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Cultivar Repair of Local Vigna Radiata L to Use Multigamma Irradiation Technique (Nuclear) That Tolerant to Dry Condition, Rainy Season, Germ, and High Production

Bartholomeus Pasangka[1*], Irvandi Gorby Pasangka[2], Zoran S. Ilic[3]

[1] Professor of Applied Nuclear Physics, Department of Physical Science collaborated by Agricultural Science, Nusa Cendana University, Indonesia (Specialist: Applied Nuclear Physics on Plant Breeding).
[2] Mathematics Department, Faculty of Sciences and Engineering, Nusa Cendana University, Indonesia.
[3] Faculty of Agriculture University of Priština,Priština Lešak, Serbia.

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Abstract: Vigna Radiata L is grouped as the third important legume in Indonesia after soybean and peanut with high nutrition. The research aims to develop local Vigna Radiata L from Timor Island Indonesia with multi-gamma irradiation technique and carefully selection for obtaining several variations of superior varieties. The main research method comprised of observation, irradiation, purifying, careful selection, comparative, analysis, and interpretation. The results of research on final purifying are obtained three variations of mutant varieties with several superior chemical and physical characteristics. The production of *Vigna Radiata* L as a result of Multigamma irradiation significantly increased, and on final purifying obtained especial superior of selected mutant varieties namely, two varieties can be fruited for the second time with harvest age are relatively short.

Keywords: irradiation; breeding; Vigna Radiata L; dry condition; germ.

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Introduction

Although its cultivation was still limited, Vigna Radiata L is the third important legumes in Indonesia after Soybean and Peanut. Vigna Radiata L is included in one important commodity because its nutrition content is high. For example in 100.0 grams contained 56.9 grams of carbohydrate, 22.0 grams of protein, 1.5 grams of fat, 0.46 milligrams vitamin B_1, 10.0 milligrams vitamin C, 223.0 milligrams calcium, 319.0 milligrams phosphorus, 7.5 milligrams iron, 10 grams water, 157 U vitamin A, and 323 calories (Fitriyanti and Dahlia, 2017; Yufdi, 2020; Utami, 2021). The results of Vigna Radiata L processing that turned in the market were tauco, porridge, milk, cake, and can be used as fodder (animal food), manure, medicinal treatment, and bakpia (Yufdi, 2020; Widianingsih et al. 2021).

The production of Vigna Radiata L in Indonesia in 2015 reached 271,463 tons. In 2018, the production decreased, i.e., only 234,718 tons (BPS, 2018; Candra et al., 2020; Suhartono et al., 2020). In the time range of five years latest from 2015 up to 2018, the production of Vigna Radiata L in Indonesia inclined drastically decreased about 271,463 tons., 252,985 tons., 241,334 tons, and 234,718 tons (BPS, 2018; BPS, 2021; Hastuti et al., 2018). As a consequence of this decreased production, the government imports 29,443 tons per year to fulfill the requirements of Vigna Radiata L in Indonesia (Yulia et al., 2016).

If the average requirement of Vigna Radiata L is approximately 2.5 kilograms per capita per year, that means that Vigna Radiata L is 12,117.28 tons per year. The government necessary imports the Vigna Radiata L to fulfill that requirement (BPS, 2018).

*Email: bpasangka15@gmail.com

The average production of Vigna Radiata L at the farmer land is relatively low, only approximately 0.7 tons/ha, the average production on specimen partition is 2.0 tons/ ha (Hastuti et al., 2018). Several factors like as cause the low production of Vigna Radiata L in the farmers land: superior seeds are not enough (not available), the dibble of dryness, cultivation system is not optimum, the aggression of germ like as *Cercospora canescens*, *Erysiphe polygony*, *Elsinoe glycines*, Scabies, *Agromiza Phaseoli*, *Etiella Zinckenella*) and *Maruca testutal*, *Plusia chalcites*, Virus (Rahayu and Sumartini, 2017; Ramadhan, 2015).

The production of Vigna Radiata L, especially in East Nusa Tenggara, is still relatively low, with cultivation still to be limited. One prominent factor caused is the limited superior seed of Vigna Radiata L. The result of the researcher survey in several areas in East Nusa Tenggara shows that the production of Vigna Radiata L in 2016 was only 0.4 tons/ha up to 0.6 tons/ha.

The procurement of superior seeds Vigna Radiata L is one of the problems that is considered difficult by farmers, especially on Timor island and generally in East Nusa Tenggara. The problem occurs because the environmental conditions are dry, calcium is high, salt is high, and so the cause is not all Vigna Radiata L seeds can grow in the environment. Development of Vigna Radiata L seed from Timor Island with the application of multi-gamma irradiation method gives the hope to obtain superior seed of Vigna Radiata L that tolerant to those above conditions, that finally can increase production of the farmer of Vigna Radiata L on Regional and National level. The positive impact of readiness of superior seed of *Vigna Radiata* L is reached of efficiency of farm operations and intimate terms of environment (BALITKABI, 2015)

The superiority of the multi-gamma irradiation method is obtained superior variety in relatively short time compared with artificial crossbreeding until to generation 7 up to 9 in the long term. Behind that, several variations of superior varieties were obtained as a result of breeding that different characteristic with initial (parent) characteristics, in order that is easy to select of superior seeds of Vigna Radiata L (Pasangka and Refli 2018).

The aims of this research are: 1) to develop local Vigna Radiata L with using multi-gamma irradiation method for obtaining superior varieties that are tolerant to dry condition, rainfall, germ, and high production, 2) to purify mutant varieties as a result of multi-gamma irradiation on first-year research for obtaining varieties with genitive and *fenotive* uniformity are relatively same and had put to the test of growing ability at several areas (locations) with different conditions, 3) to increase superior varieties of *Vigna Radiata* L to be cultivated by the farmers.

Method

Material Study

The main equipment used in this research comprises standard multi-gamma irradiation source, counter of radiation dosage, protein analyzer, water analyzer, tractor, and a number of other proponent equipment like germ sprayer, mattock crowbar, pail, huller, hose, etc. The local Vigna Radiata L sample, which is breeding, is local Vigna Radiata L from Timor Island East Nusa Tenggara Indonesia.

Description of Research Location and Time Research.

Research sites to obtain mutant varieties are located in four places in Kupang (one province) of Timor Island, Indonesia (The location names are Fukdale, Oesao, Baumata, Bakunase, and Bolok). The five places have relatively similar environmental conditions, such as the average lighting time is six hours per day, soil structure, dry conditions, and salt and calcium content. In the multi-location purification and test, steps used one location in four provinces. The name of location at each province is Fukdale province of East Nusa Tenggara, Tana Toraja province of South Sulawesi, Mamuju province of West Sulawesi, and Palu province of Middle Sulawesi. All locations have relatively different environmental conditions. The research was done during three years, from March 2017 up to March 2020.

Research methods include observation, sampling, irradiation, selection, comparison, purifying, analysis, and interpretation. Observation is the pre-step of activity for determining planting location. Collection and data analysis is done through observations, measurements, calculations, and analysis of selected mutant varieties' chosen samples (water content). Quality control is performed to compare qualitatively (direct observation results) and quantitative (measurement and calculation results) of important physical and chemical characteristics in superior varieties (selected mutant varieties) and early varieties.

Research Procedures

Procedures or research steps comprise of:

1) To observe to select local Vigna Radiata L samples and decide on several vigna Radiata L planting sites as a result of multi-gamma irradiation in the first year of research, to continue testing the physical and chemical characteristics required in determining the variation in each variation of the superior variety in the second and third years of the study.

2) To process planting area with to plow using a tractor in order that the area free from weeds trouble and the soil is loose, so, the growth of Vigna Radiata L is very good. Continuously to be done embankment that appropriated to area conditions for ease of irrigation.
3) To soak the area that has been processed and to islet dry for two days (soil condition is damp).
4) Vigna Radiata L seeds of selected mutant variety as a result of multi-gamma irradiation on the first year of research, purifying result on second and third years of research and then to be planted at the several locations (one place at four provinces).
5) The planting distance of Vigna Radiata L seeds is 40 cm x 15 cm. Vigna Radiata L seeds were planted to dibble with a pointed stick to sow seeds on 3 cm up to 4 cm depth. To obtain optimal production, so that fertilizing is directly done moment seeds planting that is between planting hole is done another hole with depth 5 cm up to 7 cm and put in fertilizer of Urea plus NPK (1:2) one eats spoon and then to be closed with soil.
6) Irrigation after planting is appropriated with rainfall at the research location (planting area).
7) To observe growth ability and growth age on both variety's initial and treatment samples.
8) To clear plant of weeds and fertilize according to theory in order that plant free from weeds trouble and fertile growth.
9) To do observation series during plant growth like growth ability, tenacity to germ (disease and pest), tolerance to dry conditions, high salt and calcium, flowered age, carefully selected plant, and so on. On near harvest is done the second selection, measurement of high plant, calculation pod number per tree, and calculation the number seeds per pod.
10) Harvest and seeds drying. Harvest is done after fruits are good ripening that is shown by skin color is brown or black. After that is done drying, split the seeds from the pods and the cleaning seeds from the skin. The seeds are dried again for two or three days until the moisture content is about 10%-11%.
11) After harvesting the best seeds, selected and measured mass pes 1,000 seeds in grams. Also, analyze water contents. The water contents for seeds will be continuously developed about 10% -11%, and water content to be consumed about 12%.
12) To compare physical and chemical characteristics (results of direct observations, measurements, and calculating) between selected mutant varieties (Superior varieties) and initial variety.
13) The final step of procedures is to interpret and conclude discussion results.

Statistics for Data Analysis

Statistics formulation needed to calculate growth percentage, mean or average increase percentage of production, and the increasing average of production. For checking of growth percentage, the treatment and control samples are randomly chosen as many as five groups. The number of the test sample is 100 seeds in every group.

The number of sample seeds is not growth observed and calculated on every group. Growth percentage is calculated by equation (Pasangka and Refli, 2016., Pasangka, 2018., 2019).

$$GP = \left(\frac{T_{AS} - A_{SG}}{T_{AS}} \right) \times 100\% \quad \text{.................. (1)}$$

Where: GP is growing percentage (%), T_{AS} is the number of seeds total which planted, A_{SG} is the number of seeds was not growth.

Average production of treatment samples on every selected mutant variety at four provinces of planting location calculated with equation (Pasangka and Refli, 2016., Pasangka, 2017a; 2019b)

Mutant-1 Variety (M1V):

$$A_{RPSP(1)} = \frac{P_{L1} + P_{L2} + P_{L3} + P_{L4}}{4} \quad \text{............... (2)}$$

Where: $A_{RPSP(1)}$ is average production of treatment sample of mutant-1 variety at four provinces, $P_{Li}, P_{L2}, P_{L3}, P_{L4}, P_{L5}$ are mutant (treatment) and control production at four provinces of planting location, and n = 1, 2, 3, 4.

Mutant -2 Variety (M_2V):

$$A_{RPSP(2)} = \frac{P_{L1} + P_{L2} + P_{L3} + P_{L4}}{4} \quad \text{............... (3)}$$

Where: $A_{RPSP(2)}$ is average production of treatment sample of mutant-2 variety at four provinces.

Mutant-3 variety (M_3V):

$$A_{RPSP(3)} = \frac{P_{L1} + P_{L2} + P_{L3} + P_{L4}}{4} \quad \text{................ (4)}$$

Where: $A_{RPSP(3)}$ is average production of treatment sample of mutant-3 variety at four provinces Total average production of mutant variety on final purifying calculated by the formula (Pasangka, 2017a).

$$A_{RPSP(t)} = \frac{A_{PTS(1)} + A_{PTS(2)} + A_{PTS(3)}}{3} \quad \text{........... (5)}$$

Where: $A_{RPSP(t)}$ is total average production of selected on final purifying at four provinces.

The equation calculates the increasing percentage of production on every selected mutant variety:

Mutant-1 Variety *(M_1V):*

$$I_{PPPVM(1)} = \left(\frac{A_{RPSP(1)} - A_{RPSC(t)}}{A_{RPSP(1)}} \right) \times 100\% \quad \text{......... (6)}$$

Where: $I_{PPPVM(1)}$ is increasing percentage of production of mutant-1 variety at four provinces on final purifying (Pasangka, 2017a; 2019b).
Mutant-2 variety ((*VM2):*

$$I_{PPPVM(2)} = \left(\frac{A_{RPSP(2)} - A_{RPSC(2)}}{A_{RPSP(2)}} \right) \times 100\% \quad \ldots(7)$$

Where: $I_{PPPVM(2)}$ is increasing percentage of production of mutant-2 variety at four provinces on final purifying (Pasangka and Refli, 2016; Pasangka, 2017a; 2019b).
Mutant-3 variety ((*VM3):*

$$I_{PPPVM(3)} = \left(\frac{A_{RPSP(3)} - A_{RPSC(3)}}{A_{RPSP(3)}} \right) \times 100\% \quad \ldots(8)$$

Where: $I_{PPPVM(3)}$ is increasing percentage of production of mutant-3 variety at four provinces on final purifying (Pasangka, 2017a; 2019b).

The following equations calculate the average percentage of production of selected mutant varieties in the four provinces at the final purification (Pasangka and Refli, 2016; Pasangka, 2017a; 2019.b).

$$I_{PPPRTVM} = \left(\frac{I_{PPPVM\ (1)} + I_{PPPVM\ (2)} + I_{PPPVM\ (3)}}{3} \right) \quad \ldots(9)$$

Where: $I_{PPPRTVM}$ is the Total average percentage of production of selected mutant variety at four provinces on final purifying.

Result and Discussion

The Results have Obtained

The research during three years obtains three variations of selected superior mutant varieties (mutant-1, mutant-2, and mutant-3) which have similar production levels, although there are several superior characteristics differenced like as the large of seeds, pot number, the number of seeds in one pot, seeds color, leaf color, plant high, pot skin color, and mass per 1,000 seeds.

Several types of Vigna Radiata L growth of selected mutant varieties on first-year research (mutant obtaining) and second and third-year research (purifying and testing) are continuously shown in Figure 4 up to Figure 12.

Figure 13 and Figure 14 show that the Vigna radiata L variety is the result of multigamma irradiation. Careful selection at the final purification will result in new varieties with high production and can bear fruit for a second time with a relatively short second harvest age (only 25 days are calculated from flower growth again).

Figure 16 up to Figure 18 show seeds of three variations of selected mutant varieties on final purifying with harvest age about 58 days up to 62 days after planting.

Observation results of pre-growth seeds on treatments and control samples for calculation of growth percentage, several physical and chemical characteristics observed, measured, and calculated, and also estimation of production level, explained in a row in Table 1, Table 2, and Table 3. For calculation of growth percentage, five groups are randomly taken with the number of seeds observed about 100 seeds on every group. Treatment samples are taken in five groups with ten variations of observation.

Short Description of Results have obtained

The results of studies on final purification in four provinces showed that for mutant-1 (M1V) varieties, each mutant variety selected had relative diversity or uniformity equal to an average production of 3.40 tons per ha and an increase in production percentage of about 47.65%. The mutant-2 (M2V) variety is about 3.39 tons per ha, and the percentage increase in production is about 47.49%. Mutant-3 (M3V) varieties: 3.37 tons per ha and an increase in production percentage of about 47.18%. The total average production of selected mutant variety as a result of final purifying after irradiation is about 3.39 tons per ha with a total average of increasing production of about 47.44%. In four provinces, the average production of the initial variety is about 1.78 tons per ha.

This case shows that local Vigna Radiata L production developed by nuclear technique (multigamma irradiation) significantly increases. The water content of seeds for continuous development or cultivated on final purifying is about 11.0% for nutant-1 variety, 11.5% for mutant-2 variety, and 11.2 % for mutant-3 variety.

Statistical Calculation

The growth percentage of seeds on control and treatment samples can be calculated according to equation (1) and data in Table 1, as follows:
The number of seeds observed that randomly selected about 100 seeds, and average seeds are not grown on control sample about 18.2 seeds. Average seeds are not grown on mutant-1, mutant-2, and mutant-3 varieties, about 1.96 seeds.

Growth percentage on control sample:

$$GP = \left(\frac{T_{AS} - A_{SG}}{T_{AS}} \right) \times 100\% = \left(\tfrac{100-18.0}{100} \right) \times 100\% = 82.0\%$$

Growth percentage on treatment sample:

$$GP = \left(\frac{T_{AS} - A_{SG}}{T_{AS}} \right) \times 100\% = \left(\tfrac{100-1.96}{100} \right) \times 100\% = 98.04\%$$

Average production on control sample (initial variety) at four provinces planting location:

$$A_{RPSC(t)} = \frac{P_{L1} + P_{L2} + P_{L3} + P_{L4}}{4} = \frac{2.00 + 1.80 + 1.60 + 1.70}{4} = 1.78\, tons/ha$$

Average production of treatment samples on every selected mutant variety:

Mutant-1 variety (M_1V):

$$A_{RPSP(1)} = \frac{P_{L1} + P_{L2} + P_{L3} + P_{L4}}{4} = \frac{3.60 + 3.80 + 3.40 + 2.80}{4} = 3.40\, tons/ha$$

Mutant-2 variety (M_2V):

$$A_{RPSP(2)} = \frac{P_{L1} + P_{L2} + P_{L3} + P_{L4}}{4} = \frac{3.56 + 3.82 + 3.36 + 2.81}{4} = 3.39\, tons/ha$$

Mutant-3 variety (M_3V):

$$A_{RPSP(3)} = \frac{P_{L1} + P_{L2} + P_{L3} + P_{L4}}{4} = \frac{3.54 + 3.79 + 3.38 + 2.76}{4} = 3.37\, tons/ha$$

Total average production of selected mutant variety on final purifying:

$$A_{RPSP(t)} = \frac{A_{PTS(1)} + A_{PTS(2)} + A_{PTS(3)}}{3} = \frac{3.40 + 3.39 + 3.37}{3} = 3.39\, tons/ha$$

The increasing percentage of production on every selected mutant variety:

Mutant-1 variety (M_1V):

$$I_{PPPVM(1)} = \left(\frac{A_{RPSP(1)} - A_{RPSC(t)}}{A_{RPSP(1)}}\right) \times 100\% = \frac{3.40 - 1.78}{3.40} \times 100\% = 47.65\%$$

Mutant-2 variety (M_2V):

$$I_{PPPVM(2)} = \left(\frac{A_{RPSP(2)} - A_{RPSC(2)}}{A_{RPSP(2)}}\right) \times 100\% = \frac{3.39 - 1.78}{3.39} \times 100\% = 47.49\%$$

Mutant-3 variety(M_3V):

$$I_{PPPVM(3)} = \left(\frac{A_{RPSP(3)} - A_{RPSC(3)}}{A_{RPSP(3)}}\right) \times 100\% = \frac{3.37 - 1.78}{3.37} \times 100\% = 47.8\%$$

Total average of increasing percentage of production on selected mutant variety:

$$I_{PPPRTVM} = \left(\frac{I_{PPPVM(1)} + I_{PPPVM(2)} + I_{PPPVM(3)}}{3}\right) = \frac{47.65\% + 47.49\% + 47.18\%}{3} = 47.44\%$$

Table 1. The number of seeds is not a growth on control and treatments samples of final research for obtaining three variations of selected mutant varieties on final purifying at four provinces

No SG	Total number of seeds on every group	The number of seeds is not growth: Control sample	of selected mutant variety (MV): 1	2	3	4	5	6	7	8	9	10
I	100	20	1	1	2	1	1	1	2	1	2	1
II	100	17	1	1	3	2	2	2	1	1	2	3
III	100	19	2	2	1	1	1	2	2	4	1	4
IV	100	18	1	1	3	3	2	1	3	1	2	1
V	100	16	3	3	3	2	4	3	1	3	3	2
	Average = 100	18.00	1.80	1.80	2.40	1.80	2.00	1.80	1.80	2.00	2.00.	2.20
	Average of mutant						1,96					
	Growth percentage (%)	82.00	98.20	98.20	97.60	98.20	98.00	98.20	98.20	98.00	98.00	97.80
	Average of growth percentage	82.0					98.04					

SG: Sample Groups

Table 2. Physical and chemical important characteristics observed, measured, and calculated on final purifying at four provinces of Vigna Radiata L (obtaining three variations of superior selected mutant varieties)

No	Description	Control sample	Treatment samples or mutants: M_1V	M_2V	M_3V
1	Average of growth time	7 d a p	4 d a p	4 d a p	5 d a p
2	Average of growth percentage	82.00 %	98.04 %	98.04%	98.04%
3	Ranges of flowered age	45 up to 51 d a p	37 up to 44 d a p	37 up to 45 d a p	38 up to 45 d a p
4	Average of flowered age (d a p)	47	40	42	41
7	Leaf color	Dull green	Bright green	Yellow green	Yellow green
8	Flower color	Yellowish	Yellow	Yellow	Yellow
9	Ranges of plant high	28 cm up to 56 cm	43 cm up to 81 cm	47 cm up to89 cm	38 cm up to 76 cm
10	Average of plant high	43 cm	64 cm	67 cm	58 cm
11	Ranges of harvest age (d a p)	85 up to 92	58 up to 61	58 up to 62	58 up to 64
12	Average of harvest age (d a p)	87 d a p	59 d a p	60 d a p	62 d a p
13	Ranges of pots number per tree	(24 up to 57) pots	(63 up to 119) pots	(60 up to 112) pots	(59 up to109) pots
14	Average of pots number per tree	45 pots	88 pots	86 pots	85 pots
15	Ranges of seeds number per pot	(4 up to 7) seeds	(5 up to 12) seeds	(5 up to 11) seeds	(5 up to 11) seeds
16	Average of seeds number per pot	5 seeds	10 seeds	8 seeds	7 seeds
17	Color of dry pot skin	Dark brown	black	black	black
18	Seeds color	Dull green	Dull green up to brownish	Yellowish green	Brownish green

No	Description	Control	Treatment samples or mutants		
19	Ranges of mass per 1,000 seeds (grams)	24.8 up to 36.2	36.1 up to 45.6	35.8 up to 44.8	35.6 up to 44.1
20	Average of mass per 1,000 seeds	29.80 grams	39.70 grams	39.20 grams	38.76 grams
21	Adaptation to dry condition.	To be not	yes	yes	yes
22	Tolerant to germ	To be not	yes	yes	yes
23	Ranges of Water content	(14.0 up to 23.0) %	(9.0 up to 13.0) %	(9.0 up to 15.0) %	(9.0 up to 14.0) %
24	Average of water content	17.4 %	11.0 %	11.5 %	11.2 %
25	Production ranges (tons/ha)	(1.60 up to 2.00)	(2.80 up to 3.80)	(2.81 up to 3.82)	(2.76 up to 3.79)
26	Average production	1.78 tons/ha	3.40 tons/ha	3.39 tons/ha	3.37 tons/ha
27	Increasing percentage of production	-	47.65%	47.49%	47.18%
28	Maximum production potential	2.0 tons/ha	3,80 ton/ha	3,82 ton/ha	3,79 ton/ha
29	Average production of sweet sticky corns is intercropped with Vigna radiata L plant about 5 tons/ha young harvest				

d a p = days after planting

Table 3. Production Level at four provinces on control and treatment samples on final purifying

No	Planting Location	Control sample (tons/ha)	Selected mutant varieties (treatment samples) (tons/ha) VM1	VM2	VM3
1	Fukdale Kupang province of East Nusa Tenggara Indonesia	2.00	3.60	3.56	3.54
2	Tana Tojara province of South Sulawesi Indonesia	1.80	3.80	3.82	3.79
3	Mamuju province West Sulawesi Indonesia	1.60	3.40	3.36	3.38
4	Palu province of Middle Sulawesi Indonesia	1.70	2.80	2.81	2.76
	Average production	1.78	3.40	3.39	3.37
	Average of superior selected mutant variety	-		3.39	
	Increasing percentage of production (%)	-	47.65%	47.49%	47.18%
	Average of production increase	-		47.44%	

Discussion

Growth Time, growth Percentage, Flowered Age, Extreme Climate (Temperature), Dry Condition, and Fruited age

Observation results, measurement, and calculation on initial variety and selected mutant varieties on final purifying show that the growth time of the initial variety is about seven days after planting, while the average growth time of selected mutant varieties is about four days after planting.

The average growth percentage of selected mutant varieties on final purifying was about 98.04%, while the growth percentage of the initial variety was about 82.00%. The average flowering age of selected mutant varieties is about 41 days after planting, and the average flowered age of the initial variety is about 47 days after planting. This case shows that selected mutant varieties due to multigamma irradiation on final purifying have growth percentages larger than the initial variety. Flowered age on selected mutant varieties is faster than flowered age of initial variety.

Figure 1 up to Figure 3 show growth of selected mutant varieties of Vigna Radiata L (mutant-1, mutant-2, and mutant-3) on final purifying on age 45 days after planting with leaf seen or visible fertile growth and flawless. This case shows that Vigna Radiata L as a result of multigamma irradiation and careful selection on final purifying can be adapted to dry conditions, adapted to extreme climate, tolerant to the germ, and have probability high production.

Figure 1

Figure 2

Figure 3

Figure 1 up to Figure 3 obtained through individual selection from the beginning of growth until age 15 days after planting with the observation of growth ability, flowered age, tolerance to the germ, adaptation to dry condition, harvest age, and high production.

If Figure 4 up to Figure 6 are carefully inspected, so can be seen that selected mutant varieties of Vigna Radiata L as a result of multigamma irradiation and careful selection on final purifying have fruits are more than the initial variety (see Figure 12). Or other words, production of Vigna Radiata L as a result of multigamma irradiation and careful selection on final purifying is higher than initial production.

Adaptation to Extreme Climate

Continuous development of selected mutant varieties of Vigna Radiata L as a result of multigamma irradiation on first and second purifying is done on rainy season and final purifying done on dry season.

Figure 4

Figure 5

Both season conditions are different, the growth of three varieties as a result of final purifying after irradiation is relatively the same until harvest. A different case is in the rainy season, and plant watering is not necessary done but necessary to prepare good drainage. During dry season several watering is needed according to condition at the planting location. In the dry season, insecticide spraying is not necessary, while on rainy season, it is necessary during done according to plant conditions that are attacked by the germ. A condition like that still can be said that adapted to extreme climate condition.

Figure 6

Figure 4 up to Figure 6 shows three variations of selected mutant varieties as a result of multigamma irradiation that any fruits on final purifying with the average age about 45 days after planting, while

Figure 7

final purifying have high which variated that a large part is different with high of initial.

Figure 8

Figure 9

Figures 7 and 9 show three variations of selected mutant varieties on final purifying with an average age of 52 days after planting.

Ranges and Average of High Plant, Ranges, and Average of Harvest Age

Ranges of the high plant of selected mutant varieties on final purifying about 43 cm up to 81 cm (M_1V), 47 cm up to 89 cm (M_2V), and 38 cm up to 76 cm (M_3V) with average high on every variety about 64 cm (M_1V), 67 cm (M_2V), and 58 cm (M_3V). High ranges of initial variety are about 28 cm up to 56 cm with an average of 43 cm. This data shows that selected mutant varieties resulting from multigamma irradiation on final purifying have high which variated that a large part is different with high of initial.

The ranges of harvest age of selected mutant varieties as a result of multigamma irradiation on final purifying about 58 days up to 61 days after planting (M_1V), 58 days up to 62 days after planting (M_2V), and 58 days up to 64 days after planting (M_3V), while ranges of harvest age of initial variety about 85 days up to 92 days after planting. Average of harvest age of selected mutant varieties as a result of multigamma irradiation on final purifying about 59 days after

planting (M_1V), 60 days after planting (M_2V), and 62 days after planting (M_3V).
Those results show that selected mutant varieties of Vigna Radiata L as a result of multigamma irradiation on final purifying have harvest age are shorter than the initial variety.

Tolerant to germ and uniformity of Treatment Varieties.

Figure 1 to Figure 3 and Figure 4 to Figure 9 clearly show the growth and fruit of the mutant variety that vigna Radiata L selected as a result of multigamma irradiation at the final purification with perfect leaves and fruit, fertile growth, rapidly flowering, and any flowers, no indication of germ attack. On selected mutant varieties also are seen that form and leaf color, plant high, plant fertility, color and flower form, stalk and fruit form, the position of growth fruit are relatively uniform for every variety. The growth of young fruits is seen assemble or collected. The data showed that the mutant varieties selected by Vigna radiata L at the final purification were tolerant to germs, had relatively similar uniformity for each variety, and had high production potential (indicated by flowering and fertilization) when compared to the initial varieties (to be clearly shown in Figure 12 of the early varieties).

Especial Superior of Selected Mutant Varieties

Figure 10

Figure 11.

Figure 10. and 11 show two examples of mutant-1 and mutant-2 varieties at four provinces that flowered and fruited for the second time after the first harvest.

Figure 9 clearly shows that when the first fruits have been ripe and ready to harvest, any new flowers grow as the second prospective fruits. After the first fruits have been harvested, flowers and fruits are well growth and the average of the second harvest is relatively short (only 25 days calculated from the growth of the second flower). The total average of the second harvest age is about 85 days after planting. This condition shows that selected mutant varieties of Vigna radiata L have especial superior like as fruited for the second time and harvest age is a relatively short time.

Figure 10 and Figure 11 show two examples of mutant-1 and mutant-2 varieties resulting from multigamma irradiation on final purifying at four provinces which flowered and fruited for the second time after the first harvest with harvest time relatively short (25 days from flower beginning).

Ranges and Average of Pod Number, Seeds Number, and mass per 1,000 seeds.

The number of pods per tree of selected mutant varieties of Vigna Radiata L on final purifying ranged between (63 to 119) pods per tree (M_1V), (60 up to 112) pods per tree (M_2V), and (59 up to 109) pods per tree (M_3V), while for initial variety about (24 up to 57) pods per tree. The average number of pods per tree on every variety of selected mutant varieties is about 88 pods per tree (M_1V), 86 pods per tree (M_2V), 85 pods per tree (M_3V), while the initial variety is about 45 pods per tree.

Figure 12 shows one example of Vigna Radiata L growth of initial variety on age 52 days after planting

Figure 13

Figure 14

Figure 15

Figure 13 up to Figure 15 show seeds of three variations of selected superior mutant varieties (mutant-1, mutant-2, and mutant-3) on final purifying at four provinces.

Ranges and the average number of seeds per pod of selected mutant varieties and initial variety of final purifying in a row (5 up to 12) seeds per pod for M_1V, (5 up to 11) seeds per pod for M_2V, and (5 up to 11) seeds per pod for VM-3, and (4 up to 7) seeds for initial variety. Ranges and average of mass per 1,000 seeds of selected mutant varieties are about (36.1 up to 45.6) grams (M_1V), (35.8 up to 44.8) grams (M_2V), (35.6 up to 44.1) gram (M_3V), while initial variety is about (24.8 up to 36.2) grams per 1,000 seeds. Average mass per 1,000 seeds of selected mutant varieties on final purifying about 39.7 grams/1,000 seeds (M_1V), 39.2 grams/ 1,000 seeds (M_2V), 38.76 grams/1,000 seeds (M_3V), while initial variety about 29.8 grams/1,000 seeds.

This case can be proposed that the average mass per 1,000 seeds of selected mutant varieties on final purifying are higher than the initial variety. In other words, the production of selected mutant varieties significantly increasing.

Ranges and Average production, Increasing Percentage of Production, and Water Content

Production of selected mutant varieties of Vigna Radiata L on final purifying ranged between (2.80 up to 3.80) tons/ha for M_1V, (2.81 up to 3.82) tons/ha for M_2V, and (2.76 up to 3.79) tons/ha for M_3V, while initial variety is about (1.60 up to 2.00) tons/ha. Average production on every variety of selected mutant varieties in a row 3.40 tons/ha (M_1V), 3.39 tons/ha (M_2V), and 3.37 tons/ha ((M_3V), during initial variety about 1.78 ton/ha. The total average production of selected mutant varieties on final purifying at four provinces is about 3.39 tons/ha. The increasing percentage of production on every selected mutant variety on final purifying at four provinces is about 47.65% (M_1V), 47.49% (M_2V), and 47.18% (M_3V), with a total average of increasing percentage of production for selected mutant varieties on final purifying at four provinces about 47.44%.

Ranges and average of water content on every selected mutant variety and initial variety in a row about (9.0 up to 13.0) % (M_1V), (9.0 up to 15) % (M_2V), (9.0 up to 14) % (M_3V), and (14 up to 23) % (initial variety). Total average of water content about 11.0 % (M_1V), 11.5 % (M_2V), 11.2 % (M_3V), and 17.4 % (initial variety). The total average water content of selected mutant varieties on final purifying at four provinces is about 11.23 %.

The results show that the production of selected mutant varieties due to multigamma irradiation on final purifying at four provinces is significantly increased.

Conclusion

Based on explained upon can be proposed conclusion as follow. Continuously developing of selected mutant varieties of Vigna Radiata L on final purifying at four provinces produces three variations of superior selected mutant varieties with to the amounts of superior characteristics compared with the initial variety. The production of *Vigna Radiata* L as a result of Multigamma irradiation significantly increased, and on final purifying obtained especial superior of selected mutant varieties namely, two varieties can be fruited for the second time with harvest age are relatively short.

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