Original Research Article

IDENTIFICATION AND MANAGEMENT OF PESTS AND DISEASES OF GARDEN CROPS IN SANTA, CAMEROON

ABSTRACT

Agriculture is one of the pillars of the economy of Cameroon although in most instances it is still small scaled and depends largely on house hold labour, with about 70% of the active population engaged in agricultural activities. The Western Highlands of Cameroon is noted for its high involvement in agriculture especially the cultivation of vegetable crops such as cabbage (*Brassica oleracea var capitata* L.), carrots (*Daucus carota* L.), leeks (*Allium porrum* L.), tomatoes (*Lycopersicon esculentum* Mill.), celery (*Apium graveolens* L.) and onions (*Allium cepa* L.) (Abang *et al.*, 2013). Generally, this work sought to identify the pests and diseases that hinder successful gardening and how they are managed by farmers. ~~in the Santa community of Mezam Division.~~ This work was carried out in Santa, a Sub-division in Mezam Division of the North West Region of Cameroon. On each of the farms, an area of 20 x 20 m was mapped out and the plants in were ~~that area~~ observed. Insects pest, pathogenic diseases and damages were surveyed at each growth stage from crops. ~~The crops were observed for pests and nature of damage inflicted, at each growth stage.~~ The main diseases identified here were clubroot disease (*Plasmodiophora brassicae*) and late blight (*Phythophthora infestans*) while Aphids (*Myzus persicae* S.), whiteflies *(Bemisia tabaci*) fruit worms (*Helicoverpa amigera*), Cutworms, black garden ants (*Lasius niger* L.) and grasshoppers (*Zonocerus variegatus*) were the prominent pests. The most applied pesticides were ~~Cypercal, Parastar, Banko plus, Manozane, Mancozan, Pencozeb, Gramoxon and Action80.~~ Here uses the ingredient active of those products, no use the commercial name. From this study the most prominent pest of cabbage ~~here~~ was the black cutworm (*Agrotis ipsilon*), which affected the early growing stage. The main disease that affected tomato was blight. This was seen in both seasons, but the severity of attack was greater in the rainy season. ~~Fontem, (1993) in a study on the severity of tomato diseases in Cameroon found that blight is the most severe disease in the wet season in Cameroon and is widely distributed on foliage and fruits.~~ This statement needs to be included in the introduction and no in the abstract. ~~From this study it is seen that the most prominent insect pest is the cutworm (*Agrotis ipsilon*). The main disease of cabbage was clubroot disease.~~ Already you said the most

important diseases and insect's pest. Do not repeat it in the abstract. It is also noted from the research that insect pests were a main problem in the dry season causing high economic losses while there was reduced infestation in the wet season. Our findings suggest ~~In this regard, there is~~ an urgent need to educate the Santa farmers ~~gardeners~~ on good agricultural practices, through Integrated Crop and Pest Management (ICPM) practices, which will include ~~both~~ cultural, physical or mechanical, biological and chemical ~~pests~~ control methods.

Key Words: Pests, Diseases, Pesticides, Santa (Cameroon), Vegetables

INTRODUCTION

Agriculture is one of the pillars of the economy of Cameroon though in most instances it is practiced at small scale and depends largely on house hold labour, with about 70% of the active population of this country engaged in it. The text is exactly the same in the abstract, just say the same idea with different words, but do not repeat it. Also, this sector is responsible for providing food security to both the rural and urban populations of this country via local production (Wilfred *et al*., 2016). The Western Highlands of Cameroon is noted for its high involvement in agriculture especially the cultivation of vegetable crops such as cabbage (*Brassica oleraceavar capitata* L.), carrots (*Daucus carota* L.), leeks (*Allium porrum* L.), tomatoes (*Lycopersicon esculentum* Mill.), celery (*Apium graveolens* L.) and onions (*Allium cepa* L.) (Abang *et al.*, 2013). The main areas noted for this production of these garden crops in Cameroon are Santa in the North West and Foumbot in the West Regions. Their cultivation has brought about an increase in agricultural production that is used to feed the nation. Among various economic and social benefits, market gardening has a vital and multifaceted role in providing food security, meeting the demands of consumer markets, utilising labour and generating income. ~~It can provide both personal satisfaction and supplementary or even full-time income.~~ The income generated from market gardening also provides indirect socio-economic benefits for market gardeners, such as greater access to household items (televisions, chairs) and greater mobility from the purchase of motor vehicles, motorbikes or bicycles (Porter *et al.*,2003). As urban centres expand, the demand for fresh garden produce increases and the land devoted to market gardening also expands, usually in the periphery (Friesen, 1998). This is particularly true in developing countries where rapid urbanisation is prevalent.

Yield and quality are central to sustainable vegetable production. If not properly managed, pests and diseases can dramatically reduce crop yield quality and subsequent returns. At this economic injury level, there is the need to employ control measures, which may have a great negative effect on the practice of market gardening if not properly managed. Today, pests and diseases are better managed using an integrated approach and this approach brings together the best mixture of chemical, biological and cultural methods to manage pests and diseases. To successfully apply any management strategy against pests or diseases, the first step is to identify them correctly for appropriate action to be taken and this gave reason for this work to be carried out to identify the pests and diseases that hinder successful gardening and how they are managed in the Santa community of Mezam Division.

MATERIALS AND MEHODS

Study area

This study was carried out in Santa, which is one of the Sub-divisions in Mezam Division of the North West Region of Cameroon. It is located between latitudes 5° 42′and 5° 53′ north of the equator and longitudes 9° 58′ and 10° 18′ east of the Greenwich Meridian (Santa Rural Council Monographic Study, 2003). The population of this area estimated in 2008 was 99851(Fogwe, 2014) and 90% of this population are engaged in farming and grazing. It covers a surface area of about 532.67 km². It is bordered to the North by Bamenda Sub Division, to the West by Bali and Batibo Sub-Divisions, to the South by Wabane, Babadjou and Mbouda and to the East by Galim (Sonchieu *et al*., 2017).

The mean annual temperature of the area varies from 21.8 to 30.8ºC. The annual rainfall is between 2000 -3000 mm mostly from March to September and the dry season from October to February. The soils in this area are fertile and support a large human population. The altitudinal range is from 600 to 2600 m making this highland favourable for animal rearing, crop and vegetable cultivation aptly qualifying this area as an agricultural production basin in the Western Highlands of Cameroon.

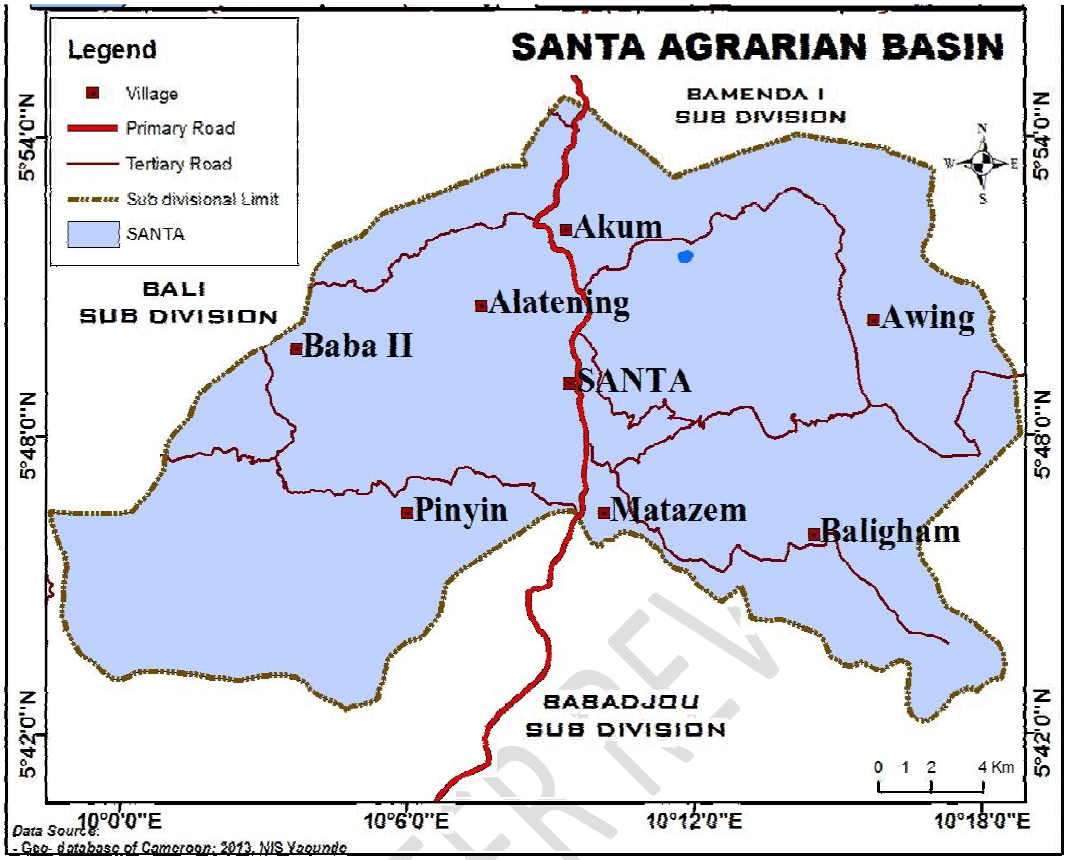

Figure 1. Map of Santa Sub Division showing the different villages

Identification of pests and diseases and their mitigation

Identification of pests and diseases was carried out three times on six farms ~~for each~~ (two at the upper, two at the middle and two at the lower Santa) during different growth stages of tomatoes, cabbage, potatoes, leeks and celery. They were observed from seedling through flowering to maturity. When this study was conducted (moths and year)

On each of the farms, an area of 20 x 20 m was mapped out and the plants were surveyed. ~~in that area observed~~. The crops were observed for pests and nature of damage inflicted, at each growth stage. The parts of the crops observed were stems, leaves, flowers and fruits. The crops were also observed for diseases. The observation for pests and diseases was done for the dry and rainy seasons. Also, the types of pesticides, and their frequency of application these two seasons to combat pests and diseases by farmers on the different crops were noted.

DATA COLLECTION

Pre-designed data recording forms were used in gathering information on the following variables: type of pesticide, frequency of application, insect pests and nature of damage, diseases and nature of damage. How those variables were measured? How you know if an insect pest was more abundant than others? In the area that you sampled (20 x 20 M) did you counted the insects? I ask that because in your tables you did not put numbers for proportion of insects of diseases. How we know that cutworms were more representative that whitefly or aphids? I have to see the numbers for those evaluations. If you do not have data (numbers), you cannot say that cutworms were the insect pest that more affected tomatoes at transplant stage following by crackets. Honestly, if you do hot have data about this study, I cannot accept it for publication.

I find this study very interesting, because it addresses insets pest, diseases and use of pesticides by growers in this specific location of Cameroon "Santa Agrarian Basin". I know, this topic is very relevant for professionals working in agriculture in order to support growers in the establishment of an Integrated Crop and Pest Management practices in this location. However, the manuscript lacks of statistical support. So, you have two options:

1- Get your data and do a very simple analysis using descriptive statistics, showing the proportion of insets and diseases affecting those vegetables crops in each stage of the plant and during each season (wet and dry).
2- Just do a description of your results as visual observations of the insect's pest and diseases for those crops, and present your results as an opinion article, addressing your observations and suggesting alternative practices for their control different to just insecticides, which growers relay that in most of the cases.

Regarding the use of pesticides by growers, the frequency of application is ok, but you need to identified the "Active Ingredient" of those products (label). It is important that you know that those products have an international nomenclature, So you must to use it.

STATISTICAL ANALYSIS

Data was entered into Microsoft excel. Descriptive ~~(frequency and percentage)~~ statistics was used to analyse the results.

NOTE:

I just stop to keep reviewing this manuscript at this point, since it lacks of statistical support. If the authors want to do the changes suggested by me, then I can review it again.

RESULTS

Pests of Selected Garden Crops and Management Practices

Cabbage (*Brassica oleracea*)

The insect pests common with cabbage at transplant stage were cutworms (*Agrotis ipsilon*), which eat through the stems of the crop at the ground level and made the crop to fall, whiteflies (*Bemisai tabaci* L), aphids (*Myzus persicae* L) and fruitworm (*Helicoverpa amigera* L) . The farmers used cypercal and parastar for their control during dry season. During this transplant stage, here was no disease affecting cabbage (Table 1). Whiteflies, aphids and fruit worms affected the crop mostly in the dry seasons while the only pest of economic importance was the rainy season was cutworms.

At the flowering and maturation stages, whiteflies, aphids fruitworms and grasshoppers were seen and same chemicals used for their control as during transplant. At the flowering and maturation stages clubroot was the only disease affecting cabbage and no pesticide was applied for its control (Table 1).

185 Table 1: Pests and diseases of cabbage, pesticides and their frequency of application used for their control

	Growth stage					
	Transplant		Flowering		Maturity	
	Pests	Disease(s)	Pests	Disease(s)	pests	Disease(s)
Pest/ disease	Cutworms, whiteflies, aphids and fruit worms	-	whiteflies, aphids, fruit worms,and grasshoppers	Clubroot	whiteflies, aphids, fruit worms, and grasshoppers	Clubroot
Pesticide	***Cypercal ***Parastar	-	***Cypercal ***Parastar	-	***Cypercal ***Parastar	-
Frequency during dry season	Thrice	-	Thrice	-	Thrice	-
Frequency during rainy season	twice	-	Twice	-	Twice	-

186 ***=Dry season, **=Rainy season

Tomato (*Lycopersiconesculentum*)

The major insect pest that damaged tomato at transplant stage was cutworm. The other insects at this stage were crickets (*Gryllus sp*.) and spider although their damage was not severe. Cypercal, Parastar and Cypercot were used against the cutworms. Blight was observed at this stage but did not cause severe damage in the dry season and was only sprayed in the rainy season with Mancozeb and Mancozane (Table 2).

The flowering stage of this crop suffered from a new set of pests. These were fruit worms (*Helicoverpa amigera* L), fruitflies (*Dacus puntatifrons* L), aphids, leaf miners and to a lesser extent the cutworms. The fruit worms ate through the fruits, fruitflies stung the fruits creating black spots on them, the leaf miners mined the leaves and cutworms present at this stage did not have major effects because the stems of the plant were already hardened. The insecticides used at this stage were Cypercal, Parastar, Cypercot (Table 2).

In the third stage of growth when the crop had reached maturity, the pests were fruit worms, aphids and whiteflies. Blight was also present and caused damage such as fruit rot, irregular ripening of fruits, some dropping to the ground and leaves yellowing and dry off. The chemicals used to spray were still those used at the flowering stage with insecticides being sprayed at higher frequencies per month (Table 2).

208 Table 2: Pests and diseases of tomato, pesticides and their frequency of application used for their control

	Growth stage					
	Transplant		Flowering		Maturity	
	Pests	Disease(s)	Pests	Disease(s)	Pests	Disease(s)
Pest/ disease	Cutworms, crickets, spiders	Blight	Cutworms, whiteflies, aphids, fruit worms, fruit flies.	Blight	Fruit worms, Aphids, Whiteflies, Fruit flies,	Blight
Pesticide	***Cypercal ***Parastar ***Cypercot	**Pencozeb	***Cypercal ***Parastar	**Banko plus, **Manozane, **Mancozan, **Pencozeb	***Cypercal ***Parastar	**Banko plus, **Manozane, **Mancozan, **Pencozeb,
Frequency during dry season	Twice	Thrice	Four	Eight	Thrice	Four
Frequency during rainy season	Thrice	Four	Thrice	Twelve	Four	Sixteen

209 ***=Dry season, **=Rainy season

Celery (*Apium graveolens* L.)

The most prominent pest of celery at transplantation during dry and rainy seasons was the cutworm which feed on the stem of the celery plant. Another insect seen at this growth stage was cricket that ate through the leaves creating holes on them. The insecticides used for pests control were Cypercal, Parastar and Cypermax which were pyrethroids. Blight was the lone disease during all stages and was managed using pencozeb and balear at transplant stage. These different pesticides were either sprayed once or twice a month (Table 3).

In the second growth stage, cutworms were still seen and whiteflies and aphids were mostly seen in the dry season. Pests were managed using cypermax, cypercal or parastar. Blight was controlled with Balear, Banko plus, Mancozeb, Manozane or Pencozeb. They were used only once at this stage (Table 3).

At maturity, leafminers were the only insects seen during dry season were sprayed two times with Parastar, and Cypercal, at this stage for insect pests. Blight had its damaging effects at this stage mostly in the rainy season and Pencozeb, Mancozeb, Manozane, Banko plus and Balear were used for its control (Table 3).

Leeks (*Allium porrum*L.)

The main pest of leek at transplant was cutworm that fed on the stems of the plant cutting through and was managed using cypercal, Parastar and Fastac as the main insecticides to kill these cutworms in the farms (Table 4).

At flowering and maturation stages, the main insect pest was aphid which was controlled with Parastar and Callidim during flowering and cypercal during maturation. Blight affected the crops causing the leaves to turn yellow at the flowering and maturation stages mostly during rainy season. It was controlled with Manozane, Moncozeb or Pencozeb during flowering and Pencozeb, Manozane and Moncozan at maturation. In the rainy season blight was sprayed 7 to 8 times in a month. In the dry season the effect of blight was very minimal that some farmers did not spray their farms with the fungicides (Table 4).

241 Table 3: Pests and diseases of celery, pesticides and their frequency of application used for their control

	Growth stage					
	Transplant		Flowering		Maturity	
	Pest	Disease(s)	Pests	Disease(s)	Pests	Disease(s)
Pest/ disease	Cutworms	Blight	Cutworms, Whiteflies, Aphids	Blight	Leaf miners,	Blight
Pesticide	***Parastar ***Cypercal, ***Cypermax	-	**Parastar, **Cypercal	**Pencozeb **Balear **Banko Plus **Mancozeb, **Manozane,	***Parastar, ***Cypercal,	**Pencozeb, **Mancozeb, **Balear,
Frequency during dry season	Thrice	-	Four	Four	Five	Five
Frequency during rainy season	Thrice	-	Thrice	Sixteen	Five	Tweenty

242 ***=Dry season, **=Rainy season,

243 Table 4: Pests and diseases of leek, pesticides and their frequency of application used for their control

	Growth stage					
	Transplant		Flowering		Maturity	
	Pest	Disease(s)	Pest	Disease	pest	Disease
Pest/ disease	Cutworms	-	Aphids	Blight	Aphids,	Blight
Pesticide	***Cypercal, ***Parastar *** Fastac	-	***Parastar, ***Callidim	**Manozane, **Mancozeb	***Cypercal,	**Pencozeb, **Mancozeb, **Manozane
Frequency during dry season	Twice	-	Twice	Seven	Twice	Seven
Frequency during rainy season	Twice	-	Once	Seven	Once	Eight

244 ***=Dry season, **=Rainy season

Potato (*Solanum tuberosum*)

During sprouting, the pest of potato was cutworms and the severity was greater in the dry than rainy season with Parastar, Cypercal and Fastac used to control it. At this early growth stage blight was also observed. This was more of economic importance in the rainy than dry season. Most farmers did not bother about blight at this stage, but the few who did used Ridomil for its control (Table 5).

At the flowering stage, the insect pests were fruitworms and aphids. The pesticides used for their control were Parastar, Cypercot and Fastac. Blight was persistent at this stage causing leaves to turn yellow and eventually drying off. Pencozeb, Manozane and Mancozeb were the main fungicides used to tackle blight at this stage. Bacteria wilt was also noticed at this stage. Crops affected by bacteria became yellowish in nature and withered. When uprooted the potato tuber inspected was watery and soft in texture.

At maturity, aphids, fruitworms and blight were still persistent. The insects were sprayed with Parastar. Plantineb, Pencozeb and Balear were the main fungicides used against blight at this stage (Table 5).

268 Table 5: Pests and diseases of potato, pesticides and their frequency of application used for their control

	Growth stage					
	Transplant		Flowering		Maturity	
	Pest	Disease	Pests	Diseases	pests	Disease
Pest/ disease	Cutworms	Blight	Fruitworms, Aphids, Leafminers,	Blight Bacteria wilt	Aphids, Fruitworms	Blight
Pesticide	***Parastar, ***Cypercal, ***Fastac,	Ridomil	***Parastar, ***Fastac,	**Pencozeb, **Monozane, ** Mancozeb	***Parastar, ***Fastac,	**Pencozeb, **Monozane ** Mancozeb
Application frequency for dry season	Thrice	-	Thrice	Seven	Twice	Seven
Application frequency for rainy season	-	Twice	Twice	Eight	Twice	Seven

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270 ***=Dry season, **=Rainy season

DISCUSSION

Six cabbage farms observed through the growth stages revealed insect pests as the main problem to proper cabbage growth. The pests were cutworms, fruit worms, aphids and whiteflies. This is in line with the findings of Dzomeku*et al.* (2011).The most prominent pest of cabbage here was the black cutworm (*Agrotis ipsilon*) which affected the early growing stage. Norida and John (2005), in Malaysia found *A. ipsilon* to be recognized by 80% of the farmers during the early growing period. As opposed to the findings of Talekar and Shelton, (1993) who found diamondback moth (*Plutella xylostella*) to be the most prominent pest of cabbage worldwide, diamondback moth was not noticed in this area. This might be due to climatic factors that do not favour its survival in the Santa area or the farmers sprayed with the insecticides and controlled its population. A range of insecticides were used to kill insect pests by the farmers, at different spraying frequencies. The insects caused much damage in the dry season than in the rainy season. This is because the populations of insects were higher during dry season compared with rainy season This is in conformity with studies by Nsobinenyui *et al.* (2017) who indicated insects are more abundant in dry season than rainy season. This might be due to increase temperatures. Increase temperature is known to speed up the life cycle of insects leading to faster increase in pest population. It has been estimated that a $2^{o}C$ increase in temperature has the potential to increase the number of insect life cycles by one to five times (Bale et al., 2002; Petzoldt and Seaman, 2010). The main disease of cabbage in this area was the clubroot disease (*Plasmodiophora brassicae),* commonly called 'Ginger' in this area, that affected the roots of the cabbage plant. Here the disease did not respond to any pesticide. The only method farmers had to use was to practice crop rotation to disrupt the life cycle of the fungus.

The different tomato farms observed experienced the same kind of pests at the same level of the plant growth. In the dry season the effects of insect pests were more than that of fungi on the crop. Many more farmers spray against insects than diseases in the dry season and this could suggest that insect pests are more serious in the dry season. The main insect pests of tomatoes in the dry season that caused economic damage were cutworms, aphids, fruit flies, leaf miners, whiteflies and fruit worms. This is also

reported by Sait (2003). The main disease that affected tomatoes was blight. This was seen in both seasons but the severity of attack was greater in the rainy season. Fontem,(1993) in a study on the severity of tomato diseases in Cameroon found that blight is the most severe disease in the wet season in Cameroon and is widely distributed on foliage and fruits. The plant was affected at all the three growth stages examined by this blight.

A wide range of pests affected the celery crops in the fields observed. Key insect pests here included cutworms, whiteflies, aphids, crickets and fruit worms. Blight was also seen affecting the crops. Farmers relied heavily on the use of pesticides to control these pests (Ntonifor *et al*., 2013). Producers used a wide range of pesticides, as many farmers believe that the only way to tackle pest problems was to use pesticides.

Insects affected the potatoes in the field at its different growth stages. Some affected the foliage, some tubers and some transmitted diseases as seen in the findings of Radcliffe and Ragsdale, (2002). The effect was greater in the dry season. Blight was less important in the dry season such that some farmers did not spray their farms against this disease during this season. Blight caused the greatest damage in the rainy season (Fontem, 1993). Bacteria disease was also a problem in the farms as crops were affected by this disease leading to low yields. This is in line with the findings of Kaguongo*et al.,* (2008) who pointed out bacteria as an important disease contributing to yield reduction and considered it more problematic than blight since it has no known chemical control procedures and many farmers do not know how to control it.

CONCLUSION

From this study it is seen that the most prominent insect pest is the cutworm. This insect pest is seen to attack all the crops that were used in this study. They attack primarily at the stage when the crop has just been transplanted due to the fact that the stems of the crops are still very tender and so they can chew through during feeding with their mandibles. Other insect pests noted in this study were aphids, crickets, whiteflies, fruit flies, leaf miners and black ants. These insects were all treated with insecticides.

The main insecticides that the farmers here used were Parastar and Cypercal with the prominent fungicides being Pencozeb and Mancozeb. Also these farmers used herbicides

of which the popular ones were Gramoxone, Tromissil and Action 80. Each group of these pesticides had almost the same active ingredients

All these crops suffered from fungal attack except the cabbage plant that was affected mainly by insect pests. This fungus that attacked the crops was *Pythophthora infestans* commonly known as blight. It caused the leaves of Tomato, potato, celery and leeks to become yellow and eventually dry off. Bacterial wilt was also reported in the potato farms that were observed.

The findings of this study also present another pest which affects only cabbage called clubroot disease and it affects the roots of the crop such that the roots do not extend into the soil, and thus the crop would wither and die as a result of no water being drawn up by the roots as they were damaged.

It is also noted from the research that insect pests were a main problem in the dry season causing high economic losses while there was reduced infestation in the wet season. Blight affected crops more in the rainy season than in the dry season.

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