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Review on the Integrated Management of Cercospora Leaf Spot of Groundnut (Arachis Hypogaea L.) Through Host Resistance And Fungicides

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ABSTRACT
Cercospora leaf spot of groundnut caused by cercospora arachidicola (early leaf spot) and cercosporidium persomatum (late leaf spot) are the most wide spread diseases of ground nut that result in severe yield losses. Most of the farmers do not apply disease control measures like chemical application and improved variety selection. Therefore it is necessary to develop suitable disease management practices for ground nut crop. Effective control of leaf spot diseases can be achieved by applying recommended fungicides. However repeated application of fungicide could lead to reduced efficacy of the fungicides great production costs and environmental pollution. Therefore the planting of moderately resistant variety will reduce the use of fungicides and associated expenses and increase economic gain. Thus farmers will benefits economically from plants resistant varieties and also using of integrated management are preferred approach of managing agricultural pests. It is the careful consideration of all available pest control techniques and subsequent integration of appropriate measure that discourage the development of pest population and keep pesticide and other intervention to level that are economically justified and reduce or minimize risks to human health and the environment.
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1. INTRODUCTION

Ground (Arachis hypogeae L.) is an annual legume crop which is also known as pea nut, earth nut, and goobers. It is native to southern America originating in the central part of Brazil or north eastern Paraguay (Simpson et al, 2001). Africa is recognized as a secondary center of genetic diversity (Hammeans, 1982). The genus arachis contain 70 species (coffelt and simpson 1997) and is with the subtribe stylo santhininae, the tribe aseschynomeneae, and the family fabaceal. Arochis hypogaeal is the only economical important species with in the genus arachis (mogs and Rao, 1995). All other species of the genus arachis are wild perennial and most are used for grazing (simson et al, 2001).

Ground nut is one of the most popular and universal crop cultivated in over 100 countries six continents but mainly Asia, Africa and America with a world production of 37.1 million metric ton from an area of 23.1 million hectare (FAO, 2007).

Its cultivation is mostly confined to countries ranging from 40°N to 40° S. major ground nut producing countries are china (40.1%), India (16.4%), Nigeria (8.2%), USA (5.9%), and Indonesia (4.1%). The united states, however lead the world in production of groundnut per united are (coffelt and Simpson, 1997).

Groundnut was probably brought to northern Ethiopia by the Portuguese in the 17th century and somewhat later through the Arab influence to south eastern part of the country. It is widely growing in eastern hararge zone of oromia regional state (yebio et al. 1987). The crop is also cultivated in a few localities in southern and western part of country. The total annual production in Ethiopia is estimated to be 41,761 hectares and 46,887.2 tons respectively (MOARD, 2009).

Dispite its importance the average national yield of groundnut in Ethiopia is very low (about 1.2 t/h) and diseases are one of the major constrains limiting productivity (Adugna 1992) Geremew and Asfaw, 1992. Among the fungal disease, cercospora leaf spot are of particular importance. Occurring where ever ground nut is cultivated (ALLEN, 1983). The relative importance of disease varies from place to place and season to season depending on the cropping system and prevailing environmental condition (Godfery and olorunju 2009).

Cercospora leaf spot of groundnut caused by cercospora archicola s. hovi (early leaf spot) and cercosporidium persontum (syn. Phaeois ariopisis personaty) Berk and (urt). Deight on (late leaf spot) are the most destructive disease of ground nuts worldwide (Jockson and Bell 1969, Back man and Crawford, 1984, smith et al. 1992). The host range of C. archidicola and C.personatum is confined to the genus Arachis (stalker and Simpson 1995). The damage done by these diseases generally ranged from defoliation to reduction in pod, seed and harm yield (Brennemand and Cwbreach 2000).yield losses due to cercospora leaf spots are as high as 50% in USA (shokes and cwbreath 1997, hagan et al. 2006). Leaf spot are wide spread and economically

important diseases on ground nut productivity in Ethiopia and cause about 65% yield losses in high disease pressure area of the country (Teklemariam et al. 1985).

The objective of this seminar paper is:

* To review the effect of integrated use of host resistance and fungicide sprays on cercospora leaf spot.
* To review the effect of the integrated management of cercospora leaf spot on ground nut yield.

2. INTEGRATED MANAGEMENT OF CERCOSPORA LEAF SPOT OF GROUNDNUT (*ARACHIS hypogea L.*)

2.1 Economic importance of Groundnut

Groundnut is important legume crop in tropical and sub-tropical countries of the world and is used as a source of food oil and is used as cash (Krishan et al. 2001). In addition plant residues are valuable feeds for livestock particularly during long dry season (ICRISAT, 1991). They are high in calories and are composed of up to 50% fat, 25% carbohydrates and 25% proteins. They may be boiled, broiled roasted fried ground into pea nut butter or crushed for oil. Groundnut oil is high quality and contains unsaturated fatty acid such as oleic and linoleic acid. After extraction of the oil the shev is used for animal feed.

Groundnut is a multipurpose crop in Ethiopia. It is grown by small farmers since the early 1920(yebio, 1983). Particularly in the northern and eastern parts of the country roasted seeds are directly consumed and crashed seeds are added to various types of dishes thus providing a good source of proteins and fats. Shevs are also used as fuel and organic fertilizer in many regions (Adugna 1992). Besides its superior food value Groundnut provide a surce of cash for resource poor farmers as an export crop groundnut earns foreign currency exceeding two million USD every year (Adugna 1991). These multiple uses of groundnut make it an excellent cash crop for domestic markets as well as for foreign trade in several developing and developed countries.

2.2 Groundnut production constraints

The major constraints that limit the productivity of groundnut in several countries include many biotic and abiotic stresses. Among the biotic stresses are fungal, viral and bacterial pathogens that cause considerable losses. Fungal foliar diseases such as earl leaf spot (ELS) caused by cercospora arachidicola hori late leaf spot (LLS) caused by cercosporidium personatum (Berk and curt) and rust caused by puccinia arachidis species are wide spread and economically important diseases on groundnut(NARC, 1986; Mathews and beck 1994 van wyk and cilliers 1998). These diseases caused several quality and yield losses (Pretorius, 2005).

Other diseases with minor economic importance are root, rot, wilt, stem rot, kernel rot and crown rot (IAR 1982; Tekelemaryam et al. 1985; Geremew and Asfaw 1992). Very recently however a soil borne disease causing roat and stem rot has become wide spread in major groundnut growing districts of eastern ethiopia (Tarekegne et al. 2007), Which is caused by fusarium species (mainly fusarium oxysporum). Aspergillus niger and Rhizoctonia bataticola. Virus disease such as the tomato spotted wilt virus groundnut rosette disease and the ground nut mottle virus also infect ground nut (van wyk and cilliers 2000). The relative importance of each disease varies from place to place and from season to season depending on the cropping system and the environment conditions (Godfrey and dorunju, 2009).

2.3 EARLY LEAF SPOT

2.3.1 The pathogen

Early leaf spot is caused bythe fungus cercospora are chidicola S.hori. The perfect state (with asci and septated ascosperes) of the early leaf spot pathogen (Mycosphaerella arachidicola) is rarely observed but the imperfect state the dark brown stomata produce brownish, septet conidiophores which are generally restricted to the upper leaf surface. The coridiophores produce coloress, curved, septated coridia. Dry weather influences the septation of conidia (Gibbons, 1966 MC Donald et al. 1985).

2.3.2 Symptoms

Depending up on environmental condition and cropping history, leaf symptoms usually appear between 30 to 50 days after planting. Lesion one roughly circular light brown spots on the upper leaf let surface. Somewhat lighter on the adaxial surface and surrounded by a chlorotic (yellow) halo (sub rahmanyam et al. 1982; ouzounov 1988; subbra-raoetol 1993). The may coalesce in cases of severe attack leading to defoliation. Lesions can also develop on stem petides and peqs (van wyk and cilies, 2000).symptoms can be confused wich injuries caused by soil applied chemicals especially insecticides. Howevere in the latter case lesions are scattered along the margins of leaf of groundnut seedlings were as early leaf spot symptoms are more prevent on the mature leaves (Haqan 1998).

2.3.3 ECONOMIC IMPOTRANCE

Early leaf spot alone can cause 35-50% defoliation at the peak flowering stage and yield losses may reach 20-25% (mehan and Hong 1994). Large variations in the severity of losses between locality ad seasons occur and

yield reduction of 20 to100% have been reported in south Africa and other parts of the world (venkataraman and kazi 1979; subrahanyam et al. 1992). Both yield and quality can be affected by early leaf spot and in particular by the reduced photosynthesis resulting from premature defoliation. The yield losses caused by leaf spot are mainly because of decrease in photosynthetic leaf area caused by necrotic spots and defoliation (Boote et al. 1980; Bourgeseois and Booote 1992; Naab et al. 2005). Pegrotting occurs when they are weakened by early leaf spot or by the reduced ability of diseased plant to maintain health pegs (Alcorn et al. 1976; Cole 1981, 1982 De Torres and Subero 1992).

2.3.4 EPIDEMOLOGY

Conidiophores from the imperfect state on groundnut leaf produce conidia, which are dispersed by wind, splashing rain mechanical dissemination and insects and may germinate within 10 to 14 day to repeat the imperfect state (porfer et al. 1990; Subrahamanyam et al. 1992). Conidia germinate farming germ tubes which enter open stomata and penetrate directly through the lateral faces of epideram cells. Cercospora arachidica does not produce haustoria in the plant cell. The mycelium is initially intercellular but becomes intercellular on the death of host cells (Hibbonns 1966; Porter et al. 1990). Stomata produce viable conidia after storage for 12 month at 20 to 30^{o}c and 75 to 18% relative humidity (Alabi 1986).

Optimal environmental condition for stages in the life cycle of carachidicola is variable depending on the developmental process. Climate micro environments and method of irrigation (over head or flood), have been affected the disease severity. Leaf wet ness is an important limiting factors for infection (Butler et al 1994). Prolonged periods of humidity and leaf wetness favor sporulation which results in greater disease (smith et al. 1992; Butler et al 1994; mutter and shokes 1995).optimum temperature of 25-31^{o}c minimum (18-23^{o}c) and maximum (31-35) temperatures and high humidity as well as a late rainy season favor sportulation (verkotaramon and kazi 1979; subrahmany et al. 1992). Asci and ascospres are formed by pathogen in the perfect stage (Mycosphacrella arachidicola) during over seasoning on crop residues or volunteer groundnut plants and together with mycolial fragments can also be potential sources of initial inoculum in the next season (Hemmingway 1957; porter et al. 1990).

2.4 Late Leaf Spot

2.4.1 The pathogen

Late leaf spot is caused by the fungus cercosporidum person atum(syn. Phaeoisariopsis personata, berk and curf). The late leaf spot pathogen is seen primarily in its imperfect state known as C.personatum. The perfect state (Mycos phacrella berkeleyis W.A Jenkins) is classified under the ascogeneous fungi and both asci and spermatogonia gccuron debris where the fungus over winter (patte and young 1982). During the imperfect states conidiophores are mostly hypoghyllous arising in more or less distinctly concentric reddish brown tufts, generally which hyaline tips. Conidia are generally cylindrical pale brown which somewhat attenuated tip and one or more septet (Mc Donald et al 1985).

Cercosporidium personatum conidia have 1 to 29 sept and are of clavete. Conidia vary in size from 18m to 60m × 5m to 11m condiophores from indense clusters giving rise to medium divaciean straight to slightly curved cylindrical conidia.

2.4.2 Symptoms

The lesions are very similar in size and form to those of early leaf spot. However late leaf spot is characterized by darker brown spots and usually without a definite chlorotic or yellow holo (subrahmaryam et al. 1982; suubra rao et al. 1993). On the auxial side of leaflets lesions are almost black in contrast to the lighter colored lesions of early leaf spot. Late leaf spot generally occurs latter in the season and is often seen as a complex with other leaf spots. Patte and young (1982) reported that c.persontum produced cellulotic and pectalytic enzymes that alter the starch, sugar and amino acid Content of leaf tissue resulting in reduced leaf efficiency and premature absicission. Cercosporin a biologically active phayo toxin was also isolated from c. personatum, mohapatra1982 also reported that infected leaves contained higher quantities of reducing suqar than health ones. In a study conducted by pattee and young 1982 Sever a leaf spot damage reduced the leaf area index by 80% the co_2 up take by 85% and the canopy carbon exchange rate by 93%. Photosynthesis of disease canopies was reduced not only by defoliation but also by inefficient fixation of co_2 by disease leaves. Horn et al. 1976 reported that the late leaf spot fungus produce haustoria that penetrate individual plant cell and that leaves infected with the fungus shall marked increase in respiration.

2.4.3 ECONOMIC IMPOTRANCE

Late leaf spot is an economically important foliar disease of ground nut where ever the crop is grown late leaf spot can cause severe, defoliation and reduce both harm and pod yield up to 50% (Mcdonald et al. 1985). The intensity of the disease varias from year to year depending on the rain fall and irrigation method used. It is enhanced in ground nut mono cultures and especially if plant residucs are left in the field (swanevelder 1998). Yield losses appear to be brought about more losses of meture pods due to breaking of peg during harvest than by reduction of the number of pod fromed. Ghuge et al. 1980 found that a higher number of mature pods heavier

nut (as expressed in 100- kernel weight) and enhanced pod yield.

2.4.4 EPIDEMOLOGY

Optimal environmental condition for stage in c.personatum life cycle are similar to those of c.archidicola. high relative humidity and an increase in atmospheric temperatures in spring cause an increase in fungal activity. The optimal range for growth and sporulation for c.personatum is 25-30^{o}c . light is a requirement for sporulation. Germination is optimal when temperature are slightly lower than those favorable for c.arachidicol patte and young 1982.

The pathogen perpetuates from season to season only on vollmteer ground nut plants and infected plant debris building up an inoculum reservoir for the next season (subrahmanyam et al. 1992). No outhentic host speces are known outside the genus arachis. Rao et al 1993 indicated that the condia ascospores and mycelium could only survive for between 30-60%

Days on ground nut dibers that lay under surface. Long distance distribution of pathogen may be by airborne conidia by movement of infected crop dibers and pods or seed (mcdenold et al. 1985).

2.5 REVIEW MANAGEMENT OF EARLY LEAF SPOT AND LATE LEAF SPOT

The recommended control of cercospora leaf spots includes the use of multiple fungicide application planting of resistant and tolerant cultiveries and farming practice such as crop rotation manipulation of planting dates deep ploughing of ground nut debris and clean equipment as well as biological control (potte and stalkes 1995).

2.5.1 CULTURAL PRACTICES

Most cultural practices used to control either pathogen are aimed at reducing initial inoculum. Among cultural practices many authors have emphasized the importance of plant density (mligo and crauturd 2007). Cultivar selection (bantering et al. 2003) planting date (Naab et al. 2005) and fungicide application (Dimmonck and gooding, 2002; Russell 2005) and their integration (Morrley 2004; Naab et al 2005). A crop rotation of ground nut cereal helps in efficient nutrient utilization and reduces soil borne diseases and nematodes. It also helps to reduce incidence of weeds. Maize, sorghum, pearl millet or small grain crop can be grown following ground nut. Growers are encourage to rotate ground but field on a 3 year cycle, typically with corn, cotton, and soybean (shores and culbreath 1997). Residuce of pervious rotational or cover crop can suppress early leaf spot development (Morrofort et al. 2001). Early planting dates reduce the time the crop was exposed to both early leaf spot and late leaf spot pathogens those significantly severity and defoliation and resulting in higher yields (shokes et al. 1982). However at early digging dates pod quality was reduced with a lower overall proportion of total sound mature kernus than at later digging dates (knauft et al. 1986). Deep ploughing of crop residue suppresses the spore forming ability of the pathogen (wechs et al. 2000; Brenneman and Culbreath 2005).

2.5.2 HOST RESISTANCE

Commercial cultivars vary somewhat in their susceptibility to early leaf spot and late leaf spot (waliyar et al. 1995; Bailey 2002). The highest levels of partial resistance are found in unabated germ plasem lines and in wild species derived breeding line (wynne et al. 1991). Holbrook and Isleib (2001) found that Bolivia provided the most source of early leaf spot and late leaf spot resistant groundnut germ plasm. Incompatibility and ploidy barriers along with market standards make resistance via sexual hybridization transfer difficult (ozias,akins and hill 2001).

LLS resistance has been correlated width longer latent period reduced capacity for sporulation and less defoliation. However components of resistance for ELS were not clearly correlated (Nevill 1981). Quantity resistance based on rate reducing components is important. Ricker et al (1985) suggested that latent period could be used as an effective tool in the evolution of ELS resistance in peanut lines but numer of lesions proved to be an unreliable measure.

Expression of resistance to early leaf spot and late leaf spot can at time be significantly influenced by various environmental factors including temperature and relative humidity thus resulting in unstable resistance expression (subrahmanyam et al. 1982; waltar et al. 1994 walitar et al. 1995). Houlevery shew et al (1988) found that genotype ranking across different temperature and humidity regimes remained similar based on LLS lesion number. Genotype x environment interaction may or may not be encountered across diverse environments, but should remain a consideration when breeding for resistance.

TABEL 1. Reaction of some wild *Arachis species to phaeoisariopsis personata* at ICRISAT center (from Subrahmanvam et al. 1985).

Section series and species			Components of resistance to r. personata			
	USDA plant introduction(PI) No.	ICR1SAT groundnut accession (ICG) no.	Infection frequency (lesions/cm2)	Defolliation(%)	Lesion diameter (mm)	Sporulation index1
Section: ARACS						
Series: Annuae						
A. duranensis	219823	8123	8.0	35.0	0.49	1.8
A. spegazzinii	262133	8138	12.7	75.0	0.79	3.0
Series: Perenne						
A. correntina	262137	8133	15.9	5.0	0.23	1.0
A. stenosperma	338280	8126	19.4	30.0	0.16	1.0
A. chacoense	276235	4983	17,4	32.6	0.26	1.0
Section: ERECTOIDES						
Series: Tetrafoliate						
A. apressipila		8129	19.8	5.0	0.24	1.0
A. paraguariensis		8130	8.0	0.0	0.22	1.0

2.5.3 FUNGICIDE SPRAYER (CONTROL)

Variouse strategies have been suggested for the control of the disease; however chemical method still seem to be the most effective way of controlling the disease even in the developed countries like USA (chark et al. 1974); smith and litterll 1980; culbreothet al. 2002). Previous studies have showed significant yield improvement (up to 70%) with fungicide application under experiment station condition (nab et al 2005). Leaf spot control is currently achived primarily through fungicide on sprays which should be applied beginning approximately 30 to 40 days after planting and continuing at 10 to 14 days interval (smith and littterell 1980; melouk and shokes 1995). Shokes et al.1982 report earlier initiation of fungicide application on a colendar. Schedule in florida reduces severity and defoliation and results in high yield.

Delaying spray initiation may increase amount of initial inoculum available for the following year. Although chlorothalonil and tebuconazole are most commonly used fungicides many others also are used to control cercospora leaf spots (melouk and shokes 1995; Bailey 2002).

Though chemicals play a vital role in the control of plant disease it is always worthwhile to consider the economics of their use in the light of returns or benefits derivable by the farmers from using such preparation (Bdlita and Gwiorkura 2007). Fungicide applications currently account for 20% of the variable costs needed to produce groundnuts in some countries (Hagar et al. 2000). Several fore casting system have been developed to reduce spray frequencies. Typically use of disease forecaster will save 2 to 3 sprays to a calendar spray program (Hagen et al. 2000).

2.5.4 INTEGRATED MANAGEMENT OF LEAF SPOT DISEASES

Globally impis a preferred approach of managing agricultural pest. It is the careful consideration of all available control techniques and subsequent into grat in of appropriate measures that discourage the development of pest population and keep pesticides and other interventions to levels that are economically justified and reduced or minimize risks to human health and environment (Agrios 2005). Every effort should be made to utilize all available and compatible diseases control measures. Integrated disease management (IDM) is a combination of methods such as cultural, host resistance, biological and chemical application that are environmentally compatible, economically favorable and socially acceptable to reduce damage caused by disease to tolerable level. Combination of control measure is required to combat plant diseases (Agrios 2005).

Mukankusi et al. 1999 developed IPM technologies to control the ground nut leaf spot diseases and rosette disease in ground nuts. These included use of resistant variety early planting close spacing and use of 2.3 well timed chemical sprays. Which these technologies yield increased between 16.2% and 51.3%. application of the strategies (methods has advantage such as reducing the use of chemicals input costs and reducing environments pollution (xiesong and weibo 1996).

Collecting ground nut cultivars with partial resistance to leaf spot diseases is an effective disease management technic. Although cultivars with partial resistance still need some fungicide protection total fungicide inputs required to maintain optimum yield should be gredly reduced. These can be effectively managed by a combination of fungicides and host plant resistance (Fande et al. 2001).

3. SUMMARY AND CONCLUSIONS

Groundnut is an important legume crop in tropical and subtropical countries of the world and is used as food oil and cash source in addition the residues are valuable feeds for livestock particularly during the long dry season. It is one of the three economically important oil seed crops in Ethiopia largely produced in the eastern part of the country. despite its importance the average national field of ground nut in Ethiopia is significantly lower (about 1.2 t/ha) than is potentially achievable (over 2.0 t/ha) and disease are one of the constraints to productivity. Among the fungal diseases early leaf spot caused by the fungus cercospora arachidicola and late leaf spot disease caused by the fungus. Cercosporidium personatum are destructive diseases of ground nut.

Farmers in the arid and semi-arid areas of Africa including Ethiopia are generally resouces poor and so most of them cannot afford the cost of chemical control measure as the sole method of disease management. Therefore development of integrated disease management program could be effective in decreasing the production, cost and improving productivity and quality as well as reducing the detrimental effects of chemical on the ecosystem. It is utilizing all available and compatible disease control measure. Integrated disease management (IDM) is a combination of methods such as cultural, host resistance, biological and chemical application that environmentally compatible economically feasible and socially acceptable to reduce damage causes by disease to tolerable levels.

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