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Field performance of different cashew varieties against gummosis disease caused by *Botryosphaeria* spp. in West Bengal, India

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Cashew is an economically important plantation crop in the red and laterite tracts of West Bengal, where it has experienced steadily increasing domestic demand in addition to its export potential in recent years. However, cashew cultivation in the state faces significant constraints due to the incidence of pests and diseases, among which gummosis, primarily caused by *Botryosphaeria* species, is a major concern. The present study evaluated the incidence and severity of gummosis in different cashew varieties. A total of twenty-five cashew varieties were assessed for their susceptibility to the pathogen and their disease severity along with AUDPC data in the affected areas. The results revealed that gummosis disease severity varied significantly among the varieties, ranging from 2.08% to 56.25%. Very low disease severity was recorded in Vengurla-4 (2.08%), Bidhan Jhargram-2 (4.17%), and Madakkathara-1 (8.33%). In contrast, the highest disease severity was observed in Vengurla-6 (56.25%), followed by Vengurla-1 (52.08%) and UN-50 (52.08%).The disease progress rate shows a significant positive correlation with minimum RH even at 1% level of significance in all the six varieties Vengurla-6 (r = 0.730), Madakkathara-2 (r = 0.749), VRI-3 (r = 0.749), Amrutha (r = 0.770), Dhana (r = 0.710) and NRCC-2 (r = 0.710) and at 5% level in Vengurla-1 (r = 0.617), but not significant correlation was observed between disease progress rate and maximum RH in any of the varieties. Similarly, gummosis disease progress showed no significant positive correlation with maximum or mean temperature. The findings of this study provide valuable insights for identifying relatively resistant cashew varieties and formulating effective disease management strategies. Adoption of such resilient varieties can contribute to improved yield performance and enhance the sustainability of cashew cultivation in West Bengal.

Keywords : *Botryosphaeria* spp., cashew, gummosis, disease incidence, severity, variety

INTRODUCTION

Cashew (*Anacardium occidentale* L.), derived from the Portuguese word ‘Caju’, belonging to family Anacardiaceae, which comprises more than 60 genera and 400 species of trees and shrubs, is an important tropical perennial tree indigenous to the northern regions of South America. The word *Anacardium*, originated from the Greek word, (*Ana* means “upwards” and *cardium* means “heart”) refers to the fruit’s nut, core, or heart, which is placed around the outside. More than 21 species of *Anacardium* was reported earlier (Abdul Salam and Peter, 2010; Saroj and Rupa, 2014). However, the Plants of the World Online accepted only 13 species of which *A. occidentale* is economically most important. As an export-focused crop, cashew is of great agricultural significance worldwide. In 2021, the crop set a record in the worldwide production scenario, producing 3,708,384 tonnes of raw cashew nuts (Anonymous, 2024). After almonds and walnuts, cashew ranks third in terms of marketable nut crops (Otálora *et al*. 2024). In addition to its substantial value in the world market for nuts, cashew trees are remarkably adaptable, growing well in sandy and arid soils (Sierra-Baquero *et al*. 2024). Cashew trees are said to be beneficial for waste land development,

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afforestation, and soil conservation. Consequently, identifying the emerging areas of cashew research is essential.

Despite being a crop of high market value, the economic value of cashew production is being threatened by various invisible enemies that restrict the nut yield potentiality of the crop. Cuadros-Orellana *et al*. (2013) reported that more than 10 fungal diseases like anthracnose, gummosis, wilt, powdery mildew etc. posed havoc threat to cashew production worldwide.In India, among them, gummosis and shoot-dieback caused by *Lasiodiplodia theobromae* (Khatoon *et al*. 2017), inflorescence decline caused by *Candidatus Phytoplasma Australasia* (Mitra *et al.* 2020), Fusarial wilt by *F. solani* (Joshi and Raut, 2005), Pestalotiopsis leaf spot incited by *Pestalotiopsis oxyanthi* (Patsa *et al*. 2023a), and leaf spot caused by *Pestalotia heterocornis* (Joshi, 2005) *F. falciforme* (Patsa *et al*. 2023b) were reported from different parts of the country. Among these, cashew gummosis is common in the cashew growing areas and is of major concern. The disease is caused by *Lasiodiplodia theobromae* (Pat.) (syn. *Botryodiplodia theobromae*) Griff. & Maubl. was initially reported in 1990s. The disease is characterized by large cankers in the trunk or woody branches that may rupture and release sticky, translucent resin-like substances (Freire *et al*. 2002). Gummosis damage includes dieback, plant death, branch destruction, reduction in photosynthesis, and reduction in nutrient and water uptake. The disease is prevalent in the semi arid conditions where harsh dry and warm weather is favorable where water stress is a major issue of concern.

Cashew gummosis appears on main woody trunk as well as on primary and secondary woody branches depending upon the nature of variety. The lack of knowledge of these emerging diseases of the plantation crop, their occurrence and management strategies are of major concern. Different strategies of cultural management, such as sanitation practices, pruning of diseased shoot or branches etc. reduces the disease incidence to some extent (Patsa, 2021). Hence, the adoption of disease-resistant or disease-tolerant cashew cultivars is considered one of the most reliable, economically viable, and environmentally sustainable methods for disease control in cashew orchards. A cashew improvement program should focus on developing new commercial types with dwarf or semi-dwarf canopies, large nuts with a higher shelling percentage, greater kernel grade, and resistance to biotic and abiotic stress. To date, no published research is available in India on the varietal reaction of cashew to different diseases. Therefore, the present study was undertaken to identify cultivars exhibiting resistance to gummosis disease while also producing higher nut yield, in view of the aforementioned considerations.

MATERIALS AND METHODS

An orchard consisting of 25 varieties under All India Coordinated Research Project (AICRP) on Cashew was selected to study the disease reaction by observing the incidence and severity of gummosis disease of cashew. Age of the plant was 8 years and in full bearing stage. The plant was planted at spacing of 6m x 6m. The detailed information about 25 varieties of cashew screened for disease reaction was presented in Table 1. Twelve numbers of plants for each variety were taken into consideration for scoring of gummosis disease. Three plants of each variety were treated as one replication unit and four replications was maintained against each variety. Observations on incidence and severity of gummosis, lesion number etc. were recorded during 2018 and 2019 from January to December at bimonthly interval. Disease severity was calculated based on “0-4” Gummosis disease rating scale used by Cardoso *et al*. 2006 as 0: No symptoms, 1: Small and few cankers in trunk and branches, small cracks without gum exudation, 2: Larger cracked cankers on trunk and branches, reaching up to 1/3 of diameter, with little or no gum, 3: Cracked cankers, larger than 1/3 of diameter with abundant gum exudation, 4: Cracked cankers completely girdling trunk or branches, foliage yellowing, die back and gum exudation and their corresponding pictorial presentation is given in Fig.1. The value of gummosis severity was calculated by estimating Percent Disease Index (PDI) by using the formula of Wheeler (1969).

$$PDI = \frac{\text{Sum of all numerical rating}}{\text{Total number of observation X Maximum rating}} \text{ X } 100$$

Disease incidence was calculated by using the following formula.

$$\text{Gummosis incidence (\%)} = \frac{\text{No of gummosis infected plant}}{\text{Total number of plants evaluated}} \text{ X } 100$$

Based on the formula of Wilcoxson et al. (1975), the area under disease progress curve of each plant variety was calculated with the help of disease severity.

$$A = \sum_{i=1}^{k} \frac{1}{2}(S_i + S_{i-1}) X d$$

Where, A= AUDPC value, S_i= disease severity at the end of the week *i*, *k* = the number of successive evaluations of disease and *d* = interval between two evaluations.

The experimental data were analysed statistically by using Randomised Block Design (RBD) with 25 varieties as a treatment and 4 replications. The data were analysed statistically by using SPSS (Var 16.0). Angular transformation was also done as per requirement prior to analysis. Correlation and regression analysis were also carried out to find out association between weather parameters and disease severity of gummosis.

RESULTS AND DISCUSSION

Performance of twenty-five popular varieties of cashew, grown at orchard under All India Coordinated Research Project on Cashew, was screened for disease reaction to gummosis during 2018 and 2019. Gummosis being a very slow developing in nature, diseases scoring was done at bimonthly interval. Pooled data of final disease incidence, disease severity observed prior to harvest and the area under disease progress curve (AUDPC), calculated to combine several observations of disease severity into a single value figure, and of each variety were presented (Table 2). Initially, it has been observed that eight varieties namely Bhubaneswar-1, Chintamani-1, Vengurla-4, Madakkathara-1, BPP-8, BPP-4, NRCC-2 and Bidhan Jhargram-2 were free from gummosis and percent disease incidence increased with the time in most of the varieties. Gummosis incidence was significant among the varieties and 100% gummosis incidence was observed in 15 varieties while very low incidence was recorded in Vengurla-4 (8.33%) followed by Bidhan Jhargram-2 (16.67%). In case of severity, it was recorded that gummosis disease severity varied significantly from 2.08 to 56.25% among 25 varieties. Very low disease severity was observed in Vengurla-4 (2.08%), followed by Bidhan Jhargran-2 (4.17%) and Madakkathara-1 (8.33%) which were statistically at par. On the contrary highest disease severity was recorded in Vengurla-6 (56.25%) followed by Vengurla-1 (52.08%) and UN-50 (52.08%) which were also statistically at par. When AUDPC was calculated from disease severity data of multiple observations into a single value, it has been observed that highest AUDPC value (33937.50) in Vengurla-6 variety followed by UN-50 (28750.00) and Vengurla-1 (25750.00). Variety Vengurla-4 (312.50) and Bidhan Jhargram-2 (750.00) showed very low AUDPC value, which were statistically at par.

The number of gummosis lesions per tree is an important indicator of disease severity. In orchard conditions, disease progression is slow, often taking several years to advance between disease indices. Furthermore, variation in disease intensity was evident within the same disease grade when the number of cankerous lesions, irrespective of size, was considered. To differentiate the variety within a same disease grade or index, number of gummosis lesion was recorded. Initially, it was varied from 0.00 to 2.25 and number of gummosis lesion increased with the time in all the cashew varieties tested at subsequent observation. At the final observation, highest lesion number varied significantly among the varieties and it was highest in Madakkathara-2 (25.00) followed by Bhaskara (19.00) and Bhubaneswar-1 (15.42). Bidhan Jhargram-2 and Vengurla-4 produced lowest cankerous gummosis lesion. It was found that highest area under lesion progress curve (AULPC) was recorded in Madakkathara-2 (4245.00) followed by Bhaskara (3547.50), UN-50 (3507.50) and Vengurla-6 (3367.50) while very low lesion was observed in Bidhan Jhargram-2 (30.00), Vengurla-4 (52.50). Varieties were grouped into susceptible, moderately susceptible, moderately field

Table 1: Morphological and agronomic characteristic of cashew varieties used in the experiment

Sl No.	Varity Name	Recommended for cultivation	Tree Habit	Tree Height	Apple Shape	Apple Colour
1	Bhaskara	Karnataka, West Bengal	Upright & Compact	Tall	Conical- obovate	Red
2	Madakkathara-2	Kerala, W.B.	Upright &Open	Tall	Conical- obovate	Red
3	Bhubaneswar-1	Odisha.	Upright & Compact	Semi Tall	Cylindrical	Red
4	K-22-1	Kerala, W.B.	Upright & Compact	Tall	Conical- obovate	Red
5	Chintamani-1	Karnataka, W.B.	Upright &Open	Tall	Round	Pink
6	Ullal-4	Karnataka, W.B.	Upright &Open	Tall	Conical- obovate	Yellow
7	Vengurla-7	Maharastra	Upright & Compact	Tall	Conical- obovate	Yellow
8	VIR-3	Tamil Nadu, W.B.	Upright & Compact	Semi Tall	Cylindrical	Red
9	BPP-6	Andhra Pradesh	Spreading	Tall	Cylindrical	Yellow
10	Amrutha	Kerala, W.B.	Spreading	Tall	Conical- obovate	Yellow
11	Vengurla-4	Maharastra	Upright &Open	Tall	Conical- obovate	Red
12	Goa-1	Goa	Semi Spreading	Semi Tall	Conical- obovate	Yellow
13	Madakkathara-1	Kerala, W.B.	Upright & Compact	Tall	Conical- obovate	Yellow
14	Priyanka	Kerala, W.B.	Upright &Open	Tall	Conical- obovate	Pink
15	BPP-8	A.P. , W.B, Odisha,Jharkhand	Upright & Compact	Tall	Conical- obovate	Yellow
16	Kanaka	Kerala, W.B.	Upright &Open	Tall	Conical- obovate	Yellow
17	Vengurla-1	Maharastra	Upright & Compact	Tall	Round	Yellow
18	Vengurla-6	Maharastra	Upright & Compact	Tall	Conical- obovate	Yellow
19	Ullal-3	Karnataka, W.B.	Upright &Open	Tall	Conical- obovate	Red
20	Dhana	Kerala, W.B.	Upright & Compact	Tall	Conical- obovate	Yellow
21	BPP-4	Andhra Pradesh	Upright &Open	Tall	Conical- obovate	Yellow
22	UN-50	Karnataka, W.B.	Upright &Open	Tall	Cylindrical	Yellow
23	Jhargram-1	W.B	Upright &Open	Semi Tall	Conical- obovate	Yellow
24	NRCC-2	Karnataka, W.b.	-	Semi Tall	Obovate	Pink
25	Bidhan Jhargram-2	W.B	Upright & Compact	Tall	Conical- obovate	Yellow

Tall: (>4.0m); Medium: (2.5-4.0m); Dwarf: (<2.5m)

resistance and field resistance based on both AUDPC and AULPC value. Vengurla-4, Bidhan Jhargram-2, Madakkathara-1, BPP-4, NRCC-2, Vengurla-7 and Ullal-3 were grouped into under field resistance while Amrutha, Jhargram -1, Goa-1, K-22-1, Dhana, BPP-6 were under moderately field resistance. Several varieties, namely, Ullal-4, VRI-3, Kanaka and Priyanka were grouped into moderately susceptible to gummosis whereas Vengurla-6, UN-50, Vengurla-1 were under susceptible category.

In India, information on varietal reactions and host resistance to major cashew diseases, particularly gummosis, is limited. Several long-cultivated varieties now suffer yield losses due to severe disease infestation, compounded by poor adoption of improved management practices. In contrast, extensive germplasm screening for gummosis resistance has been conducted in Brazil to identify high-yielding and disease-resistant clones (Cardoso *et al.* 2006). Studies on dwarf cashew clones reveal varying levels of susceptibility to major pathogens. Under controlled conditions, Lopez and Lucas (2010) observed that while all anthracnose isolates produced symptoms, clone CCP-1001 showed partial resistance compared to the highly susceptible CCP-06. Regarding gummosis (*Lasiodiplodia theobromae*), BRS-226 and CAC 38 are identified as highly resistant and suitable for semi-arid regions (Cardoso *et al*. 2010; de Paiva *et al*. 2008). Notably, CCP-06 is a superior rootstock, reducing disease incidence and severity regardless of the scion (Cardoso *et al*. 2010). However, a lack of research on scion-stock genotypic interactions remains a primary driver of gummosis epidemics in Brazil. Moreira et al. (2013) reported that gummosis symptoms typically emerge 12–35 months after planting (MAP), with rapid progression after 20 MAP. While several clones (e.g., CNPAT 08, CNPAT 06, CNPAT 11) reach high incidence levels, others like CNPAT 15 and CNPAT 11 demonstrate the

Table 2: Incidence, severity, lesion number and area under disease or lesion progress curve of cashew gummosis in different varieties

		Gummosis severity			Gummosis Lesion		
Name of the verity	Gummosis Incidence	Disease Severity	AUDPC	Rank	Lesion Number	AULPC	Rank
Bhaskara	100.00(90.00)a	39.58(39.23)bcde	17125.00def	18	19.00(4.33)ab	3547.50ab	23
Madakkathara-2	100.00(90.00)a	50(45.29)abc	20375.00cde	20	25.00(4.99)a	4245.00a	24
Bhubaneswar-1	100.00(90.00)a	33.33(35.38)def	13500.00efgh	12	15.42(3.93)bc	2672.50bcd	20
K-22-1	100.00(90.00)a	35.42(36.61)cdef	12562.50efghi	11	7.75(2.56)defg	1577.50defgh	12
Chintamani-1	100.00(90.00)a	39.58(39.23)bcde	12437.50efghi	9	6.00(2.39)efgh	1180.00efghij	9
Ullal-4	100.00(90.00)a	41.67(40.46)abcde	20187.50cde	19	9.50(3.08)cdef	2407.50bcde	18
Vengurla-7	83.33(72.37)ab	22.92(28.71)fg	8000.00ghijk	6	2.50(1.56)hi	847.50fghij	6
VRI-3	100.00(90.00)a	43.75(41.63)abcde	22312.50bcd	22	9.92(3.00)defg	2535.00bcde	19
BPP-6	100.00(90.00)a	29.17(32.95)ef	15000.00defg	15	5.00(2.21)fgh	1630.00defg	13
Amrutha	91.67(81.18)a	37.5(37.92)bcdef	15812.50defg	16	7.17(2.61)defg	1662.50defg	14
Vengurla-4	8.33(9.78)e	2.08(7.36)j	312.50k	1	0.42(0.50)j	52.50ij	2
Goa-1	100.00(90.00)a	31.25(34.18)def	12500.00efghi	10	4.25(2.06)gh	1492.50defghi	10
Madakkathara-1	33.33(35.26)d	8.33(17.29)hi	2125.00jk	3	0.67(0.83)ij	130.00hij	3
Priyanka	100.00(90.00)a	45.83(42.89)abcd	20500.00cde	21	6.92(2.62)defg	2192.50bcdef	17
BPP-8	100.00(90.00)a	31.25(34.18)def	11812.50efghi	8	4.33(2.09)gh	1040.00efghij	7
Kanaka	100.00(90.00)a	43.75(41.63)abcde	16937.50def	17	8.00(2.78)defg	2040.00cdef	16
Vengurla-1	100.00(90.00)a	52.08(46.53)ab	25750.00bc	23	11.00(3.29)cde	2877.50abcd	21
Vengurla-6	100.00(90.00)a	56.25(48.96)a	33937.50a	25	12.25(3.48)cd	3367.50abc	25
Ullal-3	91.67(81.18)a	22.92(28.87)fg	10250.00fghij	7	4.92(2.21)fgh	1145.00efghij	8
Dhana	100.00(90.00)a	31.25(34.26)def	14000.00defg	13	8.00(2.80)defg	1862.50def	15
BPP-4	66.67(58.68)bc	16.67(24.14)gh	4875.00ijk	4	1.33(1.13)ij	305.00ghij	4
UN-50	91.67(81.18)a	52.08(46.62)ab	28750.00ab	24	8.00(2.83)defg	3507.50ab	22
Jhargram-1	91.67(81.18)a	33.33(35.26)def	15187.50defg	14	5.42(2.24)fgh	1520.00defghi	11
NRCC-2	58.33(49.87)cd	14.58(22.68)gh	5187.50hijk	5	1.17(1.10)ij	320.00ghij	5
Bidhan Jhargram-2	16.67(18.27)e	4.17(10.67)ij	750.00k	2	0.17(0.42)j	30.00j	1
S.Em (±)	5.48	2.83	2612.24		0.29	443.77	
CD (<0.05)	15.44	7.98	7363.28		0.80	1250.89	

*Values within a column followed by the same letter are not significantly different (P = 0.05). **Figure in parenthesis indicates angular transformed value

Table 3 : Correlation studies between gummosis severity and weather variables

Field performance	Disease progress rate	Min RH	Max RH	Mean RH	Min Temp	Max Temp	Mean Temp	Rainfall
Susceptible	Vengurla-1	0.617*	0.205	0.588 *	0.546	0.295	0.467	0.771 **
	Vengurla-6	0.730**	0.267	0.700**	0.642 *	0.301	0.531	0.915**
Moderately	Madakkathara-2	0.749**	0.446	0.753 **	0.559 *	0.185	0.431	0.885 **
susceptible	VRI-3	0.7 49**	0.392	0.743 **	0.598 *	0.273	0.492	0.906**
Moderately	Amrutha	0.770 **	0.181	0.718 **	0.765**	0.459	0.673 *	0.887**
field resistant	Dhana	0.710**	0.426	0.715 **	0.557 *	0.215	0.442	0.864**
Field resistant	NRCC-2	0.710 **	0.426	0.715 **	0.557 *	0.215	0.442	0.864**

* Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed).

Table 4 : Multiple regression equation of gummosis progress rate using stepwise technique

Disease reaction	Variety	Regration equation	R^2 Value
Susceptible	Vengurla-1	Y= 0.097-0.001(Max. RH)	R^2 = 0.598 R^2adj. = 0.518
	Vengurla-6	Y= -0.621-0.002 (Min. RH)-0.003 (Max. RH) + 0.008(Min Temp.) -0.012 (Max Temp.)	R^2 = 0.894 R^2adj. = 0.819
Moderately Susceptible	Madakkathara-2	Y= 0.096 - 0.004 (Max Temp)	R^2 = 0.806 R^2adj. = 0.768
	VRI-3	Y= 0.011 - 0.001(Min Temp)	R^2 = 0.832 R^2adj. = 0.798
Moderately field resistant	Amrutha	Y= - 0.034 + 0.002 (Min Temp)	R^2 = 0.815 R^2adj. = 0.778
	Dhana	Y= -0.179 + 0.002(Max RH.)	R^2 =0.766 R^2adj. = 0.719

ability to recover by alleviating cankers. In India, the height of popular tall varieties makes manual screening for gummosis logistically difficult and imprecise. To overcome this, researchers utilize the high correlation between disease incidence and severity to predict epidemic pressure (Cardoso *et al*., 2004; McRoberts *et al*. 2003). This relationship remains consistent across various genotypes, ages, and environmental pressures (Cardoso *et al*. 2004). To find the relationship between the disease progress rate with weather variables, Pearson correlation coefficient was carried out and subsequently regression analysis was done to predict the disease rate based on independent weather variables. In these cases, total seven varieties, i.e. Vengurla-1 and Vengurla-6 from susceptible, Madakkathara-2 and VRI-3 from moderately susceptible, Amrutha and Dhana from moderately field resistant and NRCC-2 from field resistant disease reaction, were selected (Table 3). Disease progress rate shows positive correlation with minimum RH even at 1% level of significance in all the six varieties Vengurla-6 (r = 0.730), Madakkathara-2 (r = 0.749), VRI-3 (r = 0.749), Amrutha (r = 0.770), Dhana (r = 0.710) and NRCC-2 (r = 0.710) and at 5% level in Vengurla-1 (r = 0.617). However, Disease progress rate was significantly not correlated with maximum RH in any variety. Similarly, disease progress rate in all the selected varieties was also significantly positively correlated with mean RH at 1% level excepting Vengurla-1 which was positively correlated at 5% level. Minimum temperature was also positively correlated with gummosis disease progress rate at 5% level of significance excepting Vengurla -1. There was no positive significant correlation between gummosis disease progress rate and maximum temperature as well as mean temperature. Disease progress rate was positively correlated with the rainfall at 1% level of significance in all the seven varieties like Vengurla 1 (r=0.771), Vengurla-6 (r = 0.915), Madakkathara-2 (r = 0.885), VRI-3 (r = 0.906), Amrutha (r = 0.887), Dhana (r = 0.864) and NRCC-2 (r = 0.864).

Step-wise regression by considering all the weather variables as predictors to explain the disease growth rate was done for reducing the multi-co linearity and finding the most critical weather-based contributors in the selected seven varieties (Table 4). The gummosis growth rate was kept as dependent variable and weather variables were taken as independent variable. The most critical predictor for Vengurla-1 variety was maximum relative humidity (Max. RH). The value of final adjusted R^2 is 0.518 which means that the predictors Max RH solely accounted for 51.8% of the variance in disease growth rate. However, in other susceptible variety Vengurla-6 most critical predictors for disease growth rate were minimum relative humidity (Min. RH), maximum relative humidity (Max RH), minimum temperature (Min Temp.) and maximum temperature (Max. Temp). The value of final adjusted R^2 was 0.819 which means that these four predictors (Min. RH, Max RH, Min Temp. and Max. Temp) conjointly accounted for 81.9% of the variance in gummosis growth. Similarly, maximum temperature or minimum temperature

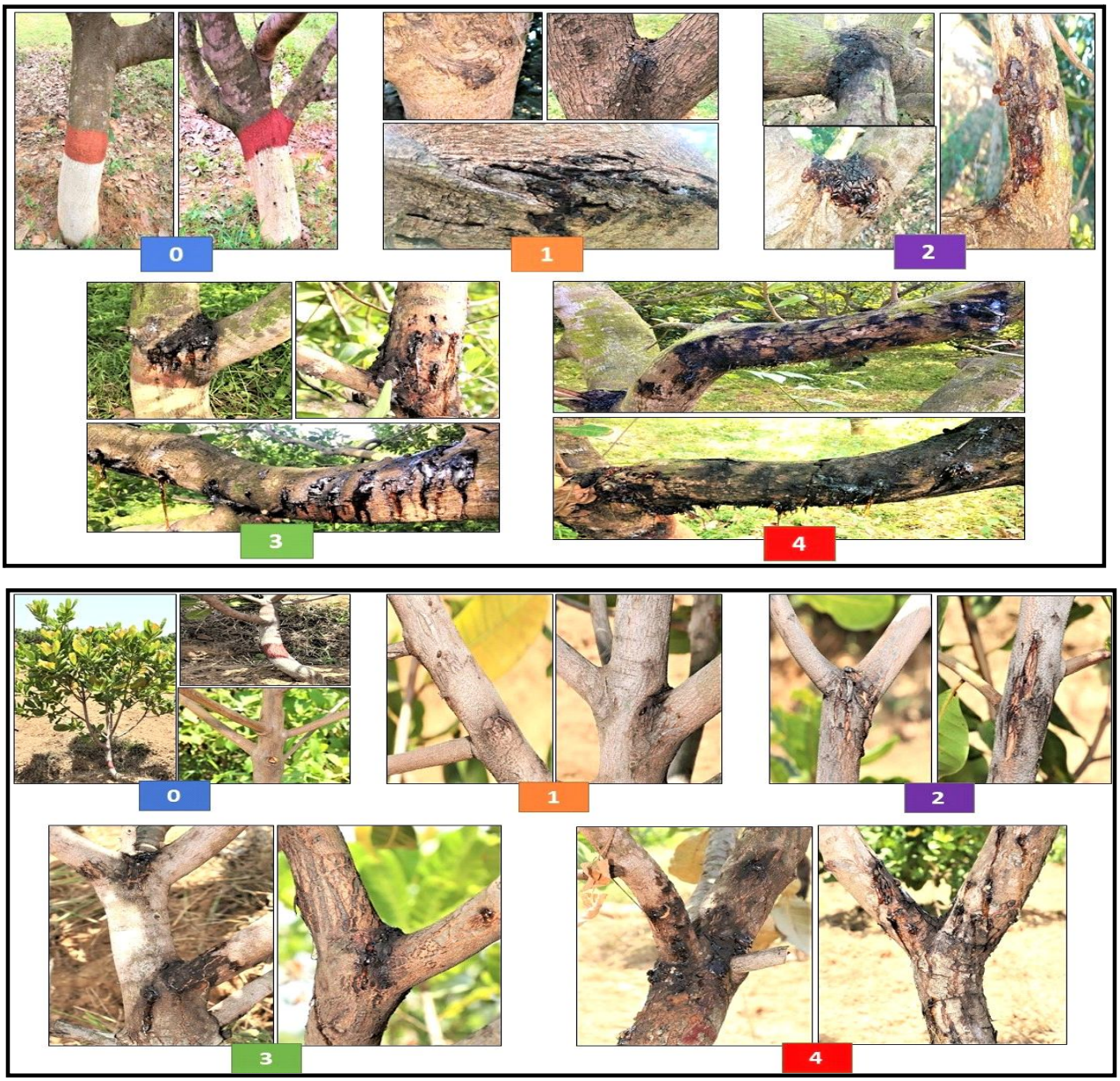

Fig 1: Different grade of "0-4" disease rating scale

was the single predictor for the variety Madakkathara-2 (R^2adj. = 0.768) and VRI-3 (R^2adj. = 0.798), respectively. In case of moderately field resistance variety Amrutha and Dhana, single predictor was Min Temp (R^2adj. = 0.778) and Max RH (R^2adj. = 0.719), respectively.

In the present study, only four weather parameters like minimum relative humidity, mean relative humidity, minimum temperature, and rainfall—showed a significant positive correlation with the gummosis disease progress rate. However, establishing clear relationships between prevailing weather variables and disease progression is challenging due to the extremely slow and perennial nature of gummosis in cashew trees. In Brazil, several workers reported that gummosis disease was not uniformly distributed across the cashew growing states (Cardoso *et al*. 2009; Alves *et al*. 2020). The coastal region where largest commercial orchards were concentrated, has always been characterized by very low incidence of the gummosis disease, while in the southeast and southwest of the state of Piauí, the middle Jaguaribe and the Serra do Catimbau in Pernambuco disease incidence and

severity were medium to high (Alves et al. 2020). There was a report that gummosis severity was non-significant with maximum temperature, minimum temperature and rainfall in correlation studies (Alves *et al.* 2020). Rainfall may help in releasing of conidia from resting structure and dispersal but correlation coefficient between rainfall and number of infections was low in case of peach bark gummosis caused by *Botryosphaeria dothidea*. No significant correlation was found between the total number of conidia collected and the volume of rainfall, the concentration of conidia and the volume of rainfall or the concentration of conidia collected and the mean air temperature.

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DECLARATION

Conflict of Interest. Authors declare no conflict of interest.

REFERENCES

Abdul Salam, M., Peter, K. V. 2010. Cashew -A Monograph, Studium Press (India) Pvt. Ltd. Darya Ganj, New Delhi. pp: 257.

Alves, E. S., Fonseca, W. L., Silva, L. G. C. D., Lima, J. S., Cardoso, J. E. 2020. Effect of climate and geographical conditions on the occurrence of cashew gummosis in the northeast of Brazil. *Rev. Ciênc Agron*. **51**:3.

Anonymous, 2024. FAOSTAT, crops and livestock products. Food and Agriculture Organization. Available at: https://www.fao.org/faostat/en/#data/QCL. [Accessed March 30, 2024]

Cardoso, J. E., Bezerra, M. A., Viana, F. M. P., Sousa, T. R. M. D., Cysne, A. Q., Farias, F. C. 2009. Ocorrência endofítica de *Lasiodiplodia theobromae* emtecidos de cajueiro e sua transmissão por propágulos. *Summa Phytopathologica*. **35**:262-266.

Cardoso, J. E., Cavalcanti, J. J. V., Cysne, A. Q., Sousa, T. R. M. D., Correa, M. C. D. M. 2010. Effect of cashew clone used as rootstocks and scions on gummosis incidence in cashew plants. *Rev. Bras. Frutic*. **32**:847-854.

Cardoso, J. E., Paiva, J. R, Cavalcanti, J. J. V., Santos, A. A. D., Vidal, J. C. 2006. Evaluation of resistance in dwarf cashew to gummosis in north-eastern Brazil. *Crop* Prot. **25**: 855–859.

Cardoso, J. E., Santos, A. A., Rossetti, A. G., Vidal, J. C. 2004. Relationship between incidence and severity of cashew gummosisin semiarid north-eastern Brazil. *Plant Pathol*. **53**: 363–367.

Cuadros-Orellana, S., Leite, L. R., Smith, A., Medeiros, J. D., Badotti, F., Fonseca, P. L. C., et al. 2013. Assessment of fungal diversity in the environment using metagenomics: a decade in review. *Fungal Genome Biol*. **3**: 110.

de Paiva, J. R., Cardoso, J. E., Mesquita, A. L., Cavalcanti, J. J., dos Santos, A. A. 2008. Performance of cashew dwarf clones in the semi-arid of the State of Piauí, Brazil. Rev. Ciênc. *Agron*. **39**:295-300.

Freire, F.C.O., Cardoso, J.E., Santos, A.A., Viana, F.M.P. 2002. Diseases of cashew (*Anacardium occidentale* L.) in Brazil. *Crop Protect*. **21**: 489–494.

Joshi, M. S. 2005. Leaf blight of cashew incited by *Pestalotia heterocornis* Guba. *Indian Phytopathol*. **58**:252.

Joshi, V., Raut, S. P. 2005. Promising bio-agents in management of *Fusarium solani* causing seedling wilt of cashew hybrid. *Ann. Plant Prot. Sci.* **13**:149-151.

Khatoon, A., Mohapatra, A., Satapathy, K. B. 2017. Major diseases of Cashew (*Anacardium occidentale* L.) caused by fungi and their control in Odisha, India. *Int. J. Biosci.* **11**:68-74.

Lopez, A. M. Q., Lucas, J. A. 2010. Reaction of dwarf cashew clones to *Colletotrichum gloeosporioides* isolates in controlled environment. *Scientia Agricola*. **67**:228-235.

McRoberts, N., Hughes, G., Madden, L. V. 2003. The theoretical basis and practical application of relationships between different disease intensity measurements in plants. *Ann. Appl. Biol*. **142**:191-211.

Mitra, S., Debnath, P., Bahadur, A., Das, S. C., Kirdat, K., Yadav, A., Rao, G. P. 2020. First Report of an Association of '*Candidatus Phytoplasma Australasia*' with Cashew Nut Inflorescence Decline in Tripura, a Northeastern State of India. *Plant Dis*. **104**:970-970.

Moreira, R. C., Lima, J. S., Silva, L. G. C., Cardoso, J. E. 2013. Resistance to gummosis in wild cashew genotypes in northern Brazil. *Crop Prot*. **52**: 10-13.

Otálora, A., Mora, M. A., Palencia, M., Combatt, E. M., Arrieta, Á. A., Jarma, A. 2024. 'Cashew, anacardo or marañón'(*Anacardium occidentale*): an overview about its crop, economic aspects and nutritional relevance. *J. Sci. Technol. Appl.* **16**: 1–10. Doi. 10.34294/j.jsta.24.16.98

Patsa, R. 2021. Survey, surveillance and management of major diseases of cashewnut in West Bengal. Ph D. dissertation, Department of Plant Pathology, Bidhan Chandra Krishi Viswavidyalaya, Mohanpur, Nadia, West Bengal, India, 265p

Patsa, R., Jash, S., Dutta, S., Barman, A. R., Poduval, M., Ray, S. K. 2023(a). Pestalotiopsis leaf spot: an important foliar disease in cashewnut seedling incited by *Pestalotiopsis oxyanthi* in West Bengal, India. *Indian Phytopathol.* **76**: 713-725.

Patsa, R., Jash, S., Sarkar, A., Dutta, S., Poduval, M. 2023(b). Identification and characterization of *Fusarium falciforme*, incitant of wilt disease in cashew seedlings and its management. *Arch. Phytopathol. Pflanzenschutz*. **56**: 1521-1539.

Saroj, P. L., Rupa, T. R. 2014. Cashew research in India: achievements and strategies. *Progress. Hort*. **46**: 1-17.

Sierra-Baquero, P., Catarino, S., Costa, G. J., Barai, A., Correia, Z., Ferreira, M. R., ... Monteiro, F. 2024. Insights into the cashew production system in Guinea-Bissau: implications for agroecosystem sustainability. *Front. Sustain. Food Syst*. **8**: 1439820.

Silva-Acuña, R., Maffia, L. A., Zambolim, L., Berger, R. D. 1999. Incidence-severity relationship in the pathosystem *Coffea arabica-Hemileia vastatrix*. *Plant Dis*. **83**:186–188.

Wheeler, B. E. J. 1969. An Introduction to Plant Diseases. John Willey and Sons Ltd. London. 249p.

Wilcoxson, R.D., Skovmand, B., Atif, A.A. 1975. Evaluation of wheat cultivars for the ability to retard development of stem rust. *Ann. Appl. Biol*. **80**:275–287.