YIELD COMPONENTS AND SEED ATTRIBUTES OF NINE VARIETIES OF OPEN-POLLINATED CHILI

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ABSTRACT

Many studies related to chili varieties and productivity have been conducted. However, studies on the potential of seed production based on seed rendements to fulfil the need for chilli seeds are still limited. The study aimed to present rendement results, yield, and quality of the nine open-pollinated chilli seed varieties owned by the Indonesian Vegetable Research Institute (IVegRI), i.e. were Tanjung-2, Lembang 1, Ciko, Lingga, Kencana, Prima Agrihorti, Rabani Agrihorti, Carvi Agrihorti, and Branang, planted in a screen house. This study was conducted from January to December 2019. Cultivation techniques and seed certification followed the applicable Procedures. Data were analysed using descriptive methods. Observations were made on harvested fruits for yield and quality of seeds produced. The study revealed that Branang had the highest chili productivity (34.15 gm^{-2}). Meanwhile, the highest seed rendement was Lembang 1 (5.48%). All varieties had good germination, namely above 75%. Based on the results, the breeders are expected to obtain information related to seed productivity from chili varieties owned by the Indonesian Vegetable Crops Research Institute (IVegRI).

Key words : Certification, Open-pollinated, Productivity, Quality, Screenhouse.

ABSTRAK

Penelitian terkait varietas dan produktivitas cabai telah banyak dilakukan. Akan tetapi, penelitian tentang potensi produksi benih berdasarkan rendemen benih untuk memenuhi kebutuhan benih cabai masih terbatas. Penelitian ini bertujuan untuk menyajikan hasil rendemen, daya hasil, dan mutu sembilan varietas benih cabai menyerbuk terbuka milik Balai Penelitian Tanaman Sayuran (Balitsa) yaitu Tanjung-2, Lembang 1, Ciko, Lingga, Kencana, Prima Agrihorti, Rabani Agrihorti, Carvi Agrihorti, dan Branang yang ditanam di rumah kaca. Penelitian ini dilaksanakan pada bulan Januari sampai dengan Desember 2019. Teknik budidaya dan sertifikasi benih mengikuti Prosedur yang berlaku. Data dianalisis dengan metode deskriptif. Pengamatan dilakukan terhadap buah yang dipanen untuk mengetahui daya hasil dan mutu benih yang dihasilkan. Hasil penelitian menunjukkan bahwa Branang memiliki produktivitas cabai tertinggi (34,15 gm^{-2}). Sementara itu, rendemen benih tertinggi

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adalah Lembang 1 (5,48%). Semua varietas memiliki daya berkecambah yang baik, yaitu di atas 75%. Berdasarkan hasil penelitian ini diharapkan para pemulia tanaman dapat memperoleh informasi terkait produktivitas benih dari varietas cabai yang dimiliki Balai Penelitian Tanaman Sayuran (Balitsa).

Kata kunci : Sertifikasi, Serbuk sari, Produktivitas, Mutu, Rumah kaca

INTRODUCTION

Chili (*Capsicum annuum* L.) is Indonesia's main vegetable commodity. This plant originated in Mexico (Kraft et al., 2014), and has competitive and comparative advantages compared to other vegetable crops (Saptana et al., 2022). With the population of Indonesia that is around 273 million people and the average consumption of chili (big and cayenne) per capita per year of Indonesians is around 3.9 kg in 2021 (BPS, 2022b), the need for 272 people in 2021 was 1.06 million tons. Indonesia's chili production 2021 was 2.75 million tons (BPS, 2022a). Therefore, chili production had a surplus of 1.68 million tons. This surplus was used in industry or exported. Chili production of 2.75 million tons is estimated to require around 27.4 tons of extension seeds with an assumption of an average chili production of 20 tons per hectare.Chili is used in Indonesian cuisine to give a spicy taste or red colour so that it is more appetising. Indonesian people use chili peppers in fresh, processed like pasta, chili sauce, and tomato sauce (Hanny Wijaya *et al.,* 2020), also as powder and chili oil (Ngoenchai et al., 2019; Wang et al., 2017; Zhang et al., 2019; Zhu et al., 2023). Indonesia's chili production in 2021 reached 1.39 million tons of cayenne and 1.36 million tons of big and curly chili (BPS, 2022a). The amount comes from hundreds of varieties released by seed producers throughout Indonesia with varying productivity.

The chili varieties in circulation are officially registered, and their presence in the market will follow consumer preferences. Varieties that favour will be produced in large quantities by seed producers. Conversely, less desirable types will be produced in small amounts or not produced anymore (discontinued). From the seed consumers/chilli farmers' side, chilli varieties are selected based on the best combination of PGA (Plant Growth Attributes) and FA (Fruit attributes). Furthermore, Prima Agrihorti is a type of cayenne pepper preferred by farmers (Basuki et al., 2022).). In West Java, farmers prefer Carvi Agrihorti over Ciko and Tanjung-2 because of its high production and fruit weight (Sembiring et al., 2022). As for curly chilli, the Kencana variety is preferred more (Sujitno & Dianawati, 2015).

Indonesia's chili harvested area in 2021 was about 321,923 ha (FAO, 2023). This area is equivalent to the need for certified extension seeds of around 29.0-57.9 t, assuming the average need for chilli seeds is 90-180 g ha^{-1} (Azmi et al., 2023). Information related to seed rendement is necessary to predict the target seeds produced from the planted area. Every seed production process must be carried out according to studies that support good seed yield and quality to get the optimum chilli seed yield and quality (Azmi et al., 2022; Azmi et al., 2023; Kirana et al., 2021;

Krestini et al., 2017; Rahayu et al., 2018). The seed production process is conducted based on previous to recent studies.

Using manure for land in cultivating chilli plants can increase phosphate availability in the soil and reduce the need for chemical fertilisers in the next season (Jaya et al., 2021). Worm-fermented cow dung significantly increased agronomic variables and chilli yields compared to the controls (Aminifard, 2022).

Seed processing is better when the fruit is fresh than dry (Afandiyah & Purnamaningsih, 2020). Various varieties and priming solutions (KCl, NaCl, and Cacl) interact to increase chili seed vigour (Aloui et al., 2014). Soaking fresh fruit that has been split in water for 1 hour increases the germination of chili seeds (Azmi et al., 2022). After becoming seeds, using aluminium foil packaging to store seeds can extend the shelf life while maintaining the germination of chili seeds (Soh et al., 2014; Waluyo et al., 2014).

On the other side, research related to chilli varieties and productivity has been widely conducted. Starting from the creation of hybrid chili varieties or OP chili varieties (Medeiros *et al.,* 2018); chili fruit productivity (Karyani *et al.,* 2021); chili seed treatment (Agustiansyah *et al.,* 2021); chili seed production (Permatasari, Okti Syah Isyani Widjajati *et al.,* 2016); chili seed processing (Rahayu *et al.,* 2018); chili seed storage (Madyasari *et al.,* 2017). However, it is rare to find articles that discuss the potential of seed production and the seed quality of chili (Kurniawan & Azmi, 2021). Therefore, this manuscript was written to determine the potential seed yield, seed rendement and seed quality of chili from the varieties owned by the Indonesian Vegetables Research Institute.

MATERIALS AND METHODES

The research was conducted from January to December 2019 at Margahayu, Indonesian Vegetables Research Institute (IVegRI) experimental field, Lembang, West Java, Indonesia. Nine open-pollinated chili varieties owned by IVegRI, namely Tanjung-2, Lembang 1, Ciko, Lingga, Kencana, Prima Agrihorti, Rabani Agrihorti, Carvi Agrihorti, and Branang, almost each variety planted in a screenhouse. Some materials used were sterile soil, manure, KCl fertilizers, SP-36, ZA, NPK, silver black mulch, cuttings, stakes, raffia rope, majun rope, crackle bags, buckets/tanks, trays, and aluminium foil.

The land preparation was carried out by clearing grass. Then, the soil was rotated with a plough to turn it. After that, beds were made, and basic fertilisations were given. The essential fertilisers were 30t ha^{-1} of chicken manure, 1t ha^{-1} of dolomite, 100 kg ha^{-1} of KCl, 100kg ha^{-1} of SP-36, and 70kg ha^{-1} of ZA. The beds were then covered with plastic mulch and left for 3 weeks.

Seed sowing using sterile soil to avoid soil-borne diseases. Seeds were spread on seedling media and covered with black plastic to accelerate germination. After the first leaf appeared, the seedlings were planted and maintained for 1-2 weeks. After 3-4 weeks of age, the seeds were planted in beds with a spacing of 50 cm x 70 cm. All varieties were planted in one screenhouse.

The plants were given supplementary fertilisers 30 days after planting (DAP) and 60 DAP. The fertilisers comprised a mixture of 100kg ha^{-1} KCl, 100kg ha^{-1} SP-36, and

130kg ha^{-1} ZA. Watering and pest-diseases control were carried out according to the plant needs. During the plant's life, roguing was carried out to remove off-type plants, plants affected by diseases/viruses, or mixtures of other varieties. Roguing had been done during the life of chili plants minimally before field inspection was conducted.

In this study, the seed certification was carried out to certify the seeds produced. The certification process began with certification registration and then preliminary inspection before planting. Vegetative and generative inspections were carried out according to the conditions of each variety. The Quality Control of the Seed Production Unit of IVegRI performed the certification process.

Physiologically, ripe fruit observation was a parameter for chili fruit harvesting. The chili's physiological ripeness was characterised by entirely red fruit on the entire surface of the fruit. Only healthy chili fruits were processed. The wet method was used to extract the fruit, and it was sliced longitudinally and soaked in water (Azmi et al., 2022). Then, the seeds were drained in the seed drying chamber at 30-35 °C for 5-7 days until the moisture content was below 7%. After drying, the seeds were sorted to separate pure seeds from seed impurities (chilli pulps, broken seeds, and sands). The seeds were stored in aluminium foil (Soh et al., 2014) and kept at ± 15°C and then tested for seed quality, such as moisture content, germination, and physical purity, in an accredited laboratory for chilli seed quality testing. Generally, the chlli seed production procedure up to seed classification followed the chili certification seed regulation (Setyanto, 2019).

The variables observed at harvest included fruit weight, dry seed weight, net seed weight, seed weight per lot, seed productivity per square meter and seed rendement percentage. Seed yield was calculated by dividing seed weight by area (1), while seed rendement was calculated using the formula 2 :

$$Seed\ yield = \frac{Seed\ weight\ (g)}{area\ (m^2)} \quad (1)$$

$$Seed\ rendement\ (\%) = \frac{Net\ dry\ seed\ weight\ (g)}{Fruit\ weight\ (g)} x\ 100\% \quad (2)$$

Data obtained from the production process were tabulated and presented with descriptive statistics.

RESULTS AND DISCUSSIONS

Table 1 shows chili varieties planted, size, and sowing to harvesting period. Each variety was planted in one screen house, except for Ciko, Prima Agrihorti, and Rabani Agrihorti, which were planted in two screen houses. All varieties were planted at the same time except for Ciko variety. It was planted in two stages because the seeds sown were insufficient for two screens. The chili seed production was conducted in the screen house to prevent cross-pollination with other varieties. Moreover, planting in the screen house could reduce pest attacks and decrease the use of insecticides (Moekasan *et al.,* 2015; Prabaningrum & Moekasan, 2014).

The inspection before planting ensured that the land had previously not been planted with the same family crops. Meanwhile, the inspection after planting was in the vegetative phase (20 DAP until before flowering) and the generative phase (when the plant had flowered and fertilisation had occurred). Inspection of vegetative and generative phases should follow the horticulture seed quality certification's guidelines. For chili plants, covering other varieties, off-type, and plant health. The level of anthracnose, viruses, and leaf spot infections for source seed production is expected to be less than 0.1% of the population for each type of infection (Setyanto, 2019). If it exceeds, the plants should be treated intensively, uprooted, or downgraded to a lower seed class. Infected plants with viruses, fusarium wilt and anthracnose are recommended to be uprooted because these diseases are considered seed-borne diseases (Ramdan & Kalsum, 2017; Sukapiring & Nurliana, 2020).

Table 1. Varieties, planted area, and sowing-to-harvest period time of twelve screenhouses of nine varieties of open pollinated (OP) chili

Variety	Screenhouse area (m^2)	Total plant population	Sowing-to-harvest period
Tanjung-2	200	400	February–July 2019
Lembang 1	200	400	February–September 2019
Ciko (1)	200	400	February–August 2019
Ciko (2)	200	400	May-November 2019
Lingga	200	400	February–August 2019
Kencana	200	400	February–October 2019
Prima Agrihorti (1)	120	140	February–October 2019
Prima Agrihorti (2)	120	140	February–October 2019
Rabani Agrihorti (1)	120	140	February–October 2019
Rabani Agrihorti (2)	120	140	February–October 2019
Carvi Agrihorti	150	300	February–September 2019
Branang	150	300	February–September 2019

During the lifetime of plants, roguing was carried out by the production department, and the seed quality certification department of a seed production unit of IVegRI did a field inspection. The chili plants were uprooted as they were attacked by viruses or wilting and were difficult to overcome with pesticides would be uprooted. The uprooted plant data was not separated between plants with virus symptoms, anthracnose, or wilted or off-type plants. In this study, it's suspect that an inoculum was accidentally carried, trapped and multiplied in the screenhouse. Plants that can host viruses include chillies, tomatoes, eggplants, cucumbers, green beans, long beans, and billy goat-weed (Gaswanto et al., 2016). The billygoat weed around the production area was likely the host for the chili plant virus. Even though sanitation around the screenhouse was always maintained, it was still possible that some had escaped scrutiny, causing the same varieties in different screen houses to have different disease attack rates. Meanwhile, differences in attack between varieties are also possible due to genetic differences. In addition, sanitation and maintenance factors, as well as nutrition, also affect the level of disease.

The uprooted plant data are shown in Table 2. Ciko and Kencana were the most uprooted plantings, at 35% and 30%, respectively. In several previous studies, the same variety showed different levels of resistance. In Bangli, Lembang 1, Kencana, and Branang Regencies were highly susceptible, susceptible and resistant varieties to Fusarium oxysporum with severity levels of 34.4%, 27.7% and 5.7%, respectively (Ferniah et al., 2014). In another study, the Branang variety was categorised as Fusarium wilt-resistant, while Lembang 1 was highly susceptible, and Kencana was classified as susceptible (Ferniah et al., 2014, 2018). It also found no correlation between capsaicin levels and resistance to Fusarium oxysporum, which causes wilt.

Tanjung 2 was detected as susceptible anthracnose with lesions of 47 mm^2 (Nugroho et al., 2019), while Ciko, Lingga, Prima Agrihorti, Kencana, and Lembang 1 with lesions of 14, 16, 18, 34, and 45 mm^2 respectively. With the following categories: lesion 0 = immune variety; lesion between $0 < d \leq 5$ = resistant variety; $5 < d \leq 10$ = moderately resistant variety; $10 < d \leq 20$ = moderately susceptible variety; and > 20 susceptible variety, means Ciko, Lingga and Prima Agrihorti were included in moderately resistant varieties and susceptible varieties for Kencana and Lembang 1.

Different results were produced in other studies that mentioned Tanjung 2, including varieties that were moderately resistant to anthracnose (Adhni et al., 2022). Furthermore, the type of chili species was not correlated with anthracnose's resistance. There was *Capsicum frustescens* that was less resistant than *C. annum*, and there was also *C. annuum* that was more resistant than *C. frustescens.* In addition, it found that in green fruits, Tanjung-2 and Kencana were categorised as moderately susceptible varieties against anthracnose (Gunaeni et al., 2021). Meanwhile, in red fruits, Tanjung 2 and Kencana were classified as susceptible to anthracnose caused by *Colletotrichum acutatum* (Kirana et al., 2014). That result showed a higher level of defence of young fruits than older fruits. Those differences may be due to crop conditions, inoculation methods, types of inoculations and inoculation densities.

Table 2. Total population and number of plants uprooted in twelve screenhouses of nine OP chili varieties

Variety	Total plant population	The number of plants uprooted*	The number of plants uprooted**	Percentage of uprooted plants (%)
Tanjung-2	400	0	4	1.00
Lembang 1	400	0	18	4.50
Ciko (1)	400	20	120	35.00
Ciko (2)	400	0	5	1.25
Lingga	400	0	5	1.25
Kencana	400	20	100	30.00
Prima Agrihorti (1)	140	0	5	3.57
Prima Agrihorti (2)	140	0	5	3.57
Rabani Agrihorti (1)	140	0	5	3.57
Rabani Agrihorti (2)	140	0	5	3.57
Carvi Agrihorti	300	20	13	11.00
Branang	300	15	20	11.67

Note : * = vegetative phase inspection; ** = generative phase inspection

Regarding on resistance to *Fusarium oxysporum*, the Branang variety resisted to *Fusarium oxysporum* wilt, whereas Lembang 1 was very susceptible, and Kencana was classified as a *Fusarium oxysporum* susceptible variety (Ferniah et al., 2014, 2018). Furthermore, there was no correlation between capsaicin levels and *Fusarium oxysporum* resistance, which causes wilt disease.

Once the chili plants had passed the generative inspection, they kept growing until harvest. Chilli fruit is harvested when the fruit is physiologically ripe, which is characterised by fully red fruit. At this stage, chili's dry matter content and germination are constant and maximum compared to un-fully fruit colour (Gomes et al., 2017). Each variety of chili had a different harvest time and period. The earliest chili varieties harvested were Tanjung-2 (big chili), Lembang 1 (curly chili) and Prima Agrihorti (cayenne chili). They could be harvested at 16 weeks after planting (WAP), 19 WAP, and 20 WAP. The shortest harvest variety period was Tanjung-2 (5 weeks), and the longest was Prima Agrihorti (15 weeks) (Figure 1).

The next step was the process of fruits to obtain dry seeds. The seeds were sorted and cleaned them from dirt (Table 3). The chili fruit yields and seed rendements obtained were varied depending on the variety and plant conditions in each screen house. In this study, Tanjung-2, within 5 weeks, 6-times harvests could produce 188.5 kg of fruit with 5,640 g of seeds. Lembang 1, within 10 weeks, 7-time harvests, produced a whole fruit of 98 kg, with net seeds obtained as much as 5,369 g. Ciko, in 8-9 weeks, 7-time harvests, produced 57.0-108.5 kg of fruit and obtained 1,745-3,367 g seeds. Lingga in 6 weeks, 5-time harvests produced 193 kg of fruit with 6,360 g net seeds. Kencana in 12 weeks, 8-time harvests produced 66.5 kg of fruit, with 2,443 g net seeds. Prima Agrihorti, in 15 weeks with 11-12 harvests, produced 80-104 kg of fruit and obtained 3,323-4,026 g net seeds. Rabbani Agrihorti, in 12 weeks, 9-time harvests produced 46.8-68.5 kg of fruit, 2,675-3,530 g net seeds. Carvi Agrihorti in 10 weeks, 9 harvests produced whole fruit 162.5 kg, net seeds obtained 3,785 g. Branang, in 11 weeks with 10 harvests, produced 116 kg of fruit, and seeds obtained 5,122 g. Based on the harvest time range, it can be concluded that Tanjung-2 has the shortest harvest duration (5 weeks) as the flowers on the Tanjung-2 variety appear more synchronously than other varieties.

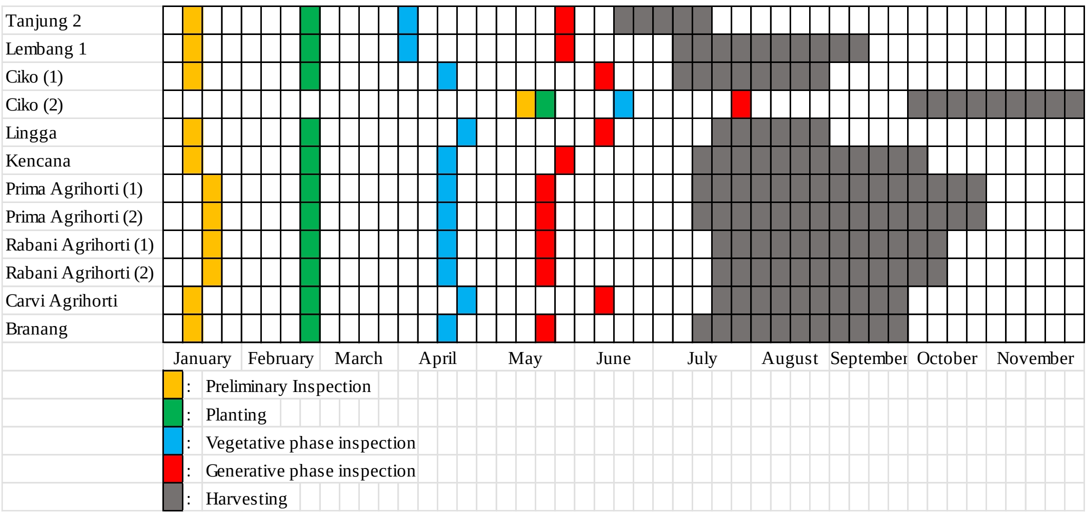

Figure 1. Tabulation of the planting to-harvest period of twelve screen houses of nine OP chili varieties.

Ciko, Prima Agrihorti, and Rabani Agrihorti varieties planted in two screen houses generated different fruit and seed yields. This finding is in line with statement that genetic and environmental interactions influence the number of fruits per plant (Cabral et al*.,* 2017). The environment could be a different planting period or a different screen house. Ciko was planted in two screen houses at two different planting periods. Meanwhile, Prima Agrihorti and Rabbani Agrihorti were planted in two different screen houses, in the same planting period. The weather conditions (temperature and moisture) in each screen houses with different planting periods and microclimates caused the difference effect. This is supported by other studies, which also state that the planting location significantly influences yield componens and yield of chili (Syukur et al., 2022).

Table 3. Fruit and seed productions of twelve screenhouses of nine OP chili varieties

Variety	The population of harvested plants	Total fruit weight (kg)	Total dry seed weight (g)	Total seed weight (g)
Tanjung-2	396	188.5	6,011.6	5,640
Lembang 1	382	98.0	5,765.0	5,369
Ciko (1)	260	108.5	3,683.6	3,367
Ciko (2)	395	57.0	2,027.0	1,745
Lingga	395	193.0	8,806.0	6,360
Kencana	280	66.5	2,751.6	2,443
Prima Agrihorti (1)	135	80.0	3,660.7	3,323
Prima Agrihorti (2)	135	104.0	4,442.5	4,026
Rabani Agrihorti (1)	135	46.8	2,990.0	2,675
Rabani Agrihorti (2)	135	68.5	4,028.0	3,530
Carvi Agrihorti	267	162.5	4,175.0	3,785
Branang	265	116.0	5,584.6	5,122

Table 4 shows the seed productivity and seed rendement of nine OP chili varieties. The productivity of chili fruit, chili seeds, and seed rendements between varieties varies. Even the same variety planted in different screen houses had different fruit, seed productivity, and seed rendement. Genetics and the environment also affect the seed rendement. This study aligns with the research results of Suharsi (Suharsi *et al.,* 2015). The average production of chili fruit from 9 varieties ranged from 0.33 kg m^{-2} (Kencana) to 1.08 kg m^{-2} (Carvi Agrihorti), while the average production of chili seed of the varieties ranged from 12.22 g m^{-2} (Kencana) to 34.15 g m^{-2} (Carvi Agrihorti). The average seed rendements of the 9 varieties ranged from 2.33% (Carvi Agrihorti) to 5.48% (Lembang 1). These seed rendements indicate the number of seeds produced compared to the amount of fruit processed. The seed rendement of 2.33% means that of 1 kg of chili fruit, 23.3 grams of pure chili seeds are produced. The yield data shows that the Lembang 1 variety had more seeds per fruit than other varieties. In contrast, Tanjung-2 and Carvi Agrihorti had fewer seeds per fruit than other varieties.

Table 5 shows the results of seed quality testing for each variety and lot tested. The seed lots were divided based on the harvest time span. The purity of all lots of all varieties was 100%, indicating that the seed sorting was excellent and appropriate. This is shown by the seed moisture content ranging from 5.0-6.0%, and this figure meets the standard moisture content of chili seeds (maximum 7.0%). The germination seed rate ranged from 75-100%. The higher the germination rate, the better the seed quality. According to Agustiansyah (Agustiansyah *et al.,* 2021), seeds with high germination will be able to survive under aluminium stress conditions. Of the 31 seed lots, one lot was Extension Seed (ES), 10 lots were Foundation Seed (FS), and 20 were Breeder Seed (BS). Breeder Seed (BS) can be used as a source seed for production to produce the next seed class (Foundation seed, Stock Seed, and Extension seed). Furthermore, Foundation Seed (FS) can be used as a source seed for production to produce Stock Seed (SS) and Extension Seed (ES). Meanwhile, the Extension Seed (ES) cannot be used as a seed source anymore for the next seed class. It is directly planted to generate chili for consumption. Based on the information above, seed producers and potential licensors can select and obtain information about varieties they are interested in adopting, producing, and disseminating seeds.

Table 4. Seed productivity and seed rendement of nine OP chili varieties

Variety	Fruit productivity per m^2 ($kg\ m^{-2}$)		Seed productivity per m2 ($g\ m^{-2}$)		Seed rendement (%)	
	A	B	A	B	A	B
Tanjung-2	0.94		28.20		2.99	
Lembang 1	0.49		26.85		5.48	
Ciko (1)	0.54	0.41	16.84	12.78	3.10	3.08
Ciko (2)	0.29		8.73		3.06	
Lingga	0.97		31.80		3.30	
Kencana	0.33		12.22		3.67	
Prima Agrihorti (1)	0.67	0.77	27.69	30.62	4.15	4.01
Prima Agrihorti (2)	0.87		33.55		3.87	
Rabani Agrihorti (1)	0.39	0.48	22.29	25.85	5.72	5.43
Rabani Agrihorti (2)	0.57		29.42		5.15	
Carvi Agrihorti	1.08		25.23		2.33	
Branang	0.77		34.15		4.42	

Note : A = one screenhouse; B = Average two screenhouse; 1 = first screenhouse; 2 = second screenhouse

Differences in seed classes occur due to different seed quality, caused by several factors such as fruit harvest age, seed processing, species/varieties, interactions between varieties/species, and physiological maturity fruit harvest age (Martínez-Muñoz et al., 2019). Fruits harvested before physiological maturity have lower seed viability than those harvested when physiological maturity. Harvesting physiologically mature chili also reduces seed browning rates (Park et al., 2020). Seed viability is negatively correlated with electrical conductivity. The lower the electrical conductivity, the higher the viability of the seed. While the protein's late embryogenesis abundant (LEA) in seeds is directly correlated with the maximal physiological quality of chili seeds (Martínez-Muñoz et al., 2019).

The physiological maturity of chili seeds differs depending on the variety (Suharsi et al., 2015). Generally, the physiological maturity of chili fruit is characterised by red fruit. Meanwhile, the viability of seeds is not affected by the position of the fruit on the tree (Suharsi et al., 2015). So that the fruit from any branch can be used as a seed as long as the nutrients are sufficient and supportive for seed development, the ripening time of fruits on the lower branches is shorter; however, the size and weight are greater than those on the upper branches (Suharsi et al., 2015).

Table 5. The quality of nine OP chili varieties

Variety	Lot umber	Total seeds per lot (g)	Purtity (%)	Moisture content (%)	Germination (%)	Seed Class
Tanjung 2	KBB/01/2019	1,420	100	6.7	79	ES
	KBB/02/2019	1,260	100	6.3	90	BS
	KBB/03/2019	1,955	100	5.6	86	BS
	KBB/04/2019	1,005	100	5.8	86	BS
Lembang-1	KBB/01/2019	2,387	100	5.9	89	BS
	KBB/02/2019	1,735	100	5.8	90	BS
	KBB/03/2019	1,247	100	6.6	81	FS
Ciko	KBB/01/2019	1,792	100	5.5	88	BS
	KBB/02/2019	1,575	100	5.5	88	BS
	KBB/03/2019	1,745	100	5.0	82	FS
Lingga	KBB/01/2019	1,700	100	6.4	83	FS
	KBB/02/2019	2,220	100	5.4	90	BS
	KBB/03/2019	2,440	100	5.4	80	FS
Kencana	KBB/01/2019	1,493	100	6.5	89	BS
	KBB/02/2019	950	100	6.5	81	FS
Prima Agrihorti	KBB/01/2019	1,130	100	6.4	77	FS
	KBB/02/2019	1,296	100	6.7	75	FS
	KBB/03/2019	1,138	100	6.8	83	FS
	KBB/04/2019	1,365	100	6.0	92	BS
	KBB/05/2019	1,055	100	6.1	85	BS
	KBB/06/2019	1,365	100	6.4	79	FS
Rabani Agrihorti	KBB/01/2019	1,385	100	6.2	100	BS
	KBB/02/2019	1,870	100	6.7	99	BS
	KBB/03/2019	1,290	100	6.5	97	BS
	KBB/04/2019	1,660	100	6.1	98	BS
Carvi Agrihorti	KBB/01/2019	970	100	6.5	93	BS
	KBB/02/2019	1,290	100	6.1	96	BS
	KBB/03/2019	1,525	100	6.0	93	BS
Branang	KBB/01/2019	1,285	100	5.9	87	BS
	KBB/02/2019	1,575	100	5.8	83	FS
	KBB/03/2019	2,262	100	6.1	95	BS

Note: BS = Breeder Seed; FS = Foundation Seed; ES = Extension Seed

In this study, it is possible that in seed lots under the breeder seed class, the harvest fruits were mixed between red and orange, so that it mixed between physiological maturity and physiologically immature ones so that the final germination was not as high as the lot whose fruit was harvested during red physiological maturity (red, extreme red, dan intense red). In hot peppers, the later the fruit is harvested (intense red fruit), the higher the germination value. Chili fruits are recommended to be harvested when the fruit is red, extreme red, and intense red (Gomes, Damasceno, et al., 2017). Furthermore, it is stated that the harvest of intense red fruit chili (red and the fruit's skin is soft) and seed processing by splitting and soaking the harvested fruits obtain the best results for germination speed, germination value and seed purity (Husaini & Widiarti, 2017). Late-harvested fruit does not require storage time before seed extraction, while the earlier ones require before extraction (Martínez-Muñoz et al., 2019). Harvested fruits that are green to orange (for cayenne) should be allowed to stand for 10 days so that the seed germination can be increased (Gonçalves et al., 2018).

Processing chili seeds by soaking is better than splitting, blending, or grinding (Krestini et al., 2017). Moreover, processing chili seeds with the wet method (fruit split then soaked in water) results in better seed viability compared to fresh fruit without soaking (Azmi et al., 2022) or fresh fruit dried and then processed (Afandiyah & Purnamaningsih, 2020).

CONCLUSIONS

1. Branang was the highest seed productivity (34.15 g m^{-2})
2. Lembang 1 produced the highest chili seed rendement 5.48%.

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