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Kuta Bali, Indonesia
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## *Emerging Challenges and Opportunities in Horticulture Supporting Sustainable Development Goals*

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# PROCEEDINGS OF INTERNATIONAL SYMPOSIA ON HORTICULTURE (ISH) 2018

## "Emerging Challenges and Opportunities in Horticulture Supporting Sustainable Development Goals"

(Kuta, Bali, Indonesia 27-30 November 2018)

Indonesian Center for Horticulture Research and Development
Indonesian Agency for Agricultural Research and Development
Ministry of Agriculture Republic Indonesia

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# Effect of Slow Release Nitrogen (SRN) Addition to NPK Fertilization on Cauliflower Growth

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**Abstract.** Urea is fertilizer nitrogen source that is high water solubility, so its not efficient. In this study, three kinds of slow release nitrogen (SRN) fertilizers were evaluated for cauliflower growth. These fertilizer is the standard fertilization, while single N is addition. Hence, in the discussion should focus on the effect of such nitrogen addition. The experiment was carried out in a greenhouse, using randomized block design in 5x2 factorial scheme with three replicates. Treatments corresponded to five kinds of nitrogen sources i.e : without fertilizer (A0), Urea (A1), SRN-Bentonite (A2), SRN-BBA (A3) and SRN-Mesopore (A4) and two treatments of NPK: without NPK (B0) and NPK addition (B1). The dosage of fertilizer is equivalent to Urea 200 kg.ha-1. Data obtained were identified using analysis of variance and followed by Orthogonal Contrast at 5% level. It was found that the use of fertilizer nitrogen significantly increased the growth of cauliflower compared to without fertilizer. There is any difference between urea and SRN application on the number of leaves and curd weight. The growth of cauliflower fertilized by the SRN's with the NPK addition was better than that without NPK, especially the number of leaves, leaf length, leaf width, root dry weight, curd diameter, and curd weight. The results also showed that the effects of SRN- types were no significant differences on the cauliflower growth but on the basis of variable observed, SRN-Mesopore agronomically was potential to be developed compared to SRN-Bentonite and SRN-BBA.

**Keywords:** *nitrogen, addition of NPK, fertilizer, cauliflower*

## 1. Introduction

Cauliflower (*Brassica oleraceae* var. Botrytis L.) is one of the horticultural products that has complete nutritional. Nutrient content in 100 grams of cauliflower are calories (25.0 cal), protein (2.1 g), fat (0.3 g), carbohydrates (5.2 g), calcium (41 mg), phosphorus (42, 0 mg), iron (1.1 mg), vitamin A (23 RE), vitamin B2 (0.12 mg), vitamin C (82 mg), niacin (0.7 mg) [1]. These nutrients are needed by human body to meet the needs of a healthy life. In addition cauliflower also has the benefits of being an antioxidant, anticancer, reducing estrogen levels, neutralizing carcinogens, and improving bowel movements.

Based on data from the Central Statistics Agency (BPS), the average production of flower cabbage in Indonesia in 2011- 2013 were 12.02 tons.ha-1, 11.53 tons.ha-1, and 12.18 tons ha-1 respectively, but in 2014 the production decreased to 12.08 tons. ha-1 [2] due to less effective of fertilization.. Fertilization will be effective if soil and fertilizer conditions support each other. The most common soil conditions in Indonesia are hard soil conditions, high acidity (average pH <4.50), high saturation of Al, low organic matter [3]. This soil condition is included in the Ultisol soil type, which is poor in nutrients and difficult to be fertilized due to intensive alkaline washing. Fertilizers that are easily absorbed by plants are fertilizers that are not volatile, washed, or bound by other substances.

Fertilization is the addition of nutrients needed by plants because of lack availability in the soil for optimal plant growth. Nutrients that function for tissue formation are nitrogen elements [4]. This nitrogen nutrient is needed in large quantities, especially in vegetable crops. The highest type of fertilizer containing nitrogen is urea and is widely used by farmers. Besides Urea, other N sources fertilizer which also contain elements of P and K are Nitrofoska or NPK compounds. Urea fertilizer has a nitrogen content of 45% which has very hygroscopic so that it is easily soluble and volatile before is absorbed by plants.

Efforts to improve the efficiency of providing nitrogen nutrients in the soil are by modifying the physical and chemical forms of conventional urea fertilizer into urea fertilizer slowly (Slow Release urea = SRU). Slow-release urea fertilizer is a fertilizer with the mechanism of release of nitrogen elements periodically following the pattern of nutrient absorption by plants. The mechanism of urea fertilizer works slowly (Slow release nitrogen = SRN), which is by coating the urea fertilizer with water-insoluble compounds such as sulphur, polyethylene, alkyd resin, polyurethane [5}; [6} or by melting urea and then mixing it bentonite as with a substrate: and polyacrylamideas a binder [7]. The release of nutrients is in accordance with the time and amount needed by the plant, as well as maintaining the presence of fertilizer in the soil so that absorption by plants is more optimal. In this study SRN fertilizer types that were utilized were synthesized by melting urea and then mixing it with one of various substrates (bentonite, silica from bagasse bottom ash ((BBA), mesostructuredcellulair form silica) and corn starch as a binder [8]. SRN using bentonitewas named SRN-Bentonite, using silica from bagasse bottom ash (BBA) was named SRN-BBA and using mesostructuredcellulair form silica was named SRN-Mesopore.

## 2. Methodology

This research was carried out in the greenhouse of the Faculty of Agriculture Lampung University in September to November 2017. The treatment was applied in factorial pattern (5x2) in a randomized block design (RBD) with 3 replications. The first factor is the type of source fertilizer N (A): no fertilizer (A0), Urea (A1), SRN- Bentonite (A2), SRN- BBA (A3), and SRN- Mesopori (A4). The second factor is the addition of NPK (B): without NPK (B0) and addition of NPK (B1). The dosage of fertilizer given is equivalent to Urea 200 kg ha-1 and NPK 600 kg ha-1. The application of SRN fertilizer was carried out at the age of one week after planting and NPK fertilizer 10 days after planting each with the amount of 1.6 g Urea, 1.8 g SRN, and 5 g NPK per plant.

The variables observed included: plant height, leaf number, leaf length, leaf width, root dry weight, curd diameter, and curd weight. Data were analyzed by variance, followed by Orthogonal Contrast at 5% level.

## 3. Results And Discussion

### *3.1. Results*

The results showed that the various types of nitrogen source fertilizers produced higher growth of cauliflower than without fertilization, which was shown on variables: plant height, leaf number, leaf length, leaf width, root dry weight, curd diameter, and curd weight. Among the types of nitrogen sources fertilizer do not show a significant difference, except for the number of leaves and curd weight of urea fertilizer results are higher than SRN, but if added NPK, SRN fertilizer is the higher yield.

### 3.1.1. Plant height

The results showed that the various types of nitrogen source fertilizers produced higher plant heights than without fertilization, but among the types of fertilizers used did not show differences in both single N fertilizer and added of NPK fertilizer compounds (Table 1).

Table 1. Effect of type N fertilizer and NPK addition on plant height

| Comparison | Difference (cm) | Difference (%) | $F_{count}$ |
|---|---|---|---|
| P1: No fertilizer vs. Fertilization | 40.36-48.90= -8.54 | 17.46 | 23.73* |
| P2: Urea vs SRN | 52.01-48.43= 3.58 | 7.40 | 0.97tn |
| P3: Bentonit vs BBA and Mesopori | 43.22-51.04= -7.81 | 15.31 | 1.39 tn |
| P4: BBA vs Mesopori | 50.68-51.09= -0.71 | 1.39 | 0.08 tn |
| P5: Urea vs Urea +NPK | 52.01-47.85= 4.16 | 8.70 | 1.46 tn |
| P6: SRN vs SRN+NPK | 48.53-48.79= -0.36 | 0.74 | 0.29 tn |
| P7: Urea +NPKvs SRN+NPK | 47.85-48.79= -0.71 | 1.45 | 0.76 tn |
| P8: Bentonit +NPKvs BBA +NPK and Mesopori+NPK | 46.14-50.12= -3.97 | 7.93 | 1.72 tn |
| P9: BBA +NPK vs Mesopori+NPK | 46.55-53.69= -3.57 | 6.65 | 4.36 tn |

Description: * = significantly different at level α 5%
tn = not significantly different at level α 5%

### 3.1.2. Number of leaves

The results showed that the various types of nitrogen source fertilizers increased the number of leaves of the cauliflower compared to no fertilizer. Among the various types of nitogen source fertilizer, urea fertilizer significantly produces more leaves than SRN fertilizer. Mesopori SRN fertilizer and BBA (Bagasse Bottom Ash) significantly produce more leaves compared to SRN- Bentonite fertilizer. However, there is no difference in the number of leaves between Mesopori fertilizer and BBA (Bagasse Bottom Ash). The type of SRU and addition of NPK significantly produced more leaves than without fertilizer of NPK (Table 2).

Table 2. Effect of type N fertilizer and NPK addition on number of leaves

| Comparison | Difference (strand) | Difference (%) | $F_{count}$ |
|---|---|---|---|
| P1: No fertilizer vs. Fertilization | 14.83-16.76= -1.93 | 11.63 | 8.12* |
| P2: Urea vs SRN | 17.83-14.89= 2.94 | 19.78 | 15.82* |
| P3: Bentonit vs BBA and Mesopori | 13.50-15.58= -2.08 | 13.37 | 7.04* |
| P4: BBA vs Mesopori | 14.83-16.33= -1.50 | 9.18 | 2.74tn |
| P5: Urea vs Urea +NPK | 17.83-18.67= -0.83 | 4.46 | 0.84 tn |
| P6: SRN vs SRN+NPK | 14.83-17.44= -2.56 | 14.65 | 23.83* |
| P7: Urea +NPKvs SRN+NPK | 18.67-17.44= 1.22 | 6.98 | 2.73 tn |
| P8: Bentonit +NPKvs BBA +NPK and Mesopori+NPK | 17.50-17.42= 0.08 | 0.48 | 0.01 tn |
| P9: BBA +NPK vs Mesopori+NPK | 17.33-17.50 = -0.17 | 0.95 | 0.03 tn |

Description: * = significantly different at level α 5%
tn = not significantly different at level α 5%

### 3.1.3. Leaf length

The results showed that the various types of nitogen source fertilizer increased the length of the leaves of the cauliflower compared to without fertilizer. SRN fertilizer with the addition of NPK significantly produced a longer leaf length than SRN fertilizer alone (Table 3).

### *3.1.4. Leaf width*

The results showed that the various types of nitrogen source fertilizers increased the width of the leaves in the flower beds compared to without fertilizer. Among the various types of nitrogen source fertilizers, fertilizers actually produce more water than fertilizer SRN. SRN fertilizer with the addition of NPK significantly produced a wider yield than SRU fertilizer alone (Table 4).

### *3.1.5. Root dry weight*

The results showed that the various types of nitrogen source fertilizers produced the dry weight of roots of heavier cabbage plants compared to without fertilizer. Among the administration of various types of nitrogen source fertilizers, SRU with the addition of NPK produces heavy dry weight compared to SRN fertilizer alone (Table 5).

Table 3. Effect of N source fertilizer and NPK addition on leaf length

| Comparison | Difference (cm) | (%) | $F_{count}$ |
|---|---|---|---|
| P1: No fertilizer vs. Fertilization | 12.38-18.63=-7.53 | 39.33 | 45.22* |
| P2: Urea vs SRN | 20.00-18.17=1.83 | 7.35 | 2.21 tn |
| P3: Bentonit vs BBA and Mesopori | 17.04-18.74=-1.70 | 9.34 | 1.70 tn |
| P4: BBA vs Mesopori | 18.19-19.29=-1.11 | 5.63 | 0.54 tn |
| P5: Urea vs Urea +NPK | 20.00-20.77=-0.77 | 3.92 | 0.26 tn |
| P6: SRN vs SRN+NPK | 18.17-21.26=-3.09 | 14.62 | 12.68* |
| P7: Urea +NPKvs SRN+NPK | 20.77-21.26=-0.49 | 2.32 | 0.16 tn |
| P8: Bentonit +NPKvs BBA +NPK and Mesopori+NPK | 19.71-22.07=-2.36 | 10.97 | 3.21 tn |
| P9: BBA +NPK vs Mesopori+NPK | 21.26-22.04=-0.75 | 3.40 | 0.25 tn |

Description: * = significantly different at level α 5%
tn = not significantly different at level α 5%

Table 4. Effect of N source fertilizer and NPK addition on leaf width

| Comparison | Difference (cm) | (%) | $F_{count}$ |
|---|---|---|---|
| P1: No fertilizer vs. Fertilization | 9.21-21.75=-3.55 | 27.80 | 58.18* |
| P2: Urea vs SRN | 13.79-12.43=1.36 | 10.98 | 10.34* |
| P3: Bentonit vs BBA and Mesopori | 12.35-11.21=-1.15 | 9.57 | 3.64tn |
| P4: BBA vs Mesopori | 11.92-12.79=-0.88 | 6.81 | 1.59 tn |
| P5: Urea vs Urea +NPK | 13.79-13.92=-0.13 | 0.97 | 0.03 tn |
| P6: SRN vs SRN+NPK | 11.97-13.93=-1.96 | 14.06 | 23.95* |
| P7: Urea +NPKvs SRN+NPK | 13.92-13.93=-0.01 | 0.10 | 0.00 tn |
| P8: Bentonit +NPKvs BBA +NPK and Mesopori+NPK | 13.17-13.93=-0.76 | 5.48 | 3.64 tn |
| P9: BBA +NPK vs Mesopori+NPK | 14.04-14.58=-0.54 | 3.78 | 0.61 tn |

Description: * = significantly different at level α 5%
tn = not significantly different at level α 5%

### *3.1.6. Curd Diameter*

The results showed that the various types of nitrogen source fertilizers increased the diameter of the curd of cauliflower compared to no fertilizer. Mesopori SRU fertilizer and BBA significantly produced higher curd diameter than Bentonite SRU fertilizer. SRU fertilizer with the addition of NPK significantly produced higher curd diameter than without fertilizer of NPK (Table 6).

Table 5. Effect of types N fertilizer and NPK addition on the dry weight of oots

| Comparison | Difference (cm) | (%) | $F_{count}$ |
|---|---|---|---|
| P1: No fertilizer vs. Fertilization | 1.54-3.81=-2.27 | 59.60 | $21.43^{*}$ |
| P2: Urea vs SRN | 4.34-3.65=0.69 | 18.76 | $2.34^{tn}$ |
| P3: Bentonit vs BBA and Mesopori | 3.11-3.42=-0.31 | 9.18 | $0.55^{tn}$ |
| P4: BBA vs Mesopori | 3.56-3.61=-0.05 | 1.31 | $0.00^{tn}$ |
| P5: Urea vs Urea +NPK | 4.34-4.73=-0.39 | 10.01 | $0.29^{tn}$ |
| P6: SRN vs SRN+NPK | 3.42-4.40=-0.98 | 21.78 | $5.35^{*}$ |
| P7: Urea +NPKvs SRN+NPK | 4.73-4.40=0.33 | 7.34 | $0.30^{tn}$ |
| P8: Bentonit +NPKvs BBA +NPK and Mesopori+NPK | 4.41-4.53=-0.39 | 9.49 | $0.38^{tn}$ |
| P9: BBA +NPK vs Mesopori+NPK | 4.13-4.94=-0.81 | 17.80 | $1.22^{tn}$ |

Description: * = significantly different at level α 5%
tn = not significantly different at level α 5%

Table 6. Effect of types N fertilizer and NPK addition on curd diameter

| Comparison | Difference (cm) | (%) | $F_{count}$ |
|---|---|---|---|
| P1: No fertilizer vs. Fertilization | 7.00-9.05 = -2.05 | 22.66 | $12.77^{*}$ |
| P2: Urea vs SRN | 9.83-8.80 = 1.03 | 11.69 | $3.86^{tn}$ |
| P3: Bentonit vs BBA and Mesopori | 7.22-8.46 = -1.24 | 14.71 | $6.35^{*}$ |
| P4: BBA vs Mesopori | 8.79-9.38 = -0.58 | 6.26 | $0.46^{tn}$ |
| P5: Urea vs Urea +NPK | 9.83-10.50 = - 0.67 | 7.42 | $0.61^{tn}$ |
| P6: SRN vs SRN+NPK | 8.46-9.51= -1.05 | 10.79 | $4.54^{*}$ |
| P7: Urea +NPKvs SRN+NPK | 10.50-9.51 = 0.99 | 10.10 | $1.99^{tn}$ |
| P8: Bentonit +NPKvs BBA +NPK and Mesopori+NPK | 9.25-9.65 = - 0.40 | 4.16 | $0.29^{tn}$ |
| P9: BBA +NPK vs Mesopori+NPK | 9.54-9.75 = - 0.21 | 2.16 | $0.06^{tn}$ |

Description: * = significantly different at level α 5%
tn = not significantly different at level α 5%

### *3.1.7. Curd Weight*

The results showed that the various types of nitrogen fertilizer increased the curd weight of the cabbage flower compared to no fertilizer. Among various types of nitrogen source fertilizers, urea actually produces heavier curd weights than SRU fertilizer. The addition of NPK produced heavier curd weights in both urea and SRU fertilizers than compared with no addition of NPK (Table 7).

Table 7. Effect of types N fertilizer and NPK addition on curd weight

| Comparison | Difference (g) | (%) | $F_{count}$ |
|---|---|---|---|
| P1: No fertilizer vs. Fertilization | 46.85-98.82= -51.97 | 52.59 | $29.35^{*}$ |
| P2: Urea vs SRN | 107.45-85.63=21.83 | 25.49 | $6.21^{*}$ |
| P3: Bentonit vs BBA and Mesopori | 62.82-78.35= -15.54 | 19.83 | $3.54^{tn}$ |
| P4: BBA vs Mesopori | 85.58-86.66= - 1.09 | 1.17 | $0.01^{tn}$ |
| P5: Urea vs Urea +NPK | 107.45-139.11= - 31.66 | 31.91 | $4.90^{*}$ |
| P6: SRN vs SRN+NPK | 78.35-120.07=-41.72 | 33.42 | $25.54^{*}$ |
| P7: Urea +NPKvs SRN+NPK | 139.11-120.07=19.04 | 15.25 | $2.66^{tn}$ |
| P8: Bentonit +NPKvs BBA +NPK and Mesopori+NPK | 111.19-120.07=-8.88 | 7.40 | $1.16^{tn}$ |
| P9: BBA +NPK vs Mesopori+NPK | 127.90-121.12= 6.78 | 5.44 | $0.22^{tn}$ |

Description: * = significantly different at level α 5%
tn = not significantly different at level α 5%

### 3.2. Discussion

The provision of various types of nitrogen source fertilizer and the addition of NPK serves to provide nutrients for both vegetative and generative plant growth. The availability of nutrients in the soil will affect plant growth. Vegetative growth of plants can be stimulated by applying nitrogen source fertilizer [9]. Nitrogen elements play a role in the formation of chlorophyll, fat, protein, other assimilates needed by plants [10]. Besides N, P and K elements are also needed for flower cabbage plants. According [11] P elements play a role in photosynthesis, respiration, electron transfer, root extension, storage of energy and increase the efficiency of N elemental functions. The element K plays a role in the metabolic process as photosynthetic regulator, transport of nutrients from root to leaf, and translocate assimilate throughout plant parts. Flower cabbage plants require the availability of high amounts of nutrients for metabolic processes during their life cycle, especially the final phase of growth. [12] recommended fertilizer for cauliflower is 300 kg SP36 ha, 225 kg ha KCl, and 200 kg ha urea. The administration of urea fertilizer compared to slow release fertilizer (SRU) shows better growth, especially in the number of leaves and curd weight. This increase in growth is due to the availability of N nutrients from urea available more quickly and at the beginning of the growth of flower cabbage requires large amounts of N elements so that the administration of urea at the age of one week after planting is very helpful in the supply of nitrogen. However, if the source N fertilizer is combined with NPK, the slow release nitrogen fertilizer shows better results than urea fertilizer. The addition of NPK fertilizer causes the availability of balanced nutrients and in sufficient quantities is met for the growth of flower cabbage plants. The N and K fertilizers can increase the activity of PEP carboxylase in leaves, although the role of N in stimulating the activity of photosynthetic enzymes is more dominant than K. P elements also play a role in the formation of ATP energy which will then be used for photosynthetic translocation to the part of the plant organ that needs it. The P element contained in NPK plays an important role in the formation and growth of mustard roots, so that the roots are better able to absorb more water and nutrients and in the end the plant will grow and develop better overall.

The SRU fertilizer and addition of NPK produced better growth than without NPK, especially in the number of leaves, leaf length, leaf width, root dry weight, curd diameter, and curd weight. While the better growth of urea and NPK fertilizers is only seen in the number of leaves and curd weight. This is because plant growth is dominated by vegetative growth of plants such as number of leaves, leaf size and root system development. Increasing the nitrogen dose increases the leaf area index, relative growth rate, and the rate of assimilation. which in turn will increase the resulting photosynthetic to be translocated to the curd so that the weight increases. The addition of NPK, causes the supply of K, which functions in regulating the pattern of photosynthetic partition so that photosynthetic partitions are more directed to the economic part of the curd.

The absorption of N by cauliflower was very low before the leaf formation stage to -4 to 6 and there was a tendency to increase absorption of N at the beginning of curd initiation and then continue to increase until harvest [13]. In general, the SRU fertilizer has the potential to be developed as an alternative source of N fertilizer, although in the cauliflower plants need additional sources of other elements, such as P and K to support plant growth. The added of P and K as basic fertilizers serves to supplement the nutrient requirements other than N from the SRU fertilizer. Another advantage with the use of SRU is that it saves the use of labor for fertilization because of its pellet shape, while the urea fertilizer is pril-shaped.

Cauliflower depends on N fertilizer and excessive application of N rarely has a negative impact. Increasing the number of leaves and the size of the leaves will increase the chlorophyll content in the leaves. This chlorophyll will capture sunlight in photosynthesis. The photosynthesis process will produce photosynthates which are translocated to increase leaf size. The development and increase in leaf size are influenced by the availability of water and the dissolved nutrients are then transported to the upper part of the plant and some will be used to increase the pressure of leaf cell turgor [14].

Overall this study shows that various sources of nitrogen (N) and adding NPK can increase the growth of cauliflower. N source fertilizers from both urea or SRU fertilizers and addition of NPK produce heavier curd weights compared to without NPK. The use of SRN fertilizer and NPK increased the curd weight with 3 leaves by 41.72 grams or 33.42% compared to without NPK. The urea fertilizer with the addition of NPK increased the weight of curd (31.66 grams or 31.91%) compared without NPK. This shows that the use of SRU fertilizer and addition of NPK has the potential to be developed and used for fertilizing crops, especially Mesopori SRN fertilizer. In connection with the addition of NPK fertilizer in this study, which did not use basic fertilizer, for the next study can be tested the use of SRN which is added basic fertilizer, especially the source elements of P and K.

## 4. Conclusions and Suggestions

### *4.1. Conclusion*

Based on the results of the research that has been done, the following conclusions are obtained:

The provision of various types of N fertilizer resulted in the growth of plant height, leaf number, leaf length, leaf width, root dry weight, curd diameter, and curd weight higher than without fertilization. Addition of NPK increases the growth of cauliflower compared to without NPK, especially in curd diameter and curd weight. The provision of N-source fertilizers from both urea and SRN and addition of NPK further increases the growth and yield of cauliflower compared to without NPK.

### *4.2. Recommendations*

The advice given for the next research is that it is necessary to try the use of SRN fertilizer in the field with the addition of basic fertilizer containing P and K elements because in this study no basic fertilizer was used.

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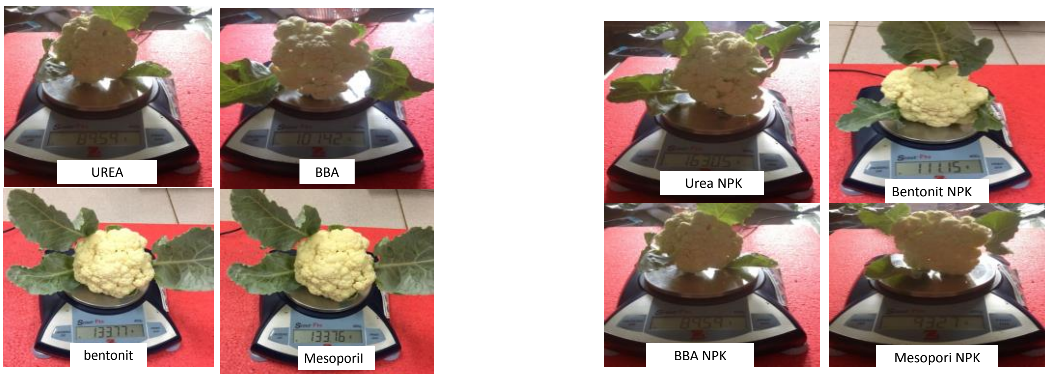
**Illustration**


Picture 1. *The appearance of plants with types of N fertilizer source and NPK addition*




Picture 2. The difference of *influence of N fertilizer source and NPK addition to Curd weights*

# PROCEEDING

## International Symposia on Horticulture

The International Symposia on Horticulture (ISH) was held for 4 days from 27 until 30 November 2018. This Symposia was organized by Indonesian Center for Horticulture Research and Development (ICHORD) under Indonesian Agency for Agricultural Research and Development (IAARD) Ministry of Agriculture, and was supported by Australian Center for International Agricultural Research (ACIAR), Indonesian Horticulture Association (PERHORTI) and Indonesian Agronomy Association (PERAGI). Theme of ISH was "Emerging Challenges and Opportunities in Horticulture Supporting Sustainable Development Goals". The outputs of the Symposia were (1) elevation a number of new ideas of horticulture innovation development, (2) spread information related to technology of horticulture innovation among horticulture scientists and practicians, and (3) increase collaboration among the various parties to develop agrihorticulture networks. This proceeding contains 5 main topics such as tropical and sub-tropical fruits, vegetables, ornamental plants, socio economics studies and integrated crop managements, which have been selected and reviewed by reviewers.

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