CHAPTER 9

GROWTH AND PRODUCTIVITY OF POTATO AS INFLUENCED BY CULTIVAR AND REPRODUCTIVE GROWTH: II. GROWTH ANALYSIS, TUBER YIELD AND QUALITY

9.1 ABSTRACT

A field experiment was conducted under sub-humid tropical conditions in Ethiopia using determinate cultivars Al-624, Al-436, CIP-388453-3(A) and CIP-388453-3(B) to study the effect of flowering and berry set on the growth, tuber yield, and quality of potato. Three treatments viz. debudded, flowering, and fruiting plants were compared and standard growth analysis techniques were applied to study the growth pattern. Fruiting plants exhibited reduced leaf area index, tuber growth rates, and partitioning coefficient, but had higher crop growth rates and net assimilation rates. Fruit development reduced total and marketable tuber mass and tuber number without affecting the unmarketable component. Cultivars varied with respect to tuber yield, tuber number, size distribution, specific gravity, dry matter content, and nutrient composition. Fruiting reduced tuber specific gravity and dry matter content while increasing P, K, Mg, Fe, and Mn content of the tubers. Reproductive growth did not affect tuber Ca, S, Cu, and Zn concentrations. The field experiment demonstrated that reproductive growth restricts vegetative growth and reduces tuber yield and dry matter content of potato.

Keywords: Berry set, dry matter; Ethiopia; growth analysis; tuber quality; tuber yield; specific gravity

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9.2 INTRODUCTION

In most herbaceous annual plants, vegetative growth is terminated by reproductive growth. Developing flowers and fruit are strong sinks for mineral nutrients, sugar and amino acids, and there is a corresponding decrease in the amounts available for the growth of other plant parts (Salisbury & Ross, 1992). Moreover, during the reproductive phase, leaves, stems, and other vegetative parts compete for current assimilates with the developing fruit (Eckstein *et al.*, 1995; Heuvelink, 1997; Famiani *et al.*, 2000) and sometimes previously accumulated carbon and minerals are mobilized and redistributed (Gardner *et al.*, 1985). The distribution of assimilates within the plant is primarily regulated by the sink strength of sink organs (Ho *et al.*, 1989; Marcelis, 1996). Studies in various crops showed that growing fruit is a strong sink and suppresses the growth of vegetative organs (Cockshull *et al.*, 1992; Eckstein *et al.*, 1995; Letchamo & Gosselin, 1995; Heuvelink, 1997).

Albeit the relationship is not well understood, shoot and tuber growth of potato are often considered competing processes (Almekinders & Struik, 1996). The inflorescence as a sink in potato plants has not received adequate research attention and growers view flowers and berries as a minor nuisance. Results with other root crops showed that reproductive growth restricts the development of underground storage organs such as in sugar beet (Wood & Scott, 1975), onion (Khan & Asif, 1981) and Jerusalem artichoke (Rice *et al.*, 1990). However, detailed work has not been done regarding the effect of reproductive growth on potato tuber growth, and results are conflicting. It has been reported that flower formation and berry set have a depressing effect on tuber growth (ProundFoot, 1965; Jansky & Thompson, 1990). On the contrary, Haile-Micheal (1973) observed no consistent relationship between reproductive growth and tuber growth. Tsegaw & Zelleke (2002) showed that reproductive growth restricted vegetative growth and

reduced tuber yield and quality of potato. This finding called for a more detailed investigation of how reproductive growth affects growth, dry matter production and allocation, tuber quality and nutrient composition. This chapter reports on the effect of cultivar and reproductive growth on the growth, yield, quality and nutrient composition of potato tubers.

9.3 MATERIALS AND METHODS

9.3.1 Experimental site description

Detail of the experimental site is described in Chapter 8.

9.3.2 Cultivars

The description of the cultivars is presented in Chapter 8.

9.3.3 General field procedure

The general field procedure is described in Chapter 8.

9.3.4 Treatments

The treatments that were applied are presented in Chapter 8.

9.3.5 Data recorded

Growth analysis

Every 14 days three plants were sampled from each plot and separated into leaves, stems, tubers, and roots and stolons. Green leaf area was measured with a portable CI-202 leaf area meter

(CID Inc., Vancouver, Washington State, USA). Plant tissues were oven dried at 72 °C to a constant mass. The following standard growth analysis parameters were calculated:

$LAI = [(L_{A2} + L_{A1})/2] * (1/G_A)$ (Gardner *et al.*, 1985)

$CGR = 1/G_A * (W_2 - W_1) / (t_2 - t_1)$ (Gardner *et al.*, 1985)

$TGR = 1/G_A * (T_2 - T_1) / (t_2 - t_1)$ (Manrique, 1989)

$FGR = 1/G_A * (F_2 - F_1) / (t_2 - t_1)$

$RGR = ((\ln W_2 - \ln W_1) / (t_2 - t_1))*1000$ (Gardner *et al.*, 1985)

$NAR = [(W_2 - W_1) / (t_2 - t_1)] * (\ln L_{A2} - \ln L_{A1})/ (L_{A2} - L_{A1})]$ (Gardner *et al.*, 1985)

$PC = TGR / CGR$ (Duncan *et al.*, 1978)

Where:

LAI is leaf area index; L_{A2} and L_{A1} are leaf area at time 2 (t_2) and time 1 (t_1), respectively; G_A ground area covered by the crop; CGR is crop growth rate expressed in g m^{-2} day^{-1}, W_2 and W_1 are total crop dry mass (g) at t_2 and t_1; TGR is tuber growth rate expressed in g m^{-2} day^{-1}; T_2 and T_1 are tuber dry mass (g) at t_2 and t_1; FGR is fruit growth rate expressed in g m^{-2} day^{-1}; F_2 and F_1 are fruit dry mass (g) at t_2 and t_1; RGR is relative growth rate expressed in mg g^{-1} day^{-1}; NAR is net assimilation rate expressed in g m^{-2} day^{-1}; PC is partitioning coefficient.

Tuber yield and yield components

Tubers fresh mass and tuber numbers represent the average of 15 plants sampled per a sub-plot. Tubers weighing less than 50 g were considered unmarketable.

Quality assessment

At harvest a representative tuber sample from each plot was taken and washed. Tuber specific gravity was determined by weighing in air and under water (Murphy & Goven, 1959). To determine dry matter content of the tubers the samples were chopped and dried at a temperature of 60 ºC for 15h and followed by 105 ºC for 3h. Tuber dry matter content is the ratio between dry and fresh mass expressed as a percentage.

Samples dried at 60 ºC were analysed for total nitrogen (Macro-Kjeldahl method, AOAC, 1984), and tuber crude protein content was calculated by multiplying total nitrogen by a conversion factor of 6.25 (Van Gelder, 1981). Following wet-ash digestion, phosphorus was determined by colorimetry, potassium by flame photometer, sulphur by turbidimetry, and calcium, magnesium, iron, copper, manganese and zinc by atomic absorption.

9.3.6 Statistical analysis

The analyses of variance were carried out using MSTAT-C statistical software (MSTAT-C, 1991). Means were compared using least significant differences (LSD) test at 5% probability level. Correlations between parameters were computed when applicable. Trends in different growth parameters were analysed by linear regression, using Microsoft Excel 2000.

9.4 RESULTS

For most of the growth parameters considered in the growth analysis there were no differences among the cultivars. Flowering and fruit set influenced most of the growth parameters. During the first harvest period (0-2 weeks), reproductive growth did not influence leaf area index (Figure 9.1). However, during the subsequent sampling periods debudded plants showed consistently higher leaf area indices than plants allowed to flower or set berries.

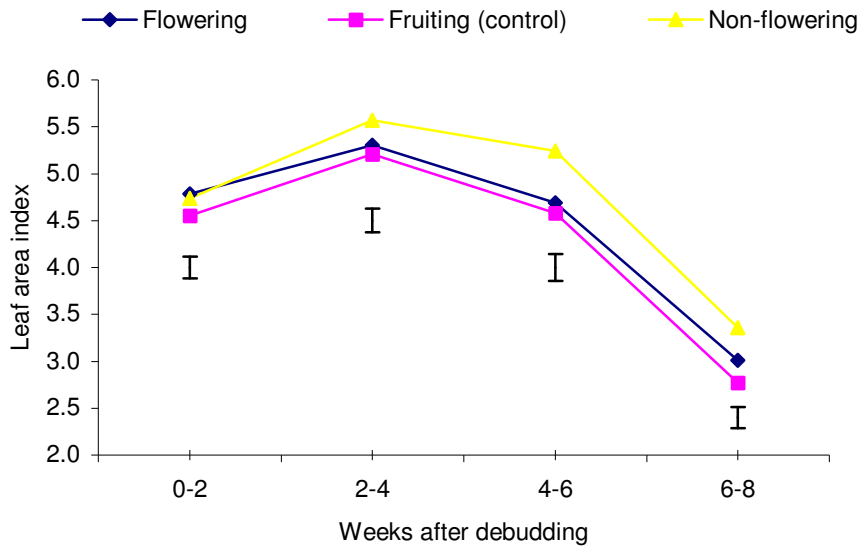

Figure 9.1 The effect of flowering and berry set on leaf area index of potato. The vertical bars represent least significant differences at P < 0.05

The relative growth rate decreased linearly over the eight-week sampling period for all three treatments (Figure 9.2). During the first sampling period, debudded plants exhibited a higher relative growth rate (21 mg g^{-1} day^{-1}) than flowering (19 mg g^{-1} day^{-1}) and fruiting (18.0 mg g^{-1} day^{-1}) plants. For the third sampling period, fruiting plants had a higher relative growth rate than other treatments, while during the second and fourth observation periods no differences occurred.

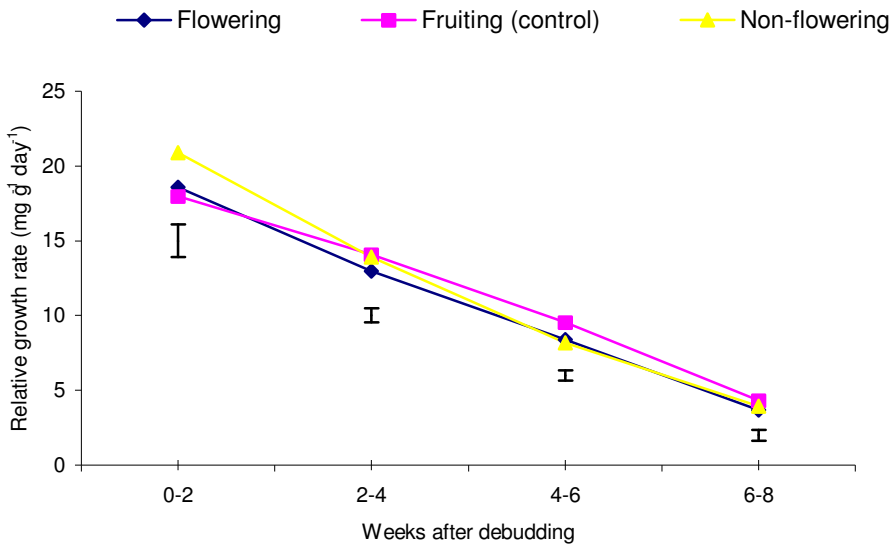

Figure 9.2 Relative growth rate of potato as affected by flowering and berry set. The vertical bars represent least significant differences at P < 0.05

The net assimilation rate declined from about 3 g m^{-2} day^{-1} to nearly 1.6 g m^{-2} day^{-1} towards maturity (Figure 9.3). During the first sampling period (0-2 weeks), debudded plants had the highest net assimilation rate (3.2 g m^{-2} day^{-1}) and flowering plants the lowest (2.6 g m^{-2} day^{-1}). During the second sampling period, fruiting plants showed a higher net assimilation rate than flowering plants while the debudded plants were intermediate. During the subsequent samplings, fruiting plants exhibited a higher net assimilation rate than flowering and debudded plants.

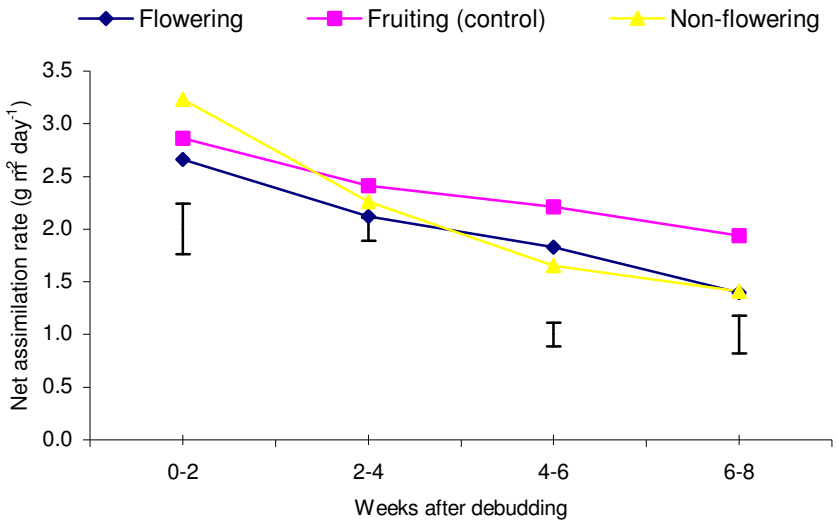

Figure 9.3 Net assimilation rate of potato as affected by flower and berry production. The vertical bars represent least significant differences at P < 0.05

Crop growth rate declined sharply from over 12 g m^{-2} day^{-1} (during 0-2 weeks) to less than 5 g m^{-2} day^{-1}during the final sampling period (Figure 9.4). From the time of debudding up to the second week, debudded plants exhibited a higher crop growth rate than flowering and fruiting plants. During the two to four week period, debudded and fruiting plants had higher crop growth rates. During the third sampling period fruiting plants showed higher crop growth rates than the other treatments. Towards maturity comparable crop growth rate of about 4.4 g m^{-2} day^{-1} was recorded for all three treatments.

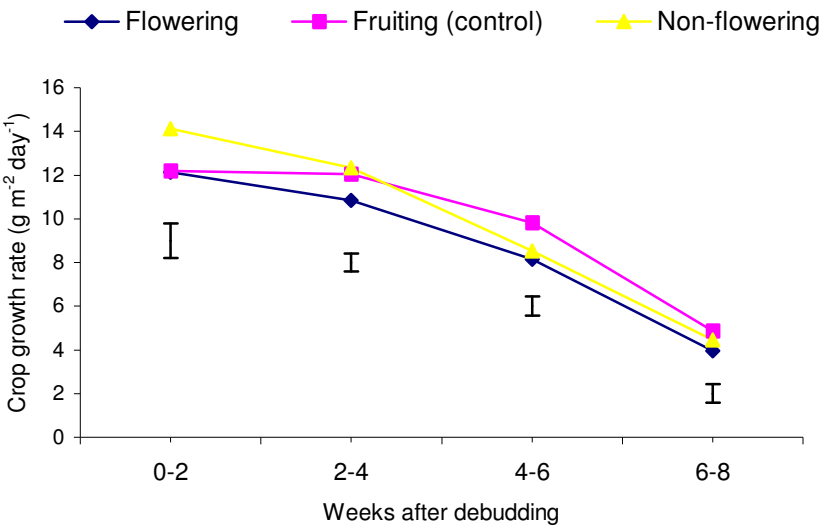

Figure 9.4 The effect of flowering and berry set on potato crop growth rate. The vertical bars represent least significant differences at P < 0.05

Fruit growth rate pooled over cultivars is presented in Figure 9.5. The fruit growth rate increased progressively from 1.14 g m^{-2} day^{-1} (0-2 weeks) to a peak of 1.7 g m^{-2} day^{-1} during the third sampling period (4-6 weeks), and declined sharply towards maturity.

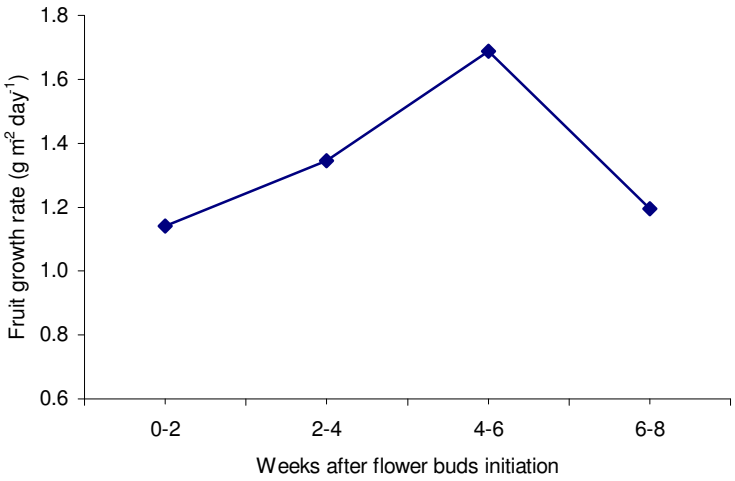

Figure 9.5 The growth rate of potato berry. Mean of four cultivars

Peak tuber growth rates were recorded two to four weeks after flower bud removal and declined afterwards (Figure 9.6). At all sampling periods, the debudded plants demonstrated a higher tuber growth rate than fruiting plants.

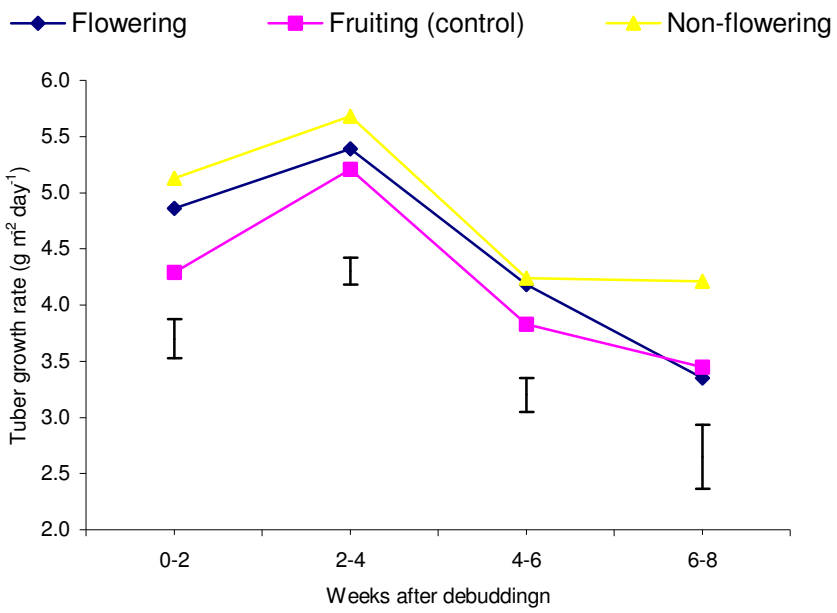

Figure 9.6 The effect of flowering and berry set on tuber growth rate of potato. The vertical bars represent least significant differences at P < 0.05

The partitioning coefficient illustrated in Figure 9.7 indicates the ratio of tuber growth rate to crop growth rate. Except for the second harvesting phase (2-4 weeks after debudding), fruiting plants exhibited a lower partitioning coefficient than non-flowering plants.

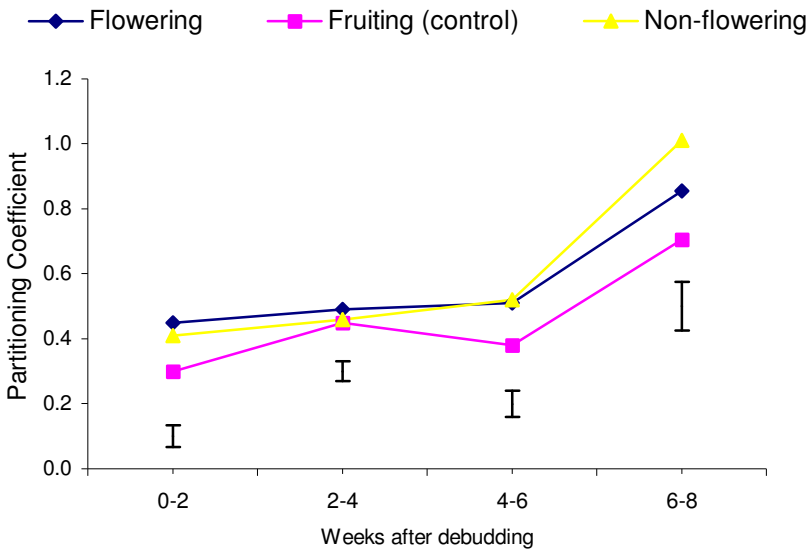

Figure 9.7 Partitioning coefficient of potato as affected by flower and berry development. The vertical bars represent least significant differences at P < 0.05

Differences between cultivars in total, marketable, and unmarketable tuber yield are presented in Table 9.1. Cultivar CIP-388453-3(A) produced the higher total tuber yield (991 g hill^{-1}), followed by Al-436 (849 g hill^{-1}), CIP-388453-3(B) (711 g hill^{-1}), and Al-624 (567 g hill^{-1}). Al-624 had a much smaller proportion of unmarketable (smaller tubers) than the other three cultivars. Cultivars CIP-388453-3(B), Al-436 and CIP-388453-3(A) produced a higher proportion of small tubers than Al-624. A significant difference was observed among cultivars with respect to total number of tubers (Table 9.1). CIP-388453-3(B) and A-436 produced a total of about 15 tubers, followed by CIP-388453-3(A) and Al-624 producing 12 and 5 tubers per hill, respectively. Fruit development decreased the productivity by reducing both tuber size and number. Without affecting the unmarketable component, fruit development reduced the total and marketable tuber yield by about 19 and 22%, respectively, as compared to the other two treatments. Similarly, without affecting the unmarketable component, fruit development decreased the total and marketable number of tubers.

Table 9.1 Total, marketable and unmarketable tuber yield and number of potato as influenced by cultivar and flowering and fruit set

	Tuber yield (g hill^{-1})			Tuber number (hill^{-1})		
Main effect	Total	Marketable	Unmarketable	Total	Marketable	Unmarketable
Cultivar						
CIP-388453-3(A)	991.0a	837.3a	153.7a	11.6b	6.4a	5.2b
A-624	566.7d	517.6c	49.1b	5.4c	3.5b	1.9c
Al-436	849.2b	672.8b	176.4a	14.0a	7.8a	6.2b
CIP-388453-3(B)	711.5c	525.2c	186.3a	15.3a	5.9ab	9.4a
SEM	21.52	15.64	10.78	0.45	0.22	0.52
Treatment						
Non-flowering	844.3a	696.6a	147.7a	12.2a	6.2a	6.0a
Flowering	822.9a	678.4a	144.5a	11.8a	6.2a	5.6a
Fruiting (control)	671.6b	539.7b	131.9a	10.7b	5.3b	5.4a
SEM	14.92	13.91	6.20	0.16	0.23	0.24

SEM: Stand error of the mean.

Means within the same main effect and column sharing the same letters are not significantly different ($P < 0.05$).

The cultivars differed in tuber dry matter content as well as specific gravity (Table 9.2). CIP-388453-3(A) and CIP-388453-3(B) produced tubers containing approximately 22% dry matter which is higher than the tuber dry matter content of Al-436 and Al-624 (19%). Cultivars in decreasing order of tuber specific gravity are CIP-388453-3(A) (1.090 g cm^{-3}), CIP-388453-3(B) (1.085 g cm^{-3}), Al-436 (1.076 g cm^{-3}), and Al-624 (1.070 g cm^{-3}). The presence of berries reduced tuber dry matter content as well as specific gravity. Fruit development reduced tuber dry matter content by about 3.3% compared to non-flowering plants. Tubers of the non-flowering and flowering plants showed higher specific gravity (1.081 g cm^{-3}) than the fruiting ones (1.078 g cm^{-3}).

Table 9.2 The effect of cultivar and reproductive growth on dry matter content, specific gravity, crude protein content, and macroelement content of potato tubers

Main effect	Dry matter content (%)	Specific gravity (g cm^{-3})	Crude protein (%)	P (%)	K (%)	Ca (%)	S (%)	Mg (%)
Cultivar								
CIP-388453-3(A)	22.8a	1.090a	5.6d	0.26b	2.25c	0.060b	0.08d	0.132b
A-624	18.6b	1.070b	10.1a	0.34a	3.00a	0.072a	0.50a	0.159a
Al-436	19.8b	1.076ab	7.4b	0.26b	2.42b	0.054b	0.15c	0.132b
CIP-388453-3(B)	21.8a	1.085ab	6.8c	0.28ab	2.27c	0.059b	0.22b	0.128b
SEM	0.39	0.002	0.04	0.002	0.02	0.002	0.007	0.001
Treatment								
Non-flowering	21.0a	1.081a	7.4b	0.28b	2.44b	0.060a	0.22a	0.136b
Flowering	20.9a	1.081a	7.3b	0.28b	2.47b	0.063a	0.25a	0.137b
Fruiting (control)	20.3b	1.078b	7.8a	0.29a	2.53a	0.061a	0.24a	0.141a
SEM	0.11	0.001	0.03	0.001	0.007	0.001	0.12	0.001

SEM: Stand error of the mean.

Means within the same main effect and column sharing the same letters are not significantly different ($P < 0.05$).

The cultivars differed with respect to tuber crude protein content and the concentration of macronutrients as indicated in Table 9.2. Cultivar Al-624 produced tubers with a higher crude protein content (10%), followed by Al-436 (7.4%), CIP-388453-3(B) (6.8%), and CIP-388453-3(A) (5.6%). Cultivar Al-624 also produced tubers with higher phosphorus, potassium, calcium, sulphur, and magnesium contents compared to the other cultivars. Interestingly, fruit development increased tuber crude protein content and phosphorus, potassium, and magnesium content without affecting calcium and sulphur (Table 9.2). Fruiting plants produced tubers containing higher crude protein, phosphorus and potassium content than tubers from the non-flowering and flowering treatments. The three treatments had comparable tuber calcium (0.06%) and sulphur (0.24%) contents.

The mean copper content of the tubers were 20 ppm for Al-624, CIP-388453-3(A) and CIP-388453-3(B) which was higher than in the case of cultivar Al-436 (18 ppm). Cultivars Al-624

and CIP-388453-3(B) had the highest tuber zinc content. All of the cultivars produced tubers with comparable iron (56 ppm) and manganese (3.8 ppm) contents. Tubers of fruiting plants contained more iron (61 ppm) than tubers of non-flowering and flowering plants (54 ppm) (Table 9.3). A higher tuber manganese concentration was observed in fruiting plants (4.9 ppm). Reproductive growth did not affect tuber copper and zinc concentrations.

Table 9.3 The effect of cultivar and reproductive growth on tuber microelement content

Main effect	Cu (ppm)	Fe (ppm)	Mn (ppm)	Zn (ppm)
Cultivar				
CIP-388453-3(A)	20.17a	54.47a	3.96a	13.83c
A-624	21.67a	59.17a	4.33a	20.83a
Al-436	18.00b	59.67a	3.00a	13.17c
CIP-388453-3(B)	20.00a	51.33a	3.83a	18.61ab
SEM	0.36	3.08	0.42	1.40
Treatment				
Non-flowering	19.25a	52.75b	3.75ab	14.75a
Flowering	20.25a	54.37b	2.74b	19.08a
Fruiting (control)	20.37a	61.13a	4.87a	16.00a
SEM	0.38	1.38	0.44	1.28

SEM: Stand error of the mean.

Means within the same column sharing the same letters are not significantly different ($P < 0.05$).

The macro- and microelement composition of potato berries is presented in Table 9.4. Mean berry nitrogen content was 2.2%, phosphorus 0.4%, potassium 3.7%, calcium 0.2%, sulphur 0.5%, magnesium 0.3%, copper 24 ppm, iron 94.2 ppm, manganese 6.8 ppm, and zinc 29 ppm. The berries contained higher concentrations of macro and micronutrients than the tubers.

Table 9.4 The concentrations of macro and micronutrients in the berries of four potato cultivars

Cultivar	N (%)	P (%)	K (%)	Ca (%)	S (%)	Mg (%)	Cu (ppm)	Fe (ppm)	Mn (ppm)	Zn (ppm)
CIP-388453-3(A)	2.10	0.40	3.81	0.20	0.40	0.24	23.7	93.7	7.01	23.67
A-624	2.23	0.47	3.93	0.19	0.42	0.29	25.0	96.3	7.33	33.33
Al-436	2.18	0.41	3.73	0.18	0.44	0.26	24.0	94.2	6.33	27.33
CIP-388453-3(B)	2.23	0.40	3.45	0.20	0.67	0.28	23.3	92.7	6.67	32.00
Mean	2.18	0.42	3.73	0.19	0.48	0.27	24.0	94.2	6.8	29.08

9.5 DISCUSSION

Depending on the strength of the sinks, potato plants allocate assimilates to the developing fruit, tubers and other vegetative structures. Under conditions of assimilate limitation competition among sink organs is imperative. Treatments that increase the partitioning of assimilates to the tubers and/or reduce utilization by other organs are likely to favour tuber growth and increase yield.

Debudded and flowering plants had higher leaf area indices which is attributed to the development of more lateral branches with larger leaves in response to apical bud and flower removal. Chatfield *et al.* (2000) reported that shoot apical meristem maintains its role as the primary site of growth by inhibiting the growth of axillary meristems. `

Fruiting plants exhibited higher crop growth rates compared to the flowering and non-flowering plants. The higher crop growth rates may be attributed to the increased photosynthetic efficiency (Chapter 8) and enhanced net assimilation rates. In a tomato, Starck *et al.* (1979) observed increased net photosynthesis and net assimilation rates in fruiting plants compared to deflorated plants.

Fruit development reduced partitioning of assimilates to the tubers and thereby suppressed tuber growth. This may probably be attributed to the strong assimilate attraction power of developing fruit. There is evidence that the developing seed and fruit are strong sinks which have priority over vegetative organs in the partitioning of assimilates (Ho, 1988; Ho *et al.*, 1989). This dominance is believed to be mediated by phytohormones, because developing seeds and fruit are rich sources of several plant hormones, including cytokinins, IAA, ABA and GA_3 (Hedden & Hoad, 1985; Brenner, 1987).

The efficiency of dry matter accumulation by the tubers was assessed by the partitioning coefficient. Berry development reduced the partitioning coefficient by about 24% as compared to debudded and flowering plants. The partitioning coefficients increased progressively over time indicating that an increasing fraction of available assimilates were allocated to the tuber growth as the crop matured.

In the fruiting plants, the proportion of dry matter partitioned to the berries varied from 5 to about 9% of the total carbon fixed. The maximum fruit growth rate was observed 4-6 weeks after flower bud initiation. A few days after pollination, potato berries start active growth and attain full development after six weeks, according to Sadik (1983).

The cultivars exhibited differences with respect to tuber yielding potential. This could be attributed to variation in days to tuber initiation, rate of photosynthesis, efficiency of assimilate partitioning to the tubers (bulking rate) and maturity period. The strong positive correlation of tuber yield with leaf net photosynthesis ($r = 0.97^{**}$), and days to maturity ($r = 0.84$) supports the speculation. Hammes & De Jager (1990) and Gawronska *et al*. (1990) reported the existence of varietial differences with respect to the rate of net photosynthesis and dry matter production.

Berry development reduced total tuber yield. This indicates that reproductive development had a depressing effect on tuber growth, which may partly be due to competition for assimilates. The strong negative correlation observed between total tuber yield and berry yield (r = -95*) and total tuber yield and berry number (r = -0.99**) signified that assimilate allocation to the tubers was to a large extent determined by the number and size of the berries. Fruit number and size determined biomass allocation in pepper (Nielsen & Veierskov, 1988) and kiwifruit (Richardson & MacAneny, 1990). Tsegaw & Zelleke (2002) conducted an experiment with the same potato cultivars and at the same location in Ethiopia and found that berry development reduced total tuber yield by about 17% compared to the non-flowering plants. ProundFoot (1965) and Jansky & Thompson (1990) also reported that berry development reduced tuber yield. However, Haile-Micheal (1973) reported no consistent relationship between reproductive growth and tuber yield in potato. Results of studies on other crops have also indicated that flower and fruit compete for assimilates and thereby depress the development of underground storage organs such as in sugar beet (Wood & Scott, 1975), onion (Khan & Asif, 1981) and Jerusalem artichoke (Rice *et al*., 1990).

Variation in tuber number among the tested cultivars indicated that there were considerable differences with respect to number of tubers initiated in the course of development. Except for cultivar CIP-388453-3(A), tuber numbers increased in response to debudding, indicating tuber initiation after blooming.

The increase in the proportion of marketable tubers as a consequence of suppressing berry development may be explained on the bases of absence of competition for assimilates between developing fruits and tubers. It is speculated that in the absence of reproductive parts, presumably since developing tubers are the predominant sinks, a large amount of dry matter is

diverted to the tubers which would otherwise be utilized for reproductive growth. As a result, most of the initiated tubers increased in size. The increase in dry matter content of tubers also substantially contributed for tuber yield improvement as indicated on a strong association between them (r = 0.73)

The variation in specific gravity and dry matter content among cultivars can be attributed to the variation in efficiency of diverting of more dry matter to the tubers. Dean (1994) indicated that although tuber dry matter content is influenced by tuber size, environmental conditions and cultural practices, tuber dry matter content appear to be genetically controlled. Lana *et al.* (1970) and Kushman & Haynes (1971) reported that variation in tuber specific gravity could be due to variation in tissue specific gravity and amount of intercellular space in the tubers. The variation in specific gravity could be due to differences in starch grain size, according to Sharma and Thompson (1956). The highly significant positive correlation (r = 0.99**) observed between specific gravity and percent dry matter indicates that specific gravity is a good indicator of tuber dry matter content. Porter *et al.* (1964) and Fitzpatrick *et al*. (1964) reported a positive correlation between specific gravity and percent dry matter. On the contrary, however, Wilson & Mlindsay (1969) reported a hyperbolic relationship between them.

Fruit development decreased tuber specific gravity and dry matter content, which may be explained on the basis of competition for assimilates between developing berries and tubers. In the absence of reproductive parts, more assimilates are presumably diverted and accumulated in the tubers. The observed negative relations between fruit yield and tuber dry matter content (r = -0.82) and fruit yield and specific gravity (r = -0.83) support the speculation. Tsegaw & Zelleke (2002) also reported that reproductive growth reduced tuber specific gravity and dry matter content..

Potato berries contained higher macro- and micronutrient concentrations than the tubers, indicating that they are strong sinks for mineral elements. Cultivars differed in tuber macro- and micronutrient concentrations. Cultivar Al-624 produced tubers containing higher concentrations of most major and trace elements than the other cultivars. Fruit development increased the concentration of tuber N, P, K, Mg, Fe, and Mn without affecting Ca, S, and Cu concentrations. Fruiting plants exhibited higher tuber nutrient content and rate of transpiration (Chapter 8). This association strengthens the hypothesis that an increased rate of transpiration enhances the rate of mineral uptake. Salisbury & Ross (1992) reported that growing plants in greenhouses where there is reduced transpiration due to high humidity may cause calcium deficiencies in certain tissues and too rapid transpiration can lead to a toxic build up of certain elements. In the current study, it was found that fruit development reduced tuber yield by reducing both tuber size and number. Hence, the observed lower concentration of macro and micronutrients in relatively larger tubers of the debudded and flowering plants may partly be a consequence of a "dilution effect".

9.6 CONCLUSION

Cultivars differences with respect to tuber fresh mass, tuber number, specific gravity, dry matter content, and nutrient composition were recorded and should be exploited in cultivar development. Fruit development reduced the leaf area index, tuber growth rate and partitioning coefficient while increasing the crop growth rate and net assimilation rate. Fruit development decreased tuber yield as well as dry matter content. Prevention of berry set by potato growers should increase tuber yield and dry matter content. Hence, simple and economical means to control flowering and berry set should be investigated. It was noticed in the trials that in addition to the reported advantages, PBZ also prevented flowering.

Consequently, trials were devised to compare the efficacy of PBZ with other chemicals proven effective as flower-controlling agents, and the results are presented in Chapter 10.