.

126 Pearson correlation analysis results showed productivity as the main character with a
127 significantly positive interaction with brix (0.38), LBS (0.41), fruit length (0.51), plant height
128 (0.54), and the fruit number (0.98). Conversely, the negatively correlated character was obtained
129 as the age of the first harvest (-0.72), while the positive aspect formed the basis for a more in-
130 depth study, including factor analysis (Fig. 1).

131 Fig. 2 represents the factor analysis results where 3 groups of treatment combinations were
132 obtained. The first category comprised M1C1, M3C1, M2C1 and M2C4, while the second
133 encompassed M1C4, M1C3, M1C2, M2C2 and M3C2. Finally, the third group contained M3C4,
134 M2C3 and M3C3. Based on the loading factor value (Table 3), factor 2 dimensions were
135 identified, where the diversity of factor 1 was strongly influenced by the fruit weight, as well as
136 its quantity and length. Meanwhile, the brix and the stomata opening width contributed to the
137 significant influence in factor 2.

138 The LSD test results showed that C2 concentration treatment was the best coconut
139 concentration treatment on fruit length, number and weight per plant, while k1 obtained the
140 minimum treatment (Table 4). Based on the wide characters of the stomata opening and brix, C3
141 was known to generate the optimal performance, followed by C2. Conversely, C1 also exhibited
142 the lowest concentration in both characters.

143 The Kruskal Wallis analysis results showed that the combination of concentration and
144 temperature treatment significantly affected the 20 days storage, in terms of color and texture
145 (Table 5). Based on the color, the refrigerator treatment obtained a lower z value value (-3.61),
146 compared to the room temperature at C2 concentration. Conversely, room temperature with k1
147 concentration generated the combination treatment with the maximum z value (3.63). Based on
148 the texture, the refrigerator treatment had a higher z value (3.86) at C3, compared to the room
149 temperature treatment, while for room temperature at C1, the minimum z value (-3.82) was
150 obtained.

151 Spearman correlation analysis was used to assess the relationship between growth and post-
152 harvest characters in the refrigerator temperature treatment (Table 6). The results showed that the
153 fruit color was more negatively correlated with its number and weight per plant. Negative values
154 in color correlation demonstrated an inverse interpretation of fruit quality, while the texture
155 obtained a significantly positive correlation with the brix character. Therefore, a more positive
156 texture correlation value tends to generate superior fruit quality

157 **Discussion**

158

159 The results of this study indicated that the difference in the coconut water concentrations was
160 very predominant in the growth of large chilies. Media treatments are generally known to affects

161 plant growth, including chili. This conclusion was also reported by Gungor and Yildirim (2013),
162 Mathowa et al. (2017), Rivai et al. (2017), Syafruddin (2017) and Khaitov et al. (2019), where
163 separate media compositions generated different responses to the chili growth and productivity.
164 However, the variation is not considered very significant if the treatment is juxtaposed with the
165 effect of coconut water concentration. This condition was further reinforced by the interaction
166 effect, without any relative impact on the plant development. According to Saptaji et al. (2015),
167 the combination of media and coconut water treatments reported a significant effect on stevia
168 growth, due to the relatively large proportion of compost from the media treatment. In contrast, a
169 more dominant soil composition was observed, in comparison to husk and compost. Yong et al.
170 (2009) and Prades et al. (2012) also showed a rich content of hormones in the coconut water. As
171 a consequence, the application of several concentrations of coconut water tends to affect the
172 plant growth (Prando et al., 2014; Buah and Agu-Asare, 2014; Winarto and Da Silva, 2015;
173 Darmawan et al., 2020), including chili (Mythili et al., 2017; Fassya et al., 2020). Based on this
174 circumstance, further analysis in the present study was then dominated by the concentration of
175 coconut water on chili growth.

176 Pearson correlation analysis is a general approach in identifying the diversity relationship
177 between two characters, specifically numerical data (Farid et al., 2020; Anshori et al., 2021).
178 Higher correlation values, either positive or negative, indicate an acceptable relationship (Mattjik
179 and Sumertajaya, 2011). Great correlations in terms of productivity were also obtained in brix
180 characters, plant height, fruit length and number. These results were equally reported by
181 Bijalwan and Mishra (2016), Yenny et al. (2019) and Fitry et al. (2021), where a significant
182 correlation between chili productivity as well as fruit length and number was generated. The
183 performances above showed that the five characters possibly serve as the basis for treatment

184 evaluation in this study, specifically coconut water concentration. However, the use of
185 correlation analysis is considered an estimation, due to its inability to describe the specific
186 relationship between characters. Correlation analysis is also inseparable from the nature of
187 multicollinearity, but forms the basis of further in-depth investigation. This concept has also
188 been reported by Anshori et al. (2019), Farid et al. (2020), Akbar et al. (2021) and Anshori et al.
189 (2021). Based on this phenomenon, a deeper analytical approach highly dependent on the
190 correlation technique, such as the factor analysis, appears very significant in the evaluation of
191 this study.

192 Factor analysis occurs among the major multivariate assessments in identifying specific
193 internal covariates and reducing the weak covariates between dimension variables (Dormann et
194 al., 2013; Rocha et al., 2017). This approach is used to evaluate the important character
195 determinants of a large variable (Mattjik and Sumertajaya, 2011). Further use of factor analysis
196 in obtaining important growth characters has been reported by Rocha et al. (2017) and Farid et
197 al. (2020). Therefore, its application in this study has the capacity to also evaluate the characters
198 specifically correlated with productivity. Under this circumstance, two resulting methods were
199 obtained, including the use of the biplot concept and identification of character diversity based
200 on factor dimensions. Biplots are significant in the diversity visualization and the grouping basis
201 between treatment objects on their variables, particularly when combined with principal
202 component or factor analysis. Figure 2 shows that the grouping was very identical to the coconut
203 concentration treatment, specifically at C2 and C1, while C3 and C4 were extended relatively in
204 each group. This observation provides another evidence that coconut water concentration is a
205 determinant of the growth diversities of large chilies. Table 3 outlines the factor dimensions,
206 where fruit length and number, productivity, brix, as well as the width of stomata opening served

207 as the evaluation characters. This outcome was based on the factor loading value of these
208 characters which exceeded 0.32 (Yong and Pearce, 2013), both on the dimensions of factors 1
209 and 2. This selection concept was also reported by Farid et al. (2020) on the determination of
210 preferred characters in lowland wheat collections. Therefore, the characters of fruit length and
211 number, productivity, brix, as well as the stomata opening width were further analyzed by the
212 LSD significant difference test.

213 The LSD test results also observed the significant effect of coconut water on the growth of
214 large chilies. In addition, the best treatment for the chili production components was obtained in
215 C2, although C3 demonstrated the ability improve the plant quality. This optimal performance of
216 C2 was based on the relatively suitable brix potential and the stomata opening width. The results
217 of this study also matched the previous study of Fassya et al. (2020), where 25% coconut water
218 was stipulated as the best dose in increasing chili growth, while a 50% increment showed a
219 linearly decreasing effect. Therefore, C2 treatment is highly recommended as a major coconut
220 water dose in the cultivation of large chilies.

221 Post-harvest testing is an important indicator in terms of the quality of large chilies, where
222 refrigerator storage was generally superior, compared to the room temperature. These results
223 have been reported by several studies, including Jany et al. (2008), Pinheiro et al. (2014), Galani
224 et al. (2017) and Contreras et al. (2021). Based on coconut water concentration, C2 treatment
225 showed a more effective storage quality, specifically when combined with refrigerated spaces. In
226 general, the observation of post-harvest characters such as color quality and texture, serves as the
227 main character in assessing storage efficiency. The process of post-harvest cell degradation
228 appears faster, depending on the fruit's physiological processes, including respiration, ripening
229 and senescence (Edusei et al., 2012; Ziv and Fallik, 2021). These prompt techniques tend to

230 induce rapid changes in fruit color and texture (Contreras et al., 2021; Ziv and Fallik, 2021).
231 Chili plants are non-climacteric (Aizat et al., 2014; Hou et al., 2018; Razo-Mendivil et al., 2021).
232 However, the post-harvest fruit quality is highly dependent on the fruit water loss (Maalekuu et
233 al., 2006; Edusei et al., 2012; Elibox et al., 2015). This causes the chili to experience a rapid
234 ripening process, identified by color and texture similar to other climacteric fruits (Soethe et al.,
235 2016; Peixoto et al., 2017; Banas et al., 2018; Maskey et al., 2021; Berry et al., 2021). In this
236 study, color depicts an inverse interpretation of the fruit quality, where the smaller color scores
237 instigate extensive change in appearance. Meanwhile, the texture showed a positive
238 interpretation, where higher texture scores obtained superior fruit texture. Based on this
239 phenomenon, C2 treatment also serves as a possible recommendation in enhancing the post-
240 harvest chili quality.

241 Spearman correlations are generally performed on data with different properties (Ruscio,
242 2008; Kantar et al., 2016; Anshori et al., 2021). The growth characters in the present study were
243 numerical or parametric, while post-harvest properties were categorical or non-parametric,
244 resulting in an effective correlation. Based on Spearman correlation results, the growth and post-
245 harvest characters showed a very close relationship, particularly in the treatment of the
246 refrigerator storage. This observation indicates that the treatment on the growth character
247 significantly impacted on the post-harvest components. Therefore, the fruit quality assessment
248 possibly refers to the plant growth, particularly in terms of the fruit number, production per plant
249 and the brix.

250

251 **Materials and Methods**

252

253 *Evaluation of the Morphological Growth Characters*

254 This study was conducted between January-May 2020 in Balang Toa village, Binamu
255 district, Jenepono Regency, Indonesia, at an altitude of 100 meters above sea level. A split-plot
256 design experiment, with 3 repetitions was also applied. The main plot served as the planting
257 medium comprising 3 levels, including M1 = soil: compost (2:1), M2 = soil: husk charcoal (2:1)
258 and M3 = soil: compost: husk charcoal (2:1:1). Meanwhile, the sub-plot showed the coconut
259 water concentration (C) of 4 levels, termed C1 = 0% (1000 mL distilled water), C2 = 15% (150
260 mL coconut water + 850 mL distilled water), C3 = 30% (300 mL coconut water + 700 mL
261 distilled water) and k4 = 45% coconut water concentration (450 mL coconut water + 550 mL
262 distilled water). Based on the two treatment blends, 3 repetitions were observed in the 12
263 combinations, resulting in a total of 36 units, with each comprising 4 samples.

264

265 *Research Procedure*

266 Chili seeds were soaked in warm water for about 12 hours and the floating portions were
267 discarded. The remnants were then induced for germination, using a moistened tissue in the
268 absence of light. This was followed by the introduction of the germinated seeds into the
269 combined soil and compost media at a ratio of 2:1, with polybags measuring 10 cm x 12 cm. The
270 seedlings were preserved for 4 weeks and transferred to polybags, based on the growing media
271 treatment without any use of basic organic or inorganic fertilizers. Meanwhile, the transplanting
272 process was conducted simultaneously in the afternoon and the polybags were moistened until
273 the attainment of field capacity. Young coconut water was obtained from similar tree that is

274 yellow colored with characteristics of smooth fruit skin color, pests, and diseases free, as well as
275 soft and thin endosperm. The coconut water was then mixed with distilled water at ratio 1:1,
276 ready to apply to sugar which was fermented for 15 days as a growth regulator. Furthermore, the
277 maintenance of chili plants involved replanting, watering, pruning of the water shoots, weeding,
278 as well as pest and disease control. The embroidery process was conducted for one week after its
279 application on the growing resistant seedlings, using similar seeds according to initial cultivation.
280 Watering was performed daily, in the morning and evening, although it was dependent on the
281 plant condition. The pruning or cutting of the shoots in the leaf axils under the Y branch
282 commenced at 7.00 pm. The weeds were subsequently removed, and the pest control process
283 involved the installation of trap bottles containing methylate glue. Growth regulators with
284 concentrations of 0, 15, 30 and 45%, were applied twice every week by the spray method.
285 Spraying was introduced when the plants are 4 weeks after planting (WAP) until the observation
286 was completed. This was followed by the harvesting process, based on certain criteria, such as
287 the absolute red appearance of the chilies (90%). The present study reported a total harvest rate
288 of 10 repetitions, with 2 occurrence every week

289 ***Observation and Data Analysis***

290 The observations parameters were plant height (cm), leaf area (cm²), stomata density,
291 stomata opening area (stomata/mm²), number of productive branches (branches), number of
292 fruits, fruit length (cm), fruit weight (gram) as well as the fruit weight per plant (gram).
293 Meanwhile, the data evaluation process encompassed several stages, with the first involving the
294 analysis of variance at 5% level. The significant characters were continued using the multivariate
295 approach in the forms of Pearson correlation and factor assessments. Duncan's test was further
296 used to sustain the important character of the multivariate analysis results at the 5% level.

297 *Evaluation of the Post-Harvest Fruit Character*

298 The initial study yields were then evaluated for their post-harvest properties, based on the fruit
299 color and texture. Room temperatures were also considered in this stage, with a combination of
300 previous investigation. These temperatures were specified at 28 and 4 C°, for the room and
301 refrigeration conditions, respectively. Furthermore, the fruit observations were performed for
302 two weeks, although the texture and color were examined on a weekly basis. These views were
303 achieved by scoring (Table 1) and subsequently analyzed using the non-parametric methods,
304 such as the Kruskal-walis and Spearman correlation analyses

305

306 **Conclusion**

307

308 Based on the overall results and discussion, the use of multivariate and non-parametric
309 analyses increased the effectiveness of the evaluation process of parametric and categorical data,
310 respectively. The concentration treatment of coconut water dominated the diversities of the
311 growth and post-harvest characters of large chillies. Plant height, brix, fruit weight, number and
312 length, as well as the stomata opening width served as the important characters, particularly on
313 the effect of coconut water concentration. The best coconut water concentration in large chili
314 cultivation in polybags potentially occurs at 15%. Combining these concentrations with the
315 refrigeration temperature generated a significant ability in enhancing the post-harvest fruit
316 quality. Therefore, a coconut water concentration of 15% is possibly recommended in the urban
317 farming of large chillies, using organic applications.

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550 **Table 1.** Score value and its description on the postharvest characters

Score	color	texture
1	Red	not hard
2	brownish red	a bit hard
3	reddish brown	quite hard
4	brown	hard
5	very brown	very hard

551

552 **Table 2.** Analysis of variance on the growth character of large chili.

Character	M	C	Mxk	Cv
Plant Height	0.4183	0.0005**	0.1576	5.91
Leaf Area	0.2858	0.0154*	0.6678	12.44
Stomata Aperture Area	0.0947	0.0002**	0.1283	18.98
Stomata Density	0.0006**	0.0396*	0.0248*	11.38
Number of Productive Branch	0.0007**	0.2977	0.4527	9.38
Fruit Length	0.2612	0.0000**	0.1523	4.78
Number of Fruits	0.3329	0.0048**	0.2983	15.77
Fruit Weight	0.4629	0.0521	0.2202	2.87
Fruit Weight Per Plant	0.3246	0.0004**	0.3576	13.89
Brix	0.0001**	0.0000**	0.1213	6.74

553 Notes : Note: M = medium, C = coconut water concentration, CV = coefficient of variance

554

555 **Table 3.** Factor analysis of characters correlated with fruit weight per plant

Variable	Height	Brix	FWP	NF	FL	SOA
Factor1	0.181	-0.13	0.332	0.346	0.413	-0.126
Factor2	-0.139	-0.506	-0.03	0.008	0.29	-0.515
Communality	0.531	0.778	0.673	0.86	0.898	0.737

556 Notes : SOA = stomata opening area, NF = number of fruits, FL = fruit length (cm), FWP = fruit weight per plant

557

558 **Table 4.** Post-hoc test of BNT 5% on coconut water concentration treatment

Treatment	Stomata Opening Area		Fruit Length		Number of Fruits		Fruit Weight Per Plant		Brix	
	Score	Notation	Score	Notation	Score	Notation	Score	Notation	Score	Notation
C1	0.0002	c	8.81	c	34.63	b	210.85	c	7.38	c
C2	0.0003	b	10.19	a	46.59	a	294.56	a	8.42	b
C3	0.0004	a	9.41	b	44.56	a	279.07	ab	10.1	a
C4	0.0003	b	9.44	b	41.15	a	255.78	b	8.94	b

559 Notes = ** significant at 1%, Multiple R-squared: 0.7519 dan Adjusted R-squared: 0.7478

560

561 **Table 5.** Kruskal-Walis analysis on post-harvest characters of chili

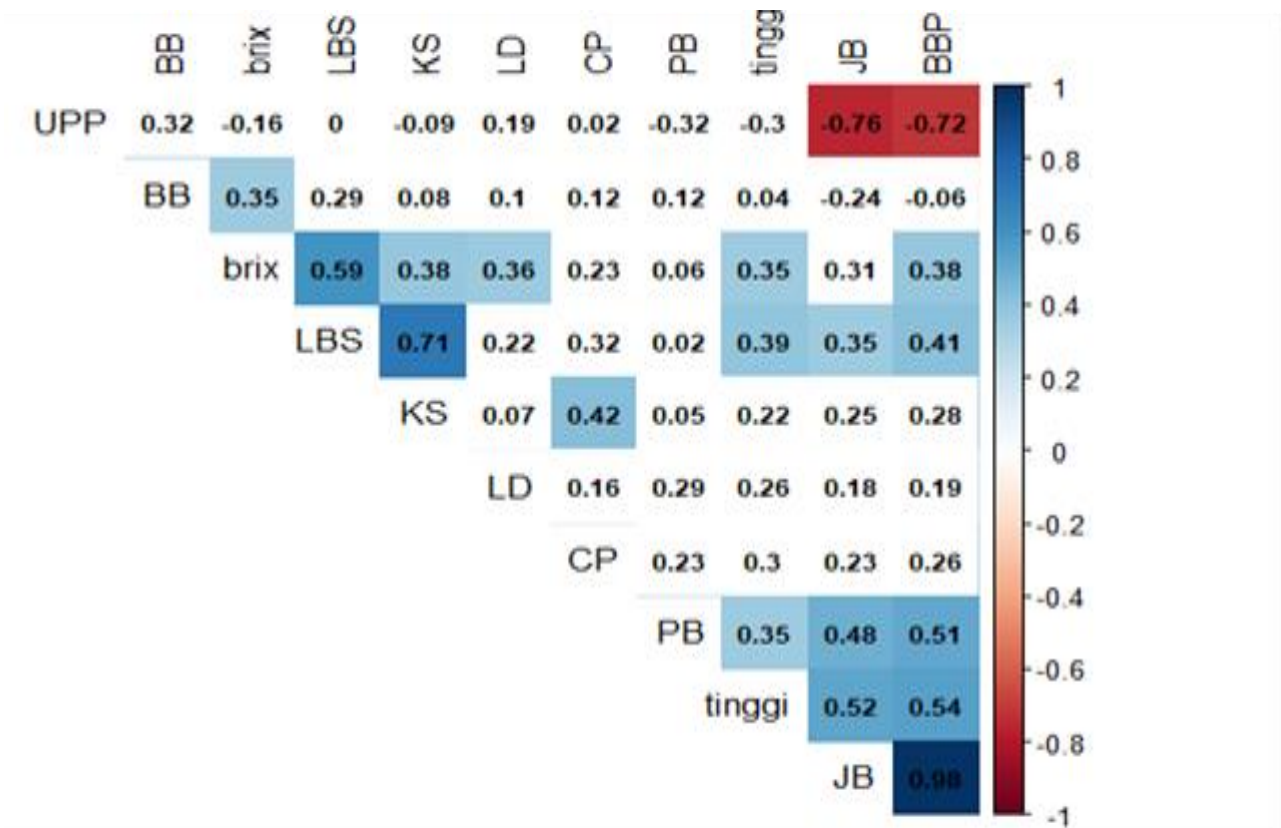
Treatment	Color 10		Color 20		Texture 10		Texture 20	
	Median	z-value	Median	z-value	Median	z-value	Median	z-value
Rf_k1	2.0	1.13	2	-2.10	3.0	-1.72	3	1.99
Rf_k2	1.5	0.07	2	-3.61	3.0	-0.9	3	2.38
Rf_k3	1.0	2.06	2	-3.34	3.0	0.40	3	3.86
Rf_k4	2.0	0.60	2	-3.07	3.0	0.08	3	3.47
R_k1	2.0	0.60	3	3.63	3.0	-0.73	1	-3.82
R_k2	1.0	-0.47	3	2.69	4.0	1.07	2	-2.63
R_k3	1.0	-1.00	3	2.69	3.5	0.90	2	-2.33
R_k4	2.0	1.13	3	3.11	3.5	0.90	2	-2.92
P value	0.178		0.000		0.331		0.000	

562 Note: Rf = refrigerator, R = room

563 **Table 6.** Spearman correlation analysis on the important characters of growth on post-harvest
 564 characters of the fruit.

	Color	Texture	SOA	FL	NF	FWP
Texture	-0.40					
SOA	-0.63	0.95				
FL	-0.80	0.20	0.32			
NF	-1.00**	0.40	0.63	0.80		
FWP	-1.00**	0.40	0.63	0.80	1.00	
Brix	-0.40	1.00**	0.95	0.20	0.40	0.40

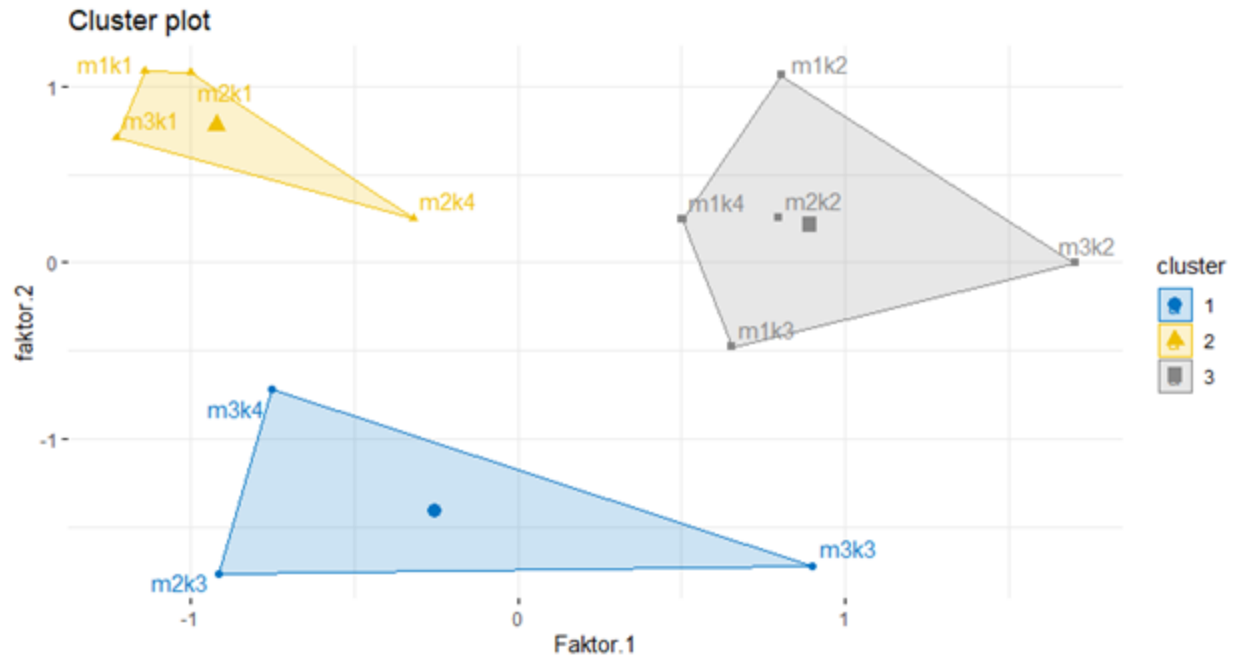
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571 **Fig 1.** Pearson correlation analysis on chili growth characters. (PH= Plant height, LA= Leaf area,
572 SD = Stomata density, SOA= Stomata opening area, NPB= Number of productive branches,
573 NF= Number of fruits, FL = Fruit Length, FW= Fruit Weight, FWP= Fruit weight per plant)

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577 **Fig 2.** Grouping of treatment combinations based on factor analysis biplots

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AJCS-Ulfa-PNE3593 [Major revisions required]

Tony Elders <tony.elders@gmail.com>
To: fachirahulfa@unhas.ac.id

Mon, Jan 31, 2022 at 7:28 PM

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Fri, Apr 1, 3:03 PM

Dear Tony Elders

We hope you are well in your home. We have revised our manuscript and we will send it to you. However, I would like to ask you, could we use the English proofreading recommended by you after our review has been completed or approved? Because it needs more budget if we always use English proofread editing when we revise. Besides that, for your information, we have proofread our manuscript before we submit it to the AJCS journal and we have an English editing certificate. Thank you very much for your wisdom

best regards
Dr. Fachira Ulfa

3 Attachments • Scanned by Gmail

- Table of Respons...
- supplementary T...
- 3593-8045-1-RV-...

Table of Response

Thank you for your correction to our manuscript. We would like to response all comments and questions

Q1	Coconut water is expensive how it can be applied for planting and farming? Is it economically possible?
A1	<p>Thank you for your question.</p> <p>Increased production can be done by using natural fertilizers and growth regulators (ZPT). One of the natural fertilizers and PGRs that can increase plant growth is coconut water (<i>Cocos nucifera</i> L.) which comes from coconuts and is an important tropical plant for Asian and Pacific countries (Amalao, et al., 2019). Coconut water is very easy to obtain at low prices, even those who live in villages do not need to buy it because it is widely grown in home gardens and in plantations, therefore the cost is cheaper than using synthetic ZPT and POC. The most important thing about the use of coconut water is that it comes from vegetable ingredients, which of course are environmentally friendly and will produce red chilies that are healthy and safe for consumption.</p> <p>Coconut water contains substances or ingredients such as carbohydrates, vitamins, minerals, proteins, sugars, amino acids, and phytohormones which have a significant effect on plant growth, as well as auxin, cytokinin and gibberellin growth substances that function as triggers for tissue proliferation, metabolism, and cellular respiration (Fassya, 2020). Ulfa's research (2014) shows that young coconut water contains gibberellins (34.37 ppm); IAA (1.28 ppm); zeatin (28.85 ppm) with a ratio of 27:1:23.</p> <p>Utilization of young coconut water in this study is economical because coconut water is obtained from young coconuts at a price of IDR 10,000 per fruit. In one young coconut, on average, it contains 900 ml of coconut water (Natalini and Syahid, 2012). In this study, coconut water was only needed in small volumes because it was mixed with water. The concentrations of coconut water used were 0%, 15%, 30% and 45%.</p> <p>The nutrient and PGR content of coconut water is influential and beneficial in helping and increasing plant growth and development, as well as the quantity and quality of crop yields (Nizar, 2018). Therefore, the use of coconut water in agriculture is considered very suitable to be applied as a substitute for synthetic fertilizers and ZPT which are expensive and not easy to obtain.</p> <p>The use of coconut water as a growth regulator and liquid organic fertilizer has been widely carried out. In Ulfa's research (2014) the use of coconut water as much as 5 ppm can produce 25.13 mini potato tubers per plant with an average mini tuber weight of 2.38 g. The results of Sembiring's research (2016) showed</p>

	that soaking shallot bulbs at a concentration of 75% coconut water resulted in the growth and production of a high number of bulbs compared to a concentration of 0%; 25%, 50% and 100%). Tampubolon (2016) from his research showed that giving coconut water with a concentration of 50% on saga plants significantly increased germination height, germination and germination time by 80% for 9 days.
Revision	-

Q2	It should be clear whether this is related to an in vitro culture.
A2	<p>Thank you for your question.</p> <p>The difference lies in the way it is applied. In an in vitro study, coconut water was given to the planting medium to enrich the nutrient and PGR content in the Murashige and Skoog base media (Pratama, Nilahayati, 2018). Meanwhile, this research was carried out in the field, where coconut water was sprayed onto plant leaves via a hand sprayer. According to Lingga and Marsono (2008) foliar fertilization has several advantages, including faster nutrient absorption and does not damage the soil. Nurmas and Putri (2011) explained that fertilization through leaves can quickly overcome nutrient deficiency diseases.</p> <p>The process of entering coconut water into plant tissues occurs due to diffusion and osmosis as well as penetration through holes called ectodesmata. Ectodesmata is a hole or pore around the stomata. As stated by Nurmas and Putri (2011) that the absorption of nutrients and water through the leaves is because the leaves of plants have leaf mouths or stomata.</p>
Revision	-

Q3	Because of English language, the manuscript should be completely re-written with help of a native or expert in English language.
A3	<p>Thank you for your recommendation. We have used English language editing and we have the certificate in English editing.</p> <p>However, it needs English editing again we can try to do it</p> <p>for this, could we use the English proofreading recommended from you after our review has been completed or approved? because it needs more budget if we always use English proofread editing when we revise. Besides that, for your information, we have proofread our manuscript before we submit it to the AJCS</p>
Revision	

Q4	The length of manuscript should be reduced to less than 6000 words.
A4	Thank you for your reminder, we have reduced twords in our draft according to your condition
Revision	-

Q5	Authors should confirm that no part of this study has been published or under publication in any form in any media before publication in AJCS.
A5	Thank you for your question. We confirm that it is original study from our team
Revision	-

Q6	Instead of this, please clearly explain how study was conducted and what measured, including experimental design and definition of treatments.
A6	Thank you for you comment. We have added information for experimental design (split-plot design) with main and sub plot factor
Revision	In abstract (lines 17-24)

Q7	Instead of this in Abstract, give the classification of soil and environment.
A7	Thank you for your suggestion. Based on the Koppen climate classification, Jeneponto Regency has a wet and dry tropical climate with two rainy and dry seasons. he soil kind was dusty clay. This research was conducted in the rainy season (January) to the end of the rainy season (May) with an average monthly rainfall of more than 120 mm per month and the wettest month is January with a monthly rainfall of more than 250 mm per month. The annual rainfall in Jeneponto Regency ranges from 1.00 to 2,500 mm per year with the number of rainy days ranging from 60 to 150 rainy days per year. The air temperature in the Jeneponto Regency area is between 21-340C with a relative humidity level of about 76%
Revision	In abstract (lines 16-17)

Q8	What was the planting media?
A8	Thank you for your question. The planting media were consisted of combination of soil, compost or husk charcoal
Revision	In abstract (lines 17-24)

Q9	Indicate three levels.
A9	Thank you for your comment. Yes the planting media were consisting of three level
Revision	In abstract (lines 17-24)

Q10	It does not make sense? What dominated means?
A10	Thank you for your question. We mean that The variance of growth and post-harvest characteristics of large chilies were more influenced by the coconut water effect than the planting media effect
Revision	In abstract (lines 25-27)

Q11	The parts related to refrigeration and polybag and in general post harvest is totally unknown and must be elaborated both in MM section and results and discussion. Was it part of separate experiment? I also did not find why and how the refrigeration experiment was conducted.
A11	Thank you for your question, we can elaborate on the first and second experiments in MM and the result section. Actually, the first and second experiments are continuous experiments. The first experiment looks at the effect of planting media and the concentration of coconut water. After that, the fruit of the first treatment continues in the post-harvest experiment with room and refrigerator conditions.
Revision	In abstract (lines 17-24)

Q12	It looks that there is no statistical plan for this temperature and refrigeration! This section must be clearly explained in MM section whether is part of experimental design or not and how authors
A12	Thank you for your question. We have added information about experimental design for post-harvest treatment. The statistical tool use the non-parametric analysis
Revision	In abstract (lines 25-29)

Q13	Prepare based on journal guidelines.
A13	Thank you for your correction. We have revised according to journal guidelines
Revision	Lines 35-37

Q14	I do not understand very well when authors talk about technology.
A14	Thank you for your question. We mean cultivation on large chili under urban farming
Revision	Lines 103-107

Q15	This section should be divided with some informative sub-headings.
A15	Thank you for your correction. We have revised according to your suggestion
Revision	In Result Section

Q16	There should a sub-heading explaining the post-harvest study of this manuscript.
A16	Thank you for your correction. We have revised according to your suggestion
Revision	In Result Section

Q17	All abbreviations should be defined.
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A17	Thank you for your correction. We have revised according to your suggestion
Revision	In Result Section

Q18	All of these abbreviation should be defined in their first place of occurrence and also in MM section.
A18	Thank you for your correction. We have revised according to your suggestion. the abbreviation of M and C have attached on material and method
Revision	In Result Section

Q19	There should be a sub-heading explaining the experimental design number of replications and also treatments.
A19	Thank you for your correction. We have added the sub-heading to explain the experimental design, number or replication and kind or treatment,
Revision	In MM Section

Q20	The area that this coconut water was applied is not clear? On what area this 1 litre applied?
A20	Thank you for your question. Making the concentration of the solution is done by taking 15 ml of young coconut water (fermented) then adding 850 ml of water so that the volume of 15% young coconut water solution becomes 1000 ml. This is also carried out to another level. Coconut water was applied twice a week until harvest with concentrations of 0%, 15%, 30%, and 45%. In the first, second, third and fourth months, the volume of giving coconut water was approximately 10 ml, 45 ml, 75 ml, and 100 ml (per plant). The application is done by spraying onto the leaves of the plant. Spraying begins when the plants are 4 weeks old after sowing until the observation is complete (10 times).
Revision	(lines 268-274)

Q21	This section should be completely re-written explaining how study was conducted, what were treatments
A21	Thank you for your question. We have rewritten according your suggestion
Revision	294-303

Q22	It looks that there is no statistical plan for this temperature and refrigeration!
A22	Thak you for your question. We used the Kruskal-walis and Spearman correlation analyses as non-parametric design
Revision	Lines 299-303

Q23	This section should be completely and precisely checked to be consistent with AJCS and also to avoid extra and missing references.
A23	Thank you for your suggestion. we have rechecked reference toward format, extra and missing references.
Revision	In references section

Q24	Not clear! Colour of what? Texture of what?
A24	Thank you for your question. We mean fruit Color and Fruit texture
Revision	Table 1

Q25	What score is? What is Notation? They must be defined in the footnote of Table.
A25	Thank you for your question. We mean average or the mean of treatment level. We have revised according to your suggestion changed with
Revision	Table 3

Q26	All these treatments must be introduced in the MM section and also footnote of table.
A26	Thank you for your suggestion. we have revised according to your suggestion
Revision	Table 4

Q27	A higher resolution required.
A27	Thank you for your suggestion. we have resize the image to be 300 dpi
Revision	Fig 1

Q28	The legends should be more informative.
A28	Thank you for your suggestion. we have revised the image and it has suited with the legends
Revision	Fig 1

Q29	It must be explained clearly.
A29	Thank you for your suggestion. we have added few information to clearly this sentence.
Revision	Fig 2

Effect of coconut water concentration and Planting Media on Growth and Post-Harvest

Characters of Large Chili Using Multivariate and Non-Parametric Analyses

Commented [A1]: Coconut water is expensive how it can be applied for planting and farming? Is it economically possible?

Commented [A2R1]: Thank you for your question. Increased production can be done by using natural fertilizers and growth regulators (ZPT). One of the natural fertilizers and PGRs that can increase plant growth is coconut water (*Cocos nucifera* L.) which comes from coconuts and is an important tropical plant for Asian and Pacific countries (Amalao, et al., 2019). Coconut water is very easy to obtain at low prices, even those who live in villages do not need to buy it because it is widely grown in home gardens and in plantations, therefore the cost is cheaper than using synthetic ZPT and POC. The most important thing about the use of coconut water is that it comes from vegetable ingredients, which of course are environmentally friendly and will produce red chilies that are healthy and safe for consumption.

Coconut water contains substances or ingredients such as carbohydrates, vitamins, minerals, proteins, sugars, amino acids, and phytohormones which have a significant effect on plant growth, as well as auxin, cytokinin and gibberellin growth substances that function as triggers for tissue proliferation, metabolism, and cellular respiration (Fassya, 2020). Ulfa's research (2014) shows that young coconut water contains gibberellins (34.37 ppm); IAA (1.28 ppm); zeatin (28.85 ppm) with a ratio of 27:1:23.

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The nutrient and PGR content of coconut water is influential and beneficial in helping and increasing plant growth and development, as well as the quantity and quality of crop yields (Nizar, 2018).

Therefore, the use of coconut water in agriculture is considered very suitable to be applied as a substitute for synthetic fertilizers and ZPT which are expensive and not easy to obtain.

The use of coconut water as a growth regulator and liquid organic fertilizer has been widely carried out. In Ulfa's research (2014) the use of coconut water as much as 5 ppm can produce 25.13 mini potato tubers per plant with an average mini tuber weight of 2.38 g. The results of Sembiring's research (2016) showed that soaking shallot bulbs at a concentration of 75% coconut water resulted in the growth and production of a high number of bulbs compared to a concentration of 0%; 25%, 50% and 100%. Tampubolon (2016) from his research showed that giving coconut water with a concentration of 50% on saga plants significantly increased germination height, germination and germination time by 80% for 9 days.

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Commented [A4R3]: Thank you for your question.

The difference lies in the way it is applied. In an in vitro study, coconut water was given to the planting medium to enrich the nutrient and PGR content in the Murashige and Skoog base media (Pratama, Nilahayati, 2018). Meanwhile, this research was carried out in the field, where coconut water was sprayed onto plant leaves via a hand sprayer. According to Lingga and Marsono (2008) foliar fertilization has several advantages, including faster nutrient absorption and does not damage the soil. Nurmas and Putri (2011) explained that fertilization through leaves can quickly overcome nutrient deficiency diseases.

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Fachirah Ulfa^{1*}, Muhammad Fuad Anshori¹, Rusdayani Amin¹, Aisyah Amini Iqbal²

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²Bachelor Student, Department of Agronomy, Hasanuddin University, Perintis Kemerdekaan
Street Km 10, Makassar, South Sulawesi, 90245, Indonesia

*Corresponding author: fachirahulfa@unhas.ac.id

Abstract. The study has two aims. The first is to determine the best cultivation for the combination of planting media and coconut water concentration on large chilies growth characteristics using multivariate analysis. The second is to determine the best combination of temperature and cultivation combination for large chilies post-harvest characteristics using non-parametric analyses. Jeneponto Regency, Indonesia, at 100 meters above sea level with dusty clay soil and 21-34 °C temperatures, served as the study location. The study has two experimental. The first experiment was arranged by split-plot design with planting media (combination of soil, compost or husk charcoal) as main factor (3 level) and concentrations of coconut water as subplot (4 level). Meanwhile, the second experiment is the temperature conditions (the room and refrigeration temperature conditions) as the post-harvest experiment after the first experiment that arranged with a nested design. The observation parameters were consisted of 9 growth parameters in the first experiment analyzed by multivariate analyses and 2 post-harvest parameters in the second stage analyzed by non-parametric analyses. Based on the results of multivariate and non-parametric analyses, an increase was observed in the cultivation

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However, it needs English editing again we can try to do it

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Commented [A22R21]: Thank you for your comment. Yes the planting media were consisting of three level

technology effectiveness. The variance of growth and post-harvest characteristics of large chillies were more influenced by the coconut water effect than the planting media effect. Furthermore, the best concentration of coconut water in large chilli is expected to occur at 15%, with a blend of refrigeration temperature for post harvest treatment. This value is recommended in the urban farming of large chillies, using organic applications.

Key words: Capsicum annum, Factor analysis, Organic fertilization, Spearman correlation, Urban farming.

Abbreviations (if any): DFH– days to first harvest; FL– fruit length; FW– fruit weight; FWP– fruit weight per plant; LA– leaf area; NF– number of fruits; NPB– number of productive branches; PH– plant height; SD– stomata density; SOA– Stomata opening area

Introduction

Chili (*Capsicum annum* L.) is a major plant type that easily found in Southeast Asia, including Indonesia. The crop appears rich in capsaicin, flavonoids as well as in vitamins C, A and E (Hamed et al., 2019; Chilczuk et al., 2021). These contents have a high capacity to protect humans from various diseases by increasing the body's immune system (Hamed et al., 2019). As a consequence, the demand for chili continues to increase alongside the growing population (Saleh et al., 2018; Agustika, 2021). However, its production is not a line with this demand (Suryani et al., 2019). Therefore, the continuous increase in chili production through intensification appears necessary in fulfilling the steady demands. A major intensification technique involves the introduction of organic fertilization.

Commented [A23]: It does not make sense? What dominated means?

Commented [A24R23]: Thank you for your question. We mean that The variance of growth and post-harvest characteristics of large chillies were more influenced by the coconut water effect than the planting media effect

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Commented [A28R27]: Thank you for your question. We have added information about experimental design for post-harvest treatment. The statistical tool use the non-parametric analysis

Commented [A29]: Prepare based on journal guidelines.

Commented [A30R29]: Thank you for your correction. We have revised according to journal guidelines

Organic fertilization is an approach closely related to the concept of sustainable agriculture (Lin et al., 2019; Beeby et al., 2020; Shah et al., 2021). Commonly applied chemical fertilizers exhibit several side effects on the soil, including the damage to its physical and biological properties (Beeby et al., 2020; Pahalvi et al., 2021). This negative outcome significantly instigates a long term impact on crop productivity. So, the development of sustainable agriculture using organic fertilization serves as an effective solution in overcoming these prevalent challenges (Lin et al., 2019; Shah et al., 2021). This concept also supports the expansion of small-scale urban farming systems (Markussen et al., 2014; Schröder et al., 2021), in line with the conversion of agricultural land resources into buildings (Avgoustaki and Xydis, 2020). Similarly, application of urban farming also help to maintain food security. Under this circumstance, the organic fertilizers play a significant role in strengthening urban farming concepts.

Organic fertilizer is obtained from the decomposition of organic materials, both in solid and liquid forms (Ji et al., 2017; Beeby et al., 2020; Shah et al., 2021). Various natural components in fertilizer production have also been widely reported, such as livestock manure, forage and microorganisms (Ji et al., 2017). One of the potential materials in organic fertilizer is coconut water. The use of coconut water not only affects plant growth, but also provides ecological and economic benefits. In general, coconut water is a major plant product that triggers crop growth (Winarto and Da Silva, 2015). Previous study results showed its content in potassium, minerals such as calcium (Ca), sodium (Na), magnesium (Mg), iron (Fe), cuprum (Cu) and sulfur (S) as well as in sugar and protein. Apart from the mineral richness, coconut water also serves as a plant growth regulator (PGR) source, particularly cytokinins and gibberellins (Tiwery, 2014;

Darmawan et al., 2020). The coconut water content is potentially applied as a natural source of nutrients and PGR that are environmentally friendly, cheap and easily obtained (Prando et al., 2014; Lazim et al., 2015; Mintah et al., 2018). These instances indicate that the use of coconut water, specifically in fermented form, appears very important in the support of plant growth and productivity (Darmawan et al., 2020).

The applications of organic fertilizers are more effective under fertilization conditions, based on specific interval and concentration as well as the interaction with the planting media. The planting media is an important element that supports plant growth, with soil as a typical example. This is because the soil contains the main factors for plant growth, such as nutrients, water and air (Bhattacharyya and Pal, 2015). However, its conditions are currently declining due to low available organic matter (Gomiero et al., 2016; Timmis and Ramos, 2021), which affects the physical, biological and chemical quality. As a consequence, farmers tend to combine the soil with other growing media, termed compost, husk charcoal and cocopeat (Gomiero et al., 2016; Khaitov et al., 2019). Several kinds of studies on planting media combination have been conducted, including Dalimunthe et.al. (2017), where a blend of compost and husk charcoal potentially increased the vegetative and generative growth of red chili plants. Therefore, study on the effect of combining planting media and coconut water concentration on large chili pepper appears very interesting. This technology needs to be evaluated with precision, in order to demonstrate a positive effect in enhancing crop productivity.

The evaluation of a cultivation technology is greatly dependent on the characters of the applied assessment. In general, yield is the commonly used character (Anshori et al., 2021), although with low effectiveness. This observation was based on the polygenic nature of

productivity, where environmental influences appear predominant (Fellahi et al., 2018). So, the evaluation should not only focus on the yield but also the yield supporting characters through the multivariate analysis approach. This concept has been reported by Abduh et al. (2021) on maize, Farid et al. (2020) as well as on wheat and Anshori et al. (2021) on rice plants. As a consequence, the use of the productivity concept in examining the combination of planting media and coconut water concentration on the growth of large chillies appears valid. However, a more effective outcome is possible with the involvement of post-harvest characters. Horticultural crops' quality generally includes post-harvest conditions or fruit phase life, where a faster rate potentially influences the product price. This means the evaluation is not only based on the effectiveness of the growth assessment but also needs to consider the post-harvest aspect analyzed by a non-parametric approach (Anshori et al. 2020). Therefore, there are two aims. The first is to determine the best cultivation for the combination of planting media and coconut water concentration on large chilies growth characteristics using multivariate analysis. The second is to determine the best combination of temperature and cultivation combination for large chilies post-harvest characteristics using non-parametric analyses.

Commented [A31]: I do not understand very well when authors talk about technology.

Commented [A32R31]: Thank you for your question. We mean cultivation on large chili under urban farming

Results

Evaluation of the morphological growth characters

Based on the analysis of variance results (Supplementary 1), the various coconut concentrations showed a significant effect on almost all growth characters, except for the age of first harvest, productive branches and fruit weight. Conversely, planting media only

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influenced the density of the stomata, productive branches and total dissolved solids (TDS), while the interaction between the growth media and concentration impacted extensively only on stomatal density.

Pearson correlation analysis results showed productivity as the main character with a significantly positive interaction with TDS (0.38), stomata aperture area (0.41), fruit length (0.51), plant height (0.54), and the fruit number (0.98). Conversely, the negatively correlated character was obtained as the age of the first harvest (-0.72), while the positive aspect formed the basis for a more in-depth study, including factor analysis (Fig. 1).

Fig. 2 represents the factor analysis results where 3 groups of treatment combinations were obtained. The first category comprised M1C1, M3C1, M2C1 and M2C4, while the second encompassed M1C4, M1C3, M1C2, M2C2 and M3C2. Finally, the third group contained M3C4, M2C3 and M3C3. Based on the loading factor value (Table 2), factor 2 dimensions were identified, where the diversity of factor 1 was strongly influenced by the fruit weight, as well as its quantity and length. Meanwhile, the TDS and the stomata opening width contributed to the significant influence in factor 2.

The LSD test results showed that C2 concentration treatment was the best coconut concentration treatment on fruit length, number and weight per plant, while k1 obtained the minimum treatment (Table 3). Based on the wide characters of the stomata opening and TDS, C3 was known to generate the optimal performance, followed by C2. Conversely, C1 also exhibited the lowest concentration in both characters.

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Evaluation of the Post-Harvest Fruit Character

The Kruskal Wallis analysis results showed that the combination of concentration and temperature treatment significantly affected the 20 days storage, in terms of color and texture (Table 4). Based on the color, the refrigerator treatment obtained a lower z value value (-3.61), compared to the room temperature at C2 concentration. Conversely, room temperature with k1 concentration generated the combination treatment with the maximum z value (3.63). Based on the texture, the refrigerator treatment had a higher z value (3.86) at C3, compared to the room temperature treatment, while for room temperature at C1, the minimum z value (-3.82) was obtained.

Spearman correlation analysis was used to assess the relationship between growth and post-harvest characters in the refrigerator temperature treatment (Table 5). The results showed that the fruit color was more negatively correlated with its number and weight per plant. Negative values in color correlation demonstrated an inverse interpretation of fruit quality, while the texture obtained a significantly positive correlation with the TDS character. Therefore, a more positive texture correlation value tends to generate superior fruit quality

Discussion

The results of this study indicated that the difference in the coconut water concentrations was very predominant in the growth of large chilies. Media treatments are generally known to affects plant growth, including chili. This conclusion was also reported by Gungor and Yildirim (2013), Mathowa et al. (2017), and Khaitov et al. (2019), where separate media compositions generated different responses to the chili growth and productivity. However, the variation is

not considered very significant if the treatment is juxtaposed with the effect of coconut water concentration. This condition was further reinforced by the interaction effect, without any relative impact on the plant development. According to Saptaji et al. (2015), the combination of media and coconut water treatments reported a significant effect on stevia growth, due to the relatively large proportion of compost from the media treatment. In contrast, a more dominant soil composition was observed, in comparison to husk and compost. Yong et al. (2009) and Prades et al. (2012) also showed a rich content of hormones in the coconut water. As a consequence, the application of several concentrations of coconut water tends to affect the plant growth (Prando et al., 2014; Winarto and Da Silva, 2015; Darmawan et al., 2020), including chili (Mythili et al., 2017; Fassya et al., 2020). Based on this circumstance, further analysis in the present study was then dominated by the concentration of coconut water on chili growth.

Great Pearson correlations in terms of productivity were also obtained in TDS characters, plant height, fruit length and number. These results were equally reported by Bijalwan and Mishra (2016), Yenny et al. (2019) and Fitry et al. (2021), where a significant correlation between chili productivity as well as fruit length and number of fruits. The performances above showed that the five characters possibly serve as the basis for treatment evaluation in this study, specifically coconut water concentration. However, the use of correlation analysis is considered an estimation, due to its inability to describe the specific relationship between characters. Correlation analysis is also inseparable from the nature of multicollinearity, but forms the basis of further in-depth investigation. This concept has also been reported by Farid et al. (2020), Akbar et al. (2021) and Anshori et al. (2021). Based on this phenomenon, a deeper

analytical approach highly dependent on the correlation technique, such as the factor analysis, appears very significant in the evaluation of this study.

Factor analysis occurs among the major multivariate assessments in identifying specific internal covariates and reducing the weak covariates between dimension variables. This approach is used to evaluate the important character determinants of a large variable (Rocha et al., 2017). Further use of factor analysis in obtaining important growth characters has been reported by Rocha et al. (2017) and Farid et al. (2020). Therefore, its application in this study has the capacity to also evaluate the characters specifically correlated with productivity. Under this circumstance, two resulting methods were obtained, including the use of the biplot concept and identification of character diversity based on factor dimensions. Biplots are significant in the diversity visualization and the grouping basis between treatment objects on their variables, particularly when combined with principal component or factor analysis. Figure 2 shows that the grouping was very identical to the coconut concentration treatment, specifically at C2 and C1, while C3 and C4 were extended relatively in each group. This observation provides another evidence that coconut water concentration is a determinant of the growth diversities of large chilies. Table 2 outlines the factor dimensions, where fruit length and number, productivity, TDS, as well as the width of stomata opening served as the evaluation characters. This outcome was based on the factor loading value of these characters which exceeded 0.32 (Yong and Pearce, 2013), both on the dimensions of factors 1 and 2. This selection concept was also reported by Farid et al. (2020) on the determination of preferred characters in lowland wheat collections. Therefore, the characters of fruit length and number,

productivity, TDS, as well as the stomata opening width were further analyzed by the LSD significant difference test.

The LSD test results also observed the significant effect of coconut water on the growth of large chilies. In addition, the best treatment for the chili production components was obtained in C2, although C3 demonstrated the ability improve the plant quality. This optimal performance of C2 was based on the relatively suitable TDS potential and the stomata opening width. The results of this study also matched the previous study of Fassya et al. (2020), where 25% coconut water was stipulated as the best dose in increasing chili growth, while a 50% increment showed a linearly decreasing effect. Therefore, C2 treatment is highly recommended as a major coconut water dose in the cultivation of large chilies.

Post-harvest testing is an important indicator in terms of the quality of large chilies, where refrigerator storage was generally superior, compared to the room temperature. These results have been reported by several studies, including Galani et al. (2017) and Contreras et al. (2021). Based on coconut water concentration, C2 treatment showed a more effective storage quality, specifically when combined with refrigerated spaces. In general, the observation of post-harvest characters such as color quality and texture, serves as the main character in assessing storage efficiency. The process of post-harvest cell degradation appears faster, depending on the fruit's physiological processes, including respiration, ripening and senescence (Edusei et al., 2012; Ziv and Fallik, 2021). These prompt techniques tend to induce rapid changes in fruit color and texture (Contreras et al., 2021; Ziv and Fallik, 2021). Chili plants are non-climacteric (Razo-Mendivil et al., 2021). However, the post-harvest fruit quality is highly dependent on the fruit water loss (Maalekuu et al., 2006; Edusei et al., 2012; Elibox et al., 2015). This causes the chili to

experience a rapid ripening process, identified by color and texture similar to other climacteric fruits (Maskey et al., 2021; Berry et al., 2021). In this study, color depicts an inverse interpretation of the fruit quality, where the smaller color scores instigate extensive change in appearance. Meanwhile, the texture showed a positive interpretation, where higher texture scores obtained superior fruit texture. Based on this phenomenon, C2 treatment also serves as a possible recommendation in enhancing the post-harvest chili quality.

Spearman correlations are generally performed on data with different properties (Anshori et al., 2020;2021). The growth characters in the present study were numerical or parametric, while post-harvest properties were categorical or non-parametric, resulting in an effective correlation. Based on Spearman correlation results, the growth and post-harvest characters showed a very close relationship, particularly in the treatment of the refrigerator storage. This observation indicates that the treatment on the growth character significantly impacted on the post-harvest components. Therefore, the fruit quality assessment possibly refers to the plant growth, particularly in terms of the fruit number, production per plant and the TDS.

Materials and Methods

This study was conducted between January-May 2020 in Balang Toa village, Jeneponto Regency, Indonesia, at an altitude of 100 meters above sea level. The soil kind was dusty clay. The average monthly rainfall of more than 120 mm per month and the wettest month is January with a monthly rainfall of more than 250 mm per month. The air temperature in the Jeneponto Regency area is between 21-34 °C with a relative humidity level of about 76%. The study was consisted of two experiments. The first experiment focussed on evaluating of the morphological

Commented [A41]: There should be a sub-heading explaining the experimental design number of replications and also treatments.

Commented [A42R41]: Thank you for your correction. We have added the sub-heading to explain the experimental design, number or replication and kind or treatment, at lines 267-276

growth characters and the second experiment is evaluation of the post-harvest fruit characters.

The chili variety used in this study was the “Pilar” variety.

Evaluation of the morphological growth characters

Experimental design

The first experiment was arranged by a split-plot design experiment with randomized complete block design as environmental design. The main plot served as the planting media (M) comprising 3 levels, including M1 = soil: compost (2:1), M2 = soil: husk charcoal (2:1) and M3 = soil: compost: husk charcoal (2:1:1). Meanwhile, the sub-plot showed the coconut water concentration (C) of 4 levels, termed C1 = 0% (1000 mL distilled water), C2 = 15% (150 mL coconut water + 850 mL distilled water), C3 = 30% (300 mL coconut water + 700 mL distilled water) and k4 = 45% coconut water concentration (450 mL coconut water + 550 mL distilled water). Based on the two treatment blends, 3 repetitions were observed in the 12 combinations, resulting in a total of 36 units, with each comprising 4 samples.

Research procedure

Chili seeds were soaked in warm water for about 12 hours and the floating portions were discarded. The remnants were then induced for germination, using a moistened tissue in the absence of light. This was followed by the introduction of the germinated seeds into the combined soil and compost media at a ratio of 2:1, with polybags measuring 10 cm x 12 cm. The seedlings were preserved for 4 weeks and transferred to polybags, based on the growing media treatment without any use of basic organic or inorganic fertilizers. Meanwhile, the transplanting process was conducted simultaneously in the afternoon and the polybags were moistened until

Commented [A43]: The area that this coconut water was applied is not clear? On what area this 1 litre applied?

Commented [A44R43]: Thank you for your question. Making the concentration of the solution is done by taking 15 ml of young coconut water (fermented) then adding 850 ml of water so that the volume of 15% young coconut water solution becomes 1000 ml. This is also carried out to another level. Coconut water was applied twice a week until harvest with concentrations of 0%, 15%, 30%, and 45%. In the first, second, third and fourth months, the volume of giving coconut water was approximately 10 ml, 45 ml, 75 ml, and 100 ml (per plant). The application is done by spraying onto the leaves of the plant. Spraying begins when the plants are 4 weeks old after sowing until the observation is complete (10 times). (lines 289-294)

the attainment of field capacity. Young coconut water was obtained from similar tree that is yellow colored with characteristics of smooth fruit skin color, pests, and diseases free, as well as soft and thin endosperm. The coconut water was then mixed with distilled water at ratio 1:1, ready to apply to sugar which was fermented for 15 days as a growth regulator. Coconut water was applied twice a week until harvest with according to experiment concentrations. In the first, second, third, and fourth months, the volume of giving coconut water was approximately 10 ml, 45 ml, 75 ml, and 100 ml (per plant), respectively. The application is done by spraying onto the leaves of the plant. Spraying begins when the plants are 4 weeks old after sowing until the observation is complete (10 times). Furthermore, the maintenance of chili plants involved replanting, watering, pruning of the water shoots, weeding, as well as pest and disease control. The embroidery process was conducted for one week after its application on the growing resistant seedlings, using similar seeds according to initial cultivation. Watering was performed daily, in the morning and evening, although it was dependent on the plant condition. The pruning or cutting of the shoots in the leaf axils under the Y branch commenced at 7.00 pm. The weeds were subsequently removed, and the pest control process involved the installation of trap bottles containing methylate glue. Growth regulators with concentrations of 0, 15, 30 and 45%, were applied twice every week by the spray method. Spraying was introduced when the plants are 4 weeks after planting (WAP) until the observation was completed. This was followed by the harvesting process, based on certain criteria, such as the absolute red appearance of the chilies (90%). The present study reported a total harvest rate of 10 repetitions, with 2 occurrence every week

Observation and Data Analysis

The observations parameters were plant height (cm), leaf area (cm²), stomata density, stomata opening area (stomata/mm²), number of productive branches (branches), number of fruits, fruit length (cm), fruit weight (gram) as well as the fruit weight per plant (gram). Meanwhile, the data evaluation process encompassed several stages, with the first involving the analysis of variance at 5% level. The significant characters were continued using the multivariate approach in the forms of Pearson correlation and factor assessments. Duncan's test was further used to sustain the important character of the multivariate analysis results at the 5% level.

Evaluation of the Post-Harvest Fruit Character

The second experiment is continued of the first experiment. After the fruits harvested, the fruits of the coconut water concentration on first experiment were stored in two temperature conditions (the room (R) and refrigeration temperature conditions) that arranged with a randomized complete nesting design. These temperatures were specified at 28 and 4 C°, for the room and refrigeration conditions, respectively. The evaluation of the post-harvest properties, based on the fruit color and texture. The fruit observations were performed for two weeks, although the texture and color were examined on a weekly basis. These views were achieved by scoring (Table 1) and subsequently analyzed using the non-parametric methods, such as the Kruskal-walis and Spearman correlation analyses

Conclusion

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Commented [A47]: It looks that there is no statistical plan for this temperature and refrigeration!

Commented [A48R47]: Thank you for your question. We used the Kruskal-walis and Spearman correlation analyses as non-parametric design

Based on this study, the use of multivariate and non-parametric analyses increased the effectiveness of the evaluation process of parametric and categorical data, respectively. The concentration treatment of coconut water dominated the diversities of the growth and post-harvest characters of large chillies. Plant height, TDS, fruit weight, number and length, as well as the stomata opening width served as the important characters, particularly on the effect of coconut water concentration. The best coconut water concentration in large chili cultivation in polybags potentially occurs at 15%. Combining these concentrations with the refrigeration temperature generated a significant ability in enhancing the post-harvest fruit quality. Therefore, a coconut water concentration of 15% is possibly recommended in the urban farming of large chillies, using organic applications.

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Commented [A49]: This section should be completely and precisely checked to be consistent with AJCS and also to avoid extra and missing references.

Commented [A50R49]: Thank you for your suggestion. we have rechecked reference toward format, extra and missing references.

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Table 1. Score value and its description on the postharvest characters

Score	Fruit Color	Fruit texture
1	Red	not hard
2	brownish red	a bit hard
3	reddish brown	quite hard
4	brown	hard
5	very brown	very hard

Commented [A51]: Not clear! Colour of what? Texture of what?

Commented [A52R51]: Thank you for your question. We mean fruit Color and Fruit texture

Table 2. Factor analysis of characters correlated with fruit weight per plant

Variable	Height	TDS	FWP	NF	FL	SOA
Factor1	0.181	-0.13	0.332	0.346	0.413	-0.126
Factor2	-0.139	-0.506	-0.03	0.008	0.29	-0.515
Communality	0.531	0.778	0.673	0.86	0.898	0.737

Notes : SOA = stomata opening area, NF = number of fruits, FL = fruit length (cm), FWP = fruit weight per plant, TDS = total dissolved solids

Table 3. Post-hoc test of BNT 5% on coconut water concentration treatment

Treatment	Stomata Opening Area		Fruit Length		Number of Fruits		Fruit Weight Per Plant		TDS	
	Mean	Notation	Mean	Notation	Mean	Notation	Mean	Notation	Mean	Notation
	n	n	n	n	n	n	n	n	n	n
C1	0.0002	c	8.81	c	34.63	b	210.85	c	7.38	c
C2	0.0003	b	10.19	a	46.59	a	294.56	a	8.42	b
C3	0.0004	a	9.41	b	44.56	a	279.07	ab	10.1	a
C4	0.0003	b	9.44	b	41.15	a	255.78	b	8.94	b

Notes = the same letter in one column indicates a value that is not significantly different based on duncan multiple range test at 5 % level, C= coconut water concentration, TDS = total dissolved solids, ** significant at 1%, Multiple R-squared: 0.7519 dan Adjusted R-squared: 0.7478

Commented [A53]: What score is? What is Notation? They must be defined in the footnote of Table.

Table 4. Kruskal-Walis analysis on post-harvest characters of chili

Treatment	Color 10 days		Color 20 days		Texture 10 days		Texture 20 days	
	Median	z-value	Median	z-value	Median	z-value	Median	z-value
Rf_C1	2.0	1.13	2	-2.10	3.0	-1.72	3	1.99

Commented [A55]: All these treatments must be introduced in the MM section and also footnote of table.

Commented [A56R55]: Thank you for your suggestion. we have revised according to your suggestion

Rf_C2	1.5	0.07	2	-3.61	3.0	-0.9	3	2.38
Rf_C3	1.0	2.06	2	-3.34	3.0	0.40	3	3.86
Rf_C4	2.0	0.60	2	-3.07	3.0	0.08	3	3.47
R_C1	2.0	0.60	3	3.63	3.0	-0.73	1	-3.82
R_C2	1.0	-0.47	3	2.69	4.0	1.07	2	-2.63
R_C3	1.0	-1.00	3	2.69	3.5	0.90	2	-2.33
R_C4	2.0	1.13	3	3.11	3.5	0.90	2	-2.92
P value	0.178	0.000	0.331	0.000				

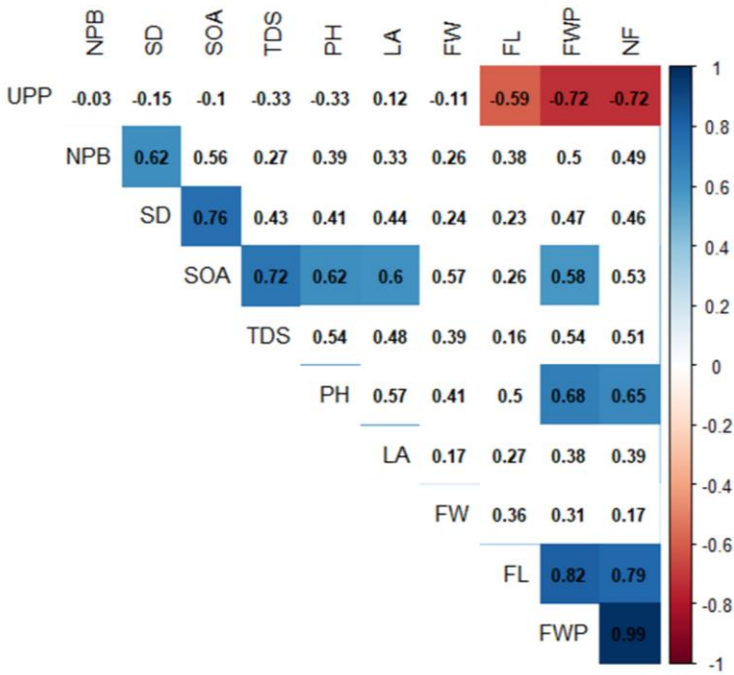
Note: Rf = refrigerator, R = room, C= coconut water concentration

Table 5. Spearman correlation analysis on the important characters of growth on post-harvest characters of the fruit.

	Color	Texture	SOA	FL	NF	FWP
Texture	-0.40					
SOA	-0.63	0.95				
FL	-0.80	0.20	0.32			
NF	-1.00**	0.40	0.63	0.80		
FWP	-1.00**	0.40	0.63	0.80	1.00	
TDS	-0.40	1.00**	0.95	0.20	0.40	0.40

Notes: SOA= stomata opening area, TDS = total dissolved solids FL = fruit length (cm), NF = number of fruits, FWP = fruit weight per plant

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Fig 1. Pearson correlation analysis on chili growth characters. (PH= Plant height, LA= Leaf area, SD = Stomata density, SOA= Stomata opening area, NPB= Number of productive branches, NF= Number of fruits, FL = Fruit Length, FW= Fruit Weight, FWP= Fruit weight per plant)

Commented [A59]: The legends should be more informative.

Commented [A60R59]: Thank you for your suggestion. we have revised the image and it has suited with the legends

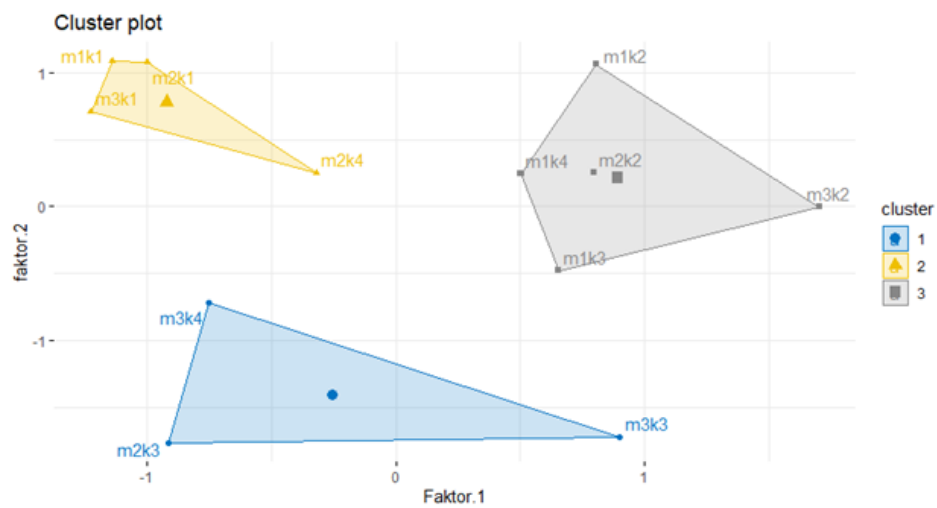


Fig 2. Grouping of combinations of planting media and the coconut water concentration based on factor analysis biplots


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Commented [A62R61]: Thank you for your suggestion. we have added few information to clearly this sentence.

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8 of 20

Dr. Ir. Fachirah Ulfa, MP. <fachirahulfa@unhas.ac.id> to Tony Apr 1, 2022, 10:40 PM ☆ ↶ ⋮

 Copy of Certifica...

Tony Elders <tony.elders@gmail.com> to me Apr 7, 2022, 11:24 AM ☆ ↶ ⋮

Dear Dr. Fachira Ulfa

I checked your revised files and it definitely needs more English proofreading which we can offer **after acceptance**. It means that we can proceed with a scientific acceptance but you must approve that you are willing to use our English language service with a fee of 210 AUD.

Otherwise, you may try any other third party to do a proper English language service.

Please let me know if you are happy with our English language facility then I can proceed towards the scientific decision and possible acceptance.

Regards
Tony

Dr. Ir. Fachirah Ulfa, MP. <fachirahulfa@unhas.ac.id> to Tony Apr 9, 2022, 10:42 AM ☆ ↶ ⋮

Dear Tony Elders

we are happy to get your information. Yes, we accept suitable with your English language service recommendation. After acceptance, we will pay for the English language service. Thank you for your wisdom

Dr. Fachirah Ulfa

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Tony Elders <tony.elders@gmail.com> to me Tue, Apr 19, 9:50 AM

Dear Dr. Fachira Ulfa

I am pleased to inform you that your manuscript entitled,"Effect of coconut water concentration and Planting Media on Growth and Post-Harvest Characters of Large Chili Using Multivariate and Non-Parametric Analyses", has been accepted for publication in AJCS.

Please find the invoice, read it carefully and let me know with the proof of your transaction as soon as you made the payment.

As you agreed to pay the English edition fee, we will edit your manuscript with minimum alterations before publication and you do not need to do anything else until the galley proof of your manuscript is ready (proof stage).

Please be notified that after payment your manuscript will be queued for publication (unless you choose to use the rapid scheme see: item 3 in your publication invoice attached).

Please do not hesitate to contact me if you have any other questions.

Regards
Tony Elders
AJCS Managing Editor

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Dr. Fachirah Ulfa

Dr. Ir. Fachirah Ulfa, MP. <fachirahulfa@unhas.ac.id>


to Tony

Fri, Apr 22, 2:01 PM

Dear Tony Elders

We have paid our payment entitled "**Effect of coconut water concentration and Planting Media on Growth and Post-Harvest Characters of Large Chili Using Multivariate and Non-Parametric Analyses**". However, there is a mistake, the bank office forgets to attach Ref No: PNE3593 in the payment proof. So, I convey to you please check our payment. The transfer time needs three days. Thank you for your wisdom

best regard
Dr. Fachirah Ulfa
Agronomy Department



Mail interface showing an email from Tony Elders to Dr. Fachirah Ulfa, dated May 3, 2022, 11:36 AM. The email content includes:

Dear Dr. Fachirah Ulfa

Thanks a lot for your payment and contribution to AJCS. Now, I have scheduled your manuscript for publication in June 2022.

As you have paid for the English proofreading service, we will edit your manuscript with minimum alterations before publication and you do not need to do anything else until the galley proof of your manuscript is ready (proof stage).

We normally publish the galley proof of accepted manuscripts online by 25-30th of the scheduled month. Please be kind enough to wait and I will notify you by email as soon as the galley proof of your manuscript is ready.

We'll also be needing a signed consent to publisher form available at: <https://www.cropj.com/guidlines.html> (must be sent directly to me).

Please do not hesitate to contact me if you have any other questions.

Hereby, I congratulate you on this big achievement and thanks again for your contribution. We hope to receive more manuscripts from you in the future.

Regards
Tony Elders
Australian Journal of Crop Science

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Dr. Ir. Fachirah Ulfa, MP. <fachirahulfa@unhas.ac.id> to Tony

Fri, May 6, 4:28 AM

thank you for your email. I have attached the consent to publish form according to your requirement
thank you

best regards

Dr Fachira Ulfa

consent to publi...

Tony Elders <tony.elders@gmail.com> to me

May 16, 2022, 12:00 PM

Received, thank you.

[AJCS] May 2022 issue [Proof Correction]

Tony Elders <tony.elders@gmail.com>
To: Tony Elders <tony.elders@gmail.com>
Bcc: fachirahulfa@unhas.ac.id

Wed, Jul 20, 2022 at 5:22 PM

Dear valued authors

Reply this email ONCE with all corrections.

[Please be reminded that DOIs issued by the journal but have not been registered with CrossRef. For all DOI matters please contact me and NOT CrossRef]

I am pleased to inform you that the uncorrected proof of your manuscript is ready. Please be reminded that your manuscript is fully citable now.

Please click on the following link to find your manuscript, read it carefully and make the final proofreading and send it directly to me within maximum 3 days from the date of this email.

<https://www.cropj.com/may2022.html>

Please refresh your browser after opening the page if you did not see your manuscript/issue.

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Please also download, sign and send back the copyright form with your corrections (if you have not done so), otherwise publication of your manuscript will be delayed or even cancelled.

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NO change in the affiliation and authorship list will be accepted at this stage.

We only accept corrections from corresponding authors. Please only reply to this email once with all your corrections. As receipt of corrections will not be acknowledge, please make sure that you are sending your emails to: tony.elders@gmail.com

Authors will also be charged for excessive alterations on proofs and submission of revised files after the article has been transmitted to the printer.

Please do not forget to cite your manuscript in your future publications, if possible.

Look forward to receiving your corrections soon.

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Kind Regards

Tony Elders
AJCS Managing Editor
QLD 4074
AUSTRALIA