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Investigating the Potentials of Four Cowpea (Southern pea) Cultivars for Fresh Seed Production

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Abstract

Recent surge in fresh cowpea seed consumption in the United States has resulted in the search for appropriate cultivars for fresh seed production. Consequently, four cowpea cultivars, "*Coronet, Quick Pick, Early Scarlet* and *Excel Select*" were identified and evaluated for fresh seed production potentials. The three year (2000, 2001 and 2006) research data indicate that the four cultivars could be designated as major cowpea cultivars for fresh seed production. However, the cultivar, "Early Scarlet" is the most consistent with respect to high seed yields. Our studies also reveal that annual fresh cowpea seed harvest of between 824.7 and 2166.8 kg ha^{-1} is very feasible, and at a current market price of \$5 kg^{-1} of fresh seed, fresh cowpea production stands as a profitable agribusiness for farmers in the United States and elsewhere in the world. There is no direct link between high seed yield and earliness in flowering among the cultivars. Indeed, flowering date is negatively correlated with fresh and dry seed yields. These results are discussed in this paper.

Keywords: Cowpea, evaluation, fresh seed, *Vigna unguiculata*, yield.

Introduction

"Southern pea", *Vigna unguiculata*, (L.) Walp. is most commonly known as "cowpea". In the United States (US), Southern pea is also known as *Crowder pea* and *Blackeye pea*. Internationally, it is called cowpea, beans, agwa, wake, mebe, lubia, coupe, frijole, *etc*. In this paper, the nomenclature "southern pea" is taken to be

"cowpea" and may be used interchangeably. Cowpea is regarded as an alternative or minor crop in the US.

Alternative crops include those crops with small markets, or for which seed market is very small to be served by existing private sector farms. Alternative crops, such as southern pea, especially when produced and marketed as fresh peas, contribute a significant part of the agribusiness/farming by small scale (limited-resource) farmers. In the US, the small scale farmers own and farm small acreages (less than 50 ha) and cannot successfully compete with large-scale farmers in the "major crops" (such as soybean, rice, wheat, cotton and corn) agribusiness. This has caused a rapid decline in number of small farms, as the small farmers find themselves unable to earn a living on farming, and hence, resort to selling their farms. Due to their high market values, farming in alternative crops such as southern pea can provide them opportunities for economically viable agribusinesses. This in-turn slows down the loss of small-scale farms to large-scale farmers.

Cowpeas are widely grown in East Africa and Southeast Asia primarily as a leafy vegetable. The protein content of the leafy cowpea parts consumed annually in Africa and Asia is equivalent to 5 million tonnes of dry cowpea seeds and this represents as much as 30% of the total food legume production in the lowland tropics[1]. Studies indicate that an area of 9.8 million ha of cowpea is cultivated annually worldwide, with a total grain production of 3.7 million tonnes. Farmers in the semi-arid and sub-humid regions of Africa are the major producers and consumers [2]. West and Central Africa are the leading cowpea producing regions in the world; these regions produce 64% of the estimated 3 million tonnes of cowpea seed produced annually [3]. Nigeria is the world's leading cowpea producing country. Other countries in Africa such as Ghana, Niger, Senegal, and Cameroon, are significant producers. Outside Africa, the major production areas are Asia and Central and South America. Brazil is the world's second leading producer of cowpea seed, producing 600,000 tonnes annually [4]. Other producing countries include Haiti, India, Myanmar, Sri Lanka, Australia, Bosnia, and Herzegovina.

In the United States, cowpeas are produced mainly in Alabama, Arkansas, California, Georgia, Louisiana, Mississippi, Missouri, South Carolina, Tennessee, and Texas [5]. Cowpea has long been valued in the Southern US as a vegetable crop. It is a popular item with home gardeners throughout the South. The US cultivars include, *blackeye*, *pinkeye*, *crowder*, and *cream* cowpeas. It was a major agronomic crop during the early part of the 20th century. However, production dropped due to the introduction of newer types of forage crops and the availability of mechanized harvesting equipment for these newer crops. In 1937, US production capacity peaked at 2.4 million ha, but fell to 0.9 million ha in 1964 [5]. By the early 1980s, annual cowpea production in the US had declined to about 80,000 ha.

Cowpea is a highly nutritious food crop. The seed contains about 25% protein together with several other nutrients [6]. The tender shoot tips and leaves can be

consumed as soon as the plants reach the seeding stage, and immature pods and seeds can be consumed during the fruiting stage [7]. Harvested dry seeds can be ground into slurry to make cowpea cake (*moimoi*), or deep fried into bean balls (*akara*), or the seeds could be boiled, mixed with sauce or stew and consumed directly. Plant residues are used as fodder for farm animals. Cowpea has wide soil type adaptability, and is considered more drought tolerant than soybeans [8]. Tolerance to drought reduces the use of irrigation, and subsequently the cost of production. It is also used as a cover crop [6] and as fodder for livestock [2]. In addition, cowpeas contain bioactive antioxidants such as tocopherols, vitamin C, carotenoids, and phenolic compounds [9, 10]. Some phenolic compounds exist as natural antioxidants and represent an important group of bioactive compounds in foods which may prevent the development of many diseases, including atherosclerosis, cancer, etc [11, 12].

The aims of this study are: i) to evaluate four cowpea cultivars for fresh seed production potentials, ii) to determine whether early flowering among the cultivars may be related to yield, iii) to investigate whether cowpea varieties developed for fresh seed production could also be used for dry seed production, and iv) to draw the attention of cowpea farmers worldwide to the profitability and/or opportunities in fresh cowpea seed agriculture.

Materials and Methods

Plant materials

The four southern pea varieties known as "*Excel select, Coronet, Quick Pick* (or *L. A. Purple Hull*) and *Early Scarlet*" are among the few southern pea cultivars developed locally for cultivation in the United States. Seeds of the four varieties were obtained from Dr. Teddy E. Morelock, a cowpea breeder at the University of Arkansas at Fayetteville, and from Dr. Owen Porter from the University of Arkansas at Pine Bluff.

The few seeds were subsequently grown for seed multiplication at the University of Arkansas at Pine Bluff research farm.

Field experimentation

Seeds of the four cultivars (Table 1) were grown in a performance evaluation trial conducted at the research farm site of the University of Arkansas at Pine Bluff. The trials lasted for three years; that is, in 2000, 2001 and 2006. The seeds were planted between June 7 and June 10 in each of the three year trial periods. A randomized complete block (RCB) design with four replicates of each variety was used. Seeding was done mechanically with a seed planter. The seeding rate was four to six plants within foot of row. Plots were designed in rows of 8.5 meters length, 0.67 meters wide, and with a row-to-row spacing of 0.8 meters. The planter was designed to plant at a depth of 2.5 cm. The cultivars were evaluated and selected on their yield and agronomic desirability, both for fresh seed and dry-mature seed production potentials.

Data were also collected on dates of flowering, fresh pod and dry-mature pod characteristics. Weeds were controlled mechanically. Chemical herbicides were not applied. Both fresh pod and dry-mature pod harvests were done manually.

Data were analyzed using the Analysis of Variance (ANOVA). Pearson correlations (r) between selected variables were also calculated.

Table 1 : Means* of fresh pea yield (kg ha^{-1}) of four cowpea (*Vigna unguiculata*, [L.] Walp) varieties in Lower Mississippi Delta.

Local name	Entry code	2000	2001	2006
Coronet	501	819.9a	1646.5b	1087.7b
Quick Pick	503	751.0a	1906.5b	952.6b
Early Scarlet	504	934.1a	2938.3a	1672.4a
Excel Select	511	794.0a	2175.5b	1419.0ab

* Means within columns and followed by same letter are not significantly different ($\alpha \leq 0.05$)

Results and Discussions

Results of the three year studies are shown in Tables 1 – 4. The results indicate that the environmental conditions prevalent in the Lower Mississippi Delta region favor the production of fresh cowpeas, and that the four cultivars (Table 1) evaluated in this study could be developed as the major cowpea lines for the production of fresh seed ("fresh pea" in the US) in the region, and indeed mature seeds of these high yielding cultivars could be exported to other cowpea producing nations for fresh cowpea production. Cowpea agriculture is synonymous with dry seed production in most regions of the world. This study has demonstrated that fresh cowpea seed production could also be an important world agribusiness. With a three year fresh seed yield range of 824.7 – 2166.8 kg ha^{-1} (Table 3), fresh cowpea seed production agriculture can compete favorably with the dry seed agriculture. Indeed, the fresh seed yield range is higher than the dry seed yield range of 517.3 – 1210.2 $kg.ha^{-1}$ (Table 3), nevertheless, the high moisture content of the fresh seeds may have contributed to higher weight. Our present results are at variance with previous data [13], but are however consistent with the findings of Izikor et al [14].

Although the focus of this research is on fresh seed yield, however, the high dry seed yields of the four cultivars may be of interest to breeders. The dry seed yield recorded in this study is in close agreement with the results on cowpea yield range of 680.2 – 1120.9 $kg.ha^{-1}$ [2], and are higher than the results of Okiror et al [13], but lower than 1131 – 1483 $kg.ha^{-1}$ as reported previously [15]. The yield data suggest that the

four cowpea cultivars under the present investigation have high potentials in both the fresh seed and dry seed production systems.

Table 2 : Means* of three year yield performances and agronomic attribute of four cowpea (*Vigna unguiculata*, [L.] Walp) varieties in Lower Mississippi Delta.

Local name	Entry code	Days to Flower	Fresh pod yield (kg ha^{-1})	Fresh pea yield (kg ha^{-1})	Dry pea yield (kg ha^{-1})
Coronet	501	42.9c	2815.7a	1184.7b	676.3b
Quick Pick	503	40ab	2870.1a	1203.4b	825.6ab
Early Scarlet	504	38.8a	3327.4a	1848.3a	1030.8a
Excel Select	511	41.8bc	3526.3a	1462.8ab	714.7b

* Means within columns and followed by same letter are not significantly different ($\alpha \leq 0.05$)

On the performance of the individual cultivars, it may be observed that the variety "Early Scarlet" could be selected as the top variety suitable for fresh pea production in the US. It also has the potentials for high dry seed yield. The variety consistently outperformed the other three cultivars in the three years of our study (Tables 1 - 3). With the current average market price of \$5 kg^{-1}, fresh cowpea seed agriculture is apparently a highly profitable agribusiness for cowpea farmers.

Commercial production of fresh seeds is apparently of limited interest to major cowpea producing nations, probably due to costs associated with preservation and/or storage. The producers' much focus on dry seed production limits the farmer's choice on production system and with no access to the highly profitable fresh seed market. Additionally, the consumer has no choice, and is restricted to only dry seed consumption. Information on nutritional disparity between the fresh and dry seeds of the four cultivars will follow in our subsequent studies. Nevertheless, the market for fresh cowpea is relatively small (at the moment) in the United States and other parts of the world. Undoubtedly, this is a serious challenge which the fresh cowpea farmers need to overcome. If fully developed, and with the current unit price, fresh cowpea agriculture will be more profitable than the present "major" crops such as soybean, corn, wheat, rice, etc.

The four cowpea cultivars in our study have close range of number of days to flower (38.8 – 42.9 days) (Tables 2 & 3), and flowering date is negatively and without significance correlated to fresh and dry seed yields (Table 4). This suggests that high yield could not be directly linked to earliness in flowering (Tables 2 and 3). Therefore, the high yield recorded for "Early Scarlet" (Table 2) may not necessarily be due to its earliness in flowering but to other external and internal factors. This is explained further in Table 3 which shows the yield data in the year 2006 to be higher than those for the year 2000 even though cowpeas generally flowered earlier in 2000 than in 2006. Our findings are in agreement with earlier reports on negative and no significant correlation between yield characteristics (pods/plant and seeds/pod) and flowering date in some crop plants [16]. However, our results differ with Makeen et al

[17] on the positive significant ($\alpha \leq 0.05$) correlation between flowering date and yield in some *Vigna radiate* varieties.

Table 3 : Means* of variety variables in three experimental years

Year	Days of flower	Fresh pod yield ha^{-1})	Fresh pea yield (kg ha^{-1})	Dry pea yield (kg ha^{-1})
2000	39.6b	1699.09c	824.7c	517.3c
2001	39.6b	4481.6a	2166.8a	1210.2a
2006	43.5a	3224.0b	1283.0b	707.9b

* Means within columns and followed by same letter are not significantly different ($\alpha \leq 0.05$)

There is high significant correlation (0.84) between dry seed and fresh seed yields (Table 4). This suggests that the four cowpea cultivars, especially "Early Scarlet" could be used for both fresh and dry seed productions. This finding is necessary as it affords the farmer an opportunity to use the same planting material for either the fresh or dry seed production, or use the same cultivar in both farming operations instead of using different cultivars for different production systems.

Table 4 : Correlation between three year agronomic data

Variables	Days to flower	Fresh pod yld. (kg ha^{-1})	Fresh pea yld. (kg ha^{-1})	Dry pea yld. (kg ha^{-1})
Days to flower	1	-0.01	-0.22	-0.30*
Fresh pod yld. (kg ha^{-1})	-0.01	1	0.90**	0.69**
Fresh pea yld. (kg ha^{-1})	-0.22	0.90**	1	0.84**
Dry pea yld. (kg ha^{-1})	-0.30*	0.69**	0.84**	1

* significant @ $\alpha \leq 0.05$; ** significant @ $\alpha \leq 0.01$

Conclusions

1. Our results show that although fresh cowpea seed production is yet to attract the attention of the major cowpea farmers or nations, however, its net revenue generation potentials compare favorably, and indeed surpass the potentials of some much improved and much genetically engineered crops such as soybean, corn, wheat, and rice.
2. The four cultivars investigated could be adopted nationally and internationally for both the fresh seed and dry seed productions.
3. Early or late flowering of the four cultivars may not provide significant

information on their overall yield performance.

4. Great opportunities exist in international trade on fresh cowpea seeds. This would offer choices to both the consumers and the producers.

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