Effectivity of *Pseudomonas fluorescens* TBT214 in increasing soybean seed quality in different seed vigor

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**Abstract:** The research aims to assess *P. fluorescens* TBT214 as biopriming to increase seeds quality. Research conducted in Field Laboratory, Faculty of Agriculture, Halu Oleo University. Research arranged in randomized block designs. The first factor is the level of seed vigor consisting of 2 levels: V1= low vigor seeds (60-65% germination rate), and V2=high vigor seeds (86-100% germination rate). The second factor is the seed bio-invigoration technique which consists of 6 levels: B0=without seed bio-invigoration (control), B1=KNO3 1%, B2= KNO3 1% + *P. fluorescens* TBT214, B3= *P. fluorescens* TBT214, B4= *P. fluorescens* TBT214 + red brick powder, B5= *P. fluorescens* TBT214 + husk charcoal powder. (B5). So that obtained 12 treatment combinations. The variables observed in this study were (1) The total number of pods, (2) The number of filled pods, (3) the weight of 1,000 grains (g), and (4) Grain production (ton ha-1). The results showed that biopriming treatment could improve seed quality in seeds with low vigor levels or seeds with higher vigor. Increasing seed quality resulted in the high potential of pod production, the weight of 1,000 grain seeds, and yield. It can conclude that the biopriming treatment can improve the quality of seeds, both seeds with low vigor and seeds with high vigor.

1. Introduction

Soybean (*Glycine max* L. Merrill) in Indonesia is a vital commodity in supplying food [1-2], mainly as a source of vegetable protein [3]. Soybean especially consumed as a source of protein [4], minerals [5], vitamins [6], fat [7] and energy [8]. Many processed products food using soybean as raw material, such as soy milk, tofu [9, 10], tempeh [11], and sauce [12]. Soybean has an essential role in public health and supplying nutritive food [13].

The demand for soybean increases every year for direct consumption or industrial food [13]. The soybean consumption level in Indonesia still low and yearly only reached 10.20 kg per capita. While the soybean production capacity in 2018 only 982,598 tons [14], and cannot fulfill the soybean requirement. The soybean imports in 2018 reached 1.2 million tons.

The efforts to boosting soybean production in Indonesia included through extensification and intensification program. One of the problems in increasing soybean production is limited the availability of seed of high quality. The seed quality is the main factor in the cultivation of soybean to produce maximum [15]. Another alternative to increase seed quality is using *Pseudomonas fluorescens* TBT214 as priming seed [16]. Bio-priming is a seed hydrate using biological compounds...
such as rhizobacteria [17, 18] effective to increase seed quality of hot pepper [19], upland rice [20, 21], onion [22, 23] and shallots [24].

Rhizobacteria who live in soil, rhizosphere can act as plant growth promoters and nutrient cycling and could increase the seed viability and vigor of cocoa [25], rice [26, 27]. Many researchers showed that rhizobacteria could promote growth and yield [28]. Other results also showed that the bioprimer technique could increase the growth and yield of maize [29], okra [30], onion [31] and areca nut [32, 33]. Besides could alleviate salt stress [34] and drought [35] This research aimed to increase soybean seed quality with indigenous biological agents *P. fluorescens* TBT214.

2. Materials and methods

Soybean seeds variety Anjasmoro received from Food and Horticultural Seed Certification, Southeast Sulawesi Province, with two levels of seed vigor: low vigor (germination capacity of 60-65%) and high vigor (germination rate of 86-100%). *P. fluorescens* TBT214 isolate was grown on solid media King's B and incubated for 48 hours. Growing bacterial colonies were suspended in sterile aquades to a population density of 10^9 cfu ml^-1, while for KNO3 used with a concentration of 1% as much as 1 g KNO3 is suspended in 100 ml of sterile distilled water and ready for use.

Soybean seeds were then put into bacterial suspension and 1% KNO3 suspension according to invigoration treatment at different levels of seed vigor B1=KNO3 1%, B2= KNO3 1% + *P. fluorescens* TBT214, B3= *P. fluorescens* TBT214 + red brick powder, B4= *P. fluorescens* TBT214 + red brick powder, B5= *P. fluorescens* TBT214 + husk charcoal powder. (B5). So that obtained 12 treatment combinations. Every treatment was repeated three times, and there are 24 experimental units. The variables observed in this study were (1) The total number of pods, (2) The number of filled pods, (3) the weight of 1000 grains (g) and (4) Grain production (ton ha^-1). Research data were tested using variance (ANOVA) analysis and further analyses using DMRT (Duncan Multiple Range Test) on α = 0.05.

3. Results and discussion

3.1 Seed vigor

The analysis of variance showed that seed invigoration treatment at different levels of seed vigor has significantly affected the number of pods, number of filled pods, 1,000 grain weights, and soybean grain yield (table 1-4). The results showed that invigoration treatment could increase the total number of pods, both for seed with low vigor and high vigor (table 1). The highest number of pods was due to invigoration treatment found on *P. fluorescens* TBT214 + red brick powder (B4), both for seeds with low and high vigor. The number of pods on low seed vigor was 70.40 pods and on the high vigor was 75.60 pods.

![Table 1. Effect of interaction of vigor level and seed bio-invigoration techniques on the total number of soybean pods.](image-url)
Invigoration Treatment | Level of Seed Vigor | 
|-----------------------|------------------| 
|                        | Low ($V_1$)      | High ($V_2$)       | 
| B$_4$                 | 70.40 ± 1.51 bP  | 75.60 ± 0.40 aP   | 
| B$_5$                 | 63.87 ± 1.03 bR  | 72.43 ± 1.40 aP   | 

Note: The numbers followed by the same letters are not significantly different in the DMRT test at $\alpha = 0.05$.

The highest number of filled pods due to invigoration treatment was also found on $P. \text{fluorescens}$ TBT214 + red brick powder (B4), both for seeds with low and high vigor. The number of filled pods on low seed vigor was 64.20 pods, and on the high vigor was 73.13 pods (table 2).

**Table 2.** Effect of interaction of vigor level and seed bio-invigoration techniques on the total number of soybean filled pods.

| Invigoration Treatment | Level of Seed Vigor | 
|-----------------------|---------------------| 
|                        | Low ($V_1$)         | High ($V_2$)        | 
| B$_0$                 | 44.33 ± 1.50 bR     | 54.64 ± 0.98 aT    | 
| B$_1$                 | 46.67 ± 2.48 bR     | 62.73 ± 1.86 aS    | 
| B$_2$                 | 62.03 ± 0.67 bPQ    | 65.40 ± 0.40 aR    | 
| B$_3$                 | 58.20 ± 1.60 bQ     | 71.13 ± 2.23 aPQ   | 
| B$_4$                 | 64.20 ± 1.71 bP     | 73.13 ± 0.46 aP    | 
| B$_5$                 | 60.00 ± 0.40 bQ     | 69.67 ± 1.10 aQ    | 

Note: The numbers followed by the same letters are not significantly different in the DMRT test at $\alpha = 0.05$.

The invigoration technique influences the weight of 1000 grain. In seed with a low level of vigor ($v_1$), the highest BSB found in the rhizobacterial treatment of $P. \text{fluorescens}$ TBT214 (B3). While the seeds with an increased vigor found in the treatment of $P. \text{fluorescens}$ TBT214 rhizobacteria + red brick powder (B4). The highest BSB at $v_1$ was 161.63 g and at $v_2$ it was 183.80 (table 3).

**Table 3.** Effect of interaction of vigor level and seed bio-invigoration techniques on the weight of 1000 grain.

| Invigoration Treatment | Level of Seed Vigor | 
|-----------------------|---------------------| 
|                        | Low ($V_1$)         | High ($V_2$)        | 
| B$_0$                 | 131.60              | 142.70               | 
| B$_1$                 | 142.30              | 159.60               | 
| B$_2$                 | 145.03              | 159.33               | 
| B$_3$                 | 161.63              | 162.13               | 
| B$_4$                 | 150.70              | 183.80               | 
| B$_5$                 | 150.63              | 176.03               | 

Note: The numbers followed by the same letters are not significantly different in the DMRT test at $\alpha = 0.05$.

Invigoration techniques have an effect on soybean production in both low and high vigor seeds. The results showed that soybean production was higher in seeds that gave biopriming treatment than no treatment. In low-seeded seed, the treatment with $P. \text{fluorescens}$ TBT214 (B3) biopriming, the effect was higher than other priming treatments. The seed with high levels of vigor, treatment with $P. \text{fluorescens}$ TBT214 rhizobacteria + red brick powder (B4), gave the highest yield compared to other treatments. Interaction of vigor level and seed bio-invigoration techniques on the grain yield (ton ha$^{-1}$) can be seen in the table 4.
Table 4. Effect of interaction of vigor level and seed bio-invigoration techniques on the grain yield (ton ha$^{-1}$).

| Invigoration Treatment | Level of Seed Vigor | Low ($V_1$) | High ($V_2$) |
|------------------------|---------------------|-------------|-------------|
| B0                     | low ($V_1$)         | 1.48 ± 0.06 bQ | 1.86 ± 0.02 aS |
| B1                     | high ($V_2$)        | 1.48 ± 0.08 bQ | 1.92 ± 0.05 aS |
| B2                     | low ($V_1$)         | 1.97 ± 0.03 bP | 2.18 ± 0.09 aS |
| B3                     | high ($V_2$)        | 2.00 ± 0.04 bP | 2.29 ± 0.06 aS |
| B4                     | low ($V_1$)         | 1.95 ± 0.02 bP | 2.41 ± 0.06 aP |
| B5                     | high ($V_2$)        | 1.99 ± 0.03 bP | 2.36 ± 0.10 aP |

Note: The numbers followed by the same letters in the same row and column are not significantly different.

3.2. Discussion

The results showed that biopriming treatment could improve seed quality in seeds with low vigor levels or seeds with high vigor. Increasing seed quality resulted in the high potential of pod production, the weight of 1,000 grain seed, and yield. In general, biopriming treatment with carrier materials such as brick powder and charcoal effectively improves seed quality. While in seeds with low vigor, the biopriming treatment without carrier material is more effective in increasing seed quality.

4. Conclusion

It can conclude that the biopriming treatment can improve the quality of seeds, both seeds with low vigor and seeds with high vigor. Seed invigoration techniques using P. fluorescens TBT214 rhizobacteria are very effective in improving seed quality. In low vigor seeds, invigoration treatment without a carrier is more effective. While in seeds with high vigor, administration of a carrier can increase P. fluorescens TBT214.

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