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Research Article

Variable response of interspecific breeding lines of groundnut to *Sclerotium rolfsii* infection under field and laboratory conditions

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Abstract
Evaluation of interspecific derivatives of groundnut was carried out under field and laboratory conditions for stem rot caused by *Sclerotium rolfsii* during rainy and post-rainy seasons from 2005-2008. Disease incidence was higher during rainy compared to post-rainy season. During initial screening of interspecific derivatives for stem rot under sick plot, 42 lines were found to be promising with no disease incidence. Advanced screening of these promising lines was carried out in concrete block with sick soil under field conditions and earthen pot with sick soil under lab conditions. Interspecific lines NRCGCS-47, NRCGCS-99, NRCGCS-131 and NRCGCS-319 were found promising against stem rot during early stages and later stages of crop growth. Out of which interspecific line NRCGCS-319 was found to be most stable one with comparatively lower pooled disease incidence over concrete block and laboratory conditions.

Key words: Groundnut, *S. rolfsii*, interspecific derivatives, rainy, post-rainy

Introduction:
Groundnut (*Arachis hypogaea* L.) is an important oilseed crop grown in approximately 25 m ha in Semi Arid Tropics region of the world (FAO, 2012). Stem rot of groundnut caused by *S. rolfsii* Sacc. is one of the major constraint to groundnut production in many countries in warm and humid areas, especially where groundnut cultivation under irrigated condition is expanding and/ or where cultural practices are changing. Stem rot is also known as southern-blight, southern-stem rot, *Sclerotium* rot, or white mold. They are widely distributed in India and USA. Besides, it causes serious losses in Bolivia, China, Egypt, Taiwan, and Thailand. Stem and pod rots caused by *S. rolfsii* cause economic losses on many crops but soybean, groundnut, sugar beet, pepper, tomato and potato suffer maximum losses. Yield loss in groundnut due to stem rot commonly ranges from 10-40%, but can reach over 80% in heavily infested fields (Poter *et al.*,1982, Mehan and Macdonald, 1990). *S. rolfsii* also causes indirect losses such as reduction in both dry weight and oil content of groundnut kernels besides downgrading the quality of pod and fodder. In the USA, annual yield losses caused by stem rot are valued at US$43 million (Branch and Brenneman, 1993).

Stem rot is a persistent soil borne disease throughout India and its incidence is increasing even at maturity stage of the groundnut crop. Though *S. rolfsii* resides both on seed and soil, soil-borne nature of the disease is more prevalent than seed borne (Kumar *et al*., 2013). The occurrence of the disease is more visible at 30 to 45 days after germination and at the time of harvest under rainfed situations due to low and erratic distribution of rainfall. The fungus is ubiquitous, soil inhabitant, non-target and one of the most destructive plant pathogen. *S. rolfsii* preferentially attacks stem, but it can infect any part of the plant including root, leaf, flower and fruit. On erect plant, yellowing and wilting are usually preceded by light to dark brown lesions at collar region of the stem adjacent to the ground. Drying or shriveling of the foliage and ultimately death of the plants occur after wilting. Characteristic sclerotia, at first white and later brown to black, are produced on mats of mycelium on stem surface of the plant adjacent to soil or on soil surface. *S. rolfsii* penetrates non-wounded host seedlings directly by the formation of aspersoria. Penetration may also be affected through natural openings such as lenticels and stomata. The fungus is both inter and intra cellular. Batmen and Beer (1965) have claimed that both oxalic acid and pectic enzymes are involved in the destruction of host tissues by the fungus and that two fungal products acting together are more effective than either alone.

Chemical and cultural practices have been the predominant means for the management of this disease (Porter *et al.,* 1982). Persistence of the pathogen in soil and wide host range (about 500 species) often limits the effectiveness of chemical and cultural control of stem rot disease (Shew *et al.*,1987). However, such cultural practices coupled with resistant cultivars can increase the efficiency of the disease management (Shew *et al.*,1984). Host plant resistance is an important component of such an approach which is currently not available in groundnut. Because screening for resistance in the field is complicated by the non-uniform spatial distribution of the pathogen (Shew *et al.*, 1984). As a result, consistent and reliable data is difficult to obtain in fields under natural infestation. While

development and maintenance of artificial sick plot with optimum inoculums load under field condition for screening of large genotypes and breeding lines are very difficult because of sensitivity of the pathogen to temperature, humidity, soil type, cropping system and host preference. Thus, limiting the success of breeding groundnut cultivar, resistant to stem rot through conventional breeding. Certain genotypes (e.g., ICG 12083) have shown resistance in the field, but are less resistant in greenhouse tests (Singh *et al*., 1997). Promising genotypes should be evaluated in field, microplot and greenhouse environments to identify and characterize components of resistance (Shew *et al*., 1987). In our studies, interspecific groundnut lines were screened for tolerance to stem and pod diseases caused by *S. rolfsii* under artificially inoculated conditions in field as well as in laboratory.

Material and Methods

Directorate of Groundnut Research (DGR), Junagadh, India has developed a set of 286 interspecific groundnut breeding lines using cultivated groundnut as female parent and wild *Arachis* species viz, *A. batizocoi, A. cardenasii, A. correntina, A diogoi, A. duranensis, A. helodes, A. kempff-mercadoi, A. kretschmeri, A. monticola, A. oteroi, A. pintoi, A. pusilla, A. stenosperma, A. villosa and A. villosulicarpa* as male parents (Bera *et al*., 2010a, b, c, d, e, f, 2012a, b, c). These genotypes were screened for resistance to stem and pod rot during rainy 2005 to 2009 (June to October) and also during post rainy 2005-2008 (January to May) at DGR, Junagadh. DGR is situated between 21.52 °N latitude and 70.47 °E longitude at an elevation of 107 meters above mean sea level with an average rainfall of 1520.3 mm. The monthly mean maximum and minimum temperature ranged from 43.2 °C (May) to 5.5 °C (January) and mean relative humidity varies from 88.0 per cent (July) to 35.0 per cent (march) (www.jau.in).

Multiplication of inoculum

The *S. rolfsii* isolate was cultured in 90 mm petri dishes containing standard potato dextrose agar (PDA) medium. The fungus was further mass multiplied on sorghum grains. Sorghum grains (about 500g) were boiled in tap water for 30 minutes and autoclaved for 15 minutes under 121 ^{o}C and 15 lb pressure. Sterile sorghum grains were inoculated with mycelium of *S. rolfsii* taken from margin of actively growing cultures in PDA medium using crock borer of 10 mm in diameter. The inoculated bags were incubated for 8-10 days at room temperature for healthy growth of the fungus and for further use. The fungus multiplied in sorghum grain was released to the crop in specified growth stages confirming sufficient (field capacity) soil moisture. Each interspecific line was inoculated by placing infested sorghum grains on soil surface nearer to the main stem. (For each row of 5 m about 50 - 60 g of infested sorghum grains were used). While plants were inoculated at 3 - 4 leaves stage by adding infested sorghum grains (8-10 g/pot) on soil surface nearer to main stem and kept in the B.O.D for potted experiments under fixed temperature (27 ^{o}C) and humidity (90%). Pots were regularly watered to maintain maximum soil moisture. Observation on mortality was recorded on 15th day after inoculation.

Initial screening with sick soil under field conditions: Screening of interspecific lines was done in the disease nursery maintained under normal field conditions. Each genotype was planted in two rows of five meter length with a spacing of 45 cm between rows and 10 cm between plants and replicated thrice. A susceptible check (GG-20 during rainy season and GG-2 during post rainy season) was planted after every five lines of test entries. The crop was raised as per the recommended package of practices except for the plant protection measures against stem rot. Crop grown during post rainy season was irrigated at regular interval whereas life saving irrigation was provided to rainy season crop to maintain healthy growth of the crop. Inoculum was added on the soil surface in each line, closer to main stem on 30 and 50 days after sowing. The per cent disease incidence in terms of mortality of plants was calculated by using the formula "Per cent disease = (Number of infected plants/ Total number of plants) X 100".

Advanced screening with sick soil under field conditions: Selected promising interspecific lines were further screened for confirmation of resistance to stem rot in concrete block (5 m length x 1 m width) with sick soils during rainy season. Each line was sown in one line of 5 m length with a spacing of 30 cm between rows and 10 cm between plants in three replications. The crop was raised as per the recommended package of practices except for the plant protection measures against stem rot. Life saving irrigation was provided to the crop as and when required to maintain healthy growth of the crop as well as maintain saturated soil moisture. Inoculum was added on soil surface on 30 and 50 days after sowing. Initial plant count was recorded in all genotypes at 20 DAS while the number of healthy and diseased plants were recorded one week before harvest of the crop and expressed in terms of per cent disease incidence.

Advanced screening with sick soil in laboratory:

Selected promising interspecific lines were further screened for confirmation of resistance to stem rot in small earthen pot with ~500 g of sterilized soil with maximum (field capacity) soil moisture. Each line was sown in two pots with five kernels each and raised in BOD under fixed temperature (27 ^{0}C) and relative humidity (90%). Inoculum was added on soil surface on 7th days after sowing and observation on mortality was recorded after three weeks of inoculation. The experiment was repeated

three times and pooled disease incidence in per cent was calculated.

Results and Discussion

Among the biotic stresses, stem and pod rot disease caused by *S. rolfsii* is predominant, accounting for yield loss to the extent of 10-25% and up to 80% in severely infected fields (Pujer *et al.*, 2013).

Screening in the disease nursery

In this study, a total of 286 interspecific groundnut lines along with susceptible check cultivar (GG-20 during rainy season and GG-2 during post rainy season) were screened for resistance to stem rot disease both in rainy as well as post rainy seasons during 2005 to 2009.

Rainy season:Screening of interspecific lines, irrespective of habit groups, were under taken based on availability of seeds during 2005 to 2009 and some of these lines were common between the years (Table 1). During rainy 2005, 16 lines among 242 lines screened were found promising with no disease incidence. Like wise a total of 16 lines were found free from the stem rot disease out of 166 lines screened during 2006. Similarly, 166 lines were screened during 2007 and no disease incidence observed in five lines. Further, 92 lines were screened during 2008 and eight lines were found free from the disease. However, no lines were found promising among 65 lines screened during 2009. Genotypes NRCGCS 106, 137 and 144 showed no disease incidence during 2005 and 2006; genotype NRCGCS 141 showed no disease incidence during 2006 and 2007 whereas genotype NRCGCS 72 did not show any disease incidence during 2006 and 2008. The variable response of interspecific groundnut lines to stem rot disease agreed with previous studies (Branch and Brenneman, 1993, 1996, 1999; Brenneman *et al*., 1990; Grichar and Smith, 1992).

Post rainy season:Screening of Spanish bunch interspecific lines was under taken from 2005 to 2008 based on availability of seeds and some of these lines were common between the years (Table 1). Five lines were found promising with no incidence of the disease among 26 lines screened during 2005. A total of 26 out of 28 lines were found free from the disease in 2006. Twenty-seven lines were screened during 2007 and 18 lines were found promising with no disease incidence. Thirty-two lines were screened during 2008 and nine lines were found promising without any disease incidence. Interspecific lines NRCGCS 12, 19, 77, 115 and 189 recorded no disease incidence during 2005 and 2006 whereas NRCGCS 214, 247, 253, 258 and 263 had no disease incidence during 2007 and 2008. Ashok *et al*., (2004) screened 584 germplasm under sick plot and identified ten genotypes (ICG 10707, 8274, 13902, 2252, 3857, 3048, 9581, 10174, 8501 and 6205) highly resistant to stem and pod rot of groundnut. Shew *et al.* (1986) identified NCAc 18416 having partial resistance to stem and pod rot in field and greenhouse. Mehan *et al*. (1995) screened 859 groundnut germplasm and advanced breeding lines and identified 7 interspecific derivatives having stable resistance and 9 breeding lines having low susceptibility to stem and pod rot.

In general higher average disease incidence was observed during rainy seasons over post rainy seasons in the disease nursery. This is in agreement with earlier reports (Ayocock *et al*., 1966; Wells, 1977; Backman, 1984; Culbreath *et al.*, 1992). Range of disease incidence in rainy seasons was wider over the post rainy season. Likewise check cultivar also recorded higher disease incidence during rainy season over post rainy season. This indicates that climatic conditions play important role in occurrence of the stem rot disease in groundnut and rainy season is more congenial for the growth of the fungus and occurrence of the disease under field conditions. Moderate to high temperature (25 - 35 ^{o}C) and moist conditions enhance disease development. Fluctuation in temperature/ moisture levels increased disease incidence and severity (Aycock, 1966, Rodriguez-Kabana *et al*., 1975).

Advanced screening: Interspecific lines were selected based on their disease incidence under disease nursery over seasons and years. A total of 42 lines were found promising with no disease incidence. Out of these, seeds of 34 lines were available in sufficient quantity and used further for confirmation under artificially inoculated conditions.

Concrete block with sick soil: Advanced screening of 34 interspecific groundnut lines in concrete block with sick soil under field conditions revealed wide variability among lines (Table 2). Disease incidence ranged from 28.7 to 81.9% with an average value of 57%. None of the lines were found resistant (< 20% disease incidence) while, lowest incidence was observed in NRCGCS-131 followed by NRCGCS-99, NRCGCS-47 and NRCGCS-319. Infected pod percent ranged from 22.0 to 90.0% with an average value of 46.0%. Lowest pod infection was observed in NRCGCS-268 followed by NRCGCS-90, NRCGCS-47 and NRCGCS-20. Similarly infected kernel percent ranged from 5.9 to 60.0% with an average value of 34%. The lowest kernel infection was observed in NRCGCS-90 followed by NRCGCS-349, NRCGCS-47 and NRCGCS-192. The present study indicated that none of the interspecific lines among 296 screened were either immune or resistant to stem rot disease which is in agreement with earlier reports (McClintock, 1918; Branch, 1987). The lines found free from the disease under disease nursery failed to sustain their resistance under concrete block with sick soil conditions. Thus, indicating that these 34 lines were actually

susceptible to the disease and might have escaped in the disease nursery. Hence, Shew *et al*. (1987) were of opinion that promising genotypes should be evaluated in field, microplot and greenhouse environments to identify resistance to stem rot. However, NRCGCS-47 with lower disease incidence in terms of mortality, pod infection and kernel infection would be a better option where high disease pressure prevails during entire crop season. We also compared disease incidence in terms of mortality between three different stages viz., 45 DAS, 75 DAS and at harvest (Table 3). Disease incidence in terms of mortality increased in all the lines from 45 DAS to harvest however, degree of increase varied along with the lines. Lines NRCGCS-47, NRCGCS-99, NRCGCS-131 and NRCGCS-319 would be the best option for those situations where disease occurs in early stages of the crop.The lines NRCGCS-47, NRCGCS-99, NRCGCS-131 and NRCGCS-319 which were found promising with lower disease incidence in terms of mortality at harvest also recorded lower disease incidence at 45 as well as 75 DAS.

Earthen pot with sick soil:Advanced screening of 34 lines was done to further confirm resistance to stem rot disease under laboratory conditions. Disease incidence ranged from 38 to 90% with an average value of 71% (Table 2). Lowest mortality was observed in NRCGCS-19 (37.8%) followed by NRCGCS-319 (40.9%). Range and average disease incidence were higher under lab conditions over concrete block with sick soil conditions. This is because of high disease pressure immediately after germination which is unlikely in normal crop conditions where disease mostly occurs during 40 to 60 DAS. Thus, disease incidence of promising lines NRCGCS-47, NRCGCS-99, NRCGCS-131 and NRCGCS-319 may increase in case severe disease appears at very early sage of the crop along with congenial environmental conditions. Of which NRCGCS-319 was most stable one with lower disease incidence under both concrete block as well laboratory conditions (Fig. 1). Thus disease incidence of NRCGCS-319 in terms of mortality could be around 42% at any given circumstances.

Results of the present study indicated that response of interspecific lines to stem rot disease was variable over the seasons and years. Resistance of inetspecific lines to *S. rolfsii* varied with the growth stages of the plant. In other words resistance could be controlled by different mechanism/ genes in different growth stages of the plant. Screening for resistance to *S. rolfsii* must be specific to growth stages for identification of genotypes. NRCGCS-47, NRCGCS-99, NRCGCS-131 and NRCGCS-319 were found promising for stem rot disease during early stages as well as later stages of crop growth. Out of which interspecific line NRCGCS-319 was found most stable one with comparatively lower pooled disease incidence over concrete block and laboratory conditions.

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Table 1. Initial screening of interspecific lines of groundnut screened in the disease nursery under field conditions

Environment	No of genotypes screened	Range of disease incidence (%)	Average disease incidence (%)	Genotypes with Nil disease incidence	Disease Incidence in check (%)
Rainy-2005	242	0.0-87.5	19.6	NRCGCS-19, NRCGCS-27, NRCGCS-47, NRCGCS-56, NRCGCS-63, NRCGCS-90, NRCGCS-91, NRCGCS-106, NRCGCS-137, NRCGCS-140, NRCGCS-141, NRCGCS-144, NRCGCS-239, NRCGCS-250, NRCGCS-319, NRCGCS-327, Total=16	29.02
Rainy-2006	166	0.0-60.9	10.9	NRCGCS-17, NRCGCS-20, NRCGCS-72, NRCGCS-75, NRCGCS-80, NRCGCS-85, NRCGCS-105, NRCGCS-106, NRCGCS-122, NRCGCS-132, NRCGCS-137, NRCGCS-143, NRCGCS-144, NRCGCS-188, NRCGCS-192, NRCGCS-257, Total=16	8.35
Rainy-2007	166	0.0-46.3	16.2	NRCGCS-99, NRCGCS-131,NRCGCS-141, NRCGCS-303, NRCGCS-346, Total=05	22.58
Rainy-2008	92	0.0-52.9	12.6	NRCGCS-72, NRCGCS-79, NRCGCS-127, NRCGCS-151, NRCGCS-320, NRCGCS-329, NRCGCS-365, NRCGCS-387,Total=08	52.78
Rainy-2009	65	9.43-65.6	30.4	Nil	43.75
Post rainy-2005	26	0.0-12.0	4.6	NRCGCS-12, NRCGCS-19, NRCGCS-77, NRCGCS-115, NRCGCS-189, Total=05	9.7
Post rainy - 2006	28	0.0-3.3	0.2	NRCGCS-12, NRCGCS-13, NRCGCS-16, NRCGCS-19, NRCGCS-24, NRCGCS-25, NRCGCS-28, NRCGCS-77, NRCGCS-86, NRCGCS-88, NRCGCS-110, NRCGCS-115, NRCGCS-117, NRCGCS-132, NRCGCS-151, NRCGCS-156, NRCGCS-157, NRCGCS-160, NRCGCS-164, NRCGCS-168, NRCGCS-186, NRCGCS-189, NRCGCS-193, NRCGCS-200, NRCGCS-202, NRCGCS-251, Total=26	0.0
Post rainy - 2007	27	0.00-7.4	1.4	NRCGCS-19, NRCGCS-101, NRCGCS-214, NRCGCS-241, NRCGCS-243, NRCGCS-247, NRCGCS-251, NRCGCS-253, NRCGCS-258, NRCGCS-263, NRCGCS-266, NRCGCS-270, NRCGCS-272, NRCGCS-273, NRCGCS-280, NRCGCS-290, NRCGCS-292, NRCGCS-301, Total=18	8.33
Post rainy - 2008	31	0.0-14.6	3.7	NRCGCS-108, NRCGCS-109, NRCGCS-160, NRCGCS-168, NRCGCS-214, NRCGCS-247, NRCGCS-253, NRCGCS-258, NRCGCS-263, Total=09	22.74

Cultivar used as check in Rainy season was GG-20 and in post rainy season was GG-2

Table 2. Advanced screening of interspecific lines of groundnut in concrete blocks with sick soil under field and earthen pots under lab conditions

Genotype	Concrete block						Earthen pots	
	Initial PP	Disease incidence at harvest (%) *	No. of pods harvested	Infected pod (%) **	No. of kernel	Infected kernel (%) ***	Initial PP	Mortality of Plants at 21DAS (%)
NRCGCS-17	53	58.0 (38)	45	53.1 (29)	55	49.1 (27)	8	90.0 (8)
NRCGCS-19	52	54.9 (35)	41	55.6 (28)	45	40.0 (18)	8	37.8 (3)
NRCGCS-20	75	50.2(44)	116	36.9 (42)	153	20.3 (31)	7	67.8 (6)
NRCGCS-27	50	55.6 (34)	6	65.7 (5)	5	60.0 (3)	10	90.0 (10)
NRCGCS-47	47	38.0 (18)	68	32.0 (19)	115	15.7 (18)	7	67.8 (6)
NRCGCS-56	48	43.9 (23)	55	48.4 (31)	70	24.3 (17)	9	70.5 (8)
NRCGCS-63	59	56.2 (41)	74	47.3 (40)	106	24.5 (26)	8	69.3 (7)
NRCGCS-72	28	74.7 (26)	0	0.0 (0)	0	0.0 (0)	7	90.0 (7)
NRCGCS-75	62	54.3 (41)	19	46.7 (10)	27	22.2 (6)	7	90.0 (7)
NRCGCS-80	34	50.2(20)	8	90.0 (8)	7	57.1 (4)	9	70.5 (8)
NRCGCS-85	56	81.9 (55)	0	0.0	0	0.0 (0)	10	90.0 (10)
NRCGCS-90	51	60.0 (38)	62	30.7 (16)	102	5.9 (6)	10	71.6 (9)
NRCGCS-91	49	58.7 (36)	24	65.7 (20)	27	48.1 (13)	8	69.3 (7)
NRCGCS-99	44	36.9 (16)	66	45.0 (33)	77	39.0 (30)	8	90.0 (8)
NRCGCS-106	47	70.6 (42)	3	54.9 (2)	5	60.0 (3)	9	90.0 (9)
NRCGCS-122	50	42.7 (23)	10	90.0 (10)	13	38.5(5)	10	63.4 (8)
NRCGCS-127	48	46.2 (35)	42	47.9 (23)	58	24.1(14)	9	61.9 (7)
NRCGCS-131	47	28.7 (11)	34	67.2 (29)	45	28.9(13)	9	54.8 (6)
NRCGCS-132	46	81.9 (45)	0	0.0	0	0.0 (0)	9	90.0 (9)
NRCGCS-137	48	81.9 (47)	0	0.0	0	0.0 (0)	7	90.0 (7)
NRCGCS-140	51	50.2 (30)	14	53.1 (9)	23	30.4 (7)	8	60.0 (6)
NRCGCS-141	62	52.5 (39)	27	56.8 (19)	37	24.3 (9)	9	70.5(8)
NRCGCS-143	30	50.8 (18)	7	90 (7)	10	50.0 (5)	7	49.0 (4)
NRCGCS-144	48	60.0 (36)	20	67.2 (17)	36	27.8 (10)	7	90.0 (7)
NRCGCS-151	61	80.0 (59)	0	0.0 (0)	0	0.0 (0)	10	90.0 (10)
NRCGCS-192	45	58.7 (33)	60	49.0 (34)	101	16.8 (17)	10	71.6 (9)
NRCGCS-239	74	73.6 (68)	29	38.0 (11)	37	32.4 (12)	10	90.0 (10)
NRCGCS-268	41	51.4 (25)	42	22.0 (6)	48	20.8 (10)	10	56.8 (7)
NRCGCS-303	61	48.5 (34)	11	53.1 (7)	18	22.2 (4)	8	52.2 (5)
NRCGCS-319	52	41.6 (23)	29	43.9 (14)	20	35.0 (7)	7	40.9 (7)
NRCGCS-320	60	74.7 (56)	4	90 (4)	6	50.0 (3)	7	49.0 (4)
NRCGCS-349	55	58.7 (40)	16	60 (12)	21	14.3 (3)	7	57.9(5)
NRCGCS-365	43	62.7 (34)	36	75.8 (34)	43	48.8 (21)	7	67.9(6)
NRCGCS-387	52	54.9 (35)	27	46.2 (14)	40	42.5(17)	7	67.9 (6)
Mean		57		57		34		71
Range		29-82		22-90		6-66		38-90
STDEV		13.7		20.2		14.8		16.14

Values in parenthesis indicates: * - No. of dead plant, ** - No. of infected Pod, *** - No. of infected Kernel,
Values mentioned in parameters “mortality at harvest” and “pod infection” are arc-sign transformed values

Table 3. Disease incidence of interspecific lines at three stages of growth

Genotype	Disease incidence at 45 DAS (%)	Disease incidence at 75 DAS (%)	Disease incidence at harvest (%)
NRCGCS-17	14.2	32.0	58.1
NRCGCS-19	51.9	53.7	54.9
NRCGCS-20	0.0	36.9	50.2
NRCGCS-27	47.3	49.6	55.6
NRCGCS-47	22.8	33.2	38.1
NRCGCS-56	24.4	30.0	43.9
NRCGCS-63	22.0	48.5	56.2
NRCGCS-72	51.4	57.4	74.7
NRCGCS-75	10.0	34.5	54.3
NRCGCS-80	45.0	46.7	50.2
NRCGCS-85	78.5	78.5	81.9
NRCGCS-90	18.4	38.7	60.0
NRCGCS-91	57.4	57.4	58.7
NRCGCS-99	12.9	23.6	36.9
NRCGCS-106	55.6	62.7	70.6
NRCGCS-122	29.3	38.1	42.7
NRCGCS-127	25.8	40.4	46.2
NRCGCS-131	19.4	22.8	28.7
NRCGCS-132	62.0	72.5	81.9
NRCGCS-137	61.3	73.6	81.9
NRCGCS-140	14.2	33.8	50.2
NRCGCS-141	10.0	36.3	52.5
NRCGCS-143	24.4	35.1	50.8
NRCGCS-144	54.9	56.2	60.0
NRCGCS-151	73.6	77.1	80.0
NRCGCS-192	26.6	49.6	58.7
NRCGCS-239	62.0	66.4	73.6
NRCGCS-268	22.8	41.6	51.4
NRCGCS-303	23.6	33.2	48.5
NRCGCS-319	28.7	38.1	41.6
NRCGCS-320	50.8	64.9	74.7
NRCGCS-349	47.9	48.5	58.7
NRCGCS-365	54.9	56.8	62.7
NRCGCS-387	43.9	52.5	54.9
Mean	37	48	57
Range	0-78	23-78	29-82
STDEV	20.5	15.3	13.7

Values mentioned in parameters "mortality at 45 DAS", "mortality at 75 DAS" and "mortality at harvest" are arc-sign transformed values

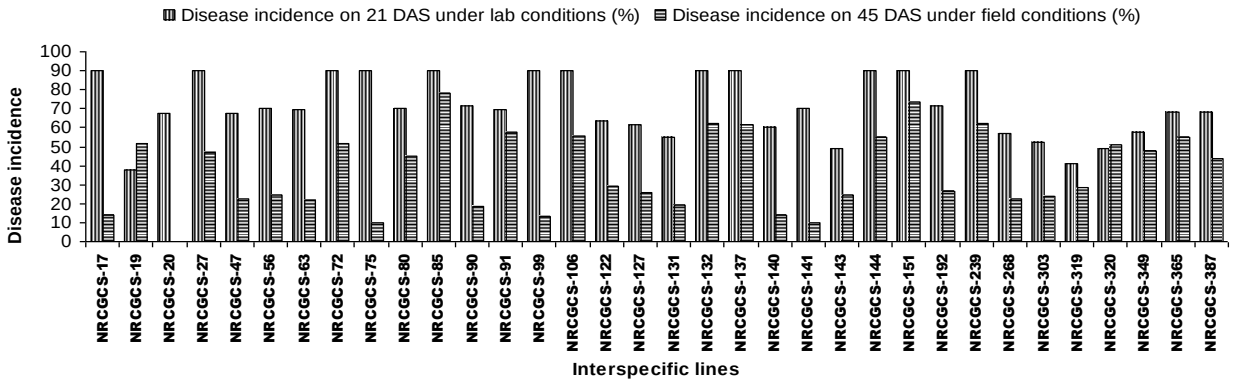

Figure 1. Disease incidences in interspecific lines of groundnut for stem rot under field and lab conditions