Weed Control in Maize/Legume Intercrops

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Introduction

Maize is the most important cereal crop produced in eastern Africa and it is often intercropped with legumes. The most important intercrop combinations are: maize with beans, cowpeas, and with pigeon peas. Almost all the farmers in eastern Africa that practise intercropping can be defined as small-scale farmers. It has been suggested that the small-scale farmer intercrops maize and legumes primarily for the following reasons: to maximize the productivity of land, particularly in the high rainfall areas where land is often limited; to produce the variety of food that is preferred in the diet of the farm family; and to minimize the risk associated with unreliable rainfall. Though land is mentioned as a constraint to the small-scale farmer, labour is often even more limiting. It is estimated that hand weeding may utilize 35-70% of the total agricultural labor. Maximizing the returns to labor, and spreading out the demand for labor throughout the growing season when possible are logical strategies used by the farmer.

Competition for light, mineral nutrients, water and space by weeds is one of the most serious constraints to achieving the economic yield potential of maize based cropping systems in the tropics. Though the actual yield losses due to weeds vary from environment to environment, and from year to year and even from farmer to farmer, almost every farmer must expend considerable scarce resources to ensure that these losses are within tolerable limits. Weed control is often a year long process that includes factors such as the method and timing of land preparation as well as the actual removal of weeds from the growing crop.

Here I will briefly describe the methods of weed control commonly used in eastern Africa, describe some of the issues related to weed control in intercrops, and conclude by discussing some general aspects of weed control that need further research.

Current Methods of Weed Control

Weed control in most environments begins with the preparation of land for planting. Land preparation is done by hand, with the use of animal traction and with tractors. The principal objective of land preparation related to weed control is to destroy any living vegetation, and to remove subterranean plant parts from which perennial weeds will propagate. Weeds arising from rhizomes and rootstalks often cause the most damage to the crop and require the most effort to control once the crop is established. In areas of high weed pressure, such as the coast of Kenya and the 'fertile crescent' in Uganda, tractor-pulled implements are the preferred means of preparing land, because they do a better job of burying existing vegetation and destroying vegetative shoots. Land prepared using tractors on the coast of Kenya requires significantly less labor for the first weeding than does land prepared by hand. For the most part, land preparation by tractors consists of a single ploughing with a disc plough.

Animal traction is often used in the drier areas of Eastern Africa, and throughout Ethiopia. One advantage of preparing land with animals is that significantly more area can be ploughed in a day than can be prepared by hand. In some environments, there is considerable advantage in delaying the final ploughing until after the onset of the rains and the first flush of weed seeds has germinated, thus reducing weed pressure early in the season. This is practised in some areas where moisture conservation is not an overriding consideration.

Land preparation, using a hand hoe, usually begins well before the onset of the rains. In some areas large beds are used for planting. These beds are split at the time of land preparation, and a new bed is formed from the sides of two neighboring beds. This method allows for the inversion of the soil and the burying of weed seeds and rhizomes up to 30 cm deep in the soil. This method is usually restricted to small areas because it is time consuming, and labor demanding. In most areas hand hoeing merely scrapes the soil surface and rarely inverts the soil to any depth. Plant residues are often burned in conjunction with the hoeing. In areas where perennial weeds are a problem, a hoe is used (sometimes a forked hoe) to bring the rhizomes to the surface of the soil to allow them to dry and die before the onset of the rains. In farms where weed control has been good throughout the season, very little soil disturbance may be required, and land preparation begins while the crop is still in the field (in areas of bimodal rainfall where maize/beans is followed by maize/beans e.g. Embu district in Kenya).

With the exception of areas where animal traction is abundant, most weeding during the cropping season is done by hand. When planting patterns permit, inter-row weeds are controlled using a hand hoe. Typically the hand hoes used for weeding have a smaller blade than those used for land preparation. In plantings where there are no distinct interrows, weeds are removed by hand, or with the blade of a cutlass or knife. The number of weedings required for good weed control will vary from area to area, but generally two are sufficient. Depending on competing activities,

weed control commences soon after the emergence of the crop. In some systems, the planting of the legume may correspond with the first weeding of the maize crop. The quality and timeliness of the first weeding is critical for efficient production. Research has shown that crop yields are not affected if the first weeding is thorough and timely, regardless of the method of land preparation used (Kamau and Odhiambo, 1987). The first weeding is often delayed, however, because of the tediousness of the task and because of adverse weather. Not only is the first weeding delayed for at least part of the field, an essential second weeding may also be omitted (Vernon, 1978).

In systems where animals are abundant, the first weeding is often done using draught power. If animals are used, the spatial arrangement of the intercrop must be such that it will allow the passage of the animal and implement without destroying the crop, necessitating the planting of the maize and the legume in the same row. Even when using draught animals, the timeliness of the first weeding is often dependent on the availability of animals, particularly if the animals are hired. Intra-row weeding is usually done by hand, and can be a serious constraint to production (Seubert *et al.*, 1985).

Issues Related to Weed Control in Intercrops

Generally, the most important issues related to weed control within an intercrop are similar to those of monoculture maize. These issues include the timeliness of weeding and the reduction of weed seed levels in the soil. I highlight only those issues that are more related to intercrops.

Issues related to labor requirement

The amount of labor required to adequately control weeds in an intercrop relative to a monocrop depends largely on the cropping system and the spatial arrangement of the intercrop. Generally, given the management practices used in Eastern Africa, the amount of labor required for the first weeding in a maize/bean intercrop greatly exceeds the amount required for monoculture maize. In eastern Africa, maize is planted in rows and beans are planted in a random fashion throughout the maize inter-row space. This spatial arrangement requires that weeding be done around each plant, precluding the rapid weeding of the relatively large unobstructed inter-row area that is characteristic of row planted monoculture maize. In systems where the beans or other legumes are planted in the same row or in the same hill as maize, the differences in time requirement for weeding an intercrop and a monocrop are generally minimal. The yield of the legume in the latter type of arrangement is predictably lower than the former, however. Planting a single row of legume equidistant between maize rows results in a substantial increase in the productivity of the legume when compared to the within-row planted system, yet it requires substantially less labor during the first weeding than the randomly planted legume system. The major drawback of the single legume row, is that it apparently requires more labor at planting than either of the other systems described (I have no hard data to support these last statements, they are based primarily on discussions with researchers and farmers addressing this issue).

In a well managed intercrop, the second weeding will generally require less labor than for a pure stand of maize. This is because the additional crop plants out-compete the weeds for vacant ecological niches (Mugabe *et al.*, 1982).

Issues related to herbicide use

Herbicides are not widely used in eastern and southern Africa nor are they likely to become important over an extensive area in the near future given current agricultural policies. Nevertheless there are several areas where herbicides are and will be an important technology for the small-scale farmer. These areas include environments with high levels of weed pressure such as the humid lowland tropics and where the majority of the weeds are perennial. A second area where herbicides are used is where there is significant off-farm activities, so the farmer has cash but little time to farm. Farming systems that include labor intensive cash crops such as coffee and tea, may also lend themselves to the effective utilization of herbicides.

One problem of using herbicides in a maize/legume intercrop is that there is a limited selection of herbicides that will control weeds without also injuring one or both of the crops. Atrazine, the most commonly used and least expensive maize herbicide, for example, cannot be used on a maize/bean intercrop because of its phytotoxicity to the beans. By the same token a bean herbicide like chloramben, cannot be used because of its phytotoxicity to maize. Though the selection might be limited there are a few herbicides available for use in a maize/bean intercrop (see Table 1). Of these herbicides the most readily available in eastern Africa are: Linuron, alachlor, metolachlor, bentazon, and pendimethalin. Mixtures of suitable herbicides are also commercially available; linuron plus alachlor is the most common in Kenya, and metolachlor plus chlorbromuron in Tanzania. CIAT recommends fenmetaline, EPTC + protector, and

linuron + fluorodifen as other useful herbicides for a maize/bean intercrop (Davis and Smithson, 1986).

One of the main drawbacks of herbicide use in eastern Africa is the fact that proper application requires a relatively high level of skill. There is substantial risk involved for the small-scale farmer when purchasing inputs, particularly when they are improperly applied. Appropriate application techniques need to be developed and/or taught if herbicides are going to gain widespread use in the farming systems for which they are well suited.

Some of the questions that need to be asked in the development of a research program relative to the issues raised here are:

Labor and weeding-

a) Is the farmer interested in distributing the labor demand over a longer period of time, and what activities compete with the labor required for land preparation, planting and weeding?

b) What is the relative importance of the maize and the legume to the farmer? How much maize or bean yield would the farmer be willing to sacrifice for a saving of labor?

c) At what period is labor most limiting (valuable)?

Herbicide use-

a) Does the farmer have an excess of cash relative to labor?

b) Is the farmer currently hiring labor for weeding?

c) Are there problem weeds in the system that defeat the farmer's attempts to control them by hand?

d) Can the resource requirements, other than just those used for weeding the intercrop, be reduced through the use of herbicides (i.e. can the need for resources for both tillage and weeding be reduced through the application of herbicides in a zero tillage approach)?

e) If the labor required for weeding an intercrop can be reduced, are there other enterprises that will benefit?

Areas Needing Further Research

It is a difficult task to describe in general terms what research is needed, as the problems and circumstances of each environment can vary substantially. There are some general points that should be considered in the development of a weed control program in a maize/legume intercrop, however.

The first point is that research on weed control should not be undertaken unless there is a well-defined problem. Doing research on weed control in an intercrop just for the sake of doing research is a waste of resources. Identifying weed control problems is best done through interaction with the farmers, and by observing the crop in the field (i.e. through diagnostic activities).

Secondly, it is important that the objectives of the farmer for growing an intercrop are well understood, and that the research takes these objectives into account. For example, there is little point spending time to develop intercropping technologies that might conflict with the farmer's desire to spread out the demand for labor uniformly throughout the season.

I believe that these points in addition to the issues raised earlier in this paper indicate that future research related to weed control in maize/legume intercropping must look more closely at the labor used/required in controlling weeds. When developing a research program it is beneficial to bear in mind that weed control requires more labor than probably any other crop management activity and that in order for a new technology to be acceptable to the farmer, it must not increase the demand for labor beyond an acceptable range.

One final point that needs mentioning is that the interaction between any new technology under development and the weed management of an intercrop should be investigated as part of the research process. For example, if the spatial arrangement of an intercrop is altered significantly, information on how this will affect the labor requirements of weeding should also be obtained before the technology is released to the farmers.

References

Davis, J.H.C., J.B. Smithson (1986). Principles of inter-cropping with beans. CIAT, Cali, Colombia.

Kamau, G.M., and G.D. Odhiambo (1987). Maize Agronomy Report to the National Maize Committee Meeting. Coast Agricultural Research Station, Mtwapa, Kenya.

Mugabe, N.R., M.K. Sinije, and K.P. Sibuge (1982). A study of Crop/ Weed Competition in Intercropping. In C.L. Keswani and B.J. Ndunguru (eds). *Intercropping: proceedings of the second Symposium on Intercropping in Semi-Arid Areas.* Ottawa Ont. IDRC.

Seubert, C.E., A. Low, J. Curry Jr. (1985). An on-farm research approach to the identification of appropriate weed technology for maize in Swaziland. Agronomy Abstracts p 38.

Vernon, R. (1978). Weed problems and control strategies in Zambia. In Akobundu, I.O. (ed) *Weeds and their control in the humid and subhumid tropics.* Proc. Ser. No. 3 Int. Inst. Trop. Agric., Ibadan, Nigeria. pp 221-227.

Table 1. Herbicides with potential for use in a maize/bean intercrop.

Common name	Trade name	Compound group	How applied
Alachlor	Lasso	Amide	Pre-emergence
Bentazon	Basagran	Benzothiadiazole	Post emergence
Chlorbromuron	Maluron	Substituted Urea	Pre-emergence
EPTC	Eptam	Carbamate	PPI
Fenmetalline[1]	-	-	-
Fluorodifen[1]	-	-	-
Linuron	Afolan, Lorox	Substituted urea	Pre-emergence
Metolachlor	Dual	Amide	Pre-emergence
Pendimethalin	Prowl, Stomp	Dinitroaniline	Pre-emergence
Metolachlor+ Chlorbromuron	Galex	-	Pre-emergence

[1] No technical information was found on these herbicides.