Tropical Root Crops

RESEARCH STRATEGIES FOR THE 1980s

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WEED INTERFERENCE IN WHITE YAM

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The effects of weed interference on the growth and development of white yam (Dioscorea rotundata Nwapo cultivar) were evaluated in an alfisol (Apomu sandy loam) in Ibadan, Nigeria. The evaluation indicated that weed interference ranged from 4 weeks to full season. From planting date, yam was more affected by weeds between 10 and 22 weeks than at other times. At about 10 weeks, the shoot exhibits greater growth than do the other growth organs (phase II), and this growth phase persists to 14 weeks after planting. The growth phase predominated by increased tuber bulking (phase III) is from 15 to 22 weeks after planting. Reductions in dry-matter accumulation in the crop roots, vines, and leaves as well as reductions in the fresh tuber relative growth rate were closely correlated with percent reductions in fresh tuber yield. The time that weeds caused serious reductions in tuber yields corresponded to the time interval during which loss in the growth and development parameters indicated yield-reducing potential. The adverse effects of weed interference during growth from 15 – 22 weeks after planting (phase III) was 65% more than that caused by weeds during maximum root development (phase I) and was 36% more than that observed at 10 – 14 weeks after planting (phase II) in white yam. The critical stages for weed interference in yam synchronized with the growth phases when leaf development and tuber bulking were maximal. Adverse effects at a given phase tended to be carried over to subsequent phases.

Recherche sur l’incidence des mauvaises herbes sur la croissance et le développement de l’igname blanche (Dioscorea rotundata Poir. cv. Nwapo) cultivée sur des affisols (glaize sableuse Apomu) à Ibadan, Nigeria. Les résultats ont démontré que la durée de l’action des mauvaises herbes s’étend de 4 semaines à la saison entière. De la 10e à la 22e semaine après la plantation, au moment de la levée, l’igname a été plus affectée par les mauvaises herbes. A environ 10 semaines, les racines étaient beaucoup plus développées que les parties aériennes, phase II qui dure jusqu’à la 14e semaine. La phase III, de 15 à 22 semaines après les semis, est caractérisée par le développement des tubercules. La réduction des matières sèches tirées des racines, tiges et feuilles et du taux de croissance des tubercules a été évaluée par rapport à la proportion de baisse de rendement en tubercules. La période pendant laquelle les mauvaises herbes ont le plus contribué à diminuer le rendement en tubercules correspond à celle prévue par les paramètres de croissance et de développement. Les effets nocifs des mauvaises herbes au cours de la phase III, soit de 15 à 22 semaines suivant la plantation, ont été jusqu’à 65% supérieurs à l’incidence sur la phase I et 36% de plus que sur la phase II. La période critique des effets des mauvaises herbes sur l’igname blanche correspond aux phases de croissance, au moment de développement maximal des feuilles et des tubercules. Les effets nocifs subis au cours d’une phase donnée se répercutent sur la suivante.

Crop-yield reductions due to weed interference are proportional to the amount of water, light, and nutrients used by the weeds at the expense of the crop (Blackman and Templeman 1938; Hurst and Feltner 1966; Wiese et al. 1964) and to the extent of allelopathic influence of the weeds on the crops (Grummer 1965; Winter 1961).

Weed interference begins early in the crop cycle and often persists through a major part of the growing season. It is caused mainly by weeds that emerge with the crop but also by weeds that emerge after the crop has become established (Hurst and Feltner 1966; Wiese et al. 1964). Kasasian and Seeyave (1969) and Nieto et al. (1959) reported that the first 30 days of the crops’ life are the most critical for competition from weeds in maize, beans, tomatoes, and sweet potatoes but that the critical period in yam is much longer.

Uncontrolled annual broad leaves and grasses that constitute the major weed problems in yam plots in the rain-forest zone of Nigeria have reduced yam yield by about 90% (Onochie 1974). This reduction was suggested to be attributable to injury inflicted by weeds during tuberization more than that during canopy formation (Onochie 1974). Work at IITA, Ibadan (1973, 1978), indicated that
the first 16 weeks after planting date are the most critical for competition from weeds with yams, and Onwueme (1975a, b) observed that tuber initiation occurs between 10 and 11 weeks after emergence. This period falls within phase II (6–13 weeks after the plant’s emergence) of a four-phase cycle of yam crop growth; it is characterized by foliage development and tuber initiation. Phase I (the period from sprouting to the sixth week after emergence) is characterized almost entirely by the development of a profuse root system and vine elongation; phase III by an increase in tuber bulk; and the final phase, IV, is marked by large-scale senescence of the shoot accompanied possibly by a decrease in tuber dry weight (Sobulo 1972; Njoku et al. 1973).

Although weeds are generally known to reduce tuber yield in yams, very little is known about the basis for this yield reduction. The objective of this investigation, therefore, was to determine the effects of weed interference on the growth and development in white yam and to identify the yield components whose sensitivity to weed interference contributed to the crop-yield reduction.

**MATERIALS AND METHODS**

The study was carried out in a research farm at the International Institute of Tropical Agriculture. The mean annual rainfall at the experimental site is 1400 mm distributed in two wet seasons — March–July and September–November. Air temperature varies from 20°C to 36°C. The soil is an alfisol (Apomu sandy loam). The environmental conditions favour rapid growth of both yams and weeds.

The experiment was set up in a randomized complete block design with three replications. Yam setts (400 g each) were planted at a spacing of 100 × 100 cm on ridges. Each treatment plot was 5 m wide and 10 m long.

The setts for the first and second replicates were presprouted tops, which either were at the two-node stage or were cut back to two nodes, whereas in the third replicate they were nonsprouted tops (thus, time of planting is used here as time of emergence because more than 66% of the total plant population had sprouted at planting time (Onwueme 1978). In any case, all the stands in replicate three had emerged by 4 weeks after planting date. The experiment was set up at the beginning of the rains. The first half of each plot was used for destructive sampling to obtain plant growth and development data. The remaining half was maintained for yam-yield determination. Fertilizer (NPK) was applied at the rate of 30 kg/ha (15:15:15), at 8 weeks after planting.

In one set of treatments, weeds were allowed to grow with the crop for 4, 8, 12, 16, 20, or 24 weeks after yam crop planting, following which the crop was kept weed-free until harvest by repeated hoe weeding. Control plots included plots that were kept either weed-free or weedy until crop harvest.

Three yam stands were randomly sampled for growth and development studies from the portions of the plots set out for destructive sampling. These samplings were taken at 4-week intervals beginning from 4 weeks after emergence and continuing through the 24th week. The data recorded for yams included those on vines, leaf dry-matter accumulation per stand (1 m²) per day, and fresh tuber relative growth rate (TRGR). We obtained TRGR by finding the Napierian logarithm of the actual weight or area measurement using the method described by Little and Hills (1972). Relative growth rate was used because, where data are subject to unavoidable variation, this figure in graphic representation provides a good indication of the nature of the growth (Evans 1972; Paterson 1949).

We obtained weed biomass data by sampling weeds from a 2-m² area in the centre of the two middle ridges in each plot. Biomass data as a function of the ecological activity were considered the best measurement for the weed species population in the experiment (Harper 1960; Truelove 1977). We analyzed data collected on yield compo-

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**Fig. 1.** Effect of weed interference on root growth and yield of white yam.
of depression in vine, leaf dry-matter accumulation, and TRGR were similar (Fig. 2 and 3). Reduction in leaf dry-matter accumulation occurred earlier than did the reduction in TRGR.

Uncontrolled weed growth significantly reduced dry-matter accumulation in yam roots. This reduction was most pronounced during phase I of the growth period (Fig. 1). The effect of weed interference became pronounced after 4 weeks of weed association with the crop. A close positive correlation between the reduction in root dry-matter accumulation and the reduction in crop yield was observed during the first 8 weeks after planting (Fig. 4).

At this stage of the crop’s life, the plant is partially dependent on the mother sett (Onwueme 1978) for its nutrient requirements; therefore, competition for nutrients between weeds and the crop is probably small. The observed reduction in root weight could have been caused by allelopathy.

Phases II and III were critical for vine growth in white yam. Uncontrolled weed growth caused up to 44% reduction in yam vine dry-matter accumulation. Maximum reduction in vine growth occurred at 12 weeks after plant emergence. A correlation existed between the percent loss in vine dry-matter accumulation and the percent reduction in yield at the 16th week (Fig. 5).

There was similarity in the patterns of dry-matter accumulation in the vine and leaves. This is to be expected, as the vine size determines the amount of

![Graph showing crop growth phases and weed interference](image)

**Fig. 2. Effect of weed interference on vine growth and yield of white yam.**

The major weeds at the experimental site were annual broadleaves, grasses, and sedges. The broadleaves included Acanthospernum hispidum, Ageratum conyzoides, Amaranthus spinosus, Commelina benghalensis, and Euphorbia heterophylla. The grasses were Brachiaria deflexa, B. lata, Digitaria horizontalis, and the sedges comprised Cyperus difformis, C. nemorallis, and Mariscus alternifolium.

Root, vine, leaf dry-matter accumulation, and the TRGR were affected by uncontrolled weed growth. Reduction in root growth occurred very early in the yam growth cycle (Fig. 1). The patterns to determine the pattern of growth and development of the crop in relation to the crop yield loss and the accompanying weed dry-matter weight. Correlation analysis was used in determinations of the relationship between yam growth parameters at the intervals in which they showed yield-reducing potential and the percent tuber yield at harvest, as affected by presence or absence of weed interference.

The sample data on the growth of organs were converted to a per-plant basis, whereas the fresh tuber yield at harvest and the weed dry weight at first weeding were converted to a per-hectare basis for data interpretation.

**RESULTS AND DISCUSSION**

The major weeds at the experimental site were annual broadleaves, grasses, and sedges. The broadleaves included Acanthospernum hispidum, Ageratum conyzoides, Amaranthus spinosus, Commelina benghalensis, and Euphorbia heterophylla. The grasses were Brachiaria deflexa, B. lata, Digitaria horizontalis, and the sedges comprised Cyperus difformis, C. nemorallis, and Mariscus alternifolium.

Root, vine, leaf dry-matter accumulation, and the TRGR were affected by uncontrolled weed growth. Reduction in root growth occurred very early in the yam growth cycle (Fig. 1). The patterns...
leaves the plant can support. Although leaf enlargement continues after vine elongation ceases, growth activities in these organs together with photoperiod and other environmental factors contribute to tuber development (Sobulo 1972).

In white yam, phase II constituted the critical period when weed interference reduced dry-matter accumulation in the leaf (Fig. 3). A reduction of 52% in dry-matter accumulation was recorded when the weeds were associated with the crop for the entire season. A positive correlation between the percent loss in leaf dry-matter accumulation and percent crop yield loss was observed during the first 16 weeks (Fig. 4). The effect of weed interference on dry-matter accumulation in leaves was most pronounced during the 8th and 16th weeks. Loss in tuber weight due to weed interference was also very pronounced during this period.

The data suggest that the reduction in the leaf dry-matter accumulation is more important in influencing the final crop yield than is reduction in dry-matter production in the vines or root. This is to be expected because the leaf canopy determines the amount of photosynthetic that is manufactured for subsequent translocation to other organs and for storage in the tuber.

The highest value in weed dry weight was observed at 8 weeks after planting date, declining thereafter (Fig. 3). The increase in weed growth possibly interfered with ambient light reaching the lower leaves of the crop, and this interference resulted in less dry-matter production in the growth organs and a reduction in the final yield. Yield reduction caused by shading of lower leaves has been reported for soybean (Johnston et al. 1969; Oliver et al. 1976). If this phenomenon operates in yam, then it is possible that one of the ways through which weeds exert their pressure on the crop is through shading. The contribution of allelopathy to yield reduction in yam cannot be ruled out.

Full season weed interference caused 35% reductions in TRGR in white yam at the 16th week. This period coincides with phase III in the growth cycle (Fig. 5). The closest positive correlation existed between the percent reduction in TRGR and the percent yield loss of white yam at the 12th and 16th weeks after planting date (Fig. 4).

In this investigation, 100% tuber initiation had occurred at the 12th week after planting. Root growth ceased at about the 10th week and was declining at the time of 100% tuber initiation.

Although the greatest depressions in the growth and development parameters and the final yield depressions were manifested at phase III, the damage done by weeds started during the phases I and II and was carried forward to subsequent growth stages.

**WEED INTERFERENCE DURATION**

The percent yield reduction in white yam steadily increased with weed dry weight up to the 8th week.
of weed interference; beyond this point the reduction continued at a decreasing rate (Fig. 1–3, 5). The percent yield reduction for weed interference up to 24 weeks was higher than that for full season interference. This finding possibly reflects moisture losses caused by exposure of topsoil as a result of weed removal late in the growing cycle of the crop, an operation that Kang (Moody and Ezumah 1974) suggested removes the mulching effect of the weeds.

The time that weeds caused serious reductions in tuber yield was synchronized with the intervals during which loss in the growth and development parameters indicated yield-reducing potential.

Based on the highest yield reduction in each phase, the adverse effect of weed interference during growth phase III was 65% more than that caused by weeds during phase I, 36% more than during phase II, and 10% less than during phase IV.

By the 8th week after crop emergence, weed biomass production had picked up in yam plots infested by weeds, and weed species were numerous and varied. By this period, the root growth of the white yam had been greatly depressed. Weed biomass production picked up at the crop vegetative phases I and II when reductions in crop growth parameters indicated yield-reducing potential. The data suggest that the injury inflicted by weeds on the crop early in the season, during vegetative growth, is magnified during the reproductive phase. Reductions in the crop growth and development parameters were closely correlated with percent fresh tuber yield reduction at harvest. Leaving the crop unweeded for any time from 4 weeks to full season produces some losses in crop growth and development and, consequently, in crop yield, but the greatest weed pressure is exerted during the vegetative and tuber-bulking stages.

We emphasize that the results apply to the environment and conditions under which this experiment was performed. Under different situations, with different weed flora, the results may be different.