*https://doi.org/ 10.33472/AFJBS.6.5.2024. 8274-8278*

**African Journal of Biological Sciences**


# Assessment of the influence of Groundnut (*Arachis Hypogaea* L.) Canopy Architecture on Rust Disease Dynamics during Kharif Season

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**ABSTRACT:**

A field investigation was carried out at the Agricultural Instructional Farm', BCKV, Jaguli, Nadia, West Bengal, West Bengal for the Kharif season in 2015 to study the macroclimate and canopy architecture inter-relationship and their impact on Rust disease incidence of groundnut. The rust disease of groundnuts is considered as the major foliar disease of groundnuts. The results showed that the incidence of Rust had different significant (CD>0.05) effects on the both Spanish and Virginia-type varieties of Groundnut. In general, the Spanish variety was shown to have a greater disease severity, and the flatbed seeding method, when paired with larger nitrogen dosages, exacerbated disease severity even more. According to field tests conducted in 2015. Many morphological features had a dynamic impact on the severity of the illness, and macroclimatic and microclimatic factors such as humidity, temperature, and rainfall were important. The study emphasizes the importance of canopy architectural factors in determining the dynamics of foliar diseases in groundnut farming.

***Keywords***: *Canopy architecture, Macroclimate, Microclimate, Rust, Simple linear regression equation*

Groundnut (Arachis hypogea L.) is an annual soil-enriching, self-pollinated legume that is extensively grown in dry and semi-arid regions across the world (40°N and 40°S), ranging from warm temperate to equatorial temperatures. It is a major oilseed crop in the semi-arid tropics **(Fletcher et al. 1992; Tarimo, 1997; ICRISAT, 2008)**. The crop is the thirteenth most important crop in the world **(Hatam and Abbasi, 1994).** Groundnut is highly sensitive to soil salinity, and can tolerate a broad range of pH values, but prefers neutral to slightly acidic soils **(Tsigbey et al., 2003).** Groundnut is the most common oilseed crop in India, accounting for around 50% of total acreage and 45% of total oil output. In India, approximately 75% of the groundnut area is in a low to moderate rainfall zone (parts of the peninsular region, as well as the western and central areas), with a short distribution time (90-120 days. Although the crop may be produced all year, it is mostly grown during the rainy season (Kharif; June-September). The Kharif season accounts for around 80% of overall groundnut output. Several illnesses caused by fungi, viruses, and nematodes have been recorded on groundnuts in India. Among the most serious foliar diseases, Rust produced by *Puccinia arachidis Speg* can lower yields by more than 50% depending on the variety and climatic circumstances **(Subrahmanyam et al., 1980)**. As a result, the primary focus of the study will be on the epidemiological aspects of Rust disease about diverse crop canopy topologies to establish a forewarning system with predictive capability for practical application in the future. There is little information on the persistence, transmission, and dissemination of rust pathogens in India. There is no information available on the interactions between the host, pathogen, and environment. These data are critical for developing integrated disease management strategies. To limit the usage of pesticides, novel studies have been designed that place the plant at the centre of the crop protection system. Although multiple epidemiological researches have been undertaken by various professionals, notably on macroclimate conditions, microclimatic studies have remained under-discussed and have not been conducted in India or West Bengal for more effective warning systems.

***Experimental details***

The field experiments were laid out in Randomized Block Design (RBD) following split-split plot design comprising 9treatments including controls with 3 replications for each ($R_1$, $R_2$ & $R_3$) for the Kharif season. The layout for the Experiment ($T_1$ – $T_9$) including control where normal spacing was maintained (30x10cms) TAG-24(Spanish/bunchy type). the main-treatment factor and the method of sowing was the sub-treatment factor.i.e. ($M_1$, $M_2$, $M_3$) for the experimental trial. The sub-sub treatment factor was the Nitrogen dose. i.e. ($N_1$, $N_2$ & $N_3$).

***Result and Discussion***

***Epidemic development in field crop***

Having assessed, mostly under controlled conditions, the effects of biometereological parameters during the process of disease development, it was investigated what influence these parameters have on the field crop. During epidemic development during the Kharif season per year viz, disease severity was recorded every 10 days from 30 days onwards till 120 days, i.e.,15 days before harvest. Field experiments were conducted using TAG-24 variety of groundnut and field trials were followed where different methods of sowing were considered as sub-sub treatments by maintaining the general spacing, which resulted in biometeorological diversity. The disease progression data collected for the kharif season and one year were examined in various ways to build prototype equations as a function of biometeorological factors. To begin with, starting and final illness severity were connected with distinct sowing dates (at 10-day intervals) for each season. The data was subjected to Simple linear regression and Multiple linear regression irrespective of the $R^2$ values (highly significant) and the MRA provided the best fit based on low SE values for all seasons. This allows for a better understanding of the interactive relationship between macroclimatic, microclimatic, and morphological parameters and disease severity. The results indicated that both preliminary and highest disease severity varied according to the date of planting. In 2015, during the kharif season, the maximum disease was recorded at 120 days after planting (FDS=59.37%) in the lower leaf, and the lowest at 30 days after planting (IDS=8.10%) in the crown leaf. different days following planting fluctuated generally, with ups and downs on different sowing dates, indicating the effect of biometeorological variables.

***Interaction among morphological parameters concerning disease severity***

During 2015, it was observed that with the increase of leaf area index, leaf angle orientation, no. of branches/plant, no. of leaves per plant and canopy measurement there is certain increase of disease severity with an increase of the age of the plant irrespective of both varieties, seasons and leaf area of the crop.

***Interaction among macroclimatic parameters concerning disease severity***

In 2015, Macroclimatic research revealed that the severity of rust disease during the kharif season decreased when the maximum temperature decreased and the minimum temperature and PDI were reversely correlated. Relative humidity (at 6:35 a.m.) correlated positively with PDI for rust during kharif. PDI revealed a positive correlation with disease severity when RH was measured at 1:35 pm. However, Rainfall also demonstrated a distinct interacting association with PDI; for example, during the kharif season, PDI exhibited a negative correlation with rainfall. Wind speed exhibited a reverse correlation with PDI for both the crown and middle leaves, except for the lower leaf, which negatively correlated with disease severity during the kharif season for rust disease. The Bright Sunshine hours were positively associated with PDI during the Kharif season. This means that the Disease severity had fewer ups and downs in 2015, indicating the presence of additional unknown miscellaneous parameter interventions Which is similar to that with the research findings of

**(Venkataraman and Kazi, 1979). (Fig.1)**

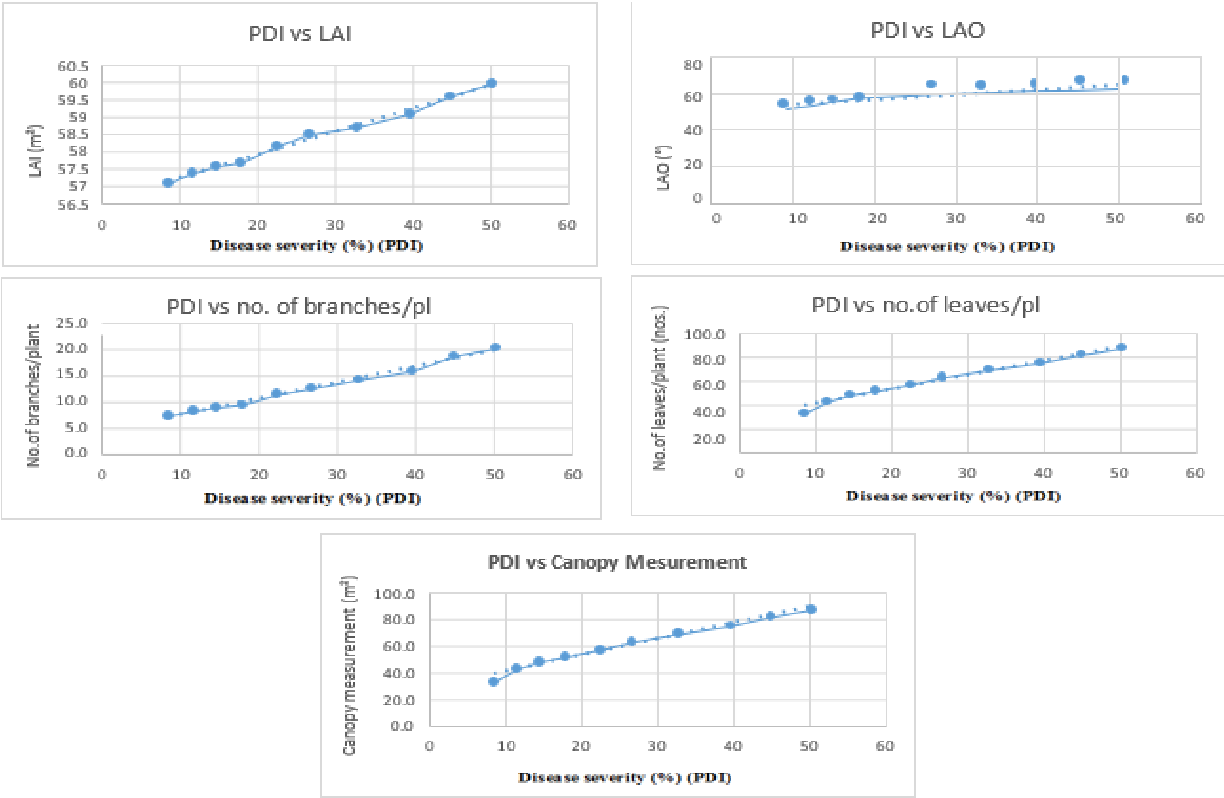


**Fig:1: Generalized graphical representation between morphological parameters and PDI (2015) in Rust disease**

***Interaction among macroclimatic parameters concerning disease severity***

Microclimatic studies in 2015 showed that all the parameters like canopy temperature (at 6:35am and 1:35pm) and Relative humidity (at 6:35am and 1:35pm) both had positive correlation with the disease severity that signifies with increase of the age of the plant the disease severity also increases in relation with the microclimatic parameters for Rust disease irrespective of the variety during Kharif season.Therefore, it can be concluded that for both of the year the microclimatic parameters followed a similar trend pattern. that matches with the findings of **Kao and Wu (1970). (Fig.2)**

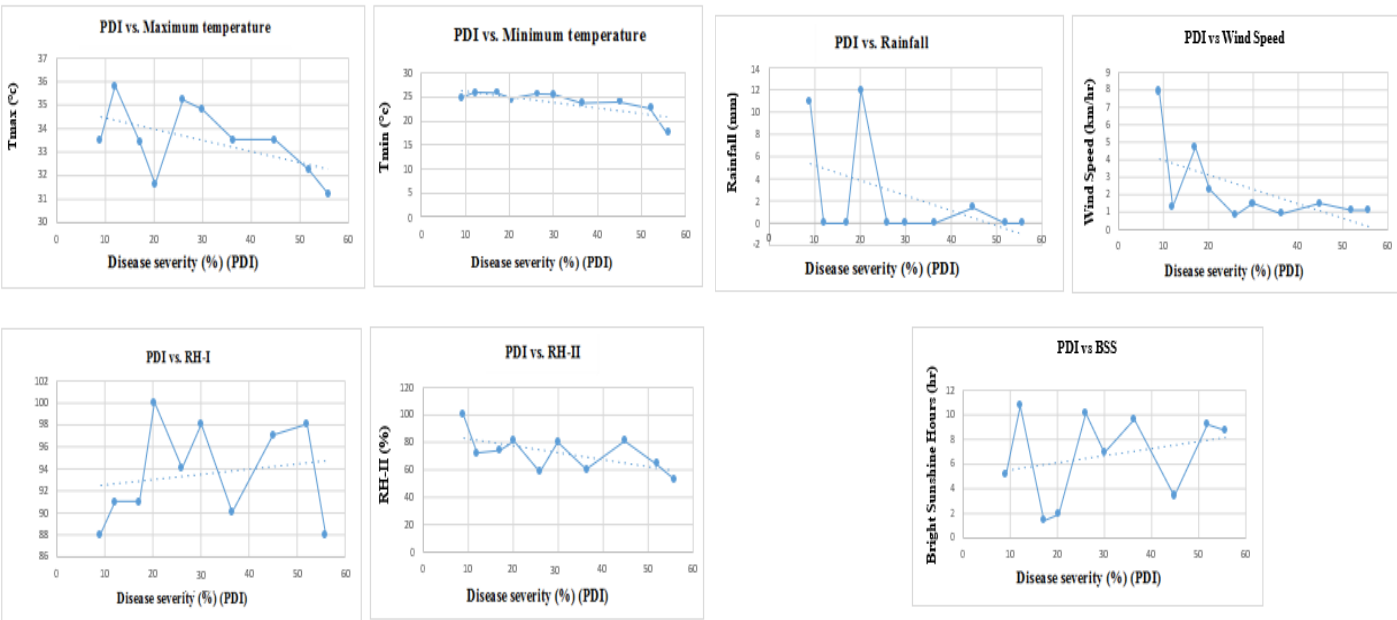


**Fig:2: Generalized graphical representation between macroclimatic parameters and PDI (2015) in Rust disease**

***General understanding of the experimental trials on crop canopy***

Rust severity was greatly influenced by different weather parameters as well as the morphology of the plant. Different varieties of groundnut showed different morphological characters regarding the LAI, LAO, No. of branches/plant, no. of leaves/plant, and canopy measurement. From the data obtained from the parametric analysis, it was observed that with the increased age of the plant. There morphological characters also showed different morphological reactions among themselves and there differences were statistically significant.Interaction between 2 varieties,3 methods of sowing, and 3 different Nitrogen doses along with standard $P_2O_5$ and $K_2O$ showed significant differences among themselves with respect to no. of branches, no. of leaves/plant, and canopy measurement. Among the two varieties, V1(TAG- 24)(Spanish or bunch type variety) was found to be superior in the Kharif season. At 30 DAP highest value of no. of branches/plant was observed in the treatment combination of $V_1M_1N_1$ which indicates the Spanish variety sown by following the flatbed method combined with the higher $N_2$ dose gives the best result. Whereas $V_1M_3N_1$ (Spanish variety combined with high $N_2$ and raised bed method) showed higher value in case of no. of leaves/plant.$V_1M_1N_2$ and $V_1M_1N_3$ both showed higher value of canopy measurement. Similarly at 120 DAP $V_1M_1N_1$ gave the higher result in the case of a number of branches/ plant, whereas the lowest were observed on $V_2M_2N_2$, the difference between the highest valued treatment and the controlled treatment the difference were statistically significant.$V_1M_3N_2$ showed highest canopy measurement value, where the lowest being observed at $V_2M_2N_3$ and $V_1M_1N_2$ gave the highest value regarding the no. of leaves/plant.The microclimatic relationship study with the disease severity data showed that with the increment of LAO, LAI, no. of branches/plant, number. of leaves per plant there is a significant increase of disease severity at different DAP.Generated disease progress data collected during Kharif season was variously analysed for developing prediction equation as a function of biometereological parameters.Subjecting the data to multiple regression showed that irrespective of the $R^2$ value (highly significant) it gave the best fit in linearising the data on the basis of low S.E values during Kharif season.During the Kharif season disease severity was recorded lowest on the crown leaf in the treatment $M_1N_1$(7.17%) whereas the highest was recorded at 120 DAP on lower leaf(56.2%) in $M_1N_1$.The partial regression coefficient of the equation showed that Canopy temperature (CT-I)6:35am,(CT-II)1.35pm and RH-I(6:35am) are positively correlated with the disease progression, but negatively correlated with RH- II(1.35pm)during kharif season.It was proved with high coefficient of determination value($R^2$) and low S.E value. In case of the macroclimatic parameters maximum temp, minimum temperature, RH-I, rainfall and bright sunshine hour were positively correlated except the RH-II that is negatively correlated with the foliar disease progression.

**ACKNOWLEDGEMENTS**

The author is grateful to the Department of Plant Pathology, BCKV, Mohanpur, Nadia, for kindly providing resources and space for the research. Furthermore, sincere gratitude is offered to all of the field workers whose excellent help was critical during the trial time.

**FINANCIAL SUPPORT**

The research received no external funding.

**AUTHOR CONTRIBUTION STATEMENT**

Ankita Mukhopadhyay Biswas managed the study proposal's ideation and formulation, as well as the experiments, data collection, analysis, and paper drafting. All authors reviewed and approved the final article.

**CONFLICT OF INTEREST**

No conflict of interest.

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