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Seed quality of six eggplant cultivars as influenced by harvesting time

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Abstract

Seed quality is a key factor in crop production and food security, particularly during the increasing uncertainty due to climate change. In this study, the effect of harvesting time on seed quality of six eggplant cultivars (*Solanum gilo:* Dwomo, Kpando, *Solanum melongena*: GH 3870, GH 3887, *Solanum macrocarpon*: GH 1072, GH 4918) was assessed at the experimental site of CSIR-Plant Genetic Resources Research Institute, Bunso, Eastern Region, Ghana. The experiment was arranged in a randomised complete block design with three replications. Fruits of six eggplant cultivars were harvested at the mature (fully ripe) stage and at weekly intervals for a period of eight weeks and seeds extracted after each harvest. Seed quality of eggplant cultivars was assessed by 100-seed weight, seed vigour and germination percentage at weekly intervals. The results showed a significant difference in 100-seed weight among all the cultivars at different harvesting times. GH 1072 had the highest 100-seed weight with the lowest being in Dwomo at all harvesting times. No germination was observed at first harvest among the six cultivars. Seed vigour increased at 6, 7 and 8 weeks after maturity in all the cultivars. The highest vigour and germination percentage were observed in GH 1072 followed by GH 3870. The results obtained indicates that seed quality of eggplant cultivars increases with harvesting time and vary within and among eggplant species.

Key words: Eggplant, cultivars, germination, harvesting time, seed quality

Introduction

Eggplant (*Solanum* spp.) is one of the most popular fruit vegetables in many parts of the world especially in parts of Africa, South-East Asia and Central America. It is the most important vegetable crop produced by famers in Ghana and represents the main source of income for many rural households in the forest zone of the country (Owusu-Ansah *et al.,* 2001). In West Africa, it is probably the third most consumed vegetable in Ghana (Horna *et al.*, 2006). Global production of eggplant in 2016 was around 51.3 million tons being the fifth most economically important solanaceous crop after potato, tomato, pepper, and tobacco (FAO, 2016). Out of the total global production, 62 % came from China alone with the other top four producing countries being India (24.5 % of world total), Egypt, Turkey, and Iran. The fruit can be eaten raw or served as a baked, grilled, fried or boiled vegetable and can be used in stews. Plazas *et al.* (2014) and Docimo *et al.* (2016) reported that eggplant has a very low caloric value and is considered among the healthiest vegetables for its high content of vitamins, minerals and bioactive compounds for human health. However, production of high quality seeds is a major problem. For sustainable eggplant production and adaptation to climate change, high quality seeds are needed by farmers.

Harvesting time and maturity stage are important factors that affects the seed quality of crops (Demir *et al.,* 2008; Samarah and Abu-Yahya, 2008). Fu *et al.* (2017) reported that harvesting too early may result in immature seeds with poor vigour. Besides, delaying the harvesting of fruits for seed production may increase the potential damages from insects and microorganisms that may accelerate the seed deterioration process (Malik, 2013). Thus, successful eggplant seed production depends on the identification of optimal time of harvesting.

Studies conducted by Eskandari (2012) indicated that the best time of harvest to get quality seeds depends on the species, cultivar and even the production system. Passam *et al.* (2010) observed the optimum time of harvest for seed production in eggplant at 55 days after anthesis. However, seeds extracted from fruits harvested at 25-35 days after anthesis did not germinate, but when fruits harvested at the same age were stored for 20 days at 25 °C prior to seed extraction germination was induced. At present, limited research has been conducted on the optimum harvest time for high quality seeds of eggplant species. The study therefore sought to determine the optimum harvest time for eggplant species for high quality seed production and ascertain whether differences exist within and among species.

Materials and methods

Study site, planting material and experimental design: The study was conducted at the experimental site of CSIR-Plant Genetic Resources Research Institute, Bunso (N 06° 17.839, W 000° 27.595, Alt 198.3 m above sea level), Eastern region, Ghana. Seeds of two cultivars (Fig. 1) each of *Solanum gilo* (Dwomo and Kpando), *Solanum macrocarpon* (GH 4918 and GH 1072) and *Solanum melongena* (GH 3887 and GH 3870) were used. Seeds were sown on 25th March, 2019 in seedboxes filled with sterilised topsoil and pricked out on 10th April, 2019. Transplanting was done on 24th April, 2019. The experiment was arranged in a randomised complete block design (RCBD) with three replications.

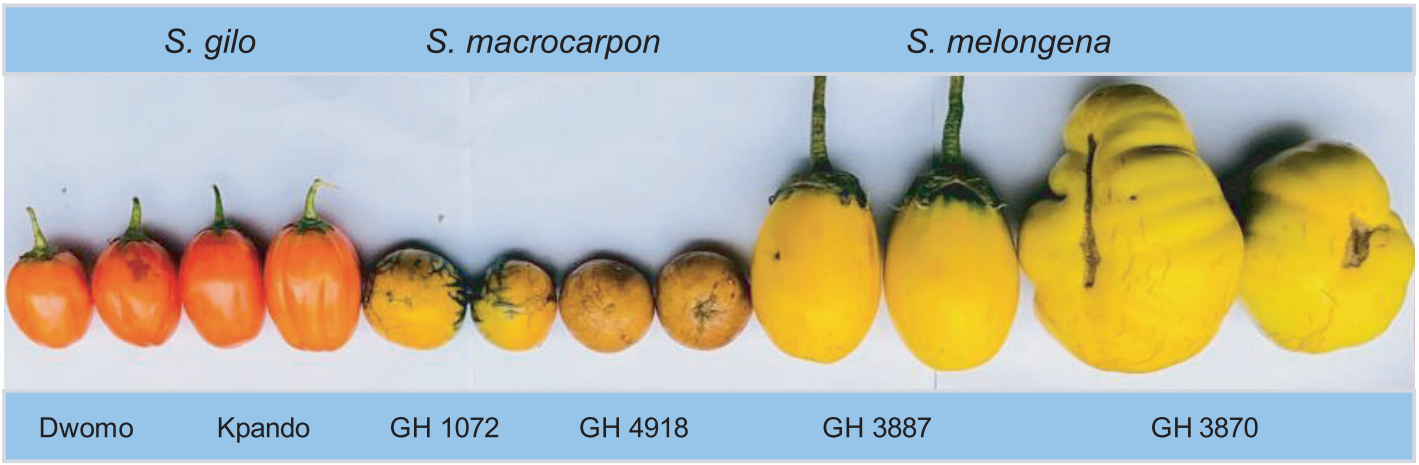

Fig. 1. Fruits of six eggplant cultivars

Agronomic practices: Agronomic practices which were undertaken during the period include fertiliser application (NPK-15-15-15) at a rate of 400 kg per hectare in splits. Watering and weeding was carried out as and when necessary. Insect pests were controlled using K-optimal insecticide (Lamda-cyhalothrin 15g/L+Acetamiprid 20g/L: EC) at a recommended rate of 40 mL to 15 L of water at two weeks interval.

Harvesting of fruits for seed extraction, drying and processing: Harvesting of fruits was done at weekly intervals for a period of 8 weeks for seed extraction. First harvesting of the six eggplant cultivars was done at fruit maturity (fully ripe) as follows; Dwomo (100 days after sowing: DAS), Kpando (115 DAS), GH 4918 (113 DAS), GH 1072 (113 DAS), GH 3887 (113 DAS) and GH 3870 (109 DAS). Before seed extraction, fruits were rinsed with tap water to remove unwanted materials. Seeds were extracted manually, and air dried at ambient temperature for 7 days to attain a lower moisture content. After drying, manual cleaning of seeds was done to remove inert materials and bad seeds. Seeds were placed on silica gel to attain a constant moisture content.

100-seed weight determination: For 100-seed weight determination, hundred seeds from each cultivar were counted for the different harvesting time and weighed with an electronic balance and replicated four times.

Seed vigour and germination percentage: Germination test was carried out under field conditions using seed boxes with sterilised top soil. For each cultivar, 50 seeds were used and replicated three times. The randomised complete block design (RCBD) was used. The first count (seed vigour) and final count (germination percentage) were established on the 8th and 14th days respectively for all the six eggplant cultivars. Seed germination was calculated by the following formula (ISTA, 1999):

$$\text{Seed germination (\%)} = \frac{\text{Number of seed germinated}}{\text{Total number of seeds}} \times 100$$

Statistical analysis: Statistical analysis was undertaken using the SPSS Statistics 21 (IBM, Chicago, IL, USA). Data was subjected to one-way ANOVA, and when the treatment means were significant, Tukey's HSD test was conducted to identify differences among treatments.

Results and discussion

The effect of harvesting time on 100-seed weight of six eggplant cultivars are shown in Table 1. Significant (P<0.001) differences were observed in 100-seed weight among the six eggplant cultivars at first harvest (at maturity) and 1, 2, 3, 4, 5, 6, 7, and 8 weeks after fruit maturity (WAM). At first harvest, the highest seed weight was observed in GH 4918. GH 1072 had the highest 100-seed weight at all harvest dates followed by GH 4918. Dwomo had the lowest seed weight at all harvest dates. Perhaps, the low seed quality observed in some of the cultivars in the present study at the early stages of seed development could be attributed to seed immaturity (Ghassemi-Golezani and

Table 1. Effect of harvesting time on 100-seed weight of six eggplant cultivars

WAH	Cultivar					
	Dwomo	Kpando	GH 4918	GH 1072	GH 3887	GH 3870
At Ist harvest	0.225 (0.005)e	0.232 (0.002)e	0.449 (0.005)a	0.302 (0.005)d	0.348 (0.006)b	0.324 (0.002)c
1 WAM	0.222 (0.005)f	0.273 (0.007)e	0.415 (0.010)b	0.502 (0.006)a	0.364 (0.007)d	0.395 (0.002)c
2 WAM	0.219 (0.002)e	0.285 (0.007)d	0.438 (0.012)b	0.548 (0.016)a	0.407(0.007)c	0.432 (0.004)b
3 WAM	0.218 (0.013)d	0.287 (0.002)c	0.443 (0.008)b	0.504 (0.005)a	0.495 (0.011)a	0.424 (0.016)b
4 WAM	0.234 (0.003)e	0.285 (0.004)d	0.444 (0.002)b	0.615 (0.001)a	0.425 (0.006)c	0.446 (0.004)b
5 WAM	0.235 (0.001)e	0.284 (0.003)d	0.445 (0.001)b	0.617 (0.001)a	0.427 (0.002)c	0.449 (0.009)b
6 WAM	0.260 (0.005)e	0.284 (0.003)d	0.466 (0.003)b	0.623 (0.005)a	0.445 (0.004)c	0.440 (0.015)c
7 WAM	0.258 (0.012)e	0.282 (0.005)d	0.483 (0.012)b	0.625 (0.005)a	0.445 (0.004)c	0.460 (0.004)c
8 WAM	0.239 (0.007)e	0.279 (0.005)d	0.475 (0.008)b	0.653 (0.006)a	0.430 (0.010)c	0.472 (0.031)b

WAM: Weeks after maturity. Each value is the mean of four replicates and the standard deviation is shown in parentheses. Values with different letters are significantly different at P<0.05.

Mazloomi-Oskooyi, 2008) and differences in the genetic make-up of cultivars. Demir *et al.* (2002) reported that seed filling in a field-grown eggplant cultivar took 40-42 days after anthesis, whereas maximum seed quality was attained 10-20 days later. Passam *et al.* (2001) indicated that during fruit development and maturation, there is competition between fruits on the plant, leading to reduced seed size.

In the present study, harvesting time had significant (P<0.001) effect on seed vigour of six eggplant cultivars at all dates of harvesting after first harvesting (Table 2). At 2 and 3 WAM, GH 3870 had the highest seed vigour with Dwomo recording the lowest. GH 1072 had the highest seed vigour at 1, 4, 6, 7 and 8 WAM. At 5 WAM, GH 1072 and GH 3870 showed the same seed vigour. No vigour was observed at first harvest. Seed vigour is the sum of those properties that determine the activity and performance of seedlots of acceptable germination in a wide range of environments' (ISTA, 2015). It is influenced by the maturity stage at harvesting time (Ghassemi and Hosseinzadeh, 2009; Finch-savage and Bassel, 2015). According to Still and Bradford (1998), seed vigour progressively increases to the point of maximum seed quality and then begins to decline as seeds age before harvest. In present study, similar observations were made in all the six eggplant cultivars. Seed vigour was low at the early harvesting stages but increased progressively in all the six eggplant cultivars. van Gastel *et al.* (1996) observed a positive correlation between seed size and seed vigour as larger seeds produced more vigorous seedlings. Furthermore, Poorter and Rose (2005) indicated that seed reserve food, frequently represented by seed mass, potentially contributes to seedling vigour as it is generally assumed that larger seeds produce more vigorous seedlings. The observed differences in seed vigour among the various species could be attributed to their seed size.

Significant (P<0.001) differences were observed in germination percentage at all dates of harvesting after first harvesting (Table 3) among the six eggplant cultivars. At 2 and 3 WAM, GH 3870 had the highest germination with Dwomo recording the lowest. GH 1072 had the highest germination percentage at 1, 4, 6, 7 and 8 WAM. At 5 WAM, GH 1072 and GH 3870 were not significantly different from each other. No germination was recorded at first harvesting in all the eggplant cultivars. Germination of the seed represents its quality and magnitude of viability - thus seed with high germination percentage is of better quality than that with low germination percentage (van Gastel *et al.*, 1996). In the present study, seeds harvested at first harvest had no germination in all the six eggplant cultivars. However, an increase in germination was observed with increase in harvesting times in all the six cultivars. Perhaps, the seeds harvested initially were physiologically immature. In agreement with our findings, Wang *et al.* (2008) reported that harvesting too early may result in low yield and quality, because of the partial development of essential structures of seeds. Miranda *et al.* (1992) studying eggplant seeds found that seeds of fruits harvested at 50, 60, and 70 days after anthesis, in the lower third of the plant, did not show any difference in the physiological quality. Takac *et al.* (2015) reported that seeds extracted from fruits at 20 days after harvest had significantly higher germination, which ranged from 25 % at the technological maturity stage up to 99 % at botanical maturity stage. Yogeesha *et al.* (2008) found germination to be negligible before 41 days after anthesis, but both germination and vigour were maximal at 57 days after anthesis, which was the stage at which the fruit started to turn brown. The differences in seed quality observed among species at different harvesting times in the present study could be attributed to their genetic make-up.

The present study showed a significant effect of harvesting time

Table 2. Effect of harvesting time on seed vigour of six eggplant cultivars

Cultivar	Seed vigour								
	At maturity	1 WAM	2 WAM	3 WAM	4 WAM	5 WAM	6 WAM	7 WAM	8 WAM
Dwomo	0	0.0 (0.0)d	0.0 (0.0)d	3.0 (1.0)e	5.3 (0.6)f	5.0 (1.0)e	21.7 (2.9)c	30.7 (0.6)b	32.7 (0.6)bc
Kpando	0	11.0 (3.6)b	21.7 (3.5)c	19.3 (2.3)d	27.3 (3.1)d	27.7 (5.5)c	45.7 (3.1)a	40.7 (0.6)a	41.7 (1.5)ab
GH 4918	0	0.0 (0.0)d	0.0 (0.0)d	5.3 (0.6)e	12.7 (0.6)e	17.7 (1.5)d	24.7 (2.5)c	24.3 (0.6)b	31.3 (1.5)c
GH 1072	0	17.0 (1.0)a	31.7 (0.6)b	27.3 (1.5)b	47.0 (1.0)a	43.0 (2.0)a	44.3 (1.5)a	42.7 (5.8)a	42.0 (1.0)a
GH 3887	0	5.0 (1.0)c	25.0 (1.7)c	23.7 (0.6)c	37.7 (1.5)c	33.7 (1.5)bc	35.0 (2.6)b	38.7 (0.6)a	35.3 (7.6)abc
GH 3870	0	2.3 (0.6)cd	42.3 (1.2)a	45.7 (0.6)a	42.7 (0.6)b	40.3 (0.6)ab	40.7 (1.5)ab	40.7 (0.6)a	39.0 (1.0)abc

WAM: Weeks after maturity. Each value is the mean of three replicates and the standard deviation is shown in parentheses. Values with different letters are significantly different at P<0.05. *Seed vigour was expressed as the number of seeds germinated at first count.

Table 3. Effect of harvesting time on germination percentage of six eggplant cultivars

Cultivar	Germination (%)								
	At maturity	1 WAM	2 WAM	3 WAM	4 WAM	5 WAM	6 WAM	7 WAM	8 WAM
Dwomo	0	0.00 (0.00)d	0.00 (0.00)d	8.00 (0.00)d	12.67 (3.06)e	12.67 (1.15)d	68.67 (6.43)b	70.7 (1.2)c	72.67 (3.06)b
Kpando	0	25.33 (4.16)b	46.67 (4.16)c	48.67 (5.03)c	61.33 (5.03)c	62.00 (7.21)b	94.67 (4.61)a	90.67 (1.15)ab	92.00 (2.00)a
GH 4918	0	0.00 (0.00)d	0.00 (0.00)d	14.00 (2.00)d	30.67 (1.15)d	36.67 (3.06)c	50.00 (5.29)c	56.00 (2.00)d	74.67 (4.16)b
GH 1072	0	36.00 (0.0)a	68.00 (2.00)b	61.33 (3.06)b	99.33 (1.15)a	91.33 (1.15)a	94.00 (2.00)a	96.00 (4.00)a	90.67 (3.06)a
GH 3887	0	10.67 (1.15)c	55.33 (7.57)c	56.67 (2.31)b	82.67 (3.06)b	83.33 (3.06)a	86.67 (1.15)a	88.67 (1.15)b	90.00 (3.46)a
GH 3870	0	7.33 (1.15)c	89.33 (1.54)a	91.33 (1.15)a	92.00 (2.00)a	91.33 (1.15)a	90.00 (2.00)a	91.33 (4.16)ab	89.33 (1.15)a

WAM: Weeks after maturity. Each value is the mean of three replicates and the standard deviation is shown in parentheses. Values with different letters are significantly different at P<0.05.

on seed quality of the six eggplant cultivars. Significant difference was observed in 100-seed weight among the six cultivars at different harvesting times. The highest 100-seed weight was observed in GH 1072 with the lowest being in Dwomo at all harvesting times. Seed vigour increased at 6, 7 and 8 weeks after maturity in all the six cultivars. The highest vigour and germination percentage was observed in GH 1072 followed by GH 3870. The results obtained in the present study indicates that seed quality of eggplant cultivars increases with harvesting time. This varied within and among eggplant species (*S. gilo*, *S. macrocarpon*, *S. melongena*).

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