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Management of Moringa Pests.

Developing management strategies for pests of *Moringa* species in Kenya.

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Abstract

High value tree crops are increasingly being sought for domestication and development into sustainable agroforestry technologies. Such trees can provide products and services that will improve the livelihood of the resource-poor farmer and also help protect the environment. One group of tree species with such potential belongs to the family Moringaceae occurring in tropical Africa, Madagascar, the Middle - East and the Indian sub-continent. They are drought tolerant and mainly found in sub-humid to arid conditions. Our current research focus in Kenya is on two species: *Moringa oleifera* Lam., a naturalised species which was introduced to eastern Africa in the early part of the century from India; and the indigenous *M. stenopetala* (Buk. f.) Cuf.

Moringa oleifera is the most widely distributed and domesticated species. Its tender fruits are highly prized as a nutritious vegetable by the Indian communities. Other edible parts include the leaves, flowers and seeds. The seeds can also be used as a natural coagulant for water treatment. Virtually every part of the plant (including roots and tubers) has some kind of remedial or curative properties (herbal medicine).

Recently *Noorda blitealis* (Walker) (Lepidoptera: Pyralidae), a 'new' pest of moringa has been reported in several areas of Kenya. The pest manifests itself by defoliation of leaves and flowers, and occasional leaf mining, rolling and debarking of stems, branches, twigs and fruit capsules. The infestations peak just after rainy seasons or during droughts. Although the trees are often resilient, the damage can be so severe that the above ground biomass of the socio-economically important products such as leaves, fruits and seeds decline.

Consequently, an integrated management strategy has been initiated starting from a catalogue of all insect fauna of *Moringa,* delineating their status. Recently an on-station chemical control programme has been instituted in order to develop appropriate protocols for future control of the pest. This paper describes some of our observations and findings to date.

Introduction

High value tree crops are increasingly being sought for domestication and development for use in agroforestry technologies. Such trees provide products and services that will improve the livelihoods of the resource-poor farmer and also help protect the environment. Ideal agroforestry tree species should have an array of desirable attributes such as fast growth, ability to improve soil fertility and stability, and provision of marketable products, among others.

Some domesticated members of this monogeneric family of trees and shrubs, the Moringaceae, have been shown to be of economic importance in various parts of the world. There are currently about 10-12 known or described species with geographical distribution in Africa, Madagascar, Middle East, India, the West Indies, South East Asia and the Americas where they are indigenous, naturalised or only recently introduced (Ramachandran *et al.*, 1980; Morton, 1990; Cáceres *et al.*, 1991). In Kenya, there are about six known species namely:- *Moringa oleifera* Lam. (syn. *M. pterygosperma* Gaertn.), *M. stenopetala* (Bak. f.) Cuf., *M. arborea* Verdc., *M. borziana* Mattei, *M. longituba* Engl. and *M. rivae* Chiov. Other species occurring elsewhere include *M. ovalifolia* Dinter and Berger in Namibia, *M. drouhardii* Jumelle in Madagascar, *M. concanensis* Nimmo in the East Indies and India, and *M. peregrina* (Forssk.) of north eastern tropical Africa, Syria and Palestine. The Kenya Forestry Research Institute's current interest in the family Moringaceae focuses on two species. One is *M. oleifera* (the drumstick or horseradish tree), a naturalised species in Kenya that was introduced from its native India in the late 19th and early 20th centuries by colonial plant enthusiasts and migrant workers (Berger *et al.*, 1984). The other is *M. stenopetala*, an indigenous species that occurs naturally mainly in riverine or lakeside habitats of Rift Valley Province (Beentje, 1994). *Moringa oleifera* is geographically the most widely distributed species and perhaps also the most economically important species within the family Moringaceae. In Kenya, *M. oleifera* can be found in the Coastal lowland, Eastern and Rift Valley Provinces and Lake Victoria regions. The main *M. oleifera* resource areas, representing the early introductions and now naturalised populations include Likoni (near and around Mombasa), Mbololo (near Voi) and Kibwezi-Makueni in Eastern Province. Our current genetic analysis on the Kenyan *M. oleifera* populations using multi-locus molecular assays (RAPDs and AFLPs) suggest at least two sources of germplasm introductions to Kenya (Muluvi *et al.*, submitted).

The highly prized tender fruit used in various culinary preparations is perhaps responsible for the nearly worldwide distribution of *M. oleifera* from its native range in the sub-Himalayan tracts. The tender fruits can be cooked and eaten like spinach or peeled, chopped and added to curries. The leaves and flowers are cooked and eaten as vegetables while seeds are consumed after roasting or frying (Ramachandran *et al.*, 1980; Jahn, 1986). The roots are pungent and taste like horseradish and can be used as a condiment or garnish. The leaves and twigs are sometimes used as fodder. The tree has also medicinal values. Virtually every part of the plant namely: roots, tubers, leaves, flowers, bark and seeds are variously employed in indigenous herbal medicine (Ramachandran *et al.*, 1980; Morton, 1991). The seeds contain high quality edible oil comparable to olive oil, which is also used for illumination and in cosmetics industry (Ramachandran *et al.*, 1980). In recent years, the seeds of *M. oleifera* have increasingly being used to clarify or purify turbid or brown surface water from rivers, lakes, ponds, water holes and wells such as is common in rural areas of the tropics during rainy seasons (Jahn 1986; Morton, 1991; Folkard and Sutherland, 1996). This is attributed to the fact that the seeds contain cationic polypeptides which act as a natural coagulant during water purification. The seed also contains antimicrobial activities that can significantly reduce the bacterial populations in contaminated water (Sutherland *et al.*, 1989). Research findings have shown that the crushed seed of *M. oleifera* can be a viable low-cost alternative to the synthetic polyelectrolytes such as aluminium sulphate (alum) in water treatment works (Folkard and Sutherland, 1996). Other uses of this species include living fences, ornamentals or aesthetics, production of gums for tanning leather, rayon and paper pulp, bark fibre for mats and fancy items (Ramachandran *et al.*, 1980; Morton, 1991).

In Kenya, on the hand, the leaves and flowers of *M. oleifera* are also used as vegetables. Leaves are occasionally used as fodder. The primary reason for cultivating *M. oleifera* in Mbololo, Likoni and Kibwezi-Makueni resource-base areas in the 1970's was for its highly-prized tender fruits. The fruits were collected and sold to local and European markets targeting Asian communities. However, the demand for fruits has dwindled in the recent past to the extent that some farmers have neglected their moringa crops. Nonetheless, *M. oleifera* seed is presently taking over as a major cash earner to Mbololo farmers because of the demand from OPTIMA of Africa, an Arusha-based company in the neighbouring Tanzania. The company is establishing on-farm plantations to meet its future seed requirements for oil extraction. There are also plans to establish low-cost water treatment works by the Tanzanian government using *M. oleifera* seed as a natural coagulant. On the other hand, the less utilised *M. stenopetala* is used mainly as a vegetable. The leaves are an important vegetable during the dry season for the Burjis in Marsabit district and other tribes around the north-eastern border between Kenya and Ethopia (Jahn, 1986). The Maasai Njemps tribe living on the Islands and eastern shores of Lake Baringo use *M. stenopetala* as a medicinal plant, its seeds as water clarifier and leaves as vegetable (Berger *et al.*, 1984).

Species for development for agroforestry technologies as these two, will also host potential pest species (Day *et al.*, 1996). Ramachandran *et al.* (1980) cites a variety of insect pests of *M. oleifera* in its native India that include defoliators, borers and scale insects. In Kenya, a defoliator of *Moringa* species which occurs in Marigat, Mbololo and Kibwezi-Makueni areas has been identified. Known as, *N. blitealis,* the pest has Afrotropical distribution which extends to India and Sri Lanka (Betts, 1987). Larvae feed on leaves, flowers, stems, twigs and fruits. The socio-economic importance attached to these products by the farmers, justifies development of an integrated pest management strategy that would ensure sustainable yields of valuable products and services. These major components of this management strategy will be chemical, biological and cultural control.

Insect fauna associated with Moringa spp.

A defoliator of *Moringa* spp. in Kenya was first reported to by the Institute in May 1997. It was found in a forestry experimental site located in the Perrkera irrigation scheme, Marigat Division, Baringo District. The initial goals of this experiment were to assess growth and biomass production of three local provenances of *M. oleifera* and one of *M. stenopetala*. There were three espacement levels. Another report of the defoliator was received soon after (June 1997) from Mbololo, Voi Division in Taita Taveta District on *M. oleifera*.

General surveys of insects fauna associated with *Moringa* spp. were initiated response to the pest reports. They covered Marigat, Mbololo, Kibwezi, Kitui and Ramogi. A summary of the findings is given in table 1 below.

These findings show that *N. blitealis* is present in all areas visited except Ramogi. Worthly noting is the vast insect natural enemy complex that is associated with the defoliator.

Table 1: Insects associated with *Moringa* spp. in five locations in Kenya.

Insect Classification			Survey locations/sites				
Insect order	**Family**	**Genus/species**	**Kibwezi**	**Kitui**	**Mbololo**	**Ramogi**	**Marigat**
Lepidoptera	Pyralidae	*Noorda blitealis*	●	●	●		●
	Lasiocampidae	*Nadiasa sp.*		●			
Coleoptera	Staphylinidae	*Paederus fuscipes*	●			●	
	Coccinellidae	*Stethorus sp.*	●				
		Cheilomenes sp.			●		●
		Epilachna sp.					●
	Lycidae	*Lycus sp.*			●	●	
	Cerambycidae	*Tragocephala sp.*			●		
	Lagriidae	*Chrysolagria sp.*					●
	Meloidae						●

Insect Classification			Survey locations/sites				
Insect order	Family	Genus/species	Kibwezi	Kitui	Mbololo	Ramogi	Marigat
	Garelucidae	*Megalognatha sp.*				●	
	Chrysomelidae	*Blephalida sp.*			●		
		Exosoma sp.					●
Hemiptera	Pentatomidae	*Nezara sp.*	●				
		Sphaerocoris sp			●		
		calidea bohemanni		●			
		Macrorhaphis sp.					●
	Aradidae	*Pseudophonotonus sp.*				●	
Othroptera	Mantidae					●	
Dictyoptera	Blattidae					●	
Isoptera	Termitidae	*macrotermes sp.*				●	

Some of the collected insects were identified as pests, others as natural enemies and the rest were uncategorised. The activity of this fauna requires further investigations. In the pest category, *N. blitealis* is the primary pest of *moringa* species. It is possibly due to environmental factors that it does not occur at Ramogi. This calls for further studies of the ecology of the pest. Other potential pests includes termites, borers etc, whose distribution and impact continues to be monitored.

Several natural enemies were found in association with *N. blitealis*. They include various predators and a parasite. Since the pest population sometimes attains outbreak levels, this an indication that natural enemy complex is not efficient in maintaining it below economic threshold levels. It is for to this reason that biological control alone cannot be an adequate tool for moringa pest management.

Current Control Strategies

The purpose of any pest control programme is to lower the pest population below economic injury level. The control strategies should be compatible, environmentally friendly, economically feasible and socially acceptable. It is apparent that domestication of moringa and integration into farming systems have created ecological boons for the defoliator *N.* blitealis, hence its present pest status. The current priority is to reduce the defoliation of on-station moringa experiments within the shortest time possible and with minimal cost so that the initial goals of the experiment can be achieved.

The control interventions to be developed should be able to counter the boom and burst type of population growth that is a characteristic of many defoliators. Chemical application is recommended as it is successful in controlling some pests particularly those associated with high value crops and *K*-strategy insect pests, of which the moringa defoliator is one. The use of insecticides in the control of the defoliators will give a fast action response and thus reduce any likely economic loss. Action threshold strategy in the application of insecticides will be adopted instead of routine application method. This involves determining the lowest insect pest population that causes economic loss (Economic Threshold Level), the point at which the cost of application of the selected insecticide is equal to the yield loss. This requires detailed studies of the pest population dynamics and the damage due to pests so as to determine the action threshold, that is, the point at which the chemical should be applied.

Development of chemical control measures - a case study

To develop an action threshold strategy of chemical control for moringa defoliator, an experiment was superimposed on moringa provenace trial at Marigat. On trial were three local provenances of *M. oleifera* (Likoni, Mbololo, and Kibwezi) and one provenance of *M. stenopetala* (Baringo). The primary objective was to identify the lowest population level at which a chemical should be applied for control of *N. blitealis.*

The experimental layout of the trial comprises of four blocks with 16 plots each. Each block has a different spacing (four espacement treatments). The chemical control experiment was carried out in eight plots per block with guard plots between the two treatments (sprayed and control) *(Figure 1.)*

Pest Population Monitoring

On weekly basis, a sample population is recorded on three randomly selected trees per plot from all provenances and spacing represented. This involves counting defoliator larvae, pupae and eggs present on a 50 cm terminal section of two branches per tree. On the same sample unit, damage is assessed using a four point scale. All other insects observed are recorded and specimens collected for identification.

Chemical Spraying

A synthetic pyrethroid, Deltamethrine (Trade name - *Decis)*, which is both a contact and ingestion insecticide, is applied at a rate of 35 ml the emusifiable concentrate in 10 litres of water. This selective pesticide kills only lepidoptera larva. It has a medium residue effect. To enhance the effect of the insecticide, a synergid white oil (Trade name - *Medopaz)* is added at a rate of 300 ml in 10 litres of water.

The chemical is applied using a motorized knapsack mistblower. This kind of applicator facilitates homogenous coverage of the foliage and enables insecticide to reach the top of tree canopy at a height of about 6-8m.

Preliminary Results

Figure 2 shows the population trend of defoliator larvae in the sprayed and control plots. It is clear that *N. blitealis* population is higher on *M. stenopetala* than on *M. oleifera*. In the sprayed plots, the defoliator population declined from more than 1.7 to 0 larvae per sample unit within a period of two weeks. This low population was maintained for a period of five weeks. However from the sixth week, the population increased to just over

10 and over 1 larvae in *M. stenopetala* and *M. oleifera* respectively warranting re-spraying during the seventh week. The larva population on *M. stenopetala* peaked at over 10 larva during the sixth week after which it declined rapidly to just under 4 in seventh week. On *M. oleifera,* the population increased very gradually after the fifth week, and attained a maximum level of just under 2 larvae at the end of the assessment period under reference.

In the control plots, the population continued to increase and peaked during the sixth week at nearly 7 larvae and then crashed during the seventh week for *M. stenopetala.* On *M. oleifera* the population increased rapidly attaining a level of just over 14 larvae during the seventh week.

Discussions

The defoliator larvae population trend appear to be dependent on *moringa* species. Thus, it rises fast on *M. stenopetala*. This is possibly due to palatability differences. Future studies can verify such a possibility.

Chemical spraying suppressed the larva population up to the fifth week, for both *moringa* species. During that period, trees were noted to have put on a large biomass of foliage, particularly *M. stenopetala*. The protection afforded by the pyrethroid chemical however appears to have broken down by the sixth week. IT was then that, a peak population was recorded on *M. stenopetala*, and a steady increase was observed on *M. oleifera*. This was yet another indication that the pest preferred *M. stenopetala* to *M. oleifera*. Under the circumstances, the action threshold for the two *moringa* species cannot therefore be the same. It will thus be necessary to determine the action threshold for each species.

Conclusion

The situation of moringa in the recent times has change from scattered trees intercropped with other subsistence crops to close monoculture stands. This change has contributed towards *N. blitealis*, an indigenous insect, attaining pest status.

It will be necessary to study the farming systems in which moringa species are incorporated in order to investigate further factors leading to pests outbreaks.

Recommendations

- For the management of pests of *moringa* species it will be necessary to implement an IPM program in which chemical and biological control will play important complimentary roles. The selected chemical, should therefore be compatible with the other elements of control.
- In developing a control strategy for moringa pests cultural method based on indigenous/farmers' knowledge should be incorporated.
- Further research should be undertaken on biology and ecology of *N. blitealis.*

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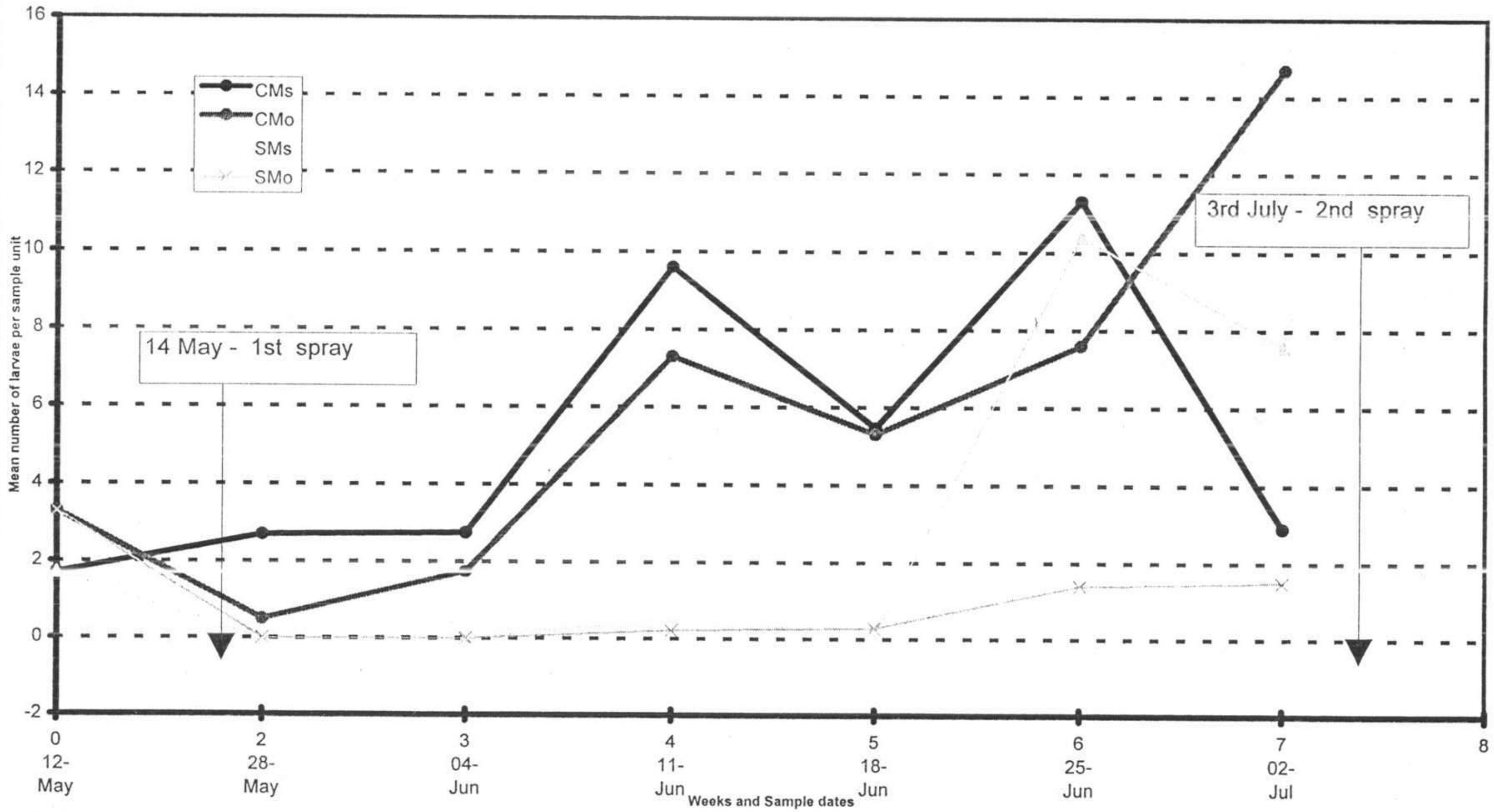
Fig. 2 Population Trend of *N. blistealis* larave on the two treatments



Key

CMs - Control *Moringa stenopetela*

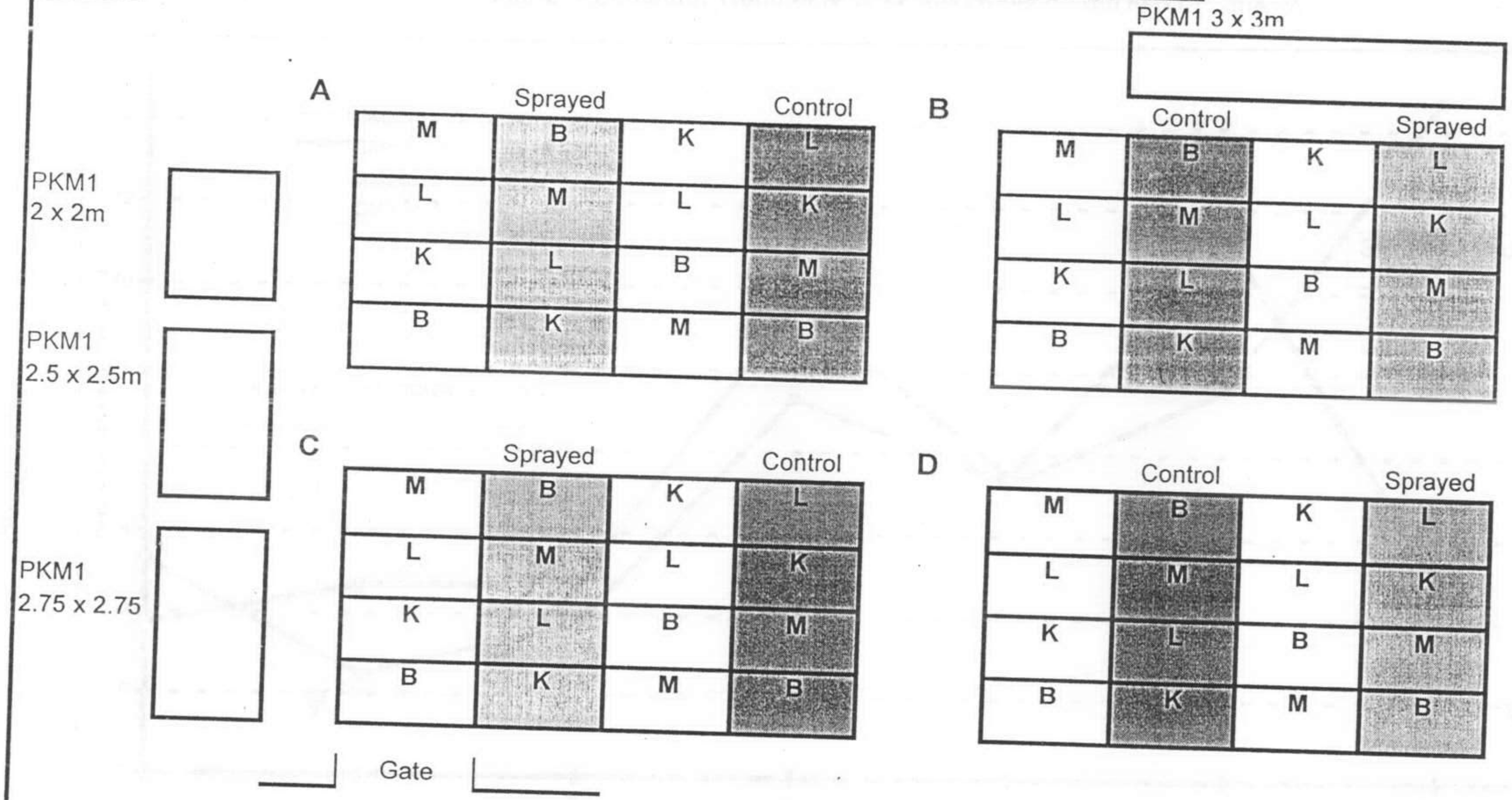
CM0 - Control *Moringa olifera*

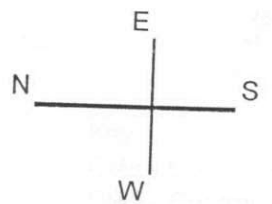
SMs - Sprayed *Moringa stenopetela*

SMo - Sprayed *Moringa olifera*

CHEMICAL CONTROL EXPERIMENTAL LAYOUT ON MORINGA PROVENANCE TRIAL AT MARIGAT

Figure 1.





A, B, C, and D are blocks of different spacing as shown below
Each block consist of 16 compartments of different moringa provenance
Spacing of nine trees in each compartment per block
Compartment A - 3 x 3m
Compartment B - 2 x 2m
Compartment C - 2.5 x 2.5m
Compartment D - 2.75 x 2.75m
Sprayed with Deltamethrin to compared the pest population with the controls