

PERFORMANCE OF POTATOES GROWN FROM TRUE SEED UNDER DIFFERENT ENVIRONMENTAL CONDITIONS IN WEST JAVA

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ABSTRACT

True potato seed (TPS) has been considered as an alternative planting material of seed tuber in potato production, especially in developing countries where good quality of seed tuber at reasonable price is difficult to obtain. This study was conducted to investigate the effects of environment and genotype on potatoes grown from TPS in contrasting seasons and sites in West Java, Indonesia over a period of two years (September 1990-October 1992). Different methods of establishing the potato crop from TPS were tested and compared with cv. Granola established from seed tubers. Data were interpreted in terms of relationships between total and tuber dry matter yield and intercepted radiation (IR). The growth and yield of potatoes grown from TPS were generally better at higher rather than lower altitudes, probably related to the lower temperatures which was reflected in an increase in IR and in the efficiency of conversion of IR into total and tuber dry matter. In the highland, seedling transplants and seedling tubers were both suitable for establishing crops from TPS in the wet season, but not in the dry season. All progenies, in general performed well at the highland especially the medium-late maturing progenies such as HPS 7/13. Atlantic x LT-7 initiated tubers and matured more rapidly than the other progenies and performed well at the lower altitudes. Atzimba x DTO-28 had a more gradual decline in ground cover and was more resistant to late blight than other early-medium maturing progenies. The medium-late maturing progeny, Atzimba x R-128.6 matured later and performed poorly at the lower altitudes.

[Keywords: *Solanum tuberosum*; seed; altitudes; propagation materials; progeny; West Java]

INTRODUCTION

As in many areas, in West Java, potatoes are traditionally grown from seed tubers and mostly grown in the highland at the altitudes of more than 1,000 m above sea level (asl). The low availability and high cost of good-quality seed tubers are the major constraints to potato production in most developing countries including Indonesia (Kusumo, 1983; Asandhi, 1992). Potato seed tubers are expensive and imported, mainly from Europe, then multiplied by

seed growers or big farmers to a limited number of generations before being used for ware production. Alternatively, many farmers especially small farmers use cheaper local seed tubers which are degenerated due to pests and diseases, particularly bacterial wilt (*Ralstonia solanacearum*), and root-knot nematode (*Meloidogyne* spp.), which results in lower yields. True potato seed (TPS), sometimes is called botanical seed has a potential role to overcome the problems. The use of TPS as planting material to produce potatoes offers several advantages. The advantages are that most tuber borne diseases are not transmitted and that the cost of planting material may be reduced. Also, it is less bulky, more easily stored and transported and easily sown at any time (Sadik, 1983; Umaerus, 1987; Malagamba, 1988).

The International Potato Center (CIP) started conducting research on TPS in 1977 through both research at CIP and with cooperating institutions (CIP, 1984). TPS has been developed to the point where it is considered as an alternative propagation material in potato production (Umaerus, 1987; Malagamba, 1988). TPS has been used at the farmer level in some developing countries such as China (Li, 1983) and Vietnam (Vander Zaag *et al.*, 1987).

In Indonesia, research on TPS has been carried out since 1984 at the Research Institute for Vegetables (RIV), formerly Lembang Horticultural Research Institute (LEHRI) where the CIP has had an office since 1987. Most of this research was concerned with developing appropriate agronomic practices, such as plant spacing, fertilizer rate, number of seedlings per hill as well as the tuber yields (Satjadipura and Sutapradja, 1985; Satjadipura, 1987; Asandhi and Chilver, 1992). More recently, on-farm research based on farmer-led experimentation with a group of approximately 20 farmers in Cibodas village (1,300 m asl), West Java has been carried out since 1988 (Gunadi *et al.*, 1992; Potts *et al.*, 1992). Similar research has also

been carried out at Sukadana village (750 m asl), West Java. In general, the performance of TPS differed between the two villages. The crops at Cibodas had better growth and yield compared with those at Sukadana. These differences were attributed to the differing socio-economic conditions of the farmers. However, the differences may also in part be due to agroclimatic conditions, soil type, and management.

The main objectives of the study were to measure and account for the growth and yield of potatoes grown from TPS in contrasting environments, so that the suitability of TPS could be tested over a wide range of agroclimatic conditions.

MATERIALS AND METHODS

Experimental Sites

The experiments were conducted separately in four growing seasons, two in the dry and two in the wet seasons.

Experiment 1

Three sites in West Java with different agro-ecological conditions, i.e., Cibodas (Lembang, 1,300 m asl, cool, fertile, intensive vegetable production), Pulosari (Pangalengan, 1,250 m asl, cool, traditional potato area), and Sukajadi (Ciwidey, 715 m asl, warm, heavy soil, rice paddy). The experiment was conducted in the wet season of 1990/91, from September 1990 to February 1991. Five TPS progenies, i.e. Atzimba x DTO-28, Atzimba x R-128.6, Serrana x DTO-28, HPS 7/13, and Atlantic x LT-7 were used. The seedling transplants were assigned at random to plots in a complete randomized block design with four replications.

Experiment 2

This experiment was carried out in the dry season of 1991 from May to August 1991 at Cibodas (Lembang, 1,300 m asl), Margamulya (Pangalengan, 1,150 m asl) and Maruyung (Pacet, 750 m asl). The treatments were arranged in a split plot design with three replications. Two methods of establishment, i.e. seedling transplant and seedling tuber, were assigned to main plots, whereas four TPS progenies, i.e. Atzimba x DTO-28, Atzimba x R-128.6, HPS 7/13, and Atlantic x LT-7 were assigned to subplots. Potato seed tuber cv. Granola was used as a control.

Experiment 3

This experiment was carried out at three different sites as in the experiment 2, from December 1991 to

March 1992. The treatments were arranged in a split plot design with three replications. Three methods of establishment, i.e., seedling transplant, seedling tuber generation 1, and seedling tuber generation 2 were assigned to main plots, whereas four TPS progenies as in experiment 2 were assigned to sub-plots. Control was used as described in experiment 2.

Experiment 4

This experiment was carried out in dry season of 1992 (July-October 1992) at Cibodas, Margamulya, and Maruyung using a split plot design with three replications and the same methods of establishment as in the experiment 2.

Planting Materials

Five TPS progenies differing in their maturity were used, i.e., Atzimba x R-128.6 and HPS 7/13 for medium to late maturing, and Atzimba x DTO-28, Serrana x DTO-28, and Atlantic x LT-7 for early to medium maturing progenies. For comparison with the TPS progenies, cv. Granola was included.

Three types of planting materials were used, i.e., seedling transplants, seedling tubers, and seed tubers. Seedling transplants were produced in nursery beds by sowing TPS in seed trays. The seedling were then transplanted to banana leaf-pots for about two weeks before being transplanted to the field plots. Seedling tubers were produced from plants grown from true seeds. These seedling tubers could be the first generation seedling tubers produced from TPS seedlings, or second generation seedling tubers, derived from the first generation seedling tubers, etc. Seed tubers were produced from plants grown from a clone or a variety, i.e. cv. Granola.

Seed Sowing and Seedling Maintenance

In the first season, the seeds were sowed at each site, while in the second season onwards, the seeds were sowed at Cibodas since in the first season, this gave the best transplants and maintenance was easier at this site.

Seeds were sown in plastic seed trays containing compost. The coarse part of the compost was placed at the bottom (5 cm) and the fine part was placed at the top (5 cm). Before sowing, the compost was watered using a knapsack sprayer. The seeds were sown on the surface of the substrate, covered with a thin layer of fine compost and then watered and covered with a transparent plastic sheet and banana leaves. After the seedling had emerged, usually 3 - 7

days after sowing (DAS), the plastic and banana leaves were removed, then seedlings were watered daily. At 15 DAS, the seedlings were transplanted to banana-leaf pots (3 cm diameter) containing compost similar to that used in the seed trays and placed in raised nursery beds (1.0 m wide).

Management Practices

Field plots were prepared using the methods for planting the traditional seed tubers. Furrows were spaced 70 cm apart and plants spaced 25 cm apart within rows. Plots in the lower elevation consisted of two beds to get good drainage. Each plot was 3.5 x 5.0 m and the experimental unit was 100 plants. Prior to planting or transplanting, animal manure of 30 t ha⁻¹ was applied on the bases of each furrow followed with ammonium sulphate (ZA) and triple super phosphate (TSP) at a rate of 165 kg N and 360 kg P₂O₅ ha⁻¹, respectively. ZA at a rate of 65 kg N ha⁻¹ was applied as a top dressing at the first hilling-up, i.e., 25 days after planting or transplanting (DAP/DAT). The second hilling-up was done at 40 DAP/DAT. Weeding was done manually just before the first and second hilling-up. Crops were sprayed regularly during the growing season using mancozeb to control late blight (*Phytophthora infestans*) and profenofos to control insect pests, such as thrips and aphids.

Parameters Observed

Total radiation intercepted and the efficiency with which intercepted radiation is used (Monteith, 1977). This analysis involved accounting for tuber yield in terms of relationship between the amount of radiation intercepted and the efficiency of its conversion into dry matter and the partitioning of dry matter into tubers. The factors determining the amount of radiation intercepted were ground cover and incident radiation. Estimates of percent ground cover of the leaf canopy followed the method outlined by Burstall and Harris (1983). A wooden frame of 70 x 50 cm divided with wires into 100 rectangles was held over the crop at four designated sites per plot. The ground cover was measured weekly. Number of rectangles more than 50% filled with green leaf gave the percent ground cover. The total radiation receipts were recorded at the experimental station of RIV using a Gunn Bellani radiation integrator and the estimates of percent ground cover at each site were used to calculate the radiation intercepted by the crop.

Sampling for growth analyses was carried out at intervals during the growing season at times specific to particular experiments. Sampled plants were taken to the laboratory that day, tubers subsequently washed, separated into various components and then oven-dried at 90°C until complete dryness.

For final harvest, a bordered sub-plot of known area in each field plot was used. The number of plants harvested in that area was counted. Tubers were graded into categories >80 g, 46-80 g, 20-45 g, and <20 g by weighing each tuber.

Analysis of variance (ANOVA) was carried out on all data. Treatment comparisons were performed using the least significant difference (LSD). Unless otherwise indicated, significant differences were calculated at the 5% probability level.

RESULTS AND DISCUSSION

Meteorological Conditions

Meteorological data obtained from the meteorological station at each site showed that air temperature and precipitation in the highland, Cibodas and Pulosari/Margamulya, were similar during the growing period (Table 1). In the highland, monthly minimum and maximum air temperature were 12.6°-15.8°C and 23.1°-25.7°C, respectively, while those in the lower elevation, Sukajadi/Maruyung were 19.8°-23.1°C and 27.9°-30.1°C, respectively. The precipitation in the dry season of 1992 was slightly higher than that in a normal dry season.

Differences Between Sites

The results of experiments in four growing seasons showed that tuber fresh yields at final harvest were always higher at Cibodas than that at the other two sites, except in dry season of 1992 in which the yield at Maruyung, the lowest site, was higher than that at the highland (Table 2). The higher yield obtained at Maruyung was probably associated with water availability due to the better irrigation facilities during the growing season compared with the other sites in the highland. The use of irrigation at Maruyung was unavoidable since the irrigation channel was used to irrigate the surrounding rice paddy crops especially in the dry season. Thus it was not possible to eliminate water as a variable affecting crop performance between sites.

Table 1. Average of mean monthly minimum and maximum air temperatures and rainfall during the growing season at each site.

Season	Site	Air temperature (°C)		Rainfall (mm)	No. of days with rainfall
		Min.	Max.		
1 (1990/91 WS)	Cibodas	15.8	25.7	126.2	10
	Pulosari	15.3	25.7	154.8	18
	Sukajadi	23.1	30.1	157.0	10
2 (1991 DS)	Cibodas	14.2	25.4	11.1	1
	Margamulya	12.6	23.4	17.9	1
	Maruyung	19.9	27.9	na	na
3 (1991/92 WS)	Cibodas	15.8	23.8	283.4	21
	Margamulya	14.6	23.1	286.2	20
	Maruyung	20.1	29.2	448.7	24
4 (1992 DS)	Cibodas	14.5	23.8	230.9	12
	Margamulya	14.0	23.1	144.9	10
	Maruyung	19.8	28.1	121.9	9

WS = wet season

DS = dry season

na = data not available

Table 2. Tuber fresh yield of potatoes at final harvest at each site in four growing seasons.

Site	Yield (t ha ⁻¹)			
	Season 1 (1990/91 WS)	Season 2 (1991 DS)	Season 3 (1991/92 WS)	Season 4 (1992 DS)
Cibodas	27.10	12.18	21.41	22.19
Pulosari/ Margamulya	12.47	7.18	15.18	12.29
Sukajadi/ Maruyung	4.02	14.78	14.24	11.38
LSD	2.66	3.58	2.17	2.21

WS = wet season

DS = dry season

LSD = least significant difference

The growth and yield of potatoes grown from TPS were expected to be similar at the highland, Cibodas and Margamulya (seasons 2-4) and also at Pulosari (season 1), because these sites generally had similar physico-environmental conditions such as soil type, air temperature, and distribution of rainfall. However at the lower sites, Maruyung (seasons 2-4) and Sukajadi (season 1), lower yields were expected due to the higher temperatures (Table 1). Although no specific data in terms of pests and diseases were taken, differences in crop growth between the highland sites may be affected by differences in the incidence of pests and diseases. At Cibodas, for example, the incidence of pests and diseases was lower than that at Margamulya. Thrips (*Thrips palmi*)

which were a problem in the dry or wet seasons at Margamulya, were not really a problem at Cibodas. This was presumably associated with the absence of potato crops around the experimental field at Cibodas, whereas at Margamulya, because it was in the main potato production area, there were many potato crops in the vicinity of the experimental field. Cibodas, while formerly a traditional potato producing area, has more recently changed to a tomato producing area.

The growth of potato crops can be related to ground cover. Between sites, differences in the development of ground cover were observed. Deviation in ground cover development between the two highland sites was due to pest and disease

attack. Figure 1 illustrates the ground cover development of Atzimba x DTO-28, the early-medium maturing progeny, at three different sites. At the highland, Cibodas and Pulosari, maximum ground cover was reached later compared with that at the lower site, Sukajadi. Full ground cover was rarely reached at the lower site. The lower ground cover development in Atzimba x DTO-28 at Pulosari was associated with an attack of late blight. It was impossible to prevent late blight infection where potato is the main crop in the area. In the early part of the growing period, ground cover development at the lower site was faster than that at the highland sites but so was senescence. This was associated with the higher temperature at the lower site. In general, higher temperature favours haulm development and earlier senescence (Haverkort, 1990; Midmore, 1992).

Most of the results reported here are interpreted in terms of total radiation intercepted and the efficiency with which radiation intercepted is used (Monteith, 1977). This method of analysing crop growth has recently been strongly criticized by Demetriades-Shah *et al.* (1992) because under normal conditions, light interception is not an important limitation to the growth of crops. However, the method has been equally strongly defended by Arkebauer *et al.* (1994), Kiniry (1994), and Monteith (1994). Glauert (1983) in Allen and Scott (1992) showed that net photosynthesis was very closely associated with incident radiation. This method of analysis makes it possible to summarize crop growth by three convenient and meaningful measures: the amount of radiation

intercepted, the efficiency (e) of its use, and it can also be used to describe the way in which dry-matter is partitioned to economic yield.

Between sites, differences in the growth of crops grown from TPS were also observed as shown in Table 3. In the highland, particularly at Cibodas, the crops intercepted more radiation than that in the lower sites. This was due to the better development of ground cover of crops grown at Cibodas compared with that at the lower site. The efficiency of the crops in the highland in converting intercepted radiation into total plant dry matter (e_{total}) was also greater than that in the lower site. Reduction in the efficiency of conversion in the lower site as compared to those in the highland sites could be attributed to the higher temperature at the lower site as has been reported by Trebejo and Midmore (1990). This could possibly be due to the decrease of photosynthesis owing to rapid stomatal closure and high respiration rate.

Differences in the conversion efficiency between the two highland sites may also have been due to thrips attack, which defoliated leave. Pests/diseases could be one of the factors that caused deviations in the relationship between intercepted radiation and dry-matter production for potato crops (Haverkort and Harris, 1986).

The crops at Cibodas intercepted more radiation and had a higher value of e_{total} , as already indicated, compared with the other sites. These associations, combined with a relatively high partition ratio e_{tuber}/e_{total} , contributed to the highest tuber dry matter and tuber fresh weight yields.

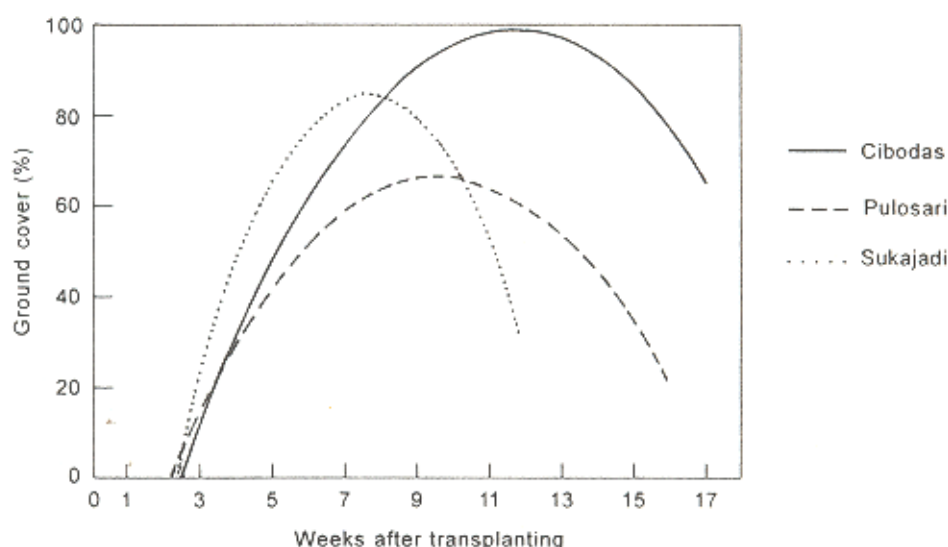


Fig. 1. Trend of ground cover development of Atzimba x DTO-28 at Cibodas, Pulosari, and Sukajadi (West Java).

Table 3. Effect of sites on the growth parameters of potatoes grown from true seed.

Growth parameters	Sites		
	Cibodas	Margamulya	Maruyung
IR (MJ m ⁻²)	640	531	519
e _{total}	1.030	0.868	0.788
e _{tuber} /e _{total}	0.700	0.710	0.657
Tuber dry matter (g m ⁻²) ^a	459	331	232
Tuber fresh weight (t ha ⁻¹) ^b	18.6	11.6	13.5

^aValues taken from the last growth analysis harvest

^bValues taken from final harvest

IR = intercepted radiation

MJ = megajoule

e_{total} = efficiency of the crops in converting intercepted radiation into total plant dry matter

e_{tuber} = efficiency of the crops in converting intercepted radiation into tuber dry matter

One of the objectives of the experiments reported here, was to test the suitability of such lower sites (Sukajadi, 715 m asl and Maruyung, 750 m asl) for potato production and particularly to test the benefits of using TPS as a means of propagating the crop. Potato growth at the lower sites, Sukajadi (season 1) and Maruyung (seasons 2-4), suffered from high temperatures. It had been shown that high temperature at the lower sites resulted in a faster development of ground cover and caused earlier senescence soon after it reached maximum (Fig. 1). Similar observation of a rapid decline of ground cover in potatoes grown under tropical conditions was found by Vander Zaag and Demagante (1988). The average minimum and maximum air temperatures at the lower sites were 5.5 and 4.5°C, respectively higher than those in the highland sites. Although no systematic data on leaves were taken, potato leaves in the lower site were thinner and smaller than those in the highland sites. Similar result was also reported by Nelson (1987) in Midmore (1992), Midmore and Rhoades (1988), and Manrique *et al.* (1989).

Method of Establishment in the Use of TPS

The growth and yield of crops grown from seedling transplants and seedling tubers were compared in seasons 2-4. The crop growth in the field was generally poor due to either dry conditions or thrips. Initial growth of the crops grown from seedling transplants was slow, possibly due to transplanting shock. Although seedling transplants had been placed in banana leaf pots to avoid transplanting shock, this problem still occurred particularly in dry conditions. Sadik (1983) reported that potato seedlings are sensitive to the trauma of transplanting

and therefore it required a considerable time to recover. Visual shock symptom appeared in the field. Water was always needed soon after transplanting to facilitate establishment otherwise seedling transplants died due to dry conditions. The seedling transplants of potatoes were more sensitive to dry conditions compared to other crops such as cabbage and tomato. It had been shown that the poor establishment of crops in the field, the slow initial growth, and the lower ground cover development were frequently observed in crops grown from seedling transplants, which contributed to the lower intercepted radiation of crops grown from seedling transplants relative to crops grown from seedling tubers (Table 4). Therefore, yield of crops grown from seedling transplants was lower compared to that of seedling tubers, despite the high value in e_{total} found in crops grown from seedling transplants. Harris (1984) also reported that slow initial growth of seedling transplants compared with seedling tubers was observed in a temperate region.

In agreement with experiment carried out by Wiersema (1986), the tuber fresh weight yield from seedling tubers at final harvest tended to be higher than that from seedling transplants. This was due to poor establishment of crops in the field, the slow initial growth, and the lower ground cover development. Crops grown from seedling transplants also produced smaller tubers than that of seedling tubers. On average, tubers >80 g from crops grown from seedling transplants and seedling tubers ranged from 9 to 11% and 22 to 40%, respectively (in seasons 2 and 4). It thus appears that seedling transplants were more suitable for the production of seedling tubers, whereas seedling tuber was suitable for production of ware potatoes.

Serrana x DTO-28, Atzimba x R-128.6 derived from *S. tuberosum* and *S. andigena* matured later and had a greater ground cover compared with early-medium maturing progenies, however it performed badly at the lower sites, probably because the parents of this progeny, Atzimba and R-128.6, were bred for adaptation to cool tropical conditions (CIP, 1991). The medium-late maturing progeny, HPS 7/13, for which information of its genetic background was not available, had the most well developed and persistent ground cover. This progeny was also tolerant to dry conditions, particularly when established from seedling transplants, an important factor when planted in the dry season.

Table 6 shows the differences in growth parameters as affected by progenies. HPS 7/13, the medium-late maturing progenies, intercepted more radiation than the early-medium maturing progenies due to their superior ground cover. The medium-late maturing progenies had higher e_{total} values than the early-medium maturing progenies. However, the e_{tuber}/e_{total} of early-medium maturing progenies had an advantage because they produced tuber earlier. Tuber dry matter yield of HPS 7/13 was the highest, followed by Atlantic x LT-7, Atzimba x DTO-28, and Atzimba x R-128.6. Although the partition ratio of HPS 7/13 was relatively low compared with that of the early-medium progenies, the greater IR (16%) and the higher value in e_{total} (14%) resulted in higher tuber dry matter yield. Deviation between tuber dry matter yield and tuber fresh weight yield may be due to the time gap between the last harvest for growth analysis and the final harvest; differences in tuber dry matter content may also be involved, but unfortunately, this was not assessed at the final harvest.

In all experiments, the yields of crops grown from seed tubers, cv. Granola tended to be higher than that grown

from TPS, either grown from seedling transplants or seedling tubers. Data of crops established from seedling tubers were selected from season 3, which was considered to have optimum growing conditions. In addition, the seed tubers of cv. Granola used in this season were considered the same as seed tubers commonly used by farmers. The efficiency of conversion of IR into total plant dry matter e_{total} between progenies were not significant, although the early-medium maturing progenies tended to be the least efficient (Table 7). However, the e_{tuber} of TPS progenies and cv. Granola was significantly different. Granola was the most efficient in converting intercepted radiation into tuber dry matter because it has high dry-matter accumulation associated with its early tuber formation. Although no systematic observations of tuberization were made on Granola, early tuberization was frequently observed, followed by a faster tuber bulking rate compared with crops grown from TPS.

The low e_{tuber} of crops grown from TPS was associated with late tuber formation and relatively low partitioning of assimilate to tubers, particularly in the medium-late maturing progenies. The high e_{tuber} combined with high partition ratio of crops grown from seed tubers, Granola (Table 7) can account for the higher yields of this cultivar compared with those of crops grown from TPS.

CONCLUSION

The growth and yield of potatoes grown from TPS varied in different environments and were generally better at higher than that in lower altitudes. This probably related to the lower temperatures which was reflected in an increase in IR and in the

Table 6. Effect of different progenies on the growth parameters of potatoes grown from true seed.

Growth parameters	Atzimba x DTO-28	Atzimba x R-128.6	HPS 7/13	Atlantic x LT-7
IR (MJ m ⁻²)	640	687	765	606
e_{total}	0.857	0.958	1.001	0.860
e_{tuber}/e_{total}	0.799	0.624	0.653	0.784
Tuber dry matter yield (g m ⁻²) ^a	326	321	378	337
Tuber fresh weight (t ha ⁻¹) ^b	15.7	13.5	16.1	12.7

^aValues taken from the last growth analysis harvest

^bValues taken from final harvest

IR = intercepted radiation

MJ = megajoule

e_{total} = efficiency of the crops in converting intercepted radiation into total plant dry matter

e_{tuber} = efficiency of the crops in converting intercepted radiation into tuber dry matter

Table 7. Efficiency of total plant and tuber dry matter of four true potato seed progenies and cv. Granola.

Progenies	e_{total} (g MJ ⁻¹)	e_{tuber} (g MJ ⁻¹)	e_{tuber}/e_{total}
	P>0.05	P<0.05	
Atzimba x DTO-28	0.898	0.731	0.814
Atzimba x R-128.6	1.009	0.616	0.610
HPS 7/13	1.132	0.704	0.622
Atlantic x LT-7	0.959	0.762	0.794
cv. Granola	1.167	1.071	0.917

Data for TPS progenies were taken from seedling tuber generation I in season 3.

e_{total} = efficiency of the crops in converting intercepted radiation into total plant dry matter

e_{tuber} = efficiency of the crops in converting intercepted radiation into tuber dry matter

efficiency of conversion of IR into total and tuber dry matter.

In the highland, seedling transplants and seedling tubers were both suitable for establishing crops from TPS in the wet season, but not in the dry season. All progenies, in general performed well at the highland sites especially the medium-late maturing progenies such as HPS 7/13. Atlantic x LT-7 initiated tubers and matured more rapidly than the other progenies and performed well at the lower sites. Atzimba x DTO-28 had a more gradual decline in ground cover and was more resistant to late blight than other early-medium maturing progenies. The medium-late maturing progeny, Atzimba x R-128.6 matured later and performed poorly at the lower sites.

The concept of growing potatoes from TPS instead of seed tubers has been widely recognised by farmers in Indonesia. However, most of the existing TPS progenies, had the characteristics of late maturity, lower yields, and larger plants, which may affect the production costs particularly pesticide, the loss of flexibility in responding the market price fluctuations, and the difficulties in fitting into the three crops per year required in an intensive vegetable cropping system. Therefore, research on the use of TPS should include the reverse characteristics mentioned above. Progeny with the ability to establish better in the field and with faster initial growth would also be beneficial.

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