International Journal on Food, Agriculture, and Natural Resources
Volume 7, Issue 2, Page 34-37
ISSN: 2722-4066
http://www.fanres.org

Original Paper

Effect of Potassium Fertilizer Rate and Timing on Super Red Dragon Fruit Yield

Bintang Febriansyah[1], Tri Ratnasari[1], Yagus Wijayanto[1], Nilasari Dewi[1]*
1) Department of Agrotechnology, Faculty of Agriculture, University of Jember, Jember, Indonesia
*) *Corresponding Author: ratnasaribersama.11@gmail.com*

Received: 19 May 2026; Revised: 03 May 2026; Accepted: 28 June 2026
DOI: *https://doi.org/10.46676/ij-fanres.v7i2.658*

***Abstract*—Potassium availability and fertilizer timing are important for fruit filling, carbohydrate translocation, and soluble solid accumulation in dragon fruit. This study evaluated the effects of ZK potassium sulphate fertilizer rate and application timing on the yield and quality of super red dragon fruit (Hylocereus costaricensis). A factorial randomized complete block design with three replications was conducted from July to October 2025 in Bulurejo Village, Purwoharjo District, Banyuwangi Regency, Indonesia. The first factor was ZK rate consisting of 0, 72, 144, and 216 g plant-1, while the second factor was application timing at 0, 15, and 30 days after flowering. Fruit diameter, fruit number, total fruit weight, mean fruit weight, moisture content, and total soluble solids were analyzed using analysis of variance followed by Duncan multiple range test at 5 percent. Potassium rate significantly affected fruit moisture content and total soluble solids, while application timing significantly affected total fruit weight. The rate x timing interaction significantly affected fruit number and total fruit weight. The combination of 144 g plant-1 applied 15 days after flowering produced the highest fruit number (9.00 fruits plant-1) and total fruit weight (4038.33 g plant-1). Across potassium rates, 144 g plant-1 produced the highest moisture content (84.12 percent) and total soluble solids (19.33 degrees Brix). Therefore, 144 g plant-1 ZK applied 15 days after flowering is recommended for improving super red dragon fruit yield under the conditions of this study.**

Keywords*—application timing; dragon fruit; potassium; total soluble solids; yield

I. INTRODUCTION

Dragon fruit is a horticultural commodity with increasing market demand because of its attractive appearance, refreshing taste, and nutritional value. Among cultivated pitaya types, super red dragon fruit (Hylocereus costaricensis) is valued for its red pulp, high sweetness, and marketable fruit size. However, the production of dragon fruit in several Indonesian growing areas remains unstable, particularly in fruit number, fruit weight, and sweetness. This instability indicates that cultivation practices, especially nutrient management during the generative phase, still require improvement [1]-[3].

Potassium is a primary macronutrient involved in photosynthesis, enzyme activation, stomatal regulation, osmoregulation, and the movement of assimilates from source organs to developing fruit. Adequate potassium supply can improve fruit filling, total soluble solids, and harvestable yield in pitaya and other fruit crops, whereas deficiency reduces carbohydrate transport and sink development [4]-[7]. Potassium management is also relevant because high fruit production removes a substantial amount of potassium from the plant-soil system [8].

Previous studies have demonstrated positive responses of dragon fruit to potassium fertilization, including increases in fruit mass, fruit quality, and soluble solids [5], [6]. Nevertheless, fertilizer effectiveness depends not only on rate but also on timing. In practice, potassium is often applied without considering the physiological stages of flowering, fruit set, and fruit enlargement. Application that is too early may not coincide with peak fruit demand, while late application may fail to support the main period of assimilate accumulation. Flowering-to-harvest management and the biological characteristics of pitaya support the need for stage-specific potassium recommendations [15]-[20]. Therefore, the interaction between potassium rate and application timing should be clarified for super red dragon fruit grown under local field conditions.

The objective of this study was to evaluate the effects of ZK potassium fertilizer rate, application timing, and their interaction on the yield components and fruit quality of super red dragon fruit. The study also aimed to determine the most effective rate and timing combination for increasing fruit number, total fruit weight, moisture content, and total soluble solids.

II. MATERIALS AND METHODS

A. Experimental site and plant material

The experiment was conducted from July to October 2025 in Bulurejo Village, Purwoharjo District, Banyuwangi Regency, East Java, Indonesia. The plant material consisted of uniform three-year-old super red dragon fruit plants grown under field conditions. The fertilizer treatment used ZK potassium sulphate, while standard crop maintenance included basal NPK fertilization, irrigation, pest and disease prevention, and fruit protection by wrapping when fruit color began to change from green to red.

TABLE I. ANALYSIS OF VARIANCE SUMMARY FOR YIELD AND QUALITY VARIABLES

Variable	Rate (P)	Timing (W)	P x W
Fruit diameter	1.048 ns	1.198 ns	0.648 ns
Fruit number	2.529 ns	2.641 ns	3.375 *
Total fruit weight	1.760 ns	3.532 *	3.244 *
Mean fruit weight	1.012 ns	1.829 ns	2.116 ns
Moisture content	12.742 **	0.686 ns	1.190 ns
Total soluble solids	19.221 **	0.500 ns	1.180 ns

Note: ns = not significant; * = significant at 5 percent; ** = significant at 1 percent.

B. Experimental design and treatment application

A factorial randomized complete block design was used with two treatment factors and three replications. The first factor was the ZK fertilizer rate: 0 g plant-1 (P1), 72 g plant-1 (P2), 144 g plant-1 (P3), and 216 g plant-1 (P4). The second factor was application timing: 0 days after flowering (W1), 15 days after flowering (W2), and 30 days after flowering (W3). The design produced 12 treatment combinations and 36 experimental units. ZK fertilizer was dissolved in 2 L of water according to each treatment rate and applied once by drenching the solution at the base of each plant during the generative phase.

C. Observation variables and statistical analysis

Fruit harvesting was conducted gradually when the fruit showed uniform red skin color. The observed variables were fruit diameter (mm), fruit number (fruits plant-1), total fruit weight (g plant-1), mean fruit weight (g fruit-1), fruit moisture content (%), and total soluble solids (degrees Brix). Fruit diameter was measured at the widest middle part of the fruit using a vernier caliper. Fruit number and total fruit weight were calculated from all harvested fruit within the experimental observation period. Mean fruit weight was obtained by weighing each harvested fruit with a digital scale. Moisture content was determined by oven drying a 2 g pulp sample at 105 C for 3 h and weighing it after cooling in a desiccator. Total soluble solids were measured using a refractometer from fruit juice extracted from the pulp. Data were analyzed using analysis of variance. When significant effects occurred, mean separation was performed using Duncan multiple range test at the 5 percent level.

III. RESULTS AND DISCUSSION

A. Analysis of variance and general response pattern

The analysis of variance showed that the response of super red dragon fruit depended on the observed variable (Table I). Potassium rate had a highly significant effect on moisture content and total soluble solids but did not significantly affect fruit diameter, fruit number, total fruit weight, or mean fruit weight as a single factor. Application timing had a significant effect on total fruit weight, whereas the interaction between rate and timing significantly affected fruit number and total fruit weight. These results indicate that yield formation in this study was controlled more strongly by the synchronization between potassium supply and the generative stage than by fertilizer rate alone.

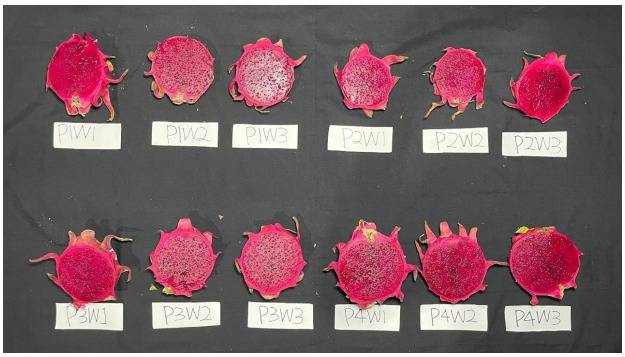


Fig. 1. Cross-section samples of super red dragon fruit used for fruit observation and quality measurement.



Fig. 2. Whole-fruit samples of super red dragon fruit from different potassium rate and application timing combinations.

B. Fruit diameter and mean fruit weight

Fruit diameter and mean fruit weight were not significantly affected by potassium rate, application timing, or their interaction (Table I). The largest mean diameter in the single factor comparison was observed in the control treatment (90.70 mm), while the largest mean diameter for application timing occurred at 15 days after flowering (89.63 mm). A similar pattern was found for mean fruit weight, in which the largest mean value was observed in the control rate (488.86 g fruit-1) and the 15-day timing treatment (480.27 g fruit-1). Although potassium is physiologically important for osmotic adjustment and fruit enlargement, the absence of significant differences suggests that the tested field condition may already have supported sufficient fruit expansion or that fruit load and assimilate competition were more limiting than potassium rate alone. Fruit size in pitaya is also strongly affected by crop load per cladode, which can reduce individual fruit size when too many fruit develop on the same photosynthetic structure [9].

C. Fruit number

The interaction between potassium rate and application timing significantly affected fruit number (Table II). The highest fruit number was obtained from 144 g plant-1 applied at 15 days after flowering (P3W2), producing 9.00 fruits plant-1. This combination was higher than several other treatments and indicates that moderate potassium supply during the early fruit development stage supported fruit retention. At 30 days after flowering, the same rate produced 8.00 fruits plant-1, while 216 g plant-1 at 30 days after flowering produced the lowest number (2.67 fruits plant-1). This response suggests that

TABLE II. INTERACTION EFFECT OF POTASSIUM RATE AND APPLICATION TIMING ON FRUIT NUMBER

ZK rate	0 DAF	15 DAF	30 DAF
0 g	6.00 a/B	5.00 a/A	3.00 a/A
72 g	4.33 a/A	4.33 a/A	7.00 a/B
144 g	4.33 a/AB	9.00 b/A	8.00 ab/B
216 g	5.67 a/AB	8.33 a/A	2.67 a/A

Note: DAF = days after flowering. Lowercase letters compare timing within the same rate; uppercase letters compare rates within the same timing according to Duncan multiple range test at 5 percent.

TABLE III. INTERACTION EFFECT OF POTASSIUM RATE AND APPLICATION TIMING ON TOTAL FRUIT WEIGHT

ZK rate	0 DAF	15 DAF	30 DAF
0 g	2800.00 a/A	2648.33 a/A	1496.67 a/A
72 g	1466.67 a/A	2213.33 a/A	3135.00 a/B
144 g	1780.00 a/A	4038.33 b/A	3575.00 b/B
216 g	2435.00 a/A	3425.00 a/A	1378.33 a/A

Note: values are expressed as g plant-1. DAF = days after flowering. Lowercase letters compare timing within the same rate; uppercase letters compare rates within the same timing according to Duncan multiple range test at 5 percent.

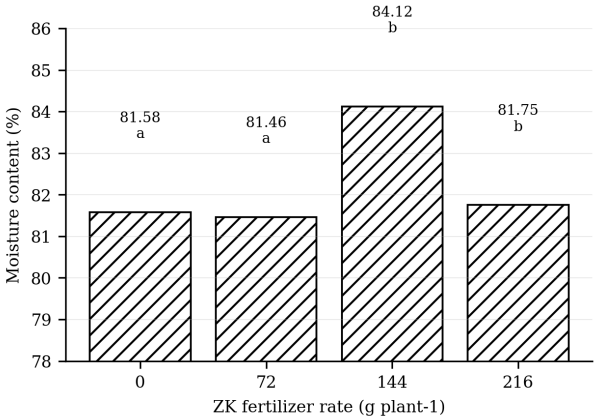


Fig. 3. Effect of ZK fertilizer rate on fruit moisture content. Bars followed by the same letter are not significantly different according to Duncan multiple range test at 5 percent.

excessive potassium or a mismatch between supply and fruit demand may not increase fruit set and may reduce fertilizer efficiency.

The role of potassium in fruit number can be linked to improved water regulation, energy balance, assimilate transport, and sink strength during early fruit development. Adequate potassium can support the maintenance of young fruit and reduce the risk of fruit drop. However, the benefit is not unlimited. Excessive crop load may increase total fruit number but reduce fruit size because more fruit compete for available assimilates [9]. Therefore, potassium fertilization should be combined with appropriate canopy and fruit-load management to balance fruit number and marketable fruit size.

D. Total fruit weight

Total fruit weight followed a similar interaction pattern (Table III). The highest value was recorded at P3W2, reaching 4038.33 g plant-1, followed by P3W3 with 3575.00 g plant-1. At the same time, the 216 g plant-1 rate applied at 30 days after flowering resulted in only 1378.33 g plant-1. These results confirm that 144 g plant-1 was more efficient than the higher rate when applied during the period when developing fruit required potassium for assimilate transport and cell expansion.

Total fruit weight is a composite variable determined by fruit number and individual fruit weight. Because potassium contributes to carbohydrate translocation, osmotic regulation, and fruit filling, an optimum rate can increase total harvest weight by improving both fruit retention and fruit growth. Previous studies on pitaya reported improved production and fruit quality when potassium was supplied at suitable rates [5], [6]. Conversely, excessive potassium can reduce nutrient-use efficiency and may interfere with the uptake of calcium and magnesium, both of which are important for cell wall formation and fruit quality [10]. The present result supports the concept of an optimum potassium range rather than a linear response to increasing fertilizer rate.

E. Fruit moisture content and total soluble solids

Potassium rate significantly influenced fruit moisture content (Fig. 3). The highest moisture content was recorded at 144 g plant-1 (84.12 percent), followed by 216 g plant-1 (81.75 percent), 0 g plant-1 (81.58 percent), and 72 g plant-1 (81.46 percent). Application timing did not significantly affect this variable, although the highest average value was observed at 15 days after flowering. Potassium regulates water relations in plant tissue by maintaining osmotic balance and supporting the movement of assimilates into fruit. This role may explain why an optimum potassium rate maintained pulp water status while supporting the accumulation of soluble compounds during fruit development.

Total soluble solids were also significantly affected by potassium rate (Fig. 4). The highest value was obtained from 144 g plant-1 (19.33 degrees Brix), followed by 216 g plant-1 (18.33 degrees Brix), 0 g plant-1 (16.33 degrees Brix), and 72 g plant-1 (15.67 degrees Brix). The increase in soluble solids at the optimum potassium rate is consistent with the role of potassium in sugar transport, carbohydrate metabolism, and organic acid balance in fruit [11], [12]. Similar mechanisms have been reported in citrus and grape, where potassium improved carbon flow and sugar metabolism [13], [14]. In dragon fruit, improved total soluble solids is particularly important because sweetness is a key determinant of consumer preference and market value.

Although 216 g plant-1 produced relatively high soluble solids, it did not improve yield as effectively as 144 g plant-1 and produced low total fruit weight when applied at 30 days after flowering. This result shows that higher fertilizer rates do not necessarily generate better agronomic responses. Balanced potassium supply is required to increase yield while avoiding nutrient imbalance, possible salinity effects, and antagonistic interactions with other cations [10]. Based on yield and quality together, the 144 g plant-1 rate applied at 15 days after flowering was the most favorable treatment under the experimental conditions.

IV. CONCLUSION

The interaction between ZK potassium fertilizer rate and application timing significantly affected fruit number and total fruit weight of super red dragon fruit. The best treatment combination was 144 g plant-1 applied 15 days after flowering,

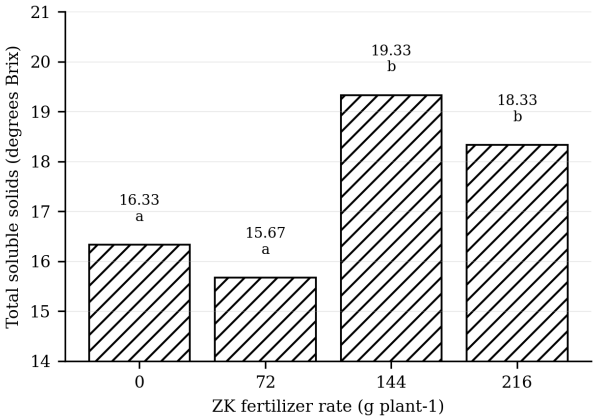


Fig. 4. Effect of ZK fertilizer rate on total soluble solids of super red dragon fruit. Bars followed by the same letter are not significantly different according to Duncan multiple range test at 5 percent.

which produced 9.00 fruits plant-1 and 4038.33 g plant-1 total fruit weight. Potassium rate significantly affected fruit moisture content and total soluble solids, with 144 g plant-1 producing the highest values of 84.12 percent and 19.33 degrees Brix, respectively. Fruit diameter and mean fruit weight were not significantly affected by the treatments. Therefore, ZK fertilizer at 144 g plant-1 applied at 15 days after flowering can be recommended as an effective practice for improving yield and fruit quality under the conditions of this study. Further studies across seasons and soil fertility levels are recommended to refine the recommendation for wider production areas.

ACKNOWLEDGMENT

The authors express appreciation to the Faculty of Agriculture, University of Jember, and to all field and laboratory assistants who supported the implementation of this research.

References

[1] A. Kusmiati, J. Januar, and F. I. W. Harvey, ”Trend produksi dan prospek pengembangan komoditas buah naga di Kabupaten Jember,” Jurnal Sosial Ekonomi Pertanian, vol. 3, no. 2, 2009.

[2] R. Mardikaningsih, E. A. Sinambela, E. Retnowati, B. Purwatiningsih, S. N. Halizah, D. Darmawan, and A. R. Putra, ”Strategi pengembangan usahatani buah naga di Kecamatan Lawang Kabupaten Malang,” Jurnal Lima Daun Ilmu, vol. 2, no. 1, pp. 21-32, 2022.

[3] T. Perween and M. A. Hasan, ”Growth, yield and quality of dragon fruit as influenced by NPK fertilization,” Indian Journal of Horticulture, vol. 76, no. 1, pp. 180-183, 2019.

[4] A. Sahu, K. Kishore, R. K. Nayak, S. N. Dash, S. C. Sahoo, and S. Barik, ”Influence of potassium on mineral content, yield and quality attributes of dragon fruit (Selenicereus monacanthus) in acidic soil of Eastern tropical region of India,” Journal of Plant Nutrition, vol. 46, no. 11, pp. 2621-2636, 2023.

[5] D. R. Fernandes, R. A. Moreira, M. D. C. M. Cruz, J. M. Rabelo, and J. D. Oliveira, ”Improvement of production and fruit quality of pitayas with potassium fertilization,” Acta Scientiarum. Agronomy, vol. 40, e35290, 2018.

[6] J. M. Rabelo, M. D. C. M. Cruz, C. G. Sena, L. Pantoja, A. S. Santos, L. A. C. Reis, and A. G. Guimaraes, ”Potassium fertilization in the quality improvement and centesimal composition of pitaya,” Emirates Journal of Food and Agriculture, vol. 32, no. 9, pp. 658-665, 2020.

[7] C. Hafsi, A. Debez, and C. Abdelly, ”Potassium deficiency in plants: effects and signaling cascades,” Acta Physiologiae Plantarum, vol. 36, no. 5, pp. 1055-1070, 2014.

[8] G. Garbanzo-Leon, J. C. Vargas-Rojas, and E. V. Vega-Villalobos, ”Crecimiento y absorcion de nutrimentos del cultivo de pitahaya (Hylocereus costaricensis y H. monocanthus) de Costa Rica,” Agronomia Mesoamericana, vol. 35, no. 1, 57493, 2024.

[9] N. C. Santos, M. D. C. M. Cruz, D. D. A. Alves, J. E. Lima, and A. G. Guimaraes, ”Commercial productivity and quality of pitaya as a function of number of fruits per cladode,” Revista Ceres, vol. 70, no. 2, pp. 41-48, 2023.

[10] K. Xie, I. Cakmak, S. Wang, F. Zhang, and S. Guo, ”Synergistic and antagonistic interactions between potassium and magnesium in higher plants,” The Crop Journal, vol. 9, no. 2, pp. 249-256, 2021.

[11] D. S. Magalhaes, D. M. da Silva, J. D. Ramos, L. A. S. Pio, M. Pasqual, E. V. B. V. Boas, and E. T. de Melo, ”Changes in the physical and physico-chemical characteristics of red-pulp dragon fruit during its development,” Scientia Horticulturae, vol. 253, pp. 180-186, 2019.

[12] T. Chen, S. Lu, Y. Tan, B. Wang, F. Lu, J. Li, and R. Huang, ”Co-application nitrogen and potassium fertilizer enhances nutrient uptake and quality of Hylocereus undulatus by changing soil properties in karst regions,” Journal of Soil Science and Plant Nutrition, pp. 1-12, 2025.

[13] K. Wu, C. Hu, P. Liao, Y. Hu, X. Sun, Q. Tan, and S. Wu, ”Potassium stimulates fruit sugar accumulation by increasing carbon flow in Citrus sinensis,” Horticulture Research, vol. 11, no. 11, uhae240, 2024.

[14] J. Wang, Y. Lu, X. Zhang, W. Hu, L. Lin, Q. Deng, and X. Lv, ”Effects of potassium-containing fertilizers on sugar and organic acid metabolism in grape fruits,” International Journal of Molecular Sciences, vol. 25, no. 5, 2828, 2024.

[15] K. Shah, J. Chen, J. Chen, and Y. Qin, ”Pitaya nutrition, biology, and biotechnology: A review,” International Journal of Molecular Sciences, vol. 24, no. 18, 13986, 2023.

[16] S. Shameena, P. R. G. Lekshmi, P. P. Gopinath, P. Gidagiri, and S. Kanagarajan, ”Dynamic transformations in fruit color, bioactive compounds, and textural characteristics of purple-fleshed dragon fruit (Hylocereus costaricensis) across fruit developmental stages under humid tropical climate,” Horticulturae, vol. 10, no. 12, 1280, 2024.

[17] H. E. Khoo, X. He, Y. Tang, Z. Li, C. Li, Y. Zeng, and J. Sun, ”Betacyanins and anthocyanins in pulp and peel of red pitaya (Hylocereus polyrhizus cv. Jindu), inhibition of oxidative stress, lipid reducing, and cytotoxic effects,” Frontiers in Nutrition, vol. 9, 894438, 2022.

[18] K. Abirami, S. Swain, V. Baskaran, K. Venkatesan, K. Sakthivel, and N. Bommayasamy, ”Distinguishing three dragon fruit (Hylocereus spp.) species grown in Andaman and Nicobar Islands of India using morphological, biochemical and molecular traits,” Scientific Reports, vol. 11, no. 1, 2894, 2021.

[19] A. Dachlan, E. Syam’un, L. Asrul, F. Ulfa, and D. Irindu, ”Growth of red dragon fruit seedlings (Hylocereus costaricensis L.) from two sources of cuttings at various concentrations of shallot solutions,” IOP Conference Series: Earth and Environmental Science, vol. 486, no. 1, 012112, 2020.

[20] O. Kristriandiny and S. Susanto, ”Budi daya buah naga putih (Hylocereus undatus) di Sleman, Yogyakarta: panen dan pascapanen,” Buletin Agrohorti, vol. 4, no. 1, pp. 1-8, 2016.