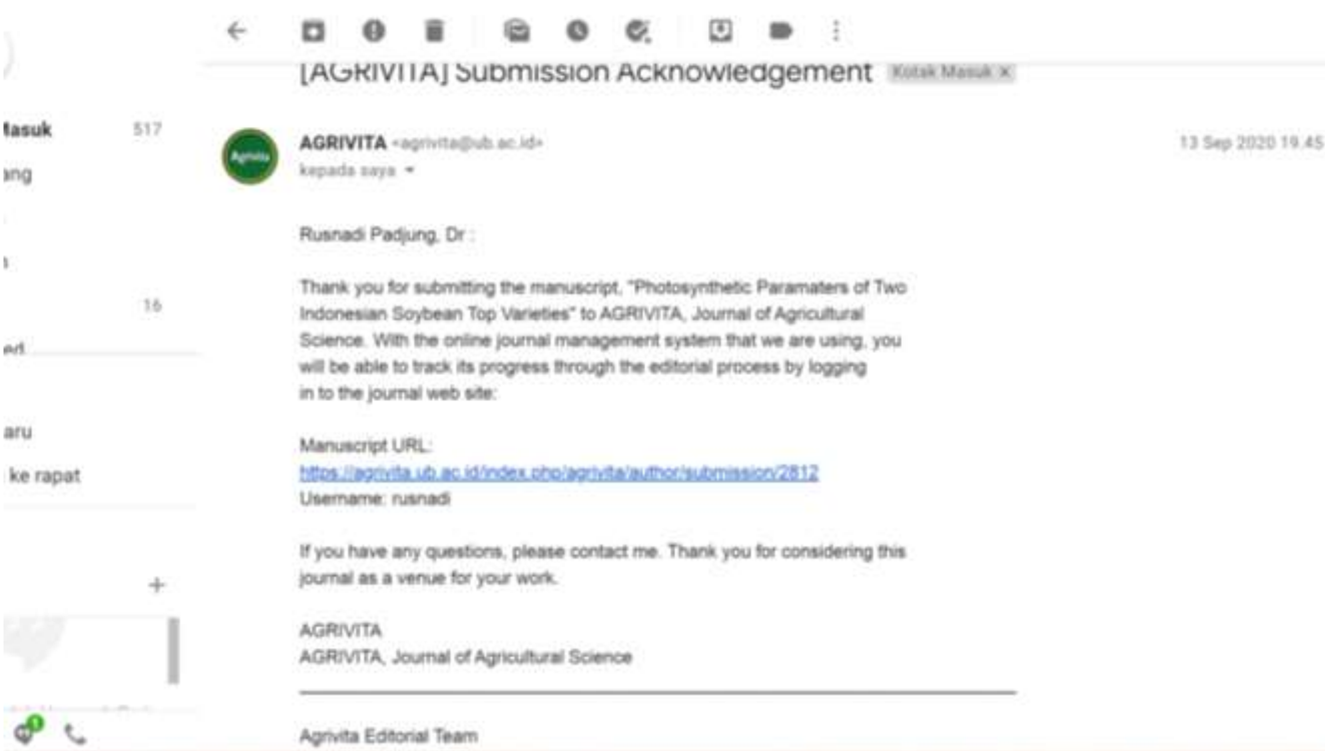
# RIWAYAT KORESPONDESI DENGAN EDITOR DAN REVIEWER AGRIVITA

1. E mail 13 Sept 2020 tentang konfirmasi dari editor ke Rusnadi bahwa manuskripnya telah diterima,



[AGRIVITA] Submission Acknowledgement

AGRIVITA <agrivita@ub.ac.id>
kepada saya

13 Sep 2020 19.45

Rusnadi Padjung, Dr :

Thank you for submitting the manuscript, "Photosynthetic Paramaters of Two Indonesian Soybean Top Varieties" to AGRIVITA, Journal of Agricultural Science. With the online journal management system that we are using, you will be able to track its progress through the editorial process by logging in to the journal web site:

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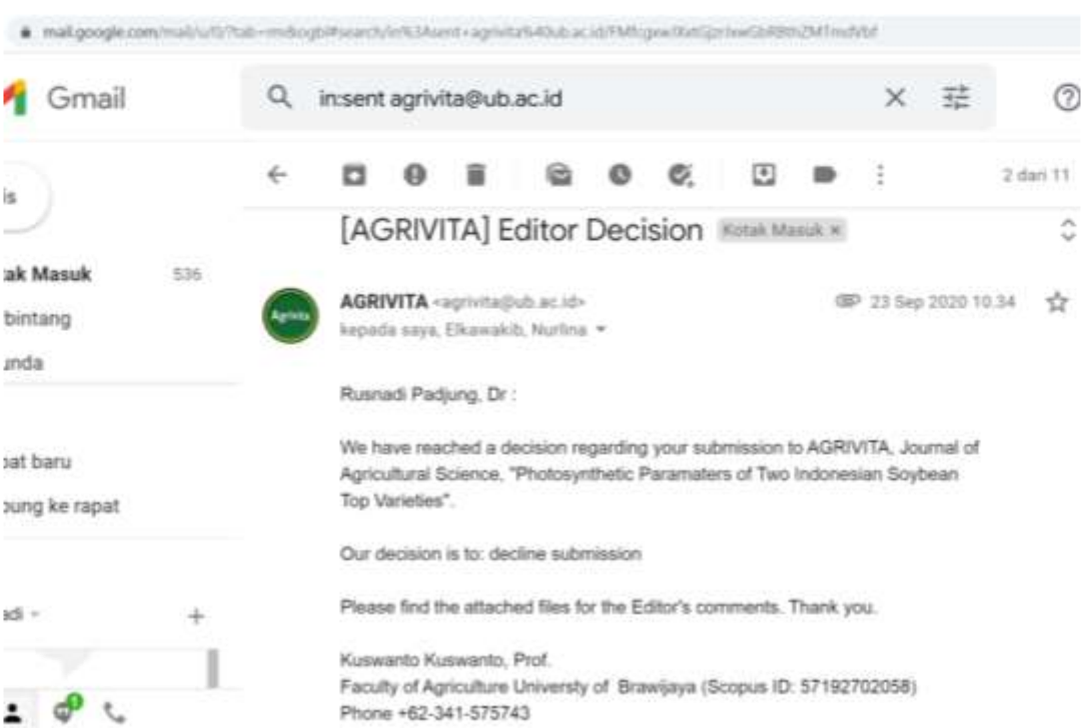
2. Email 23 September 2020 dari editor bahwa manuscriptnya ditolak (declined) karena tidak disertai dengan Copyright Agreement dan Competing Interest (CI),



[AGRIVITA] Editor Decision

AGRIVITA <agrivita@ub.ac.id>
kepada saya, Elkawakib, Nurlina

23 Sep 2020 10.34

Rusnadi Padjung, Dr :

We have reached a decision regarding your submission to AGRIVITA, Journal of Agricultural Science, "Photosynthetic Paramaters of Two Indonesian Soybean Top Varieties".

Our decision is to: decline submission

Please find the attached files for the Editor's comments. Thank you.

Kuswanto Kuswanto, Prof.
Faculty of Agriculture Universty of Brawijaya (Scopus ID: 57192702058)
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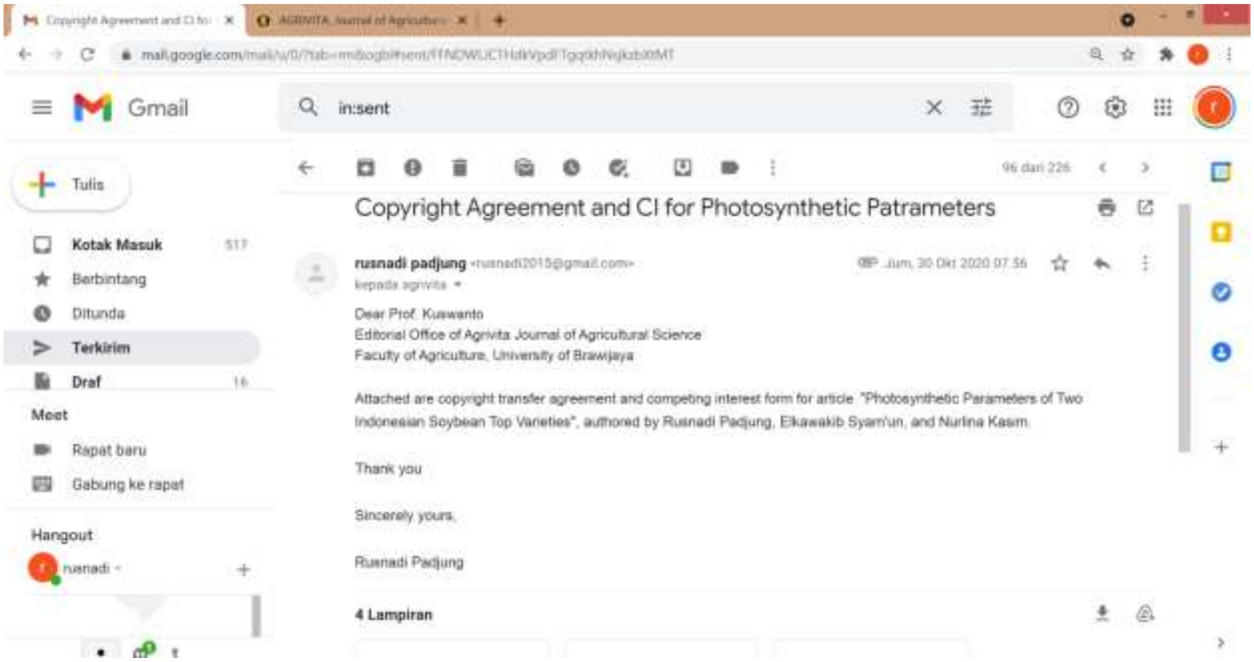
3. Email 30 Oktober 2020 dari Rusnadi ke editor untuk pengiriman Copyright Agreement dan CI,

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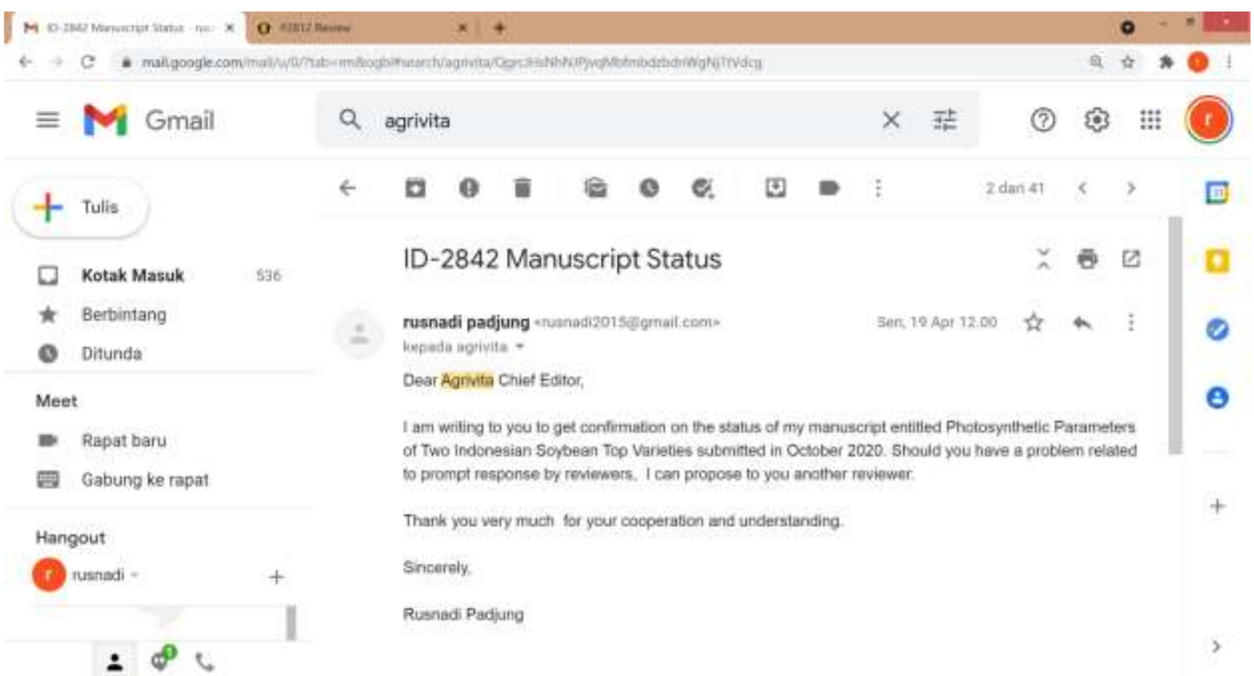

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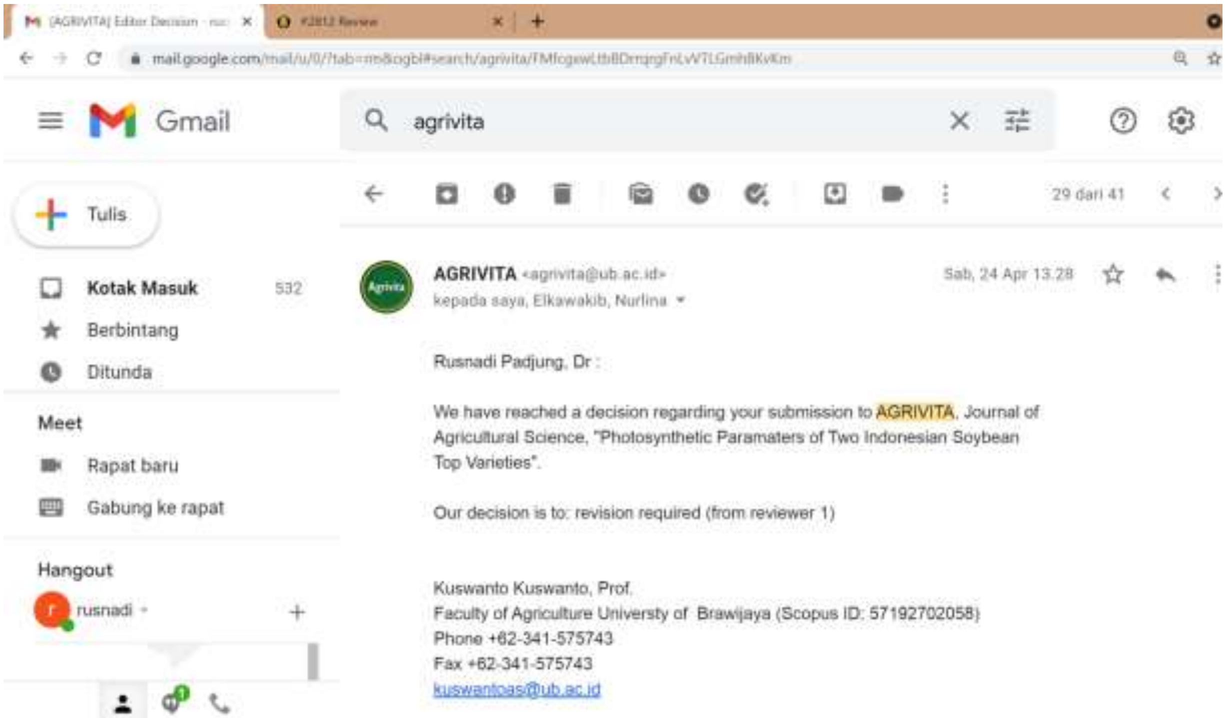


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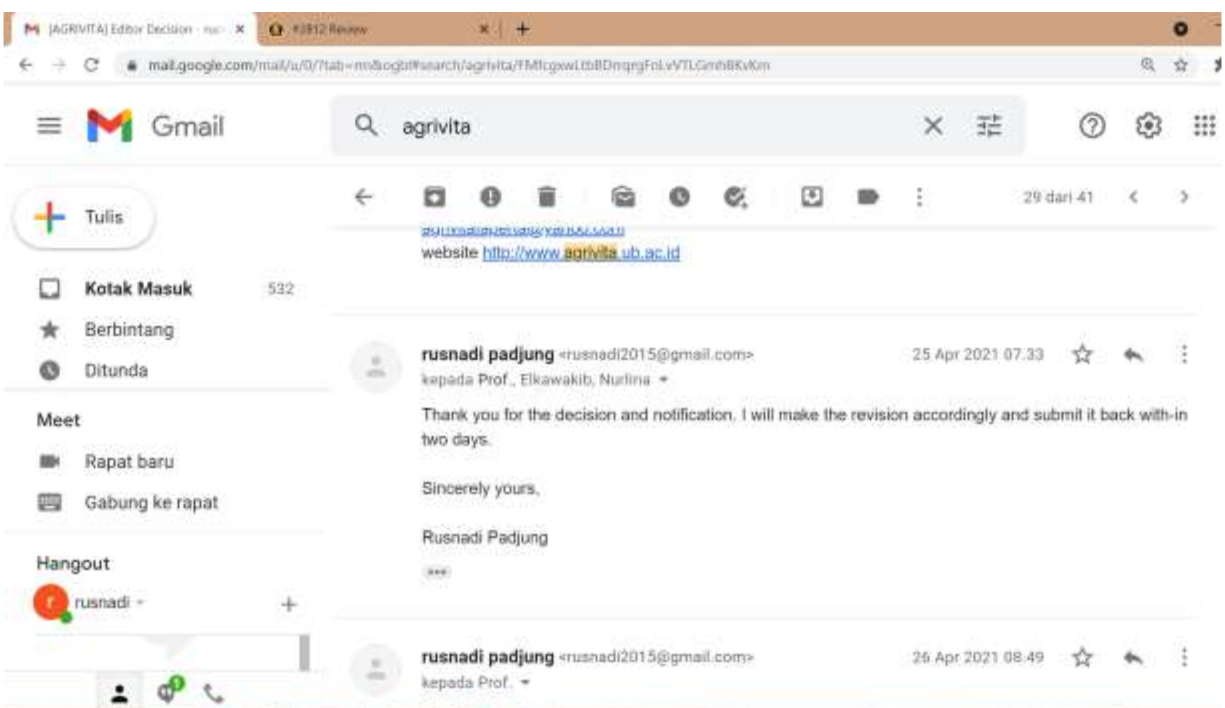

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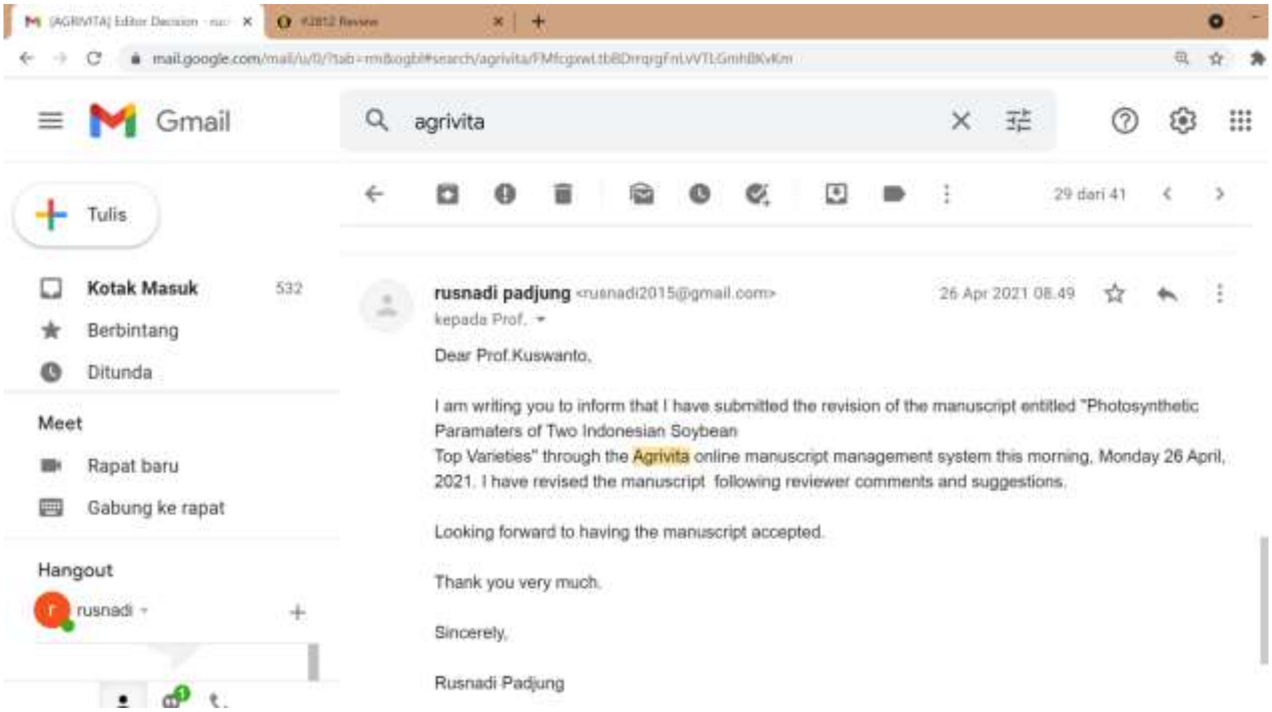
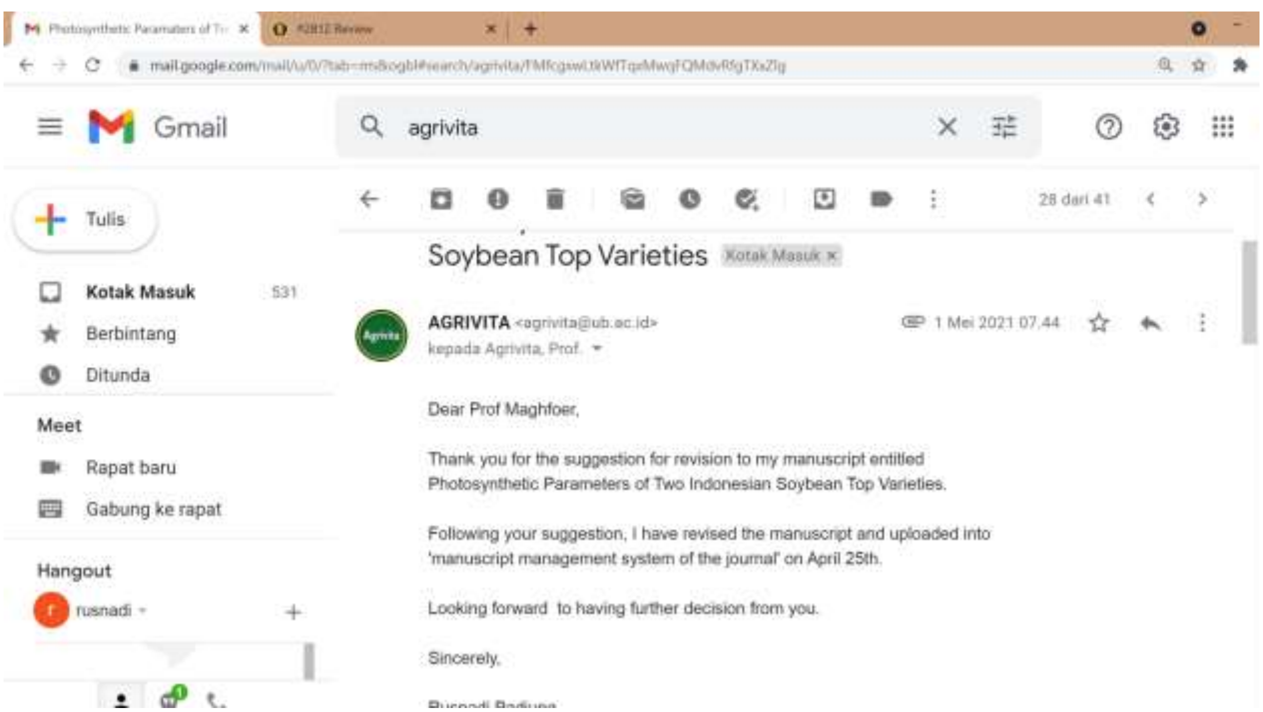



8. Email 1 Mei 2021 dari Rusnadi ke editor (Prof Magfoer) menyampaikan kembali bahwa revisi manuskrip telah diunggah ke manuscript management system Email ini dikirm karena tidah ada notifikasi apakah revisi sudah diterima.



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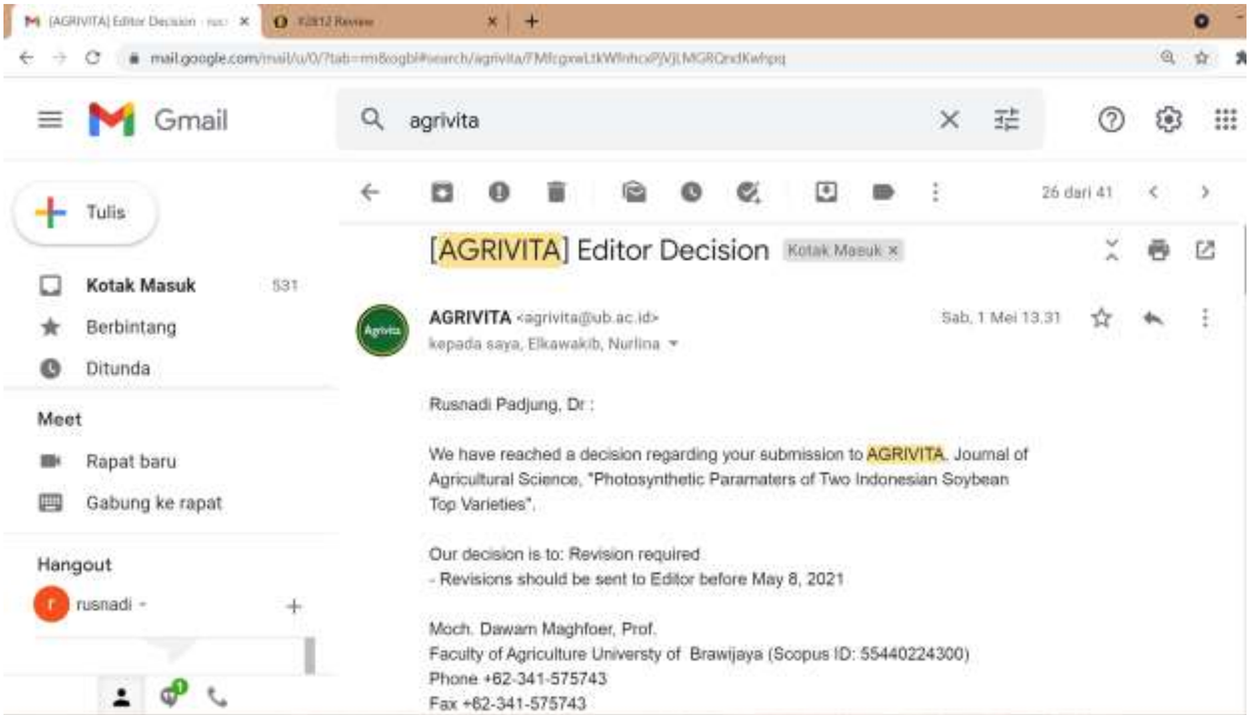
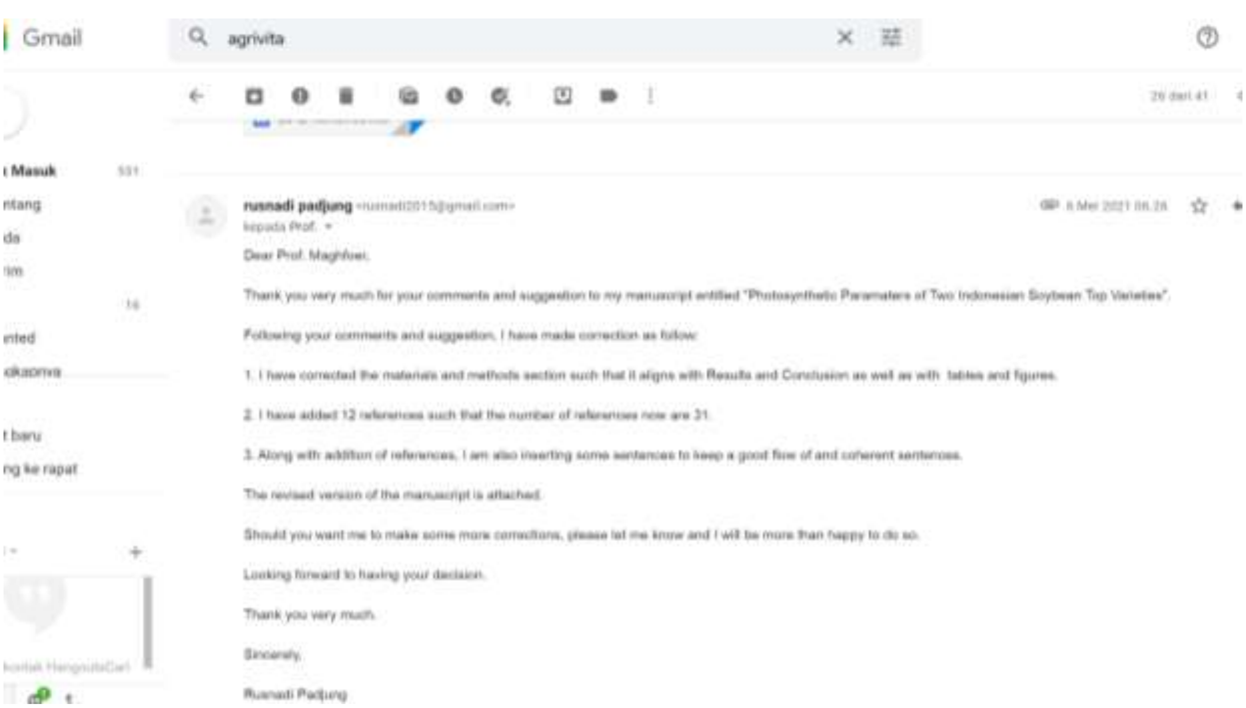



10.Email 6 Mei 2021 dari Rusnadi ke editor tentang pengiriman hasil revisi ke 2



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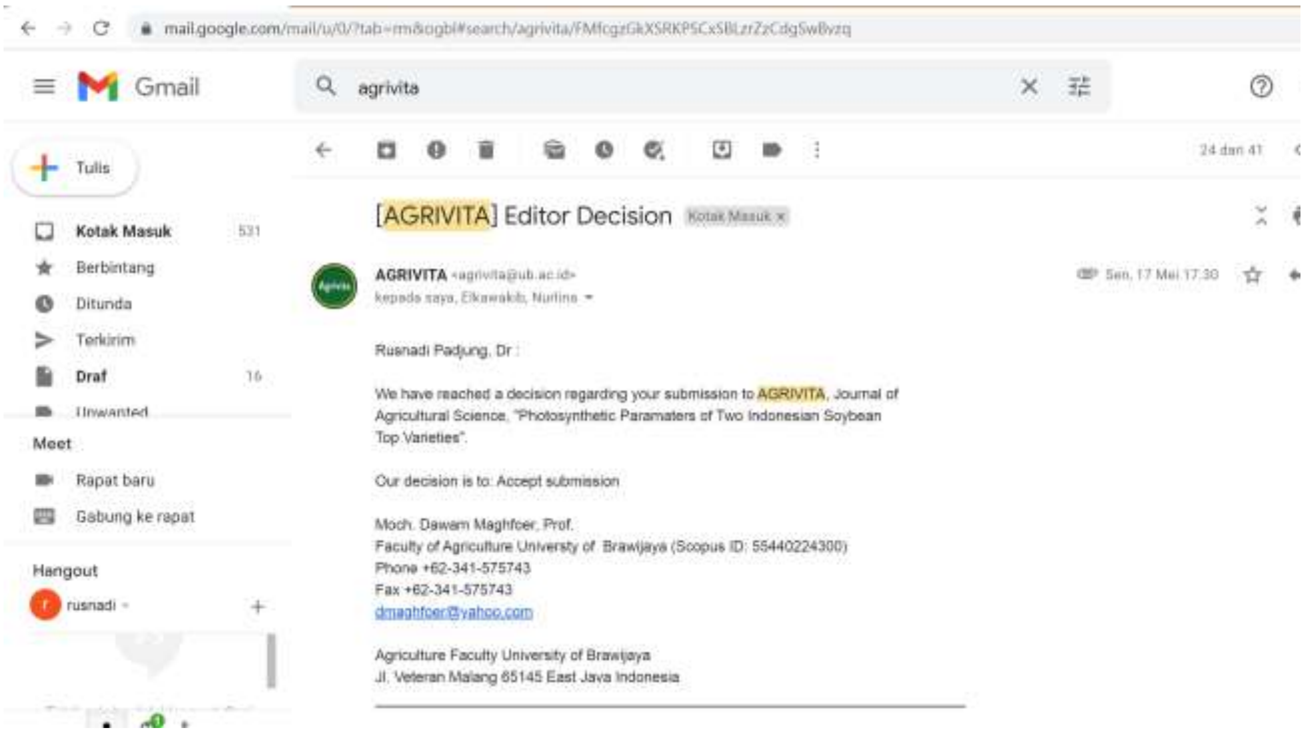
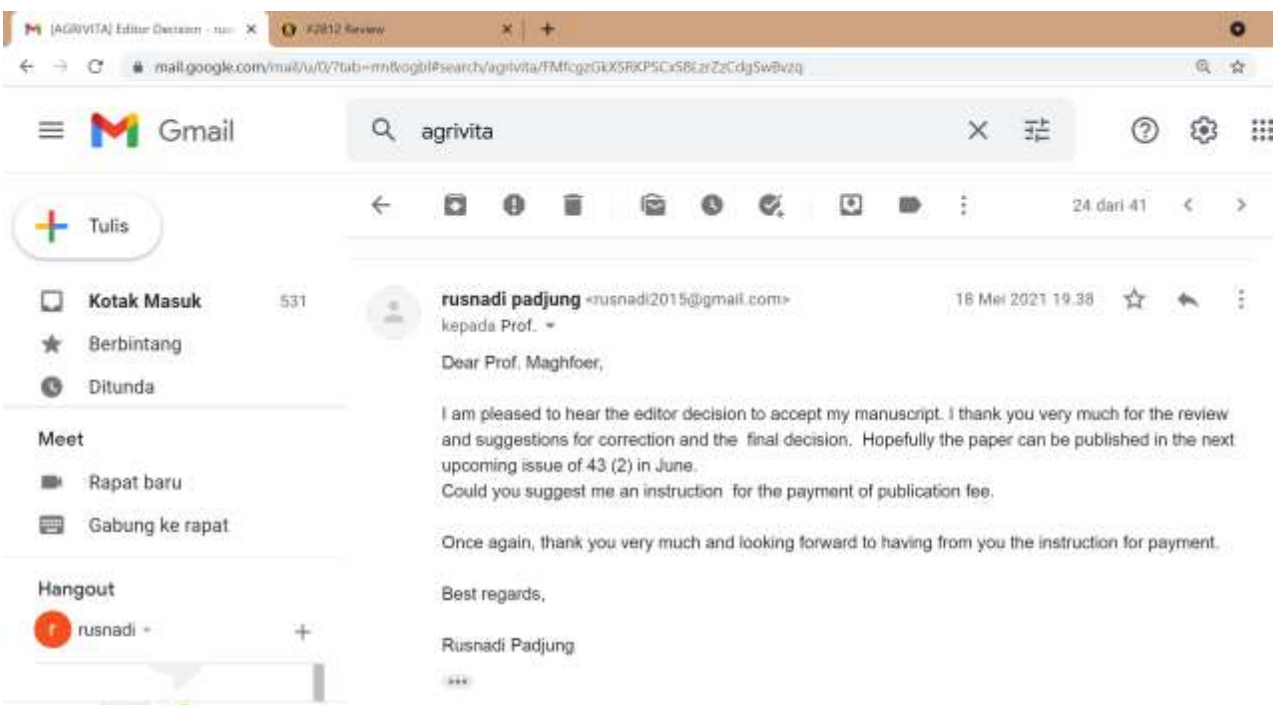
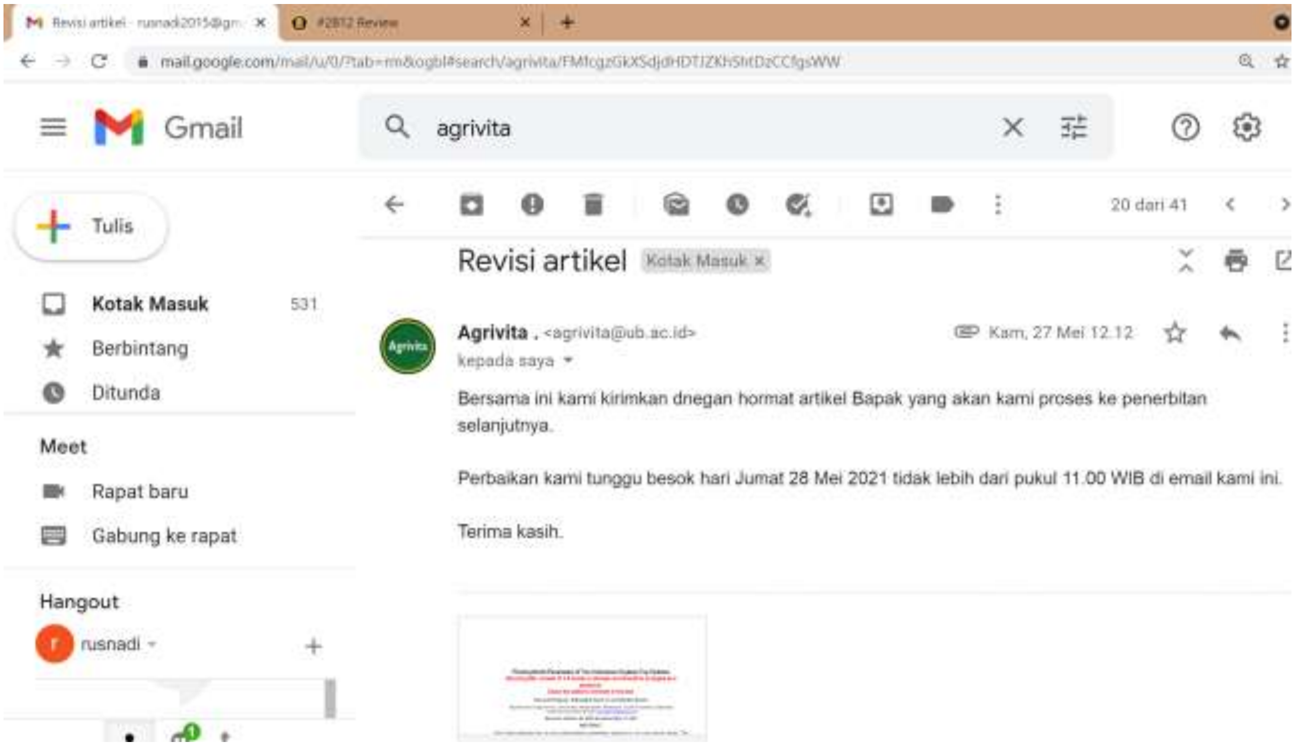



12. Email 18 Mei 2021 dari Rusnadi tentang penyampaian terimaksih  manuscriptnya  diterimma (accepted)



13. Email 27 Mei 2021 dari editor (Silvi) permintaan perbaiakan lanjutan manuscript

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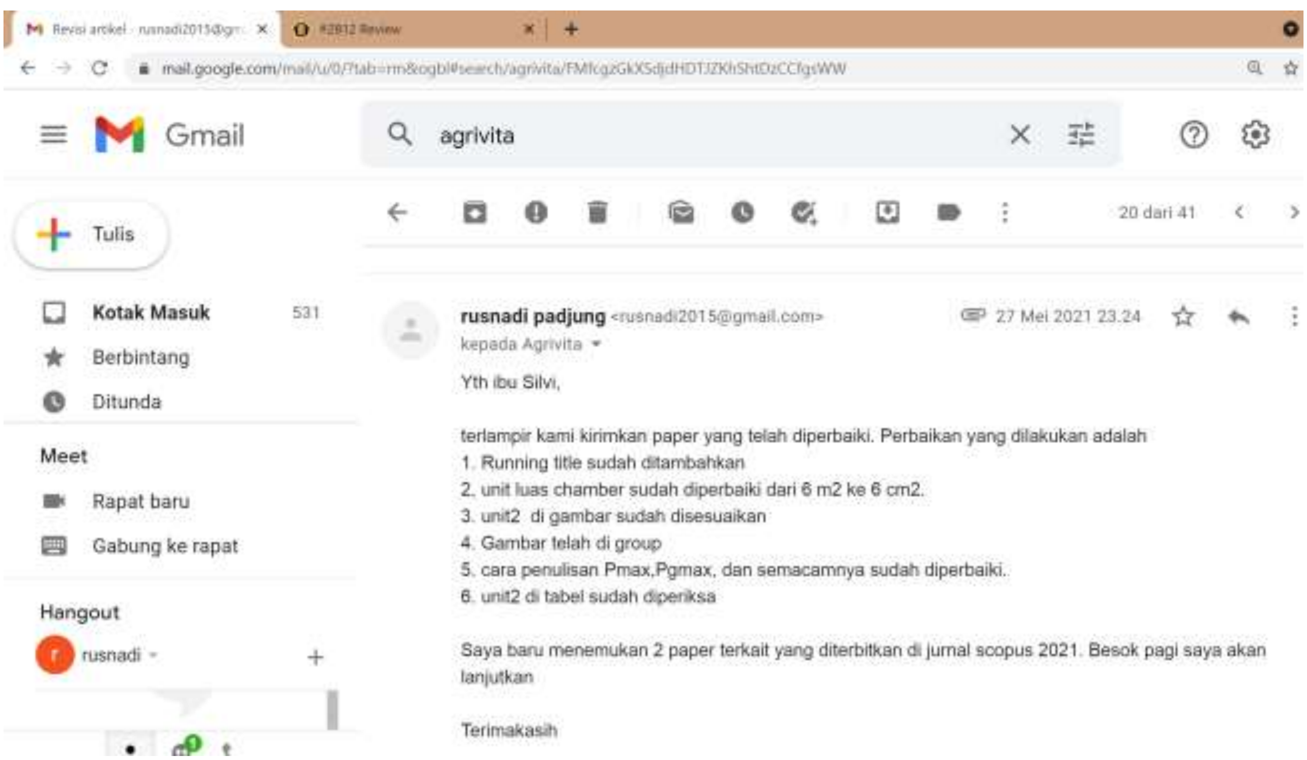

15. Email 28 Mei 2021 dari Rusnadi ke Silvi (editor) tentang perbaikan susulan yang  menambahkan referensi scopus 2021 dan perbaikan gambar


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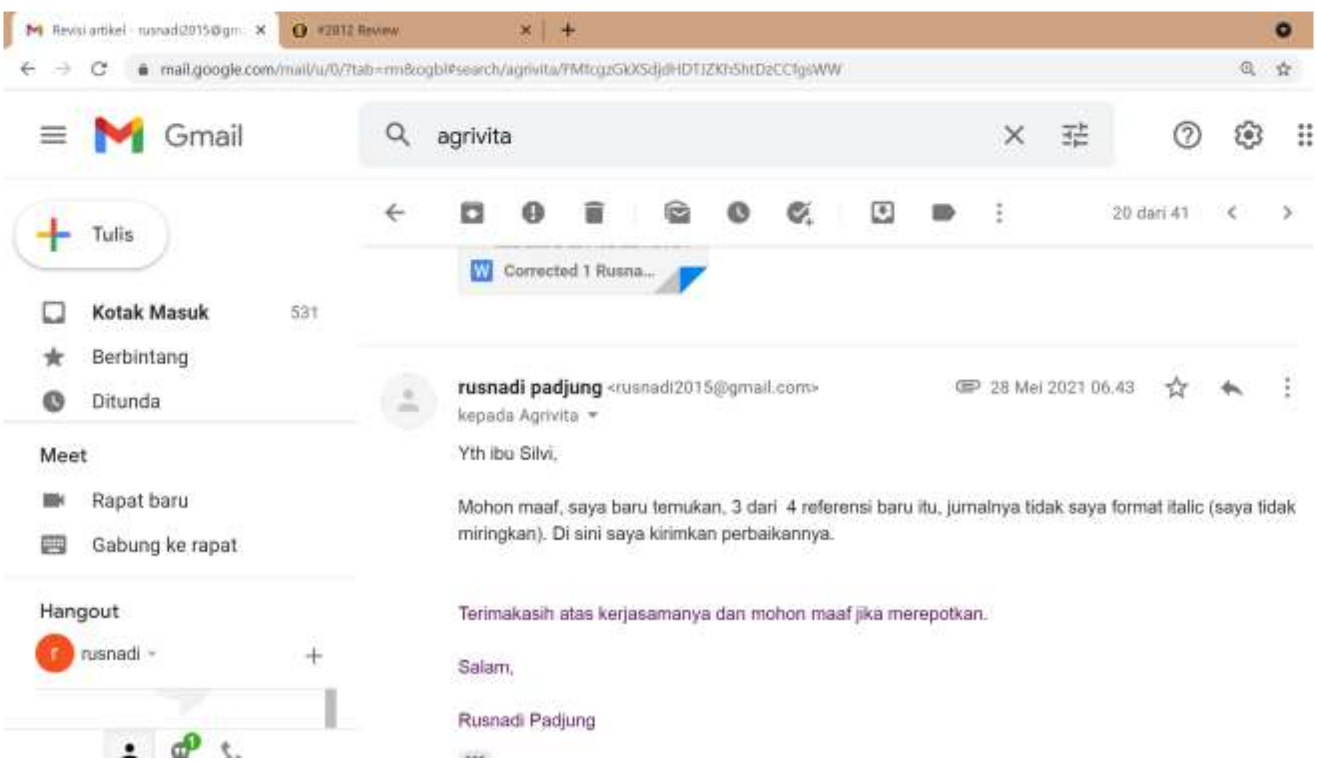
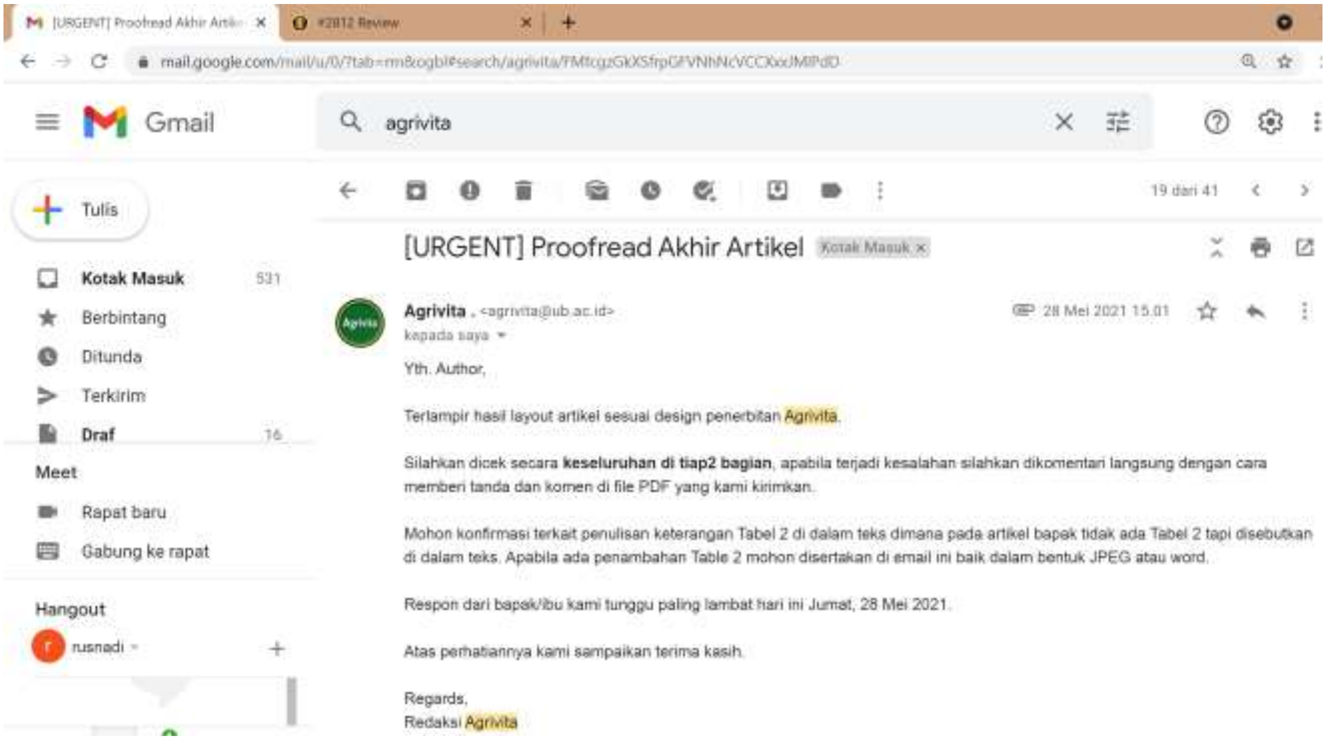
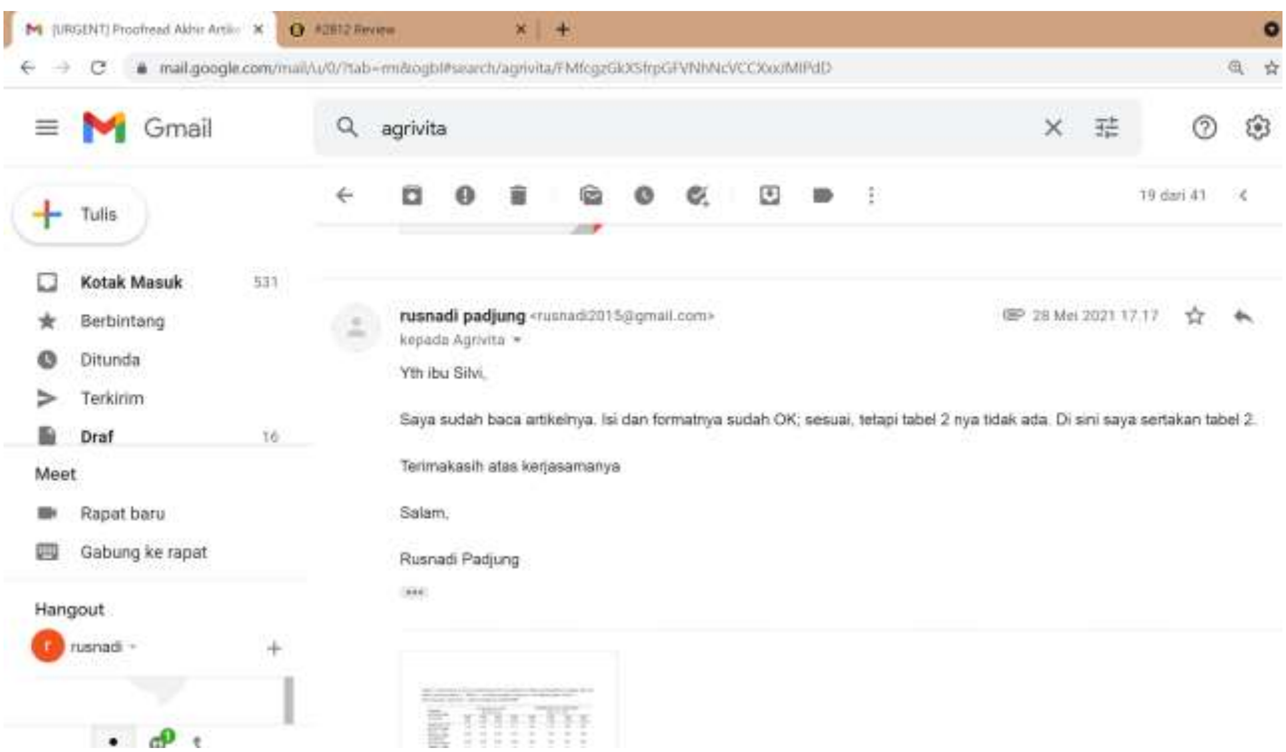


17. Email 28 Mei 2021 dari editor tentang Proofreading




18. Email 28 Mei 2021 dari Rusnadi berupa persetujuan format dan isi dan penambahan table 2 yang tercecer



**Editor's comments:**

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## COVER PAGE

**I. Photosynthetic Parameters of Two Indonesian Soybean Top Varieties**

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**V. Acknowledgement**

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# Photosynthetic Paramaters of Two Indonesian Soybean Top Varieties


## ABSTRACT

Each variety has its own photosynthetic parameters required to run crop growth model. The research is aimed at characterizing photosynthetic parameters particularly maximum photosynthesis and initial light use efficiency of two soybean varieties widely planted in Indonesia, *Dena-1* and *Anjasmoro* variety. Photosynthetic performances were measured in an experiment designed to study the effect of *Actinomycetes spp* on growth and yield of soybean. Photosynthesis was measured using an open chamber portable photosynthetic system (LI-6400), at variable Photosynthetically Active Radiation (PAR), i.e. 500; 1,000; 1,500; and 2,000 µ mol (photon) $m^{-2}$ $s^{-1}$. The photosynthetic light response curve (PN/I curve) was developed using Solver function of Microsoft Excel. Maximum gross photosynthesis (Pgmax) of *Dena-1* is 45.64 µmol ($CO_2$) $m^{-2}$ $s^{-1}$, while *Anjasmoro* variety is only 34.81 µmol ($CO_2$) $m^{-2}$ $s^{-1}$. Quantum yield at low light (initial light use efficiency) of *Dena-1* variety is also higher which is 0.068 µmol ($CO_2$) $µmol^{-1}$ (photons) compare to Anjasmoro 0.058 µmol ($CO_2$) $µmol^{-1}$ (photons). Hence light response curve of *Dena-1* variety is consistently higher than *Anjasmoro*. Under *Actinomycetes spp* treatment the light response curve is higher in *Dena-1* than in *Anjasmoro* at PAR lower than 706 µmol (photon) $m^{-2}$ $s^{-1}$ and higher at PAR above it.



## KEYWORDS

Actinomycetes spp., crop model, light efficiency, light response curve, maximum photosynthesis.


## INTRODUCTION

Crop growth models require plant parameters associated to characteristic of a variety to run the model. As a new variety is developed, a set of plant parameters associated to respected variety need to be characterized. Some of required parameters, particularly by detail crop models, are photosynthetic parameters. Radiation is a driving force for photosynthesis (Strada and Unger, 2016; Gu et al., 2017). Hence, the response of photosynthesis to change in radiation, or specifically Photosynthetic Photon Flux Density (PPFD) has a high significance in crop growth model. Such a response is well known as Photosynthetic Light Response Curve (Baly, 1935; Farquhar, 1980; Yin and Struik, 2009). There are two important parameters in the photosynthetic light response curve, i.e.: maximum photosynthesis (Pmax), and initial light use efficiency, and in some cases is light compensation point. Pmax is a rate of photosynthesis by which increase in PPFD will no longer increasing photosynthesis rate; and initial light use efficiency is the slope of photosynthetic rate to light intensity at low light. These parameters are characterized in two new soybean varieties widely planted in Indonesia.

*Anjasmoro* and *Dena-1* are two soybean varieties widely planted in Indonesia. *Anjasmoro* variety is preferred by farmers because it is suitable for *tempe* and *tofu* industry as it has yellow grain color, relatively big bean size (14.8 g – 15.3 g per 100 grains), and high protein content (37 – 43 %) (Ginting et al., 2009; Krisnawati and Adie, 2017). Yellow and big grain soybean (> 13 g/100 grains) are good for *tempe* as it would give good color and high recovery of *tempe*. Of about 2.4 million ton per year soybean demand in Indonesia, 83.7% are used for *tempe* and *tofu*. In addition to its good quality grain, *Anjasmoro* variety also resistant to major disease in soybean such as leaf rust, and it is logging resistant (Mahdiannoor et al., 2017). Leaf rust of soybean, caused by *Phakopsora pachyrhizi* may cause yield loss of 40% to 80%.

*Dena-1* variety was released in 2015 particularly as shaded tolerate variety. In addition to some good characters such as yellow color, big grain, high protein content, and resistant to leaf rust, *Dena-1* variety also tolerant to shading up to 50% of shading (Pratiwi and Artari, 2018). Hence, it is suitable for intercropping with young high estate crops, such as coconut, oil palm, and rubber. With large plantation area of those estate crops Indonesia, expansion of soybean crop to plantation area is promising. *Dena-1* variety, along with *Dena 2* variety as well, are considered as varieties suitable to be intercropped with young trees at community forest (Abidin, 2015)

Characterizing photosynthetic parameters of Dena-1 variety is also important to understand the physiological trait underlying the capacity of the variety to tolerate shading. More importantly, it will give physiological explanation up to which light condition this variety produce enough photosynthate for reasonable yield.

## MATERIALS AND METHODS

The experiment was conducted in Tarowang farm, owned by a smallholder farmer in Tarowang village, district of Takalar, South Sulawesi province, Indonesia from August to November 2017. Tarowang is located at $119^0$ $28^1$East and $5^0$ $39^1$ South with altitude of 15 m above sea level.

Photosynthetic performances were measured in an experiment designed to study the effect of *Actinomycetes spp* on growth and yield of soybean. Therefore the experimental design was Factorial Design, in which soybean varieties as first factor that consist of Dena-1 variety (V1) and Anjasmoro vatiety (V2), and the second factor is density of *Actinomycetes spp* that consist of no *Actinomycetes spp* (A0), *Actinomycetes spp* with concentration of $1x10^3$ CFU $mL^{-1}$ (A1), and *Actinomycetes spp* with concentration of $1x10^6$ CFU $mL^{-1}$ (A2). Each treatment combination was repeated three times and therefore there were 18 experimental units or plots in total. The plot size is 3 m x 4 m, and the soybeans were sowed in August 20, 2017 in a row of 20 cm x 40 cm with 2 seeds per hole. However, the photosynthetic measurements were not following this experimental design, but were taken at two contrasting *Actinomycetes spp* treatments of two varieties, i.e. no *Actinomycetes* and $1x10^6$ CFU $mL^{-1}$ *Actinomycetes* at Anjasmoro and Dena-1 varieties (W1A0, W1A2, W2A0, and W2A2).

The photosynthetic measurement was taken in October 15, 2017 using an open chamber portable photosynthetic system (LI-6400, LI-COR, Inc., Logan, NE, USA). Mature leaf exposed to full sunlight was flipped to the chamber. The size of the chamber used, or the area of leaf flipped in the chamber, is 2 cm x 3 cm, or $6m^2$. To develop a light response curve, the photosynthesis was measured at variable Photosynthetically Active Radiation (PAR), i.e. 500; 1,000; 1,500; and 2,000 µ mol (photon) $m^2$ $s^{-1}$. Environment conditions during experiments were as follows: air temperature – 25-27 $^oC$; block and leaf temperature – 25-27 °C; air flow rate – 500 µmol $s^{-1}$; $CO_2$ concentration in sample cell – 380–400 µmol $CO_2$ $mol^{-1}$; and relative humidity in sample cell – 56-70 %. The measurements are repeated three times (once for each experimental unit). In each replication the system run for 5 second, and the data were registered every second, and therefore there are 15 data set available for each PAR level, or 60 data set for all replications and PAR levels. The parameters used are photosynthetic rate (Pn) (µmol CO2 $m^{-2}s^{-1}$), intercellular $CO_2$ concentration(Ci) (µmol $CO_2$ mol $air^{-1}$), and conductance to H2O (mol H2O $m^{-2}$ $s^{-1}$)

The photosynthetic light response curve (PN/I curve) was developed using Solver function of Microsoft Excel to fit it to the model suggested by Labo, et. al. (2013). The Solver function fit the function by finding the least sum of square difference between data and model.

## RESULTS AND DISCUSSION

Photosynthetic light response curves of Arjasmoro and Dena-1 varieties are shown in Figure 1. Under normal condition or no *Actinomycetes* the curve of Dena-1 variety is higher than that of Anjasmoro (Figure 1.a.). This indicates that Dena-1 variety responses better than Anjasmoro variety to light, as it has higher initial light use efficiency as well as higher maximum photosynthesis.

Maximum gross photosynthesis (Pgmax) of Dena-1 is 45.64 μmol (CO2) $m^{-2}$ $s^{-1}$, while Anjasmoro variety is only 34.81 μmol (CO2) $m^{-2}$ $s^{-1}$ (Table 1). Along with high maximum photosynthesis, quantum yield at low light (initial light use efficiency) of Dena-1 variety is also higher which is 0.068 μmol ($CO_2$) μmol-1 (photons) compare to Anjasmoro 0.058 μmol ($CO_2$) μmol-1 (photons). Such a difference explains why Dena-1 variety is more tolerant to shading than Anjasmoro variety. As reported by Pratiwi and Artari (2018). Dena-1 variety is tolerant shading up to 50%. Quantum yield of Dena-1 variety both at light compensation point (ϕ(Icomp)) and at light between compensation point to 200 (ϕ(Ic-I200)) is higher (0.07 and 0.05 μmol (CO2) μmol-1 (photons)) than quantum yield of Anjasmoro variety (0.06 and 0.04 μmol (CO2) μmol-1 (photons)) (Table 1). In another word, photosynthesis at Dena-1 variety still occurs at acceptable rate even under low light or under shading.

Along with high maximum gross photosynthesis, initial light use efficiency, and quantum yield, the light saturation point of Dena-1 variety is consistently higher at percentile 50 % all the way up to 95% than that of Anjasmoro variety. Light saturation point at 50% percentile of Dena-1 variety is 667 μmol (photons) $m^{-2}$ $s^{-1}$, while Anjasmoro is 603 μmol (photons) $m^{-2}$ $s^{-1}$. At 95 percentile, the light saturation point of Dena-1 variety is 6,004 μmol (photons) $m^{-2}$ $s^{-1}$, while Anjasmoro variety is 5,429 μmol (photons) $m^{-2}$ $s^{-1}$ (Table 2). High light saturation point indicates that Dena-1 varieties is not only tolerant to shading but also tolerant to high light. In another word, increase in light intensity can be accommodated by Dena-1 variety due to high capacity of its photosynthetic apparatus.

The photosynthetic light response curves of these two varieties change under Actinomycetes treatment. Under such condition the curve of Dena-1 variety is higher than that of Anjasmoro at the beginning or at low light but then as light increase, the quantum yield is decreasing at a rate faster in Dena-1 than in Anjasmoro such that Dena-1 curve is surpassed by Anjasmoro curve at PAR 706 μmol (photon) $m^{-2}$ $s^{-1}$ (Figure 1.b.). In another word, the photosynthetic light-response curve of Dena-1 variety is higher than Anjasmoro at PAR below 706 μmol (photon) $m^{-2}$ $s^{-1}$, but it is the other way round at PAR above 706 μmol (photon) $m^{-2}$ $s^{-1}$. Intial light use efficiency of Dena-1 variety is higher (0.096 μmol ($CO_2$) $\mu mol^{-1}$ (photons)) than Anjasmoro variety (0.058 μmol ($CO_2$) $\mu mol^{-1}$ (photons)). In contrast, the maximum photosynthesis ($P_{gmax}$) is lower in Dena-1 variety (33.03 μmol ($CO_2$) $m^{-2}$ $s^{-1}$) then in Anjasmoro variety (48.77 μmol ($CO_2$) $m^{-2}$ $s^{-1}$) (Table 1). This indicates that Anjasmoro variety responses better to *Actinomycetes spp* variety than Dena-1 variety such that additional nutrient from *Actinomycetes spp* can be converted well into increase in the capacity of photosynthetic apparatus. With an increase in capacity of photosynthetic apparatus, photosynthesis rate increases along with increase in light, and so increase in light saturation point, and maximum photosynthesis (Table 1). Hence, the rate of decrease in quantum yield from light compensation point ($I_c$) to $I_{200}$ is much higher in Dena-1 variety than in Anjasmoro variety, i.e. 40 % (from 0.10 to 0.04) vs 17% (from 0.06 to 0.05).

*Actinomycetes spp.* play an important role in soil nutrient cycling (Elliot and Lynch, 1995), solubilize inorganic phosphates (Ghorbani-Nasrabadi et al., 2013), hydrolyze phytate, a dominant form of organic P in soils (Ghorbani-Nasrabadi et al., 2012), and so improve the availability of nutrients (Bhatti et al., 2017) particularly phosphorus. Phosphorus (P) is required in many compounds in cells and organelles that are closely associated with energy transfer (Rychter and Rao, 2005). Anjasmoro variety seems response better than Dena-1 variety to *Actinomycetes spp* treatment such that more phosphorus is available for energy transfer in the photosynthetic system that in turn increase the capacity of photosynthetic metabolism to accommodate light (PAR) increase. Mahdiannoor et al. (2017) reported that growth and yield responses of *Anjasmoro* variety are much higher than local soybean variety to bio-fertilizer application. Similar result was also found by Maysaroh (2018) that *Anjasmoro* variety responded better than *Dena-1* variety to NPK fertilizer in term of plant height, biomass weight, number of pods, weight of 100 seeds, and yield.

Beside the limitation by energy transfer, photosynthesis at high light is apparently also limited by the availability of $CO_2$ as can be indicated by conductance to $H_2O$ and internal $CO_2$ concentration. Under normal condition or no Actinomycetes treatment, Dena 1 variety has higher conductance (2.28 mol $H_2O$ $m^{-2}$ $s^{-1}$) than Anjasmoro variety (2.09 mol $H_2O$ $m^{-2}$ $s^{-1}$) and it increases faster with the increase of PAR from 500 to 2,000 µmol (photon) $m^{-2}$ $s^{-1}$. Along with this increase, internal $CO_2$ concentration in Dena 1 variety decreae at a rate slower than in Anjasmoro variety (Table 2). This indicates that stomata of Dena 1 variety is more resilient to keep the internal $CO_2$ concentration higher than Anjasmoro variety as a demand for $CO_2$ increase

It has been known widely that light affect stomatal opening, and so leaf conductance. The effect of light to the stomatal response is mainly`through a direct response and is only a small extent through change in intercellular CO2 concentration (Sharkey, and Raschke, 1981). Sharkey and Raschke (1981) demonstrated a high difference on stomatal response to light between *Xanthium stumarium* L., *Gossypium hirsutum* L., *Phaseolis vulgaris* L., and *Perilla frutescens* (L.), Britt. McAusland et al. (2016) also reported a significant variation in the rapidity of stomatal responses amongst species to light change. For soybean, Bunce (2016) found 15 cultivars differed significantly in stomatal conductance.

Unlike at normal condition, under *Actinomycetes spp*. treatment, the decrease in internal $CO_2$ concentration due to light increase in Dena 1 variety is faster than Anjasmoro. This is brought about by high response of Anjasmoro variety to *Actinomicetes spp.* than Dena 1 variety. As discussed earlier, Anjasmoro variety responses better to soil fertilization than Dena 1 variety.

## CONCLUSIONS

Initial light use efficiency and maximum photosynthesis of Dena 1 variety is 0.068 µmol (CO2) $\mu mol^{-1}$ (photons) and 45.64 µmol (CO2) $m^{-2}$ $s^{-1}$ respectively. while Anjasmoro variety is 0.068 µmol (CO2) $\mu mol^{-1}$ (photons) and 34.81 µmol (CO2) $m^{-2}$ $s^{-1}$ respectively. High initial light use efficiency of Dena-1 could be one of the reasons that made Dena 1 variety tolerant to shading. Responses of stomatal conductance and internal $CO_2$ concentration to light is higher in Anjasmoro than in Dena 1 variety.

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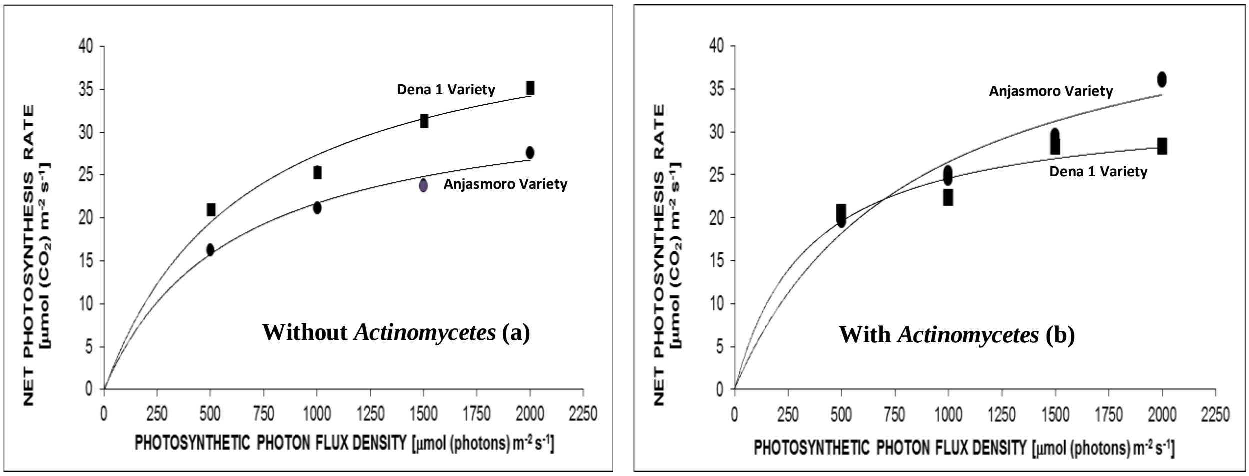


Figure 1. Photosynthetic light response curve of Dena-1 and Anjasmoro variety under normal condition (a), and under Actinomycetes treatment (b).

**Without *Actinomycetes* (a)**

The following are the  editable graph for Figure 1.

Figure 1.a. Without Actinomycetes

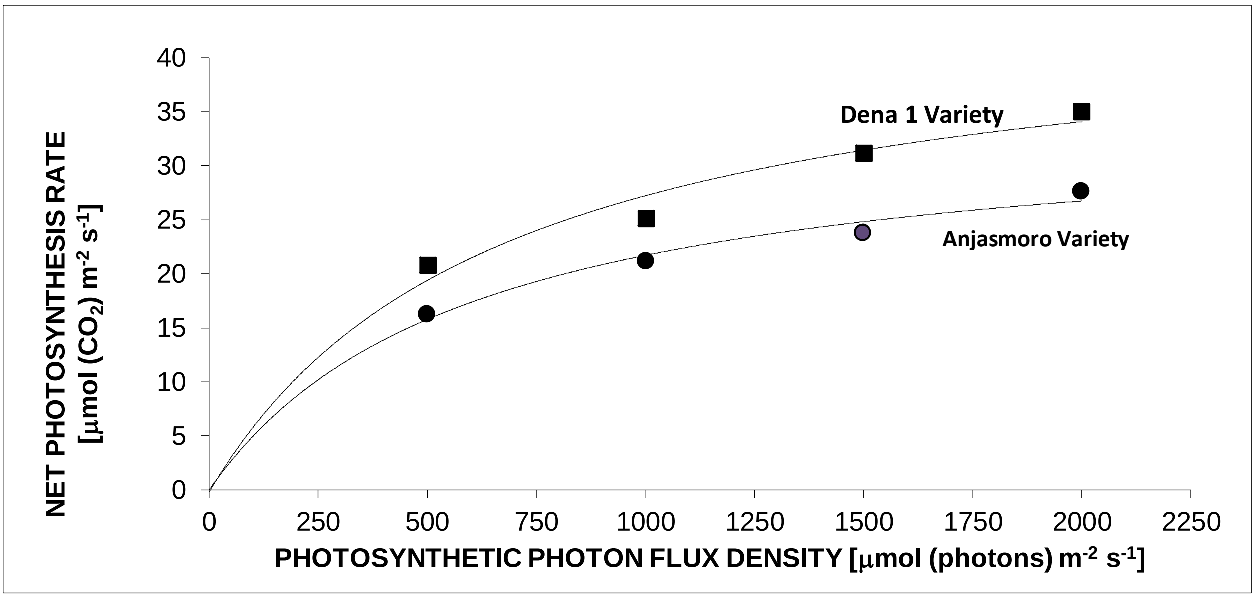


Figure 1.b . With Actinomycetes

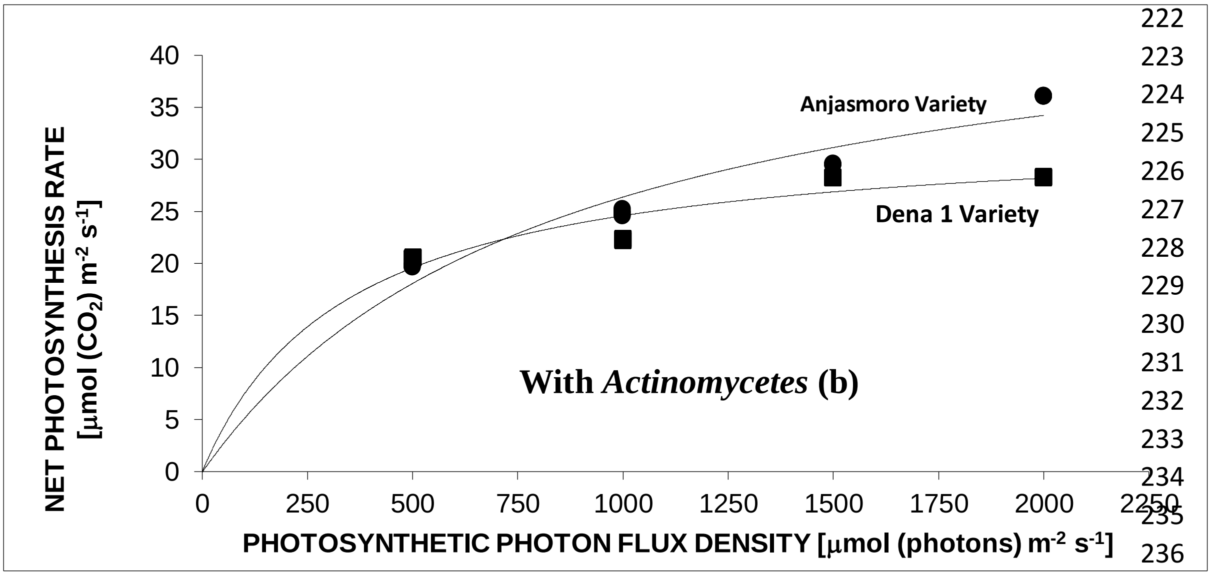

Table 1. Light response curve related parameters of Dena 1 and Anjasmoro varieties with and without Actinomycetes, i.e. Dena-1 – no Actinomycetes, Anjamoro – no Actinomycetes, Dena-1 – Actinomycetes, Anjasmoro - Actinomycetes.

| Varieties and Actinomycetes Tratments | Standard Parameters | | Light saturation point at | | | | Light-saturated net $CO_2$ uptake | Quantum yield at | |
|---|---|---|---|---|---|---|---|---|---|
| | Maximum Photosynthesis | quantum yield at I = 0 | 50 percen-tile | 85 percen-tile | 90 percen-tile | 95 Percent-tile | | light compensation point | LCP to I = 200 |
| | $P_{gmax}$ | ϕ(Io) | $I_{sat(50)}$ | $I_{sat(85)}$ | $I_{sat(90)}$ | $I_{sat(95)}$ | PN($I_{max}$) | ϕ(Icomp) | ϕ(Ic-I200) |
| | (µmol ($CO_2$) $m^{-2}$ $s^{-1}$) | (µmol ($CO_2$) $µmol^{-1}$ (photons)) | (µmol photons) $m^{-2}$ $s^{-1}$) | (µmol (photons) $m^{-2}$ $s^{-1}$) | (µmol (photons) $m^{-2}$ s-1) | (µmol (photons) $m^{-2}$ $s^{-1}$) | (µmol ($CO_2$) $m^{-2}$ $s^{-1}$) | (µmol ($CO_2$) $µmol^{-1}$ (photons)) | (µmol ($CO_2$) $µmol^{-1}$ (photons)) |
| Anjasmoro – No Actinomycetes | 34.81 | 0.058 | 603.26 | 3,418.47 | 5,429.33 | 11,461.92 | 26.59 | 0.06 | 0.04 |
| Dena-1 – No Actinomycetes | 45.64 | 0.068 | 667.17 | 3,780.66 | 6,004.57 | 12,676.32 | 34.01 | 0.07 | 0.05 |
| Anjasmoro - Actinomycetes | 48.77 | 0.058 | 843.63 | 4,780.60 | 7,592.71 | 16,029.06 | 34.04 | 0.06 | 0.05 |
| Dena-1 – with Actinomycetes | 33.03 | 0.096 | 343.41 | 1,945.97 | 3,090.66 | 6,524.73 | 28.09 | 0.10 | 0.06 |

Table 2. Conductance to H2O and Intercellular CO2 concentration of Dena and Anjasmoro varieties with and without Actinomycetes, i.e. Dena-1 – no Actinomycetes, Anjamoro – no Actinomycetes, Dena-1 – Actinomycetes, Anjasmoro – Actinomycetes at variable PAR

| Varieties - Actinomycetes Tratments | Conductance to $H_2O$ mol $H_2O$ $m^{-2}s^{-1}$ | | | | Intercellular $CO_2$ Concentration µmol $CO_2$ $mol^{-1}$ | | | |
|---|---|---|---|---|---|---|---|---|
| | PAR 500 | PAR 1,000 | PAR 1,500 | PAR 2,000 | PAR 500 | PAR 1,000 | PAR 1,500 | PAR 2,000 |
| Anjasmoro – No Actinomycetes | 2.09 | 3.52 | 2.29 | 3.01 | 316 | 314 | 295 | 286 |
| Dena-1 – No Actinomycetes | 2.28 | 2.70 | 3.50 | 3.00 | 327 | 318 | 315 | 305 |
| Anjasmoro - Actinomycetes | 3.92 | 3.46 | 3.82 | 4.08 | 323 | 312 | 301 | 294 |
| Dena-1 – with Actinomycetes | 2.90 | 1.59 | 2.34 | 1.72 | 321 | 306 | 299 | 292 |

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