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ABSTRACT

GRAIN LEGUMES IMPROVEMENT THROUGH INDUCED MUTATIONS WITH SPECIAL REFERENCE TO SOYBEAN AND MUNGBEAN. This paper deals with soybean and mungbean which represent two of the three major grain legumes commonly grown in Indonesia as food crops. They are traditionally cultivated in sequential rice based cropping systems in irrigated lowland areas or in upland cropping pattern in association with other upland crops. Breeding of improved varieties of soybean and mungbean oriented to the existing production constraints is of great importance to achieve production increase at a considerable rate. Induced mutations have been used since 1979 to create variability to meet the needs of such diverse agronomical and agroecological condition. The first success was the release of Muria soybean variety in 1987 as a result of mutation breeding. In mungbean, a number of promising mutant lines has been identified from trials at various locations. The work on soybean has also produced a number of promising mutant lines, one of then is being further improved through a cross with an AVRDC line. Strong efforts are being made to assess the lines for possible release in the near future.

ABSTRAK

PEMULIAAN KACANG KACANGAN DENGAN MUTASI, TERUTAMA PADA KEDELAI DAN KACANG HIJAU. Makalah ini mencakup kedelai dan kacang hijau yang merupakan dua dari tiga jenis kacang-kacangan penting yang biasa ditanam di Indonesia. Secara tradisional dua jenis kacang-kacangan ini ditanam setelah padi lahan sawah yang beririgasi atau di lahan kering secara tumpang sari dengan tanaman lain. Pengembangan varietas unggul kedelai dan kacang hijau dengan orientasi kendala-kendala produksi adalah sangat penting untuk mencapai kenaikan produksi dengan laju

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yang memadai. Mutasi telah digunakan sejak tahun 1979 untuk menciptakan variabilitas sesuai dengan tuntutan berbagai ragam kondisi agronomi dan agroekologi. Penglepasan varietas kedelai Muria pada tahun 1987 adalah keberhasilan pertama dari kegiatan pemuliaan mutasi tanaman kacang-kacangan. Pada kacang hijau dan kedelai, beberapa mutan harapan telah diidentifikasi dari hasil percobaan di berbagai lokasi. Bahkan pada kedelai, salah satu diantaranya sedang dimuliakan lebih lanjut melalui persilangan dengan salah satu galur dari koleksi AVRDC. Pada saat ini sedang dilakukan usaha-usaha untuk menguji dan menilai galur-galur tersebut mengenai kemungkinan untuk dilepas sebagai varietas baru dikemudian hari.

## INTRODUCTION

Soybean and mungbean are two of the major grain legumes traditionally grown as food crops in Indonesia. These legumes are cultivated in a cropping system after rice in irrigated lowland, in dryland, in pure stand or associated with various other crops. Among the grain legumes, mungbeab ranks third in production after soybean peanut.

The soybean and mungbean production in Indonesia has been increasing at a lower rate than the increase of domestic consumption. Soybean production has increased from 589,831 ton in 1975 to 817,494 ton in 1985 with an average annual increase of 5.75 percent as compared to 5.74 percent rate of increase in domestic consumption (1). Within the same period, mungbean production has moved up from 63,000 ton to 192,000 ton (2). To cover the gap between the demands and the production, Indonesia has been importing soybean

amount fluctuating from 100,000 ton/year to 400,000 ton/year (1). In mungbean, the current import figure reaches to about 10 percent of the production (2). Efforts to increase production of both soybean and mungbean have been made by the government of Indonesia, particularly soybean which has received priority for attaining self sufficiency in the near future. The aim of this paper is to provide information on current status of mutation breeding activities in grain legumes at the Centre for the Application of Isotopes and Radiation (CAIR) in Indonesia, with special reference to soybean and mungbean.

## PRODUCTION CONSTRAINTS

The constraints to achieve high yield could be generally varietal, edaphic, environmental, biological, socio-economic or combination of the above (3). Considering those which are controlable, breeding improved varieties seems to be one of the important approach. As clearly shown in Fig.1, the significant production increase occuring in the five year period from 1983 to 1987 was largely due to area expansion and only slightly due to yield per unit of area (kg/ha). The current national average of the soybean yield per hectar is still around 1.0 ton/ha as

compared to 0.84 ton/ha in 1983 (4). In mungbean, dramatic increase in production from 63,000 ton in 1975 to 192,000 ton in 1985 was also largely associated with the doubling of harvested area from 137,000 ha to 280,000 ha (2). At the same time, the average yield increased by 50% from 460 to 680 ton/ha but it currently still remains at the level of much less than 1.0 ton/ha.

The yield of soybean at experimental levels has ever reached 3.0 ton/ha. The gap between the yield obtained from the experiments and from the farmers reflects the insufficient adoption of recommended technology developed through research in addition to the environmental and biological variation as well as socio-economical constraints (5).

## VARIETAL IMPROVEMENT

Soybean and mungbean cultivation in the major production areas is largely done in a cropping system after lowland rice or in a dryland intercropped with other food crops (maize, cassava). Local low yielding varieties are traditionally grown in those areas as they are already well adapted to the environments and cropping patterns. The improved varieties are usually high yielding. They are also better in grain quality

and appearance. However, in many cases they are not well adapted to the environments and cropping systems traditionally practiced in lowland after rice and upland in association with other food crops.

Since 1974, 15 soybean varieties have been released. Most of them have been developed through hybridization and selection of improved breeding lines introduced from foreign countkies. Only one of them (Muria) was developed through induced mutations. With respect to mungbean, only 8 varieties have been released since 1979 and none of them was developed through induced mutations (Table 1).

## INDUCED MUTATIONS

In attempts to develope more improved varieties of soybean and mungbean, gamma radiation has been used to induce mutations. The first mutation breeding activities in soybean was started in late 1979 and intensified afterwards through the IAEA Regional Project on Grain Legume Improvement and the UNDP Country Project No. INS/78/074 during 1982-1987 (6-9). This activity has produced a new variety Muria which was released in 1987.

This variety has a better yield, shorter plant stature and earlier in maturity as compared to the

original variety Orba (Irradiation dose 400 Gy gamma rays). Further activities in soybean mutation breeding have been stressing on the development of early maturing lines designed to meet the need of varieties suitable for rice-rice-grain legume cropping pattern under irrigated lowland condition. Induced mutations were made by using gamma irradiation on Guntur variety at doses ranging from 150-250 Gy. A number of selected lines were tested for their yielding ability and other agronomical performance. One of them ( Mutant line No. 23) is very early maturing (70 days) but it has small grain size. This line was then crossed with one of the AVRDC breeding accessions (AGS-153) which has a good pod and grain quality. The progenies of the cross were selected for earliness and grain size. From this cross, a number of improved lines has been identified and some of them have been included in the yield trials at different locations.

In addition to selection for earliness and better grain quality, laboratory and greenhouse screening for aluminum tolerance was also applied to mutant lines developed from irradiation of Guntur. Several lines ( particularly No. 21 ) have been identified as Al tolerance. It will be further tested for cultivation in acid soils.

Induced mutations in mungbean has been initiated in 1983 with the aim to develop high yielding varieties

with earlier and synchronous maturity and better pod/seed quality. Resistance to major deseases is also one of the considerations in the selection. Irradiation was applied to Manyar at doses ranging from 100 to 400 Gy. From these irradiation treatments, 45 lines have been selected and included in the preliminary yield trial during 1986. Improvements have been observed in pod quality (16 lines), early/synchronous maturity (6 lines), shorter stature (13 lines), rust resistance (8 lines) and higher protein content (2 lines). The most promising lines out of the 45 have been subjected to yield trials at different locations.

Irradiation with gamma rays has also been done on Walet at doses varying from 100 to 900 Gy. From this irradiation treatments, several higher yielding lines have been identified in addition to lines with bigger seeds and some shorter stature lines. The fast neutron irradiated Nuri (5-20 Gy) has generated in most cases shorter stature mutant lines, one of them has a higher protein content as compared to the original.

The variability created through induced mutations may have great values in both soybean and mungbean varietal improvements. Yield trials have been conducted to identify and select promising lines for further development into new improved varieties.

## AGRONOMIC TRIALS

Yield and agronomic trials conducted on selected lines at a number of locations have identified some promising lines in soybean (No.23, No.23-D, No.21, No.214, and No.231-B-1) and mungbean (M-I-2, M-I-5, M-I-9, M-I-10, M-I-11, M-I-41, M-I-45, M-II-4). Results of these trials are presented in Tables 2 and 3. In addition to lines listed above, several others are potential for inclusion in the future trials. One of them which is important to be mentioned is the soybean line No.231-A. This line has specifically extensive rooting system and early maturing (70 days) which would be suitable for intercropping.

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Table 1. Improved varieties of soybean and mungbean

| Crop/variety | Year of release | Days to maturity |
|---|---|---|
| Soybean | | |
| Orba | 1974 | 90 |
| Galunggung | 1981 | 85 |
| Lokon | 1982 | 76 |
| Guntur | 1982 | 78 |
| Wilis | 1983 | 88 |
| Dempo | 1984 | 90 |
| Kerinci | 1985 | 87 |
| Merbabu | 1986 | 85 |
| Raung | 1986 | 85 |
| Muria* | 1987 | 83 |
| Tidar | 1987 | 75 |
| Rinjani | 1989 | 88 |
| Petek | 1989 | 81 |
| Tambora | 1989 | 86 |
| Lompo Batang | 1989 | 86 |

*) Developed through induced mutations

| Crop/variety | Year of release | Days to maturity |
|---|---|---|
| Mungbean | | |
| No.129 | 1979 | 58 |
| Merak | 1981 | 56 |
| Nuri | 1983 | 58 |
| Manyar | 1083 | 58 |
| Betet | 1983 | 60 |
| Walet | 1985 | 59 |
| Gelatik | 1985 | 59 |
| Parkit | 1988 | 59 |

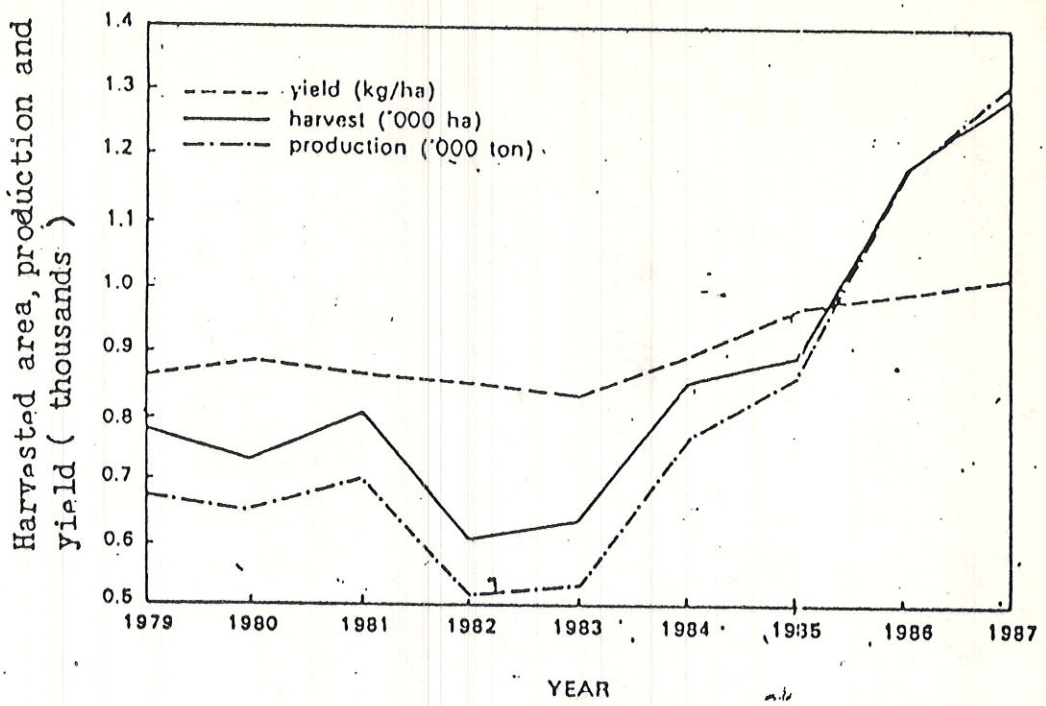


Figure 1. Harvested area, production, and yield of soybean in Indonesia.
(Source : Sebayang, K. and Sihombing, D.A 1987).

Table 2. Yield and other agronomic performance of the promising soybean mutant lines.

| Line | Yield* (kg/ha) | Days to maturity | 100 seed wt (g) | No. of pods/plant | Al tolerance** |
|---|---|---|---|---|---|
| 21 | 1582 | 75 | 11 | 57 | ++ |
| 23 | 1375 | 70 | 9 | 47 | + |
| 23-D | 1764 | 83 | 15 | 45 | + |
| 214 | 1615 | 78 | 11 | 60 | + |
| 231-B-1 | 1078 | 70 | 14 | 45 | - |
| Guntur | 1525 | 79 | 10 | 60 | - |
| Tidar | 1344 | 75 | 9 | 65 | - |

*) Average of yields obtained from 4 different locations (Bogor, Central Lampung, Kuningan, and Bone South Sulawesi).

**) Based on laboratory assessment using nutrient culture technique and acid soils in pots.

Table 3. Yield and other agronomic performance of the mungbean promising lines.

| Line | Yield*) (kg/ha) | Plant ht. (cm) | Days to maturity | 100 seed wt (g) | Remarks |
|---|---|---|---|---|---|
| M-I-2 | 1471 | 59 | 59 | 5 | Bigger pods/seeds, synchronous maturity |
| M-I-5 | 1467 | 69 | 61 | 4 | Slender pods, higher seed protein content, resistant to cercospora leaf spots and rust. |
| M-I-9 | 1614 | 67 | 62 | 4 | Slender pods, resistant to cercospora. |
| M-I-10 | 1317 | 64 | 63 | 5 | Slender pods, tolerant to bean flies |
| M-I-11 | 1282 | 68 | 62 | 5 | Bigger pods, resistant to cercospora and rust |
| M-I-41 | 1188 | 61 | 59 | 5 | Slender pods |
| M-I-45 | 1524 | 69 | 63 | 4 | Slender pods, synchronous maturity, resistant to cercospora and rust |
| M-II-4 | 999 | 56 | 59 | 4 | Resistant to rust and cercospora |
| Manyar | 1561 | 59 | 62 | 4 | Resistant to rust, moderately resistant to cercospora |
| Walet | 1162 | 60 | 62 | 7 | Resistant to rust and moderately resistant to cercospora |

*) Average of yields obtained from 4-6 different locations.