Response of loquat seedling growth to interaction between fertilizers and plant growth regulators

Muhammad Imam Surya¹, Vandra kurniawan¹, Dwinda Mariska Putri¹, Lily Ismaini¹, Suluh Normasiwi¹

¹Research Center for Plant Conservation and Botanic Gardens-Indonesian Institute of Sciences, Kebun Raya Cibodas-LIPI, Cipanas-Cianjur 43253, Indonesia

muhammad.imam.surya@lipi.go.id

Abstract. Loquat is an important commercial crop in several countries. Seedling growth was affecting the production of loquat. Fertilizers and plant growth regulators was an important factors to obtain the high quality seedling. This experiment aimed to determine the effects of fertilizers and plant growth regulators on loquat seedling growth. Two doses of compound fertilizers (5 and 10 gram/polybag) with two times of application and three types of plant growth regulators (naphthalene acetic acid/auxin, gibberellic acid/gibberellin, benzylaminopurine/cytokinin) with four doses (0, 25, 50, 100 ppm) were applied to the seedling of loquat. Fifteen parameters i.e. plant height, number of mature and young leaves, number of buds, stem diameter, roots length, leaf surface area of mature and young leaves, fresh and dry weight of leaves, stem, and roots, and total biomass were observed during the experiment. Twenty combination treatments between fertilizers and plant growth regulators gave difference response on loquat seedling. In general, the best treatment is the combination between 5 gr/pot of fertilizers and 100 ppm of cytokinin. Although fertilizers was not significantly affecting the loquat seedling growth, and plant growth regulators was affecting some parameters, the interactions of fertilizers and plant growth regulators was significantly affecting the loquat seedling growth, and almost all parameters has correlated. Our recommendation, the application of plant growth regulators during seedling growth was more effective and efficient than fertilizers.

Key words: seedling, eriobotrya, fertilizers, cytokinin

1. Introduction

Loquat (Eriobotrya japonica Lindl) is indigenous to China and possibly southern Japan. The fruit contains sucrose and malic acid and lesser amounts of citric, tartaric and succinic acid. The pulp contains the carotenoids B-carotene (33%); y-carotene (6%); cryptoxanthin (22%), lutein, violaxanthin, neoxanthin (3-4% each) [1]. Loquat also well-known as a medicinal plant in Japan and China. Its astringent leaves have been used a long time to treat chronic bronchitis, coughs, phlegm, high fever and gastroenteric disorder [2]. In Indonesia, loquat is found in the highland of North Sumatra. It has economic potential and specific market for Chinese ethnic, but not widely cultivated yet [3]. Traditionally, the problem existed that limiting the propagation of loquat varieties is that seed reproduction takes too long juvenescent phase [4]. The importance of fast-growing cultivation techniques of loquat seedlings has not been paid enough attention. However, the data and information
about seedling of loquat in Indonesia are still limited especially about the effective and efficient use of fertilizer and PGRs.

Fertilizer plays an important role in promoting the initial growth and improving the quality of plant [5]. Nitrogen (N), Phosphate (P) and Kalium (K) was an essential macro nutrients for plant growth. The main functions of N and P are that they are constituents of proteins and nucleic acids, which are important components of plant tissue. K is the only nutrient that is not a constituent of organic plant compounds, but is mainly of importance in the regulation of processes in the plant, such as osmosis and enzyme activities. [6] found that superphosphate promoted the height and stem diameter of plants to the greatest extent after 30 d of transplanting. There was a trend of increase in plant height and leaf area with addition of nitrogen [7]. [8] reported that the most significant changes of loquat rootstock seedlings under fertilization (NPK) were plant height and stem diameter. The diameter of main stem is the primary factor to measure the growth and quality of rootstock seedling [9,10].

Plant growth regulators (PGRs) also influences the development of plants and are generally active at very low concentrations. In particular, PGRs are known to regulate axillary bud growth. Cytokinins (BA), auxin (IAA) and gibberellic acid (GA3) are the important growth regulators. Cytokinins are a class of plant growth regulators involved in many processes of plant growth, including cell division and shoot and root morphogenesis. [11] reported that cytokinin enhances number of shoots, number of leaves, shoot length, fresh and dry weights on loquat cultivar. Auxins have a cardinal role in coordination of many growth processes in a plant’s life cycle and are essential for plant root development [12]. Gibberellic acid application to the shoot enhances both shoot and root elongation [13].

The application of fertilizer and PGR are expected to improve the quality of loquat seedlings. This research was aimed to determine the effect of fertilizer and PGR on seedling growth of loquat.

2. Material and methods
The study was conducted on August 2019 to July 2020 at the green house and laboratory of Cibodas Botanical Garden-Indonesian Institute of Sciences. The seedlings of loquat were obtained from seed propagation on November 2018. After nine months, the seedlings were transplanted to the new polybag that containing humus and burnt husk (1:1). Three types of PGRs i.e. NAA (naphthalene acetic acid/auxin), GA3 (gibberellic acid/gibberellin) and BA (benzylaminopurine/cytokinins), with four different concentrations 0 ppm (control), 25 ppm, 50 ppm and 100 ppm were applied one time to the seedling of loquat in five weeks after transplanted by spraying into the leaves. Furthermore, compound fertilizers with three major nutrients compositions (16% N: 16% P: 16% K) were used during the experiment. Two doses of compound fertilizers (5 and 10 gram/polybag) with two times of application (7 and 21 weeks after transplanted) were applied. Fifteen parameters i.e. plant height (PH), number of young leaves (YL), number of mature leaves (ML), number of bud (NB), stem diameter (SD), roots length (RL), leaf surface of mature leaves (LSML), leaf surface of young leaves (LSYL), fresh weight of stem (FWS), fresh weight of leaves (FWL), fresh weight of roots (FWR), dry weight of stem (DWS), dry weight of leaves (DWL), dry weight of roots (DWR), total biomass (TB) were used to see response of loquat seedling on fertilizers and plant growth regulators. Moreover, data were analyzed using SPSS 16.0. Differences between treatments groups were analyzed using an analysis of variance and continue with DMRT test. The correlations between parameters were evaluated using the Pearson coefficient.

3. Results and discussions
3.1. Effect of fertilizer on loquat seedling growth
Plant nutrient through the application of fertilizer is one of the most important aspect for high yield, plant growth and development. Based on our results, it is shown in Figure 1 that no significant differences between 5 gr/pot and 10 gr/pot of compound fertilizer treatments. The mean value of 5
gr/pot was higher than 10 gr/pot in all parameters except number of bud. Fertilizer application is carried out in such a way to replenish the planting media or soil nutrient levels removed during the growth and to optimally maintain the physiological health of the plant. Moreover, some type of compound fertilizer are might be slow-release. [8] suggested that slow-release fertilizer is beneficial to N accumulation and chlorophyll synthesis in loquat leaves, the balanced fertilizer showed greatest promotion on leaf growth, while our results showed that adding compound fertilizers during seedling growth was not significant. In the other hand, [14] reported that for young or juvenile loquat, fertilizer is applied every two months. A month after planting, it was applied 113 g per tree of fertilizer with 6-6-6 (6% nitrogen, 6% phosphate, 6% potassium), which is 20-30% of the nitrogen should come from organic sources. In the opposite results, [15] reported that the dose of 10 kg m⁻³ of the controlled-release fertilizer promotes the best responses for most of the variables related to loquat seedlings growth and quality. It is also possible to infer that loquat can still respond to higher doses of fertilizer. However, our results have shown differences with [15]. It might be due to our compound fertilizers was slow-release and the nutrient from the combination media (humus + roasted husk) was able to support the seedling growth. Refer to our results 5 gr per polybag was sufficient for loquat seedling growth, it means that compound-fertilizer application more than 5 gr per polybag will be not effective or efficient or seedling growth.

![Figure 1](image.png)

**Figure 1.** Effect of fertilizers on loquat seedling growth

### 3.2. Effect of plant growth regulators on loquat seedling growth

Plant hormones play an important role in the regulation of plant growth and development. Plant growth regulators is a simple chemicals produced naturally by plants to regulate their growth and development. Moreover, it can also be a synthetic plant hormone. There are nine major classes i.e. abscisic acid, auxin, benzoates, brassinosteroids, cytokinins, ethylene, jasmonic acid gibberellins, and strigolactones [16]. As show in Table 1, almost all parameters was significant except number of bud, roots length, fresh weight of roots and leaf surface of mature leaves. The highest response on PGR was shown by cytokinin treatment on 50 ppm and 100 ppm. In general, the treatment of cytokinin was able to increase the total biomass, plant height, stem diameter, number of leaves, and leaf surface of loquat seedling. [17] reported that cytokinin have been shown to have effects on many other physiological and developmental processes, including leaf senescence, nutrient mobilization, apical dominance, the formation and activity of shoot apical meristems, floral development, the breaking of bud dormancy, and seed germination.
Table 1. Effect of plant growth regulators on loquat seedling growth

| Parameters                | Control | Auxin 25 ppm | Auxin 50 ppm | Auxin 100 ppm | Cytokinin 25 ppm | Cytokinin 50 ppm | Cytokinin 100 ppm | Gibberellin 25 ppm | Gibberellin 50 ppm | Gibberellin 100 ppm |
|---------------------------|---------|---------------|--------------|---------------|------------------|------------------|-------------------|---------------------|-------------------|---------------------|
| Plant height              | 30.76 ab| 35.29 ab      | 23.96 a      | 41.17 b       | 29.00 a          | 42.48 b          | 40.87 b           | 26.81 a             | 32.10 ab          | 27.62 a             |
| Young leaves              | 1.53 ab | 2.29 b        | 2.08 ab      | 1.83 ab       | 1.08 a           | 1.00 a           | 1.17 ab           | 1.29 ab             | 1.29 ab           | 1.17 ab             |
| Mature leaves             | 10.89 ab| 11.58 ab      | 9.58 a       | 10.33 a       | 8.67 a           | 10.92 ab         | 14.33 b           | 8.96 a              | 11.79 ab          | 10.00 a             |
| Stem diameter             | 5.48 ab | 5.97 ab       | 4.77 a       | 5.42 ab       | 5.53 ab          | 6.58 b           | 6.38 b            | 4.92 a              | 5.76 ab           | 5.37 ab             |
| Number of bud             | 1.89    | 1.63          | 1.29         | 1.50          | 1.42             | 1.63             | 1.92              | 2.13                | 1.83              | 1.92                |
| Roots length              | 55.66   | 62.85         | 52.16        | 53.79         | 54.83            | 58.19            | 56.37             | 53.83               | 62.10             | 52.19               |
| Fresh weight of roots     | 6.28    | 7.76          | 3.71         | 6.22          | 4.22             | 8.09             | 7.69              | 3.56                | 7.12              | 5.43                |
| Fresh weight of stem      | 8.78 ab | 10.88 ab      | 5.57 a       | 9.94 ab       | 7.86 ab          | 14.35 b          | 14.36 b           | 6.41 a              | 10.82 ab          | 6.79 a              |
| Fresh weight of leaves    | 11.82 abc| 12.59 abc     | 6.11 a       | 10.40 abc     | 8.00 ab          | 16.45 bc         | 17.91 bc          | 8.02 ab             | 16.07 bc          | 10.99 abc           |
| Dry weight of roots       | 1.66 ab | 2.16 ab       | 1.16 a       | 1.88 ab       | 1.93 ab          | 2.46 ab          | 2.59 b            | 1.17 a              | 2.19 ab           | 1.58 ab             |
| Dry weight of leaves      | 5.12 abc| 5.78 abc      | 3.07 a       | 5.65 abc      | 3.93 ab          | 7.52 bc          | 8.64 c            | 3.86 ab             | 7.04 abc          | 5.54 abc            |
| Dry weight of stem        | 2.86 abc| 3.28 abc      | 1.75 a       | 3.24 abc      | 2.55 ab          | 4.69 bc          | 4.98 c            | 2.07 a              | 3.45 abc          | 2.36 ab             |
| Total biomass             | 9.65 abc| 11.22 abc     | 5.98 a       | 10.78 abc     | 8.42 abc         | 14.66 bc         | 16.20 c           | 7.10 ab             | 12.67 abc         | 9.48 abc            |
| Leaf surface of mature leaves | 54.61 | 61.66         | 47.81        | 53.35         | 50.92            | 69.39            | 61.46             | 51.95               | 64.39             | 54.12               |
| Leaf surface of young leaves | 48.47 ab| 59.52 ab      | 44.48 a      | 45.61 ab      | 41.61 a          | 68.04 b          | 54.86 ab          | 45.61 ab             | 54.76 ab          | 53.65 ab            |

*) Number followed by different letters in the same column are statistically difference at the 5% probability level according to DMRT test.
3.3. Interaction between fertilizer and plant growth regulators
Based on our study the combination between 5 gr/pot of fertilizers and 100 ppm of cytokinin gave the
highest result on 10 parameters i.e. plant height, number of mature leaves, stem diameter, roots length,
fresh weight of stem, fresh weight of leaves, dry weight of roots, dry weight of stem, dry weight of
leaves, and total biomass. Moreover, our results were in line with [18] that reported higher
concentration of PGRs (2000 ppm) was able to produce seedling growth which was better than other
concentration while 0 to 1250 ppm of NPK liquid fertilizer concentration was not affected to all
observation variables in vanilla seedling. However, our results showed that the interaction between
fertilizer and plant growth regulators was significantly affecting seedling growth on all parameters
(Table 2).

3.4. Correlation between parameters
Depending on the effect of fertilizers and PGRs, we were observed the relationships of some
parameters on the loquat seedling growth. The results of correlation analyses showed that all
parameters was significantly contribute to the total biomass of loquat seedling (Table 3). The
parameters are variables related to allocation of biomass, and physiology, chemical composition, as
well as morphology of stems and roots. Moreover, number of mature leaves, stem diameter, roots
length, fresh and dry weight, and leaf surface of mature and young leaves significantly affected plant
height of loquat seedling. In the other hand, number of bud has low correlation with the other
parameters such as stem diameter, fresh and dry weight of stem, and leaf surface of mature and young
leaves. Currently, there are different ways to express biological data, and for the process of
photosynthesis, [19] reported that normalization for leaf area has been a very useful one. Furthermore,
[20] also reported that ecophysiological variables form a spectrum of correlated traits, specially on leaf
traits. Our result showed that the correlation parameters on loquat seedling growth was also in line
with the previous experiments, which is total biomass affected by others traits, such as leaves, stem,
roots, and also fresh and dry weight of loquat.
|                | PH  | YL  | ML  | SD  | NB  | RL  | FWR | FWS | FWL | DWR | DWL | TB  | LSML | LSYL |
|----------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|------|------|
| 5 gr/pot of fertilizers, No PGR | 27.01 | 1.33 | 10.22 | 5.10 | 1.78 | 52.67 | 4.03 | 6.54 | 9.66 | 1.27 | 4.15 | 2.19 | 7.60 | 50.63 | 44.23 |
| 10 gr/pot of fertilizers, No PGR | 34.50 | 1.72 | 11.56 | 5.86 | 2.00 | 58.66 | 8.52 | 11.03 | 13.99 | 2.06 | 6.09 | 3.54 | 11.69 | 58.59 | 52.71 |
| 5 gr/pot of fertilizers, 10 gr/pot of PGR | 41.21 | 2.58 | 14.17 | 6.64 | 2.08 | 64.88 | 11.24 | 15.05 | 17.73 | 3.09 | 8.08 | 4.65 | 15.82 | 65.73 | 54.39 |
| Auxin 25 ppm | 21.92 | 2.67 | 10.00 | 4.65 | 1.33 | 48.20 | 3.44 | 4.99 | 5.03 | 1.10 | 2.59 | 1.56 | 5.24 | 36.78 | 34.84 |
| Auxin 50 ppm | a | bc | ab | ab | a | ab | ab | a | ab | ab | ab | ab | ab | a |
| 5 gr/pot of fertilizers, 10 gr/pot of Auxin | 45.00 | 0.83 | 9.33 | 4.82 | 1.17 | 50.58 | 5.84 | 7.50 | 8.54 | 1.61 | 5.65 | 2.75 | 10.00 | 55.77 | 43.22 |
| Auxin 100 ppm | cd | a | ab | ab | a | abc | abcd | ab | abc | ab | abc | ab | abc | ab | abc |
| 5 gr/pot of fertilizers, 5 gr/pot of Auxin | 25.92 | 1.00 | 8.33 | 4.93 | 1.17 | 55.75 | 3.99 | 6.47 | 8.49 | 2.18 | 3.86 | 1.93 | 7.97 | 56.66 | 50.90 |
| Cytokinin 25 ppm | ab | ab | a | abc | a | abc | ab | abc | ab | abc | abc | ab | abc | abc | abc | abc |
| 5 gr/pot of fertilizers, 5 gr/pot of Cytokinin | 45.13 | 1.50 | 12.50 | 6.94 | 1.75 | 53.63 | 10.26 | 16.61 | 21.34 | 2.85 | 9.34 | 5.15 | 17.35 | 76.97 | 73.46 |
| Cytokinin 50 ppm | cd | abc | ab | abc | de | abc | cd | cd | cd | cd | cd | cd | c | b |
| 5 gr/pot of fertilizers, 10 gr/pot of Cytokinin | 46.75 | 1.50 | 16.17 | 7.07 | 2.17 | 70.33 | 9.26 | 18.31 | 22.09 | 3.30 | 11.41 | 6.80 | 21.52 | 70.95 | 56.68 |
| Cytokinin 100 ppm | d | abc | c | e | e | ab | c | bed | d | d | c | d | d | d | be | ab |
| 5 gr/pot of fertilizers, 10 gr/pot of Cytokinin | 32.83 | 1.50 | 10.83 | 5.69 | 2.50 | 56.17 | 5.75 | 6.71 | 12.55 | 1.89 | 6.15 | 3.25 | 11.29 | 73.40 | 61.16 |
| Gibberelin 25 ppm | abcd | abc | abc | abde | ab | abc | ab | abc | ab | abc | ab | abc | ab | abc | ab | abc | ab |
| 5 gr/pot of fertilizers, 5 gr/pot of Gibberelin | 34.38 | 1.25 | 12.50 | 5.87 | 1.75 | 67.38 | 6.29 | 6.55 | 17.27 | 1.87 | 7.33 | 2.82 | 12.02 | 70.11 | 56.96 |
| Gibberelin 50 ppm | abcd | abc | abc | abde | ab | bc | abcd | ab | bed | abc | ab | abc | ab | abc | ab | abc | ab |
| 5 gr/pot of fertilizers, 10 gr/pot of Gibberelin | 29.37 | 1.00 | 10.50 | 7.57 | 1.17 | 52.63 | 5.78 | 12.38 | 11.57 | 1.69 | 6.58 | 2.64 | 10.91 | 57.37 | 54.46 |
| Gibberelin 100 ppm | abc | abc | ab | abde | a | abc | abc | abc | ab | abc | abc | abc | abc | abc | abc | abc |
| 10 gr/pot of fertilizers | 29.37 | 2.00 | 9.00 | 5.30 | 1.17 | 60.83 | 4.29 | 6.71 | 7.45 | 1.23 | 3.48 | 1.92 | 6.63 | 57.59 | 64.65 |
| Auxin 25 ppm | abcd | abc | abde | a | abc | abc | abc | ab | abc | abc | abc | abc | abc | abc | abc | abc | abc |
| 10 gr/pot of fertilizers | 36.00 | 2.67 | 9.17 | 4.89 | 1.25 | 56.13 | 3.97 | 6.55 | 7.19 | 1.23 | 3.56 | 1.94 | 6.72 | 58.85 | 54.12 |
| Auxin 50 ppm | ab | bc | ab | abc | a | abc | abc | ab | abc | abc | abc | abc | abc | abc | abc | abc | abc |
| 10 gr/pot of fertilizers | 37.33 | 2.83 | 11.33 | 6.01 | 1.83 | 57 | 6.60 | 12.38 | 12.26 | 2.15 | 5.66 | 3.74 | 11.55 | 50.94 | 58.73 |
| Auxin 100 ppm | abc | c | abc | abde | a | abc | abc | ab | abc | abc | abc | abc | abc | abc | abc | abc | abc | abc |

Table 2. Effect of interaction between fertilizers and plant growth regulators on loquat seedling growth
| PH   | YL     | ML     | SD     | NB     | RL     | FWR    | FWS    | FWL    | DWR    | DWL    | DWS    | TB     | LSML   | LSYL   |
|------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| 1    | 0.148  | 0.595**| 0.665**| 0.132  | 0.480**| 0.636**| 0.730**| 0.694**| 0.669**| 1      | 1      | 1      | 1      | 1      |
|      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
|      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |
|      |        |        |        |        |        |        |        |        |        |        |        |        |        |        |

*) Number followed by different letters in the same column are statistically difference at the 5% probability level according to DMRT test. PH: plant height; YL: number of young leaves; ML: number of mature leaves; SD: stem diameter; NB: number of buds; RL: roots length; FWR: fresh weight of roots; FWS: fresh weight of stem; FWL: fresh weight of leaves; DWR: dry weight of roots; DWL: dry weight of leaves; DWS: dry weight of stem; TB: total biomass; LSML: leaf surface of mature leaves; LSYL: leaf surface of young leaves
|     | DWL   | DWS   | TB    | LSML  | LSYL  |
|-----|-------|-------|-------|-------|-------|
| PH  | 0.718** | 0.735** | 0.734** | 0.591** | 0.485** |
| YL  | 0.165*  | 0.235** | 0.199*  | 0.117  | 0.199*  |
| ML  | 0.815** | 0.785** | 0.814** | 0.614** | 0.503** |
| SD  | 0.809** | 0.839** | 0.838** | 0.743** | 0.636** |
| NB  | 0.135   | 0.230** | 0.172*  | 0.070  | 0.108   |
| RL  | 0.606** | 0.560** | 0.603** | 0.573** | 0.440** |
| FWR | 0.863** | 0.822** | 0.872** | 0.751** | 0.583** |
| FWS | 0.923** | 0.967** | 0.956** | 0.758** | 0.593** |
| FWL | 0.951** | 0.874** | 0.936** | 0.803** | 0.605** |
| DWL | 0.888** | 0.905** | 0.936** | 0.830** | 0.586** |
| DWS | 0.935** | 0.975** | 0.987** | 0.745** | 0.645** |
| TB  | 1       | 0.975** | 0.975** | 0.758** | 0.597** |
| LSML| 1       | 1       | 1       | 1       | 1       |

**PH**: plant height; **YL**: number of young leaves; **ML**: number of mature leaves; **SD**: stem diameter; **NB**: number of buds; **RL**: roots length; **FWR**: fresh weight of roots; **FWS**: fresh weight of stem; **FWL**: fresh weight of leaves; **DWR**: dry weight of roots; **DWL**: dry weight of leaves; **DWS**: dry weight of stem; **TB**: total biomass; **LSML**: leaf surface of mature leaf; **LSYL**: leaf surface of young leaves
4. Conclusions

In conclusion, the combination treatment between 5 gr/pot of fertilizers and 100 ppm of cytokinin gave higher response in almost all parameters. Fertilizers was not affecting the loquat seedling growth. In other hand, PGRs was affecting the loquat seedling growth, specially on plant high, number of young leaves, number of mature leaves, stem diameter, fresh weight of stem, fresh weight of leaves, dry weight of roots, dry weight of leaves, dry weight of stem, total biomass and leaf surface of young leaves.

References

[1] Morton JF 1987 Loquat. Fruits of warm climates (Julia F. Morton-Miami, FL) p 445
[2] Ito H, Kobayashi E, Takamatsu Y, Li SH, Hatano T, Sakagami H, Kusama K, Satoh K, Sugita D, Shimura S, et al. 2000. Chem. Pharm. Bull. 48 687–693
[3] Karsinah EB, Silalahi FH and Manik F 2008 Jerami 1 3237
[4] Blasco M, Zuriaga E, Naval M and Badenes ML 2014 Tree Gen. Geno. 10 5 138798.
[5] Carmo M, Ruiz RG, Ferreira MI and Domingos T 2017 Sci. Rep. 7 1 8111.
[6] Silva LL, Nascimento AC, Carvalho CM, Feitosa HO and Pereira JA 2014 Braz. J. Appl. Technol. Agric. Science, Guarapuava-PR. 7 2 3340
[7] Ciriello, V, Guerrini IA and Backes C 2014 Cerne. 20 4 653–660.
[8] Xu F, Chu C and Xu Z 2020 Nature research. 10 1033
[9] Kviklys D, Lanauskas J, Sakalauskaitė J, Kvikliene N and Uselis N 2011 Acta Hort. 903 425
[10] Grzyb ZS, Piotrowski W, Bielicki P, Pasz LS and Malusà E 2012 J. Fruit. Ornament Plant. Res. 20 1 43–53.
[11] Abbasi NA, Pervaiz T, Hafiz IA, Yaseen M and Hussain A 2013 J Zhejiang Univ-Sci B (Biomed & Biotechnol) 14 9 774-784.
[12] Nordström A, Tarkowski P, Tarkowska D, Norbaek R, Åstot C, Dolezal K and Sandberg G 2004 Proceedings of the National Academy of Sciences 101 21 8039-8044.
[13] Fu X, Harberd NP 2003 Nature 421 740-743.
[14] Polat AA 2007 The European Journal of Plant Science and Biotechnology 1 2 187-199.
[15] Gomes EN, Vieira LM, de Moraes Fagundes C, Rossa ÚB, Tofanelli MBD and Deschamps C 2020 Comunicata Scientiae 11 e3353-e3353.
[16] Westfall CS, Muehler AM, Jez JM 2013 Journal of Biological Chemistry 288 27 19304-19311.
[17] Taiz L, Zeiger E 2002 Plant Physiology 3rd ed (Sinauer Associates Inc Publishers - Sunderland, MA) p 690
[18] Yudha A 2015 Bulletin Agrohorti 3 1 39-46.
[19] Poorter H, Lambers H and Evans JR 2014 New Phytologist 201 2 378-382
[20] Wright IJ, Reich PB, Westoby M, Ackerly DD, Baruch Z, Bongers F, Cavender-Bares J, Chapin T, Cornelissen JH, Diemer M, and Flexas J 2004 Nature 428 6985 821-827.