VOL. 8, NO. 5, MAY 2013 ISSN 1990-6145
ARPN Journal of Agricultural and Biological Science

www.arpnjournals.com

THE APPLICATION OF MULTIGAMMA RADIATION AS A PHYSICAL MUTAGEN FOR BREEDING OF LOCAL SOYBEAN

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ABSTRACT

The general effect of multigamma radiation causes mutation on the all species of plant. The largest effect of multigamma radiation occurred on genetics factor and chromosome, specific on structure and composition of chromosome and DNA. This case can be used for breeding of several importent plants in the world. The objective of this research is the breeding of local soybean from Bajawa Flores NTT with aplicaton of multigamma radiation to obtain the primer seed of local soybean with high production and tolerant to dry condition. The primer seed or superior seed obtained as mutation rusult of multigamma radiation as many as 10 varieties, and the production revolved between 3.78 tons/ha up to 4.92 tons/ha, with mean production 4.41 tons/ha. The mean production of initial soybean is 2.54 tons/ha, it shows that production significantly increase as big as 42.40% per hectare.

Keywords: soybean, multigamma, radiation, breeding, mutation.

INTRODUCTION

Mutation is a changing process on genetics matter of an organism, which spontaneously occurred (called spontaneous mutation) and random, and also through induce mutation (Soedjono, 2003). Those process produce genetics variation as the basic of plant selection (natural or breeding), in order that, the breeder is easy to select genotive apropriate for purpose of breeding (Gepts and Hancock, 2006; Carsono, 2008). Induce mutation on the plants can be done to reproduction of organ of plant like as: seed, cutting stalk, pollen, rhizome, etc. On general, physical mutagen is radioactive source with high energy that produced by nuclear reaction.

There are two categories about theory of radiation effect (Hollaender, 2002), 1). **Target theory or direct action theory:** The biologists qualitatively and quantitatively investigate and explain the cell multiplication and mutation on the organism, and around vital structure or molecular structure. Biologists begin their investigation on outher morphology effect of organism, continuously to sensitive spot and vital structure (Handayani, 2006). Continuously research on citology and genetics obtained the changing in molecular structure. 2) **Indirect action theory:** This theory comes from chemicalists who begins their investigation about radiation effect on act aspect of molecular and continued to macromolecular which cell composing, like as DNA, RNA, protein, etc for easy explaining of organism mutation. Another effects of nuclear radiation:

Radiation effect ionizes nucleic-acid and nucleo-protein

Nucleic-acid and nucleo-protein are important component in chromosome which support characterisric of generation (Hollaender, 2002). Ionization energy disturbs of cell fission and mutation that causes chromosome aberation. Multigamma radiation produces depolarization and viscosity descent on thymonucleic acid (TNA), impedes syntesis of deoxyribo nucleic acid (DNA).

Radiation effect on protein

Multigamma radiation leads to the changing of struture and composition of chromosome and DNA on several species of plant. This process leads several forms of mutation on the plant generation which characteristics differenced to initial plant. The small doses of radiation as big as 10 mSv up to 100 mSv cause 1% speed of DNA naturally broken. The several approaches of physics and biology have been done for illustrating of doses limit and speed of low doses. According to microdosimetry aspect, low doses is smaller than 1 mGy, radiobiology: low doses is 20 mGy, epidemiology: low doses 200 mGy (UNCEAR, 2005).

Radiation effect on DNA

DNA structure formed of double helicks which composed from bundle between phosphate group and dioxiribo sugar that form of strand DNA, and bundle between nitrogen bases which connect to two strands DNA. The damages on DNA consist of damage on bases, bases have lost, the bundle between bases has broken, and the bundle of sugar and phosphate has broken, in order that, occurred broken on one strand is called single strand break (ssb). This damage can be quickly reconstructed without mistake by enzymatic repairs process with using strand DNA that is not break in establishment. Cell can do the contruction process to the broken of DNA in a few hours, but can be not perfect, mainly to the broken of DNA is called double strends breaks (dsb) (Brenner, 2006). The reconstruction process with mistake causes mutaion of abnormality genetics and chromosom. Figure 1, illustrates the broken on DNA as consequnce of radiation.

Radiation effect on chromosome

Multgamma radaition causes changing of chromosome structure. Normally, chromosome comprises of upper-arm and fore-arm connected by a centromer. Multigamma radiation causes the forming of: 1) assentric

fragment (formed of chromosome fragment without centromer), 2) disentric chromosome (chromosome has two centromers), 3) ring chromosome, 4) translocation (removal of genetic matter betwen chromosome arm) (UNCEAR, 2005).

Mutation on the plant is spontaneously changes of genetic matters in cells caused by (IAEA, 2008): 1) rearrangement occurred on chromosome structure, 2) changing in genetics, 3) segments duplication of chromosome loss. Physical mutagen is mutagen which uses ionizing radiation, like as: alpha ray, beta ray, gamma/multigamma ray, X-ray, neutron, proton, acceletaor particle, etc. Radiation technique has several superiorities among others: 1) radiation technique is easy to do and practical, 2) the change of genotive a few only, but causes much changes of characteristics on generation species, 3) the generation species obtain in the short time.

Doses standard of gamma/ multigamma radiation is used on breeding of plants (IAEA, 2003., 2004., 2006): 1). Mutation on plants: 100 rads up to 3, 000 rads, 2). Mutation in seeds plant: 1, 000 rads up to 4, 000 rads, 3.) Growth stimulation of seeds plant: 250 rads up to 1, 000 rads, 4). Growth obstruction on root: 5, 000 up to 10, 000 rads (BATAN, 2005).

This research focused on development of local soybean from Bajawa Flores with using multigamma radiation technique. This method obtain enable several variations of superior generation variety, in order that is easy to select superior variety. The general characteristics of superior seed of soybean variety are: 1) high production, 2) the age of plant is shorter, 3) tolerant to germ specially viruses (Radiyanto, dkk, 2011), 4) tolerant to plant disease like as agromyza, phaedonia inclusa, lamprosema litura, riptortus linearis, etiella zinkkenella, and nezara viridula (Sunarto, 2003., DP2TP, 2006), 5) tolerant to abiotic conditions like as dry condition (Hartati, 2000), 6) the quality of seed increase (content of protein and fat) (Irwan, 2006., BATAN, 2008). The soybean is the first important logumes in Indonesia, with high content of nutrient as a protein sources of concerning plants and low cholesterol, and also the price reached by the all societies. Each year the soybean requirements in National scale increases (Amaliyah, 2009). In 2004, the production of soybean in the country was only 1, 878, 898 tons, while requirement of soybean in National scale on this time achieved 2, 955, 000 tons (Indrawan, 2009). The mean production of soybean in the world this time achieve 1.9 tons per hectare, while the mean production on National scale achieve 1.2 tons per hectare (Amaliyah, 2009). Last time, soybean production decreases. As a consequence government import soybean as many as 300 thousand tons every year (Arsyad and Syam, 2004).

As the fasting 2018, it is estimetad that request projection of soybean will achieve 6.11 million tons, while in 2003, the production of soybean was 672, 000 tons only, in 1992, the production of soybean achieved 1.87 million tons (Hilman *et al*, 2004; Atman, 2006). The commodity production of soybean per hectare in Indonesia does not achieve maximum product. That is influenced by soil factor which damaged the production and poor micro-elements, growing hormone, dry conditions, germ, climate, and the using of superior seed (DP2TP, 2006). The soybean is the first important logumes in Indonesia, has low production on the farmers level (Indrawan, 2009).

These research aimed: to develop local soybean variety from Bajawa Flores through breeding with application of multigamma radiation method and carefully selection to obtain superior seed with high production, and tolerant to dry condition.

Several researches have been done by researchers

On 2009, researcher successed to develop local sweet yellow corn and sweet white corn, which tolerant to dry conditions, high calsium and salt. The increase of mean production is 46.20% (from 3-7 tons/ha go up to 11-15 tons/ha) for sweet yellow corn and 40% (from 3-6 tons/ha go up to 9-10 tons/ha) for sweet white corn (Pasangka and Jaelani, 2010).

On 2010, researcher successed to develop erect local penaut and creep local peanut from East Sumba with using multigamma radiation. The increase of mean production was 43.86% for creep local peanut and 42.22% for erect local peanut, or mean production 5.7 tons/ha (from 3.2 tons/ha go up to 5.7 tons/ha) for creep local peanut, production potential 5.9 tons/ha, and 4.5 tons/ha (from 2.6 tons/ha- 4.5 tons/ha) for erect local peanut, production potential 4.7 tons/ha (Pasangka and Jaelani, 2011).

On 2011, continuous research, of perifying obtained production to be revolved between 4.75 tons/ha up to 6.84 tons/ha for creep local peanut, and between 3.95 tons/ha up to 5.45 tons/ha for erect local peanut (Pasangka and Jaelani, 2011).

MATERIALS AND METHODS

The main instruments used in this research consist of: 1) Multigamma radiation source, 2) counter of radiation doses, 3) protein analyzer, 4) tractor, 5) digital balance, 6) other equipments. The research area located in Kupang Nusa Tenggara Timur, at five areas (Fukdale, Oesao, Baumata, Tabenu, and Bolok). The 5^{th} location is different condition like as high salt and calcium, dry condition. The method of research comprise of: obsrvation/ surveying, sampling, radiation, selection, comparison, and interpretation. Collecting and data analysis are done with observation, measurement, protein analysis on initial soybean and also on generation soybean (result of multigamma radiation). Quality control is done to compare between analysis results of initial soybean and analysis results of generations soybean (superior seeds). The superiority of this methods is obtained superior seed in short time and many variations of superior seed varieties (is easy to select generation variety or the best superior seed). The development of local soybean in these research, uses multigamma radiation method. Multigamma radiation method lead of gecetic effect like as the changes of structure and composition of chromosome, and

molecule of deoxiribo nucleat acid (DNA) on several species of food plant.

The simple procedures of this research comprise of : 1) to determine research location and choose sample of local soybean, 2) to design example garden, 3) to radiate samples of soybean, 4) to plant sample of soybean in the area has been prepared, 5) watering if it is necessary, 6) weeding and cultivating, 7) observation to tenacity of germ, growth in dry area, high calsium and salt, and physical characteristics which needed as a standard comparison, and also select plants. On the resemble harvest, selection is done, measurement of high plant, in time after harvest is measured heavy or weight for a group of 1, 000 peanut seeds, 8) to analize protein, 9) drying and selection. 10) For quality control, comparison between analysis results of initial local soybean and analysis results of generation varieties (superior seeds) is done. 11) The last procedure is to put insecticide sufficient to superior seeds of soybean and storage for continuously development. The first selection of soybean plant is done since the age of plant is one month, the second selection since the age of plant two months, M_n selection since near to harvest, and the third selection after harvest.

RESULTS

The important physical and chemical characteristics observed and measured of initial and generation varieties of local soybean as a result of multigamma radiation are completely prepared in Table-1. Grow time of initial soybean 7 days after planted, and generation varieties 4 days after planted. Flowered age of initial soybean 62 days after planted (dap), and generation vaieties 44 days after planted (dap). The plant high of initial soybean is 15.32cm up to 25.78cm and generation varieties is 15.38cm up to 32.29cm. The initial soybean adapted to area with high calcium dan salt, and the generation varieties of local soybean adapted to area with high calcium, salt, and dry condition.

The grow power of initial soybean is 82% and the generation varieties is 98%. Protein content of initial soybean is 12.40% and the generation soybean is 13.92%. The mean of dry heavy per 1000 sedds of initial soybean: 172.69 grams, and generation varieties of soybean: 273.77 grams. Production potential of initial soybean is 1.26 tons/ha up to 3.10 tons/ha with mean production 2.54 tons/ha, and generation verieties is 3.78 tons/ha up to 4.92 tons/ha with mean production 4.41 tons/ha.

DISCUSSIONS

On the observation result shows that soybean seed which irradiated by multigamma source, grow faster than soybean without irradiation, i.e., 4 days after planted, and since the age is 7 days, the growth of sprout is 98%. The plants begin to be flowered since 68 dap, and the age of harvest is 94 dap. The physical growth of initial local soybean from Bajawa Flores is shown in Figure-3. Figure-3, shows two examples of initial local soybean variety from Bajawa Flores, which are good to grow at area with high calcium, although fruits of this plants are a little. While, Figure-4, shows two examples of local soybean selected from Bajawa Flores as a result of multigamma radaiation. Figure-3 and Figure-4, clearly shows that the seeds of initial plant variety and the seeds of generation plant variety as a result of mutigamma radiation is significantly different. Based on data in Table-1 and Table-2, can be suggested any arguments i.e., generation varieties is more quickly powered, more vertile, heavy per 1, 000 seeds is higher, grow power is higher, adapted to: germ, dry condition, the main production is higher. The mean production of initial variety is 2.54 tons/ha, and mean production of generation variety 4.41 tons/ha. This result shows that mean production of local soybean from Bajawa Flores NTT as a result of multigamma radaition significaltly increase. The increase of mean production is 42.40% (percent). The number of varieties continuously developed is 10 primer seeds (superior seeds). Figure-5, shows one example of initial soybean, and Figure-6(a) up to Figure-6(e), shows 5 examples of generation seed varieties as a result of development to use multigamma radaition. On continuously research, will be developed primer seeds of soybean for purifying to obtain superior seed. From figures and analysis it can be proposed that development of local soybean from Bajawa Flores NTT with multigamma radiation and carefully selection, obtained primer seeds or superior seeds to be caused by genetics mutation. The production of generation soybean revolved between 3.78 tons/ha up to 4.92 tons/ha, with mean production 4.41 tons/ha. The increase of mean production is 42.40% (percent).

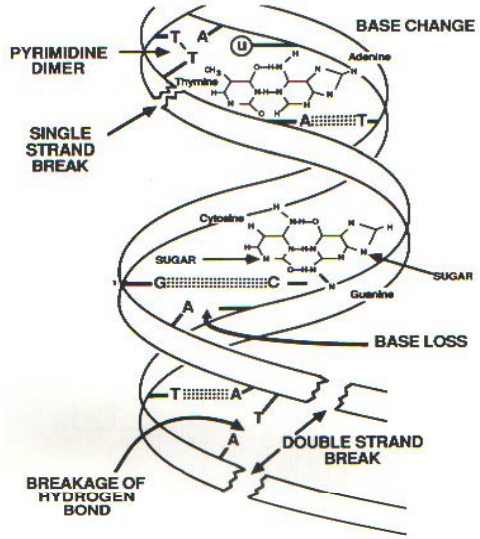
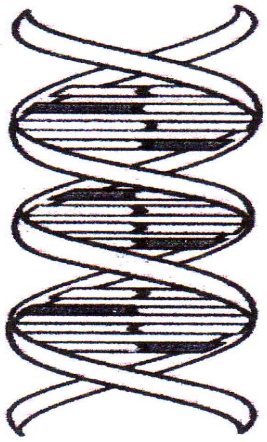


Figure-1. The broken of DNA as consequnce of radiation.



Normal chromosome break chromosome

Figure-2. Radation effect on chromosome.

Figure-3. The physical growth of initial local soybean from bajawa flores.

Figure-4. Physical growth is observed on generation soybean varieties as a result of multigamma radiation.

Figure-5. Initial variety of soybean from bajawa flores NTT.

Figure-6(a)

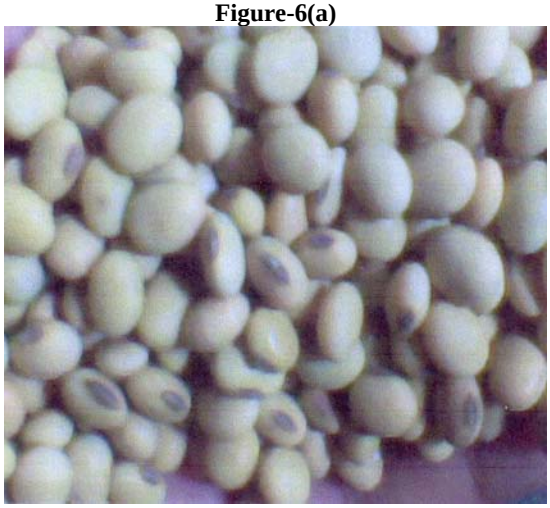


Figure-6(b)

Figure-6(c)

Figure-6(d)

Figure-6(e)

Figure-6(a)- (e). Five examples of generation seed varieties as a result of multigamma radiation.

Table-1. The important physical and chemical characteristics observed and measured.

S. No.	Description	Initial variety	Generation variety
1	Grow time	7 days after planted (dap)	4 dap
2	Flowered age	62 dap	44 dap
3	High of plant	15, 32 cm up to 25, 78 cm	15, 38 cm up to 32, 29 cm
4	Tenacity of germ	not tenacity	Tenacity
5	Adaptation	Adaptation to area with high calcium and salt.	Adaptation to area with high calcium and salt, dry condition.
6	Grow power	82%	98%
7	Protein content	12, 40%	13, 92%
8	Dry heavy per 1000 seeds	172, 69 grams	273, 77 grams
9	Production potential	1, 26 tons/ha up to 3, 10 tons/ha	3,78 tons/ha up to 4, 92 tons/ha
10	Mean production	2, 54 tons/ha	4, 41 tons/ha

Table-2. Production level at several planting locations of local soybean variety as a result of multigamma radiation.

S. No.	Location	**Production level** (tons/ha)	**Mean production** (tons/ha)
1	Oesao	4,92	
2	Fukdale	4,87	
3	Tabenu	3,96	4,41
4	Bakunase	3,78	
5	Bolok	4,53	

ACKNOWLEDGEMENT

This research or study was supported by National Strategy Research DP2M DIKTI, 2011/2012.

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