Productivity of SS Sakato Shallot Variety in Three Locations in Indonesia

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Abstract. To reduce fluctuations in the supply and price of shallots, the release of shallot varieties is necessary because shallots are an important vegetable crop in Indonesia and as an effort to increase the productivity of shallots in Indonesia. The availability of high-yielding and disease-resistant shallot varieties will ensure long-term output. This research aims to test the productivity of the newly released variety, SS Sakato, in three different locations in Indonesia. This variety was developed by the Center for Tropical Horticultural Studies in a participatory plant breeding scheme with farmers from 2014 to 2017. The research was conducted in Solok, Kuningan, and Bogor from September 2020 to July 2021. The results showed that the SS Sakato variety grew well in all locations. According to the variety description, SS Sakato had the potential for tuber yields of 17.52–28 tons/ha, whereas productivity in the three research locations was 27.62–29.44 tons/ha (Bogor), 26.66–29.42 tons/ha (Solok), and 18.20–21.33 tons/ha (Kuningan). This indicates that the SS Sakato variety is adaptable and can be used as a national variety in Indonesia to increase shallot production and farmers' incomes.

Keywords: Horticulture · Participatory Plant breeding · Released variety · Vegetable

1 Introduction

According to Ministry of Agriculture [1], shallot harvested area expanded about 10.11% per year from 2014 to 2018. However, shallot productivity did not increase as a result, decreasing by 1.23% per year. In addition, because shallots are one of the national superior commodities that play an important role in the agricultural sector, it is necessary to develop their productivity potential. In Indonesia, shallots are considered to involve a significant role in economic growth, particularly in areas where shallot production is concentrated [2], such as Central Java, East Java, and West Nusa Tenggara [3]. One of the benefits received by the community is as the major spice, it cannot be substituted with other commodities. Shallots are also used in traditional medicine because they have an antiseptic effect and function as a bactericidal anti-microbial [4]. The various advantages

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received by the community motivate the government to focus on the potential of shallots by increasing shallot productivity in areas where shallot production is not concentrated.

That according Ministry of Agriculture [1], Indonesia produced 1.46 million tons of shallots in 2019, with an estimated scattered amount of 77.98 thousand tons. Meanwhile, Indonesian shallot consumption has been increasing, at 2.67 kg/capita/year from 2013 to 2018, with population growth of 6.42% per year during the same period. Additionally, the average shallot import volume in 2017–2018 was 211 tons. The People use shallots in a variety of different ways, including as food ingredients, seeds, and stocking (other uses). According to Dewi and Sutrisna [5], the high demand and consumption for shallots is in line with population growth and the development of the processed food industry. However, there are a number of challenges in cultivating shallots, including limited land, cultivation methods, fertilization, diversity of soil types, and post-harvest handling [6]. Furthermore, the price of shallot seeds is relatively high [7]. This is related to the reasons that shallot seeds are seasonal, during harvest the price tends to be cheap but during the off-season, the price of shallot seeds is quite expensive [8].

The instability of production results that occur every year is the impact of changes in environmental factors related to plant performance. According Astuti et al. [9], farmers tend to enlarge the shallot planting area in the dry season to increase shallot yield over the rainy season. Because of the risk of rotting shallots, farmers reduce shallot productivity during the wet season. To increase productivity, shallot varieties with high adaptability and tolerance should be developed. According to Basundari and Krisdianto [10], plants must be able to adapt to changing environmental conditions in order to obtain optimal growth and production results. Testing plants in various growing environments is one method for determining shallot level of adaption and performance [11].

In the development of shallot varieties, several things need to be considered, namely the agroecosystem and plant varieties that will be used to achieve optimal yields [4]. Generally, shallots are planted at an altitude of 0–900 masl during the dry season because shallots are sensitive to water [12]. In this research, we used a new variety SS Sakato from Solok, West Sumatera which is suitable for areas with low air temperature conditions and can be planted all year. The SS Sakato variety also has advantages, such as an oval tuber shape, purplish red tuber colour, and a potential tuber yield of 17.52–28 tons/ha [13]. The objective of this research is to evaluate the productivity of the new SS Sakato variety in three different Indonesian locations. The successful development of shallot varieties is expected to contribute to supply and price stability, as well as inflation control.

2 Materials and Methods

2.1 Study Area and Materials

This study was carried out in three locations: Solok Regency (Alahan Panjang Village), Kuningan (Bandorasa Wetan Village), and Bogor (Sukamantri Village) from September 2020 to July 2021. Plant material used in this study was SS Sakato variety. Other materials used in this study were manure 20 ton/ha, NPK fertilizer 125 kg/ha, Urea fertilizer 100 kg/ha, SP-36 fertilizer 150 kg/ha, KCL fertilizer 100 kg/ha, insecticides, and fungicides. The tools used in this study consisted of stationary and agricultural cultivation tools.

2.2 Procedure

This research used a single-factor split-plot experimental design. The factors observed were three locations and repeated three times. Each experimental unit consisted of 162500 plants with a spacing of 20 cm × 20 cm. The number of sample plants observed was 100 plants in each experimental unit.

Crop management included regular watering and weed and insect control. In shallot, weeds are physically removed according to crop conditions. Pest control was based on the IPM (Integrated Pest Management) concept, which included both preventative and curative measures. Fertilization was carried out in three steps: basic fertilizer, supplementary fertilizer 1 and supplementary fertilizer 2 [13]. Basic fertilization is given a week before planting. Supplementary fertilization is given two times, which is at the age of 10 and 30 days after planting (DAP). Shallot plants are ready-to-harvest when more than 80% of population's leaves began to turn yellow and dried up. SS Sakato variety should be able to be harvested at the age of 85–95 days after planting [14].

2.3 Observation

The variables observed included tuber weight per plant, tuber weight per plot, and yield per ha.

2.4 Data Analysis

Data obtained were analysed to determine the effect of the treatment using the F test at a significant level of 5%. The further test used Tukey's HSD (Honest Significant Difference) test at a significant level of 5%. The entire process of data analysis used Microsoft office Excel 2016 software and Statistical Analysis System (SAS) 9.0.

3 Results and Discussion

3.1 General Condition

The research was conducted in three different locations, namely Solok, Bogor, and Kuningan. The first research location was in Alahan Panjang Village, Lembah Gumanti, Solok Regency, West Sumatera. The research area is located at an altitude of about 1382–1458 masl [15]. The average temperature is 23.87 °C, while the average humidity is 86.01% at the time of the study. The average precipitation during this research was 345.84 mm/month (Table 1).

The second research location was in Sukamantri Village, Bogor Regency, West Java. The research area is located at an altitude of about 532 masl [15]. During this research, the average temperature was 24.68 °C, while the average humidity was 87.65% with an average precipitation of 258.24 mm/month (Table 2).

The third research location was in Bandorasa Wetan Village, Kuningan Regency, West Java. The research area is located at an altitude of about 400 masl [15]. The average temperature is 24.99 °C, while the average humidity is 88.03% and the average precipitation per month is 258.93 mm during the research (Table 3).

Table 1. Average temperature, humidity, and precipitation in September 2020–July 2021 in Solok Regency [16]

Month	Temperature (°C)	Humidity (%)	Precipitation (mm/month)
September	23.85	86.66	427.13
October	23.46	84.81	313.11
November	23.75	88.09	588.26
December	23.20	85.28	295.31
January	23.71	84.10	295.08
February	24.30	85.11	88.66
March	23.99	86.64	57.98
April	24.02	85.70	287.04
May	24.71	87.95	536.26
June	23.77	86.34	250.77
July	23.81	85.47	143.67

Table 2. Average temperature, humidity, and precipitation in September 2020–July 2021 in Bogor Regency [16]

Month	Temperature (°C)	Humidity (%)	Precipitation (mm/month)
September	25.18	82.76	149.68
October	25.14	86.34	305.99
November	25.23	85.88	203.44
December	24.24	89.07	228.88
January	24.03	90.12	315.04
February	24.11	91.75	551.27
March	24.56	88.65	484.41
April	24.74	87.47	206.81
May	25.25	88.70	166.83
June	24.78	87.98	158.62
July	24.21	85.46	69.72

Data on temperature, humidity, and precipitation [16] shows that the three research locations have the same climate conditions even though the altitudes of the three locations are different. Precipitation in all locations is included in the high intensity of rain.

Table 3. Average temperature, humidity, and precipitation in September 2020–July 2021 in Kuningan Regency [16]

Month	Temperature (°C)	Humidity (%)	Precipitation (mm/month)
September	24.86	84.49	98.19
October	25.15	86.32	296.16
November	25.50	87.36	353.53
December	24.92	89.06	452.39
January	24.76	89.77	344.37
February	24.75	91.11	520.86
March	25.11	87.88	353.48
April	25.05	87.91	161.64
May	25.49	88.42	79.25
June	25.08	88.19	146.61
July	24.21	87.86	41.72

3.2 Tuber Weight Per Plant

The results analysis showed that the difference in planting locations affected the weight of shallot bulbs per plant produced. Table 4 shows that block 2 in Solok gave the highest tuber weight yield per plant, which was 177.50 g, significantly different from block 2 in Kuningan (93.63 g). Meanwhile, the yield of tuber weight per plant in block 2 in Bogor is 151 g not significantly different from the other. Shallot variety SS Sakato comes from Solok which has an adaptation area in the highlands and able to grow in low temperature areas [14]. Tables 1, 2 and 3 shows that the three locations have the same climate conditions.

The difference tuber weight per plant produced at the research location indicates an interaction between the environment around the planting area and the varieties planted. There are differences in geographical conditions in the research location, namely the soil types. In Solok and Bogor, soil type found was Andosol, while Kuningan had alluvial soil type. Both soil types have characteristics and properties of each soil. According to Simanungkalit [17], soil physical properties are one of the inhibiting factors for plant growth. Good physical soil conditions can help root growth and tuber formation so that plants can produce optimal production. The sticky nature of alluvial soil [18] results in limited movement of plant roots and inhibits plant growth. This is thought to affect the yield of tuber weight per plant produced by shallots at each research location.

3.3 Tuber Weight Per Plot

Differences in planting location also affected tuber weight per plot, as shown in Table 5. The results analysis showed tuber weight per plot in Solok and Bogor was not significantly different, but significantly different from Kuningan. The highest tuber weight

Table 4. Average tuber weight per plant of SS Sakato variety in three locations

Location	Tuber Weight per Plant (g)		
	Block 1	*Block 2*	*Block 3*
Solok	139.75^{abc}	177.50^{a}	158.16^{ab}
Kuningan	93.33^{c}	93.63^{c}	109.43^{bc}
Bogor	142.00^{abc}	151.00^{abc}	141.67^{abc}

Note: numbers followed by the same letter in the same column are not significantly different based on the Tukey test with = 5%; *) significantly different at = 5%; **) significantly different at = 1%; tn) the difference is not real.

Table 5. Average tuber weight per plot of SS Sakato variety in three locations

Location	Tuber Weight per Plot (kg/m^2)		
	Block 1	*Block 2*	*Block 3*
Solok	4.10^{a}	4.52^{a}	4.53^{a}
Kuningan	2.80^{b}	2.81^{b}	3.28^{b}
Bogor	4.26^{a}	4.53^{a}	4.25^{a}

Note: numbers followed by the same letter in the same column are not significantly different based on the Tukey test with = 5%; *) significantly different at = 5%; **) significantly different at = 1%; tn) the difference is not real.

per plot was in block 3 in Solok (4.53 kg/m^2) and block 2 in Bogor (4.53 kg/m^2), while the lowest bulb weight per plot was in block 1 in Kuningan (2.80 kg/m^2).

The difference in tuber weight per plot is thought to be due to diversity soil types at each planting location. Solok and Bogor have the same soil type, namely Andosol. The characteristics of Andosol soil are high porosity, dusty clay texture [19], and excellent soil physical properties for plant root growth and contains high organic matter [20]. While Kuningan has alluvial soil type. In contrast to andosols, alluvial soils have a loam texture with slow permeability [21]. The difference in water absorption of the two types of soil is thought to affect the weight of the tubers produced. The reason is that onion cultivation in the three locations is carried out during the rainy season. In Kuningan, the alluvial soil was unable to absorb large amounts of water, so water flooded the shallot cultivation area of SS Sakato. This is related to soil aeration, soil with good aeration will make it easier for air to enter so that the oxygen content in the soil is sufficient for plants [22]. Oxygen is needed by plants for respiration which is useful for supplying energy for plant growth [23]. If the oxygen content in the soil is reduced, the plants will wilt and can cause root rot.

3.4 Productivity

The SS Sakato productivity data presented in Table 6 shows that the Solok and Bogor planting locations did not statistically show a significant difference, while Kuningan

Table 6. Average productivity of SS Sakato variety in three locations

Location	Productivity (tons/ha)		
	Block 1	*Block 2*	*Block 3*
Solok	26.66^{a}	29.36^{a}	29.42^{a}
Kuningan	18.20^{b}	18.26^{b}	21.33^{b}
Bogor	27.69^{a}	29.44^{a}	27.62^{a}

Note: numbers followed by the same letter in the same column are not significantly different based on the Tukey test with = 5%; *) significantly different at = 5%; **) significantly different at = 1%; tn) the difference is not real.

showed a very significant difference with the other two locations. The productivity of the SS sakato variety in Kuningan ranges from 18.20 to 21.33 tons/ha. Meanwhile, the productivity of shallots in Solok showed a yield of 26.66–29.42 tons/ha, not significantly different from the productivity of shallots in Bogor which was 27.62–29.44 tons/ha.

The low productivity of shallots in Kuningan is caused by poor drainage in shallot plantations. According to Jaenudin [18], alluvial soil is not good for plant cultivation. Alluvial soil has sticky soil properties because it comes from the parent material of clay deposits which are often found in areas that are often flooded. However, the productivity of shallots produced at the three research locations is still within the range of potential yield in the description of the variety, namely 17.52–28 tons/ha [14].

4 Conclusion

The results of the research reported that all the parameters observed did not show significant differences between the research locations in Solok and Bogor. The highest productivity of SS Sakato variety was produced in Bogor, which was 27.62–29.44 tons/ha, followed by Solok and Kuningan at 26.66–29.42 tons/ha and 18.20–21.33 tons/ha. The productivity at the three research locations is following the yield potential in the description of the variety, which is 17.52–28 tons/ha. This shows that this variety has a wide adaptability because it can grow and develop in three different locations so that it can be used as a national variety to increase the productivity of shallots in Indonesia, as well as farmers' income.

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