Universal Journal of Agricultural Research 11(6): 1102-1108, 2023 http://www.hrpub.org
DOI: 10.13189/ujar.2023.110617

Yield Evaluation of IPB Cayenne Pepper (*Capsicum annuum* L.) to Registration Variety

Undang[1,2,*], Muhamad Syukur[3], Yudiwanti Wahyu[3], Abdul Qadir[3], Sulassih[2], Siti Marwiyah[3], Uding Sastrawan[2]

[1]Plant Breeding and Biotechnology Graduate Program, Department of Agronomy and Horticulture, Faculty of Agriculture, Bogor Agricultural University, Indonesia
[2]College of Vocational Studies, Bogor Agricultural University, Indonesia
[3]Department of Agronomy and Horticulture, Faculty of Agriculture, Bogor Agricultural University, Indonesia

Received August 21, 2023; Revised October 16, 2023; Accepted November 1, 2023

Cite This Paper in the Following Citation Styles

(a): *[1] Undang, Muhamad Syukur, Yudiwanti Wahyu, Abdul Qadir, Sulassih, Siti Marwiyah, Uding Sastrawan, "Yield Evaluation of IPB Cayenne Pepper (Capsicum annuum L.) to Registration Variety," Universal Journal of Agricultural Research, Vol. 11, No. 6, pp. 1102 - 1108, 2023. DOI: 10.13189/ujar.2023.110617.*

(b): *Undang, Muhamad Syukur, Yudiwanti Wahyu, Abdul Qadir, Sulassih, Siti Marwiyah, Uding Sastrawan (2023). Yield Evaluation of IPB Cayenne Pepper (Capsicum annuum L.) to Registration Variety. Universal Journal of Agricultural Research, 11(6), 1102 - 1108. DOI: 10.13189/ujar.2023.110617.*

Abstract Cayenne pepper (*Capsicum annuum* L.) is a leading horticultural commodity widely cultivated in Indonesia. The high demand for cayenne pepper has prompted various efforts to increase plant productivity. This study aims to evaluate the yield potential of seven IPB cayenne pepper genotypes with two check varieties to release the variety. The research was conducted at Leuwikopo Experimental Garden and Plant Breeding Laboratory of Bogor Agricultural University (IPB). This study used a one-factor randomized complete block design (RCBD), namely the cayenne pepper genotype. The results of variance analysis of nine cayenne pepper genotypes showed that genotype had a significant effect on all quantitative characters, except for fruit weight per bed, productivity, and percentage of live plants. Some of the tested lines had superior characteristics of the two check varieties (Genie and Bara): flowering age, harvesting age, fruit length, fruit diameter, weight per fruit, and weight of 1000 seeds. The flowering age and harvest age characters were the fastest in the Harita genotype. Genotypes F10.145291, F11.145291, F11.160291, F8.145291, F10.145174, and F12.145291 have advantages in several fruit characters so that all tested lines have the potential to be released as candidates for new varieties.

Keywords *Capsicum annuum* L., Cayenne Pepper, New Variety, Registration Variety, Yield Evaluation

1. Introduction

Pepper (*Capsicum* spp) is a vegetable crop belonging to the large Solanaceae family, which includes among the most important horticultural species cultivated and consumed worldwide [1]. There are over 35 recognized Capsicum species, the most common of which comprise the cultivated type of *Capsicum annuum*, and four domesticated namely *C. frutescens*, *C. chinense*, *C. baccatum* and *C. pubescens* [2]. Meanwhile, in Indonesia the type that is most widely distributed is *C. annuum*, one type of which is cayenne pepper [3]. Cayenne pepper is a plant that in general imparts a spicy taste (capsaicin) to food consumed by humans [4]. Behind the spiciness, there are cayenne pepper that have many secondary metabolite compounds that have the potential to be developed, including phenolic compounds [5], flavonoids [6], antioxidants [7], and even α-glucosidase inhibitory activity [8]. The α-glucosidase inhibitor is an enzyme that inhibits sugar absorption in the blood [9]. Research shows that α-glucosidase inhibitors may be useful as antivirals for COVID-19 [10].

Cayenne pepper is one of the leading seasonal vegetable commodities produced in almost all provinces of Indonesia.

The harvested area of cayenne pepper in 2018 was the highest at 172,847 ha, while cayenne pepper production was in third place after shallots and cabbage, which was 1.34 million tons. The harvested area and production of cayenne pepper have increased compared to 2017 [11]. The demand for cayenne pepper consumption increases as the population increases. Cayenne pepper consumed in Indonesia are divided into bird's eye, red, and green Cayenne pepper. More than 45 percent of Cayenne pepper is used for direct household consumption, 50 percent is used for raw materials for the processed industry, and the rest is scattered or used as seeds. Consumption of cayenne pepper in Indonesia on a household scale was 1.835 kg per capita in 2018. This amount fluctuated and tended to increase by an average of 7.53% in 2002–2018 [12].

One of the efforts to increase the productivity of cayenne pepper to meet the community's needs is through plant breeding. According to [12], improvement in yield potential can be obtained by using new superior varieties resulting from plant breeding. One of the stages in plant breeding before getting new superior varieties is testing. The tests carried out included preliminary yield tests, advanced yield tests, and multi-location tests. Tests were carried out to analyze the adaptation and stability of the candidate varieties. Advanced yield trial produces promising lines or candidate varieties ready to be released after multi-location test. Multilocation tests were carried out before the potential varieties were released as varieties at several locations and seasons. Preliminary yield tests were conducted to determine yield potential and other agronomic characteristics before further testing for the variety registration process through a superiority test [13].

According to Minister of Agriculture Regulation Number 40/Permentan/TP.010/11/2017, the release of varieties is the government's recognition of superior varieties resulting from domestic plant breeding or introductions from abroad that can be distributed. Prospective varieties to be released must undergo a series of adaptation test processes. Adaptation tests included production superiority, yield quality superiority, responsiveness to fertilization, tolerance to major pests and diseases, plant age, resistance to environmental stress, plant uniformity and stability, and differences with released varieties. This study aims to test the yield of seven lines of cayenne pepper IPB with two control varieties for releasing varieties.

2. Materials and Methods

The research was conducted at Leuwikopo Experimental Garden and Plant Breeding Laboratory, Department of Agronomy and Horticulture, Faculty of Agriculture, Bogor Agricultural University. The planting materials used in this research were seven IPB cayenne pepper genotypes consisting of genotypes F10.145291, F11.145291, F11.160291, F8.145291, F10.145174, F12.145291, and Harita, as well as two check varieties, namely: Genie (PT Benih Citra Asia), and Bara (PT East West Seed Indonesia). Planting material was obtained from the Plant Breeding Laboratory, Department of Agronomy and Horticulture, Faculty of Agriculture, Bogor Agricultural University.

The research was conducted based on a one factor randomized complete block design (RCBD), namely cayenne pepper genotypes consisting of seven lines and two control varieties. Each genotype was repeated three times, so that there were 27 experimental units. Each experimental unit consisted of 20 plants. Observations were made on 10 sample plants in each experimental unit.

The experimental procedure consisted of sowing, land preparation, planting, maintenance, and harvesting. The observed characters refer to the Decree of the Minister of Agriculture of the Republic of Indonesia Number: 12/Kpts/SR.130/D/8/2019 concerning techniques for preparing descriptions and testing the truth of horticultural plant varieties [12], while the observation method is based on descriptors for *Capsicum* [14]. Quantitative characters observed included flowering age (days), harvest age (days), plant height (cm), dichotomous height (cm), stem diameter (cm), header width (cm), leaf length (cm), leaf width (cm), fruit length (cm), fruit stalk length (cm), fruit diameter (mm), thickness of fruit flesh (mm), fruit weight (g), number of fruits per plant, fruit weight per plant (g), fruit weight per bed (g), productivity (tons/ha), weight of 1000 seeds (g), percentage of live plants (%), and fruit shelf life (DAH/Day after harvest). The quantitative data obtained was processed using Microsoft Excel, and then further HSD test analysis was carried out at the 0.05 level with PKBT STAT 3.1.

3. Results and Discussion

3.1. General Conditions of Research

Field research (Figure 1) was carried out at the Leuwikopo Experimental Garden of Bogor Agricultural University, Dramaga, Bogor, with an elevation of 207 m above sea level. Data from the Bogor Climatology Station stated that rainfall during the study ranged from 149.70–583.70 mm/month, while the average temperature ranged from 25.25–26.87°C and average humidity 78.33–88.75 % [15]. Cayenne pepper can produce optimally in the lowlands and highlands up to 1300 m above sea level, rainfall optimum ranges from 600–1250 mm/year, temperatures of 24–27°C and sufficient watering [16].

3.2. Quantitative Character

Quantitative characters are controlled by many genes, each of which has little effect on the character. Environmental factors heavily influence quantitative characteristics [17]. Variance analysis was used to estimate the impact of treatment in the form of genotype on the

quantitative characters observed. The results of the analysis of variance on nine genotypes of cayenne pepper showed a very significant effect on the characters of flowering age, harvesting age, plant height, dichotomous height, stem diameter, header width, leaf length, leaf width, fruit length, fruit stalk length, fruit diameter, thickness of fruit fleshfruit, 1000 seed weight, fruit weight, and fruit shelf life. Characters that significantly affected the treatment included the number of fruits and fruit weight per plant. At the same time, an insignificant effect was found in the fruit weight per plot, productivity, and percentage of live plants. The observed characters coefficient of variance (CV) ranged from 1.59–18.91% (Table 1). According to [18], CV shows the level of accuracy with the treatments being compared. That is, the higher the value of the coefficient of variance, the lower the validation of an experiment.

Figure 1. Performance of cayenne pepper plants and fruit in the field from seven test genotypes and two control varieties

Table 1. Recapitulation values of various quantitative characters from cayenne pepper

Character	Sum Square	F	CV (%)
Flowering age (DAP)	24,84	9,28**	5,81
Harvest age (DAP)	61,15	8,78**	3,65
Plant height (cm)	147,44	29,26**	3,18
Dichotomous height (cm)	23,93	18,11**	4,22
Stem diameter (mm)	1,90	14,06**	3,55
Header width (cm)	76,59	7,63**	3,83
Leaf length (cm)	3,92	7,23**	9,08
Leaf width (cm)	0,69	8,32**	8,89
Fruit length (cm)	0,94	42,71**	3,27
Length of fruit stalk (cm)	0,34	9,78**	5,86
Fruit diameter (mm)	1,08	9,31**	3,82
Thickness of fruit flesh(mm)	0,02	5,45**	6,36
Weight of 1000 seeds (g)	0,63	150,90**	1,59
Number of fruits per plant	3268,26	3,36*	13,23
Weight per fruit (g)	0,26	31,07**	5,39
Fruit weight per plant (g)	7108,44	3,04*	14,61
Fruit weight per bed (g)	1.883.177,63	2,15tn	18,90
Productivity (tons/ha)	3,35	2,15tn	18,91
Percentage of live plants (%)	214,12	2,21tn	10,90
Fruit shelf life (DAH)	56,79	5,67**	17,88

Note: DAP = Day After Planting; DAH = Day After Harvest

3.3. Vegetative Phase

The plant height of the cayenne pepper genotype ranged from 60.90–79.91 cm, while that of the control varieties ranged from 66.35–76.19 cm. The plant height of the genotype F11.145291 was comparable to lines F10.145291, F8.145291 and significantly higher than the control variety Bara. The dichotomous height of the test strains of cayenne pepper ranged from 21.72–28.64 cm, while that of the control varieties ranged from 28.99–32.06 cm. The genotypes F10.145291, F11.145291, F11.160291, F8.145291, F10.145174, and F12.145291 had a dichotomous height equivalent to the control variety Bara. The stem diameter of the cayenne pepper genotype ranged from 9.83–11.05 mm, while that of the control varieties ranged from 8.55–10.13 mm. The stem diameter of genotype F10.145291 is equivalent to genotypes F11.160291, F8.145291, F10.145174, F11.145291, Harita, and the check variety Genie. The F12.145291 genotype has a stem diameter equivalent to the Genie control variety. The header width of the genotypes of cayenne pepper ranged from 76.24–90.73 cm, while that of the control varieties ranged from 78.90–81.96 cm. The F11.145291 and F10.145174 genotypes had equivalent header widths and were significantly larger than the Genie control variety. The leaf length of the test strains of cayenne pepper ranged from 6.61–9.95 cm, while that of the control varieties ranged from 7.50–8.37 cm. The leaf length of the F10.145291 line is equivalent to the Genie variety. The leaf width of cayenne pepper strains ranged from 2.52–4.00 cm, while that of the control varieties ranged from 3.34–3.62 cm. The width of the F10.145291 line is equivalent to the Genie and Bara varieties. The percentage alive ranged from 75-98.33% (Table 2).

Cayenne pepper genotype with plant height and large stem diameter indicated that the plant was sturdy, such as, in line F10.145291. Sturdy plants are shown by the absence of broken stem branches, especially after heavy rains [19]. A high dichotomous can avoid splashing water from the ground on the fruit, reducing the potential for fruit disease attacks such as anthracnose [20]. The effect of a plant canopy that is too wide and short plant size on cayenne pepper can result in a decrease in production. Leaves are the main organs that play a role in plant photosynthesis. Leaf size affects the ability of plants to produce assimilates, radiation absorption, CO_2 assimilation rate, and translocation of assimilation results to other plant organs [21]. A broad leaf surface tends to produce more photosynthesis, so it has the potential to produce more fruit [13]. The leaf length and width were observed on the third to fifth leaf branches. The size of the leaves of the F10.145174 genotype tended to be small because, in one replicate, quite a severe anthracnose attacked all plants, so the leaves dropped and could only be observed on the upper branches of Bara varieties. The percentage alive ranged from 75-98.33% (Table 2).

Table 2. The average value of the vegetative characters of cayenne pepper plants

Genotype	Plant height (cm)	Dichotomous height (cm)	Stem diameter (mm)	Header width (cm)	Leaf length (cm)	Leaf width (cm)	Live percentage (%)
F10.145291	78,37^{a}	27,67^{b}	11,05^{a}	78,03^{cd}	9,95^{a}	4,00^{a}	98,33
F11.145291	68,13^{c}	27,87^{b}	9,83^{b}	79,54^{bcd}	7,87^{abc}	3,13^{bcd}	90,00
F11.160291	62,03^{cd}	26,43^{b}	10,69^{ab}	85,04^{a-d}	7,36^{bc}	2,85^{cd}	95,00
F8.145291	74,94^{ab}	26,07^{b}	10,37^{ab}	86,31^{abc}	9,18^{ab}	3,70^{ab}	78,33
F10.145174	68,50^{bc}	25,67^{b}	11,03^{a}	88,43^{ab}	7,69^{bc}	2,76^{d}	98,33
F12.145291	79,91^{a}	28,64^{b}	10,82^{ab}	90,73^{a}	8,94^{ab}	3.30^{a-d}	91,67
Harita	60,90^{d}	21,72^{c}	10,81^{ab}	76,24^{d}	6,11^{c}	2,52^{d}	75,00
Genie	76,19^{a}	32,06^{a}	10,13^{ab}	78,90^{cd}	8,37^{ab}	3,62^{abc}	96,67
Bara	66,35^{cd}	28,99^{ab}	8,55^{c}	81,96^{a-d}	7,50^{bc}	3,34^{a-d}	90,00
HSD 5%	6,56	3,36	1,07	9,25	2,15	0,84	-

Note: Average values in the same column followed by the same letter are not significantly different according to HSD at 0.05 level.

3.4. Generative Phase

Further test results showed that the flowering ages of the tested cayenne pepper lines ranged from 22.67–31.00 DAP (day after planting), while the control varieties ranged from 31.33–31.67 DAP. The fastest flowering period occurred in the Harita genotype, while the longest occurred in the Genie and Bara check varieties. The harvesting age of the cayenne pepper genotypes ranged from 62.67–78.67 DAP, while the control varieties ranged from 72.00–74.00 DAP. The fastest harvesting age occurred in the Harita genotype and the longest in the F11.145291 genotype (Table 3).

The fruit length of cayenne pepper genotype ranged from 4.03–5.39 cm, while that of the control varieties ranged from 3.92–3.96 cm. The fruit length of the F11.145291 genotype was significantly longer than the Genie and Bara control varieties. The longest fruit stalks were found in line F11.145291 and were equivalent to the Genie and Bara control varieties. The F10.145291 genotype had fruit stalk length equivalent to the F11.160291, F8.145291, and F10.145174 genotypes and the control varieties Genie and Bara. The fruit stalk length of the Harita genotype was significantly shorter than the Genie and Bara control varieties. The fruit diameter of genotype F8.145291 was considerably larger than the control varieties Genie and Bara and was on par with genotype F11.145291. The thickness of the fruit flesh of genotype F11.145291 was equivalent to that of the check variety Bara but significantly thicker than the check variety Genie. The number of fruits per plant of the cayenne pepper genotype ranged from 205.67–295.00 fruit, while the control varieties ranged from 218.00–234.67. The highest number of fruits per plant was found in the Harita genotype and was on par with the Genie and Bara control varieties. The weight per fruit of the test strains of cayenne pepper ranged from 1.38–2.18 g, while the control varieties ranged from 1.42–1.58 g. Fruit weight per plant of the cayenne pepper genotype ranged from 305.04–407.80 g, while that of the control varieties ranged from 247.76–276.58 g.

Harita genotype included early aged cayenne pepper because it is fast on flowering and harvesting. The fast-flowering age causes a quick harvest age as well. Early maturity is one of the superior characteristics of cayenne pepper plant breeding [22]. A fast-harvesting age could reduce the occurrence of biotic and abiotic stresses [20]. The cayenne pepper genotype did not significantly affect the fruit weight per plot and plant productivity. The highest fruit weight per bed was shown by the genotype F11.160291, while the lowest was by the control variety Bara. Plant productivity per hectare also offers the same thing because it is obtained from the fruit weight conversion per bed. The productivity of genotypes F10.145291, F11.160291, F10.145174, and Harita, as well as varieties Genie and Bara in previous studies, showed lower yields, namely 6.36 tons/ha, 6.12 tons/ha, 4.90 tons/ha, 4.61 tons/ha, 3.48 tons/ha, and 2.89 tons/ha. The productivity of the F11.145291 and F8.145291 genotypes in previous studies showed higher results, namely 8.48 tons/ha and 7.19 tons/ha [23]. This indicates that most of the cayenne pepper genotypes in this study experienced improved yields. Based on the variety description by the Ministry of Agriculture, the cayenne varieties Genie and Bara, because of the research, had lower productivity. The yield potential of the Genie variety reaches 13.3 tons/ha to 16.8 tons/ha [24], while the Bara variety reaches 10 tons/ha [19] (Table 4).

Table 3. The average value of the generative characters of cayenne pepper plants

Genotype	Flowering age (DAP))	Harvest age (DAP)	Fruit length (cm)	Length of fruit stalk (cm)	Fruit diameter (mm)	Thickness of fruit flesh (mm)	Number of fruits per plant (fruit)	Weight per fruit (g)	Fruit weight per plant (g)
F10.145291	28,33^{ab}	76,00^{ab}	4,06^{c}	3,16^{b}	8,54^{c}	0,90^{b}	281,67^{a}	1,38^{d}	334,55^{ab}
F11.145291	27,67^{ab}	72,67^{ab}	5,39^{a}	3,31^{ab}	9,02^{bc}	1,21^{a}	205,67^{b}	2,18^{a}	366,23^{ab}
F11.160291	26,33^{bc}	72,00^{ab}	5,13^{ab}	3,09^{bc}	8,62^{c}	1,01^{b}	223,00^{ab}	2,02^{a}	355,25^{ab}
F8.145291	27,33^{abc}	74,33^{ab}	4,85^{b}	3,02^{bc}	10,03^{a}	1,01^{b}	248,33^{a}	2,01^{ab}	407,80^{a}
F10.145174	27,00^{abc}	69,33^{bc}	4,87^{b}	2,86^{bc}	8,33^{c}	0,95^{b}	207,33^{ab}	1,60^{cd}	305,04^{ab}
F12.145291	31,00^{ab}	78,67^{a}	4,74^{b}	3,73^{a}	9,86^{ab}	1,08^{ab}	218,67^{ab}	1,74^{bc}	356,52^{ab}
Harita	22,67^{c}	62,67^{c}	4,03^{c}	2,58^{c}	8,80^{c}	1,07^{ab}	295,00^{a}	1,43^{d}	330,07^{ab}
Genie	31,67^{a}	74,00^{ab}	3,92^{c}	3,37^{ab}	8,53^{c}	0,98^{b}	234,67^{a}	1,42^{d}	276,58^{ab}
Bara	31,33^{a}	72,00^{ab}	3,96^{c}	3,40^{ab}	8,73^{c}	1,08^{ab}	208,00^{ab}	1,58^{cd}	247,76^{b}
HSD 5%	4,78	7,71	0,43	0,54	1,00	0,19	91,10	0,27	141,27

Note: Average values in the same column followed by the same letter are not significantly different according to HSD at 0.05 level.

DAP=Day After Planting

Table 4. The average post-harvest value for each genotype

Genotype	Fruit weight per bed (g)	Productivity (tons/ha)	Fruit shelf life (days)	Weight of 1000 seeds (g)
F10.145291	5659,33	7,55	17,33^{abc}	4,30^{b}
F11.145291	5735,04	7,65	23,67^{a}	4,76^{a}
F11.160291	5755,01	7,67	23,00^{ab}	4,82^{a}
F8.145291	5246,72	7,00	16,00^{abc}	4,08^{c}
F10.145174	4396,03	5,86	14,33^{bc}	3,72^{de}
F12.145291	5553,92	7,41	21,67^{ab}	3,96^{c}
Harita	4225,83	5,63	10,33^{c}	3,54^{e}
Genie	4205,61	5,61	17,00^{abc}	3,76^{d}
Bara	3759,97	5,01	16,00^{abc}	3,76^{d}
HSD 5%	-	-	9,25	0,19

Note: Note: Average values in the same column followed by the same letter are not significantly different according to HSD at 0.05 level

The genotype of cayenne pepper had no significant effect on the percentage of live plants. The percentage of live plants is calculated based on the number of plants that survive until the end of the harvest. The highest percentage of live plants was shown by the genotypes F10.145291 and F10.145174, while the Harita genotype was the lowest. The low percentage of living plants in the Harita genotype was caused by a fusarium wilt attack when the plants started to bear fruit.

The weight of 1000 seeds of the test strains of cayenne pepper ranged from 3.54–4.82 g, while that of the control variety was 3.76 g. The genotypes F11.145291 and F11.160291 had equivalent weights of 1000 seeds and were significantly different in weight compared to the control varieties Genie and Bara. The F10.145291 genotype also had significantly different weights compared to the Genie and Bara control varieties. The genotypes F8.145291 and F11.145291 had the same weight of 1000 seeds and were significantly different in weight compared to the control varieties Genie and Bara. The weight of 1000 seeds of genotype F10.145174 is equivalent to the control varieties Genie and Bara, while the Harita line is lighter than the control varieties Genie and Bara.

4. Conclusions

The genotype of cayenne pepper had superior quantitative character compared to the Genie and Bara control varieties. The F10.145291 genotype had a significantly higher 1000 seed weight than the control variety. The genotypes F11.145291 and F11.160291 had significantly higher fruit length, weight per fruit, and weight of 1000 seeds than the control varieties. The F8.145291 genotype had significantly higher fruit length, diameter, weight per fruit, and weight of 1000 seeds than the control varieties. The F10.145174 genotype had significantly higher fruit length than the control variety. The F11.145291 genotype had significantly higher fruit length, fruit diameter, and 1000 seed weight than the control varieties. The Harita genotype had significantly faster flowering and harvesting times than the control varieties. The cayenne pepper genotype had no significant effect on the characteristics of weight per plot, productivity, and percentage of plant survival.

Genotypes F10.145291, F11.145291, F11.160291, and F12.145291 have the potential to be registered as superior varieties for commercialization because they have the advantage of high-yielding varieties. The Harita IPB test variety also has the potential to be registered as a superior variety for commercialization because it has an early maturity (59–65 DAP). Qualitative character differences between the genotypes and check varieties were found in the leaf shape characteristics and intensity of leaf edge waves, fruit shape, and bright fruit color.

Acknowledgements

This research was funded by IPB University Vocational School grant with research assignment agreement letter number: 6099/IT3.S3/PT.01.05/M/B/2023.

REFERENCES

[1] Tripodi P., Lo Scalzo R., N. Ficcadenti. Dissection of Heterotic, Genotypic, and Environmental Factors Influencing the Variation of Yield Components and Health-Related Compounds in Chilli Pepper (*Capsicum annuum*). Euphytica, vol. 216, no.112, pp.1-17, 2020. DOI: 10.1007/s10681-020-02648-0.

[2] Di Dato F, Parisi M, Cardi T., P. Tripodi. Genetic Diversity and Assessment of Markers Linked to Resistance and Pungency Genes in *Capsicum* germplasm. Euphytica, vol. 204, no. 1, pp. 103–119, 2015. DOI: 10.1007/s10681-014-1345-4.

[3] Undang, Syukur M., Sobir. Identification of Cayenne Pepper (*Capsicum* spp.) Species Based on Cross-linking and Morphological Characters. Indonesian Journal of Agronomy, vol. 43, no, 2, pp.118–125, 2015. DOI:10.24831/jai.v43i2.10413.

[4] Sahid Z. D., Syukur M., A. Maharijaya. Diversity of Capsaicin Content, Quantitative, and Yield Components in

Cayenne pepper (*Capsicum annuum* L.) Genotypes and Their F_1 Hybrid. Biodiversitas,vol. 21, no. 5, pp. 2251-2257, 2020. DOI:10.13057/biodiv/d210555.

[5] Anjos G. L., Moreira G.C, C. N. Carneiro C. N., F. S. Dias. Effect of Phytoregulators on the Composition of Phenolic Compounds in Chili Peppers (*Capsicum frutescens*) and Exploratory Analysis. Scientia Horticultura, vol. 292, no. 4, pp.110660, 2022. DOI: 10.1016/j.scienta.2021.110660.

[6] Vazquez-Flores A. A., Góngora-Pérez O., I. Olivas- Orduña I., O. Muñoz-Bernal A., P. Osuna- Avila. Pytochemical Profile and Antioxidant Activity of Chiltepin Cayenne pepper (*Capsicum annuum* var. *glabriusculum*), Sonora, Mexico. Journal Food Bioactives, vol. 11, pp. 57-65, 2020. DOI: 10.31665/JFB.2020.11237.

[7] Alam M. A., Syazwanie N. F., Mahmod N. H., Badaluddin N. A, Mustafa K.'A., Alias N., Aslani F., M. A. Prodhan. Evaluation of Antioxidant Compounds, Antioxidant Activities and Capsaicinoid Compounds of Cayenne pepper (*Capsicum* sp.) Germplasms Available in Malaysia. Journal of Applied Research of Medical Aromatic Plants, vol. 9, no. 9, pp. 46-54, 2018. DOI: 10.1016/j.jarmap.2018.02.001.

[8] Nanok K., S. Sansenya. α-Glucosidase, α-Amylase, and Tyrosinase Inhibitory Potential of Capsaicin and Dihydrocapsaicin. Journal of Food Biochemistry, vol. 44, no. 1, pp. 1-10, 2019. DOI: 10.1111/ jfbc.13099.

[9] Stefano E. D., Oliviero T., C. C. Udenigwe. Functional Significance and Structure-activity Relationship of Food-derived α-glucosidase Inhibitors. Current Opinion in Food Science, vol. 20, pp. 7-12, 2018. DOI: 10.1016/j.cofs.2018.02.008.

[10] Williams S. J., E. D. Goddard-Borger. α-Glucosidase Inhibitors as Host-directed Antiviral Agents with Potential for the Treatment of COVID-19. Biochemmical Society Transactions, vol. 48, no. 3, pp. 1287-1295, 2020. DOI: 10.1042/BST20200505.

[11] Central Bureau of Statistics. Statistics of Indonesian Seasonal Vegetables and Fruits, https://www.bps.go.id/publication/2019/10/07/1846605363955649c9f6dd6d/statistik-tanaman-buah-buahan-dan-sayuran-tahunan-indonesia-2018.html (accessed Oct. 13, 2023).

[12] Ministry of Agriculture. Food Consumption Bulletin. https://leap.unep.org/countries/id/national-legislation/strategic-plan-indonesian-ministry-agriculture-2015-2019. (accessed Oct. 13, 2023).

[13] Kusmana Y., Kusandriani, D . Djuariah. Yield Test of Seven Genotypes of Cayenne Pepper in Highland Ecosystems Pangalengan, West Java. Journal Horticulture, vol. 27, no. 2, pp.147–154, 2017. DOI: 10.21082/jhort.v27n2.2017.p147-154.

[14] [IPGRI] International Plant Genetic Resources Institute. Descriptors for Capsicum (*Capsicum* spp.). https://cgspace.cgiar.org/handle/10568/72851(accessed Oct. 13, 2023).

[15] Syukur M., Yunianti R., R. Dermawan. Cultivating Cayenne Pepper Harvest Every Day. 1st ed. Penebar Swadaya [in Indonesia], 2016, pp. 1-200.

[16] Ilhamiyah, Salamiah, Samharinto, H. Halim. Agroecosystem Management on Green Mustard Plants in Wetlands during Dry Season. Available on line at: http://ijwem.ulm.ac.id/index.php/ijwem (accessed Oct. 25, 2023).

[17] Syukur M, Sujiprihati S, R . Yunianti. Plant Breeding Techniques, 1st ed. Penebar Swadaya (in Indonesian), 2018. pp. 1-348.

[18] Gomez K. A., A. A. Gomez. Statistical Procedures for Agriculture Research, 2n ed, A Wiley-Intersclence Publication John Wiley & Sons,1995. pp. 1-690.

[19] Kusmanto, Ritonga A. W., M. Syukur. Yield Test of 10 Cayenne pepper Lines (*Capsicum annuum* L.) with Open Pollination Potential as Superior Varieties. Agrohorti Bulletin, vol. 3, no. 2, pp. 154–159, 2015. https://doi.org/10.29244/agrob.v3i2.14974.

[20] Ritonga A. W., Syukur M., Sujiprihati S., A. R. Hakim. Evaluation of Growth and Yield of Fourteen Cayenne Pepper Hybrids. Journal Horticulture Indonesian, vol. 1, no. 1, pp. 20–25, 2017. http://dx.doi.org/10.29244/-chj.1.1.-20-25.

[21] Setiawan A. B, Purwanti S., Toekidjo. Growth and Seed Yield of Five Varieties of Red Cayenne Pepper (*Capsicum annuum* L.) in the Middle Land. Vegetalika, vol. 1, no. 3, pp. 1–11, 2014. DOI: 10.22146/veg.1345.

[22] Syukur M., Sujiprihati S., Yunianti Y., D. A. Kusumah. Non Parametric Stability Analysis for Yield of Hybrid Cayenne Pepper (*Capsicum annuum* L.) Across Six Different Environments. Indonesian Journal of Agronomy, vol. 42, no. 1, pp. 32-38, 2014. http://dx.doi.org/10.24831/jai.v42i1.8146.

[23] Ashar S. Evaluation of Characteristics and Yield Components of Cayenne Pepper (*Capsicum annuum* L.) in Dramaga, Bogor. [thesis]. pp. 1-68, 2019. https://repository.ipb.ac.id/handle/123456789/100981 (accessed Oct. 25, 2023).

[24] Ministry of Agriculture Indonesian. Description of Genie Variety Cayenne Pepper. Attachment to Decree of the Minister of Agriculture Indonesian Number 70/Kpts/SR.120/1/2008,https://varitas.net/dbvarietas/deskripsi/2095.pdf (accessed Oct. 25, 2023).