Early Leaf Harvest Reduces Yield but Not Protein Concentration of Cowpea Seeds

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Abstract. Five greenhouse-grown cowpea [*Vigna unguiculata* (L.) Walp] cultivars were tested in a generalized random complete-block design to determine the effect of early leaf harvest on dry weight and protein concentration of plant parts at maturity. The most recent, fully expanded leaves on each branch from one group of plants were harvested at 5 and 7 weeks after planting. On the other groups of plants, no early leaf harvest was performed. Dry weight and protein concentration (dry weight basis) were determined for leaves, stems, and seeds at maturity and for leaves harvested early. Weight and protein concentration of seeds, leaves, and stems differed significantly between cultivars; protein concentration of leaves harvested at 5 or 7 weeks did not. Dry weight of leaves harvested at 5 vs. 7 weeks did not differ significantly, but leaf protein concentration was significantly higher at 5 weeks compared to 7 weeks. Across all cultivars, early leaf harvest had no significant effect on leaf or stem weight per plant at maturity. However, there was a significant decrease in seed weight when leaves were harvested early. Results suggest that even limited leaf harvest at 5 and 7 weeks has detrimental effects on yield, but not on protein concentration, of cowpea seeds harvested at maturity.

Cowpea seeds are eaten in the United States, but in Africa and Asia, the young leaves are a dietary staple (Bubenheim et al., 1990). The International Institute of Tropical Agriculture (IITA) in Ibadan, Nigeria, has a systematic program of cowpea breeding designed to identify lines of cowpea that can be used for fodder and grain (Akundabweni et al., 1989).

Cowpea foliage usage has been studied for many years in Africa, but only recently has it been studied in the United States in relation to Controlled Ecological Life Support Systems (CELSS) for use in space (Bubenheim et al., 1990). Using cowpea as a leafy vegetable and grain source may provide versatility not available with many other candidate crops for CELSS (Bubenheim and Mitchell, 1988; Bubenheim et al., 1990).

The nutrient composition of cowpea is superior to that of many vegetables crops (Bittenbender et al., 1984; Bubenheim et al., 1990). Cowpea leaves are a good source of protein—29% to 43% protein on a dry-weight basis (dwb); reported differences apparently are due to leaf age (Berry, 1981). Cowpea seed protein concentration can be from 21% to 33% on a dwb (Baker et al., 1989). However, productivity and yield efficiency must be considered in a harvest strategy to obtain cowpea

foliage and seed. Bubenheim et al. (1990) suggested that a given cowpea crop should be grown to supply either leaves or seeds, but not both. For the two cultivars they studied, yield efficiency was suppressed by a combination of leaf and seed harvest. However, other researchers have shown that, within limits, leaves can be harvested from cowpea without adversely affecting seed yield (Imungi and Potter, 1983; Oomen and Grubben, 1977). The relationship between leaf harvest and seed yield varies among cultivars; although some cultivars show adverse effects, leaf harvest does not appear to compromise seed yield of other cultivars (Bittenbender et al., 1984). These conflicting results about the effect of leaf harvest on seed yield have been attributed to differences between cultivars. Our objective was to determine the effect of limited early leaf harvest on the yield and protein concentration of cowpea plant parts at maturity for five cowpea lines.

IITA in Ibadan, Nigeria, provided the five cowpea cultivars (TVx 1948-01 F, Kenya Local, IT83S-755-1, IT81D-994, and KNW), and we grew the plants in a greenhouse at Purdue Univ. using soilless culture and a 13-h photoperiod. The experiment was performed as a generalized random complete-block design on two benches (blocks). From five plants per cultivar per bench, the two most recent, fully expanded leaves from each branch (separated from the petiole and shoot tip) were harvested at 5 and 7 weeks. No leaves were harvested from three other plants of each cultivar and bench. All plants were harvested at maturity (11–12 weeks after planting, depending on the cultivar), when ≈80% to 90% of seed pods were senescent but before most leaves had abscised. All plant materials were dried at 70°C in a forced-air oven. Dry weight and protein concentration (dwb) were determined for leaves, stems, and seeds collected at maturity and for leaves harvested at 5 and 7 weeks. Total N was determined by the Kjeldahl method (Association of Official Analytical Chemists, 1984) (no reduction step to include nitrate-N), and crude protein content was calculated as N x 6.25. We performed an unweighed mean analysis of variance on the data and tested all treatment effects for significance at $P < 0.05$. Mean comparisons were done by the Student–Newman–Keuls method.

Results and Discussion

There was no significant cultivar × harvest treatment interaction; thus, results for cultivar and harvest main effects are presented. Across all cultivars, there was no significant difference in mean dry weight of leaves harvested at 5 vs. 7 weeks (mean = 2.11 and 2.20 g/plant, respectively), but the mean protein concentration of leaves harvested at 5 weeks (40.2%, dwb) was significantly higher than that at 7 weeks (37.9%). Cultivars did not differ in protein concentration of leaves harvested at 5 or 7 weeks or in dry weight of leaves harvested at 7 weeks. However, the dry weight of leaves harvested at 5 weeks was significantly higher for ‘TVx 1948-01 F’ (2.84 g/plant) compared to all other cultivars (mean = 1.92 g/plant).

Table 1. Dry weight and protein concentration of cowpea plant parts.²

Variable	Cultivar ^y				
	1	2	3	4	5
Dry wt (g/plant) ^y					
Seeds	20.3 b ^x	17.1 b	34.4 a	22.3 b	46.5 a
Leaves	8.1 b	6.1 b	12.6 b	13.1 b	35.8 a
Stem	22.8 b	21.7 b	31.0 b	30.5 b	66.2 a
Protein concn (%) ^w					
Seeds	32.9 ab	33.2 ab	34.6 a	31.7 b	29.1 c
Leaves	30.2 a	28.0 ab	23.5 b	22.8 b	23.8 b
Stem	8.6 a	9.0 a	8.8 a	8.6 a	6.9 b

²Mean values for plants of each cultivar across treatments. Plants harvested at maturity with or without leaf harvest at 5 and 7 weeks.

^yCultivars: 1 = TVx 1948-01F, 2 = Kenya Local, 3 = IT83S-755-1, 4 = IT81D-994, 5 = KNW.

^xMean separations between cultivars at $P \leq 0.05$.

^wOn a dry-weight basis.

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Significant differences existed between the cultivars for weight and protein concentration of seeds, leaves, and stems (Table 1). For example, 'KNW' (no. 5) had significantly higher leaf and stem weights but a significantly lower protein concentration for seeds and stem than all other cultivars.

The harvest of leaves at 5 and 7 weeks had no significant effect across all cultivars on the leaf or stem weight per plant at maturity. However, there was a significant decrease in seed weight (mean = 23.5 vs. 32.7 g/plant) when plants had an early leaf harvest. Seed and stem protein concentration was not affected by early leaf harvest. Protein concentration of leaves harvested at maturity was significantly higher ($P = 0.048$) for plants that had an early leaf harvest (27.0% vs. 24.3%). Bubenheim et al. (1990) also reported a decrease in weight of cowpea seeds as a result of early leaf harvest. Contrary to what we discovered, they reported that twice as much cumulative leaf dry weight was produced by plants when there was leaf

harvest as compared to plants for which leaves were not harvested.

Our results suggest that even limited harvest of leaves at 5 and 7 weeks has a detrimental effect on yield, but not on protein concentration, of cowpea seeds harvested at maturity. However, decisions on any early leaf harvest plan must be based on when food is needed by the consumer and in what form the food is desired.

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