GLIP PHYSIOLOGY SUBPROGRAM

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To provide a basis for discussion of our future collaborative efforts, an understanding of growth and yield production of cowpea under field conditions is essential. From growth analysis experiments and from gas exchange measurements in the field, we know that cowpea growth rates are just as high as those for high-yielding legumes (e.g. soybeans) grown in temperate areas. Both soybeans and cowpeas grown at IITA produce total dry matter at rates up to 14 g/m^2-day during our rainy season (Annual Report, 1972). Gas exchange rates of individual leaves in the canopy are up to 55 mg CO_2/dm^2-hr., which are similar to the highest rates quoted for soybeans under field conditions in Illinois (Annual Report, 1974).

In spite of high total dry matter production, cowpea seed yields are only half to two-thirds those of soybeans. Inefficient partitioning of dry matter is partly to blame for this, particularly for the indeterminate varieties, which continue vegetative growth into the late productive period. This vegetative growth is of course encouraged by unfavourable photoperiod in photoperiodically sensitive varieties, but appears to be enhanced by low light intensities during growth, even in photo insensitive varieties. Coupled with inefficient partitioning is the short pod-fill period of individual pods, which averages only 19 days (Annual Report, 1973), though recently identified is a line with period of 24 days. Pod-fill time directly correlates with size of seed and pod (Table 1).

Table 1. The relationship of pod-fill time with seed and pod characters for 65 cowpea cultivars grown in second season, 1974.

Parameter	Mean	Range	Correlation with pod-fill time (r)
Pod fill time, days	19.3	16.5-24.2	-
100 seed weight, g	12.3	4.2-21.4	0.639^{***}
Seed wt. of 20 pods, g	27.6	8.0-55.6	0.325^{**}
Seed no. per pod	11.4	2.6-16.4	-0.432^{***}

Since the pod-fill time is so short, total yield is composed of the accumulation of yield over several pickings. The leaf duration of a variety determines how much yield will be accumulated. If leaf life is shortened due to disease or high temperature, yield will suffer (Annual Report, 1974). Compact varieties have a feed-back mechanism by which the ripening of the pods induces senescence of the leaves and thus limits the yield. We have been able to induce this in an indeterminate variety by flower removal, after which many pods were set all at once (Annual Report, 1973). We are thus faced with the dilemma of not wanting vegetative growth in the reproductive period because of inefficient yield production, but needing additional leaf area to overcome the senescence-induction of the first-ripening pods.

Source-sink relationship studies have indicated that compact varieties produce more than enough reproductive structures, but leaf area is limiting in the reproductive period. Removal of only one-third the leaf area at flowering decreases yield, whereas pod cutting in the "thin green" stage has no effect (Annual Report, 1974).

Recent work with carbon-14 indicates that the compact erect variety TVu 4552 stores from 8 to 15% of carbohydrates assimilated in the week before flowering and during early flowering; these later end up in the seed. A large portion (45-59%) of the assimilates were lost in respiration before final harvest.

Table 2. Translocation of C-14 after dosing of cowpea plants with $^{14}CO_2$ one week before flowering and at flowering. Plants were grown in pots out doors.

Time Dosed	Time Harvested	Original activity lost, %	Activity remaining in seed, %	Original activity in seed, %
1 wk. b.f.	48 hrs. later	32.34 ± 15.99*	-	-
1 wk. b.f.	At F.H.	58.78 ± 12.70	18.60 ± 2.34	7.73 ± 2.76
At flo.	48 hrs. later	24.92 ± 18.53	-	-
At flo.	At F.H.	45.46 ± 14.88	27.84 ± 2.53	15.09 ± 3.94

*Standard error.

Gas exchange of the pods of this variety is not high enough to give a net positive uptake of CO_2, but with increasing light levels, the high respiration rate of green pods and seeds is considerably reduced. The dark respiration of pods is very sensitive to temperature. Temperature dependance of the gas exchange of leaves is also a problem, with CO_2 uptake declining as leaf temperatures rise above 31-32°C. Since leaf temperatures above 35°C are fairly common under IITA field conditions in the early afternoon, high temperatures may limit gas exchange rates of leaves during part of the day.

Leaf development rate also shows a marked temperature dependence, with the time interval between appearance of successive leaves decreasing to half with a 5^o increase in average temperatures (from 24 to 29°C). The growth cabinet experiments of our Reading collaborators provide much more information on the effect of high temperatures on cowpea growth and yield. Further study is needed to determine if varietal differences exist in response to high day temperatures.