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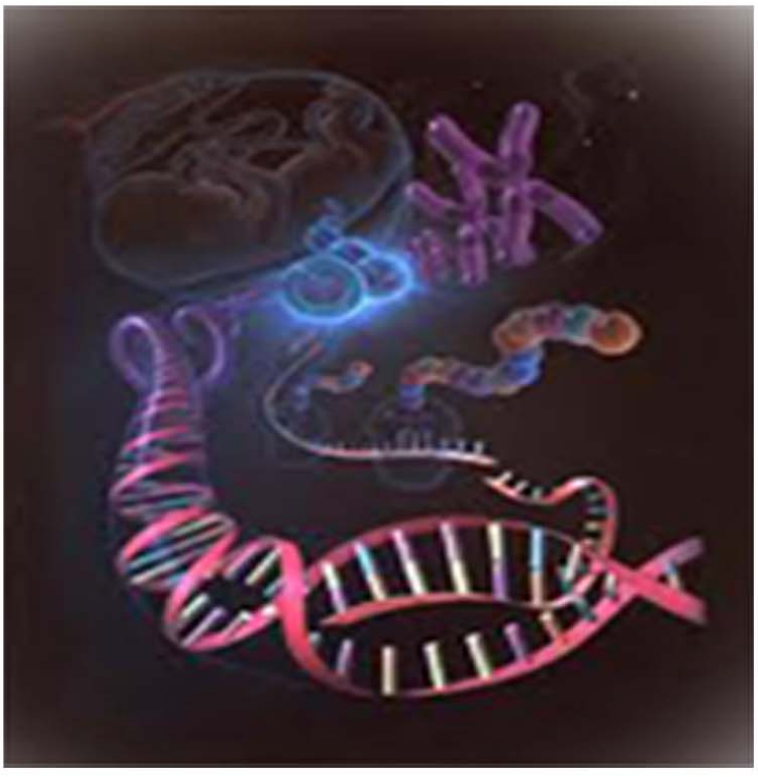

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Research Paper

VARIABILITY IN GROUNDNUT (*ARACHIS HYPOGAEA* L.) TO CERCOSPORA LEAF SPOT DISEASE TOLERANCE

S B Thakur[1*], S K Ghimire[1], N K Chaudhary[1], S M Shrestha[1] and B Mishra[2]

Corresponding Author: **S B Thakur, ✉ sbthakur500@rediffmail.com*

Groundnut *Arachis hypogaea* L. is an important crop both in subsistence and commercial agriculture in arid and semi-arid regions of the world. Leaf spot disease caused by fungus have been a major destructive disease of groundnut and could cause a yield loss of up to 50 % or more. Twenty five groundnut genotypes along with local checks (B -4 and Jayanti) were collected and an experiment conducted during 2010 and 2011at National Oilseed Research Program (NORP), Nawalpur, Sarlahi, Nepal. The experiment was conducted to study their level of variability to Cercospora leaf spot disease tolerance in a randomized complete block design (RCBD) with 3 replications. The objective of the study was to determine the reaction of different groundnut genotypes to Cercospora leaf spot diseases to create basis for selection for the disease tolerance. The analysis of variance (ANOVA) indicated highly significant difference among the groundnut genotypes for the traits days to 75% flowering, days to maturity, 100 kernel weight and Cercospora leaf spot score. The results indicated that the genotype ICGV-91074, ICGV-88473, ICGV-92173, B-4, Rajashri, ICGV-91104 and ICGV-98089 had the lowest level of Cercospora leaf spot disease incidence. The genotypes ICGV-91074, ICGV-98089, ICGV-92173 and ICGV-88473 produced the highest pod yield also had the lowest Cercospora leaf spot incidence. The genotypes ICGV-91104, ICGV-92173, B-4 and ICGV-91074 produced the highest haulm yield had the lowest Cercospora leaf spot incidence. The study found the remarkable level of variability existing among the groundnut varieties that is essential in groundnut improvement. This study recommends that the development or selection of tolerant genotypes to leaf spot disease should be based on their level of incidence. This will be the only effective measure in decreasing production costs and protect the environment from pollution. Therefore potential genotypes exist for selection among the evaluated groundnut genotypes for Cercospora leaf spot disease tolerance.

Keywords: Groundnut, Leaf spot, Cercospora, Tolerance, Incidence

INTRODUCTION

Groundnut (*Arachis hypogaea* L.) is an important crop both in subsistence and commercial agriculture in arid and semi-arid regions of the world (Izge *et al*., 2005). Groundnut kernel contains 40-50% high quality oil, more than 25%

[1] Institute of Agriculture and Animal Science, Rampur Chitwan, Nepal.

[2] Nepal Agriculture Reseach Council, Khumaltar, Nepal.

highly assumable protein and vitamin B and E. In the world, It is mainly grown as cash crop for oilseed, food and animal feed. It is cultivated in some 90 countries around the world. The groundnut's native is South America, where it has been cultivated for several centuries. In the 16th century, the Portuguese took it from Brazil to West Africa and Spaniards took it across the Pacific to the Philippines. From there, it spread to China, Japan, Malaysia and India and as far as Madagascar. Groundnut is produced predominantly in developing countries. It is cultivated in some 90 countries around the world (Virmani and Singh 1985). About 90 % of total world production comes from this region. India and China produce about one half of world production. It is one of the most nourishing foods available in the world.

The groundnut is particularly valued for its protein contents, which is of high biological value. Groundnuts contain more protein than meat-about two and a half times more than eggs, and far more than any other vegetable food except yeast.

Groundnut cultivation in Nepal was confined only in kitchen garden during seventies. However, this crop was commercially grown with the beginning of early eighties and the total area was around 6000 ha while the area was increased up to 10,000 ha during nineties. In recent years, the area has increased up to 15000 ha. The low rate of increase in area is mainly due to high cost of cultivation, high labor requirement and limited availability of seeds. The average productivity of groundnut is 1000kg ha^{-1}, which is as low as compared to other countries. In the fiscal year 2004/05 groundnut oil of worth Rs.201420 imported from overseas countries, (NORP, 2008).

Groundnut is generally grown in upland condition during monsoon season. Early maturing groundnut varieties are more susceptible to foliar diseases. Four varieties of groundnut, B-4, Janak, Jyoti and Jayanti have been released for general cultivation. Its successful production has been drastically affected by a number of problems; some of which leaf spot disease, which is economically important. Early leaf spot disease caused by the fungus *Cercospora arachidis* S. Hori (teleomorph *Mycosphaerella arachidis* Deighton) and late leaf spot disease caused by fungus *Cercosporidium personatum* (Berk and Curtis) Deighton (teleomorph *Mycosphaerella berkeleyi* Jenk.) are the major destructive disease of groundnuts worldwide, (Backman and Crawford, 1984; Jackson and Bell, 1969; Smith *et al*., 1992). Problems related to leaf spot diseases cause nearly complete defoliation and yield losses of up to 50 % or more. The leaf spot disease epidemics are affected by weather patterns such as hot and wet conditions (Shew *et al*. 1988).

Diseases like early and late leaf spots caused by *Cercospora arachidicola* and *Phaeoisariopsis personata* and rust (*Puccinia arachidis*) are the most important diseases of groundnut causing 50% pod yield loss. Yield loss due to combination of early and late leaf spot range from 10-50 %, vary considerable from place to place and between seasons (Mc Donald *et al*.1985). However late leaf spots are endemically present in groundnut growing belts of the Nepal in severe and devastating form. It is estimated pod yield loss of 20% in commercially grown varieties Jyoti and B-4 at moderate leaf spots severity under terai conditions of Nepal (Chaudhary *et al*.,2007).

Groundnut Cercospora leaf spot diseases occur mainly in the warm and humid areas. Therefore, the disease is prevalent in the Terai and mid-hill of Nepal during the rainy seasons. Farmers in the region where groundnuts are

grown extensively; are generally poor resource farmers and so most of them cannot afford chemical control measure of this disease.

Development of cultivars tolerant to this disease could be effective in decreasing the production costs, improving production quality and reducing the detrimental effects of chemicals on our ecosystem. It is for these reasons that, this study was conducted to determine the level of variability in tolerance of different groundnut cultivars to leaf spot disease.

MATERIALS AND METHODS

The experiment was conducted at the experimental farm of the National Oilseed Research Program (NORP), Nawalpur, Sarlahi district, Nepal during kharif season in year 2010 and 2011. The area lies in the central terai with high potential for groundnut crop. Total area of the farm is 33 ha and lies between 85^0 35' 52" east longitude and 27^0 03' 86" north latitude. Average altitude of the district is 144 msl. Average annual temperature was maximum 38 to 40°C and minimum 4 to 5°C. Average annual rainfall was about 1200 to 1500 mm. Soil of the experimental plot was sandy loam in texture with soil pH of 5.5 in the area. The climate was sub-tropical in average. It was dry with moderate temperature during vegetative and flowering stage and low rain at flowering with low temperature at late flowering and maturity stage of the crop. Twenty five genotypes collected from NORP and ICRISAT along with local check varieties (B-4 and Jayanti) were used to study the different genetic components. The experimental plots were prepared properly with basal dose of fertilizers application I.e. 20:40:20 Kg.NPK ha^{-1}.

The experiment was laid out in Randomized Complete Block Design (RCBD) with 3 replications. The unit plot size was 2.5X1.2 m^2. The distance between rows and plants was 30 and 15 cm respectively. On the other hand plot to plot and replication to replication distance was 0.5 and 1.0 m respectively. Seeds of genetic materials were sown on 1st week of July, 2010 and 2nd week of July, 2011. Seeds were sown in furrow at the depth of 4 cm approximately.

Observations on plant per plot, days to 75% flowering, days to maturity, plant height, pod per plant, 100 kernel weight, shelling %, Cercospora leaf spot score, haulm yield and pod yield ha^{-1} were taken. The response of the genotypes on severity of Cercospora leaf spot and were recorded on five plants selected randomly from each plot one week before harvesting by using modified 9 point scale and pictorial key (Subrahmanyam *et al*., 1995).

Description of Modified 9-point Scale

1= no disease, 2=1-5% leaf area damaged, 3=6-10% leaf area damaged, 4=11-20% leaf area damaged, 5=21-30% leaf area damaged, 6=31-40% leaf area damaged, 7=41-60% leaf area damaged, 8=61-80% leaf area damaged and 9=81-100% leaf area damaged.

The shelling percentage was calculated by using the following formula:

$$\text{Shelling \%} = \frac{\text{Net kernel weight in gram i.e. (pod weight - shell weight)}}{\text{Total pod weight in gram}} \times 100$$

The data collected were subjected to analysis of variance (ANOVA) and means were compared using Duncan's Multiple Range Test (DMRT) at 5% level of probability according to Duncan (1955). The co-efficient of variability were calculated by formula suggested by Burton, 1952.

RESULTS AND DISCUSSION

Characters were taken for the study is major indicators of pod yield and kernel yield of groundnut. Analysis of Variance (ANOVA) indicating the source of variation and mean square for the yield and yield component traits among the groundnut genotypes studied were presented in Table 1. The ANOVA indicated that highly significant variation among the genotypes for the traits days to 75% flowering, days to maturity, 100 kernel weight and Cercospora leaf spot incidence score.

The mean performance values for the groundnut genotypes in all the characters studied are presented in Table 2. The results indicated that the groundnut genotypes; ICGV-00350, ICGV-97098, ICGV-00440 and ICGV-91104 recorded the highest plant establishment 82.7, 82.7, 71.7 and 71.1 per plot respectively. However, the lowest plant population in ICGV-95005, ICGV-980100 and ICGV-91058 with 46.7, 46.7 and 47.7 respectively. Incidentally, the genotype ICGV-91074 had moderate plant population in plot had the highest pod yield and the lowest leaf spot incidence among the genotypes.

The genotypes; ICGV-97243, ICGV-97087, ICGV-91114 and Jyanti recorded earliest in 75% flowering with 26.33, 26.33, 27.33 and 27.66 days respectively, while the genotypes ICGV-00350, ICGV-92173, B-4, ICGV-91104 and ICGV-97100 had late in flowering of 31.66, 31.66, 30.66, 30.33 and 30.33 days respectively. Incidentally, genotype ICGV-97087 recorded the earliest to 75% flowering had shown late in maturity.

The result also showed that significant difference was observed among groundnut varieties in days to maturity. The earliest genotypes for the days to maturity observed in ICGV-97100, ICGV-91114, Jyanti and ICGV-97098 with 123.66, 124.33, 125.33 and 125 days respectively. Late maturity was observed in ICGV-97087(135), ICGV-92173 (134.66 days), ICGV-00440 (134.33 days), ICGV-95005 (134 days) and ICGV-88473 (134 days). Among the late maturing genotypes ICGV-92173 and ICGV-88473 showed the lowest level of leaf spot incidence.

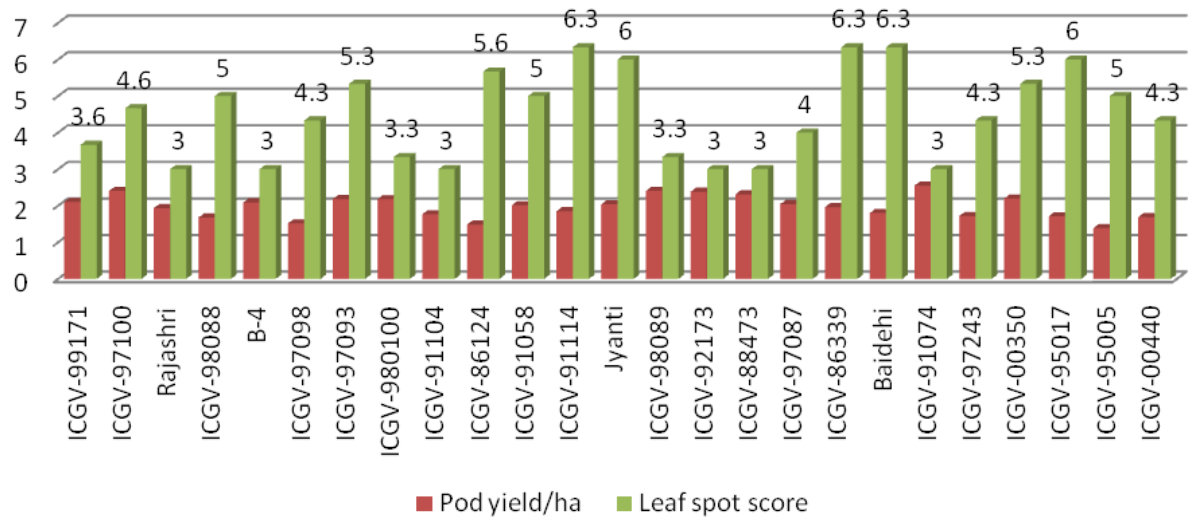
The character plant height also showed significant difference among the genotypes investigated. The highest plant height was observed in ICGV-91074, ICGV-91114, ICGV-86339 and ICGV-97098 of 75.8, 74.7, 72.5 and 72.0 cm respectively. The genotype ICGV-99171, Jyanti and Rajashri had lowest plant height of 46.9, 51.6 and 53.2 cm respectively. The highest plant height genotype ICGV-91074 had the highest pod yield.

Table 1: Analysis of Variance (ANOVA) Showing Mean Squares for Yield, Yield Components and Cercospora Disease Incidence of Groundnut

Source of variation	Df	No of Plant per Plot	Day to 75% Flower-ing	Days to Maturity	Plant Height (cm)	Pod per Plant (No)	100 Kernel wt.(g)	Shelling %	Leaf Spot Score (1-9)	Haulm Yield (kg/ha)	Pod Yield (kg/ha)
Replication	2	317.05	4.120	1.120	873.71	18	100.33	144.21	3.293	98361655.32	2164389.84
Treatments	24	337.86	6.052	39.108	163.55	97	161.17	74.91	4.42	14259898.88	293413.80
Error	48	211.10	0.884**	17.481**	137.57	23.47	74.29**	58.38	0.835**	9167924.50	354279.43
F value		0.082	0.000	0.008	0.29	0.07	0.010	0.22	0.000	0.095	0.08

Note: ** = Highly significant (at 1% probability level).

Graph 1: Groundnut genotypes showing reaction to Cercospora leaf spot (1-9 score) in relation and pod yield (mt/ha)



The highest number of pod per plant was observed in genotypes ICGV-99171, ICGV-97087, ICGV-00350, ICGV-95017, ICGV-86124 and ICGV-95005 with 20.3, 20.2, 19.2, 19.0, 17.8, and 17.8 respectively. The lowest number of pod per plant was shown in genotypes ICGV-91104, ICGV-97093, ICGV-91074, ICGV-92173 and ICGV-980100 with 11.3, 12.4, 12.4, 13.2 and 13.4 respectively.

The yield parameter 100 kernel weight has shown the highest in genotype ICGV-91104, ICGV-88473, ICGV-91074, ICGV-91058 and ICGV-00440 of 55.0, 55 .0, 53.3, 50 and 50 respectively. The lowest 100 kernel weight was recorded in genotype ICGV-86339 (30.0g) and ICGV-95005, ICGV-95017, ICGV-00350 (31.7g).

On the other hand the highest shelling % was recorded in ICGV-97100, ICGV-86339, Baidehi, B-4 and ICGV-95005 with 80.0, 80.0, 76.3, 75 and 75 % respectively. The lowest was recorded in ICGV-97087 and ICGV-92173.

The result also showed that the groundnut genotypes differed significantly in their level of tolerance to the *cercopsora* leaf spot disease. The result indicated that ICGV-91074, ICGV-88473, ICGV-92173, ICGV-91104, B-4, Rajashri, ICGV-980100 and ICGV-98089 recorded the lowest level of Cercospora leaf spot disease incidence. However, Baidehi, ICGV-86339, ICGV-91114, Jyanti and ICGV-95017 recorded the highest level of Cercospora disease incidence.

The highest haulm yield was produced by ICGV-91104, ICGV-92173, B-4, ICGV-91058 and ICGV-91074 groundnut genotypes with 16688.9, 16033.3, 15311.1,14877.8 and 14688.9 kg/ha respectively. The lowest haulm weight was produced by Jyanti, ICGV-97098, ICGV-86339, ICGV-86124 and ICGV-95017with 8800.0, 9466.6, 9633.3, 9877.7 9922.2 kg/ha respectively.

The highest pod yield was produced by genotype ICGV-91074, ICGV-98089 ICGV-97100 and ICGV-92173 with 2550.00, 2405.56, 2405.55 and 2383.33 kg/ha respectively. The lowest pod

Table 2: Mean Performance of Pod Yield Component Traits and Cercospora Disease Incidence of Groundnut Genotypes

Genotype	Plant Plot	Day to 75% Flower-ing	Days to Maturity	Plant Height (cm)	Pod per Plant (No)	100 Kernel wt.(g)	Shelling %	Leaf Spot Score (1-9)	Haulm Yield (kg/ha)	Pod Yield (kg/ha)
ICGV-99171	61.3	29.66	127.66	46.9	20.3	40.0	70.0	3.7	13866.7	2105.55
ICGV-97100	60.7	30.33	123.66	57.8	16.9	35.0	80.0	4.7	11077.8	2405.55
Rajashri	51.0	29.66	129.00	53.2	15.7	46.7	66.7	3.0	12988.9	1933.33
ICGV-98088	70.0	28.00	125.66	68.1	16.4	41.7	68.3	5.0	11322.2	1677.78
B-4	66.3	30.66	125.33	57.5	15.3	38.3	75.0	3.0	15311.1	2088.89
ICGV-97098	82.7	30.00	125.00	72.0	14.6	35.0	73.3	4.3	9466.6	1516.67
ICGV-97093	53.0	28.00	130.00	60.4	12.4	40.0	66.7	5.3	13311.1	2183.33
ICGV-980100	46.7	29.33	130.33	64.9	13.4	40.0	65.0	3.3	11866.7	2177.78
ICGV-91104	71.7	30.33	132.66	65.9	11.3	55.0	65.0	3.0	16688.9	1766.67
ICGV-86124	58.7	29.00	126.66	62.9	17.8	45.0	65.0	5.7	9877.7	1483.33
ICGV-91058	47.7	28.33	128.33	68.3	15.7	50.0	66.7	5.0	14877.8	2011.11
ICGV-91114	68.0	27.33	124.33	74.7	17.2	36.7	71.7	6.3	12077.8	1850.00
Jyanti	65.3	27.66	125.33	51.6	16.0	40.0	71.7	6.0	8800.0	2038.89
ICGV-98089	64.7	28.66	132.00	59.3	15.8	38.3	68.3	3.3	14022.2	2405.56
ICGV-92173	64.7	31.66	134.66	68.3	13.2	35.0	63.3	3.0	16033.3	2383.33
ICGV-88473	64.0	29.33	134.00	57.8	13.8	55.0	73.3	3.0	14255.6	2311.11
ICGV-97087	61.3	26.33	135.00	70.1	20.2	40.0	61.7	4.0	11988.9	2043.33
ICGV-86339	60.7	28.33	133.00	72.5	14.0	30.0	80.0	6.3	9633.3	1961.11
Baidehi	51.0	29.00	131.33	67.0	13.8	40.0	76.3	6.3	10533.3	1800.00
ICGV-91074	70.0	30.00	130.66	75.8	12.4	53.3	66.7	3.0	14688.9	2550.00
ICGV-97243	66.3	26.33	131.33	69.6	15.1	43.3	68.3	4.3	12666.7	1716.67
ICGV-00350	82.7	31.66	133.33	67.6	19.2	31.7	66.7	5.3	11544.4	2194.44
ICGV-95017	53.0	30.66	129.33	65.0	19.0	31.7	65.0	6.0	9922.2	1711.11
ICGV-95005	46.7	28.33	134.00	70.2	17.8	31.7	75.0	5.0	10755.6	1388.89
ICGV-00440	71.7	29.33	134.33	68.6	16.5	50.0	66.7	4.3	13444.4	1688.89
(X)	63.60	29.12	129.88	64.6	15.8	40.9	69.5	4.5	12440.9	1975.7
LSD at 0.05	23.9	1.5	6.9	19.3	8.0	14.2	12.5	1.5	4971.0	293.1
CV %	22.9	3.23	3.22	18.2	30.8	21.1	11.0	20.3	24.3	30.1

yield was recorded in ICGV-95005, ICGV-86124 and ICGV-97098 respectively.

The genotypes ICGV-91074, ICGV 98089 and ICGV- 92173 produced the highest pod yield and haulm yield among the genotypes also recorded the low level of Cercospora leaf spot disease incidence.

Thus the remarkable level of variability existing among the groundnut genotypes studied indicated a positive step in their improvement. The presence of genetic variability in crop plants have been described as essential in plant breeding by Falconer (1989) and Izege *et al*. (2005). Genetic variability encourages selection, because selection on its own does not create variability.

The groundnut genotype ICGV-91074 was found to have recorded the highest pod yield also had the lowest Cercospora disease incidence. Izge *et al*. (1998) reported similar result in groundnut where low incidence of Cercospora leaf spot disease is directly correlated with kernel yield. A lot of review works in groundnut revealed that high pod yielding ability is directly correlated with kernel yield.

The genotype ICGV-97100 gave the highest pod yield had the lowest numbers of days to maturity interestingly it was recorded the highest shelling %. The similar result was observed by Izge *et al*. (2007) where early maturing variety of groundnut showed the highest kernel yield. The kernel yield is directly positive correlated with shelling %.

The genotypes ICGV-92173, ICGV-88473, Rajashri B-4, and ICGV-91074 found to be the lowest percentage of defoliation due to Cercospora leaf spot disease incidence, showed tolerance to the disease reaction. The similar result was reported by Hossain *et al*. (2007) where no genotypes were shown resistant to the Cercospora disease in groundnut. Chaudhary (2010) also revealed that commercially grown variety of groundnut B-4 had moderate leaf spot severity under terai conditions of Nepal.

The late maturing varieties are mostly shows the susceptibility to leaf spot diseases. However, the late maturing genotypes of ICGV-92173, ICGV-88473 and ICGV-97087 recorded the lowest severity and incidence of Cercospora leaf spot disease. Godfrey *et al*. (2009) also reported low severity of leaf spot disease in 49-85A and ICGV-SM-93532 groundnut variety. Similarly, early maturing variety mostly shows less severity from leaf sport diseases, but the early maturing genotype ICGV-91114 and Jyanti had low severity to leaf spot disease. The similar result was obtained by Godfrey *et al*. (2009).

Variation and reaction of groundnut to Cercospora leaf spot disease were reported by Knauft and Gorbet (1990). The control of leaf spot disease in groundnut has also been reported to depend very much on multiple application of fungicides could cause slow erosion of disease control due to a loss of sensitivity in the target pathogen population and contribute to grater production costs and environmental pollution. The development or selection of tolerant varieties or cultivars could therefore be an effective method in decreasing production costs and improving product quality.

CONCLUSION

The most of the indicators used for the study were found to be highly significant among the genotypes. The result indicated that ICGV-91074, ICGV-88473, ICGV-92173, ICGV-91104, B-4,

Rajashri, ICGV-980100 and ICGV-98089 recorded the lowest level of Cercospora leaf spot disease incidence. Result of field experiment clearly indicated that the genotypes ICGV-91074, ICGV-98089 and ICGV-92173 produced the highest pod yield also had the lowest Cercospora leaf spot incidence compared to Jayanti and B-4 genotypes. The genotypes ICGV-91104, ICGV-92173, B-4 and ICGV-91074 produced the highest haulm yield with the lowest Cercospora leaf spot incidence. Hence, during the groundnut breeding program ICGV-91074, ICGV-98089 and ICGV-92173 genotypes can be used as the parent material for Cercospora leaf spot disease tolerance and can be cultivated in Cercospora leaf spot disese prone area for cultivation.

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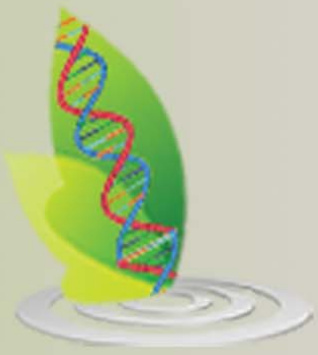

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