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A REVIEW ON ROOT AND TUBER CROP PRODUCTION AND THEIR WEED MANAGEMENT AMONG SMALL SCALE FARMERS IN NIGERIA

Iyagba A. G.
Department of Agricultural Science, Rivers State College of Education, Port Harcourt, Nigeria
E-Mail: apegragba@yahoo.com

ABSTRACT

Weed infestation is one of the constraints the small scale farmers in Nigeria must contend with in the cultivation of root and crop tubers. The effects of weeds on the cultivation and yield losses in root and tuber crops are discussed. The concepts of weed control and weed management are differentiated in this paper. The approaches in weed management include cultural method mainly by hand weeding at different weeding regimes for various crops, biological method using low growing crops, chemical method using various herbicides and suggested ways of over-coming the constraints on herbicide use and integrated weed management practices such as applying herbicides with cultural and biological practices.

Keywords: weed management, tuber crops, root crops, production, yield, losses, Nigerian farmers.

INTRODUCTION

Root crops are the edible energy-rich underground plant structures developed from modified roots while tuber crops are those crops in which the edible carbohydrate-rich storage organs develop wholly or partly from underground stems (Okigbo, 1989).

Root and tuber crops are important in the sub-Saharan Africa especially in Nigeria as they form a major part of the staple food consumed by the populace. The major root and tuber crops grown in Nigeria are Cassava (*Manihot esculenta*), Yams (*Dioscorea spp*.), Sweet potato (*Ipomoea batatas*), Cocoyams (*Xanthosoma spp* and *Colocasia spp*), while others which are gaining prominence are Carrot (*Daucus carota*), Ginger (*Zingiber officinale*) and Irish potato (*Solanum tuberosum*). They are historically and currently more than 90% of them are mainly used as food (Quin, 2001). They are mainly carbohydrate energy food staples, used by rural and urban communities in fresh and processed food preparations. Some are used as substitute for wheat flour in bread, cake and pie making (Cassava) and some confectionery uses (e.g. Cassava flour for biscuits). Some are used as animal feed; residues - Cassava, Sweet potato, yams; direct use - cassava; agro-industrial uses (e.g. starch, alcohol), the peels in organo-mineral fertilizers formulation and raw materials in the textile and pharmaceutical industries and battery casing (Ojeniyi, 2001; Akanbi, *et al*., 2006). Cassava recently has become the magic crop as a result of the Presidential initiative on Cassava production few years back with good export potential. In all, sub-Saharan African produces about 20% of the world's total production of root and tuber crops, for about 10% of the world's total human population (Quin, 2001). The different tiers of government in the country are supporting the small-scale farmers who are the major food producers in their recently introduced Cassava cultivation programme.

It is worthy to note that the root crops occupy a strategic position among cultivated crops and the positions they occupy vary in the different agro-ecological zones in the country. While in the Southern part of the country Cassava occupies the first position, it is Yams in the middle belt and in the semi-arid region Sorghum with Cassava occupying the 8th position (Amans *et al*, 2001; Olaniyan *et al*; 2001).

CONSTRAINTS IN ROOT CROP PRODUCTION

Realizing that there are benefits accruable in the cultivation of root crops in Nigeria, efforts must be put in obtaining good production level. However, there are lots of constraints in achieving this.

Table-1. Major constraints to cassava expansion in the semi-arid zone of Nigeria.

Constraints	**Frequency of responses number (%)**
Production	
Insufficient knowledge	11 (31.4)
Damage/threat by livestock	11 (31.4)
Insufficient rainfall	4 (11.4)
Poor varieties	3 (8.6)
Pests and diseases	3 (8.6)
Lack of planting materials	2 (5.7)
Lack of farmlands	1 (2.9)
Total	**35 (100)**
Post-harvest	
Insufficient knowledge	22 (45.8)
Lack of processing machine	24 (50.0)
Lack of suitable varieties	1 (2.1)
Lack of market	1 (2.1)
Total	**48 (100)**

Source: Amans *et al*. (2001).

From the survey conducted by Amans *et al;* (2001) the major production constraints in the semi-arid region of Nigeria for root crop production were poor knowledge of efficient production process methods (31.4%), damage by livestock (31.4%), poor rainfall (11.4%), unsatisfactory varieties (8.4%) and pests and diseases (8.4%) among others (Table-1) while pests and diseases is the major production constraint in the South-eastern part of Nigeria (Iyagba, 1994; Iyagba and Ayeni, 1997). Ayeni (1991) revealed that the number one pest which farmers contend with in 25 out of 30 common crops were weeds. The major weed types encountered is a function of the crop type and agro-ecological zone.

EFFECT OF WEEDS ON ROOT AND TUBER CROP PRODUCTION

Cassava, Yams, Cocoyams, Irish potatoes and a host of other root crops have a slow rate of initial growth and this makes them poor weed competitors. They are susceptible to severe weed competition at their early stages of growth (Onochie, 1978). According to Milthorpe (1967) three phases of growth may usually be recognized in root crops as follows:

a) that of pre-emergence, which involves the establishment of an auto-trophic plant and the use of materials stored within the mother organ;
b) that in which leaf growth is predominant; and
c) that in which growth of the storage organs occur.

These three phases may spread over a period ranging from 4 to 12 weeks depending on the crop. During this protracted period, weed growth is rapid and luxuriant. Again, owing to the wide spacing of the root crops in the field, crop canopy develops slowly and weeds take advantage of the sunlight to grow. In the humid tropical environment where rainfall, humidity and other favourable growth factors are available in abundance, weeds grow fast and become well established before the initial slow growing tuberous crops established.

Weeds which emerge during the first three months after planting are known to endanger yields more than those appearing later. It has been shown that the most damaging effect on yield was weed competition with Cassava plants during canopy formation and early tuberization (third month after planting) and less from the 4th month until harvest (Onochie, 1974; Onochie, 1975).

According to Chikoye (2000) precise information on the total economic impact of weeds on crop production has not been properly documented because methods for estimating yield losses often differ and do not allow easy comparison of results from different regions of the country. However, Oerke *et al.* (1994) indicated that losses due to weeds were substantial (Table-2).

In order to reduce potential crop losses root crop farmers spent large proportions of resources for weed management and the investment made according to Chikoye (2000) to minimize weed infestation usually exceeds those on other pests combined. He further stated that in 1997 herbicide sales world-wide were twice those of fungicides and insecticides combined. Research findings revealed that in small scale production systems, which dominate Nigerian agriculture, it has been estimated that weeding alone consumes approximately 30 to 50% of total labour budget depending on the crop and the level of other available resources (Akobundu, 1991; IITA, 1987). Nkakini *et al.* (2006) recorded that farmers in Rivers State utilized 43.8 man days/ha for ridging and cassava planting, 57.8 man days/ha for mound making and yam planting while general weeding used 40.0 man days/ha and root weeding using 36.7 man days/ha. Nkakini *et al.* (2006) further noted that farmers in the state spent energy of 317.09 MJ in weeding yam/cassava compared to 345.60 MJ per hectare for general weeding using manual labour.

Table-2. Crop losses due to weeds in selected food and cash crops of Nigeria.

Crop	Percentage yield loss
Maize	18-60
Sorghum	51
Rice	28-100
Cassava	48-90
Yam	70-91
Cowpea	35-83
Soybean	40-53
Groundnut	54
Wheat	60

Source: Oerke *et al*. (1994).

THE CONCEPT OF WEED CONTROL AND WEED MANAGEMENT

Weed control used to be the main focus for years until scientist found out better ways of combining various methods of control and redefining it as management instead of control (Ogunnaike, 2000). It is usually thought that weed control is synonymous with or euphemism for weed management (Terry, 1991). According to Okereke (2000) there is a subtle difference between the two. Weed control according to Okereke (2000) connotes 'task work' or 'brigade attack' on established weeds and weed control methods are largely instantaneous, quick and short lived while weed management on the other hand implies that some long or short-term strategy is employed and involves some degree of foresight and predictability in order to plan treatments and integrate them into the cropping activities.

Akobundu (1987) suggested that weed control refers to those actions that seek to restrict the spread of weeds, and destroy or reduce their population in a given location and that weed control is a required input in most crop production ventures. He further stated that in food production the effectiveness of weed control is affected by the type of crop grown, timing of the weeding operation,

the nature of the weed problem, methods of weed control available to the farmer, type of weeds to be controlled, cost of the operation, available labour or cash resources and environmental conditions before, during and after the time of operation.

Akobundu (1987) posited that "weed management is the ability to manipulate weeds so that they do not seriously interfere with mankind's efficient use of their environment". He also revealed that in relation to agricultural activities, weed management refers to how weeds are manipulated so that they do not interfere with the growth, development and economic yield of crops and animals. He further observed that "weed management encompasses all aspects of weed control including prevention and spread, together with those labour - use practices and modifications in the crop habitat that interfere with the weed's ability to adapt to its environment". The practical implication of weed management practices involves the judicious use of weed control practices to minimize weed introduction, spread, competition with crops and adaptation to given habitats, Akobundu (1987) also stated. Weed management, therefore, is not only concerned with the basic weed control methods but also how these methods relate to the various manipulations of weeds, other organisms and the environment. The major components of weed management are preventive weed control, cultural control, biological and chemical weed control and each consisting of one or more methods for control and prevention of the spread of weeds.

WEED MANAGEMENT IN ROOT AND TUBER CROPS BY NIGERIAN SMALL SCALE FARMERS

The Nigerian agricultural and cropping system is still dominated by small scale farmers who practice the traditional bush fallow system despite the existence of few large scale irrigation projects in the country (Agboola, 2000). More than 55% of the farms are less than four hectares and farm sizes are relatively small in the southern states, especially in the south-east and that weeding alone consumes approximately 30-50% of total labour budget depending on the crop and the level of other available resources (Agboola, 2000; Akobundu, 1991; IITA, 1987). Weed control by small scale farmers are usually labour intensive and arable crop production in the tropics is usually associated with annual weed growth which include hard-to-eliminate perennial and parasitic weeds.

The commonly practiced weed management systems among the Nigerian small scale root and tuber crop farmers are discussed below.

1. Cultural weed management

This refers to all aspects of good crop husbandry used to minimize weed interference with crops. These consist of hand weeding, mechanical weeding, tillage, mulching, burning, flooding and crop rotation. The small scale farmers because of low income status prefer to use hand weeding to control weeds in their root and tuber crop cultivation. This probably is the oldest method of weed control and consists of hand-pulling, hand-slashing, hoeing, and mowing of weeds. This method is also common in root and tuber crops because nearly all of them are produced by small scale farmers in multiple-cropping systems. Hoe weeding is used in cassava, yams, cocoyam and sweet potato. In cassava, poor timing of hoe weeding resulting from other farm demands on the farmers' time during the first 3 months accounts for most of the yield losses associated with weeds in this crop. The recommended hand weeding regime for cassava is 3, 8 and 12 weeks after planting (WAP) in Nigeria (IITA, 1990; NACWC, 1994). It is expected that the improved varieties like TMS 30572, and TMS 4(2) which are high yielding and low in cyanogenic content would by this third weeding produce adequate canopy to suppress weed growth at a plant population of 10,000 plants/ha. Resource poor farmers whose land holdings are about 0.2 - 0.5ha mainly produce various species of yam of which the most popular variety cultivated in Nigeria is *Dioscorea rotundata* (Nigerian White Guinea yam) (Ikeorgu, 2000). Yams are traditionally grown on small scale farms as components of multiple-cropping systems. This crop requires a minimum of three weedings during the first 16WAP according to Akobundu (1987). Mulching is occasionally used by the farmers especially in seed yam production but the logistics of procuring and transporting mulch limit its use. Cocoyam is weeded twice at 3 and 8 WAP because the plots are particularly prone to be weedy during the first three to four months when the leaf canopy is sparse. When canopy closure occurs, weeds are kept reasonably in check. Sweet potato face weed problem only during the first two months of growth. After this period, vigorous growth of the vines cause rapid and effective coverage of the ground surface and smothers the weeds present (Onwueme, 1978). For this reason, most small scale farmers do not bother to weed sweet potato plots. However, a single weeding at 3WAP has been recommended by Akobundu (1987). In all these crops adequate care should be taken to ensure that the developing tubers and storage roots are not damaged during weeding and exposed to sun light.

2. Biological weed management

Biological control of weeds refers to the control or suppression of weeds by the action of one or more organisms, through natural means, or by manipulation of the weed, organism, or environment (Anon, 1985). The manipulation of plant population, spatial arrangement and ground cover management are been used in root and tuber crops as biological weed control methods. Egusi (melon) is traditionally inter-cropped with cassava or yams. Okeleye and Salawu (1999) have recommended the intercrop of cassava (10,000 plants/ha) and melon (30,000 plants/ha) as an effective means of controlling weeds in cassava plots. Nwagwu *et al* (2000) have also recommended the use of melon in cassava to control weeds while Zuofa *et al* (1992) suggested the use of cowpea, melon and groundnut intercropped with cassava to suppress weeds. Iyagba (2005) reported that weeding

carried out at 3 and 8 WAP in a cassava-fluted pumpkin intercrop at plant populations of 10,000 and 26,667 plants/ha respectively will produce greater cassava tuber yields and fresh leaf weight of fluted-pumpkin.

3. Chemical weed management

Akobundu (1994) reported that "Weed control practices have not changed significantly in the developing countries in the last 25 years despite that more people have been trained in weed science, more research activities have been initiated in these parts of the world, and there have been greater awareness of weed problems than in the past." Enough research has been carried out in screening several herbicides for weed control in root and tuber crops. This is reported in Table-3.

Table-3. Herbicides for weed control in root and tuber crops.

Herbicide	Rate (kg a.i./ha)	Crop	Time of application	Weeds controlled
alachlor	2 - 3	Cassava, Yams, Sweet potato	PE	Annual grasses
Atrazine + metolachlor	2.5	Cassava, Yams	PE	Broad spectrum control of annual weeds
Chloramben	2 - 4	Sweet potato, cocoyam	PE	Control of annual broad weeds
Chlorobromuron	1 - 4	Sweet potato	PE	Annual weeds
diuron + paraquat	2.8	Cassava, Yam	E-Post	Annual weeds
Fluometuron	2 - 3	Cassava, Yams	PE	Annual broad leaves
Fluometuron + metolachlor	2 + 2	Cassava, Yams	PE	Annual broad leaves and grasses
Fluometuron + pendimethalin	2 + 2	Cassava, Yams	PE	Annual broad leaves and grasses including *Rottboellia spp*
Metobromuron	1.5 + 2.5	Sweet potato	PE	Annual broad leaves
Fluazifop-butyl fb bentazon	0.75 + 2.0	Cassava	Post-E	Annual and perennial broad leaves and grasses

Source: Akobundu (1987) and Iyagba (2003).
PE = post-emergence; E-Post = Early postemergence; Post-E = Postemergence; Fb = followed by

Iyagba and Ayeni (1997; Iyagba and Ayeni, 2000a; b) have also reported the use of fluazifop-butyl (0.75 kg a.i. /ha) followed by bentazon (2.0 kg a.i. /ha) to control siam weed and guinea grass in cassava plots applied at 21 days after planting. The use of herbicides in Nigeria has led to sharp increase in farm sizes, and the need for other methods of weed control that will be appropriate for large scale cassava production especially with the Presidential initiative on cassava production few years ago. The new technology on yam mini-setts for large scale yam cultivation has warranted an increase in the use of herbicides to control weeds in yam plots. According to Akobundu (1987) sweet potato is one of the root and tuber crops where chemical weed controls is most promising because the crop is sensitive to weeds for a short time.

Improvement in crop yields in the industrialized countries can be partially attributed to the development of better weed control systems, specifically chemical weed control. In those parts of the world chemical control is still the cheapest means of combating weeds. However, many small scale farmers in Nigeria do not rely heavily on the use of herbicides to fight against the weed menace because of multitudes of problems. According to Fadayomi (1991) these problems are the cost of herbicides which are too expensive for the resource poor peasant farmers. Most of the peasant farmers find spray calibration and operation too complicated while adverse effects resulting from improper use of sprayers (crop injury, accidents encountered during spraying due to lack of protective wears, lack of weed control) discourage farmers from adoption of chemical weed control. Kolo (2004), Ojimba and Iyagba (2004), Ikuenobe *et al.* (2005) and Iyagba and Gedi (2005) have recently again reported of low adoption of this technology in Niger, Rivers and Bayelsa states and in three agro-ecological zones of the country. Chikoye (2000) indicated that to overcome the constraints facing the small scale farmers in adopting the herbicide use technology has suggested the followings:

a) dressing of crop seed by herbicides could reduce cost, as small quantities of herbicides would be required,
b) packaging of chemicals in quantities appropriate for small hectarages,
c) more user friendly herbicide labels, written in local languages, will enable farmers use herbicides more safely,
d) adequate technical support in areas of matching herbicides to the dominant weed communities and crops and
e) training farmers in proper spray calibration, time of application, and safe disposal of herbicides.

4. Integrated weed management

Integrated weed management (IWM) as pointed out by Akobundu (1987) "is neither a method nor a system of weed control, but a philosophy whose goal is to use all available knowledge in weed science to manage weeds that they do not cause economic loss to humans" and that a high priority in IWM is the efficient and economical use of resources while minimizing the hazard to the environment. He further opined that an appropriate IWM is one that economically combines two or more weed management systems at low inputs to obtain a level of weed suppression superior to that ordinarily obtained when one weed management system is used. Weeds encountered differ from one ecological zone to the other and in different farming systems in Nigeria.

IWM is more needed in root and tuber crops than in any other type of food crop (Akobundu, 1987). These crops according to the author have long growing seasons that make a dependence on herbicides inappropriate, particularly as none of these herbicides selective in yam and cassava persists in the soils at dosages that will give good weed control for more than 12 WAP. Combining the manipulation of plant canopy (through changes in row spacing and spatial arrangement of root and tuber crops) with other methods of weed management, has been used either to reduce input levels in chemical or cultural weed control systems or to make them more effective (Akobundu, 1987). Use of low growing crops such as fluted-pumpkin with cassava reduced the three times suggested weeding regime in cassava at 3, 8 and 12 WAP to two weeding regimes at 3 and 8 WAP by manipulating the plant population of fluted pumpkin to 26,667 plants/ha and cassava at 10,000 plants/ha (Iyagba, 2005). Emphasis should be on improving the adoption of chemical control as a component of IWM.

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