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Influence of seed size on the germination of four cowpea *(Vigna unguiculata* (L) Walp) varieties

Nataline S. Baysah[1*], Nana S. Olympio[2] and James Y. Asibuo[3]

[1]Central Agricultural Research Institute, Suakoko District Bong County, Liberia.
[2]Horticulture Department, Kwame Nkruma University of Science and Technology, Ghana.
[3]Crops Research Institute of the Centre for Scientific and Industrial Research (CSIR-CRI), Ghana.

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A study was conducted to investigate how seed size affects germination and vigor of cowpea seeds. Four cowpea varieties (Asontem, Nhyira, Soronko and Tona), were obtained from Crops Research Institute of the Centre for Scientific and Industrial Research (CSIR-CRI). The seeds were grouped in two sizes (large and small), by manually sorting by length, width and thousand seeds weight. Laboratory experiments were carried out at the Department of Horticulture, Kwame Nkruma University of Science and Technology, in 2012. Results of the study showed that seed germination was not affected by the variety and the seed size. However, variety x seed size interaction was significant. Nhyira large and Asontem small seed sizes had significant higher germination ($P \leq 0.01$) than Soronko and Tona. For seed vigor, first count, seedling dry weight and electrical conductivity were used. First count among varieties and seed sizes used as a vigor indicator, were not significant. Variety x seed size interaction was not also significant. Seedling dry weight was not affected by varieties but by seed sizes, the large seed size produced seedling dry weight (8.91 g) significantly higher than the small sized seeds (7.66 g); variety x seed size interaction were not significant. Small seed size had higher value (28.72 µ S/cm.g) significantly different from large seed. Among the varieties, there were no differences for conductivity value. Variety x seed size interaction did not affect seed electrical conductivity. It can be concluded that seed size did not have effect on the germination of cowpea seeds. Therefore, sorting it out will be of no economic return but time consuming except, for market grade purpose.

Key words: Seed size, germination, vigor.

INTRODUCTION

Cowpea *(Vigna unguiculata* (L) Walp) is a leguminous species native to Africa (Allan et al., 2016). It is a multipurpose crop, since it is cultivated for both leaf and seed yield (Allan et al., 2016). It is also a multifunctional crop, providing food for man and livestock and serving as a valuable and dependable revenue-generating commodity for farmers and grain traders (Badr et al., 2014). Cowpea is an important crop in Ghana due to its contribution to national GDP, farmer incomes and food and nutrition security for the population (TL II Project,

*Corresponding author. E-mail: natalinebaysah@yahoo.com.

2012).

Seed size (usually measured as mass) has long been regarded as an important aspect of plant reproductive biology. Seed size is one of the important yield components which has an effective role on cultivar adaptation to different condition which affects the seed vigor (Ambika et al., 2014). According to Larson et al. (2015), seed size has a significant influence on the future performance of the seedling. Seed size and seed weight are important factors in seed vigor (Snider et al., 2016).

However, other studies have established that seed mass within a species or even an individual plant can vary greatly (Li et al., 2015). Differences in seed mass within a species may affect seed germination and germination rate (Wang et al., 2017). Big seeds often have greater percent germination or emergence than small seeds (Ambika et al., 2014). On the other hand, small seeds may germinate more rapidly than large seeds and, thus, have a competitive advantage (Adebisi et al., 2013). According to Nik et al. (2011), seed size also affects seedling biomass. Usually, the seedlings from big seeds are bigger than those from small seeds, especially in the early stages of growth (Nik et al., 2011). The effect of seed size on germination and following seedling emergence have been investigated by many researchers in various crop species or cultivar (Larsen and Andreasen, 2004; Willenborg et al., 2005). However, these results varied widely between species. With increased seed size higher germination and emergence were determined in pearl millet (Erskine, 1996), while seed size has no effect on germination of seeds in other reports (Main and Nafziger, 1994) but besides higher germination percentage declined median germination time were determined in some forage plants (Larsen and Andreasen, 2004). Also in barley, germination ranged between 97.5 and 98.5% in four groups of seed sizes and there was no significant difference between them (Rukavina et al., 2002). According to Nik et al. (2011), plant grown from large seeds compared to those grown from small seeds was more vigorous and produces greater dry matter in wheat. Hojjat (2011) also reported that the germination parameters were significantly related by seed weight and large seeds germinated early and showed better germination than small seeds of lentil genotypes. Studies of Erdemci et al. (2017) on chickpea showed that large seeds of chickpea had high germination percentage, more seedling dry weight and better electrical conductivity as compare to small seeds. However (Rezapour et al., 2013) in their research about seed size on soybean germination, showed that medium seeds had higher germination percentage than that for large and small seed sizes, but there was not a significant effect of seed size on germination rate. Within normal range of seed size, variety is more essential than seed size in determining emergence (Rezapour et al., 2013). With the diverse views on seed size, it was therefore important to evaluate the influence of seed size on germination of four cowpea varieties.

MATERIALS AND METHODS

In order to evaluate the effect of seed sizes (large and small) on germination and vigor of cowpea genotypes, four cowpea varieties (Asontem, Nhyira, Soronko and Tona), were obtained from Crops Research Institute of the Centre for Scientific and Industrial Research (CSIR-CRI). The seeds were grouped in two sizes (large and small). The samples were manually sorted into two seed sizes (Large and small) by length, width and thousand seed weight. Large seeds ranged from 7.69-8.15 mm in length, 6.17-6.40 mm in width and 133-148 g in 1000 seeds weight. Small seeds ranged between 5.10-6.42 mm in length, 4.20-4.95 mm in width and 1000 seeds weight of 94-110 g (Table 1).

The experiment was arranged out as factorial, based on CRD design with four replications. The laboratory tests conducted were: Standard germination test (SGT), seedling dry weight (SDW) and electrical conductivity (EC).

Eight treatments were used for the work: (1) Asontem large seed size; (2) Asontem small seed size; (3) Nhyira large seed size; (4) Nhyira small seed size; (5) Tona large seed size; (6) Tona small seed size; (7) Soronko large seed size and (8) Soronko small seed size.

The seeds were separated by their size from the same stock, based on seed length andwidth following the procedure described by Demooy and Demooy (1990). Ten randomly selected seeds were used for measuring each of the dimensions in triplicates with Venier calipers.

1000 seeds weight was determined by randomly counting hundred seeds in eight replications, weighed and recorded in grams. The mean weight was then multiplied by ten to obtain the thousand seed weight as per the procedure given under ISTA Rules (ISTA, 1996).

Germination test consisted the sowing of 100 seeds in four replicates using sterilized river sand. The sand was sieved using 0.4 mm mesh as recommended in ISTA Rules (a range of 0.8 to 0.05 mm) and readily sterilized by heat at 150°C for 1 h. Sterilized sand was filled in each of the plastic containers with volumes of 13.2 litres which had 5 holes perforated at the base to drain excess water. Seedling counts were made on the 5th day to serve as vigor indicators of the various samples. Final counting was recorded on the 8th days after planting and total percent germination determined as recommended by ISTA (2007).

$$Germination\% = \frac{number\ of\ germinated\ seeds}{number\ of\ total\ seeds\ planted} \times 100$$

The vigour of two seed sizes of four cowpea genotypes was determined using seedling dried weight (SDW) (Perry, 1981). Twenty five (25) seedlings from each replication of the 8 samples were selected at random. Each sample was enveloped and oven dried at 80°C for 24 h. Afterwards, the dried samples were cooled and weighed using analytical balance. The recorded weight was divided by the number of seedlings (25) to obtain the seedling dried weight. The vigor was then calculated by multiplying the seedling dried weight by germination percentage of each replication as indicated by Perry (1981).

Vigour = germination % × seedling dried weight.

Conductivity test

The test gives an accurate estimation of membrane permeability.

Table 1. Physical properties of the cowpea varieties planted.

Variety	Size	1000 seed wt	Seed length	Seed width
Asontem	Large	139	7.69	6.20
	Small	94.0	5.60	4.40
Nhyira	Large	143	8.05	6.37
	Small	100	5.10	4.20
Soronko	Large	148	7.82	6.40
	Small	104	6.42	4.40
Tona	Large	133	8.15	6.17
	Small	110	5.61	4.59

Seed lots having high electrolyte leakage, that is, having high leachate conductivity, are considered as having low vigour, whilst those with low leakage (low conductivity) are considered high vigour (ISTA, 2007). Electrical conductivity was determined using 4 replicates of 50 weighed seeds for each treatment. The seeds were seeped for 24 h at a temperature of 20°C in 250 ml flasks containing sterile distilled water and two control flasks with each test run containing only sterilized distilled water. After this period the flasks were swirled for 10 to 15 s and seeds were then taken out of the water with a clean forceps. An electrical conductivity meter was used to measure seed conductivity by inserting the conductivity dip cell into the seeped water until a stabilized reading was achieved and recorded. The conductivity dip cell was rinsed once in each of two beakers of rinse water between each sample measurement. The mean of the two control flasks (sterilized distilled water) when measured served as background reading (5) (ISTA, 2007). Conductivity was calculated using the formula:

$$Conductivity\ (\mu s/cm^{-1}g^{-1}) = \frac{Conductivity\ reading(\mu s/cm^{-1}) - background\ reading}{Weight\ (g)\ of\ replicate}$$

RESULTS

The effects of variety and seed size on germination and vigor

Germination percentage

Seed germination was not affected by variety and seed size (Table 2). However, variety x seed size interaction was significant. Nhyira large and Asontem small seed sizes had significant higher germination (P≤0.01) than Soronko and Tona (Table 2). First count for varieties and seed sizes used as a vigor indicator, were not significant for seed size and varieties. Variety x seed size interaction was not also significant.

Seedling dry weight

There were no significant differences among varieties but there was significant difference between the seed sizes. The large seed size produced seedling dry weight (8.91 g) significantly higher than the small sized seeds (7.66 g) (Table 2). Variety x seed size interaction was not significant.

Electrical conductivity

Variation was found between the seed sizes. The small seed size had higher value (28.72 μ S/ cm.g) significantly different from large seed. Among the varieties, there were no differences for conductivity value (Table 2). Variety x seed size interaction did not affect seed electrical conductivity.

DISCUSSION

Germination percentage

There were no significant differences between the percentage seed germination of the varieties. This indicated that seed size might have influence on germination in some crops but not in other crops. The result from this study agrees with findings of Main and Nafziger (1992) who reported that seed size has no effect on germination of seeds in winter wheat. However (Rezapour et al., 2013) in their research about seed size on soybean germination, showed that medium seeds had higher germination percentage than that for large and small seed sizes, but there was not a significant effect of seed size on germination rate.

Nhyira variety had different reaction from large seed size. The difference between Nhyira variety and other varieties is probably because of its superior genetic potential in 1,000 seeds weight which shows more seed food storage. This result is confirmed by findings of Willenborg et al. (2005).

Seedling dry weight

The seedling dry weight was affected by seed size. The

Table 2. The effects of variety and seed size on germination and vigor of original seed.

Variety	Germination (%)			First count (%)			Seedling dry wt. (g)			Ec (μ S/ cm.g)		
	L	S	Mean	L	S	Mean	L	S	Mean	L	S	Mean
Asontem	89.25	94.50	91.88	88.50	92.25	90.38	8.70	7.88	8.29	25.03	28.20	26.61
Nhyira	94.75	89.50	92.12	92.00	87.75	89.88	9.68	7.57	8.63	26.89	30.22	28.56
Soronko	91.75	91.75	91.75	89.00	92.25	90.62	9.81	7.47	8.64	24.48	27.50	25.99
Tona	92.50	93.00	92.75	90.25	89.75	90.00	7.45	7.70	7.57	25.87	28.97	27.42
Mean	92.06	92.19		89.94	90.50		8.91	7.66		25.57	28.72	
Lsd (5%)												
Variety	3.60^{ns}			3.32^{ns}			1.35^{ns}			1.89^{ns}		
Seed size	2.54^{ns}			2.35^{ns}			0.96*			1.34**		
Variety x size	5.09*			4.70^{ns}			1.92^{ns}			2.67^{ns}		
Cv (%)	3.8			3.5			15.7			6.7		

L = Large size, S = Small size, ns = not significant, *, ** = Significant at 1 and 5% probability, respectively.

large seed size produced the highest seedling dry weight than the small seeds. This might have been attributed to the high 1000 seeds weight and protein in large seed that resulted in high seedling dry weight. This result is in agreement with that of Nik et al. (2011) who also reported that wheat plants grown from large seeds compared to those grown from small seeds were more vigorous and produced greater dry matter.

Electrical conductivity

In the study, the four cowpea genotypes had no variation in water absorption. This means that seeds of the four varieties were intact and that the amount of electrolytes which leached through the seed coats was low. Large seed had better electrical conductivity values than small sized seeds. This agrees with that of (Ali et al., 2015) who reported that germination percentage and electrical conductivity were positively influenced by bulb size of onion.

This might have been attributed to the fact that the seed coat of small seed size was not intact and also had low vigour as indicated by ISTA (2007) that a higher conductivity may indicate a low vigor seed lot.

Conclusion

The result indicated that large seeds do not have advantage over small seeds in terms of germination. Therefore, sorting it out will be of no economic return but time consuming. Large seeds size showed better vigour in seedling dry weight and electrical conductivity than small sized seeds.

However, variety and seed size interaction was significant. Nhyira large and Asontem small seed sizes had significant higher germination than Soronko and Tona. Seed size is not therefore important in germination of cowpea seed, sorting it out will be of no economic return but time consuming.

CONFLICT OF INTERESTS

The authors have not declared any conflict of interests.

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