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RESEARCH ARTICLE

TRIGGERING OF GROUND NUT (*ARACHIS HYPOGAEA L.*) PLANT DISEASES THROUGH CLIMATE CHANGES

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ABSTRACT

Atmospheric imbalances are accelerated due to altering climatic changes which are generally driven by human activities, both in small scale as well as in large scale. The effects can be various on ground nut – positive as well as negative or even neutral on agro ecosystems depending on the seasons and topography on earth, in particular in a multi-environment state like Andhra Pradesh. Plants and microorganisms are capable of exhibiting a quick visibility of the changes they underwent, particularly in the groundnut. To determine the extent of such impact one needs an extensive awareness of interdisciplinary concepts. In this article, a review of such effects that occurred in the recent past, the present scenario and an estimate on the future likely changes and impacts of similar diseases of groundnut across Andhra Pradesh is presented. This study confines to direct impact of climate on groundnut crop and micro organisms in various environments. Suggestions are also made to reduce the impact of climate changes on groundnut crop diseases.

Key words: Groundnut, atmospheric imbalances, plant diseases, climate changes, disease control.

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INTRODUCTION

Human activities coupled with various Greenhouse gas concentrations in the atmosphere effect extensive global climatic changes. Groundnut is a very popular commercial crop and farmers often face problems during its entire life cycle. There is a direct effect of the environment on the occurrence and development of ground nut and similar crops' diseases which has been observed over two thousand years which is evidenced by Theophrastus (370-286 B.C.) who observed that “cereals cultivated in higher altitude regions exposed to the wind had lower disease incidence than cereals cultivated in lower altitude areas”. It is established that the environment can influence host groundnut plant growth and susceptibility; pathogen reproduction, dispersal, survival and activity; as well as pathogen interaction. Groundnut plant diseases need a conducive environment for proliferation and they follow an established attack pattern. The conditions for disease development through interaction of susceptible hosts and virulent pathogen always need a favourable set of pre-conditions in the environment. These diseases are dynamic in nature and produce morphological and pathological influences on the hosts (Gaumann, 1950).

Effects of groundnut crop diseases

Attacks of groundnut diseases alter the pathological structure of plants and are responsible for yield losses of nearly 10% to 12% of crop threatening crop security. In addition to this, disease control methods through chemical processes result in excessive environmental contamination and also cause induction of traces of residual chemicals into food aggravating socio-economic problems. There a direct close relationship between the environment and groundnut plant diseases. Climate change salways alter current phytosanitary setup. In this article the potential impacts of climate change on groundnut plant diseases in order to employ appropriate controlling measures along with a parallel development of resistant agents, new control methods and new techniques to minimize serious losses are discussed. Also the impacts of climate on the spatial and temperature distribution of groundnut plant diseases; the effects of increased concentration of atmospheric gases and the consequences for disease control are also discussed.

Incidence of groundnut diseases in Andhra Pradesh

Andhra Pradesh is a major producer of groundnut (*Arachis hypogea L.*) and it is cultivated during Kharif, Rabi and summer seasons and also through rain fed cultivation. It is

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susceptible for attacks by a variety of insect pests and diseases leading to lower productivity and increased expenditure for the cultivators. Extreme weather events influence the crop and its pests with yield fluctuations. Climate change extensively triggers diversity, abundance of arthropods, insect pests and biotypes, activity and abundance of natural enemies. More than 50 pathogens including viruses are found to affect groundnut. Minor magnitude diseases cannot be ignored as they may become major subsequently. The fungal foliar diseases also affect the crop and a few are economically important in Andhra Pradesh which include leaf spots (early and late) and rust which are widely distributed can cause losses in susceptible genotypes to as much as 80% extent when both of them occur together. Belatedly, *Alternariaalternata* leaf spot is becoming increasingly hampering on Rabi/summer crop and also on Kharif groundnut crop. There are other fungal foliar diseases like anthracnose, leaf scorch, Phomosis leaf spot, Phyllosticta leaf spot, Pestalotiopsis leaf spot, Phoma leaf diseases, Drechslera leaf blight, Tikka diseases and *Cylindrocladium* leaf spot. Similarly, seed and soil-borne diseases collar rot; stem rot and dry root rot are major cause for drop in crop yield and quality. The root knot nematodes have been reported to cause damage in various parts of the State.

Disease identification and symptoms

Biotic diseases are primarily dependent on environmental conditions and certain specific conditions must be present for occurrence and development including presence of a susceptible host plant, the pathogen (fungi, bacteria, viruses) etc., and these shall be simultaneously together in a given point in time. Biotic diseases cannot occur if one of these essentials is missing. The fungal diseases are weather accelerated. Most fungi require free water or specific levels of humidity or moisture for prolonged periods of time to develop and the fungi fail to survive if dry climate prevails. Arid, rocky and mountain regions restrain fungal diseases whereas gardens and other microclimates exhibit conducive conditions ideal for disease development due to poor air circulation, shade, high humidity, and high moisture. The major classes of fungal diseases on groundnut are as under:

Early and late leaf spot

Incited by two species of fungus *Cercosporaarachidicola* and *Cercopora personata* pathogen. The leaf spots are also known as Tikka disease. The yield is heavily reduced. These fungi survive for longer periods in the infected plant debris, pods and seeds as conidia, dormant mycelium and perithecia in the affected soil.

Symptoms

The disease occurs on all above ground parts of the plant, more severely on the leaves. Leaves are affected and small dark brown circular spots appear and de-shape leaves. Severe attacks cause defoliation and complete loss of leaves and only the stem remains. Both the fungi produce oval to elongate lesions also on petiole, stem and pegs. The lesions caused by both species coalesce as infection widens and severely spotted leaves shed prematurely. Lesions are sub circular in shape and dark brown in colour. Infection may show up after sowing within four weeks. Lesions also may appear on petioles, stems, stipules. Excessive high humidity for long duration, low temperature below 20°C with dew on the leaf surface, heavy

doses of nitrogen and phosphorous fertilizers and deficiency of magnesium in soil are conducive for this disease.

Groundnut Rust

Pucciniaarachidis is the organism to initiate the rust disease. All aerial parts of the plant are attacked by rust. More than 80% relative humidity as well as heavy rainfall with temperature below 20°C favour this disease.

Symptoms

Rust can be easily recognized as orange red coloured pustules (uredinia) usually circular patches and appears on the lower leaflet surface. The epidermis ruptures and exposes powdery masses of reddish brown uredospores. Pustules first appear on the lower surface and in highly susceptible cultivars. The rust pustules may be surrounded by colonies of secondary pustules; they may also appear as small, necrotic, brown spots appear on the surface of the leaflet. They may be formed on all aerial plant parts apart from flowers and pegs. Severely infected leaves turn necrotic and desiccate but hang on to the plant. The disease is usually found when the plants are about 6 weeks old. In severe infection, lower leaves dry and drop prematurely which also leads to production of small shriveled seeds.

Alternaria leaf spot

Leaf spot disease is caused by *Alternariaarachidis*, *Alternariaalternata*, and *Alternaria tenuissima* pathogen.

Symptoms

Lesions produced by *Alternariaarachidistend* to be brown in colour and irregular in shape surrounded by yellowish halos. Symptoms produced by *Alternariatenuissima* are characterized by blighting of apical portions of leaflets and cause white light to dark brown colour and the blighted leaves curl inward and become brittle. Lesions produced by *Alternariaalternata* are small, chlorotic, water soaked and spread over the surface of the leaf. The lesions become necrotic and brown, found irregular in shape. Veins and vein lets adjacent to the lesions become necrotic. Affected leaves show chlorosis and in severe attacks become prematurely and senescent. Lesions coalesce and their central portions become pale, rapidly dry out followed by ragged and blighted appearance.

Stem rot/ Sclerotium wilt

The disease is incited by *Sclerotiumrolfsii*.

Symptoms

White fungal threads show up over affected plant tissue particularly on stem which results in sudden wilting of a branch which is completely or partially in contact with the soil. The leaves turn brown and wilt but remain attached to the plant. As the disease advances, a white mycelium web spreads over soil and basal canopy of the plant. The white sclerotia of mustard-seed-size produced in the infected tissues which later turn to brown colour as the disease develops and spreads. The entire plant may be killed or a few branches may be affected. Infections of pegs can take place independent together with stem. Lesions on the developing pegs can retard pod development and seeds in the infected pods show a characteristic bluish-grey discolouration.

Collar rot or seedling blight

The disease is caused by *Aspergillus niger* and *Aspergillus pulverulentum*. The fungus is both seed-borne and soil-borne and the infection can be seen at any stage from sowing onwards. Deep sowing of seeds, high soil temperature (30-35 degrees) and low soil moisture is congenial for disease growth.

Symptoms

The disease usually causes damage within one month of sowing and appears in three phases. The seed growth is affected and gets de-coloured. The seed can be attacked at any time after its sowing.

Dry root rot/dry wilt

The *Macrophomina phaseolina* and *Rhizoctonia bataticola* and the principal causal organisms of this disease. Fungus remains dormant as sclerotia for a long period in the soil and in infected plant debris. The primary infection is through soil borne and seed borne sclerotia. The secondary spread of sclerotia is aided by irrigation water, human agency, implements, cattle etc. Prolonged rainy season at seedling stage and low lying areas cause heavy occurrence of the disease.

Symptoms

The disease may appear at any stage of the crop growth. Water soaked necrotic spots appear on the stem at the ground level. Initially reddish brown lesions appear on the stem above the soil level. The lesions darken as the infection spreads upwards to the aerial parts and down into the roots. Roots, pegs and pods also rot and become covered with sclerotia. When infection spreads to underground roots, the sclerotia are formed externally as well as internally in the rotten tissue. Roots commonly attacked in the association with stem rots and wilt. The symptoms of the leaf infection are characterized by marginal zonate and irregular spots. The leaves and branches show drooping, leading to death of the whole plant. Pod infection leads to blackening of the shells and sclerotia can be seen inside the shells. The kernels turn black with abundant sclerotia internally and externally on the test as and shells.

Root-knot nematodes

The root knot nematode *Meloidogyne arenaria*, *Meloidogyne hapla*, *Meloidogyne javanica* are minute round worms which cause typical gall on the roots of groundnut.

Symptoms

Groundnut plants infected with the root knot nematode commonly develop enlarged roots and pegs which widen into galls of various sizes. It damages the plants by devitalizing root tip and causing formation of swelling in roots. The above ground symptoms are reduced growth and small pale green or yellowish leaves, pretending to wilt and generally appears as clearly defined patches in the field. Symptoms also associated with the infection are premature leaf fall, wilting, decline in production and loss in field. Pods also become infected and develop knobs, protuberances, or small warts. Plants infected with root knot nematodes may show various degrees of stunting and chlorosis and usually linger throughout the growing season, seldom killing the plant prematurely.

Disease control measures

The cultivators may benefit if the following measures to control the various above types of diseases:

Crop rotation is of primary importance in avoiding early season infection. This make the soil to deter recurrence of a disease on the subsequent variety of crop. Field sanitation also would be highly useful in restricting the pests and diseases. Rotation of groundnut with non-host crop like pearl millet or sorghum, wheat, corn etc., provides satisfactory level of control. Crop rotation with wheat, corn and soya bean may minimize the incidence of diseases like stem rot. Removal of volunteer and self-grown groundnut plants and destruction of infected crop debris is important in reducing the primary source of infection. Destroying of reservoir hosts and debris to reduce the primary source of inoculum. It is necessary to keep weeds under control and to grow groundnut and pearl millet in 7:1 ratio. Use healthy certified seeds and apply seed treatment with Carbendazim or Thiram @22g/kg of seed. Seed treatment with Carbendazim/Thiram/Captan @2-3 g/kg seed or usage of 4gm *Trichoderma viride* formulation followed by application of 2.5 kg *Trichoderma viride* formulation mixed with 100kg farm yard manure before sowing is recommended. Early sowing in the first fortnight of each season of cultivation to avoid disease incidence and to increase the resistance to disease in the groundnut plants is very essential. Deep ploughing in summer and exposure of the ploughed land to sun for a few days for eradication of existing land contamination is helpful and cultivation of groundnut in flat or slightly raised beds is further helpful. Deep ploughing during hot weather, soil solarization and flooding can significantly decrease levels of infestation of root-knot nematodes in soils. Early sown crop during kharif and rabi/summer seasons is less infected due to checked movement of migrant thrips. Optimum plant population should be maintained. Time of sowing and plant spacing are important considerations. Avoid growing large areas of highly susceptible varieties in endemic areas. Resistant varieties should be used to reduce reliance on chemical pesticides.

It is necessary to make full use of non-fungicidal control measures e.g., dispose of crop debris and control collateral and alternate host, which harbour disease. Monitor crops regularly for disease and treat before the infection becomes established. Use fungicides only in the unavoidable situations where the risk of disease warrants treatment. Make full use of effective fungicides with different modes of action as alternative sprays. Mixtures of eradicant fungicides with protectants materials offer the most flexibility as well as reducing resistance risk. While formulating spray programmes, take into account any earlier use of fungicides groups as seed treatment. Do not exceed the maximum recommended numbers of applications to each crop for any fungicide group. Avoid repeated application of very low doses. Deep summer ploughing and removal plant debris is helpful in reducing disease incidence. Cultural practices such as deep burial of organic matter, plant debris before sowing is particularly useful in reducing the diseases like sclerotium wilt. The early and late leaf spots are effectively controlled by the 2-3 spray application of Carbendazim 1gm or Mancozeb 2gm or Chlorothalanyl 2g, hexaconazole 2 ml/litre of water at 15 days interval starting from 4-5 weeks after planting. Intercropping of pearl millet or sorghum with groundnut (1:3) is useful in reducing the intensity of rust.



Fig. 1. Early and late leaf spot



Fig. 2. Groundnut Rust



Fig. 3. Alternaria leaf spot



Fig. 4. Stem rot/Sclerotium wilt



Fig. 5. Collar rot or seedling blight



Fig. 6. Dry root rot/dry wilt



Fig. 7. Root-knot nematodes

Table 1. Groundnut production details in Andhra Pradesh

SNo.	Year	Area (In Lakh Hectares)			Productivity (In Kgs/Hectare.)			Production (In Lakh Tones)		
		Kharif	Rabi	Total	Kharif	Rabi	Year	Kharif	Rabi	Total
-	Average Of Preceding 5 Years	10.90	1.07	11.97	502	2266	661	5.58	2.41	7.99
1	2010-2011	13.17	1.09	14.26	650	2279	775	8.56	2.50	11.06
2	2011-2012	10.33	1.03	11.36	344	2219	513	3.55	2.28	05.83
3	2012-2013	10.42	1.15	11.57	518	2082	674	5.40	2.40	07.80
4	2013-2014	10.86	0.90	11.76	627	2218	749	6.80	2.01	08.81
5	2014-2015	08.04	0.70	08.74	410	2325	564	3.30	1.63	04.93
6	2015-2016	06.82	0.93	07.75	876	2190	1033	5.98	2.03	08.01

Source: Directorate of Economics and Statistics India, year 2013-14
AP Govt. Publications

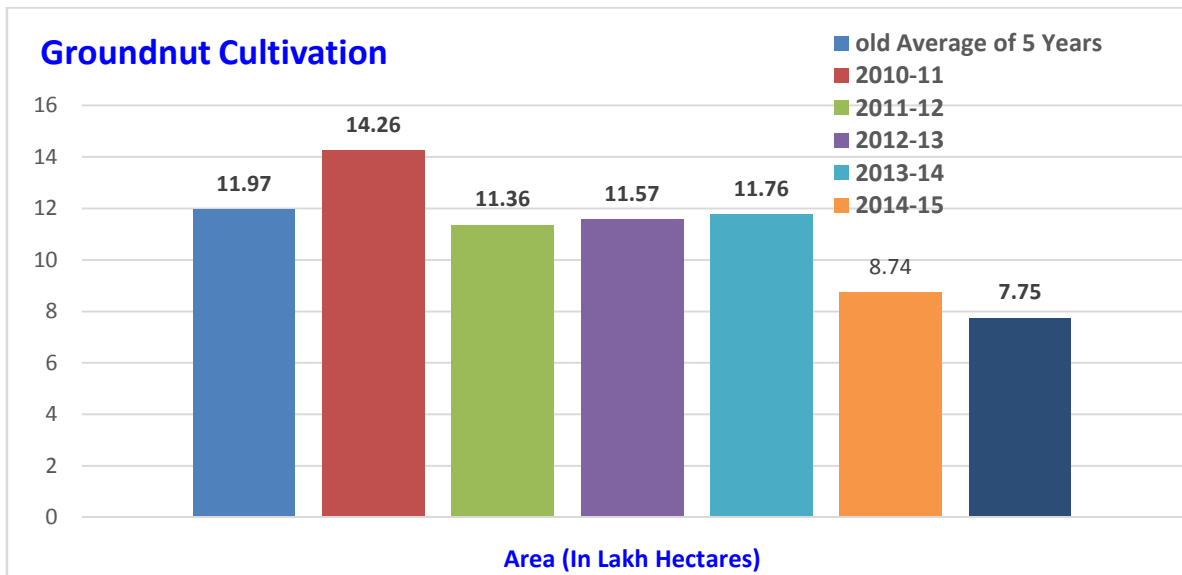


Fig. 8. Groundnut Cultivation Area in Andhra Pradesh

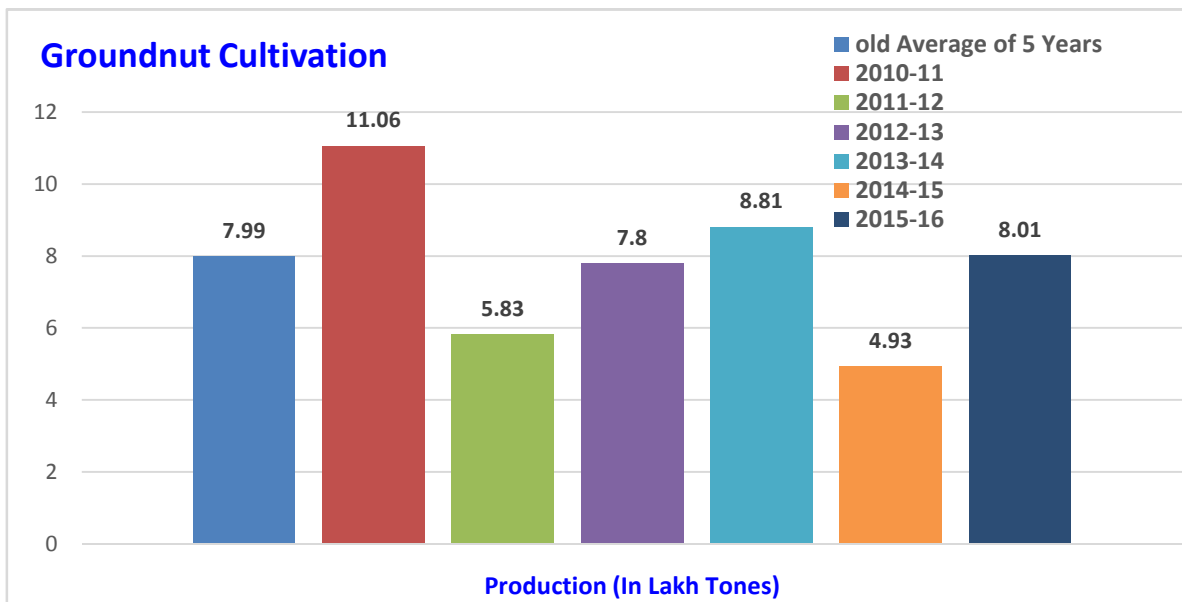


Fig. 9. Groundnut Production in Andhra Pradesh

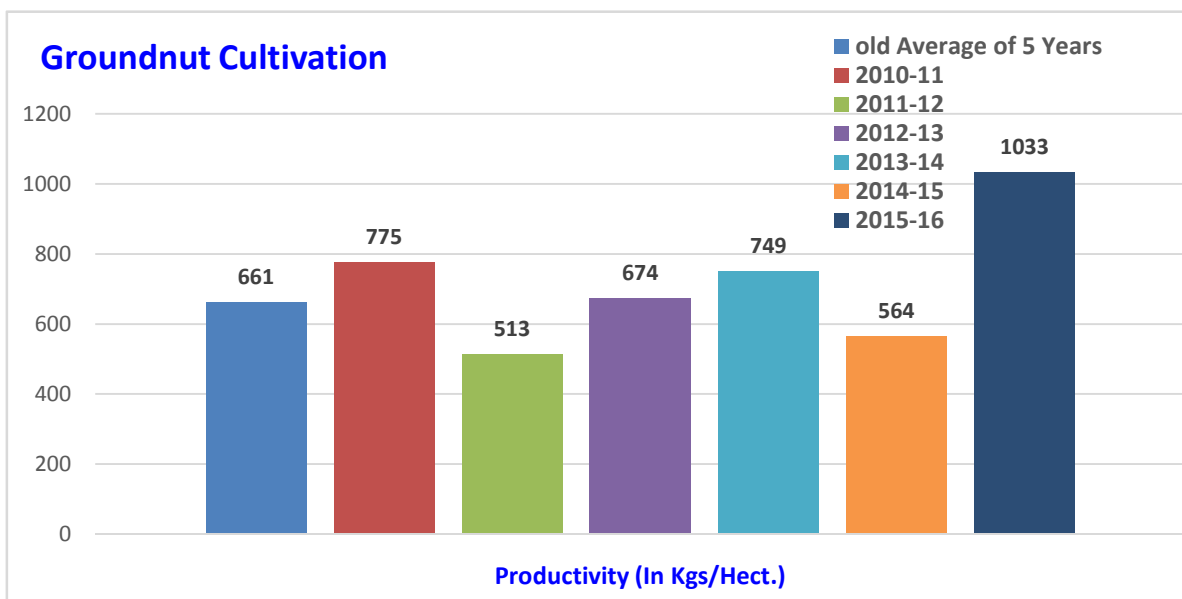


Fig. 10. Groundnut Productivity per Hectare in Andhra Pradesh

Also, three to four times spraying of Tridemorph 2gm/litre of water at two to three weeks interval gives good management of rust. Enforcement of strict plant quarantine regulations to avoid the spread of rust on the pods or seeds to disease free areas. Foliar application of aqueous neem extract @2-5 percent is useful and economical for the control of rust. Spray application of Chlorothalanyl 2g/litre or mancozeb 2g/litre or eettablesulphur 2g/litre of water during the 35 to 50 days period after sowing. Foliar spray of Copper oxychloride and Mancozeb 2.0 g/litre water are effective in controlling the diseases. Non fumigant systemic nematicides like Carbofuran 3G @ 3g/m, aldicarbsndphenamiphos (Nemacur) are most effective when applied in furrows during sowing, at the rates of 2-3 kg of active ingredient per hectare.

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