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Review On Early Blight (Alternaria spp.) of Potato Disease and its Management Options

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Abstract
This review is to reviewed with an objective of reviewing the economic importance of early blight of potato crop disease and its management options. Potato is the most important vegetable crop in terms of quantities produced and consumed worldwide. It is the fast-growing major crop in the world with important economic impact on many resource-poor farming families. However, its production is currently threatened by a number of biotic and abiotic constraints. Potato early blight disease, caused by two species of genus *Alternaria* (*A.solani* and *A.alternata*), is the major bottleneck in potato production in the world as well as in Ethiopia. Early blight of potato is prevalent worldwide wherever potatoes, tomatoes, peppers, and eggplants are grown. The disease can damage both potato foliage and tubers and can causes yield losses of 5-50%. Early blight is a poly cyclic disease that can cause more than one disease epidemics within a single cropping season. It is difficult to control because of its capacity to produce huge amounts of secondary inoculum. Since the disease is very important in causing economic losses of yields on potato crop, developing and using effective and appropriate management options is unquestionable. Using good cultural practices and applying chemical fungicides are important in reducing as well as managing of early blight disease of potato. Even thought there is no well developed biological control of early blight, it is very important to develop such management strategies. Because biological control measures are specific, efficient and environmentally safe.
Keywords: Alternaria; Fungicides; Resource-poor farming families; Secondary Inoculum ;Yield losse. 1.

INTRODUCTION

Potato (*Solanum tuberosum* L.) is one of mankind's most valuable food crops (FAO, 2004). It is the most important vegetable crop in terms of quantities produced and consumed worldwide (FAO, 2005). In volume of production it ranks fourth in the world after wheat (*Triticum aestivum* L.), rice (*Oryza sativa* L.), and maize (*Zea mays* L.) (Bowen, 2003). Potato gives an exceptionally high yield per hectare (Feustel, 1987; Talburt, 1987). World potato production increases from 30 million tonnes in 1960s to 165 million tonnes in 2007 (FAO, 2008). Potatoes are grown under a wide range of conditions - from irrigated commercial farms in Egypt and South Africa to intensively cultivated tropical highland zones of Eastern and Central Africa, where it is mainly a small farmer's crop. Ethiopia has possibly the highest potential for potato production of any country in Africa. An estimated 70% of the country's arable land is potentially suitable for potato cultivation (FAO, 2008). Potato is a highly recommended food security crop that can help shield low-income countries from the risks posed by rising international food prices (FAO, 2008). It is used in a wide variety of table, processed; livestock feed and industrial uses (Feustel, 1987; Talburt, 1987). Potato provides nutritious food in a diversity of environments. Potato can be an important food for the increasing world population, and has the potential for increased vitamin C and protein content (Pereira and Shock, Undated). Potato is increasingly a valuable source of cash income for low income farm households (FAO, 2008).

The potato is prone to more than a hundred diseases caused either by bacteria, fungi, viruses or mycoplasms. However, Early blight or Alternaria blight is worldwide in distribution and is one of the most important foliage diseases in areas with favorable weather conditions (CIP, 1996). Early blight, that is caused by two species of genus *Alternaria* (*A.solani* and *A.alternata*), occurs worldwide on potato crops, particularly in the regions with high temperature and alternating periods of dry weather and high humidity and/or irrigated potato soils, light-textured, sandy, low in organic matter (Gudmestad and Pasche, 2007). *A.solani* and *A.alternata* – causal agents of the early blight are more and more risk-important pathogens on potato crops. The early blight occurs in all potato production areas, but there is a significant impact on the tuber yield and the quality only in warm, wet conditions in the early season, which favours a rapid disease development. Quantity share of both species varies and is dependent on the climate / on the weather conditions (Hausladen and Leiminger 2007, Kapsa 2007). Early blight is a very common disease of both potato and tomato. It causes leaf spots and tuber blight on potato, and leaf spots, fruit rot and stem lesions on tomato. The disease can occur over a wide range of climatic conditions and can be very destructive if left uncontrolled, often resulting in complete defoliation of plants. In contrast to the name, it rarely develops early, but usually appears on mature foliage (Rowe *et al.*, Undated). Values in the literature for measured crop losses due to early blight vary enormously from 5–78%

(Waals *et al.* 2004; Pasche *et al.* 2004, 2005). Young and middle-aged plants have low susceptibility to infection being disease influenced by the crop age. Young plants are relatively resistant, but the susceptibility increases gradually and continuously from the initiation of tuber formation so that mature plants are most susceptible to the disease (Campo *et al*., 2001; Johnson and Teng, 1990; Rotem, 1981; Shtienberg *et al*., 1996).

Early blight is difficult to control because of its capacity to produce huge amounts of secondary inoculum (Campo Arana *et al.*, 2007; Pasche *et al.*, 2004). In order to suppress early blight and to prevent the losses it causes, potato fields are intensively sprayed with fungicides (Horsfield *et al.*, 2010). Cultural control measures such as eliminating cull piles and volunteer potatoes, using proper harvesting and storage practices, can be used to reduce the pathogen populations by reducing its survival, dispersal and reproduction (Garrett and Dendy, 2001). Most approaches to control of foliar early blight have depended on the use of protectant fungicides during the warm-hot weather, but the criteria used to determine proper time of initial fungicide have varied widely caused unnecessary sprays (Christ and Maczuga, 1989; Christ, 1991; Easton and Nagle, 1985; Reis *et al*., 1999). The objective of this review is to review the economic importance of early blight of potato crop disease and its management options.

2. GEOGRAPHIC DISTRIBUTION OF EARLY BLIGHT

Early blight (EB) can be found in many potato growing regions of the world and belongs to one of the most common and widespread diseases in potatoes (Rotem, 1994). Due to its high adaptability, early blight has the potential to become a serious threat for potato cultivation (Leiminger and Hausladen, 2011). Early blight of potato, caused by the fungus *Alternaria solani*, is prevalent worldwide wherever potatoes, tomatoes, peppers, and eggplant are grown (Anonymous, 1990). The disease can damage both potato foliage and tubers. The disease is also a common problem on tomatoes and eggplant in Alabama (Sikora, 2004). The name early blight is misleading, as the disease normally appears first on plants where the tuber crop is setting or where tubers have already formed. Actively growing young tissue and plants heavily fertilized with nitrogen do not exhibit symptoms, and most secondary spread occurs as plants age, especially after blossoming (Anonymous, 1990).

Early blight is widespread in most areas where potatoes or tomatoes are grown, but is especially prevalent in the tropics and temperate zones. The disease is a potential threat where potatoes are grown under irrigation or during times of heavy dew. Early blight is prevalent in all provinces in South Africa and is a limiting factor in production in late summer. Early blight is one of three diseases taken into account when selecting new potato varieties in South Africa, the other two being late blight and common scab. Early blight tuber rot may occur if tubers wounded during harvest are inoculated by *A. solani* spores found on or near the soil surface. Tuber rot is, however, not common and has limited distribution (van der Waals, 2002).

3. IMPORTANCE OF EARLY BLIGHT

Next to the widespread potato disease late blight (LB) caused by *Phytophthora infestans*, Early blight has become a noticeable problem for German potato production within the last years. A rapid increase in disease severity has been observed for German potato growing areas (Leiminger, 2009). Early blight is caused by *Alternaria solani* and *A. alternata*, which is also the causal agent for brown spot. Early mainly affects potato foliage and leads to leaf necrosis and premature defoliation (Leiminger and Hausladen, 2011). The primary damage of early blight is due to premature defoliation of the plant. Photosynthesis rates increase and respiration rates decrease in apparently healthy tissues. Physiological changes are difficult to measure and evaluation of crop loss is based on the level of disease. Early literature cites yield losses of 5 - 50%. There is often a discrepancy between damage to foliage and yield loss, which is due to the increase in disease spread at the end of the season, when most of the yield has been produced. When tomato fruit or potato tubers become infected, the quantity and quality of marketable produce is decreased and the number of secondary pathogens increases. Control of early blight has been shown to increase yield (van der Waals, 2002).

Yield reductions of 50 or more bushels per acre are not uncommon in Illinois where unprotected foliage is destroyed prematurely. Most rapid spread of the disease occurs during periods of alternating wet and dry weather. The disease is often most severe when potato plants are predisposed by injury, poor nutrition, or other type of stress. Besides attacking tomatoes peppers, and eggplant, the causal fungus also infects garden petunia, black and beaked nightshades, jimsonweed, henbane, apple-of-Peru or shoo-fly-plant, horsenettle, groundcherries, false Jerusalem-cherry Jerusalem cherry, spiny amaranth or pigweed, Chinese amaranth, quickweed or small flowered galinsoga as well as other ornamental and weed species of *Solanum* (Anonymous, 1990).

4. SYMPTOMS

Symptoms are initially observed on older, senescing leaves. Likewise, the most susceptible plants are those that are physiologically old, weak, malnourished and wounded by wind, sand, hail or insects (van der Waals, 2002). The first symptoms usually appear on older leaves and consist of small, irregular, dark brown to black, dead spots ranging in size from a pinpoint to 1/2 inch in diameter. As the spots enlarge, concentric rings may form as a result of irregular growth patterns by the organism in the leaf tissue. This gives the lesion a characteristic "target-spot" or "bull's eye" appearance. There is often a narrow, yellow halo around each spot and lesions are usually bordered by veins. When spots are numerous, they may grow together, causing infected leaves to turn yellow and die. Usually the oldest leaves become infected first and they dry up and drop from the plant as the disease progresses up the main stem (Rowe *et al*., Undated). Severely infected leaves eventually wither and die but usually remain attached to the plant. Severe infection of foliage by the early to mid-bulking period can result in smaller tubers, yield loss and lower tuber dry matter content.

Brown, angular, necrotic spots marked internally by a series of concentric rings form on leaves and to a lesser extent on stems. Leaf lesions are seldom circular because they are restricted by the larger leaf veins. Lesions usually develop around flowering time and become increasingly numerous as plants mature. Lesions first form on lower leaves. They may join and cause general yellowing, leaf drop, or early death. Tuber rot is dark colored, dry, and leathery. Susceptible varieties (usually early maturing) may show severe defoliation. Later maturing varieties may appear resistant. Plants under stresses that hasten maturity (such as adverse environment, warm, humid weather, other diseases, or nutritional deficiency) become susceptible and die prematurely. Control. Provide conditions for vigorous growth throughout the season, especially irrigation and fertilizer side dressing. Organic fungicides sprayed on the foliage reduce the spread of early blight. Resistance is available among late-maturing varieties (CIP, 1996).

Symptoms include characteristic concentric rings that appear dark and sunken and become papery. Lesions enlarge, coalesce and cause leaf death (Pscheidt, 1985). Initial infection usually occurs on the older, lower leaves then progresses up the plant. Lesions first appear as small spots-dry and papery in texture. Lesions become brownish black and circular as they expand. Older lesions often appear angular in appearance as their margins become limited by leaf veins (Sikora, 2004). Infected stems show sunken, elongated spots that may also display the typical concentric rings. Lesions in tubers appear as slightly sunken dark irregular spots with raised borders; a dry rot develops internally under the skin (Schultz and French, 2009). On potato tubers, early blight results in surface lesions that appear a little darker than adjacent healthy skin. Lesions are usually slightly sunken, circular or irregular, and vary in size up to 3/4 inch in diameter. There is usually a well defined and sometimes slightly raised margin between healthy and diseased tissue. Internally, the tissue shows a brown to black corky, dry rot, usually not more than 1/4 to 3/8 inch deep. Deep cracks may form in older lesions. Tuber infection is uncommon under Ohio conditions (Rowe *et al*., Undated).

5. THE PATHOGEN

Early blight is caused by the fungus, *Alternaria solani*, which survives in infected leaf or stem tissues on or in the soil. This fungus is universally present in fields where these crops have been grown. It can also be carried on tomato seed and in potato tubers. Spores form on infested plant debris at the soil surface or on active lesions over a fairly wide temperature range, especially under alternating wet and dry conditions. They are easily carried by air currents, windblown soil, splashing rain, and irrigation water. Infection of susceptible leaf or stem tissues occurs in warm, humid weather with heavy dews or rain. Early blight can develop quite rapidly in mid to late season and is more severe when plants are stressed by poor nutrition, drought, or other pests. Infection of potato tubers occurs through natural openings on the skin or through injuries. Tubers may come in contact with spores during harvest and lesions may continue to develop in storage (Schultz and French, 2009).

This fungus produces dark to black conidia (asexual spores). This fungus has not been found to produce sexual spores. Potato and tomato are the main hosts of *A. solani*. Other solanaceae (including eggplant, pepper, horse nettle and black nightshade), wild cabbage, cucumber, and zinnia are also known hosts of *A. solani* (Schultz and French, 2009). *Alternaria* spp. have dark-colored mycelium, and in older diseased tissue they produce short, simple, erect conidiophores that bear single or branched chains of conidia. Conidia are large, dark, long, or pear shaped and multicellular, with both transverse and longitudinal cross walls. Conidia are detached easily and are carried by air currents. *Alternaria* occurs on many plant/crop species throughout the world. Their spores are present in the air and dust everywhere and are one of the most common fungal causes of hay fever allergies. *Alternaria* spores also land and grow as contaminants in laboratory cultures of other microorganisms and on dead plant tissue killed by other pathogens or other causes. Actually, many species of *Alternaria* are mostly saprophytic, i.e., they cannot infect living plant tissues but grow only on dead or decaying plant tissues and, at most, on senescent or old tissues such as old petals, old leaves, and ripe fruit. Therefore, it is often difficult to decide whether an *Alternaria* fungus found on diseased tissue is the cause of the disease or a secondary contaminant. Many species of *Alternaria* produce toxins. Some *Alternaria* toxins affect many different plants, whereas others are host specific (Agrios, 2005).

6. DISEASES CYCLE

6.1. Overwintering and survival

Alternaria solani is a polycyclic pathogen, as many cycles of infection are possible during a season. Primary infections on new plantings of potatoes or tomatoes are caused by overwintering inoculum. The pathogen overwinters as mycelium or conidia in plant debris, soil and infected tubers or on other host plants of the same family (van der Waals, 2002). The early blight fungus overwinters in the field on infected plant debris from the previous season's crop (Figure 1). The fungus can also survive on other members (such as weeds) of the potato family (Sikora, 2004). The pathogen survives primarily on infected crop debris, in soil for years. It can also overwinter on volunteer hosts and weeds (Schultz and French, 2009). Chlamydospores have also been reported as a source of overwintering inoculum for early blight, allowing the pathogen to survive cold temperatures in or on the soil. The inoculum remains infective in debris in uncultivated soil for 5 to 8 months. The dark pigmentation of the hyphae increases their resistance to lysis. Spores survive most frequently in infected debris and seed and best in dry, fallow fields (van der Waals, 2002).

6.2. Dispersal

Conidia are spread by wind and splashing water. Wind, rain and insects are the principle methods of dissemination of *A. solani*. The primary inoculum produces conidia in the spring, which are then dispersed to the lower leaves of the plant where they germinate and penetrate the epidermis directly, through stomata or wounds. With the use of spore traps, it has been found that peak spore dispersal precedes the hottest and driest hour of the day by two hours, and the time of maximum wind velocity by four hours. A rapid rate of dispersal does not set in until infection has reached the stage at which whole leaves dry up and plants begin to die. The curve of wind velocity resembles that of spore dispersal, however, there appears to be no significant correlation between spore dispersal and other climatological factors (van der Waals, 2002; Figure 1).

6.3. Infection

Spores landing on leaves of susceptible plants germinate and may penetrate tissues directly through the epidermis, through stomata and or through wounds such as those caused by sand abrasion, mechanical injury or insect feeding. Free moisture (from rain, irrigation, fog or dew) and favorable temperatures (68 - 86°F) are required for spore germination and infection of plant tissues. Lesions begin to form 2 to 3 days after initial infection (Warton and Kirk, 2012). Infection occurs directly or through stomata primarily on older leaf tissue and through wounds or through moist induced swelling of lenticels on tubers (Schultz and French, 2009). Spore germination is facilitated by free moisture, but can be induced by relative humidities close to saturation. With a favorable inoculum dose and wetting period, the minimum temperature for infection can be as low as 10°C, the maximum >35°C, and the optimum between 20°C and 30°C. Incubation periods (time from infection to symptom development) vary greatly, depending on age and susceptibility of plants. Epidemics increase in severity after sandstorms, due to increased wounding of the epidermis. The primary infections become necrotic with chlorotic halos. Mycelium from necrotic lesions produces conidia that infect healthy leaves and begin secondary infections. Tubers are infected through wounds, as the conidia are unable to infect directly through intact periderm. Wound healing, by suberisation and the development of wound periderm, reduces infection markedly (van der Waals, 2002).

Tubers become infected as they are lifted through infested soil at harvest. Tuber infection usually occurs through wounds, so immature tubers and tubers of white and red-skinned varieties are more susceptible to the disease. Infection can also occur through natural openings (lenticels), which tend to open when the soil is wet. Digging tubers at least 2 weeks after vine kill allows for proper maturity and skin development and decreases the amount of tuber injury, therefore, reducing tuber infection. Digging tubers under dry conditions also reduces the risk of infection by the fungus. Tubers harvested under wet conditions should be dried as quickly as possible using force ventilation as soon as they are placed in storage (Sikora, 2004).

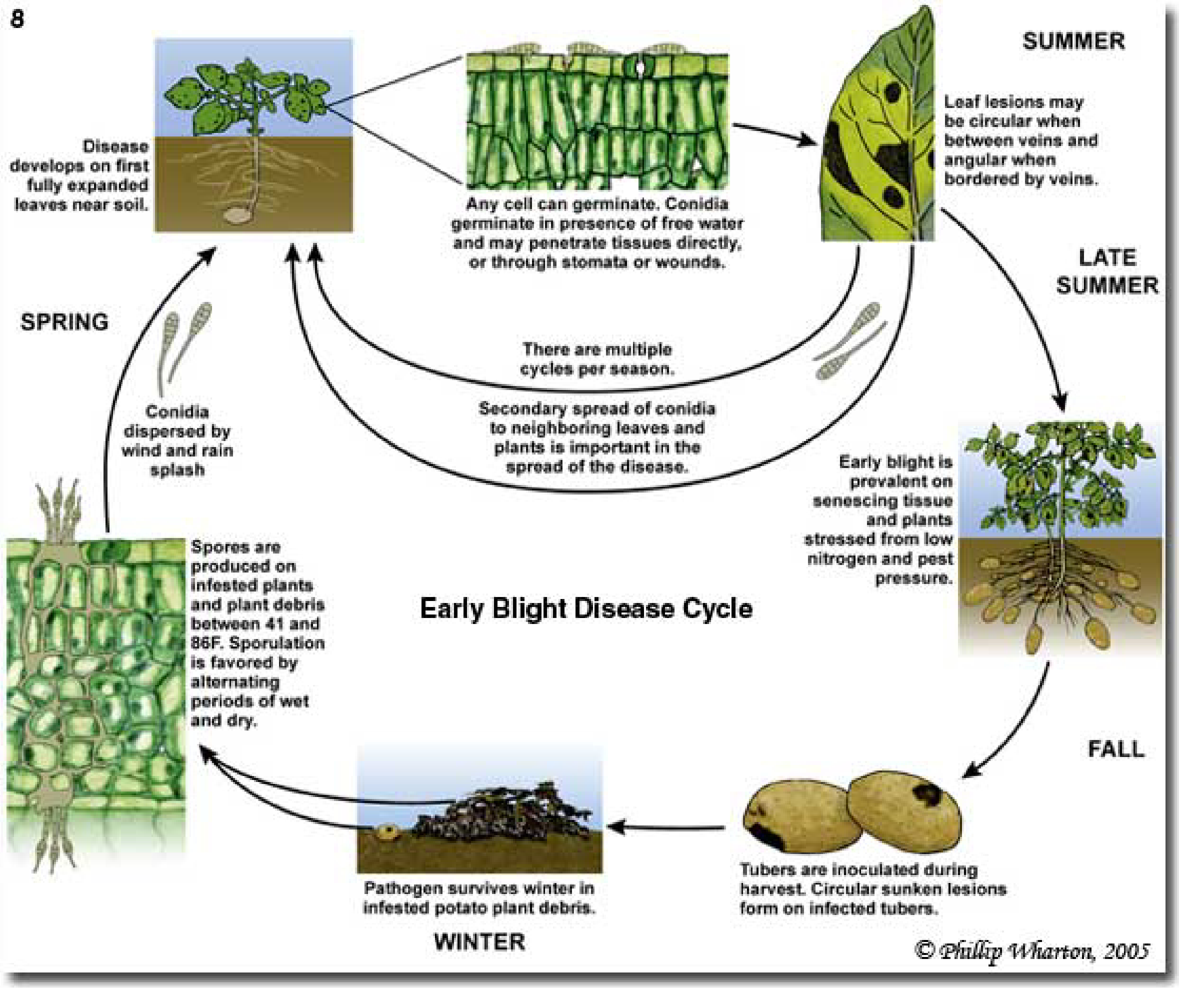

Figure 1. The diseases cycle of the early blight pathogen, *Alternaria solani*. (Warton and Kirk, 2012).

6.4. Sporulation

On potato plants, sporulation occurs between 5 and 3 °C, with the optimum around 20°C. The heaviest sporulation occurs after heavy rain or dew. Large numbers of spores are produced during alternating wet and dry periods. Sporulation of the pathogen is affected by the state of the host and tends to accelerate with an increase in necrotic tissue formation and a decrease in photosynthesis. Sporulation is inhibited by sugars, which promote vegetative growth and even the production of conidiophores. Sporulation in the field requires at least two days. Conidiophores are produced during a night with wet conditions. Light and dryness the next day induces the production of conidia, which are then formed during the second wet night (van der Waals, 2002). Symptoms appear within a week of infection. Multiple cycles can occur in one crop season under favorable conditions. Susceptibility to *A. solani* increases with the age of the plant tissue and of the plant, particularly after fruit and tuber initiation (Schultz and French, 2009).

6.5. Epidemics

Moisture plays a major role in the development of early blight. Studies have shown that free water is critical for disease development and that duration of leaf wetness can account for up to almost 90% of variability in disease development and severity. Increased leaf maturity, heavy fruit load, crowded plants, above average rainfall or dew and shading also enhance early blight development. Epidemics do not generally occur until late in the season, when the plants are most susceptible. *Alternaria solani* reacts differently to weather conditions, depending on the circumstances. In certain cases, weather factors may act indirectly by influencing the susceptibility of the host. Cooler temperatures may, for instance, retard the growth of the plant, while short photoperiods are associated with a decrease in sugar content in leaves (van der Waals, 2002).

6.6. Development of Disease

Plant pathogenic species of *Alternaria* overwinter as mycelium or spores in infected plant debris and in or on seeds. If the fungus is carried with the seed, it may attack the seedling, usually after emergence, and cause damping-off or stem lesions and collar rot. More frequently, however, spores are produced abundantly, especially during heavy dews and frequent rains, and are blown in from infected debris or infected cultivated plants and weeds (Agrios, 2005; Schultz and French, 2009; Figure 1). The germinating spores penetrate susceptible tissue directly or through wounds and soon produce new conidia that are further spread by wind, splashing rain, etc. With few exceptions, *Alternaria* diseases are more prevalent in older, senescing tissues, particularly on plants growing poorly because of some kind of stress (Agrios, 2005). Symptoms usually begin to appear on unprotected plants a week or so after flowering. Symptoms are most severe on plants that are weak due to environmental stress, poor nutrition, or on plants already infected with another disease (such as Verticillium wilt) (Schultz and French, 2009).

7. CONTROL OF EARLY BLIGHT

Effective management of this disease requires implementation of an integrated disease management approach. The disease is controlled primarily through the use of cultural practices, resistant cultivars and foliar fungicides (Warton and Kirk, 2012).

7.1. Cultural Practices

Cultural practices, such as crop rotation, removal and burning of infected plant debris, and eradication of weed hosts helps reduce the inoculum level for subsequent plantings. Since *A. solani* persists in plant debris in the field from one growing season to the next, rotation with non-host crops (e.g. small grains, corn or soy bean) reduces the amount of initial inoculum available for disease initiation (Agrios, 2005; Sikora, 2004; Schultz and French, 2009; Warton and Kirk, 2012). Other cultural control measures may include the following.

- Use certified, pathogen-free seed and resistant varieties.
- Wait at least 3 or 4 days (preferably 2 weeks) after vine killing before digging potatoes. This practice increases tuber resistance to the early blight fungus.
- After harvest, plow under all plant debris and volunteer potatoes.
- Store lesion-free tubers in a clean, dry, dark, well-ventilated location at 40° F.
- Handle tubers carefully to avoid bruising.
- Select well drained and well aerated fields, promote air circulation, and avoid dense plant stands and prolonged overhead irrigation.
- Avoid irrigation in cool cloudy weather and time irrigation to allow plants time to dry before nightfall.
- Tubers should be stored under conditions that promote rapid suberization as *A. solani* is unable to infect through intact periderm.

7.2. Resistant cultivars

Cultivars with good levels of field resistance are available, however no immunity to early blight has been found in commercial potato cultivars or in their wild parents. Highly susceptible cultivars should be avoided in locations where early blight is prevalent and disease pressure is high. Field resistance to foliage infection is associated with plant maturity. Thus late maturing cultivars are usually more resistant than early maturing cultivars and therefore, one should avoid planting early and late cultivars in the same or adjacent fields (Warton and Kirk, 2012).

7.3. Chemical Control

The most common and effective method for the control of early blight is through the application of foliar fungicides (Warton and Kirk, 2012), used from early in the growing season to vine kill. Almost as many fungicide formulations are registered for the control of early blight as for all other potato diseases together. It is recommended that contact fungicides be applied regularly in the early stages of the disease to prevent infection. From flowering onwards, 3–4 sprays of a systemic or contact fungicide should be applied. If symptoms appear before flowering, a systemic fungicide must be applied immediately. Proper timing of initial and subsequent fungicide applications can reduce the overall number of sprays with no significant yield loss (van der Waals, 2002).

A protectant-type fungicide with the active ingredient chlorothalonil, maneb, or macozeb should be applied on a 7- to 10-day spray schedule beginning at bloom, or according to a weather-timed spray schedule (such as Blitecast), and continue until the foliage dies normally or is killed artificially by a “vine-killing” agent. Intervals between fungicide applications should be shortened in areas where the disease “late blight” is common (Sikora, 2004). Alternate contact and systemic fungicides to control the disease (Schultz and French, 2009). Follow a complete spray or dust program. Proper timing and thorough coverage of foliage are essential. Start applications when early blight is first seen or just after flowering, and continue until the foliage dies normally or is killed artificially with “vine-killers.” If there is a threat of the potentially more serious late blight, applications may need to start when plants are four to six inches tall. Sprays are superior to dusts. Apply dusts and sprays in the early morning or evening when the wind is usually at a minimum (less than 5 miles per hour for dusting and 10 mph for spraying) and leaf surfaces are damp with dew. Dusts should contain at least 5 to 10 percent fungicide. Be sure to follow all directions and precautions for mixing and applying as printed on the container label (Anonymous, 1990).

The application of foliar fungicides is not necessary in plants at the vegetative stage, when they are relatively resistant. Accordingly, spraying should commence at the first sign of disease or immediately after bloom. The frequency of subsequent sprays should be determined according to the genotype and age-related resistance of the cultivar. Protectant fungicides should be applied initially at relatively long intervals and subsequently at shorter intervals as the crop ages (Warton and Kirk, 2012). Early season applications of fungicides before secondary inoculum is produced often have minimal or no effect on the spread of the disease. Early blight can be adequately controlled by relatively few fungicide applications if the initial application is properly timed. The use of predictive models to time the first application are commonly used. The first application for early blight control should be timed at 200 P days after emergence. Regular inspection of fields after plants reach 12 inches in height is recommended in order to detect early infections (Warton and Kirk, 2012).

8. CONCLUSION

Potato is the fourth most important vegetable crop in terms of quantities produced and consumed worldwide. However, its production is currently threatened by a number of biotic and abiotic constraints. Potato early blight disease, caused by two species of genus *Alternaria* (*A.solani* and *A.alternata*), is the major bottleneck in potato production in the world as well as in Ethiopia. Early blight of potato is prevalent worldwide wherever potatoes, tomatoes, peppers, and eggplant are grown. The disease can damage both potato foliage and tubers and can causes yield losses of 5 - 50%. Early blight is a poly cyclic disease that can cause more than one disease epidemics within a single cropping season. It is difficult to control because of its capacity to produce huge amounts of secondary inoculum. Since the disease is very important in causing economic losses of yields on potato crop, developing and using effective and appropriate management options is unquestionable. Using good cultural practices and applying chemical fungicides are important in reducing as well as managing of early blight disease of potato. Even thought there is no well developed biological control of early blight, it is very important to develop such management strategies. Because biological control measures are specific, efficient and environmentally safe.

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