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Effects of Season and Harvest Date on Physiological Quality of Cowpea (*Vigna unguiculata*) Seeds

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Abstract

The experiment was carried out in early and late cropping seasons of 2012 at the Teaching and Research Farm of the Obafemi Awolowo University Ile-Ife to determine the effect of season of production, and harvest date (HD) on cowpea seed quality. Three varieties of cowpea namely; IfeBPC, TVX3236 and IT97K-499-35 were used for the study. Seed production was carried out at the University's Teaching and Research Farm. Pods were harvested from seed crop fields at 14, 21, 28 and 35 days after flower opening for each variety. Fresh pods were dried and seeds were extracted and dried to about 12% moisture content. Thereafter, seed quality evaluations were conducted in both laboratory and field. For seed quality assessments in the laboratory, seeds extracted at the various harvest dates in both seasons were subjected to standard germination, accelerated ageing and seedling evaluations. Field evaluations were conducted using 4- row plots laid out in a randomized complete block design (RCBD) replicated four times. Data were collected on emergence percentage (EPCT), emergence index (EI), growth rate (GR), relative growth rate (RGR), days to first flowering (DFI), days to 50% flowering (DF50) and seed yield (YD). All data collected were subjected to Analysis of variance to test the effect of season of production and harvest date on cowpea seed quality. Means were separated using Duncan's Multiple Range Test. Seeds produced in late season had higher quality than those produced in early season. Seeds produced in early season had higher moisture content but lower hundred seed weight, and germination percentage. Harvest date influenced seed moisture content and hundred seed weight, germination, accelerated ageing germination and emergence percentages. Seeds harvested at 21 days after flower opening had the highest standard and accelerated aging germination percentages at moisture content of 45.71%. Therefore, cowpea seeds attained physiological maturity (PM) at 21 DAF. Thereafter, a week delay in harvest results in at least 30% percent decrease in germination. So harvest date is the main determinant of cowpea seeds.

Keywords

Season of Production, Harvest Dates, Physiological Maturity, Hundred Seed Weight

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1. Introduction

It has been established that seed quality depends on the prevailing climatic conditions. Agro-climatic components are the key determinants in the season of production. A knowledge of seed development and physiological maturity helps in harvesting crops at the appropriate time and ensures seed quality in terms of germination and vigour. Identifying the stage of maturity at which seeds can be harvested without lowering their germination is a beneficial practice for farmers to maximize seed yield and quality dependent on their genotype [2] Seeds harvested prior to attainment of

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physiological maturity are immature, underdeveloped and store less food reserve when compared to those harvested at physiological maturity [23, 11]. Harvesting too early may result in low yield and poor seed quality, whereas harvesting too late may result in shattering of seeds in the field with attendant reduction in yield [12, 24]. Seed harvested at physiological maturity is considered to have maximum viability and vigour [21]. When seeds are harvested influences the quality of seed in relation to germination, vigour, and storability. Harvest time is known to be a major factor responsible for physiological maturation level, size and vigour of seed during maturation [20].

During development and maturation of pods and seeds, changes occur in their moisture content, physical and physiological properties [21]. There is the need to monitor these changes in both seasons to be able to establish the right time to harvest cowpea at a given environmental condition for maximum seed quality.

Most of the studies on harvest dates and physiological maturity were in crops other than cowpea. Some researchers have worked with seeds of common bean (*Phaseolus vulgaris* L.); yardlong bean (20 DAF); southern pea (*Vigna sinensis* (L.) and (*Vigna unguiculata* (L.) Walp) [8, 6, 23, 13, 22]. Yet studies on PM of cowpea (*Vigna unguiculata* L. Walp) are scarce in literature. Therefore this study was carried out to determine when to harvest cowpeas for high quality seeds in either early or late cropping season.

2. Materials and Methods

Seeds of IfeBPC were collected from the Institute of Agricultural Research and Training (IAR&T) while seeds of TVX3236 and IT97k-499-35 were collected from International Institute of Tropical Agriculture (IITA) both in Ibadan.

2.1. Seed Production

These seeds were multiplied in a seed crop field was laid out at 60 cm x 20 cm with 10 rows of 20 m length. Two rows were used to produce seeds for each harvest date. These seeds were produced at different dates (14, 21, 28 and 35 days after flower opening) in early and late seasons of 2012 at the Teaching and Research Farm of Obafemi Awolowo University, Ile-Ife. Adequate agronomic practices were carried out.

2.2. Sampling

At anthesis, flowers were tagged with information on when to harvest pods for seeds. After tagging, pods were harvested serially at 14, 21, 28 and 35 DAF (days after flower opening) as seed lots for subsequent seed quality tests (physiological vigour). Seed quality tests carried out were standard germination, accelerated ageing and seedling analysis conductivity test.

Germination test: Hundred seeds were planted on moistened sterilized river bed sand in plastic containers in 4 replicates per harvest date according to ISTA rules [15]. Germination counts were taken at 5 and 8 days after seeding according to ISTA rules for seed testing [15] procedure for standard germination. Germination percentage (GPCT); was calculated by expressing the number of normal seedling in a replicate that emerged 8 days after seeding as a percentage of the number of seeds sown [15].

$$\text{Germination percentage} = \frac{100 \times \text{number of seedling that emerged 8 DAS}}{\text{Total number of seeds planted}}$$

(DAS = days after sowing)

Accelerated Ageing Test: Fifty seeds in four replicates from each harvest date were weighed and placed on a wire mesh in accelerated ageing boxes containing 40 ml of distilled water. The seeds were aged by placing them in an accelerated ageing chamber at 43°C for 72 h. Standard germination test was conducted with the aged seeds as described above.

2.3. Analyses

Data collected on germination and emergence percentages were subjected to descriptive statistics using means, ranges, standard deviation and coefficient of variation. Data from seed quality tests in the laboratory were analysed as combined across seasons. Square root transformation was carried out on germination and count data before analysis of variance (ANOVA). Means for season, variety and harvest date were separated using Duncan Multiple Range Test. Analysis of variance (ANOVA) were carried out with PROC GLM procedures of SAS (SAS Institute, 2001).

3. Results

Season effect was similar for accelerated ageing germination and seedling root dry weight (Table 1). Otherwise, despite that sampling was done the same number of days after flowering, seeds produced in the early season had lower seed dry weight, higher moisture content and lower hundred seed weight. The seeds also had lower mean germination percentage, conductivity value and germination indices. But, the mean values for all seedling vigour traits were significantly lower compared to seeds produced in the season. Seeds produced in the late season had a 12% germination advantage over seeds produced in early season but the bulk conductivity values were more than twice the

corresponding values for seeds produced in early season.

The field emergence percentages, though significantly different for the two seasons with the value for late season-produced seeds being higher, were nonetheless very low, 38.91% for seeds produced in early season and 46.15% for seeds produced in late season (Table 2). Except for the speed of emergence being at least 1 day significantly earlier than the emergence of seeds produced in the late season, seeds produced in the late season generally performed better in the field evaluation having significantly higher (more than twice) growth rate, relative growth rate, earlier flowering by at least 16 days, attainment of mid-flowering by at least 22 days and a yield advantage of almost 12 times over seeds produced in the early season.

At 21 days after flowering, seed conductivity value was lowest, standard germination and accelerated ageing germination as well as the mean value for all seedling vigour traits was highest with figures before and after that date reflecting poorer performance (Table 3). However, the accelerated ageing germination index for seeds harvested at 21 days was the highest, being at least 2.5 times the lowest value which was for seeds harvested at 14 days after flowering. The seeds moisture content at 21 days after flowering when seed and seedling vigour appeared to peak was very high, (45.17%).

Also at 21 days after flowering, emergence percentage, growth rate and relative growth rates were highest; and least number of days to first and 50% flowering (Table 4). Although seeds harvested 21 days after flowering had the highest magnitude for growth rate and relative growth rate, there was no difference among varieties. Seeds harvested on 21DAF flowered a day earlier than either of the other harvest dates.

Table 1. Influence of season of production on seed quality of cowpea produced in early and late cropping seasons of 2012.

Season	SMC	HSW	GPCT	GI	AAGPCT	AAGI	SHL	RTL	SHDW	RTDW
Early	47.98a	8.93a	48.63a	3.93a	21.58a	6.15a	12.88a	6.66a	0.14a	0.29a
Late	32.84b	11.02b	60.21b	4.22b	22.67a	2.11b	20.63b	10.25b	0.25b	0.33a
Mean	40.41	9.97	54.41	4.07	22.11	4.13	16.75	8.45	0.19	0.31

Means with different letters in a column are significantly different at P<0.05
SDW =Seed dry weight, SMC = Seed Moisture content, HSW = 100 seed weight, COND = Seed conductivity, GPCT = Germination Percentage, GI = Germination Index, AAGPCT = accelerated ageing germination percentage, AAGI= accelerated ageing germination index, RTL= Root length, SHL= Shoot Length, DSHW= Dry shoot weight and DRTW= Dry root weight.

Table 2. Influence of season of production seedling emergence, establishment and yield of cowpea in early and late cropping seasons of 2012 and 2013.

Season of Production	EPCT	EI	GR	RGR	DF1	DF50	YD (kg/ha)
Early	38.91a	4.29a	0.17a	0.11a	50.38a	57.23a	55.25a
Late	46.15b	5.46b	0.38b	0.20b	34.80b	35.73b	657.26b

Means with different letters in a column are significantly different at P<0.05
EPCT = Emergence percentage, EI = emergence index, GR = Growth rate,
RGR = Relative growth rate, DF1 = Days to first flowering, DF50 = Days to 50% flowering and YD = Seed yield

Table 3. Influence of seed maturation on seed quality of cowpea in early and late cropping seasons of 2012 in the Laboratory.

HD	SMC (%)	HSW (g)	GPCT (%)	GI (day)	AAGPCT (%)	AAGI (day)	SHL (cm)	RTL (cm)	SHDW (cm)	DRTW (g)
14	71.13a	6.00a	58.92a	4.34a	13.00a	2.56a	15.10a	6.79a	0.15a	0.33a
21	45.71b	11.20a	83.67b	4.18a	55.50b	6.92b	21.54b	14.36b	0.26a	0.48b
28	21.48c	11.33a	53.92c	4.27a	13.33b	3.28bc	18.15b	8.46b	0.24b	0.25bc
35	23.31d	11.38b	21.17d	3.15b	6.67b	3.77c	12.22d	4.22c	0.14b	0.18c
Mean	40.41	9.97	54.41	4.07	22.11	4.13	16.75	8.45	0.19	0.31

HD = harvest date, MC = moisture content, HSW = hundred seed weight, COND = conductivity of seed, GPCT = germination percentage, AAGPCT = accelerated ageing germination percentage, RTL = root length and SHL = shoot length

Table 4. Influence of seed maturation on physiological traits and yield of cowpea in early and late cropping seasons of 2012 in the field.

HD(DAF)	EPCT	EI	GR	RGR	DF1	DF50	YD(kg/ha)
15	43.06a	4.90a	0.21a	0.13a	43.68a	45.32a	328.27a
21	70.84b	4.83a	0.34ab	0.18ab	41.21ab	44.00b	365.89a
28	37.95c	4.95a	0.28b	0.16b	42.71bc	44.67b	393.63a
35	12.69d	4.72a	0.22b	0.13b	44.85c	47.2b	313.45a
Mean	42.37	4.85	0.27	0.15	43.02	45.21	104.69
CV%	19.45	13.42	41.69	27.51	6.35	6.66	67.85

Means with different letters in a column are significantly different at P<0.05
EPCT = Emergence percentage, EI = emergence index, GR = Growth rate,
RGR = Relative growth rate, DF1 = Days to first flowering, DF50 = Days to 50% flowering and YD = Seed yield

4. Discussion

Season of production influenced the field performance of cowpea seeds as there was almost a unilateral pattern for seed quality in both seasons because most of the traits performed better in late season than in early season. Cowpea seeds produced in late season had higher seed quality than those seeds produced in early season in the field. It reported that August and September plantings had higher seed yields and best germination percentages [1]. [4] observed higher grain yield of the best yielding variety when planted in the late season in Uganda compared to early season planting, and this was associated with the prevailing weather conditions in both seasons. According to [3], great variability exists in soybean cultivars relative to seed quality, for different sowing dates and cropping seasons. Also, Sowing in November resulted in seeds with superior physiological and health quality. Irrespective of sowing seasons, significantly maximum, oil content, seed germination and seedling vigour index were recorded over sowing seasons in soybean [10]. Season of sowing and cultivars significantly affected seed quality. A difference in the sensitivity of cultivars to variations in the sowing season was noticed, concerning seed quality attributes. Sowings in mid-December are recommended for high quality seed production [7].

Seeds produced in early season emerged faster in the field, but this did not translate to higher performance as indicated by viability and vigour traits. This points to the fact that, though seeds produced in early season emerged faster, morphological growth was slower and eventually yield was lower. Seed yield was statistically different across seasons indicating higher quality for seeds produced in late season. However, evaluation of seeds produced in early season was severely attacked which resulted in very low yield. Although there was this attack by pod suckers on early season seed evaluation, there was no difference in yield across harvest dates in either of the seasons.

This study showed that when seeds are harvested between flower opening and final maturation influence the quality of seeds in cowpea. Seeds harvested at 14DAF were desiccation tolerant and performed well during evaluations both in the laboratory and the field. As seeds enter into the late maturation phase they have already gained their germination capacity and desiccation tolerance, both occurring much earlier, when seeds are being filled [18]. But under accelerated aging tests these seeds performed poorly because of the immaturity of the embryo, resulting from the fact that maturation was on-going in the seeds. [19], in their study on oleaginous gourds (*lagenaria siceraria*) reported that harvesting too early may result in low yield and quality, because of the partial development of essential structures of seeds. Seed composition or the relative proportion of seed reserves is more important than seed weight in cowpea seed quality.

When seeds attained the highest standard and accelerated aging germination percentages at moisture content of 45.71%; is the time when cowpea seeds reached maximum quality and is 21 DAF in cowpeas. According to [16],[20], the time taken to attain physiological maturity varies with genotypes and environmental conditions and a genotype can differ between 7 and 10 days to reach physiological maturity in response to environmental changes. It was reported in literature that seed quality (germination and vigour) were maximum in pods harvested at 16 days after anthesis in bush cowpea variety "Bhagyalakshmi" and at 18 days after anthesis in pole cowpea variety [17].

Seed quality improves with decrease in moisture content and the best seed quality was attained at 21 DAF at moisture content of 45.71%. [22] recorded 53.6-14% moisture content at 14 and 18 DAA for cowpea, and 50 to 55% moisture content for Snap bean (*Phaseolus vulgaris*) [5]. Seed moisture content influences standard and accelerated germination percentages. This shows that moisture content influences cowpea seed quality in both seasons.

We observed that seeds produced in early season had light-green pod colour at 21 DAF especially for IT97K-499-35 and greenish yellow for Ife-BPC and TVX3236. While seeds produced in late season had generally yellow pod colour at 21 DAF and brown at 28 DAF and fully dried for Ife-BPC, IT97K-499-35 and TVX3236. This indicates that seeds produced in late season have a faster seed growth rate. Pod colour change to yellow occurred before 21 DAF across varieties in late season. It also revealed that seed deterioration sets in after 21 DAF as indicated by at least 30% drop in germination percentage between 21 and 28 DAF and 28 and 35 DAF, respectively. Similarly, [14] said that, seeds harvested at early or later stages than yellow pod stage, are physiological maturity but had lower germination percentage and seedling vigour index.

5. Conclusion

Cowpea seed quality was highest at 21DAF as indicated by physical and physiological traits. So the best time to harvest cowpea for high seed quality is at 21 DAF. But harvesting of cowpea at 21 DAF is not safe because of high moisture content. Therefore, the corn industry technique where seeds are conditioned after harvesting could be employed since these seeds could be dried as early as 14 DAF without damaging the physiological potential of the seed.

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