Indian Journal of Agricultural Sciences **94** (10): 1057–1062, October 2024/Article
https://doi.org/10.56093/ijas.v94i10.151118

Identification of resistant sources against collar rot disease in groundnut (*Arachis hypogaea*) incited by *Aspergillus niger*

GARIMA[1], N K YADAV[2]*, V K MALIK[1], ASHOK KUMAR DAHINWAL[2], DEEPAK KUMARI[1], MAHENDRA SARAN[1] and NIHARIKA SHEORAN[1]

CCS Haryana Agricultural University, Hisar, Haryana 125 004, India

Received: 01 May 2024; Accepted: 28 August 2024

ABSTRACT

Collar rot disease incited by *Aspergillus niger* van Tiegham is one of the major constraint to groundnut (*Arachis hypogaea* L.) production in India. This fungus is ubiquitous, soil inhabitant causing severe reduction in seed germination. Infected seeds appear surrounded by black conidia and post-emergence infection occurs on collar region of plants leading to mortality of emerged seedlings at the seedling stage. Therefore, present study was carried out during rainy (*kharif*) seasons of 2022 and 2023 at Regional Research Station (CCS Haryana Agricultural University, Hisar, Haryana), Bawal, Haryana to identify the strategy of disease management by identification of new resistant lines which will be useful to develop introgression lines using marker-assisted backcrossing approach to improve disease resistance against soil-borne pathogens in popular groundnut varieties. A total of 245 groundnut genotypes were screened under natural epiphytotic field conditions in randomized block design (RBD) with three replications for their resistance against collar rot disease The results of the investigation indicated that 65 genotypes displayed resistant reactions among which ICGV-6285, GC-131-1, ICGV-06319, ICGV-02038, GC-100, GC-98, ICGV-02038, ICGV-7403, ICGV-7214, TG-37A and GC-133 exhibited the lowest collar rot incidence while, rest of the genotypes displayed moderately resistant, susceptible and highly susceptible reaction. Thus, these resistant genotypes could be utilized in the hybridization programme to develop high yielding groundnut variety with inbuilt resistance against collar rot of groundnut.

Keywords: *Arachis hypogaea*, *Aspergillus niger*, Collar rot, Genotypes, Resistance

Groundnut (*Arachis hypogaea* L.) is one of the important tropical oilseed crop grown in India (Kumari *et al.* 2017, Gunri *et al.* 2023). Although, groundnut is cultivated in India throughout one or more seasons, the *kharif* crop accounts for around 80% of the country's yearly area and production (Bajaya *et al.* 2022, Shokri *et al.* 2024). India is one of the leading countries in the production of groundnut followed by China with production of 10.244 Mt from 6.015 Mha of cultivated area with productivity of 1703 kg/ha. In Haryana, groundnut covers about 0.009 Mha area with production and productivity of 0.009 Mt and 1020 kg/ha, respectively (Indiastat 2022).

Constraints are many and varied, both between and within states, but diseases are generally regarded as major constraints to groundnut production throughout the region (Rohtas *et al.* 2016, Rani *et al.* 2018). More than 55 diseases have been reported so far to cause considerable losses in graindnut (Janila *et al.* 2013, Muthukumar *et al.* 2014, Rani *et al.* 2016). Amongst these diseases, the collar rot incited by *Aspergillus niger* van Tiegham is one of the most damaging (Mohammed and Chala 2014, Le *et al.* 2018, Lora and Begum 2019, Nathawat *et al.* 2021) with up to 40% losses (Jadon *et al.* 2015). It is widespread disease which occurs during seed and seedling stages. The disease manifests as pre-emergence seed rot and post-emergence collar rot in the seedlings which was first reported by Jochem (1926) and in India it was reported by Jain and Nema (1952) as Aspergillus blight (Kumari *et al.* 2017). The disease is more widespread at high temperature of about 30±1°C. Occasionally, collar rot can persist up to the crop harvesting stage thereby, causing damage to the seeds (Gajera *et al.* 2015). Due to lack of resistant varieties, it is essential to identify sources of resistance that can be incorporated into groundnut breeding programme. Therefore, the objective of current study was to identify sources of resistance to collar rot by screening groundnut genotypes in response to collar rot pathogen.

MATERIALS AND METHODS

The present study was carried out during rainy (*kharif*) seasons of 2022 and 2023 at Regional Research Station (CCS Haryana Agricultural University, Hisar, Haryana),

[1]CCS Haryana Agricultural University, Hisar, Haryana; [2]Regional Research Station (CCS Haryana Agricultural University, Hisar, Haryana), Bawal, Haryana. *Corresponding author email: yadavnk67@gmail.com

Bawal, Haryana. Total of 245 groundnut genotypes were screened for resistance against collar rot disease under natural epiphytotic conditions in randomized block design (RBD) with three replications. Seeds of different genotypes of groundnut were procured from Regional Research Station (CCS Haryana Agricultural University, Hisar, Haryana), Bawal, Rewari, Haryana. The seeds of each genotypes were planted in three rows maintained with inter and intra row spacing of 30 cm × 10 cm, respectively. After every five rows, one row of susceptible checks MH-4 and HNG-10 were sown to assure the maximum incidence of collar rot disease. The good agronomic practices were followed to raise the groundnut avoiding plant protection measures. The genotypes were planted during third week of June for both the years.

Observations were recorded in terms of number of diseased plants and total number of plants at 20 and 40 days after sowing (DAS). Thereafter, per cent collar rot incidence was calculated as (Mayee and Datar 1986):

$$\text{Disease incidence (\%)} = \frac{\text{Number of diseased plants}}{\text{Total number of plants observed}} \times 100$$

After calculating incidence of collar rot disease, these genotypes were categorized into 4 groups on the basis of disease reaction, viz. resistant, moderately resistant, susceptible and highly susceptible (Table 1).

Table 1 Disease scale for rating collar rot disease in groundnut

Group	Collar rot incidence (%)	Disease reaction
1	<15%	Resistant
2	15.1–30%	Moderately resistant
3	30.1–45%	Susceptible
4	>45%	Highly susceptible

(Rani *et al.* 2018)

Analysis of variance of calculated disease incidence values was performed for randomized block design in OPSTAT software.

RESULTS AND DISCUSSION

Analysis of variance for disease reaction to collar rot disease indicated highly significant genotypic differences which is essential for genetic improvement through plant breeding. Pooled mean was calculated from the data recorded in terms of disease incidence (%) in both the years of study (2022 and 2023). Based on collar rot incidence and calculated pooled mean of both years, the genotypes were categorized as resistant, moderately resistant, susceptible and highly susceptible. The results of the investigation revealed that out of 245 genotypes of groundnut, 65 genotype exhibited resistant reaction (<15%) against collar rot disease including ICGV-07213, GC-126, ICGV-07213, GC-126, ICGV-6285, GC-118-1, ICGV-00338, GC-71, ICGV-07337, ICGV 07270, GC-35, GC-131-1, GC-3, GC-1, ICGV-06279, ICGV-7235, GC-87, ICGV-06319, ICGV-07213, GC-24, GC-08, GC-99, GC-31, ICGV-02038, GC-116, ICGV-07395, GC-132, GC-133, GC-41, GC-34, GC-55, GC-77, GC-37, GC-105, ICGV-07217, ICGV-07273, ICGV-86031, ICGV-07406, GC-131, GC-104, GC-29, GC-100, GC-64, GC-98, ICGV-02125, ICGV-04017, GC-11, GC-121-1, ICGV-07404, ICGV-7403, GC-133, ICGV-7214, GC-65-1, GC-115, ICGV-07396, GC-38, GC-136, GC-76, J-92, TG-37A, ICGV-15303, ICGV-00348, RG-638, ISK-II-18-6, ISK-II-18-18.

However, 123 genotype were found moderately resistant (15–30%) against collar rot disease, viz. ICGV-92195, ICGV-7270, GC-58, GC-50, GC-59, GC-112, GC-128, GC-75, GC-114-1, ICGV-07408, GC-40, GC-138, GC-124, ICGV-2266, GC-82, ICGV-7403, GC-25, GC-84, GC-139, GC-86-1, GC-21, GC-51, GC-22, GC-106, GC-32, GC-72, GC-140, GC-115, GC-129-1, GC-118, GC-27, GC-30, GC-88, ICGV-06237, GC-23, GC-67, GC-33, GC-97, GC-79, GC-79-1, ICGV-07210, GC-5, ICGV-07211, GC-43, GC-94, GC-48, GC-20, GC-108, GC-80, ICGV-07296, GC-34, GC-91, GC-112, GC-93, GC-68, GC-92, GC-71-1, GC-9, RG-559-3, GC-66, GC-2, ICGV-07392, GC-39, ICGV-7286, GC-81, GC-49, GC-61, GC-28, GC-129, GC-84-1, GC-65, TG-81, DH-256, ICGV-07214, TAG-24, ICGV-10008, ICGV-13027, ICGV-15296, ICGV-15305, ICGV-15309, ALR-3, Punjab-1, Kisan, TG-17, TAG-24, TG-26, Tirupati, Divya, HNG-123, GAVG-1, TGIPS-3, ICGV-00350, TGN-3 and HNG-69. The remaining genotypes were categorized in to susceptible and highly susceptible to collar rot disease (Table 2, 3 and Supplementary Table 1).

The ultimate and most economical means of controlling the collar rot disease of groundnut would be the use of resistant variety. Host resistance is an integral component of integrated disease management system; therefore, it is demand of comprehensive study of the host pathogen responses. Complete resistance against *A. niger* is not reported in literature. The disease remains overlooked at farmer's fields at a time when no remedy is possible. However, the research on finding source of resistance against the collar rot through interspecific hybridization has been a continued effort throughout country and in the world, but field resistance among available genotypes needs to be evaluated for further use in convention resistance breeding programme. During present investigation, amongst 245 genotypes of groundnut screened, 65 genotypes exhibited resistant reaction against collar rot disease including TG-37A, while, 123 genotype were found moderately resistant, about 45 genotypes were found to be susceptible while, 14 lines exhibited highly susceptible reaction to collar rot disease under natural epiphytotic field conditions (Supplementary Table 2). Similar outcomes for screening of genotypes were recorded by many workers. In the evaluation of five varieties, Nathawat *et al.* (2014) reported that only GG 2 was found resistant to collar rot disease of groundnut while, GG 5, GG 7, GG 20 and GG 37 were found susceptible to highly susceptible. Rani *et al.* (2018) also assessed 40 advanced breeding lines in addition to susceptible checks (JL-24, J-11 and TMV-2) under greenhouse conditions

Table 2 Field reactions of groundnut genotypes (1–80) against collar rot disease

S. no.	Genotype	Per cent disease incidence		Pooled mean	S. no.	Genotype	Per cent disease incidence		Pooled mean
		2022	2023				2022	2023	
1.	GC-47	37.65	29.02	33.33	41.	GC-115	16.52	18.31	17.42
2.	14328(EC-1-1)	22.55	19.9	21.23	42.	GC-115	10.37	11.61	10.99
3.	14333(NCAC-741)	36.14	40.73	38.44	43.	GC-116	10.11	10.05	10.08
4.	14339(68-43)	18	18.82	18.41	44.	GC-118	19.8	21.78	20.79
5.	14341(C-143)	37.75	32.54	35.15	45.	GC-118-1	4.79	19.76	12.28
6.	14383(ROSADO)	21.59	24.03	22.81	46.	GC-121	36.81	38.36	37.59
7.	14403(BC-119)	20.4	20.6	20.5	47.	GC-121-1	17.34	11.67	14.51
8.	14414(SAN-8)	22.28	22.65	22.46	48.	GC-123	38.64	32.07	35.35
9.	14419(PR-4056)	20.1	20.06	20.08	49.	GC-124	24.05	20	22.03
10.	14424(PB-4)	41.18	38.55	39.87	50.	GC-124-1	39.35	38.32	38.84
11.	14451 (SPA-406-RE)	21.11	16.14	18.63	51.	GC-125	39.05	42.95	41
12.	14459(PI-3560)	30.5	17.54	24.02	52.	GC-126	13.33	12	12.67
13.	14480(SLA-058)	20.39	17.39	18.9	53.	GC-127	37.7	39.17	38.43
14.	14481(SLA-060)	17.03	20.24	18.64	54.	GC-128	21.59	16.06	18.83
15.	14484(NNN-17)	17.95	19.2	18.58	55.	GC-129	18.52	18.9	18.71
16.	14492(NFC-13)	19.04	19.52	19.28	56.	GC-129-1	16.67	20.06	18.37
17.	ALR-2	40.45	40.92	40.69	57.	GC-130	21.25	15.52	18.38
18.	ALR-3	18.62	17.52	18.07	58.	GC-131	10.6	16.76	13.68
19.	DH-256	17.5	25.38	21.45	59.	GC-131-1	5.37	9.88	7.63
20.	DH-86	17.95	22.58	20.27	60.	GC-132	7.12	10.03	8.57
21.	Divya	22.1	25.79	23.95	61.	GC-133	7.36	6.94	7.15
22.	GAVG-1	18.31	16.33	17.33	62.	GC-133	10.32	7.33	8.83
23.	GC-08	12.26	14.84	13.55	63.	GC-135	33.81	43.27	38.55
24.	GC-1	11.49	13.14	12.32	64.	GC-136	8.57	17.52	13.05
25.	GC-100	6.12	7.69	6.91	65.	GC-137	41.05	40.87	40.96
26.	GC-104	5.93	20.63	13.29	66.	GC-138	18.31	18.02	18.17
27.	GC-105	8.7	9	8.85	67.	GC-139	18.35	19.98	19.17
28.	GC-106	17.79	16.72	17.25	68.	GC-140	18.75	17.86	18.31
29.	GC-107	17.83	13.46	15.65	69.	GC-2	18.42	18.22	18.32
30.	GC-108	12.66	17.56	15.11	70.	GC-20	22.47	20.45	21.46
31.	GC-109	21.88	21.52	21.7	71.	GC-21	18.78	16.33	17.56
32.	GC-11	11.58	13.06	12.32	72.	GC-22	18.62	16.39	17.51
33.	GC-110	41.55	33.31	37.43	73.	GC-23	22.87	15.93	19.4
34.	GC-110-1	41.53	35.47	38.51	74.	GC-24	12.14	16.43	14.29
35.	GC-111	34.27	33.1	33.69	75.	GC-25	17.42	18.02	17.72
36.	GC-111-1	34.67	34	34.34	76.	GC-26	39.85	42.02	40.94
37.	GC-112	23.37	20.83	22.1	77.	GC-27	20.34	18.61	19.48
38.	GC-112	10.32	25.83	18.08	78.	GC-28	18.94	21.43	20.18
39.	GC-113	40.35	32	36.18	79.	GC-29	9.95	18	13.98
40.	GC-114-1	21.03	20	20.51	80.	GC-3	10	13.33	11.67
	CD (*P*=0.05)					6.23			
	SE (m) ±					2.24			

Table 3 Field reactions of groundnut genotypes (81–160) against collar rot disease

S. no.	Genotype	Per cent disease incidence		Pooled mean	S. no.	Genotype	Per cent disease incidence		Pooled mean
		2022	2023				2022	2023	
81	GC-30	20.19	19.73	19.96	121	GC-75	21.71	22.4	22.06
82	GC-31	11.36	10.1	10.73	122	GC-76	11.56	12.76	12.16
83	GC-32	19.72	21.36	20.55	123	GC-77	14.29	12.13	13.21
84	GC-33	21.15	21.11	21.14	124	GC-77-1	48.15	49	48.57
85	GC-34	7.26	7.94	7.6	125	GC-79	19.7	20.56	20.13
86	GC-34	19.6	18.18	18.9	126	GC-79-1	15.79	22.71	19.25
87	GC-34-1	32.67	40.5	36.59	127	GC-80	23.89	17.95	20.93
88	GC-35	9.55	10.1	9.83	128	GC-81	16.59	19.62	18.1
89	GC-36	34.67	34.85	34.76	129	GC-82	14.29	18.44	16.37
90	GC-37	7.18	11.5	9.34	130	GC-83	30.63	38.1	34.36
91	GC-38	8.41	11.07	9.74	131	GC-84	19.05	20.42	19.73
92	GC-39	12.76	17.42	15.09	132	GC-84-1	21.74	11.31	16.53
93	GC-40	20.71	18.31	19.52	133	GC-86	52.5	47.91	50.21
94	GC-41	8.7	8.75	8.73	134	GC-86-1	20.83	19.09	19.96
95	GC-42	33.81	34.67	34.24	135	GC-87	6.94	11.31	9.13
96	GC-43	18.75	20.48	19.62	136	GC-87	32.76	37.03	34.9
97	GC-45	38.82	37.43	38.13	137	GC-88	20.37	20.62	20.5
98	GC-48	17.95	21.52	19.74	138	GC-89	33.57	40.2	36.88
99	GC-49	16.33	18.93	17.63	139	GC-9	16.67	20.89	18.78
100	GC-5	12.08	18.18	15.13	140	GC-91	25.23	16.84	21.04
101	GC-50	17.31	20.63	18.97	141	GC-911114	41.43	36.6	39.02
102	GC-51	19.36	20.1	19.73	142	GC-92	20.89	21.89	21.39
103	GC-53	36.44	42.48	39.46	143	GC-93	19.26	15.5	17.38
104	GC-54	61.9	48.41	55.16	144	GC-94	17.95	19.69	18.83
105	GC-55	5.24	14.32	9.78	145	GC-95	33.97	34.82	34.4
106	GC-56	40.48	36.23	38.36	146	GC-96	37.19	37.12	37.15
107	GC-58	24.41	19.72	22.07	147	GC-97	20.47	17.59	19.03
108	GC-59	20.83	25.33	23.09	148	GC-98	7.64	7.57	7.61
109	GC-6	14.05	18.85	16.45	149	GC-99	11.25	10.17	10.71
110	GC-61	16.33	29.17	22.75	150	GG-13	19.26	23.21	21.24
111	GC-64	7.42	16.67	12.04	151	GG-16	18.23	17.38	17.8
112	GC-65	20.45	30.36	25.41	152	GG-8	45.63	56	50.81
113	GC-65-1	9.13	11.9	10.52	153	GJG-17	18	18	18
114	GC-66	17.86	23.86	20.86	154	GJG-31	33.85	45	39.43
115	GC-67	19.64	19.76	19.71	155	GJG-9	22.22	20.24	21.23
116	GC-68	20	22.02	21.01	156	GNH-804	65.56	27.5	46.53
117	GC-7	37.63	38.29	37.96	157	GPBD-4	21	20	20.5
118	GC-71	13.04	12.55	12.8	158	GPBD-5	20.34	21.9	21.13
119	GC-71-1	22.25	21.76	22.01	159	HNG-10	45.69	51.67	48.68
120	GC-72	22.18	14.86	18.52	160	HNG-123	40.62	35.57	38.1
	CD (*P*=0.05)					6.23			
	SE (m) ±					2.24			

against collar rot incited by *A. niger*. The result revealed that among 40 lines, 10 lines were found resistant which showed less than 15% disease incidence including ICGV 00202, ICGV 00211, ICGV 05155, ICGV 91114, ICGV 00350, ICGV 86590, ICGV 92195, ICGV 93261, ICGV 92195 and ICR 48. Sixty-four genotypes were examined by Kumar *et al.* (2020) for resistance to collar rot in groundnut among which 5 genotypes, viz. ICG 13856, ICG 7190, ICG 4749, ICG 2734 and ICG 1994 were found to be moderately resistant. The minimum disease incidence (1%) was recorded in K-6 with maximum pod yield of 10.5 q/ha as against control TMV 2 with maximum disease incidence. Twelve cultivars of groundnut were screened by Saran *et al.* (2021) along with TMV-2 susceptible check against *A. niger* under field conditions. TG-37A, HNG-69 and GJG-22 exhibited moderately resistant reaction among all the cultivars tested. GG-7, GG-20, GJG-9 and GL-501 showed moderately susceptible reaction with 11–20% disease incidence. Four cultivars Girnar-2, HNG-123, KDG-123, Pratapmungphali-1 were susceptible and TMV-2 was considered the highly susceptible. Kiranmayee *et al.* (2024) also recommended that the potential genotypes for stem rot disease resistance are three interspecific derivative lines, ICGR 161939, ICGR 162044, ICGR 162032, and two advanced breeding lines, ICGV 10342 and ICGV 181045. Veerendrakumar *et al.* (2024) identified 7 genotypes (ICG163, ICG721, ICG10479, ICG875, ICG11457, ICG111 and ICG2857) showed consistent resistance in the field and controlled environments against stem rot across several seasons.

It is only feasible to breed resistant cultivars when sources of consistent, high resistance are accessible. The aim is to integrate the resistance against *A. niger* into the creation and breeding of commercially desirable varieties. From the present investigation we can conclude that 65 genotypes exhibited resistant reaction (<15%) among which ICGV-6285, GC-131-1, ICGV-06319, ICGV-02038, GC-100, GC-98, ICGV-02038, ICGV-7403, ICGV-7214, TG-37A and GC-133 displayed the high resistant reaction under field conditions. By employing back-cross breeding techniques, it is possible to introduce collar rot-resistant genes or alleles from these wild accessions' derivatives into domesticated species, and then identify the resistant QTLs. By creating diagnostic markers, it will be easier to choose the foreground when transferring these QTLs into groundnut.

REFERENCES

Bajaya T, Ghasolia R P, Bajya M and Shivran M. 2022. Variability and virulence analysis of *Aspergillus niger* isolates causing collar rot of groundnut. *Legume Research* **45**(7): 914–20.

Gajera H P, Savaliya D D, Patel S V and Golakiya B A. 2015. *Trichoderma viride* induces pathogenesis related defense response against rot pathogen infection in groundnut (*Arachis hypogaea* L.). *Infection, Genetics and Evolution* **34**: 314–25.

Gunri S M H, Roy S K, Ali D, Bishnu O P and Mallik B. 2023. Effect of various doses of basal and foliar application of nitrogen and potassium with trace elements on summer groundnut (*Arachis hypogaea*). *The Indian Journal of Agricultural Sciences* **93**(10): 1108–13. https://doi.org/10.56093/ijas.v93i10.136234

Indiastat. 2022. Directorate of Economics and Statistics, Ministry of Agriculture and Farmers Welfare, Govt. of India, New Delhi. https://www.indiastat.com/table/agriculture-data/2/groundnut-production/286906/17354/data.aspx (ON2282) & Past Issues.

Jadon K S, Thirumalaisamy P P, Kumar V, Koradia V G and Padavi R D. 2015. Management of soil borne diseases of groundnut through seed dressing fungicides. *Crop Protection* **78**: 198–203.

Jain A C and Nema K G. 1952. Aspergillus blight of groundnut seedlings. *Scientific Culture* **17**: 348.

Janila P, Nigam S N, Pandey M K, Nagesh P and Varshney R K. 2013. Groundnut improvement: Use of genetic and genomic tools. *Frontiers in Plant Science* **4**: 23.

Jochem S C J. 1926. *Aspergillus niger* on groundnut. *Indisch Culturen* (Teysmannia) **11**: 325–26.

Kiranmayee B, Sudini H K, Bera S K, Shivani D, Chary S, VeerendraKumar H V, Vemula A and Pasupuleti J. 2024. Resistance to stem rot disease in groundnut (*Arachis hypogaea* L.) in inter-specific derivatives of wild *Arachis* species. *Genetic Resources and Crop Evolution* 1–18.

Kumar C V, Saifulla M, Reddy M G, Naveenkumar R and Prabhukarthikeyan S R. 2020. Occurrence, pathogenicity and assessment of groundnut genotypes resistance to *Aspergillus niger* inciting collar rot disease. *International Journal of Current Microbiology and Applied Sciences* **9**(11): 874–86.

Kumari M, Sharma O P and Singh M. 2017. Collar rot (*Aspergillus niger*) a serious disease of groundnut, its present status and future prospects. *International Journal of Chemical Studies* **5**: 914–19.

Le C N, Hoang T K, Thai T H, Tran T L, Phan T P N and Raaijmakers J M. 2018. Isolation, characterization and comparative analysis of plant associated bacteria for suppression of soil-borne diseases of field grown groundnut in Vietnam. *Biological Control* **121**: 256–62.

Lora S and Begum T. 2019. Managing of collar rot disease in groundnut (*Arachis hypogaea* L.) by few chemicals. *International Journal of Scientific Research in Biological Sciences* **6**: 3.

Mayee C D and Datar V V. 1986. Diseases of groundnut in the tropics. *Tropical Plant Pathology* **5**: 85–118.

Mohammed A and Chala A. 2014. Incidence of *Aspergillus* contamination of groundnut (*Arachis hypogaea* L.) in eastern Ethiopia. *African Journal of Microbiological Research* **8**(8): 759–65.

Muthukumar A, Naveen kumar R and Venkatesh A. 2014. Efficacy of water extracts of some mangrove plants for eco-friendly management of root rot disease of groundnut. *Journal of Plant Pathology and Microbiology* **5**(5): 1–6.

Nathawat B D S and Partap M. 2014. Evaluation of fungicides, botanical and *Trichoderma* spp. against collar rot of groundnut (*Arachis hypogaea* L.) caused by *Aspergillus niger* van Tiegham. *Annals of Plant Protection Sciences* **22**(2): 382–85.

Nathawat B D S, Singh N, Singh S P, Kumar D, Shivran H and Shekhawat D S. 2021. Screening of groundnut cultivars against collar rot (*Aspergillus niger* Van Tiegham). *International Journal of Current Microbiology and Applied Sciences* **10**(2): 1912–17.

Rani D V, Sudini H, Reddy P N, Kumar K V and Devi G U. 2018. Resistance screening of groundnut advanced breeding lines against collar rot and stem rot pathogens. *International*

Journal of Pure and Applied Bioscience **6**(1): 467–74.

Rani V D, Sudini H, Reddy P N, Devi G U and Kumar K V K. 2016. Survey for the assessment of incidence of stem rot and collar rot diseases of groundnut in major groundnut growing areas of Andhra Pradesh and Telangana States. *Annals of Biological Research* **7**(7): 6–8.

Rohtas R, Saharan H S and Rathi A S. 2016. Management of collar rot of groundnut with bio-agent, botanicals and chemicals. *Biosciences Biotechnology Research Asia* **13**(3): 1657–63.

Saran M K, Ram D, Verma J R and Choudhary A. 2021. Identify the source of resistant against collar rot of groundnut caused by *Aspergillus niger* Van Tiegham. *International Journal of Agriculture Environment and Biotechnology* **14**(4): 543–45.

Shokri Z, Ashouri M, Doroudian H, Roshan N M and Sadeghi S M. 2024. Growth and yield of groundnut (*Arachis hypogaea*) under varying levels of gypsum and zinc application in Iran. *The Indian Journal of Agricultural Sciences* **94**(3): 291–96.

Veerendrakumar H V, Kiranmayee B, Vasanthi R P, Kumar A N, Pandey M K and Sudini H K. 2024. Enhancing phenotyping accuracy for stem rot disease through advanced oxalic acid assay in groundnut. *Research Square* 1–19.