

# Selection and Correlations of Character Agronomy of Onion (*Allium cepa* L.) Var. Bima in Salinity and Drought Condition In Vivo

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**Abstract.** Onion exports need to be increased through increased production. However, the area of land for the cultivation of this commodity has diminished due to the conversion of land to settlements and industry so that only marginal land is not productive for onion cultivation. This study aims to estimate the agronomic characters capable of being used as an indirect selection on the character of salinity and drought conditions and to obtain genotypes of onion are able to adapt to the artificial conditions of salinity and drought in vivo. Genetic material used is Bima onion bulbs with augmented design with a spaced planting system, with a spacing of 20 cm x 20 cm, and each hole contains 1 shallot bulb using a head-to-row system. This study uses a combination of NaCl and PEG 6000 as a salinity and drought selection agent. The results of this study indicate that agronomic characters that have a strong and positive correlation value and can be used as a direct selection character for the vegetative phase, namely root volume and root length, generative phase, namely age of harvest and yield components, namely the weight of parent plant tubers, the weight of saplings and tuber weights per plant. There are nine genotypes suspected to be able to adapt to artificial conditions of salinity and drought in vivo, namely S3-1, S3-2, S3-3, S4-1, S4-2, S4-3, S5-1, S5-2, and S5-3 resulted from Scatterplot analysis for two variables and from a comparison of five parameters to tuber weights per plant.

Keywords: adaptation, agent selection, character selection, marginal land, NaCl, PEG 6000.

## 1. Introduction

Expansion of agricultural land in Indonesia is one method of development in the agricultural sector. This expansion has decreased every year due to land conversion to settlements and the development of other non-agricultural sectors. So, what is available for agriculture is non-productive land which has many limiting factors called marginal land. The problem faced by farmers in developing shallots is the decreasing availability of productive land. [2] predicts that about 20% of agricultural land will become saline so that saline land in Indonesia reaches more than 1 million hectares. One study of salinity in Indramayu District resulted in 37,136 ha of saline land which was classified as high and very

high salinity conditions or around 33.1% [5]. In addition to saline conditions, the development of productive land is also limited by the problem of drought. The dry land area in South Sulawesi reaches 1,802,510 hectares and there are six districts in South Sulawesi that have dry land area of more than 100 hectares, namely Bone Regency 181,030 hectares, Wajo 142,059 hectares, Luwu 127,044 hectares, Enrekang 108,912 hectares, and Tana Toraja 101,948 hectares [1].

Salinity can be defined as soil conditions with  $EC > 4$  S/m with osmotic pressure of 0.2 MPa and exchangeable sodium percentage (ESP)  $< 15$ . Saline soils usually have a neutral pH and tend to be alkaline (Marschner 1995; USDA-ARS 2008). Saline can be formed due to poor irrigation systems, rising, rising surface and sea water intrusion, waste pollution and excessive exploitation of ground water [6]; [7]; [18]; [16]. While the dry land is defined as land expanse that never flooded or flooded on most of the time in a year or lifetime. Dry land is currently still possible for the development of the agricultural sector with an area of 791,000 hectares consisting of wetlands with wet climate (572,000 hectares) and drylands with dry climate (219,000 hectares). The problem faced in the development of shallots in saline and dry conditions is that there is not enough water available for plants so that photosynthesis is not optimal [20].

Photosynthesis consists of two phases, namely phase I occurs in grana by producing ATP and NADPH<sub>2</sub> and phase II occurs in the stroma by producing carbohydrates/photosynthate (Ai, 2012). Photosynthates will be transplanted to parts of the plant that are needed during vegetative and generative growth. The pattern of photosynthate distribution will be different between the vegetative phase and the generative phase. In the vegetative phase, photosynthate is only distributed to the roots, stems, leaves, petioles and branches, while the generative phase is also distributed to the flowers and pods [13]. The ability of the source (source) to produce photosynthate and the ability of the user (sink) to accommodate photosynthate greatly determines the production of a plant. The distribution of photosynthates to parts of economic value (harvested parts) provides an opportunity to obtain higher yields [20]. In suboptimal conditions (lack of water), the chances of achieving optimal results are very narrow so that solutions need to be found so that high results can still be achieved.

The use of onion varieties tolerant of saline and drought is one attempt to address the problem. However, the number of shallots varieties that are tolerant of both conditions is still relatively small. So that needs to assembling high-yielding varieties through plant breeding is the selection process. Selection of plants is a plant-breeding methods to obtain superior genotypes. However, before selecting genotype, need to determine the character selection that have a close relationship and positive impact on the character of the destination using correlation analysis. The correlation coefficient is a measure or index of the relationship between two variables with a coefficient value between +1 to -1. The coefficient of diversity can measure the interrelationships between various plant characters and determine the character of the components to be selected and based on the improvement of the characters associated with the characters of complex results [17], [12], [3], [10], [22]. Simple correlations are divided into phenotypes (which can be directly observed), genotypes (inherent relationships between characters) and environment (environmental deviations together with non-additive genetic diversity components) (Singh dan Chaudhary, 1985).

[21], states that the weight character of wheat seeds per main panicle can be used as a selection criterion with a real and positive correlation value to the weight characteristics of seeds per plant. Karyawati et al., (2016), states that the number of filled pods is positively correlated to the results so that it can be used as a direct selection character to increase soybean yields. [8], stated that the panicle length and percentage of hybrid rice grain yields had a positive and real direct effect on the results of 0.095 and 0.0956 so that these characters could be used as selection criteria.

This study aims to estimate the agronomic characters capable of being used as an indirect selection on the character of salinity and drought conditions and to obtain genotypes of onion are able to adapt to the artificial conditions of salinity and drought in vivo.

## **2. Experimental Method**

This research was carried out in the Experimental Garden of the Faculty of Agriculture, University of Cokroaminoto Palopo and took place in July-December 2018. Genetic material used is the Bima variety of shallots with augmented design with a spaced planting system, with a spacing of 20 cm x 20 cm, and each hole contains 1 shallot bulb using a head-to-row system. Early fertilization is done by adding compost as basal fertilizer. Fertilizer is spread over the beds and stirred with the soil until it is spread evenly. Added 47 kg/ha urea, 100 kg/ha ZA, and 56 kg/ha SP-36, and KCl.

This study used nine treatments namely P0 = control (MS + 0 g NaCl + 0 g PEG 6000), P1 = MS + 1.5 g NaCl + 1 g PEG 6000, P2 = MS + 2.0 g NaCl + 1.5 g PEG 6000, P3 = MS + 2.5 g NaCl + 2.0 g PEG 6000, P4 = MS + 3.0 g NaCl + 2.5 g PEG 6000, P5 = MS + 3.5 g NaCl + 3.0 g PEG 6000, P6 = MS + 4.0 g NaCl + 3.5 g PEG 6000, P7 = MS + 4.5 g NaCl + 4.0 g PEG 6000, P8 = MS + 5.5 g NaCl + 4.5 g PEG 6000 and P9 = MS + 6.0 g NaCl + 5.5 g PEG 6000. The observation parameter used is plant height (cm), number of leaves (leaf), tiller number, root length (cm), root volume (ml), harvesting (HST), the diameter of the bulbs (cm), weight of tuber parent plant (g), number of tillers, weight of tillers (g).

## **3. Result and Discussion**

### *3.1. Correlation of Agronomic Character against Yield Components*

The estimation of correlation analysis is intended to study the pattern of the relationship between agronomic traits and tuber production and to obtain the main characters that can be used as genetic improvement goals in each plant breeding program. The combination of selection characters between agronomic characters and their components can also be used to improve genetic progress and obtain onion genotypes that are capable of producing in conditions of salinity and drought in Palopo City. Particularly in the development of onions in a dense environment, agronomic characters are more influenced by environmental factors so that selection will be more effectively carried out on characters that are positively and significantly correlated to the character of yield components.

Character number of leaves a strong and positive correlation with the number of tubers tillers character correlation value reaches 0.802. Character number of tillers strong and positive correlation with the number of tubers tillers character correlation value 0.954. Root length characters were strongly and positively correlated to root length and root tuber weights with the correlation value reaching 0.953. Meanwhile, the root volume character is strongly and positively correlated to the tuber weight character with a correlation value of 0.982. Meanwhile, the age of harvest correlates strongly and positively with the character of tuber weights per plant with a correlation value of 0.907. Tuber weight was positively correlated character to character tuber weight tiller with a correlation value reached 0.633. The tuber weight character was positively correlated and significantly affected the tuber weight character per plant with a correlation value reaching 0.673.

Correlation relationship between the age of harvest and plant weight with the characteristics of seedling tuber weight showed relatively similar results and correlated strongly and positively on the character of weight per plant. This shows that there is a pressure of selection and improvement of the character of the age of the harvest and the tuber weight will increase the performance of the character weight per plant. The relationship of harvest age indicates that the faster the age of the plant, it is very influential on the weight of the tubers and the plants and vice versa.

In addition, the increasing weight of saplings tubers will also increase the weight per plant. [14] reports that selection for increasing the potential weight per plant can be done in the generative phase for observing the character of harvest age and yield components. Inhibition of harvest age on onion

genotypes is due to the influence of environmental stress that affects the weight per plant. [11] reported that high temperature stresses affect all aspects of plant poses namely germination, growth, development, reproduction and yield components. [4] reported that environmental stress will have an impact on the number of tillers and reduce the yield component.

Character number of leaves and number of roots and positively correlated to the number of tubers tillers. Increasing the number of seedlings allows plants to have relatively more leaves which can be used by plants in the formation of macromolecules during the process of photosynthesis which will be transplanted throughout all parts of the plant for seed formation. [19] stated that the higher number of leaves with upright growth conditions such as onions can increase the efficiency of light capture. Light captured by plant photoreceptors is then converted into a form of chemical energy that is utilized in the photosynthesis reaction. The resulting photosynthate accumulation will form tubers in onion plants. Khokhar et al., (2010) in [21] stated that the number of tiller tubers and tiller tuber weights greatly contributed to the weight per plant.

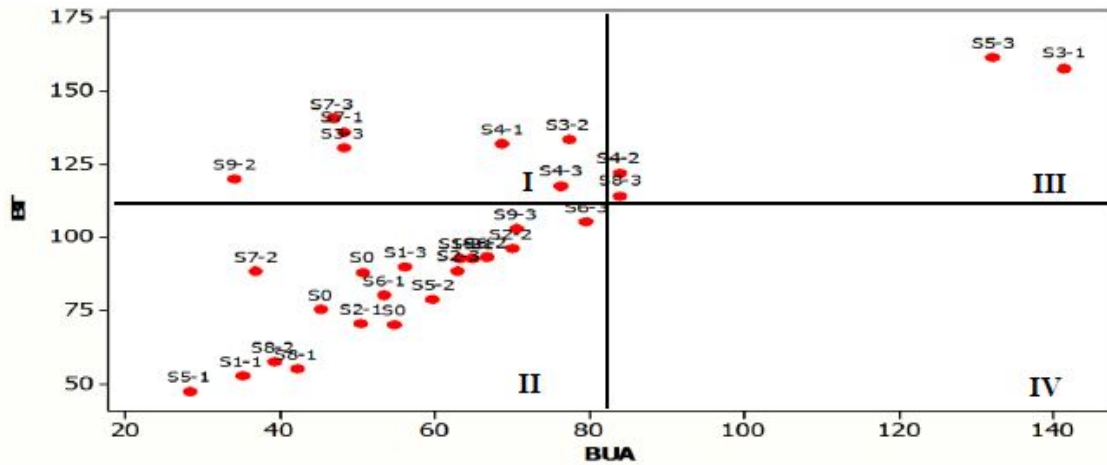
Table 1. Correlation Matrix of Onion (*Allium cepa* L.) Agronomy Character in Salinity and Drought Stress Conditions in vivo

| Characters | TT                  | JD                  | JA                        | PA                        | VA                        | UP                        | DU                  | BU                        | JUA                 | BUA                      |
|------------|---------------------|---------------------|---------------------------|---------------------------|---------------------------|---------------------------|---------------------|---------------------------|---------------------|--------------------------|
| JD         | 0.365 <sup>ns</sup> |                     |                           |                           |                           |                           |                     |                           |                     |                          |
| JA         | 0.314 <sup>ns</sup> | 0.294 <sup>ns</sup> |                           |                           |                           |                           |                     |                           |                     |                          |
| PA         | 0.366 <sup>ns</sup> | 0.285 <sup>ns</sup> | 0.539 <sup>ns</sup>       |                           |                           |                           |                     |                           |                     |                          |
| VA         | 0.449 <sup>**</sup> | 0.898 <sup>ns</sup> | 0.154 <sup>ns</sup>       | 0.009 <sup>ns</sup>       |                           |                           |                     |                           |                     |                          |
| UP         | 0.472 <sup>**</sup> | 0.392 <sup>ns</sup> | 0.492 <sup>ns</sup>       | 0.449 <sup>ns</sup>       | 0.506 <sup>**</sup>       |                           |                     |                           |                     |                          |
| DU         | 0.318 <sup>ns</sup> | 0.461 <sup>ns</sup> | 0.288 <sup>ns</sup>       | 0.331 <sup>ns</sup>       | 0.349 <sup>ns</sup>       | 0.279 <sup>ns</sup>       |                     |                           |                     |                          |
| BU         | 0.489 <sup>ns</sup> | 0.646 <sup>ns</sup> | 0.354 <sup>ns</sup>       | 0.337 <sup>ns</sup>       | 0.300 <sup>ns</sup>       | 0.624 <sup>*</sup>        | 0.617 <sup>ns</sup> |                           |                     |                          |
| JUA        | 0.213 <sup>ns</sup> | 0.802 <sup>ns</sup> | <b>0.954<sup>ns</sup></b> | 0.622 <sup>ns</sup>       | 0.686 <sup>ns</sup>       | 0.695 <sup>ns</sup>       | 0.320 <sup>ns</sup> | 0.265 <sup>ns</sup>       |                     |                          |
| BUA        | 0.436 <sup>ns</sup> | 0.679 <sup>ns</sup> | 0.474 <sup>ns</sup>       | <b>0.953<sup>ns</sup></b> | <b>0.982<sup>ns</sup></b> | 0.347 <sup>ns</sup>       | 0.276 <sup>ns</sup> | <b>0.633<sup>ns</sup></b> | 0.526 <sup>*</sup>  |                          |
| BT         | 0.378 <sup>ns</sup> | 0.405 <sup>ns</sup> | 0.411 <sup>ns</sup>       | 0.494 <sup>ns</sup>       | 0.652 <sup>ns</sup>       | <b>0.907<sup>ns</sup></b> | 0.354 <sup>ns</sup> | 0.257 <sup>ns</sup>       | 0.624 <sup>ns</sup> | <b>0.673<sup>*</sup></b> |

Description : \*\* = very significant; \* = significant; ns = non-significant; TT = Plant Height; JD = Number of Leaves; JA = Number of tillers; PA = Root Length; VA = Root Volume; UP = Harvest Age; DU = Bulb Diameter; BU = Weight of Parent Plant Bulbs; JUA = Number of Tiller Bulbs; BUA = Tiller Bulbs Weight

### 1.2. Selection on Character Weight per Plant and Seedling Weight of Tiller

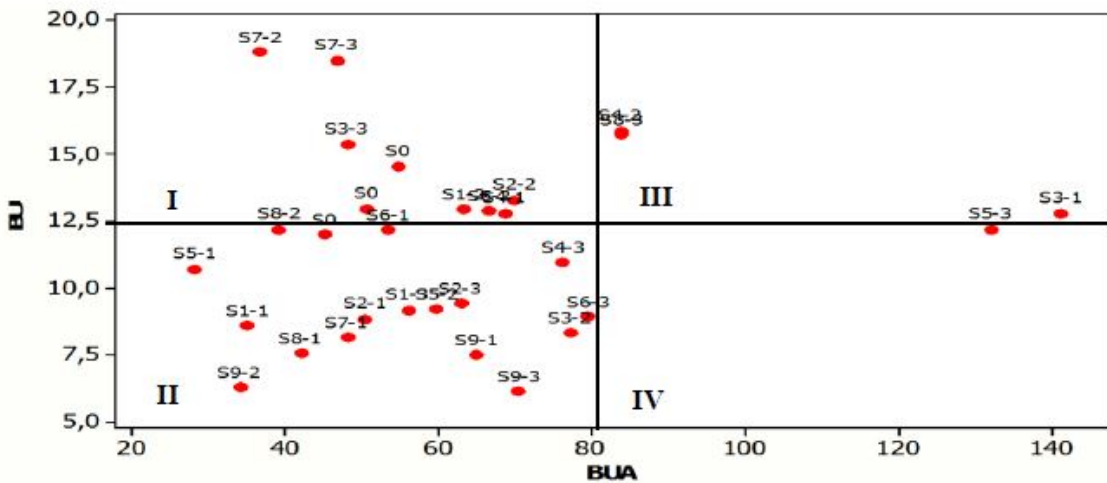
Figure 1 shows quadrant I is a quadrant for genotype which has a high weight per plant but low tuber weight. Quadrant II is a quadrant for genotype that has a low weight per plant accompanied by low tuber weight. Quadrant III is a quadrant for genotype which has a high weight per plant and high tuber weight. Whereas, for quadrant IV is a quadrant for genotypes that have low weight per plant but has high tuber weight. Based on the separation of quadrants produced genotypes that are potential for saline and dry conditions are genotypes that are in quadrant III.



**Figure 1.** Distribution of onion genotypes on salinity and drought conditions in Palopo City for the characteristics of tuber weight per plant and seedling tuber weight

Based on quadrant separation, potential genotypes were developed under saline and dry conditions, namely genotypes S3-1, S4-2, and S5-3. The figure indicates that the genes that control the yield potential are the same as the genes that control the characteristics of the root tuber weight ratio. Characteristics of weight per plant and seedling weight of tubers are controlled by a few genes. Therefore, the shallot population developed in Palopo City that has heterozygous genotypes for both characters is reduced.

*1.3. Selection on Weights Character Parent Plant Bulbs and Tubers Weight Puppies*



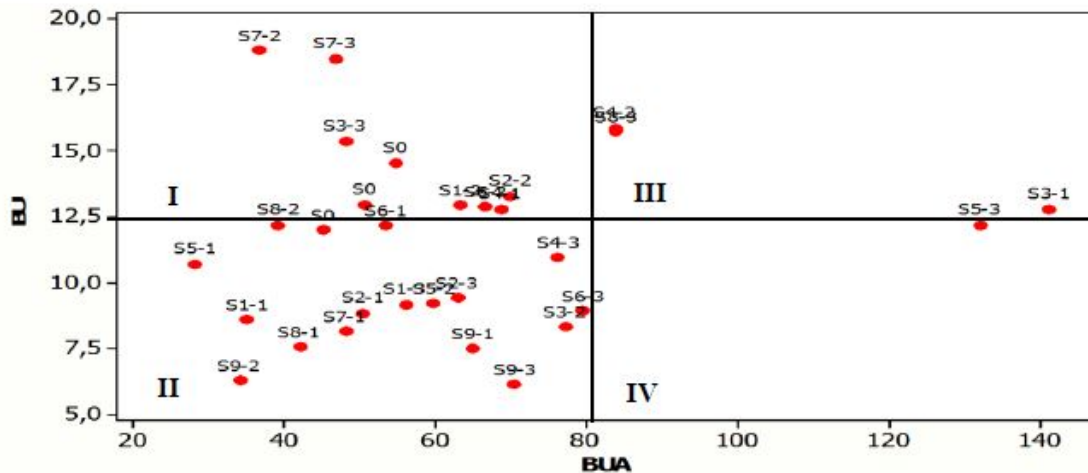
**Figure 2.** Distribution of onion genotypes in salinity and drought conditions in Palopo City for the characteristics of parent plant tuber weights and seedling tuber weights

Figure 2 shows quadrant I is the quadrant for genotypes that have high tuber weight tubers but low tuber weights. Quadrant II is a quadrant for genotypes that have low parent plant tuber weights accompanied by low seedling tuber weights. Quadrant III is a quadrant for genotypes that have high parent plant tuber weights and high seedling tuber weights. Whereas, for quadrant IV is a quadrant for genotype which has a low parent plant weight but has a high root tuber weight. Based on the separation

of squares produced genotypes that are potential for saline and dry conditions are genotypes that are in quadrant III.

Based on quadratic separation, potential genotypes are S3-1, S4-2, and S5-3 which indicate that the genotypes have a performance for the number and size of tuber which is more banik than other genotypes. This indicates that the genotype has increased sink capacity and increased source capacity, and the assimilation of photosynthesis results can be allocated for the development of tubers and shallots tillers. [21] states that an increase in the number of seeds per panicle and weight of seeds per plant for wheat plants indicates an increase in photosynthetic assimilation which acts as a sink and source.

#### 1.4. Selection on Character Age of Harvest and Weight of Bulbs per Plant



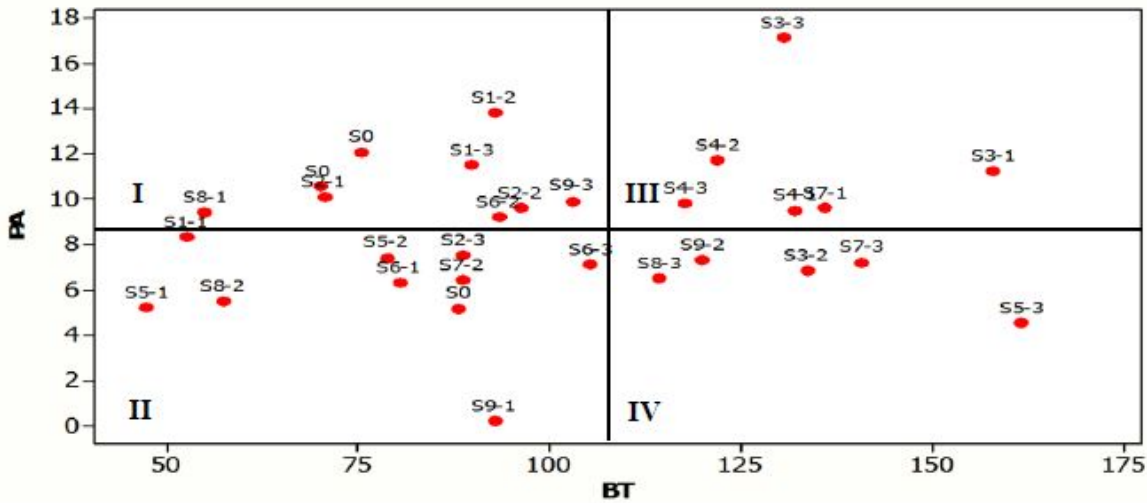
**Figure 3.** Distribution of onion genotypes in salinity and drought conditions in Palopo City for the character of harvest age and tuber weight per plant

Figure 3 shows quadrant I is a quadrant for genotypes that have a slow harvest age but low tuber weight per plant. Quadrant II is a quadrant for genotypes that have early maturity, accompanied by low tuber weights per plant. Kuadran III merupakan kuadran untuk genotipe yang memiliki umur panen lambat dan bobot umbi per tanaman yang tinggi pula. Whereas, for quadrant IV is a quadrant for genotypes that have early maturity but have high tuber weight per plant. Based on the separation of squares produced by genotypes that are potential for saline and dry conditions are genotypes that are in quadrant III.

Based on quadratic separations, potential genotypes are S3-1, S3-2, S3-3, S4-1, S4-2, S4-3, and S5-3 which indicate that these genotypes have a performance for long harvests. compared to other genotypes. This indicates that the onion genotype maximizes tuber development. Because the longer the harvest time, the more optimal the development and differentiation of tubers.

#### 1.5. Selection on Character Length of Root and Weight of Bulbs per Plant

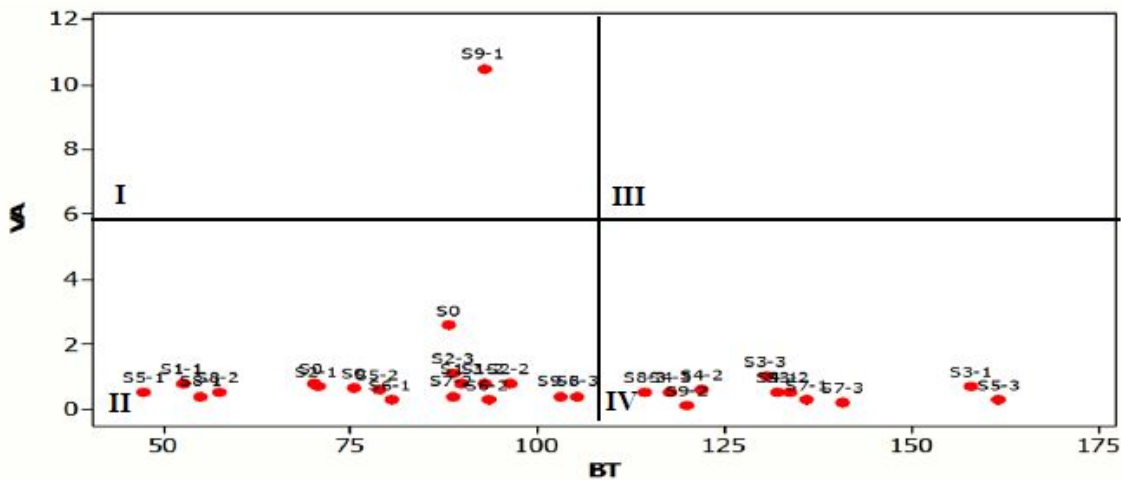
Figure 4 shows quadrant I is a quadrant for genotypes that have high root length but low tuber weight per plant. Quadrant II is a quadrant for genotype which has a root length accompanied by a low tuber weight per plant. Quadrant III is a quadrant for genotypes that have high root length and high tuber weight per plant. Whereas, for quadrant IV is a quadrant for genotype which has a low root length but has a high tuber weight per plant. Based on the separation of squares produced by genotypes that are potential for saline and dry conditions are genotypes that are in quadrant III.



**Figure 4.** Distribution of onion genotypes in salinity and drought conditions in Palopo City for the character of root length and weight per plant

Based on quadratic separation, potential genotypes are S3-1, S3-3, S4-1, S4-2, and S4-3 which indicate that these genotypes have a tolerance to environmental stress namely saline and dryness marked by growth unobstructed roots. Root role in absorbing water and mineral salts that are used for plant growth and development. The genotype has a mechanism in which conditions are gripped without significantly reducing the production of shallots.

*1.6. Selection on Root Volume Characteristics and Tuber Weight per Plant*



**Figure 5.** Distribution of onion genotypes under salinity and drought conditions in Palopo City for the character of root volume and tuber weight per plant

Figure 5 shows quadrant I is a quadrant for genotypes that have high root volume but low tuber weight per plant. Quadrant II is a quadrant for genotypes that have low root volume and tuber weights per plant. Quadrant III is a quadrant for genotypes that have high root volumes and high tuber weights per plant. Whereas, for quadrant IV is a quadrant for genotype that has low root volume but has a high

tuber weight per plant. Based on the separation of quadrants produced a potential genotype of saline and dry conditions is a genotype that is in quadrant IV.

Based on quadratic separation, potential genotypes are S3-1, S3-3, S4-1, S4-2, S4-3, S5-2, and S5-3 which indicate that these genotypes have a tolerance to environmental stress by suppressing water absorption but does not result in decreased tuber production. In particular stress conditions saline and dry, the selection agent used is NaCl and PEG suppress absorption of water so the roots are unable to absorb the water needed by the plant. With the addition of the selection agent, the process of imbibition and turgor pressure are inhibited.

### Conclusion

Estimation of the selection character is obtained through the correlation value of some agronomic characters to the yield component. An agronomic character that has a strong and positive correlation value and can be used as a direct selection character for the vegetative phase, namely root volume and root length, generative phase, i.e. harvest age and yield components, namely the parent plant tuber weights, seed tuber weights and tuber weights per plant. There are nine genotypes suspected to be able to adapt to artificial conditions of salinity and drought in vivo, namely S3-1, S3-2, S3-3, S4-1, S4-2, S4-3, S5-1, S5-2, and S5-3 resulted from Scatterplot analysis for two variables and from a comparison of five parameters to tuber weights per plant.

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