# Potato Seed Quality Evaluation Trials 2011

## Effect of seed generation derived from different seed sources on the growth and yield of potato in West Java-Indonesia

**Nikardi Gunadi, Romke Wustman, Joost van der Burg, Thomas Been, Asih K. Karyadi, Witono Adiyoga, Ineu Sulastrini and Kusmana**

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## Introduction

Potato (*Solanum tuberosum* L.) is one of the most important crops of the horticultural subsector in Indonesia. Potato production in Indonesia has more than doubled in the last 18 years, from 525,839 tons in 1991 to 1,176,304 tons in 2009. The area of potato has increased more than 50% from 39,620 ha in 1991 to 71,238 ha in 2009; and productivity increased by 22% from 13.2 to 16.5 t/ha (Dirjen Hortikultura 2010; FAO 2009). Indonesia is also the largest potato producer in Southeast Asia and only second after China among priority countries in the International Potato Center – East, Southeast Asia and the Pacific (CIP-ESEAP) region. The potato has been given high priority in vegetable research in Indonesia, because of its potential as alternative carbohydrate source in food diversification and export markets.

The main potato variety in Indonesia since the 1980's is Granola which covers 80 to 85% of the potato area. Late blight and bacterial wilt are the most important diseases followed by viruses. Potato viruses are widespread in major potato areas (West Java, Central Java, North Sumatra, East Java, and West Sumatra). PLRV, PVY and PVX appear to be the most important viruses. Crops with 1 to 5% virus-like diseased plants are common. It appears that more virus disease occurs in areas where quality seed is difficult to obtain or is too expensive. Resistance to viruses (mainly PLRV and PVY) is required for a sustained seed production. The moderate resistance to PLRV and PVY of Granola appears to have contributed to its success in Indonesia (Chujoy 1995).

Seed is the most costly component of potato production, and potato profitability often depends on access to quality seed. Seed accounts for 10-20% of the total costs of potato production (Fuglie *et al*. 2005). High quality seed is often relatively expensive and cannot be afforded by most farmers. Most potato farmers therefore use potato seed tubers saved from their previous crop. Farmers will buy seed tubers from other farmers or traders when their own seed stock has degenerated due to build-up of diseases. G3-G7 is the common generation of potato seed used by farmers.

Several sources of quality seed are available in Indonesia, including imported seed, locally grown certified seed, and private sector seed produced from tissue culture and other rapid multiplication techniques that eliminate seed-borne diseases. So far, imported seed appears to be the most economical and reliable source of quality seed. Publicly certified seed is heavily subsidized, while private-sector seed from tissue culture has not been profitable for most companies. However, seed is marketed through an 'informal' farmer seed system. Seed in the informal system is less expensive but of uncertain quality (Fuglie *et al*. 2005). Due to the incidence of (Golden) Potato Cyst Nematode (*Globodera rostochiensis*) in 2003, the government discontinued the importation of seed potatoes of Granola. This had a positive effect on the development of local seed producers, both for the public certified seed industry established in the 1990s and the seed producers association. However, informal discussions with potato farmers indicates that until now, potato farmers still rely on imported seed to renew their seed stock for the next planting season.

Information about the quality of potato seed tubers used by most farmers in Indonesia is limited. The objective of this experiment is testing the quality of seed potatoes originating from various parts and sources within Java.

## Materials and methods

The experiment was conducted at the experimental field of the Indonesian Vegetable Research Institute (IVEGRI), Lembang, West Java (1250 m asl.) from end of March to end of June 2011. The soil of the experimental field is classified as Andisols. The variety of potato in the experiment was Granola, which is commonly grown by the farmers in Pangalengan, the main potato production area in West Java.

Six generations of potato seed tuber i.e. Generation 2 (G2), Generation 3 (G3), Generation 4 (G4), Generation 5 (G5), Generation 6 (G6) and Generation 7 (G7) from four different sources or locations in West Java were used in the experiment. The sources and/or locations of potato seed tuber were Pangalengan (West Java), Garut (West Java), and Wonosobo (Central Java), the main potato production areas in Java. In Pangalengan (West Java), two seed sources were involved i.e. Hikmah and Hasan, whereas in Garut (West Java), two seed sources were also involved i.e. Khudori and Otang and in Wonosobo (Central Java), one seed source was involved i.e. Kledung. In general, the potato seed tubers derived from G2, G3 and G4 are certified by the Seed Control and Certification Institution in each province. The list of seed generation derived from different seed sources is presented in Table 1. In the field experiment, treatments were arranged in a Split Plot Design with three replications. The six seed generations i.e. G2, G3, G4, G5, G6 and G7 were assigned to main plots whereas seed sources i.e. S1, S2, S3 and S4 were assigned to sub-plots.

Field plots were prepared by making furrows spaced 75 cm apart. Plant spacing within the row was 30 cm. The experimental unit was a plot of 3.75 m x 3.0 m, consisted of five rows and 10 plants planted in each row. Therefore the total number of potato plants was 50 plants per plot. The layout of the experiment is presented in Attachment 1.

Prior to planting, horse manure was applied in bands at the bottom of each furrow at a rate of 25 t ha$^{-1}$. As basic fertilization, compound fertilizer NPK (16:16:16) were placed over the manure at rates of 800 kg ha$^{-1}$. At planting, the horse manure and the basic fertilizer were put in the furrows and then covered with soil before the seed tubers were planted. Planting the seed tubers was done by making holes with a spacing of 30 cm between plants. Carbofuran at 15 kg a.i. ha$^{-1}$ was applied in the furrow just before planting to control some insects in the soil such as mole cricket (*Gryllotalpa* sp.) and cut worm (*Agrotis ipsilon*). Twenty-five days after planting (DAP), 800 kg NPK (16:16:16) ha$^{-1}$ was applied as top dressing. Weeding and the first hilling-up were done at 25 DAP, at the same time as the top dressing. The second hilling-up was done at 40 DAP. Crops were sprayed regularly during the growing season using Mancozeb a.i. to control late blight (*Phytophthora infestans*) and Profenofos a.i. to control insect pests such as Thrips (*Thrips palmi* Karny) and Aphids (*Myzus persicae* Sulzer).

**Table 1. Seed generation and seed source of the experiment, Lembang March 2011**

| No | Seed generation | Seed source | Name of source | Location | Planting date | Harvesting date |
|---|---|---|---|---|---|---|
| 1 | G2 | S1 | Hikmah | Pangalengan | 19 Jun 2010 | 22 Oct 2010 |
| 2 | G3 | S1 | Hikmah | Pangalengan | 16 Apr 2010 | 11 Jul 2010 |
| 3 | G4 | S1 | Hikmah | Pangalengan | 7 May 2010 | 22 Aug 2010 |
| 4 | G5 | S1 | Otang | Garut | 16 Aug 2010 | 2 Dec 2010 |
| 5 | G6 | S1 | Otang | Garut | 21 Aug 2010 | 1 Dec 2010 |
| 6 | G7 | S1 | Otang | Garut | 28 Aug 2010 | 3 Dec 2010 |
| 7 | G2 | S2 | Kledung | Wonosobo | 22 Jun 2010 | 24 Sep 2010 |
| 8 | G3 | S2 | Kledung | Wonosobo | 22 Jul 2010 | 20 Oct 2010 |
| 9 | G4 | S2 | Kledung | Wonosobo | 26 Jul 2010 | 25 Oct 2010 |
| 10 | G5 | S2 | Kledung | Wonosobo | 7 Jul 2010 | 25 Oct 2010 |
| 11 | G6 | S2 | Kledung | Wonosobo | 3 Jul 2010 | 4 Oct 2010 |
| 12 | G7 | S2 | Rosad | Pangalengan | 18 Sep 2010 | 20 Dec 2010 |
| 13 | G2 | S3 | Hasan | Pangalengan | 20 Jun 2010 | 20 Oct 2010 |
| 14 | G3 | S3 | Hasan | Pangalengan | 20 Jun 2010 | 18 Oct 2010 |
| 15 | G4 | S3 | Hasan | Pangalengan | 10 Jul 2010 | 11 Nov 2010 |
| 16 | G5 | S3 | Hasan | Pangalengan | 1 Sep 2010 | 9 Dec 2010 |
| 17 | G6 | S3 | Hasan | Pangalengan | 13 Sep 2010 | 19 Dec 2010 |
| 18 | G7 | S3 | Hasan | Pangalengan | 12 Sep 2010 | 15 Dec 2010 |
| 19 | G2 | S4 | Khudori | Garut | 18 July 2010 | 22 Nov 2010 |
| 20 | G3 | S4 | Khudori | Garut | 15 Aug 2010 | 26 Nov 2010 |
| 21 | G4 | S4 | Khudori | Garut | 3 July 2010 | 10 Nov 2010 |
| 22 | G5 | S4 | Khudori | Garut | 2 Aug 2010 | 10 Nov 2010 |
| 23 | G6 | S4 | Khudori | Garut | 10 July 2010 | 22 Nov 2010 |
| 24 | G7 | S4 | Khudori | Garut | 10 July 2010 | 18 Oct 2010 |

Estimates of percent ground cover of the leaf canopy were made using the method outlined by Burstall and Harris (1983). A wooden frame of 75 x 60 cm divided with wires into 100 rectangles was used. The frame was held over the crops at four designated sites per plot. The canopy cover measured weekly, was estimated by looking vertically down onto the grid and counting the number of rectangles more than 50% filled with green leaf. The value of the total number of rectangles gave the percent ground cover.

Plant height was measured from the soil surface to the tip of the leaves of the tallest stem when pulled erect. Plant height was based on data from four representative plants in each plot.

Final harvest was conducted at 92 DAP. The number of plant harvested in each plot was counted. Data of tuber yields were assessed from the central three rows with eight plants per row and therefore a maximum of 3 x 8 plants were included for harvest analysis. Tubers were graded into categories > 60 g, 45-60 g, 30-45 g and < 30 g. Tuber number and tuber weight in each weight category were determined.

# Results and discussion

## Incidence of diseases on seed tuber and diseases on plants during the growing season

The incidence of diseases in seed tubers i.e. Fusarium dry rot (*Fusarium* spp.), black scurf (*Rhizoctonia solani*), silver scurf (*Helminthosporium solani*) and bacterial infection (*Dickeya* (previously known as: *Erwinia)* spp., *Ralstonia solanacearum* and *Clavibacter michiganensis*) were assessed before the experiment. Ten tuber seeds were taken as the sample for the diseases assessment in each seed lot. The observation of the presence of the diseases was conducted at 2, 4 and 28 days after the sample taken to the disease lab in the Indonesian Vegetable Research Institute (IVEGRI) in Lembang, West Java. The percentage of the incidence of Fusarium dry rot and silver scurf (*Helminthosporium solani*) is presented in Table 2.  In general, the incidence of Fusarium dry rot was varied between the seed generation. On average, at two days observation in the lab, the highest percentage of Fusarium dry rot incidence was found in seed generation 4 (G4) followed by seed generation 2 (G2) i.e. 30 and 25%, respectively. The percentage of Fusarium dry rot in the other seed generation ranged between 7.5 to 15%. The incidence Fusarium dry rot increased at the later observation i.e. at 4 and 28 days observation in the lab (Table 2). In term of seed source, on average the highest incidence of Fusarium dry rot was found in tuber seed came from seed source 1 (S1), followed by seed source 3 (S3), seed source 4 (S4) and seed source 2 (S2). The incidence of Fusarium dry rot between seed source ranged from 11.6 to 23% at two days observation. As the observation of Fusarium dry rot in the seed generation, the incidence of the disease increased at the later observation i.e. at 4 and 28 days observation in the lab (Table 2).

The incidence of silver scurf (*Helminthosporium solani*) in the seed tuber was found in G2, G3, G5 and G7 at two and four days observation, but not found in G4 and G6 (Table 2). At 28 days observation, the incidence of silver scurf (*Helminthosporium solani*) was found in each seed generation. In term of seed source, the incidence of silver scurf (*Helminthosporium solani*) in the seed tuber was found in the seed tuber came from seed source 1 (S1) but not in S2, S3 and S4. The presence incidences of either Fusarium dry rot or silver scurf (Helminthosporium solani) were not expected especially in seed generation 2 (G2) and seed generation 3 (G3) as these seed generations were certified.

**Table 2. Percentage of incidence of *Fusarium* spp. and *Helminthosporium solani* in the tuber seed before planting, Lembang March 2011**

| Treatment | Percentage of incidence of (in tuber seed) | | | | | |
|---|---|---|---|---|---|---|
| | *Fusarium* spp. at (days) | | | *Helminthosporium solani* at (days) | | |
| | 2 | 4 | 28 | 2 | 4 | 28 |
| **S. generation:** | | | | | | |
| **G2** | 25 | 32 | 52 | 2 | 2 | 2 |
| **G3** | 10 | 17 | 52 | 2 | 2 | 7 |
| **G4** | 30 | 32 | 57 | 0 | 0 | 15 |
| **G5** | 7 | 15 | 45 | 2 | 2 | 10 |
| **G6** | 15 | 20 | 32 | 0 | 0 | 17 |
| **G7** | 15 | 17 | 45 | 5 | 5 | 5 |
| **S. source:** | | | | | | |
| **S1** | 23 | 28 | 43 | 8 | 8 | 18 |
| **S2** | 12 | 20 | 45 | 0 | 0 | 7 |
| **S3** | 18 | 20 | 47 | 0 | 0 | 12 |
| **S4** | 12 | 21 | 55 | 0 | 0 | 2 |
| **G2 S1** | 30 | 40 | 40 | 10 | 10 | 10 |
| **G3 S1** | 20 | 20 | 30 | 10 | 10 | 10 |
| **G4 S1** | 30 | 30 | 40 | 0 | 0 | 20 |
| **G5 S1** | 0 | 20 | 50 | 10 | 10 | 10 |
| **G6 S1** | 20 | 20 | 40 | 0 | 0 | 40 |
| **G7 S1** | 40 | 40 | 60 | 20 | 20 | 20 |
| **G2 S2** | 10 | 30 | 30 | 0 | 0 | 0 |
| **G3 S2** | 0 | 20 | 80 | 0 | 0 | 10 |
| **G4 S2** | 40 | 40 | 40 | 0 | 0 | 0 |
| **G5 S2** | 10 | 10 | 70 | 0 | 0 | 10 |
| **G6 S2** | 10 | 20 | 20 | 0 | 0 | 20 |
| **G7 S2** | 0 | 0 | 30 | 0 | 0 | 0 |
| **G2 S3** | 20 | 20 | 60 | 0 | 0 | 0 |
| **G3 S3** | 10 | 10 | 30 | 0 | 0 | 10 |
| **G4 S3** | 40 | 40 | 60 | 0 | 0 | 40 |
| **G5 S3** | 10 | 10 | 30 | 0 | 0 | 10 |
| **G6 S3** | 10 | 20 | 50 | 0 | 0 | 10 |
| **G7 S3** | 20 | 20 | 50 | 0 | 0 | 0 |
| **G2 S4** | 40 | 40 | 80 | 0 | 0 | 0 |
| **G3 S4** | 10 | 20 | 70 | 0 | 0 | 0 |
| **G4 S4** | 10 | 20 | 90 | 0 | 0 | 0 |
| **G5 S4** | 10 | 20 | 30 | 0 | 0 | 10 |
| **G6 S4** | 20 | 20 | 20 | 0 | 0 | 0 |
| **G7 S4** | 0 | 10 | 40 | 0 | 0 | 0 |

The incidence of black scurf (*Rhizoctonia solani*) and bacterial infection (*Dickeya* spp., *Ralstonia solanacearum* and *Clavibacter michiganensis*) were not found in all seed tuber lots tried in the experiment. Therefore the data of these diseases are presented in the table.

During the growing season, wilting plant and plant with virus symptom were observed three times i.e. at 26, 33 and 40 days after planting (DAP). The percentage of wilt and virus incidences in the potato plants during the growing season is presented in Table 3.

**Table 3. Percentage of wilt and virus incidences in the potato plants during the growing season, Lembang May 2011**

| Treatment | Percentage of incidences of | | | | | |
|---|---|---|---|---|---|---|
| | Wilt at | | | Virus at | | |
| | 26 DAP | 33 DAP | 40 DAP | 26 DAP | 33 DAP | 40 DAP |
| **S. generation:** | | | | | | |
| **G2** | 0.3 | 1.0 | 1.3 | 0.8 | 0.8 | 1.3 |
| **G3** | 0.0 | 0.7 | 1.2 | 1.8 | 1.8 | 1.8 |
| **G4** | 1.0 | 4.0 | 5.3 | 2.5 | 2.5 | 2.5 |
| **G5** | 0.2 | 0.8 | 1.5 | 10.8 | 10.8 | 12.2 |
| **G6** | 0.5 | 1.5 | 2.2 | 11.3 | 11.3 | 12.8 |
| **G7** | 0.2 | 1.8 | 2.5 | 23.7 | 23.7 | 24.3 |
| **S. source:** | | | | | | |
| **S1** | 4.4 | 5.8 | 7.0 | 4.8 | 4.8 | 5.4 |
| **S2** | 0.8 | 3.8 | 4.9 | 3.2 | 3.2 | 3.3 |
| **S3** | 0.2 | 1.3 | 1.9 | 7.8 | 7.8 | 9.0 |
| **S4** | 0.3 | 1.1 | 2.1 | 18.2 | 18.2 | 18.9 |
| **G2 S1** | 0.7 | 0.7 | 0.7 | 0.0 | 0.0 | 0.0 |
| **G3 S1** | 0.0 | 0.0 | 0.0 | 4.0 | 4.0 | 4.0 |
| **G4 S1** | 0.0 | 0.7 | 0.7 | 2.0 | 2.0 | 2.0 |
| **G5 S1** | 0.0 | 0.7 | 0.7 | 4.0 | 4.0 | 6.0 |
| **G6 S1** | 0.0 | 0.0 | 0.0 | 4.7 | 4.7 | 6.7 |
| **G7 S1** | 0.7 | 4.7 | 6.0 | 14.0 | 14.0 | 14.0 |
| **G2 S2** | 0.0 | 0.0 | 0.0 | 1.3 | 1.3 | 1.3 |
| **G3 S2** | 0.0 | 0.0 | 0.0 | 2.0 | 2.0 | 2.0 |
| **G4 S2** | 4.0 | 14.7 | 20.0 | 2.0 | 2.0 | 2.0 |
| **G5 S2** | 0.0 | 1.3 | 1.3 | 4.7 | 4.7 | 5.3 |
| **G6 S2** | 0.0 | 2.0 | 2.0 | 4.0 | 4.0 | 4.0 |
| **G7 S2** | 0.0 | 1.3 | 2.0 | 5.3 | 5.3 | 5.3 |
| **G2 S3** | 0.7 | 3.3 | 4.7 | 2.0 | 2.0 | 4.0 |
| **G3 S3** | 0.0 | 0.7 | 0.7 | 1.3 | 1.3 | 1.3 |
| **G4 S3** | 0.0 | 0.7 | 0.7 | 2.0 | 2.0 | 2.0 |
| **G5 S3** | 0.0 | 0.7 | 2.0 | 9.3 | 9.3 | 11.3 |
| **G6 S3** | 0.7 | 1.3 | 1.3 | 18.0 | 18.0 | 19.3 |
| **G7 S3** | 0.0 | 1.3 | 1.3 | 14.0 | 14.0 | 16.0 |
| **G2 S4** | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 | 0.0 |
| **G3 S4** | 0.0 | 2.0 | 4.0 | 0.0 | 0.0 | 0.0 |
| **G4 S4** | 0.0 | 0.0 | 0.0 | 4.0 | 4.0 | 4.0 |
| **G5 S4** | 0.7 | 0.7 | 2.0 | 25.3 | 25.3 | 26.0 |
| **G6 S4** | 1.3 | 2.7 | 5.3 | 18.7 | 18.7 | 21.3 |
| **G7 S4** | 0.0 | 0.0 | 0.7 | 61.3 | 61.3 | 62.0 |

On average, wilting plants were found in all seed generations at 26 day after planting (DAP) except seed generation 3 (G3). At 33 and 40 DAP, the incidence of wilt was found in all seed generation. There was no indication that the higher seed generation, the higher incidence of wilt. In term of seed source, the incidence of wilt was found in all seed sources either at 26, 33 or 40 DAP.

In terms of virus incidence, there was an indication that the older the seed generation, the higher percentage of plants with virus symptom. This is consistent in all data observed either at 26, 33 and 40 DAP. On average, at 26 and 33 DAP, the potato plants with virus symptom were 0.8, 1.8, 2.5, 10.8, 11.3 and 23.7% in G2, G3, G4, G5, G6 and G7, respectively. At 40 DAP, the potato plants with virus symptom increased i.e. 1.3, 1.8, 2.5, 12.2, 12.8 and 24.3% in G2, G3, G4, G5, G6 and G7, respectively (Table 3). Although no plants with virus symptom were tested in the lab using ELISA, the symptom was particularly similar to potato virus Y (PVY) found in the experimental field. In terms of seed source, averaged over seed generations, the percentage of plants with virus symptom varied between seed sources. However, the lowest percentage of plants with virus symptom was found in seed source 2 (S2) i.e. 3.2% and the highest percentage of plants with virus symptom was found in seed source 4 (S4) i.e. 18.2% both at 26 and 33DAP.

## Growth parameters

Due to the differences in the physiological age of the seed tuber as they were derived from different seed sources and seed generations, plant emergence was observed at 2 and 4 weeks after planting (WAP). The plant emergence of each seed lot in the experiment observed at 2 WAP and 4 WAP is presented in Table 4 and 5. At 2 WAP, averaged over seed generation, the plant emergence varied significantly between seed source and the seed source S2 and S3 had significantly higher plant emergence than the seed source S1 and S4. In terms of seed generation, significant difference was not found between seed generation. The average plant emergence was 64.4 % at 2WAP.

**Table 4. Effect of seed generation derived from different seed sources on plant emergence of potato at 2 WAP, Lembang, April 2011**

| Seed generation (G) | Plant emergence (%) at 2 WAP | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 38.0 b y | 100.0 a w | 84.7 a x | 30.0 c y | 63.2 |
| **G3** | 31.3 b x | 74.7 ab w | 72.7 a w | 0.0 d x | 44.7 |
| **G4** | 58.7 ab w | 52.7 b w | 59.3 a w | 84.0 b w | 63.7 |
| **G5** | 56.0 ab x | 86.7 a w | 78.0 a wx | 87.3 ab w | 77.0 |
| **G6** | 84.0 a wx | 88.7 a w | 76.7 a x | 40.0 c y | 72.3 |
| **G7** | 70.0 b w | 14.7 c x | 78.7 a w | 98.7 a w | 65.5 |
| **Mean** | 56.3 B | 69.5 A | 75.0 A | 56.7 B | 64.4 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | *** |
| **Interaction GxS** | | | | | *** |

Note: WAP = Weeks After Planting; Mean separation by DMRT at 5%; Letters *a* to *c* is comparing means in a column and *w* to *y* is comparing means in a row; ns = not significant (P>.05); *** = highly significant (P<.001)

At 2 WAP, interaction between seed generation and seed source was observed in terms of plant emergence (Table 4). The significant interaction between seed generation and seed source was presumably associated with the varied plant emergence between seed generation and between seed source. For example in seed generation 2 (G2), the highest plant emergence was obtained by seed source 2 (S2) which was 100% and the lowest by seed source 4 (S4) which was 30%, however in seed generation 7 (G7), the highest plant emergence was obtained by seed source 4 (S4) which was 98.7% and the lowest by seed source 2 (S2) which was 14.7%. This indicated that the higher percent of plant emergence at 2 WAP was not associated with the seed generation and the seed source.

At 4 WAP, similar to the observation at 2 WAP, the plant emergence was not significantly differed between seed generation (Table 5). The mean plant emergence was 95.1%. However, the plant emergence was significantly differed between seed source and the plant emergence of potato derived from S1 and S3 were significantly higher than those of S2 and S4.

Table 5. Effect of seed generation derived from different seed sources on plant emergence of potato at 4 WAP, Lembang, April 2011

| Seed generation (G) | Plant emergence (%) at 4 WAP | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 100.0 a w | 100.0 a w | 100.0 a w | 82.7 b x | 95.7 |
| **G3** | 100.0 a w | 100.0 a w | 100.0 a w | 66.0 c x | 91.5 |
| **G4** | 100.0 a w | 98.0 a w | 98.7 a w | 99.3 a w | 99.0 |
| **G5** | 98.7 a w | 100.0 a w | 99.3 a w | 100.0 a w | 99.5 |
| **G6** | 98.7 a w | 100.0 a w | 98.0 a w | 97.3 a w | 98.5 |
| **G7** | 99.3 a w | 47.3 b x | 100.0 a w | 100.0 a w | 86.7 |
| **Mean** | 99.4 A | 90.9 B | 99.3 A | 90.9 B | 95.1 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | ** |
| **Interaction GxS** | | | | | *** |

Note: WAP = Weeks After Planting; Mean separation by DMRT at 5%; Letters *a* to *c* is comparing means in a column and *w* to *x* is comparing means in a row; ns = not significant (P>.05); ** = highly significant (P>.001 and <u><</u>.01); *** = highly significant (P<.001)

There was a significant interaction between seed generation and seed source in terms of plant emergence at 4 WAP (Table 5). Each seed generation obtained the maximum plant emergence (100%) varied between seed sources. For example G2, G3 and G4 derived from S1 had already obtained 100% plant emergence at 4 WAP but not the other seed generations. In the seed tuber derived from S2, the maximum plant emergence (100%) was obtained by the seed generation G2, G3, G5 and G6. The seed tuber derived from other seed sources (S3 and S4) had also indicated different response in obtaining the maximum plant emergence.

Plant height of potato as affected by seed generation and seed source is presented in Table 6, 7 and 8. Inconsistent result of plant height was observed between the dates of observation (4, 6 and 7 WAP). In the initial growing period i.e. at 4 WAP, the plant height of potatoes was not significantly differed between seed generation and the mean plant height at 4 WAP was 34.6 cm. However, the plant height of potatoes was significantly differed between the seed source and the potatoes derived from S2 and S3 had the highest plants which were not significantly differed with those derived from S1 but they were significantly differed with those derived from S4.

**Table 6. Effect of seed generation derived from different seed sources on plant height of potato at 4 WAP, Lembang, April 2011**

| Seed generation (G) | Plant height (cm) at 4 WAP | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 29.5 b x | 46.9 a w | 40.5 a w | 30.3 b x | 36.8 |
| **G3** | 28.2 b x | 42.7 a w | 39.7 a w | 11.8 c y | 30.6 |
| **G4** | 34.2 ab w | 33.1 a w | 40.4 a w | 39.7 a w | 36.8 |
| **G5** | 34.5 ab w | 37.2 a w | 35.3 a w | 39.8 a w | 36.7 |
| **G6** | 40.9 a w | 40.1 a w | 34.5 a wx | 29.6 b x | 36.3 |
| **G7** | 35.6 ab w | 15.3 b x | 32.9 a w | 36.5 a w | 30.1 |
| **Mean** | 33.8 AB | 35.9 A | 37.2 A | 31.3 B | 34.6 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | ** |
| **Interaction GxS** | | | | | *** |

Note: WAP = Weeks After Planting; Mean separation by DMRT at 5%; Letters *a* to *c* is comparing means in a column and *w* to *y* is comparing means in a row; ns = not significant (P>.05); ** = highly significant (P>.001 and <.01); *** = highly significant (P<.001)

Similar observation was found as with those at 4 WAP, the plant height of potatoes at 6 WAP was differed significantly between seed source, except that the plant height of potatoes was also significantly differed between seed generation (Table 7). At 6 WAP, the highest potato plants were obtained by potatoes derived from G4, which were not significantly differed with those of potatoes derived from G2 and G5 but were significantly higher than those of potatoes derived from G3, G6 and G7. In terms of seed source, the highest plants were obtained by the potatoes derived from S1 and S3 which were significantly differed with those of potatoes derived from S2 and S4.

As the observation at 4 WAP, significant interaction between seed generation and seed source was found in terms of plant height at 6 WAP (Table 7). Potatoes derived from G4 which came from any seed source tended to have the higher plants compared to those derived from other seed generations. In the other seed generations, the plant height of potatoes indicated varied response. This may have been due to the different physiological age as had been also shown in the plant emergence observation.

**Table 7. Effect of seed generation derived from different seed sources on plant height of potato at 6 WAP, Lembang, May 2011**

| Seed generation (G) | Plant height (cm) at 6 WAP | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 60.5 a w | 60.2 ab w | 64.1 ab w | 60.9 bc w | 61.4 AB |
| **G3** | 60.5 a w | 59.2 ab w | 61.5 ab w | 49.7 d x | 57.7 B |
| **G4** | 68.1 a w | 63.4 a w | 68.0 a w | 70.5 a w | 67.5 A |
| **G5** | 60.6 a w | 61.3 ab w | 61.3 ab w | 64.9 ab w | 62.0 AB |
| **G6** | 62.5 a w | 61.3 ab w | 59.9 ab w | 55.6 cd w | 59.8 B |
| **G7** | 61.3 a w | 50.2 b x | 58.8 b wx | 55.0 cd wx | 56.3 B |
| **Mean** | 62.3 A | 59.2 B | 62.3 A | 59.5 B | 60.8 |
| **S. generation (G)** | | | | | * |
| **S. source (S)** | | | | | * |
| **Interaction GxS** | | | | | * |

Note: WAP = Weeks After Planting; Mean separation by DMRT at 5%; Letters *a* to *d* is comparing means in a column and *w* to *x* is comparing means in a row; * = significant (P<.05)

At 7 WAP, the plant height of potatoes was only significantly affected by seed generation and interaction between seed generation and seed source was not found in terms of plant height at 7 WAP (Table 7).

**Table 8. Effect of seed generation derived from different seed sources on plant height of potato at 7 WAP, Lembang, May 2011**

| Seed generation (G) | Plant height (cm) at 7 WAP | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 64.4 | 65.2 | 70.1 | 57.3 | 64.3 AB |
| **G3** | 64.7 | 70.9 | 62.8 | 63.0 | 65.4 A |
| **G4** | 63.3 | 64.2 | 65.4 | 70.2 | 65.8 A |
| **G5** | 56.4 | 56.2 | 60.3 | 63.2 | 59.1 ABC |
| **G6** | 58.8 | 57.3 | 57.4 | 53.5 | 56.8 C |
| **G7** | 62.0 | 47.9 | 61.2 | 59.1 | 57.6 BC |
| **Mean** | 61.6 | 60.3 | 62.9 | 61.1 | 61.5 |
| **S. generation (G)** | | | | | * |
| **S. source (S)** | | | | | ns |
| **Interaction GxS** | | | | | ns |

Note: WAP = Weeks After Planting; Mean separation by DMRT at 5%; ns = not significant (P>.05); * = significant (P<.05)

In terms of seed generation, the younger seed generations (G2, G3, G4 and G5) had significantly higher potato plants than those of the older generations (G6 and G7).

Similar observation in ground cover at 4 WAP was found as the observation in plant height at 4 WAP (Table 9). At 4 WAP, the ground cover of potatoes differed significantly between seed source and potatoes derived from S2 and S3 had significantly higher ground cover than those derived from S1 and S4. No significant difference between seed generation was found in terms of ground cover at 4 WAP and the average ground cover of potatoes at 4 WAP was 23.8%.

**Table 9. Effect of seed generation derived from different seed sources on ground cover of potato at 4 WAP, Lembang, April 2011**

| Seed generation (G) | Ground cover (%) at 4 WAP | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 17.5 b y | 44.4 a w | 30.0 ab x | 15.5 b y | 26.9 |
| **G3** | 21.6 ab x | 27.0 b wx | 34.4 a w | 4.1 c y | 21.8 |
| **G4** | 24.1 ab wx | 18.5 b x | 25.4 ab wx | 28.2 a w | 24.1 |
| **G5** | 25.5ab w | 27.0 b w | 27.2 ab w | 28.8 a w | 27.1 |
| **G6** | 28.3 a x | 36.9 a w | 20.9 b y | 17.1 b z | 25.8 |
| **G7** | 17.2 b | 6.4 c | 21.1 ab | 23.1 ab | 16.9 |
| **Mean** | 22.4 B | 26.7 A | 26.5 A | 19.5 C | 23.8 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | *** |
| **Interaction GxS** | | | | | *** |

Note: WAP = Weeks After Planting; Mean separation by DMRT at 5%; Letters *a* to *c* is comparing means in a column and *w* to *z* is comparing means in a row; ns = not significant (P>.05); *** = highly significant (P<.001)

As the observation of plant height at 4 WAP, significant interaction between seed generation and seed source was found in terms of ground cover at 4 WAP (Table 9). Inconsistent result of ground cover was observed in each seed generation and in each seed source. For example, the highest ground cover in potatoes derived from S1 was obtained by seed tuber from generation 6 (G6), whereas in potatoes derived from S2 and S3, the highest ground cover was obtained by seed tuber generation 2 (G2). Similarly, in potatoes derived from S4, the highest ground cover was obtained by seed tuber generation 5 (G5). This may be associated with the plant emergence at 4 WAP.

At 6 WAP, the ground cover differed significantly between seed generation and also between seed source (Table 10). The highest ground cover was obtained by potatoes derived from G2 and G4 which were differed significantly with those of G6 and G7 but not differed significantly with those of G3 and G5. In terms of seed source, the potatoes derived from S2 and S3 had significantly higher ground cover compared to those of potatoes derived from S1 and S4.

**Table 10. Effect of seed generation derived from different seed sources on ground cover of potato at 6 WAP, Lembang, May 2011**

| Seed generation (G) | Ground cover (%) at 6 WAP | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 59.3 b x | 94.7 a w | 96.0 a w | 61.0 c x | 77.7 A |
| **G3** | 63.3 b x | 86.0 ab w | 89.9 a w | 44.8 d y | 71.0 ABC |
| **G4** | 77.9 a w | 64.6 bc x | 80.7 ab w | 89.8 a w | 78.3 A |
| **G5** | 72.6 ab wx | 80.3 ab w | 65.6 bc x | 74.8 b wx | 73.4 AB |
| **G6** | 69.7 ab wx | 83.3 ab w | 55.2 c xy | 48.3 cd y | 64.1 BC |
| **G7** | 61.7 b w | 48.1 c w | 67.8 bc w | 60.5 c w | 59.5 C |
| **Mean** | 67.4 B | 76.2 A | 75.9 A | 63.2 B | 70.7 |
| **S. generation (G)** | | | | | * |
| **S. source (S)** | | | | | *** |
| **Interaction GxS** | | | | | *** |

Note: WAP = Weeks After Planting; Mean separation by DMRT at 5%; Letters *a* to *d* is comparing means in a column and *w* to *y* is comparing means in a row; * = significant (P<.05); *** = highly significant (P<.001)

There was a significant interaction between seed generation and seed source in terms of ground cover at 6 WAP (Table 10). The highest ground cover in potatoes derived from S1 and S4 was obtained by seed tuber from generation 4 (G4), whereas in potatoes derived from S2 and S3, the highest ground cover was obtained by seed tuber generation 2 (G2).

At 8 WAP, seed generation had no effect on the ground cover and the mean ground cover at 8 WAP was 61.5% (Table 11). In terms of seed source, the highest ground cover was obtained by potatoes derived from S4 which was significantly differed with those of S1, S2 and S3.

Significant interaction between seed generation and seed source was observed in terms of ground cover at 8 WAP (Table 11). On average the ground cover at 8 WAP was lower than that at 6 WAP, however the decreased of ground cover was not consistent. For example in S1, the lowest ground cover was observed by potatoes derived from G2 at 6 WAP, but at 8 WAP, the potatoes derived from G2 had the highest ground cover compared to those of potatoes derived from other seed generation. Similar observation was also indicated in other seed source either in S2, S3 or S4. This may had been due to the different in plant emergence as affected by different physiological age of the potato seed tuber used in the experiment.

**Table 11. Effect of seed generation derived from different seed sources on ground cover of potato at 8 WAP, Lembang, May 2011**

| **Seed generation (G)** | **Ground cover (%) at 8 WAP** | | | | **Mean** |
|---|---|---|---|---|---|
| | **Seed source (S)** | | | | |
| | **S1** | **S2** | **S3** | **S4** | |
| **G2** | 63.4 a xy | 58.3 a y | 69.0 a wx | 77.3 ab w | 67.0 |
| **G3** | 53.1 a x | 60.4 a x | 66.0 a wx | 83.6 a w | 65.8 |
| **G4** | 60.4 a wx | 53.1 a x | 68.3 a wx | 78.7 ab w | 65.1 |
| **G5** | 61.6 a w | 57.8 a w | 54.7 a w | 51.3 c w | 56.4 |
| **G6** | 63.4 a w | 55.4 a w | 60.0 a w | 59.8 bc w | 59.7 |
| **G7** | 58.0 a w | 56.4 a w | 51.6 a w | 53.0 c w | 54.8 |
| **Mean** | 60.0 B | 56.9 B | 61.6 B | 67.3 A | 61.5 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | ** |
| **Interaction GxS** | | | | | * |

Note: WAP = Weeks After Planting; Mean separation by DMRT at 5%; Letters *a* to *c* is comparing means in a column and *w* to *y* is comparing means in a row; ns = not significant (P>.05); * = significant (P<.05); ** = highly significant (P>.001 and ≤.01)

## Final tuber yield and its components

The effect of seed generation derived from different seed sources on the total tuber yields per plot (kg. 5.4m$^{-1}$) at final harvest is presented in Table 12. Seed generation and seed source had no significant effect on the total tuber yields per plot. On average, the total tuber yield was 10.60 kg per 5.4 m$^{-1}$. However, interaction between seed generation and seed source was observed in terms of total tuber yields per plot. The total tuber yields per plot indicated varied results between seed sources. For example in S1, the highest total tuber yield per plot was obtained by seed generation G5 which differed significantly only with that of seed generation G7, whereas with the other seed generation, the differences were not significant. In S2, the highest total tuber yield per plot was obtained by seed generation G2 which was not significantly different with that of seed generation G3, but was significantly different with those of the other seed generations. In S3, the highest total tuber yield per plot was obtained by seed generation G3 however the difference was not significant with those of the other seed generations. In S4, the highest total tuber yields were obtained by seed generation G4, which was not significantly different with those of seed generation G2, G5 and G6, but was significantly different with those of seed generation G3 and G7.

**Table 12. Effect of seed generation derived from different seed sources on total tuber yields per plot (kg. 5.4m$^{-1}$) at final harvest, Lembang, June 2011**

| Seed generation (G) | Total tuber yields per plot (kg. 5.4m$^{-1}$) | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 10.28 ab w | 14.01 a w | 11.54 a w | 11.56 abc w | 11.85 |
| **G3** | 11.75 ab w | 13.19 ab w | 13.00 a w | 6.72 c x | 11.16 |
| **G4** | 10.93 ab w | 5.29 d x | 12.83 a w | 12.99 a w | 10.51 |
| **G5** | 12.53 a w | 10.23 c w | 9.08 a w | 12.25 ab w | 11.02 |
| **G6** | 12.22 ab w | 11.14 bc wx | 9.66 a wx | 8.13 abc x | 10.29 |
| **G7** | 9.43 b wx | 7.44 d x | 10.77 a w | 7.51 bc x | 8.79 |
| **Mean** | 11.19 | 10.22 | 11.15 | 9.86 | 10.60 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | ns |
| **Interaction GxS** | | | | | *** |

Note: Mean separation by DMRT at 5%; Letters *a* to *c* is comparing means in a column and *w* to *x* is comparing means in a row; ns = not significant (P>.05); *** = highly significant (P<.001)

Averaged over the seed source, in general the total tuber yield per plot was higher in younger seed generation compared to that of older seed generation, however significant differences were not found between the seed generations (Table 12). The inconsistent results of data of the total tuber yields per plot in each seed source may be associated with the absence of significant differences between seed generation in this experiment.

Yields of tuber >60 g per plot as affected by seed generation derived from different seed sources is presented in Table 13. Similar results with data of total tuber yields per plot were observed in the data of yields of tuber >60 g per plot. Seed generation and seed source had no significant effect on the yields of tuber >60 g per plot. On average, the yields of tuber >60 g was 5.05 kg per 5.4 m$^{-1}$. There was a significant interaction between seed generation and seed source in terms of yields of tuber >60 g per plot. As the total tuber yields per plot, yields of tuber >60 g per plot indicated varied results between seed sources. For example in S1 and S3, the highest yields of tuber >60 g per plot was obtained by seed generation G5 and G7, respectively, however there was no significant differences between seed generations in each seed source. In S2, the highest yields of tuber >60 g per plot was obtained by seed generation G2 which was not significantly differed with that of seed generation G3, G5 and G6, but was significantly differed with those of seed generation G4 and G7. In S4, the highest total tuber yields were obtained by seed generation G4, however the difference was only observed with that of seed generation G7.

**Table 13. Effect of seed generation derived from different seed sources on yields of tuber >60 g per plot (kg. 5.4m$^{-1}$) at final harvest, Lembang, June 2011**

| Seed generation (G) | Yields of tuber >60 g per plot (kg. 5.4m$^{-1}$) | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 4.31 a w | 6.81 a w | 5.29 a w | 6.62 ab w | 5.76 |
| **G3** | 5.17 a w | 6.31 a w | 5.18 a w | 3.92 ab w | 5.14 |
| **G4** | 4.06 a x | 3.02 c x | 4.53 a x | 7.58 a w | 4.80 |
| **G5** | 6.40 a w | 5.47 ab w | 3.91 a w | 5.87 ab w | 5.41 |
| **G6** | 5.65 a w | 5.51 ab w | 4.27 a w | 4.46 ab w | 4.97 |
| **G7** | 4.03 a w | 3.87 bc w | 5.57 a w | 3.49 b w | 4.24 |
| **Mean** | 4.94 | 5.16 | 4.79 | 5.32 | 5.05 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | ns |
| **Interaction GxS** | | | | | * |

Note: Mean separation by DMRT at 5%; Letters *a* to *c* is comparing means in a column and *w* to *x* is comparing means in a row; ns = not significant (P>.05); * = significant (P<.05)

In general, the higher yields of tuber >60 g per plot in potatoes with younger seed generation compared to that of older seed generation was indicated in the experiment, however there was no significant difference between the seed generations (Table 13). The inconsistent results of data of the yields of tuber >60 g per plot in each seed source, as indicated also in the total tuber yields per plot, may be associated with the absence of significant differences between seed generation in this experiment.

The effect of seed generation derived from different seed sources on the yields of tuber 45-60 g per plot is presented in Table 14. Seed generation has not affected the yields of tuber 45-60 g per plot, but seed source affected significantly the yields of tuber 45-60 g per plot. Yields of tuber 45-60 g per plot of potatoes derived from S1 and S3 were significantly higher than those of potatoes derived from S2 and S4. Interaction between seed generation and seed source was observed in terms of the yields of tuber 45-60 g per plot. In S1 and S3, significant differences were not found between the seed generation. However in S2 and S4, the effect of seed generation was varied. For example, in S2, the highest yields of tuber 45-60 g per plot was obtained by seed generation G2, which was not differed significantly with those of seed generation G3, G5 and G6, but was significantly differed with those of seed generation G4 and G7. In S4, the highest yields of tuber 45-60 g per plot was obtained by seed generation G5, which was differed significantly with those of seed generation G2, G4, and G5, but was significantly different with those of seed generation G3, G6 and G7.

**Table 14. Effect of seed generation derived from different seed sources on yields of tuber 45-60 g per plot (kg. 5.4m$^{-1}$) at final harvest, Lembang, June 2011**

| Seed generation (G) | Yields of tuber 45-60 g per plot (kg. 5.4m$^{-1}$) | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 2.60 a w | 3.58 a w | 3.01 a w | 2.81 a w | 2.99 |
| **G3** | 3.52 a w | 3.17 ab w | 4.07 a w | 1.16 c x | 2.98 |
| **G4** | 2.51 a wx | 1.27 c x | 3.34 a w | 2.58 ab wx | 2.42 |
| **G5** | 3.40 a w | 2.66 ab x | 2.68 a x | 3.20 a wx | 2.98 |
| **G6** | 3.53 a w | 2.65 ab wx | 2.79 a wx | 1.58 bc x | 2.64 |
| **G7** | 2.59 a w | 2.17 bc wx | 2.59 a w | 1.44 c x | 2.19 |
| **Mean** | 3.02 A | 2.58 B | 3.08 A | 2.16 C | 2.70 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | *** |
| **Interaction GxS** | | | | | *** |

Note: Mean separation by DMRT at 5%; Letters *a* to *c* is comparing means in a column and *w* to *x* is comparing means in a row; ns = not significant (P>.05); *** = highly significant (P<.001)

Similar pattern with the results of the yields of tuber 45-60 g per plot was observed in the yields of tuber 30-45 g per plot (Table 15). Seed generation has not affected yields of tuber 30-45 g per plot, but seed source affected significantly the yields of tuber 30-45 g per plot. Yields of tuber 30-45 g per plot of potatoes derived from S1 and 3 were significantly higher than those of potatoes derived from S2 and S4. Interaction between seed generation seed source was also observed in terms of yields of tuber 30-45 g per plot. As the yields of tuber >60 g per plot, yields of tuber 30-45 g per plot indicated varied results between seed sources. For example, in S1, there were no significant differences between seed generation, however in other seed sources i.e. in S2, S3 and S4, various responses were found in each seed source.

**Table 15. Effect of seed generation derived from different seed sources on yields of tuber 30-45 g per plot (kg. 5.4m$^{-1}$) at final harvest, Lembang, June 2011**

| Seed generation (G) | Yields of tuber 30-45 g per plot (kg. 5.4m$^{-1}$) | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 1.96 a w | 2.40 a w | 2.15 ab w | 1.36 bc w | 1.97 |
| **G3** | 1.87 a w | 2.34 a w | 2.37 ab w | 1.07 c x | 1.92 |
| **G4** | 2.71 a w | 0.57 d y | 2.98 a w | 1.84 ab x | 2.03 |
| **G5** | 1.84 a w | 1.47 bc w | 1.72 b w | 2.30 a w | 1.83 |
| **G6** | 1.85 a w | 1.90 ab w | 1.76 b w | 1.52 bc w | 1.76 |
| **G7** | 1.92 a w | 0.94 cd x | 1.73 b w | 1.35 bc wx | 1.48 |
| **Mean** | 2.03 A | 1.60 B | 2.12 A | 1.57 B | 1.83 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | *** |
| **Interaction GxS** | | | | | *** |

Note: Mean separation by DMRT at 5%; Letters *a* to *d* is comparing means in a column and *w* to *x* is comparing means in a row; ns = not significant (P>.05); *** = highly significant (P<.001)

The effect of seed generation derived from different seed sources on the yields of tuber <30 g per plot is presented in Table 16.

**Table 16. Effect of seed generation derived from different seed sources on yields of tuber <30 g per plot (kg. 5.4m$^{-1}$) at final harvest, Lembang, June 2011**

| Seed generation (G) | Yields of tuber <30 g per plot (kg. 5.4m$^{-1}$) | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 1.41 a w | 1.23 a w | 1.09 bc w | 0.77 ab w | 1.12 AB |
| **G3** | 1.18 ab w | 1.37 a w | 1.38 b w | 0.57 b x | 1.12 AB |
| **G4** | 1.65 a wx | 0.43 c y | 1.98 a w | 0.99 ab xy | 1.26 A |
| **G5** | 0.89 b w | 0.63 bc w | 0.77c w | 0.88 ab w | 0.79 C |
| **G6** | 1.19 ab w | 1.08 ab wx | 0.83 c wx | 0.57 b x | 0.92 BC |
| **G7** | 0.89 b wx | 0.46 c x | 0.87 c wx | 1.23 a w | 0.86 BC |
| **Mean** | 1.20 A | 0.87 B | 1.15 A | 0.83 B | 1.01 |
| **S. generation (G)** | | | | | * |
| **S. source (S)** | | | | | *** |
| **Interaction GxS** | | | | | *** |

Note: Mean separation by DMRT at 5%; Letters *a* to *c* is comparing means in a column and *w* to *y* is comparing means in a row; * = significant (P<.05); *** = highly significant (P<.001)

Seed generation and seed source have significantly affected the yields of tuber <30 g per plot. In terms of seed generation, the highest yields of tuber <30g was obtained by seed generation G2 which was not differed significantly with those of seed generation G3 and G4. In terms of seed source, the yields of tuber <30 g per plot of potatoes derived from S1 and S3 differed significantly with those of potatoes derived from S2 and S4. As other tuber yields data, significant interaction between seed generation and seed source was found in terms of yields of tuber <30 g per plot. Varied results were also observed in the interaction effect between seed generation and seed source.

Tuber yields per plant as affected by seed generation derived from different seed sources is presented in Table 17. Seed generation and seed source were not affected significantly tuber yields per plant. Although the seed generation G2 had the highest tuber yields per plant compared to the older seed generations, the difference was not significant. The average tuber yield per plant in this experiment was 0.466 g.

**Table 17. Effect of seed generation derived from different seed sources on tuber yields per plant (kg) at final harvest, Lembang, June 2011**

| Seed generation (G) | Tuber yields per plant (kg) | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 0.454 a w | 0.594 a w | 0.503 a w | 0.532 a w | 0.521 |
| **G3** | 0.489 a wx | 0.550 ab w | 0.542 a w | 0.344 ab x | 0.481 |
| **G4** | 0.462 a w | 0.315 d x | 0.544 a w | 0.548 a w | 0.467 |
| **G5** | 0.528 a w | 0.450 bc w | 0.384 a w | 0.516 ab w | 0.470 |
| **G6** | 0.535 a w | 0.470 b wx | 0.415 a x | 0.418 ab x | 0.459 |
| **G7** | 0.444 a w | 0.349 cd x | 0.482 a w | 0.313 b x | 0.397 |
| **Mean** | 0.485 | 0.455 | 0.478 | 0.445 | 0.466 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | ns |
| **Interaction GxS** | | | | | *** |

Note: Mean separation by DMRT at 5%; Letters *a* to *c* is comparing means in a column and *w* to *x* is comparing means in a row; ns = not significant (P>.05); *** = highly significant (P<.001)

Interaction between seed generation and seed source was found in terms of tuber yields per plant (Table 17). Varied results were also observed in the interaction effect between seed generation and seed source. In S1 and S3, the tuber yields per plant were not significantly different between seed generations. In S2, the higher tuber yields per plant was obtained by seed generation G2 and G3, which differed significantly with those of the older seed generation G4, G5, G6 and G7. In S4, similar pattern with that of S2, the younger seed generations G2 until G6 had significantly higher tuber yields than that of seed generation G7.

The effect of seed generation derived from different seed sources on tuber number per plant is presented in Table 18. Seed generation and seed source affected significantly tuber number per plant. In terms of seed generation, the highest tuber number per plant was obtained by seed generation G2 which was significantly differed with those of seed generation G3, G4 and G6, whereas the difference was significant with those of seed generation G5 and G7.

**Table 18. Effect of seed generation derived from different seed sources on tuber number per plant (#) at final harvest, Lembang, June 2011**

| Seed generation (G) | Tuber number per plant (#) | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 11.5 ab w | 12.7 a w | 10.4 bc wx | 9.0 ab x | 10.9 A |
| **G3** | 11.3 ab w | 11.5 ab w | 12.3 ab w | 7.0 b x | 10.5 AB |
| **G4** | 12.5 a wx | 6.3 c y | 13.9 a w | 10.4 a x | 10.8 A |
| **G5** | 10.3 bc w | 8.0 c x | 8.7 c wx | 10.0 a w | 9.2 BC |
| **G6** | 11.5 ab w | 9.9 b x | 9.4 c x | 8.9 ab x | 9.9 ABC |
| **G7** | 9.7 c w | 6.5 c x | 9.5 c w | 9.0 ab w | 8.7 C |
| **Mean** | 11.1 A | 9.2 B | 10.7 A | 9.1 B | 10.0 |
| **S. generation (G)** | | | | | * |
| **S. source (S)** | | | | | *** |
| **Interaction GxS** | | | | | *** |

Note: Mean separation by DMRT at 5%; Letters *a* to *c* is comparing means in a column and *w* to *y* is comparing means in a row; * = significant (P<.05); *** = highly significant (P<.001)

In terms of seed source, the tuber number per plant derived from seed source S 1 and S3 was significantly higher than those derived from seed source S2 and S4 (Table 18). Interaction between seed generation and seed source was observed in terms of tuber number per plant. Varied results were also observed in the interaction effect between seed generation and seed source.

Tuber yields per ha were not significantly affected by seed generation and seed source (Table 19). Although the younger seed generations i.e. G2 and G3 had higher tuber yields per ha than the older seed generations, the differences were not significant. The average tuber yields per ha in this experiment was 19.64 ton per ha.

As observed in the tuber yields per plant, interaction between seed generation and seed source was also found in terms of tuber yields per ha (Table 19). Varied results were also observed in the interaction between seed generation and seed source. In S1 and S3, the tuber yields per ha differed not significantly between seed generation. In S2, the higher tuber yields per ha was obtained by seed generation G2 and G3, which differed significantly with those of the older seed generation G4, G5, G6 and G7. In S4, similar pattern with that of S2, the younger seed generations G2 until G6 had significantly higher tuber yields than that of seed generation G7.

**Table 19. Effect of seed generation derived from different seed sources on tuber yields per ha (ton) at final harvest, Lembang, June 2011**

| Seed generation (G) | Tuber yields per ha (ton) | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 19.04 ab w | 25.95 a w | 21.38 a w | 21.41 abc w | 21.94 |
| **G3** | 21.75 ab w | 24.42 ab w | 24.07 a w | 12.45 c x | 20.67 |
| **G4** | 20.24 ab w | 9.80 d x | 23.76 a w | 24.05 a w | 19.46 |
| **G5** | 23.21 a w | 18.94 c w | 16.82 a w | 22.68 ab w | 20.41 |
| **G6** | 22.63 ab w | 20.63 bc wx | 17.89 a wx | 15.05 abc x | 19.05 |
| **G7** | 17.47 b wx | 13.77 d x | 19.95 a w | 13.90 bc x | 16.27 |
| **Mean** | 20.72 | 18.92 | 20.65 | 18.26 | 19.64 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | ns |
| **Interaction GxS** | | | | | *** |

Note: Mean separation by DMRT at 5%; Letters *a* to *c* is comparing means in a column and *w* to *x* is comparing means in a row; ns = not significant (P>.05); *** = highly significant (P<.001)

The effect of seed generation derived from different seed sources on the tuber size distribution are presented in Figs. 1 and 2. In terms of percentage of tuber >60 g by weight, significant difference was not found between the seed generations (Table 20) as also shown in Fig. 1. On average, the percentage of tuber >60 g was 47.2%. On the contrary, the seed source affected significantly the percentage of tuber >60 g and S2 and S4 had significantly higher percentage of tuber >60 g than S1 and S3 (Fig. 2). The higher percentage of tuber >60 g in S2 and S4 compared to those in S1 and S3 may presumably be associated with the lesser incidence of virus in S2 and the lesser incidence of wilt in S4 as indicated in Table 2. Interaction between seed generation and seed source was not observed in terms of percentage of tuber > 60 g (Table 20).

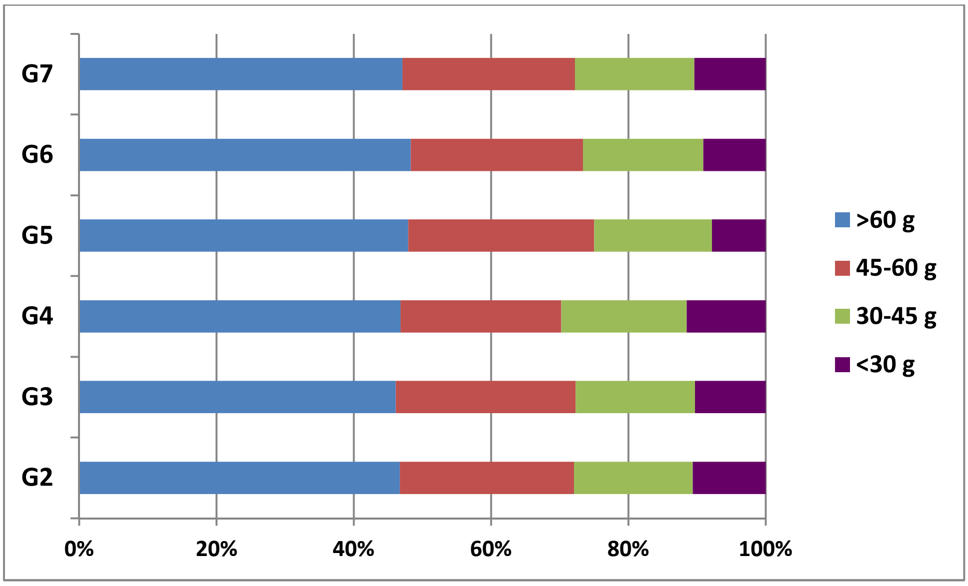

**Fig. 1.** Tuber size distribution in each seed generation at final harvest, Lembang, June 2011

**Table 20.** Effect of seed generation derived from different seed sources on percentage of tuber >60 g by weight at final harvest, Lembang, June 2011

| Seed generation (G) | Percentage of tuber >60 g by weight | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 41.8 | 48.0 | 42.1 | 54.5 | 46.6 |
| **G3** | 43.9 | 47.8 | 37.8 | 54.7 | 46.0 |
| **G4** | 37.7 | 57.1 | 34.7 | 58.5 | 46.8 |
| **G5** | 48.6 | 52.9 | 43.1 | 47.2 | 47.9 |
| **G6** | 45.2 | 49.1 | 44.1 | 55.1 | 48.4 |
| **G7** | 40.6 | 51.6 | 51.7 | 44.6 | 47.1 |
| **Mean** | 42.9 B | 51.1 A | 42.3 B | 52.4 A | 47.2 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | *** |
| **Interaction GxS** | | | | | ns |

Note: Mean separation by DMRT at 5%; ns = not significant (P>.05); *** = highly significant (P<.001)

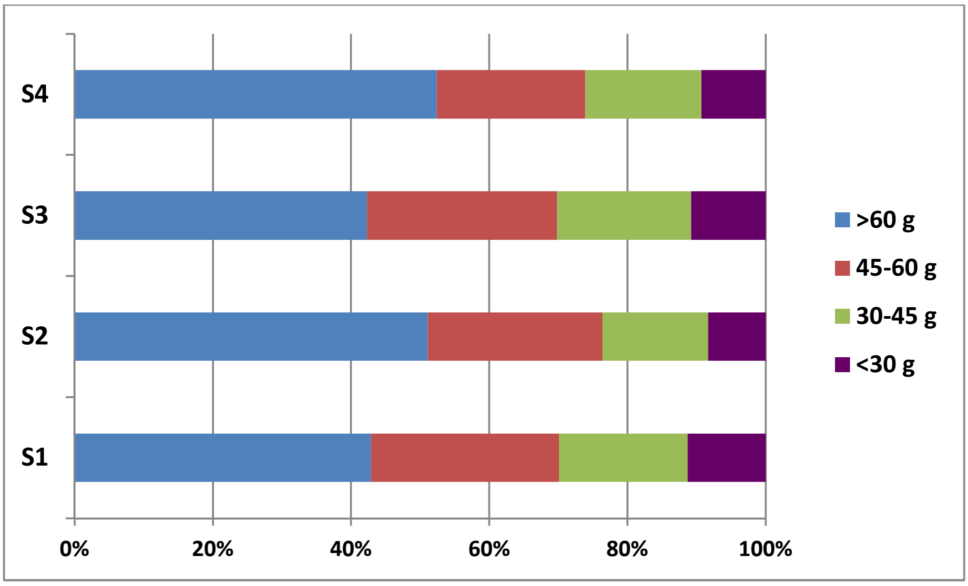

**Fig. 2.** **Tuber size distribution in each seed source at final harvest, Lembang, June 2011**

Similar pattern with the percentage of tuber >60 g was also observed in the percentage of tuber 45-60 g (Table 21). Seed generation has not affected the percentage of tuber 45-60 g as also shown in Fig. 1.

**Table 21.** **Effect of seed generation derived from different seed sources on percentage of tuber 45-60 g by weight at final harvest, Lembang, June 2011**

| Seed generation (G) | Percentage of tuber 45-60 g by weight | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 25.0 | 25.2 | 25.6 | 25.8 | 25.4 |
| **G3** | 30.1 | 23.9 | 32.1 | 18.6 | 26.2 |
| **G4** | 22.6 | 24.1 | 26.2 | 20.2 | 23.3 |
| **G5** | 27.9 | 25.5 | 29.3 | 25.6 | 27.1 |
| **G6** | 29.1 | 23.4 | 28.2 | 19.6 | 25.1 |
| **G7** | 28.3 | 29.6 | 23.9 | 18.5 | 25.1 |
| **Mean** | 27.2 A | 25.3 AB | 27.6 A | 21.4 B | 25.4 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | ** |
| **Interaction GxS** | | | | | ns |

Note: Mean separation by DMRT at 5%; ns = not significant (P>.05); ** = highly significant (P>.001 and ≤.01)

On average, the percentage of tuber 45-60 g was 25.4%. As in the percentage of tuber >60 g, the seed source affected significantly the percentage of tuber 45-60 g and potatoes derived from S3 had the highest percentage of tuber 45-60 g which differed not significantly with those of S1 and S2 but differed significantly with that of S4 (Table 21 and Fig. 2). As observed in the percentage of tuber >60 g, interaction between seed generation and seed source was not found in terms of percentage of tuber 45-60 g (Table 21).

The effect of seed generation and seed source on the percentage of tuber 30-45 g is presented in Table 22. The seed generation had no significant effect on the percentage of tuber 30-45 g and the average of percentage of tuber 30-45 g in this experiment was 17.5%.

**Table 22. Effect of seed generation derived from different seed sources on percentage of tuber 30-45 g by weight at final harvest, Lembang, June 2011**

| **Seed generation (G)** | **Percentage of tuber 30-45 g by weight** | | | | **Mean** |
|---|---|---|---|---|---|
| | **Seed source (S)** | | | | |
| | **S1** | **S2** | **S3** | **S4** | |
| **G2** | 19.2 ab w | 17.6 a w | 20.1 ab w | 12.4 a x | 17.3 |
| **G3** | 15.8 b w | 17.8 a w | 18.9 ab w | 17.1 a w | 17.4 |
| **G4** | 24.7 a w | 10.8 b x | 23.5 a w | 14.1 a x | 18.3 |
| **G5** | 15.3 b w | 15.3 ab w | 18.9 ab w | 19.5 a w | 17.2 |
| **G6** | 15.4 b w | 17.3 a w | 18.7 ab w | 18.5 a w | 17.5 |
| **G7** | 21.2 ab w | 12.7 ab w | 16.2 b w | 19.5 a w | 17.4 |
| **Mean** | 18.6 A | 15.3 B | 19.4 A | 16.8 AB | 17.5 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | * |
| **Interaction GxS** | | | | | * |

Note: Mean separation by DMRT at 5%; Letters *a* to *b* is comparing means in a column and *w* to *x* is comparing means in a row; ns = not significant (P>.05); * = significant (P<.05)

In terms of percentage of tuber 30-45 g, there was a significant difference between seed source. The highest percentage of tuber 30-45 g was obtained by potatoes derived from S3 which differed not significantly with those of potatoes derived from S1 and S4, but differed significantly with that of potatoes derived from S2. Interaction between seed generation and seed source was observed in terms of percentage of tuber 30-45 g (Table 22). Again, varied results of the percentage of tuber 30-45 g were observed in this experiment, although the older seed generation tended to have higher percentage of tuber 30-45 g.

The percentage of tuber <30 g as affected by seed generation and seed source is presented in Table 23. Seed generation has not affected significantly the percentage of tuber <30 g. On average, the percentage of tuber <30 g in this experiment was 9.9%.

**Table 23. Effect of seed generation derived from different seed sources on percentage of tuber <30 g by weight at final harvest, Lembang, June 2011**

| Seed generation (G) | Percentage of tuber <30 g by weight | | | | Mean |
|---|---|---|---|---|---|
| | Seed source (S) | | | | |
| | S1 | S2 | S3 | S4 | |
| **G2** | 13.9 ab w | 9.2 a w | 12.2 ab w | 7.2 b w | 10.6 |
| **G3** | 10.2 bc w | 10.4 a w | 11.2 ab w | 9.5 b w | 10.3 |
| **G4** | 15.4 a w | 8.0 a x | 15.5 a w | 7.2 b x | 11.5 |
| **G5** | 8.2 c w | 6.3 a w | 8.5 b w | 7.6 b w | 7.6 |
| **G6** | 10.3 bc w | 10.2 a w | 9.0 b w | 6.7 b w | 9.1 |
| **G7** | 9.9 bc wx | 5.9 a x | 8.1 b wx | 17.3 a w | 10.3 |
| **Mean** | 11.3 A | 8.3 B | 10.8 A | 9.3 AB | 9.9 |
| **S. generation (G)** | | | | | ns |
| **S. source (S)** | | | | | * |
| **Interaction GxS** | | | | | ** |

Note: Mean separation by DMRT at 5%; Letters *a* to *c* is comparing means in a column and *w* to *x* is comparing means in a row; ns = not significant (P>.05); ** = highly significant (P>.001 and ≤.01)

As observed in the percentage of tuber 30-45 g, seed source affected significantly the percentage of tuber <30 g and the highest percentage of tuber <30 g was obtained by potatoes derived from S1 which was not differed significantly with potatoes derived from S3 and S4 but differed significantly with potatoes derived from S2. Interaction between seed generation and seed source was observed in terms of percentage of tuber <30 g (Table 23). As indicated in the percentage of tuber 30-45 g, varied results of the percentage of tuber <30 g were also observed. In general, the inconsistent results made the variations data in the percentage of tuber <30 g so that the significant effect of seed generation was not pronounced except in S4 where the older seed generation tended to have higher percentage of tuber <30 g.

The effect of seed generation and seed source on tuber defects at final harvest is presented in Table 24. At final harvest, significant differences in terms of *Rhizoctonia* incidence in tubers were not found between seed generations. The lowest incidence of *Rhizoctonia* in tubers was obtained by seed generations G2, however the difference was not significant with those of other seed generations. The seed source has also not affected the incidence of *Rhizoctonia* in tubers. There was no significant interaction between seed generation and seed source in terms of *Rhizoctonia* incidence in tubers at final harvest.

In terms of growth cracks, there was no significant difference between seed generation (Table 24). The seed source has not significantly affected the growth cracks in tubers at final harvest. Significant interaction between seed generation and seed source was not observed in terms of growth cracks in tubers at final harvest.

**Table 24. Effect of seed generation derived from different seed sources on tuber defects at final harvest, Lembang, June 2011**

| **Treatment** | **Tuber defects (%)** | | | |
|---|---|---|---|---|
| | **Rhizoctonia** | **Growth cracks** | **Discolouration** | **Hollow hearts** |
| ***Seed generation (G):*** | | | | |
| **G2** | 0.47 | 1.38 | 3.37 | 0.30 |
| **G3** | 3.09 | 2.65 | 3.36 | 0.36 |
| **G4** | 1.65 | 2.66 | 4.54 | 0.12 |
| **G5** | 1.32 | 1.16 | 2.34 | 0.17 |
| **G6** | 0.82 | 1.24 | 4.42 | 1.80 |
| **G7** | 1.04 | 0.19 | 5.60 | 0.56 |
| **Mean** | | | | |
| ***Seed source (S):*** | | | | |
| **S1** | 1.64 | 1.16 | 4.50 | 0.29 |
| **S2** | 0.97 | 1.36 | 2.81 | 1.34 |
| **S3** | 1.25 | 2.26 | 6.42 | 0.46 |
| **S4** | 1.74 | 1.40 | 1.97 | 0.11 |
| **Mean** | | | | |
| **Seed generation (G)** | ns | ns | ns | ns |
| **Seed source (S)** | ns | ns | ns | ns |
| **Interaction GxS** | ns | ns | ns | ns |

Note: Data were transformed using $(x+0.5)^{0.5}$; ns= not significant (P>.05)

As observed in Rhizoctonia and growth cracks incidences in tubers, significant difference in discolouration in tubers was not found between seed generations (Table 24). The percentage of discolouration in tubers was also not significantly different between seed generation. Interaction between seed generation and seed source was not observed in terms of percentage of discolouration in tubers at final harvest.

Similar pattern as in other tuber defects parameters was also found in the percentage of hollow hearts. There was no significant difference in terms of the percentage of hollow hearts in tubers at final harvest between seed generations (Table 24). The seed source has also not affected the percentage of hollow hearts in tubers. Significant interaction between seed generation and seed source was not observed in terms of the percentage of hollow hearts in tubers at final harvest.

## Conclusions

1. In general, seed generation had no significant effect on the growth parameters i.e. plant height and ground cover. On the other hand, seed source had some significant effect on the growth parameters, however the effect was not consistent between the seed source in each observation date. The inconsistent effect on the growth parameters may have been due to the difference in plant emergence as affected by different physiological age of the potato seed tuber used in the experiment.
2. Similar to the growth parameters, seed generation in general has no affect on the tuber yields at final harvest. The effect of seed source was also not significant on tuber yields. This may be due to the inconsistent incidence of diseases in the planting material. Although the G2, G3 and G4 are in general certified seed, potato seed tubers from several sources were infected by some diseases.

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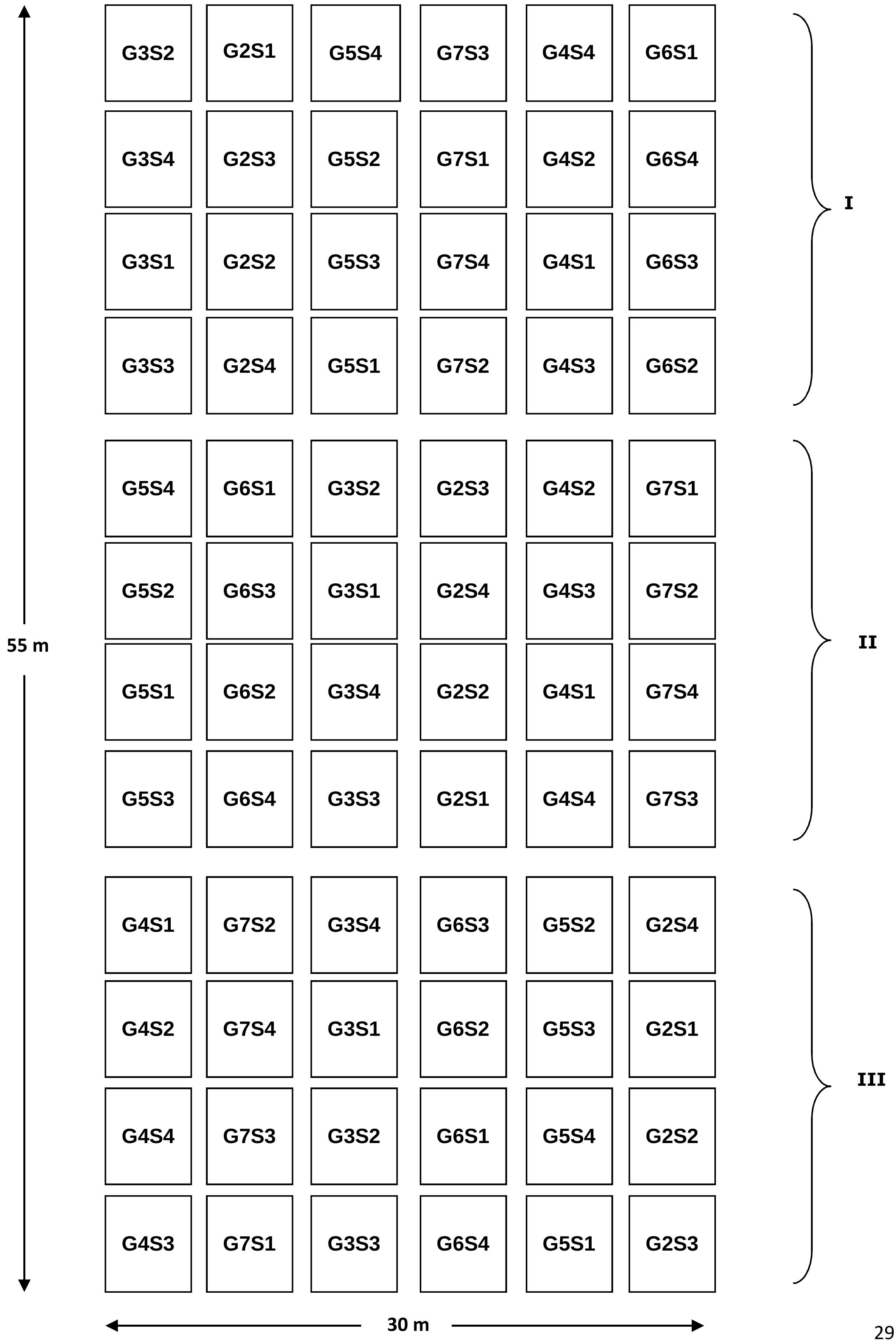
## Attachment 1. Layout of seed potato quality experiment

Experimental unit : 5 rows x 10 plants = 50 plants
Area per plot = 3.75 m x 3.0 m = 11.25 m$^2$
G = generation; S = Seed source



| | | | | | | |
|---|---|---|---|---|---|---|
| G3S2 | G2S1 | G5S4 | G7S3 | G4S4 | G6S1 | I |
| G3S4 | G2S3 | G5S2 | G7S1 | G4S2 | G6S4 | |
| G3S1 | G2S2 | G5S3 | G7S4 | G4S1 | G6S3 | |
| G3S3 | G2S4 | G5S1 | G7S2 | G4S3 | G6S2 | |
| G5S4 | G6S1 | G3S2 | G2S3 | G4S2 | G7S1 | II |
| G5S2 | G6S3 | G3S1 | G2S4 | G4S3 | G7S2 | |
| G5S1 | G6S2 | G3S4 | G2S2 | G4S1 | G7S4 | |
| G5S3 | G6S4 | G3S3 | G2S1 | G4S4 | G7S3 | |
| G4S1 | G7S2 | G3S4 | G6S3 | G5S2 | G2S4 | III |
| G4S2 | G7S4 | G3S1 | G6S2 | G5S3 | G2S1 | |
| G4S4 | G7S3 | G3S2 | G6S1 | G5S4 | G2S2 | |
| G4S3 | G7S1 | G3S3 | G6S4 | G5S1 | G2S3 | |

## Attachment 2. Protocols for identification of *Fusarium*, *Rhizoctonia* and *Helminthosporium* on potato seed tuber

1. FUNDAMENTAL ANALYSIS:

   Fungus Fusarium spp. can be transmitted by seed potatoes. Spots found on seed potatoes grown on agar, and spores that grow are identified under a microscope by comparing the form of spores obtained with the key texts for Fusarium.

2. MATERIAL:
   a. Samples of seed potatoes to be tested
   b. Agar PDA (Potato Dextrose order) sterile
   c. Lacto phenol cotton blue solution or sterile distilled water
   d. Alcohol 95% and 70%

3. EQUIPMENT:
   a. Disecting tools
   b. Sterile petri dish
   c. lights methylated
   d. needles OOSE
   e. glass objects
   f. Cover glass
   g. Microscope
   h. tissue paper
   i. Laminar air flow cabinet
   j. Autoclave
   k. Hot plate + Stirrer
   l. label

4. MAKING BUFFER / MEDIA:

   PDA (Potato Dextrosa order):
   - Potato 200 g
   - Dextrosa 15 g
   - Agar 20 g
   - Distilled water 1 L

   Method:

   a. Rinse and then peeled potato tubers, cut like dice and wash again with water flowing.
   b. Enter into a 2 liter erlemeyer previously filled 800 mL of distilled water.
   c. Boil until tender ± 1 hour.

d. Filter with cloth "cheese cloth", in order to obtain extracts of potatoes.
e. Add 20 g in order to extract the potatoes and cook until so late.
f. Add 15 g of dextrose and stir until dissolved.
g. Add up to 1 liter of distilled water and stir until homogeneous.
h. Sterilize at a temperature of 121 ° C for 15 minutes.

## 5. PROCEDURE OF WORK:

a. Clean samples of seed potatoes from the dirt.
b. Soak the seed potato samples with 0.1% formalin solution for 1 minute, then washed with sterile distilled water three times.
c. Give the number on each tuber to be tested.
d. Prepare a petri dish that already contains the PDA plate medium.
e. Slice the potato tuber skin 1-5 mm of the four positions.
f. Insert the slices into a petri dish that already contains the PDA plate medium aseptically. Each dish filled with four slices from one tuber.
g. Label each petri dish that contains dates, code, media used and other information required on the dish lid.
h. Wrap each petri dish with a paper and put it on upside down.
i. Incubated at a temperature of 30 ± 1 ° C for 3-6 days.
j. Take the mycelium and spores from the petri dish that has been incubated by using a needle OOSE and put on glass objects that have been prepared, aseptically.
k. Put 1-2 drops of lactophenol cotton blue solution or sterile distilled water on a glass object.
l. Close the glass object with a cover glass (cover glass).
m. Look under the microscope at magnification 10 x, 20 x or 40 x.
n. Observe the growth of mycelium, spores and micro-conidia under a microscope and note the Form.HP.03a.
o. Destroy the rest of the test samples, contaminated materials, media and results of testing equipment used by decontaminated (IK.K.HP.01.)

## 6. OBSERVATIONS:

a. The nature of the growth of each isolate from each seed potato tuber slices.
b. The number of septa spores (micro-conidia).
c. Draw the form spores (micro conidia).

## 7. DATA ANALYSIS:

Compare the results obtained with the key texts.

E. RELATED DOCUMENTS:

1. Booth.C.1977. Fusarium, Laboratory Guide to the Identification of the Major Species. Commonwealth Mycological Institute. Kew, Surrey, England.

2. Nelson, Toussoun, Maramas. Fusarium, Illustrated Manual for Identification. The Pensylvania State University Press.

3. Semangun, H.1991. Horticulture Plant Diseases in Indonesia. Gadjah Mada University Press. 123-126

4. Van ARX. J.A.1974. The Genera of Fungi Sporulating in Pure Culture. J. Cramer. FL-9490 Vaduz.

## Illustrations

Fig. 3. Putting manure in each experimental plot before planting

Fig. 4. One of the seed lot (G2) from Pangalengan, West Java

Fig. 5. Planting the seed tubers in each experimental plot

Fig. 6. Potato plants in each plot at 50 days after planting

Fig. 7. Observation of diseases incidence in the experimental field

Fig. 8. Harvesting the potatoes in each plot