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# SCREENING OF GROUNDUT GENOTYPES AGAINST TIKKA DISEASE

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## ABSTRACT

**An experiment was conducted at College of Agriculture, Nagpur to screen forty different groundnut genotypes against tikka disease during *kharif* 2016-17 in randomized block design with three replications. Biochemical constituents of phenol, total sugar and chlorophyll at 45 -50 DAS (flowering stage) and 90 DAS (pod development stage) were estimated from leaves of healthy and diseased samples. Forty genotypes of groundnut were screened for tikka disease under field condition. None of the genotypes were found to be immune to early leaf spot. Two entries (ACNGV-25, ACGGV-30) were highly resistant, seven entries (Kopergaon-3, 3, 10, 14, ACGGV-27, 36, 38) were resistant, fourteen entries (ACNGV-2, 5, 8, 9, 11, 13, 18, 26, ACGGV-28, 29, 31, 33, 34, 35) were moderately resistant, thirteen entries (ACNGV-1, 4, 6, 7, 12, 15, 17, 19, 21, 22, 23, 24, ACGGV-32) were susceptible and four entries (ACNGV-16, 20, ACGGV-37, TAG-24) were highly susceptible to the early leaf spot. Similarly none of the genotypes were found to be immune and highly resistant to late leaf spot disease. One entry (Kopergaon-3) was resistant, one entry (ACGGV-30) was moderately resistant, thirty six entries (ACNGV-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 20, 21, 22, 23, 24, 25, 26, ACGGV-27, 28, 29, 31, 32, 33, 34, 35, 36, 37, 38, TAG-24) were susceptible and two entries (ACNGV-16, 17) were highly susceptible to the late leaf spot. The biochemical changes (total phenol, total sugar and total chlorophyll) in tikka disease were studied in resistant and susceptible genotypes. The high total phenol content was observed in resistant genotypes than in susceptible genotypes and also total sugar content was observed maximum in resistant than susceptible genotypes. The maximum total chlorophyll content was observed in resistant genotypes compared to susceptible genotypes. The phenol and sugar contents increased with the progress of disease with the depletion of chlorophyll content. There was a significant difference in total phenol, total sugar, total chlorophyll contents between the healthy and diseased leaves of resistant and susceptible genotypes. Total phenol and total sugar are the biochemical constituents found more in resistant genotypes and considered as parameter for disease resistance.**

**(key words: Early leaf spot, late leaf spot, groundnut genotypes)**

## INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is one of the principle oilseed crops of the world. Groundnut is unique among all the leguminous crops, designated as "wonder legume", commonly called as the poor man's nut and belongs to leguminous family. The botanical name for groundnut, *Arachis* meaning a legume and *hypogaea* meaning below ground. It is an important protein supplements in cattle and poultry rations. It is also consumed as confectionary product. The cake can be used for manufacturing artificial fiber. The haulms (plant stalks) are fed (green, dried or silage) to livestock. Groundnut shell is used as fuel for manufacturing coarse boards, cork substitutes etc. The oil content of the seed varies from 44-55%. Groundnut oil is used as cooking; kernels are eaten raw, rosted and salted or swetelled. They are rich in protein (22-32%), carbohydrates (20%) and contain vitamins A, E, K and B groups. It is also one of the richest sources of Vitamin $B_1$. Groundnut cake, formed after the oil extraction is a highly proteinacious animal feed.

Groundnut crop often suffers from many fungal, bacterial, viral, phytoplasma, nematode diseases and pests. The major biotic factors affecting groundnut yield and quality in India are foliar fungal diseases, stem rot, collar rot, root rot, rust and seedling rots etc. Early (*Cercospora arachidicola* Hori.) and late leaf spots (*Phaeoisariopsi spersonata* Berk. and Curt.) are the most widely distributed and economically important foliar diseases of groundnut causing severe damage to the crop (Subrahmanyam *et al.*, 1980). Each disease alone is capable of causing substantial yield loss but when they occur together losses are further increased. For instance, rust and late leaf spot together can

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cause up to 70 per cent yield loss also have an adverse influence on seed quality and grade characteristics, deteriorate the quality of plant biomass and thus render the fodder quality production in groundnut growing in Vidarbha region (Maharashtra). Early and late leaf spot commonly called as "Tikka disease". Loss of production from the combined effect of the both leaf spot can ranges from 10-50 per cent depending on the time of appearance and weather. These diseases damage the plant by reducing the leaf area available for photosynthesis and stimulating the leaflet abscission leading to heavy defoliation (Subrahmanyam *et al*., 1980). Use of disease resistant cultivators is one of the best means of reducing crop losses from leaf spot disease. Considering the importance of disease, the study was undertaken with the objectives to screen the groundnut germplasm against tikka disease and to study biochemical constituents of germplasm against tikka disease.

# MATERIALS AND METHODS

A field experiment was conducted at Plant Pathology farm, College of Agriculture, Nagpur during *kharif,* 2016-17. The experiment was laid out in randomized block design. All standard and recommended packages of practices such as tillage, manuring, sowing, fertilizer application, weeding and pest control were followed for cultivation of crop as when required. The disease intensity was recorded from five plants of each germplasm. Six leaves of each plant (2 top leaves, 2 middle leaves, 2 bottom leaves) were selected for measurement of disease intensity on the basis of relative percentage of leaf area covered by disease per cent disease intensity (PDI) was calculated by formula given by Wheeler (1969).

$$PDI = \frac{\text{Sum of individual disease rating}}{\text{No. of leaves observed x Maximum disease grade}} \times 100$$

Screening of groundnut germplasm against tikka disease resistance was done which is based on disease scoring scale given by Mayee and Datar (1988)

| | | |
|---|---|---|
| 0 | Immune | No symptoms |
| 1 | Highly Resistant | Few small necrotic spots covering 1% or less of leaf area. |
| 3 | Resistant | Few small necrotic spots covering 1-5% of leaf area. |
| 5 | Moderately Resistant | Spots coalescing enlarging 6-20% of leaf area. |
| 7 | Susceptible | Spot enlarging, coalescing to cover 21-50% of the leaf area. |
| 9 | Highly Susceptible | Spot enlarging, coalescing to cover 51% or more of the leaf area. |

**Laboratory experiment**

Laboratory, experiment was conducted to estimate the phenol, total sugar and chlorophyll at 45-50 DAS (flowering stage) and 90 DAS (pod development stage). The above biochemical constituents were estimated from leaves of healthy and diseased sample of categorized germplasm of groundnut which were collected from experimental field of Plant Pathology, College of Agriculture, Nagpur. Total phenols were estimated using method described by Malik and Singh (1980). Estimation of sugar content both reducing and non reducing sugar from healthy and diseased leaves was estimated by titrimetric method using Benedict's quantitative reagent (Benedict, 1907). Estimation of chlorophyll was extracted in 80 per cent acetone and absorbance at 663 nm and 645 nm are read in a spectrophotometer (Gupta *et al.,* 1987).

# RESULTS AND DISCUSSION

**Symptoms of tikka disease of groundnut**

The symptoms produced by two pathogens *viz., Cercospora arachidicola* and *Phaeoisariopsis personata* different in size, shape and colour of lesions. *Phaeoisariopsis personata* spots at maturity were black on both the surface of leaf with lower surface attaining different shades. The size of spots varied from 1.5 to 3.5 mm. Halos around mature spots remain developed or attain a golden yellow halo. *Cercospora arachidicola* are dark brown on leaf surface. The spot varied in size from 3 to 5 mm round to irregular in size, when developed in yellow to golden and generally lighter than *Phaeoisariopsis personata.* Similar to this observations Ramakrishna and Appa Rao (1968) reported that apart from the time of appearance, the symptoms produced by two pathogens *viz., Cercospora arachidicola* and *Cercospora personata* were different in size, shape and colour of lesions. The symptoms of *Phaeoisariopsis personata* which appeared on the upper surface of older leaves as dark brown to black spots measuring 1 to 6 mm in diameter almost circular in out and with an in distinct pale yellow margin. *Cercospora arachidicola* produced reddish brown to form more or less circular to irregular lesions measuring about 1 to 10 mm in diameter and surrounded by a narrow bright yellow halo. These observations correlated with findings of Mayee and Datar (1988), who reported that the symptoms of *Cercospora personata* which appeared on the upper surface of older leaves were dark brown to black spots.

**Screening of genotypes**

Thirty eight genotypes and two check varieties screened under natural field condition against early and late leaf spot disease. Out of forty entries tested (Table 1) none of the genotypes were found to be immune to this disease. Two entries were shown highly resistant (ACNGV-25, ACGGV-30), seven were resistant (Kopergaon-3, ACNGV-3, 10, 14, ACGGV-27, 36, 38), fourteen were moderately resistant (ACNGV-2,5,8,9,11,13,18,26, ACGGV-28, 29,

31,33,34,35), thirteen were susceptible (ACNGV-1, 4, 6, 7, 12, 15, 17, 19, 21, 22, 23, 24, ACGGV-32) and four were highly susceptible (ACNGV-16,20, ACGGV-37, TAG-24) reaction to the early leaf spot.

The same forty entries tested against late leaf spot (Table 2) none of the genotypes were found to be immune and highly resistant to this disease. One entry was resistant (Kopergaon-3) and moderately resistant (ACGGV-30), thirty six were susceptible (ACNGV-1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 20, 21, 22, 23, 24, 25, 26, ACGGV-27, 28, 29, 31, 32, 33, 34, 35, 36, 37, 38, TAG-24) and two were highly susceptible (ACNGV-16, 17) reaction to the late leaf spot.

The data presented in table 3 revealed that susceptible genotypes shows maximum per cent disease intensity as compared to resistant genotypes. Among 40 genotypes of groundnut ACNGV-16 (9.25%), ACNGV-20 (10.74%) showed maximum, ACGGV-30 (2.59%), ACNGV-25 (2.96%) showed minimum per cent disease intensity to early leaf spot at flowering stage and ACNGV-16 (41.11%), ACNGV-17 (43.33%) showed maximum, Kopergaon-3 (18.89%), ACGGV-30 (21.85%) showed minimum per cent disease intensity to late leaf spot at pod development stage.

Similar to this result Sheela (2008) screened the 48 groundnut entries and found that INS-1-2006-5 and INS-1-2005-16 were found to be resistant to rust (grade 1.3 and 1.0 respectively) and late leaf spot (grade 3.0 and 2.0 respectively). Other two entries *viz*., INS-1-2006-10 and AIS-2006-11 were found to be resistant to late leaf spot disease alone (grade 2.6 and 2.0 respectively).The susceptible variety CO-2 recorded grade 8.3 for rust and 8.8 for late leaf spot diseases. Mane Pushpa (2012) tested total 14 groundnut cultivars and 3 check varieties against tikka disease under natural field conditions. The per cent disease intensity was worked out for each variety, based on visual observations of 5 plants plot$^{-1}$ replication$^{-1}$. Among the cultivars AK-208-14 showed moderately susceptible reaction whereas all other cultivars showed susceptible reaction to tikka disease. The check variety TAG-24 showed moderately susceptible reaction against tikka diseases among three check varieties.

**Biochemical analysis**

At the same time of screening of groundnut genotypes in natural field condition the healthy and infected sample of leaves at flowering and pod development stages were collected for detection of biochemical analysis as described in material and methods.

**Phenol estimation:** It is apparent from the table 4 there was a significant difference in total phenol contents between the healthy and diseased leaves of resistant and susceptible genotypes. The highly resistant genotype ACGGV-30 contains higher total phenol content 0.83 and 1.69 (mg g$^{-1}$ dry wt.) in healthy and diseased leaves. Resistant genotype Kopergaon-3 had 0.76 and 1.43 (mg g$^{-1}$ dry wt.); moderately resistant genotype ACNGV-2 had 0.71 and 1.38 (mg g$^{-1}$ dry wt.); susceptible genotype ACNGV-4 had 0.67 and 1.27 (mg g$^{-1}$ dry wt.); highly susceptible genotype TAG-24 had 0.61 and 1.23 (mg g$^{-1}$ dry wt.) in healthy and diseased leaves samples respectively at flowering stage (ELS). It is evident from data presented in the table 5 that there was a significant difference in total phenol contents between the healthy and diseased leaves of resistant and susceptible genotypes. Resistant genotype Kopergaon-3 had 1.02 and 2.13 (mg g$^{-1}$ dry wt.); moderately resistant genotype ACGGV-30 had 0.96 and 1.89 (mg g$^{-1}$ dry wt.); susceptible genotype TAG-24 had 0.87 and 1.72 (mg g$^{-1}$ dry wt.); highly susceptible genotype ACNGV-16 had 0.71 and 1.59 (mg g$^{-1}$ dry wt.) in healthy and diseased leaves samples respectively at pod development stage (LLS). In accordance to this result Bhaskar and Parakhia (2010) studied the biochemical changes in tikka disease caused by pathogens *Cercospora arachidicola* (Hori.) and *Phaeoisariopsis personata* (Berk. and Curt.) for two susceptible cultivars (GG-2 and GG-7) and two resistant cultivars (ICGV-86590 and ICGV-86564) of groundnut were measured at 35 and 90 days after sowing and reported higher total phenol content observed in resistance varieties than susceptible ones. The total phenol content at different stages of infection showed that it increased with the progress of infection in resistant and susceptible varieties also.

**Total Sugar estimation**

The data presented in the table 6 revealed that there was a significant difference in total sugar contents between the healthy and diseased leaves of resistant and susceptible genotypes. The highly resistant genotype ACGGV-30 had higher total sugar content 12.01 and 14.32 (mg g$^{-1}$ dry wt.) in healthy and diseased leaves. Resistant genotype Kopergaon-3 had 11.88 and 14.27 (mg g$^{-1}$ dry wt.); moderately resistant genotype ACNGV-2 had 11.43 and 13.28 (mg g$^{-1}$ dry wt.); susceptible genotype ACNGV-4 had 10.39 and 12.51 (mg g$^{-1}$ dry wt.); highly susceptible genotype TAG-24 had 9.92 and 11.18 (mg g$^{-1}$ dry wt.) in healthy and diseased leaves samples respectively at flowering stage (ELS). The data presented in the table 7 showed that there was a significant difference in total sugar contents between the healthy and diseased leaves of resistant and susceptible genotypes. Resistant genotype Kopergaon-3 had 15.88 and 16.49 (mg g$^{-1}$ dry wt.); moderately resistant genotype ACGGV-30 had 14.67 and 16.35 (mg g$^{-1}$ dry wt.); susceptible genotype TAG-24 had 14.44 and 16.19 (mg g$^{-1}$ dry wt.); highly susceptible genotype ACNGV-16 had 14.13 and 15.91 (mg g$^{-1}$ dry wt.) in healthy and diseased leaves samples respectively at pod development stage (LLS). In accordance to this result Bhaskar and Parakhia (2010) studied on the biochemical changes in tikka disease caused by pathogens *Cercospora arachidicola* (Hori.), *Phaeoisariopsi spersonata* (Berk. and Curt.) for two susceptible cultivars (GG-2 and GG-7) and two resistant cultivars (ICGV-86590 and ICGV-86564) of groundnut at 35 and 90 days after sowing and reported the maximum soluble sugar in resistance varieties than susceptible ones. The soluble sugar contents at different stages of infection showed that soluble sugar increased with the progress of infection in resistant and susceptible varieties also.

**Total chlorophyll estimation**

There was a significant difference in total chlorophyll contents between the healthy and diseased leaves of resistant and susceptible genotypes. Data showed in table 8 cleared that highly resistant genotype ACGGV-30 contains higher total chlorophyll content 1.61 and 1.23 (mg $g^{-1}$ dry wt.) in healthy and diseased leaves. Resistant genotype Kopergaon-3 had 1.57 and 1.10 (mg $g^{-1}$ dry wt.); moderately resistant genotype ACNGV-2 had 1.52 and 1.02 (mg $g^{-1}$ dry wt.); susceptible genotype ACNGV-4 had 1.41 and 0.99 (mg $g^{-1}$ dry wt.); highly susceptible genotype TAG-24 had 1.38 and 0.90 (mg $g^{-1}$ dry wt.) in healthy and diseased leaves samples respectively at flowering stage (ELS). The data presented in the table 9 revealed that there was a significant difference in total chlorophyll contents between the healthy and diseased leaves of resistant and susceptible genotypes. Resistant genotype Kopergaon-3 had 1.36 and 0.89 (mg $g^{-1}$ dry wt.); moderately resistant genotype ACGGV-30 had 1.26 and 0.76 (mg $g^{-1}$ dry wt.); susceptible genotype TAG-24 had 1.18 and 0.69 (mg $g^{-1}$ dry wt.); highly susceptible genotype ACNGV-16 had 1.10 and 0.61 (mg $g^{-1}$ dry wt.) in healthy and diseased leaves samples respectively at pod development stage (LLS). In accordance to this result Bhaskar and Parakhia (2010) studied the biochemical changes in tikka disease caused by pathogens. *Cercospora arachidicola* (Hori.), *Phaeoisariopsis personata* (Berk. and Curt.) for two susceptible cultivars (GG-2 and GG-7) and two resistant cultivars (ICGV-86590 and ICGV-86564) of groundnut were measured at 35 and 90 days after sowing and reported that the chlorophyll contents at different stages of infection showed that the chlorophyll contents decreased with the progress of infection in resistant and susceptible varieties also. The higher amount of total chlorophyll observed in resistant varieties as compared to susceptible ones.

Total phenol and total sugar were the biochemical constituents found more in resistant genotypes and considered as parameter for disease resistance. Resistance supported good growth of plant which ultimately reflects in contributing yields. Introduction of resistance in the genotypes through breeding programme can be a tool for management of the disease.

**Table 1. Reaction of groundnut genotypes against early leaf spot disease**

| Scale | Category | No. of genotypes | Genotypes |
|---|---|---|---|
| **0** | Immune (I) | 0 | Nil |
| **1** | Highly Resistant (HR) | 2 | ACNGV-25, ACGGV-30 |
| **3** | Resistant (R) | 7 | ACNGV-3, 10, 14, ACGGV-27, 36, 38. Kopergaon-3 |
| **5** | Moderately Resistant (MR) | 14 | ACNGV-2,5,8,9,11,13,18,26, ACGGV-28, 29, 31,33,34,35. |
| **7** | Susceptible (S) | 13 | ACNGV-1,4,6,7,12,15,17,19,21,22,23,24, ACGGV-32, |
| **9** | Highly Susceptible (HS) | 4 | ACNGV-16,20,ACGGV-37, TAG-24 |

**Table 2. Reaction of groundnut genotypes against late leaf spot disease**

| Scale | Category | No. of genotypes | Genotypes |
|---|---|---|---|
| **0** | Immune (I) | 0 | Nil |
| **1** | Highly Resistant (HR) | 0 | Nil |
| **3** | Resistant (R) | 1 | Kopergaon-3 |
| **5** | Moderately Resistant (MR) | 1 | ACGGV-30 |
| **7** | Susceptible (S) | 36 | ACNGV 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13, 14, 15, 18, 19, 20, 21, 22, 23, 24, 25, 26 ACGGV-27, 28, 29, 31, 32, 33, 34, 35, 36, 37, 38,TAG-24. |
| **9** | Highly Susceptible (HS) | 2 | ACNGV-16, 17 |

**Table 3. Per cent disease intensity of early and late leaf spot on groundnut genotypes**

| Genotypes | Disease reaction | | PDI | |
|---|---|---|---|---|
| | ELS | LLS | ELS | LLS |
| ACNGV-1 | S | S | 8.51 (16.96) | 37.40 (37.70) |
| ACNGV-2 | MR | S | 5.92 (14.08) | 35.92 (36.82) |
| ACNGV-3 | R | S | 3.33 (10.51) | 32.22 (34.58) |
| ACNGV-4 | S | S | 8.14 (16.57) | 35.92 (36.82) |
| ACNGV-5 | MR | S | 5.55 (13.62) | 34.44 (35.93) |
| ACNGV-6 | S | S | 7.03 (15.37) | 33.70 (35.48) |
| ACNGV-7 | S | S | 7.40 (15.78) | 40.37 (39.44) |
| ACNGV-8 | MR | S | 5.48 (13.53) | 35.92 (36.82) |
| ACNGV-9 | MR | S | 6.29 (14.52) | 31.48 (34.12) |
| ACNGV-10 | R | S | 4.07 (11.63) | 36.66 (37.26) |
| ACNGV-11 | MR | S | 5.55 (13.62) | 34.44 (35.93) |
| ACNGV-12 | S | S | 7.03 (15.37) | 33.70 (35.48) |
| ACNGV-13 | MR | S | 5.92 (14.08) | 33.70 (35.48) |
| ACNGV-14 | R | S | 4.81 (12.66) | 33.70 (35.48) |
| ACNGV-15 | S | S | 8.51 (16.96) | 37.40 (37.70) |
| ACNGV-16 | HS | HS | 9.25 (17.70) | 41.11 (39.87) |
| ACNGV-17 | S | HS | 7.77 (16.18) | 43.33 (41.16) |
| ACNGV-18 | MR | S | 6.29 (14.52) | 36.66 (37.26) |
| ACNGV-19 | S | S | 7.77 (16.18) | 36.66 (37.26) |
| ACNGV-20 | HS | S | 10.74 (19.13) | 38.14 (38.13) |
| ACNGV-21 | S | S | 7.03 (15.37) | 35.18 (36.37) |
| ACNGV-22 | S | S | 7.77 (16.18) | 34.44 (35.93) |
| ACNGV-23 | S | S | 8.14 (16.58) | 37.40 (37.70) |
| ACNGV-24 | S | S | 8.51 (16.96) | 36.66 (37.26) |
| ACNGV-25 | HR | S | 2.96 (9.90) | 36.66 (37.26) |
| ACNGV-26 | MR | S | 5.18 (13.15) | 31.48 (34.12) |
| ACGGV-27 | R | S | 4.44 (12.16) | 35.92 (36.82) |
| ACGGV-28 | MR | S | 5.18 (13.15) | 35.18 (36.37) |
| ACGGV-29 | MR | S | 5.92 (14.08) | 35.92 (36.82) |
| ACGGV-30 | HR | MR | 2.59 (9.26) | 21.85 (27.86) |
| ACGGV-31 | MR | S | 5.18 (13.15) | 32.95 (35.03) |
| ACGGV-32 | S | S | 7.77 (16.18) | 37.40 (37.70) |
| ACGGV-33 | MR | S | 6.29 (14.52) | 37.40 (37.70) |
| ACGGV-34 | MR | S | 5.55 (13.62) | 36.66 (37.26) |
| ACGGV-35 | MR | S | 5.92 (14.08) | 32.96 (35.03) |
| ACGGV-36 | R | S | 4.07 (11.63) | 34.44 (35.93) |
| ACGGV-37 | HS | S | 9.25 (17.70) | 32.96 (35.03) |
| ACGGV-38 | R | S | 3.70 (11.09) | 38.83 (38.54) |
| TAG-24 | HS | S | 10.00 (18.43) | 33.70 (35.48) |
| Kopergaon-3 | R | R | 4.07 (11.63) | 18.89 (25.76) |
| **SE m±** | | | **0.70** | **0.50** |
| **CD (0.05)** | | | **2.10** | **1.50** |

**Table 4. Effect of early leaf spot on total phenol content of groundnut genotypes at flowering stage**

| Genotypes | Reaction | Total phenol (mg $g^{-1}$ dry wt.) | |
|---|---|---|---|
| | | Healthy | Diseased |
| ACGGV-30 | HR | 0.83 | 1.69 |
| Kopergaon-3 | R | 0.76 | 1.43 |
| ACNGV-2 | MR | 0.71 | 1.38 |
| ACNGV-4 | S | 0.67 | 1.27 |
| TAG-24 | HS | 0.61 | 1.23 |
| **SEm±** | | **0.0263** | **0.0222** |
| **CD (P=0.05)** | | **0.0789** | **0.0666** |

**Table 5. Effect of late leaf spot on content of groundnut genotypes at pod development stage**

| Genotypes | Reaction | Total phenol (mg $g^{-1}$ dry wt.) | |
|---|---|---|---|
| | | Healthy | Diseased |
| Kopergaon-3 | R | 1.02 | 2.13 |
| ACGGV-30 | MR | 0.96 | 1.89 |
| TAG-24 | S | 0.87 | 1.72 |
| ACNGV-16 | HS | 0.71 | 1.59 |
| **F test** | | **Sig.** | **Sig.** |
| **SEm±** | | **0.0213** | **0.0110** |
| **CD (P=0.05)** | | **0.0639** | **0.0326** |

**Table 6. Effect of early leaf spot on total sugar (mg $g^{-1}$ dry wt.) content of groundnut genotypes at flowering stage**

| | | Reducing sugar | | Non reducing sugar | | Total sugar | |
|---|---|---|---|---|---|---|---|
| Genotypes | Reaction | Healthy | Diseased | Healthy | Diseased | Healthy | Diseased |
| ACGGV-30 | HR | 10.12 | 12.34 | 1.89 | 1.98 | 12.01 | 14.32 |
| Kopergaon-3 | R | 10.09 | 12.29 | 1.79 | 1.98 | 11.88 | 14.27 |
| ACNGV-2 | MR | 9.85 | 11.56 | 1.58 | 1.72 | 11.43 | 13.28 |
| ACNGV-4 | S | 9.21 | 11.09 | 1.18 | 1.42 | 10.39 | 12.51 |
| TAG-24 | HS | 8.91 | 10.07 | 1.01 | 1.11 | 9.92 | 11.18 |
| **SEm±** | | **0.014** | **0.032** | **0.031** | **0.023** | **0.031** | **0.033** |
| **CD (P=0.05)** | | **0.042** | **0.096** | **0.093** | **0.069** | **0.093** | **0.099** |

**Table 7. Effect of late leaf spot on total sugar (mg $g^{-1}$ dry wt.) content of groundnut genotypes at pod development stage**

| | | Reducing sugar | | Non reducing sugar | | Total sugar | |
|---|---|---|---|---|---|---|---|
| **Genotypes** | **Reaction** | **Healthy** | **Diseased** | **Healthy** | **Diseased** | **Healthy** | **Diseased** |
| Kopergaon-3 | R | 14.68 | 15.21 | 1.2 | 1.28 | 15.88 | 16.49 |
| ACGGV-30 | MR | 13.65 | 15.14 | 1.14 | 1.21 | 14.67 | 16.35 |
| TAG-24 | S | 13.35 | 15.02 | 1.09 | 1.17 | 14.44 | 16.19 |
| ACNGV-16 | HS | 13.11 | 14.79 | 1.02 | 1.12 | 14.13 | 15.91 |
| **SEm±** | | **0.0163** | **0.0156** | **0.0137** | **0.0197** | **0.017** | **0.0100** |
| **CD (P=0.05)** | | **0.0489** | **0.046** | **0.0411** | **0.0594** | **0.051** | **0.0300** |

**Table 8. Effect of early leaf spot on total chlorophyll (mg $g^{-1}$ dry wt.) content of groundnut genotypes at flowering stage**

| **Genotypes** | **Reaction** | **Chlorophyll a** | **Chlorophyll b** | **Total chlorophyll Healthy** | **Chlorophyll a** | **Chlorophyll b** | **Total chlorophyll Deseased** |
|---|---|---|---|---|---|---|---|
| ACGGV-30 | HR | 1.09 | 0.52 | 1.61 | 0.76 | 0.47 | 1.23 |
| Kopergaon-3 | R | 1.07 | 0.5 | 1.57 | 0.68 | 0.42 | 1.10 |
| ACNGV-2 | MR | 0.98 | 0.54 | 1.52 | 0.61 | 0.41 | 1.02 |
| ACNGV-4 | S | 0.93 | 0.48 | 1.41 | 0.56 | 0.43 | 0.99 |
| TAG-24 | HS | 0.9 | 0.48 | 1.38 | 0.49 | 0.41 | 0.90 |
| **SE (m)±** | | **0.028** | **0.031** | **0.053** | **0.019** | **0.012** | **0.016** |
| **CD (P=0.05)** | | **0.084** | **0.090** | **0.159** | **0.057** | **0.036** | **0.048** |

**Table 9. Effect of late leaf spot on total chlorophyll (mg $g^{-1}$ dry wt.) content of groundnut genotypes at pod development stage**

| **Genotypes** | **Reaction** | **Chlorophyll a** | **Chlorophyll b** | **Total chlorophyll Healthy** | **Chlorophyll a** | **Chlorophyll b** | **Total chlorophyll Deseased** |
|---|---|---|---|---|---|---|---|
| Kopergaon-3 | R | 0.98 | 0.38 | 1.36 | 0.61 | 0.28 | 0.89 |
| ACGGV-30 | MR | 0.86 | 0.4 | 1.26 | 0.52 | 0.24 | 0.76 |
| TAG-24 | S | 0.72 | 0.46 | 1.18 | 0.48 | 0.21 | 0.69 |
| ACNGV-16 | HS | 0.69 | 0.41 | 1.10 | 0.42 | 0.19 | 0.61 |
| **SEm±** | | **0.0342** | **0.0125** | **0.0337** | **0.018** | **0.0100** | **0.0309** |
| **CD (P=0.05)** | | **0.1026** | **0.0375** | **0.1011** | **0.054** | **0.0300** | **0.0927** |

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