Adaptability and Production Performance of Different Red Bulb Onion Varieties Under Palawan Condition

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Abstract

Onion is one of the most profitable agribusinesses in the world and is considered one of the most important vegetable crops. In the Philippines, onions are essential commercial crops that can generate a progressive and viable market for the country.
This study was conducted to establish the suitability of red bulb onions in Palawan in terms of average plant height per week, the average number of onion leaves per week, average bulb diameter, length, marketable versus non-marketable, average fresh weight, yield per plot, and yield per hectare. The experiment was was laid out in a Randomized Complete Blocked Design with four (4) red bulb onion types: T1- Red Creole, T2- Red Hawk, T3- Red Horse, and T4- Red Colorado, replicated four (4) times in the Palawan State University Experimental Area from January 2021 to June 2021,Data was analyzed using STAR software version 2.0 and analysis of variance in RCBD. Reveal no significant differences in all the criteria studied in the four (4) red bulb onion varieties. Based on the results, the four (4) red bulb onion cultivars could be planted in Palawan, notably in Barangay San Rafael.

Keywords: Adaptability, Bulb, Onion, Production, Varieties, Yield

Introduction

Onion *(Allium cepa L.)* is one of the reasons why some dishes are more exciting and intensely flavored than others. Due to its significance, it is recognized as one of the most important vegetable crops and is presently cultivated throughout the world. It is mainly grown as a food source and used in condiments to value different dishes (Etana et al., 2019). According to (Hosoda et al., 2003), the bioactive properties and the characteristic flavor of onion have been attributed to its sulfur compound, present in the volatile fraction of onion oil. Aside from using it as a natural additive, onion oil has also been demonstrated to have antioxidant, anti-browning, and antimicrobial properties that could enhance the quality and safety of the treated food (Vazquez-Armenta et al., 2016). However, onion is more than just a flavor as it offers essential nutritional benefits. (Goldman, 2011) stated that onion has chemical flavonoids such as anthocyanins, fructooligosaccharides, and organo-Sulphur compounds that offer medicinal benefits to fight against different diseases, including cancer heart, and diabetic diseases.

The local demand for onions is rapidly increasing by 2.3%, while exports average 12,340 tons, or 85% of the country's total vegetable exports (PCARRD Farm News, 2000). However, onions are more than just a flavor; they also offer essential nutritional benefits. (Goldman, 2011) states that onions have chemical flavonoids such as anthocyanins, fructooligosaccharides, and organosulfur compounds that offer medicinal benefits to fight against different diseases, including cancer, heart disease, and diabetic diseases.

As there are substantial considerable benefits derived from growing onion, production of this crop is continuously increasing in different countries. (FAOSTAT, 2018) revealed that the top five producers of onion globally were China with 24,699,576 tons of production, followed by India (22,071,000t), the United States of America (3,284,420), Egypt (2,958,324), and Iran (2,406,718). However, Central Luzon was considered the primary producer with 106.25 thousand metric tons in the Philippine setting, contributing 61.6 percent of production in 2018. Ilocos Region was next, with a 22.2 percent share, and lastly, the MIMAROPA Region, with 10.8 percent (PSA, 2019).

However, despite the popularity of onion crops, there were some constraints that affected the productivity of this crop. In the Philippines, from 2014 to 2018, the obtained data from production and area harvested for onion increased only at an average annual rate of 0.2 percent and 5.0 percent, respectively. Additionally, the 2018 data of onion production incurred only 172.67 thousand metric tons, which was 6.4 percent lower than in 2017 with 184.43 thousand metric tons. There was also a decrease in the harvested area of 354.0 hectares from 2017 to 2018 data (PSA, 2019). According to (Bua et al., 2017), the lower productivity of onions was attributed to different factors such as low soil fertility, pests, disease, price fluctuation, inadequate storage facilities, and others. Moreover, (Gessesew et al., 2015) also stated that the pertinent problems of growing onions in any area were the lack of improved varieties, seeds, and unavailable recommended rates of organic fertilizer.

Essentially, farmers needed considerable resources to have a successful journey of growing onions. (Yohannes et al., 2013) stated that improved onion production required a considerable number of inputs, including adequate soil fertility management. Unfortunately, some farmers were less fortunate enough to meet those requirements. In developing countries, including the Philippines, small and marginal farmers were aching to the continuously escalating price of inorganic fertilizers (Mandloi

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et al., 2008). Thus, working with this study could contribute to farmers by growing onions using cheap but safe methods. It may also serve as a benchmark since there are no published data yet regarding growing onions using organic amendments in the province of Palawan.

Methodology

This study was conducted at the research area of Palawan State University -San Rafael Campus, Palawan. The Randomized Complete Block Design was utilized in this study with four (4) varieties of onion such as Treatment $_1$ - Red Creole, Treatment $_2$ - Red Hawk, Treatment $_3$ - Red Horse, and Treatment $_4$ - Red Colorado, which was replicated four (4) times. With a plot size of 1m width x 2m length with a leeway of 1 meter and a total land area of 117 m_2, an onion was planted 10cm by 20cm between hills and rows. There were four (4) rows and 19 hills with a total of 76 plants per plot. The agronomic traits of the Red Creole onion is a medium maturing, open-pollinated short-day red onion. Its outer scale is dark red; with tight, red rings right through the center of the bulb; tastes slightly pungent; firm with a globe shape and good uniformity; it has dark green leaves; and for direct sowing sets and transplanting (Saka and Lawal, 2009).

Red Hawk onions' size ranges from medium to large. These onions have uniformed bulbs which are slightly flattened, with consistent color; excellent skin retention; and adaptable enough to be grown as a late intermediate-day variety. These onions have a high resistance to pink root rot (Johnny seeds, 2021). They produce very round bulbs with good storage ability and high yields. The Red Hawk intermediate variety performs differently under different climatic conditions and is usually only adaptable for specific markets (Zaden, 2021). Upon reaching maturity on its 110th to 120th day after sowing, the average weight of a raw Red Hawk onion bulb weighs 60 grams (Kaneko seeds, 2019).

The Red Horse red onion is a traditional seed heirloom pollinated variety and short day texture. It performs well in southern climates. It is a bright red flattened onion with a crisp texture and excellent onion flavor. The bulbs of Red Horse onions are excellently-uniformed and firm; tolerant to cold and plant diseases such as pink root rot, gray mold, white rot, Fusarium rot, downy mildew, and leaf blight. A medium-sized Red Horse onion bulb's average weight is 45 grams (Kaneko seeds, 2019).

Red Colorado onions are very vigorous, with excellent field holding capacity. These onions have medium to large compact deep red bulbs and it is a traditional seed with a thin neck and double skin. The bulb's average weight is 80-90 grams. It can be stored for up to six (6) to seven (7) months. Its maturity is 105-110 DAS; 80-90 days after transplanting. These onions are adaptable to lowland and dry seasons (Allied Botanical, 2020).

The area was cleared and prepared using a draft animal twice. After plowing, the area was divided into four (4) blocks and four (4) plots. Basal application of carbonized rice hull and vermicompost with an equal proportion of five (5) kilograms of each material per plot was applied.

Four varieties of onion seeds were sown in a seedbox after one month, and a seedling was transplanted in each designated plot. Partial shading of the transplanted seedling was done using a netted coconut leaf (salidap). Irrigation through the drenching method was done twice a day for one (1) month and every seven (7) days for the succeeding month. Chemical fertilizer application was done based on the recommended amount from the result of the soil analysis.

Cultivation was done as needed and rice straw was used as the organic mulch. A cultural method of controlling the presence of pests and diseases was also observed.

Harvesting of the onion plant was done after 116 days, and when the plant leaves started to dry and became yellowish. Ten (10) samples per plot were collected and measured all the data needed. The plant height, onion bulb diameter and weight, and the marketable and non-marketable data were also collected. Another observation on the presence of insect pests was also recorded. Statistical Analysis was done through Analysis of variance using Statistical Tools in Agriculture Research (STAR) 2.0 version, and the Least Significant Difference (LSD) was used for further analysis.

Results and Discussion

The average plant height (cm) of red bulb onion per week revealed that T1 - Red Creole gained the highest height mean value of (24.75,27.71,30.34,35.51 and 33.26) on the 5^{th}, 6^{th}, 7^{th}, 10^{th}, and 14^{th} weeks, T2 -Red Hawk with the highest height mean value (34.22,36.92 and 35.71) during the 9th, 12^{th}, and 13^{th} weeks; while T3 - Red Horse gained the highest height mean value (13.09, 19.27,22.86, and 30.34) on 2^{nd}, 3^{rd}, 4^{th}, and 7^{th} weeks; and T4 - Red Colorado gained the highest height mean value (5.79, 32.05 and 33.81) on 1^{st}, 8^{th}, and 11^{th} week, respectively. Thus, the Analysis of variance showed no significant differences in the different varieties throughout the weeks. The result is similar to the study of Perkasa et al., (2016) in that the average height of the Dewa leaf from 1 to 7 WAT was not significant. This finding may be due to the adaptation to a new environment of newly transplanted seedlings of onion. Another reason could be due to a lot of insect pest infestation on the leaves of the onion plant during this period. Meanwhile, in the 3rd week, significant differences were observed. The significant result may be due to the influence of different elements of soil on the growth development of the onion. The availability of Nitrogen and phosphorous can affect the leaf length of the plant. The present findings were supported by Comadug et al., (2014) and Perkasa et al., (2016). This implies that either one of the four varieties of onion could be grown

in the northern part of Palawan, specifically in Barangay San Rafael.

An average number of leaves per week revealed no significant differences, as shown in Table 2. However, T1 - Red Creole produced the highest number of leaves (2.37,3.48,4.75,5.05,5.35,5.50,5.35, and 5.30) on the 1st, 5th, 7th, 8th, 9th, 10th, 11th, and 12th weeks; while T3 - Red Horse produced the highest number of leaves mean value (3.50,3.43, and 4.28) on the 3rd, 4th, and 6th week; and T4 - Red Colorado produced the highest height mean value (2.92,4.85 and 4.32)on 2nd, 13th, and 14th week. Thus, Statistical Analysis shows no significant differences in the average number of leaves throughout the weeks. This might also be related to the aforementioned data

Table 3 shows the average bulb diameter, neck diameter, bulb length, and fresh bulb weight of onion at harvest. On the average diameter of onion at harvest, the result revealed that T_4- Red Colorado obtained the biggest bulb diameter mean value of 29.47mm. The smallest bulb diameter was 28.23 mm which was obtained by T_3- Red Horse. Thus, no significant differences were observed in the different varieties of onion on the average diameter at harvest. Hartman et al., (1981), as cited by Comadug et al., (2014) also stated that cultivars variously have very critical photoperiod requirements for bulb formation. The study was conducted in January, and the usual production of onion was in October.

In the average neck diameter of onion (mm) at harvest, the result showed that T1- Red Creole gained the largest neck diameter mean value of 12.18mm, and the smallest neck diameter of 2.11 mm was gained by T4 - Red Colorado. However, no significant differences were observed in the different varieties of onion on the average neck diameter at harvest.

On the average length of onion bulb (mm) at harvest, the result showed that T_3- Red Horse gained the highest length mean value of 28.23 mm, followed by T_4- Red Colorado with a 24 27.54 mm length mean value, T_1- Red Creole with 25.90mm length mean value, and the lowest length mean value of 25.72 mm was gained by T_2- Red Hawk. However, the Analysis of variance showed no significant differences in the different varieties of onion on average length at harvest. Nitrogen has a significant role in the bulb formation of the onion. Nitrogen deficiency can hasten or delay the production of bulbs. The different varieties absorbed the same amount of nitrogen from the soil, resulting in no significant differences. This finding is supported by Bondad (1994) as cited by Comadug et al., (2014).

On the average fresh weight of onion at harvest (g), the result showed that T_4- Red Colorado gained the highest fresh weight mean value of 28.17g, and the lowest fresh weight mean value of 19.67 g was gained by T_3- Red Horse. However, no significant differences were revealed in the Analysis of variance, which means that there were no significant differences in the different varieties of red onion on the average fresh weight at harvest. According to Nelson (1994), the treatment that performed high results in bulb height, diameter, and neck produced the highest fresh weight. Thus, the result may be due to no significant differences observed in all growth parameters. In addition, Frey and Anderson (1997), as cited by Comadug et al., (2014) mentioned that the determining factor in bulb formation response was the varietal makeup. The absence of significant results may be due to the different varieties having different growth characteristics and at the same time having different growth performances. Additionally, it might be related to the area's environmental condition, which hindered the varieties of onion to express their full potential.

Figure 1 shows the average marketable weight of red onion. The result showed that T_4- Red Colorado gained the highest mean value of 910.18g, followed by T_2- Red Hawk with 743.75g, T_1- Red Creole with 721.73g, and the lowest mean value of 589.57g was gained by T_3-26 Red Horse. However, the Analysis of variance showed no significant differences in the different red onion varieties on the average marketable weight at harvest. And on the average non-marketable weight of red onion, the result showed that T_2 gained the highest mean value of 251.22g - Red Hawk, followed by T_1 - Red Creole with a 235.94g mean value, T_3 - Red Horse with 174.95g mean value, and T_4 gained the lowest mean of 142.44g - Red Colorado. Hence, the Analysis of variance showed no significant differences in the different varieties of red onion on the average non-marketable weight at harvest. On the average yield per plot (kg), the result showed that T_1 - Red Creole gained the highest yield with 1.08 kg, followed by T_4 - Red Colorado with 1.0 kg, T_2- Red Hawk with 0.89 kg, and the lowest yield hectare was gained by T_3 - Red Horse with 0.83 kg. Hence, the Analysis of variance showed no significant differences in the different varieties of red onion on average yield/plot. However, the average computed yield per hectare at harvest showed that T_1 - Red Creole gained the highest yield tons with 540.00 tons, followed by T_4 - Red Colorado with 527.5 tons, T_2 - Red hawk with 443.75 tons, and the lowest yield tons/hectare was gained by T_3 - Red Horse with 413.5 tons. Hence, the Analysis of variance showed no significant differences in the different varieties of red onion on the average yield tons/hectare. The present result may be due to no significant effect on different growth parameters which in turn caused no significant result in all yield parameters of onions. The different elements and nutrients needed by the plant were not available or not present in the soil. Soil conditions and climate change can also affect the growth and yield performance of the onion like compacted soil, and heavy rain can cause wilting and rotting of the onion leaves and bulbs. Comadug et al., (2014) declared that during the early stages of growth or before bulbing, onions grow better at relatively lower temperatures. Still, higher temperatures and low relative humidity are desirable during bulbing up to harvesting and curing. Additionally, the overall yield production of red onion failed to show their differences due to the sea elevation of the area where the study was conducted which was almost 500 meters away from the shoreline, which contrasts with the recommendation of (Chen et al., 2021) of 2,500 meters.

Table 1. Average height of Red Bulb Onion per week (cm)

TREATMENT	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th
T1- Red Creole	5.54	11.61	16.66[b]	21.55	24.75	27.71	30.34	29.92	33.40	35.81	35.70	34.16	35.35	33.26
T2- Red Hawk	4.98	10.61	16.44[b]	20.82	24.47	26.27	27.58	30.09	34.22	35.26	34.82	36.92	35.71	32.71
T3- Red Horse	5.74	13.09	19.27[a]	22.86	23.96	27.39	30.34	31.68	33.13	34.58	34.37	33.16	32.64	32.69
T4- Red Colorado	5.79	11.79	17.86[ab]	21.98	24.19	25.84	28.16	32.05	32.82	33.81	33.81	35.74	34.20	31.76
F-test	ns	ns	*	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

Means having common letters are not significantly different from LSD at 5% probability

Table 2. Average number of red bulb onion leaves per week

TREATMENT	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th
T1- Red Creole	2.37	2.87	3.25	3.25	3.48	4.13	4.75	5.05	5.35	5.50	5.35	5.30	4.65	4.27
T2- Red Hawk	2.10	2.80	3.38	3.18	3.15	3.93	4.30	5.03	5.25	5.25	5.12	5.25	4.62	4.25
T3- Red Horse	2.30	2.90	3.50	3.43	3.38	4.28	4.58	5.03	4.87	4.65	5.25	4.50	4.35	4.10
T4- Red Colorado	2.25	2.92	3.43	3.20	3.20	4.05	4.55	4.75	4.80	5.45	5.30	5.15	4.85	4.32
F-Test	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns	ns

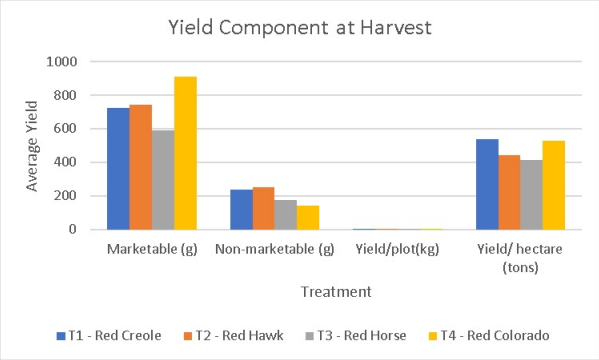

Figure 1. Yield component of red bulb onion

Conclusion

Based on the results of the study, T1-Red Creole and T4-Red Colorado had the best growth and yield performance. Only during the 3rd week showed a significant result in terms of the average height per week, while the rest of the parameters, like the number of leaves, diameter, neck, length, fresh weight, marketable and non-marketable, yield per plot, and hectare showed no significant results. Result indicates that farmers in Bgy. San Rafael, Puerto Princesa City, may use the results of this study as the foundation for their selection of any of the four types of red onions that are most suited for growing in the soil and climate of Palawan.

References

(2019). *Crops Statistics of the Philippines 2014 – 2018*. Philippine Statistics Authority.

Adebiyi, S. and Okunlola, J. (2010). Factors affecting adoption of cocoa rehabilitation techniques in oyo state of nigeria: Proceedings the 18th annual congress of the nigerian rural sociological association of nigeria. *FUTA, Nigeria: Akure*.

Anon, D. (2003). *Land and survey department data*. Jos North Local Government Area.

Ayinde, O., Adewumi, M., Olatunji, G., and Babalola, O. (2010). Determinants of adoption of downy mildew resistant maize by small-scale farmers in kwara state, nigeria. *Global Journal of Science Frontier Research*, 10(1):32–35.

Bua, B., Owiny, R., and Ocwa, A. (2017). Response of onion to different organic amendments in central uganda.

Chen, X., Krug, L., Yang, M., Berg, G., and Cernava, T. (2021). The himalayan onion (allium wallichii kunth) harbors unique spatially organized bacterial communities. *Microbial ecology*, 82:909–918.

Etana, M. B., Aga, M. C., and Fufa, B. O. (2019). Major onion (allium cepa l.) production challenges in ethiopia: A review. *Journal of Biology, Agriculture and Healthcare*, 9(7):42–47.

FAOSTAT (2018). Top ten country production of onions.

Gessesew, W. S., Woldetsadik, K., and Mohammed, W. (2015). Growth parameters of onion (allium cepa l. var. cepa) as affected by nitrogen fertilizer rates and intra-row spacing under irrigation in gode, south-eastern ethiopia. *Agriculture, Forestry and Fisheries*, 4(6):239–245.

Goldman, I. L. (2011). Molecular breeding of healthy vegetables. *EMBO reports*, 12(2):96–102.

Hosoda, H., Ohmi, K., Sakaue, K., and Tanaka, K. (2003). Inhibitory effect of onion oil on browning of shredded lettuce and its active components. *Journal of the Japanese Society for Horticultural Science*, 72(5):451–456.

Idrisa, Y., Shehu, H., and Ngamdu, M. (2012). Effects of adoption of improved maize seed on household food security in gwoza local government area of borno state, nigeria. *Global Journal of Science Frontier Research*, 12(5-D):6–12.

Table 3. Average number of red bulb onion leaves per week

Treatment	Bulb Diameter	Neck Diameter	Bulb Length	Bulb Fresh Weight
		(mm)	(mm)	(mm)
T1 - Red Creole	28.46	12.18	25.90	26.41
T2 - Red Hawk	28.70	6.78	25.72	24.38
T3 - Red Horse	28.23	4.35	28.23	19.67
T4 - Red Colorado	29.47	2.11	27.54	28.17
F-test	ns	ns	ns	ns

ns- not significant at 5% probability

Mandloi, K., Bose, U., Deshmukh, K., et al. (2008). Effect of organic manures and inorganic fertilizers on growth and yield of onion (allium cepa l.). *Asian Journal of Horticulture*, 3(2):238–240.

Mignouna, D. B., Manyong, V. M., Rusike, J., Mutabazi, K., and Senkondo, E. M. (2011). Determinants of adopting imazapyr-resistant maize technologies and its impact on household income in western kenya.

Namwata, B. M., Lwelamira, J., and Mzirai, O. (2010). Adoption of improved agricultural technologies for irish potatoes (solanum tuberosum) among farmers in mbeya rural district, tanzania: A case of ilungu ward.

NRCRI (2005). *Research Highlight NRCRI*. NRCRI.

Okoedo-Okojie, D. and Onemolease, E. (2009). Factors affecting the adoption of yam storage technologies in the northern ecological zone of edo state, nigeria. *Journal of human Ecology*, 27(2):155–160.

Oladele, O. and Kareem, A. (2003). Adoption rate and continued use of selected arable crop technologies among farmers in oyo state nigeria.

Saka, J. and Lawal, B. (2009). Determinants of adoption and productivity of improved rice varieties in southwestern nigeria. *African Journal of Biotechnology*, 8(19).

Vazquez-Armenta, F., Cruz-Valenzuela, M., and Ayala-Zavala, J. (2016). Onion (allium cepa) essential oils. In *Essential oils in food preservation, flavor and safety*, pages 617–623. Elsevier.

Yohannes, K. W., Derbew, B., Adugna, D., et al. (2013). Effect of farmyard manure and nitrogen fertilizer rates on growth, yield and yield components of onion (allium cepa l.) at jimma, southwest ethiopia. *Asian Journal of Plant Sciences*, 12(6/8):228–234.