Evaluation of groundnut families for high yield and late leaf spot diseaseresistance

Abstract

There are many factors that affect the yield of the crop among them are the biotic factors mainly foliar fungal disease like late leaf spot (LLS) caused by *Cercosporapersonata* is a major and widely distributed disease. Effective chemical control is mainly relied upon multiple fungicide applications which are costly for resource poor farmers and also raises environmental and health concerns. Therefore, development of resistant cultivars is a ecofriendly concept, with this research gap study was conducted to identify groundnut families with high yield and resistance to late leaf spot disease. From 60 F_7 families of three crosses (GKVK-16 × KCG-2, GKVK-13 × KCG-2 and GKVK-6 × KCG-2 along with checks KCG-6, KCG-2 and TMV-2) which were evaluated in augmented design during *Kharif* 2017 in disease plot and control plot, disease screening was done using modified 9-point scale.Disease scoring was done at 60, 90 and 120 days after sowing (pod filling stage). The disease scores were mainly based on the extent of leaf area damage. Results depicted that among the 60 families 19 families showed consistence performance both at normal and disease plot. However, three families showed difference in the pod yield both at normal and disease plot. The families exhibited resistant to LLS disease showed *per cent* yield reduction that ranged from 0-35%, moderately resistant families exhibited yield reduction from 35-50%, however 50-90% yield reduction was observed in the families which showed moderate susceptibility, further more than 100% yield reduction was noticed in the families which are susceptible to LLS disease in three crosses of groundnut. High values of GCV and high PCV, high heritability coupled with high GAM was observed for PDI at 60^{th}, PDI at 90^{th} and PDI at 120^{th} days after sowing in all three crosses.Among 14 superior families six, among 13 superior families eight, and from three superior families one familyshowed resistance to LLS disease from the cross GKVK-16×KCG-2, GKVK-13×KCG-2 and GKVK-6×KCG-2 respectively. Therefore, these identified families will be forwardedfor muti-location disease and further yield stabilization.

Key words: Groundnut, Late leaf spot disease, *Per cent* disease Index, Disease sore

Introduction

Groundnut (*Arachishypogaea*L.)is a self-pollinated, cleistogamus annual herb belonging to the familyFabaceaeor Leguminaceae with a chromosome number of 2n=40. It is the most important oil seed crop of India and the world in terms of area and production. It is vernacularly knownas peanut, monkey nut, earth nutand pigmy nut.Cultivated groundnut is classified into two subspecies, subsp. *fastigiata* and subsp. *hypogaea*. The subsp. *fastigiata* contains four botanical varieties, var. *vulgaris*, var. *fastigiata*, var. *peruviana*, and var. *aequatoriana*. The subsp. *hypogaea* contains two varieties, var. *hypogaea* and var. *hirsuta*. Each of these botanical types has different plant, pod and seed characteristics (Krapovickas and Gregory, 1994).

There are many factors that affect the yield of the crop among them are the biotic factors mainly foliar fungal disease like late leaf spot (LLS) caused by *Cercosporapersonata* is a major and widely distributed disease. In groundnut predominant areas, the foliar diseases like late leaf spot and rust cause substantial yield loss and in combination of the diseases increased up to 70 *per cent* in India (Subrahmanyan *et al.*, 1995). Disease generally appears at 55 to 60 days after sowing and can cause more than 50 % loss in yields in groundnut producing areas of Karnataka (Hegde*et al.*,1995 and Oteng*et al.*, 2023). Seventeen potential candidate genes were predicted at ± 300 kbp of the stable/prominent SNP positions (Oteng*et al.*, 2023). Effective chemical control is mainly relied upon multiple fungicide applications Jordan *et al.*, (2012), which are costly for resource poor farmers and also raises environmental and health concerns. Therefore, development of resistant cultivars to the diseases could be effective in decreasing the production costs, improving production quality and reducing detrimental effects of chemicals and this is the only cost effective and environmental eco-friendly method to overcome the diseases. Total of 30 functional nucleotide polymorphisms or genic SNP markers were detected, among which eight genes were found to encode leucine-rich repeat (LRR) receptor-like protein kinases and putative disease resistance proteins (Wankhade*et al.*, 2023). There are many reasons which are attributed to low yield levels *viz.,* lack of improved high yielding cultivars, cultivation under shallow soils of low fertility, uneven rainfall distribution, continuous cropping without rotation of crop, low plant population, non-availability of improved varieties and incidence of foliar diseases and pests are cited as the major limiting factors in most of the groundnut growing regions. Keeping all the above points in view, an attempt has been made to identify superior families performing better with less yield reduction under disease condition.

Material and Methods

Experimental site and plant material

The present study was conducted at the experimental field, K-Block, Department of Genetics and Plant Breeding, GKVK, University of Agricultural Sciences, Bangalore located between 13°N latitude and 77°35' E longitude and an altitude of 899 m above mean sea level (MSL), during *kharif* 2017. The details of the material used and the techniques adopted in the present investigation for recording of observations and analysis of data are briefly presented in this chapter. The experimental material for the present study comprised of F_6 and F_7 families of three crosses *viz.*,GKVK-16 × KCG-2, GKVK-13 × KCG-2 and GKVK-6 × KCG-2 and checks KCG-6, KCG-2 and TMV-2.

Late leaf spot disease screening

The F_6 plants of three crosses, their parents and checks were raised in plant to progeny rows and evaluated in augmented design for late leaf spot disease during *kharif*2017 (Figure 1). The TMV-2 was used as spreader row for natural disease incidence. Screening of Late leaf spot disease was carried out by visual screening method Figure 2 using modified 9-point scale for late leaf spot (Table 1) given by Subrahmanyam*et al*. (1995). The scores were converted into Percentage Disease Index (PDI).

Disease scoring for late leaf spot

For late leaf spot disease screening, visual screening (Figure 2) and modified 9-point scale as given by Subrahmanyam*et al*. (1995) (Table 1) was used. The visual scores (1-9) and the extent of leaf area destroyed (0-100 %) are linearly related to each other. Disease scoring was done at 60, 90 and 120 days after sowing (pod filling stage). The disease scores were mainly based on the extent of leaf area damage. The scores were converted into *Per cent*disease Index (PDI) by using the following formula.

$$PDI(\%) = \frac{\text{Sum of the individual ratings}}{\text{No of plants assessed}} \times \frac{100}{\text{maximum disease rating}}$$

Results and Discussion

Effect of LLS disease on pod yield in F_7 generation in the cross the three crosses of Groundnut

The 60 families which were evaluated both at normal and disease stress condition were compared each other to dissect out influence of the LLS disease at 90DAS (days after sowing) on the pod yield, in three crosses and data presented in the table 2, 3 and 4.Results depicted in the tables indicated that among the 60 families 19 families showed consistence performance both at normal and disease plot, which indicated that LLS disease in the sick plot has less effect on the pod yield, therefore these families could be resistant for LLS disease However three families showed difference in the pod yield both at normal and disease plot, which confirms that the pod yield of these families at disease plot is less than the normal plot and *per cent* yield reduction at disease plot is very high. Further, PDI value of these families were also high. Therefore, these families could be susceptible for LLS disease (Chauhan *et al*., 2022).

The families exhibited resistant to LLS disease showed *per cent* yield reduction that ranged from 0-35%, moderately resistant families exhibited yield reduction from 35-50%, however 50-90% yield reduction was observed in the families which showed moderate susceptibility, further more than 100% yield reduction was noticed in the families which are susceptible to LLS disease in three crosses of groundnut.

The PDI at 60^{th}, 90^{th} and 120^{th} days was estimated for the LLS disease, in 60 families of three crosses and presented in the figure 3, 4 and 5.The figure 3indicated that the PDI values at 120^{th} day were higher than the PDI at 90^{th} and 60^{th} day. Further some families like 6, 16, 18 and 22 exhibited lower PDI value at 120^{th} day in cross GKVK - 16 × KCG – 2, suggest that these families were less effected by LLS disease spores even at 120 days after sowing therefore these families could be considered as resistance families for LLS disease. The figure 4 indicated that the PDI values at 120^{th} day were higher than the PDI at 90^{th} and 60^{th} day. Further some families like 5 and 15 showed lower PDI value at 120^{th} day in cross GKVK -13 × KCG -2, indicates these families were less influenced by LLS disease spores during 120 days of cropping period therefore these families could be considered as resistance families for LLS disease. The figure 5 indicated that the PDI values at 120^{th} day were higher than the PDI at 90^{th} and 60^{th} day in cross

GKVK -6 × KCG -2, which indicates the families of this cross is more affected by LLS disease. Hence, families presented in this cross were susceptible for LLS disease (Chauhan *et al*., 2022).

Estimates of genetic variability parameters for LLS disease in F_7 generation in three crosses of groundnut.

Amount of genetic variability for LLS disease in F_7 generation was estimated by various genetic parameters *viz.*, mean, range, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability (h^2) and genetic advance as *per cent* of mean (GAM) and presented in table 5.There was fluctuation in the mean values of PDI at 60th, PDI at 90th and PDI at 120thdays after sowing in all the three crosses of groundnut.High values of GCV and high PCV, high heritability coupled with high GAM was observed forPDI at 60th, PDI at 90th and PDI at 120th days after sowing in all three crosses. indicated the presence of higher magnitude of variation for these traits. Narasimhulu*et al*., (2013), Padmaja *et al*., (2013). Thus individual plant scoring can be practiced. Similar results were reported by Azad *et al.*(2000) and Meta and Monpara (2010). High heritability coupled with high GAM suggested that characters are under additive genetic control and selection will be effective. According to Varshney *et al*., (2013), disease score is the best selection criteria in the field for used in breeding program due to high heritability and its measures, which is accordance with the present results.

superior selected families for LLS disease in F_7 generation in the three crosses of groundnut

From among the 14 superior families six families (C1-213-2-1-1-2, C1-74-4-3-3-2, C1-213-2-8-4-16, C1-40-1-5-1-8, C1-137-4-7-5-9, C1-137-4-7-5-1) showed resistance to LLS disease, three (C1-213-6-2-2-4, C1-213-6-2-7-1, C1-47-9-10-1-1) were moderately resistant to LLS disease, four (C1-213-6-2-7-2, C1-40-1-5-1-7,C1-137-4-7-5-3, C1-46-1-10-1-9) were moderately susceptible and C1-74-4-3-3-1 showed susceptible to LLS disease in the cross GKVK-16×KCG-2. From among the 13 superior families eight families (C2-42-2-5-1-6, C2-49-4-9-1-1, C2-42-2-5-1-7, C2-59-1-3-4-5, C2-70-5-2-6-3, C2-49-2-5-2-2, C2-75-5-6-1-3, C2-42-2-5-1-6) showed resistance to LLS disease, three (C2-84-6-6-5-5, C2-48-6-6-1-2, C2-59-1-3-4-1) were moderately resistant to LLS disease, three (C2-59-1-3-4-2, C2-84-6-6-5-6,C2-75-5-6-3-3) were moderately susceptible to LLS disease in the cross GKVK-

16×KCG-2.From among the three superior families, family C3-32-1-7-4-1 showed resistance, family C3-88-4-5-1-3 showed moderately resistance, and family C3-130-5-6-2-4 showed moderately susceptible to LLS disease in the cross GKVK-6×KCG-2.

Conclusion

In the present investigation 60 families were evaluated in augmented design along with three checks to identify superior families for LLS disease. Results depicted that among the 60 families 19 families showed consistence performance both at normal and disease plot. However, three families showed difference in the pod yield both at normal and disease plot. High values of GCV and high PCV, high heritability coupled with high GAM was observed for PDI at 60^{th}, PDI at 90^{th} and PDI at 120^{th} days after sowing in all three crosses. Among 14 superior families six, among 13 superior families eight, and from three superior families one family showed resistance to LLS disease from the cross GKVK-16×KCG-2, GKVK-13×KCG-2 and GKVK-6×KCG-2 respectively. Therefore, these identified families will be forwarded for muti-location disease and further yield stabilization.

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Table 1: Modified 9-Point scale used for field-screening of groundnut genotypes for LateLeaf Spot resistance (Subrahmanyam*et al.*, 1995)

Disease score	Description	Disease severity %
1	No disease	0
2	Lesions present largely on lower leaves, no defoliation	1-5
3	Lesions present largely on lower leaves,very few on middle leaves;defoliation of some leaflets evident on lower leaves.	6-10
4	Lesions present on lower and middle leaves but severe on lowerleaves, defoliation of some leaflets evident on lower leaves	11-20
5	Lesions present on lower and middle leaves, over 50 % of Defoliation of lower leaves	21-30
6	Severe lesions on lower and middle leaves; lesions present but less severe on top leaves; extensive defoliation of lower leaves; some defoliation on middle leaves	31-40
7	Lesions on all leaves but less severe on top leaves; defoliation of all lower and middle leaves	41-60
8	Defoliation of all lower and middle leaves; severe lesions on top leaves evident	61-80
9	Almost all leaves defoliated, leaving bare stem; some leaflets may remain, but show severe leaf spot	81-100

Table 2: Effect of LLS disease on pod yield in F_7 generation of the cross GKVK-16×KCG-2 in Groundnut

Sl. No.	Families	Pod yield per plant(g)under disease control condition	Pod yield per plant (g)under disease stress condition	*Per cent*yield reduction due to LLS disease	PDI of LLS disease@90DAS	LLS Disease response
1	C1-40-1-5-1-8	63.60	48.53	31.05	29.67	R
2	C1-213-6-2-4-1	28.48	12.45	128.76	65.00	S
3	C1-213-6-2-2-4	49.37	35.46	39.23	40.67	MR
4	C1-74-4-3-3-1	57.81	24.69	134.14	75.23	S
5	C1-47-9-10-1-3	36.45	32.45	12.33	27.33	R
6	C1-213-6-2-7-4	28.58	22.45	27.31	19.89	R
7	C1-40-1-4-2-12	28.33	15.67	80.79	47.52	MS
8	C1-74-4-3-3-4	32.78	11.03	197.19	75.89	S
9	C1-213-2-1-1-2	48.36	38.11	26.90	24.78	R
10	C1-46-1-10-1-4	20.45	13.11	55.99	50.18	MS
11	C1-213-6-2-4-9	36.26	24.22	49.71	44.00	MR
12	C1-213-6-2-7-1	47.48	35.25	34.70	45.21	MR
13	C1-40-1-4-5-1	34.43	20.00	72.15	50.48	MS
14	C1-47-9-10-1-1	56.24	38.11	47.57	36.58	MR
15	C1-46-1-10-1-9	58.91	33.64	75.12	46.28	MS
16	C1-74-4-3-3-2	63.60	48.33	31.60	04.39	R
17	C1-40-1-5-1-7	49.56	28.12	76.24	49.33	MS
18	C1-137-4-7-5-1	57.66	44.78	28.76	15.78	R
19	C1-43-3-8-3-1	37.93	26.89	41.06	36.00	MR
20	C1-213-6-2-7-2	62.28	35.44	75.73	45.89	MS

21	C1-213-2-8-4-16	61.79	45.98	34.38	27.60	R
22	C1-137-4-7-5-9	57.39	53.78	6.71	07.38	R
23	C1-213-2-1-3-1	34.41	20.33	69.26	38.12	MR
24	C1-137-4-7-5-3	45.52	25.56	78.09	49.77	MS

Note: PDI- Per cent disease index,

LLS- Late leaf spot

Table 3: Effect of LLS disease on pod yield in F_7 generation in the cross GKVK-13×KCG-2 of Groundnut

Sl. No	Families	Pod yield per plant(g) under disease control condition	Pod yield per plant (g) under disease stress condition	*Per cent* Yield reduction due to LLS disease	PDI of LLS disease@90DAS	LLS Disease response
1	C2-84-6-6-5-6	35.48	20.22	75.47	49.33	MS
2	C2-84-6-6-5-5	39.11	24.23	61.41	40.36	MR
3	C2-42-2-5-1-6	46.38	35.56	30.43	33.93	R
4	C2-49-4-9-1-1	48.33	38.15	26.68	31.58	R
5	C2-42-2-5-1-7	44.27	42.00	5.40	17.33	R
6	C2-57-6-7-7-1	25.46	13.93	82.77	51.33	MS
7	C2-49-2-5-2-2	50.78	45.22	12.30	13.22	R
8	C2-63-3-1-1-2	30.50	19.79	54.12	42.22	MR
9	C2-63-1-4-1-1	29.40	15.26	92.66	50.39	MS
10	C2-49-4-9-1-4	32.90	20.39	61.35	42.61	MR
11	C2-47-9-6-2-4	26.90	14.39	86.94	45.24	MS
12	C2-84-6-1-2-1	30.00	22.16	35.38	25.44	R
13	C2-70-5-2-3-1	24.00	13.65	75.82	51.78	MS
14	C2-59-1-3-4-1	41.14	28.36	45.06	38.93	MR
15	C2-75-5-6-1-3	33.56	26.78	25.32	8.11	R
16	C2-59-1-3-4-5	39.20	30.11	30.19	25.39	R
17	C2-47-9-2-1-1	29.00	19.33	50.03	37.47	MR
18	C2-48-6-6-1-2	36.30	25.14	44.39	35.93	MR
19	C2-59-1-3-4-2	38.54	23.14	66.55	45.33	MS
20	C2-75-5-6-3-3	45.56	28.33	60.82	49.33	MS
21	C2-70-5-2-6-3	40.78	36.23	12.56	17.28	R
22	C2-49-2-7-3-8	26.24	13.50	94.37	50.22	MS
23	C2-63-3-1-3-6	29.04	16.89	71.94	49.39	MS
24	C2-63-3-5-6-7	18.33	14.39	27.38	21.89	R

Note: PDI- Per cent disease index,

LLS- Late leaf spot

Table 4: Effect of LLS disease on pod yield in F_7 generation in the cross GKVK-6×KCG-2 of Groundnut

Sl.No	Families	Pod yield per plant(g) @disease control condition	Pod yield per plant (g) @disease stress condition	Per cent Yield reduction due to LLS disease	PDI of LLS disease@90DAS	LLS Disease response
1	C3-72-5-4-2-2	28.99	11.33	155.87	49.33	MS
2	C3-88-4-5-1-5	35.21	34.00	03.56	38.93	MR
3	C3-32-1-7-4-1	55.33	42.33	30.71	25.36	R
4	C3-2-3-6-1-4	37.00	22.53	64.23	44.93	MR
5	C3-62-2-10-2-4	36.32	18.41	97.28	20.38	R
6	C3-88-4-5-1-3	48.33	32.97	46.59	41.80	MR
7	C3-88-4-5-1-6	28.00	19.66	42.42	40.39	MR
8	C3-32-1-7-4-6	30.00	22.50	33.33	37.07	MR
9	C3-72-5-4-2-6	32.00	22.45	42.54	43.47	MR
10	C3-130-5-6-2-4	49.00	25.33	93.45	46.23	MS
11	C3-62-2-10-2-1	30.00	21.33	40.65	43.00	MR
12	C3-40-1-4-1-7	25.00	11.00	127.27	49.33	MS

Table 5: Estimates of genetic variability parameters for LLS disease in F_7 generation in three cross of groundnut

Crosses	Days	Mean	Range		Standardized Range	GCV (%)	PCV (%)	$h^2_{(bs)}$ %	GAM %
			Min	Max					
GKVK-16 × KCG-2	60DAS	13.55	6.32	20.45	1.04	12.36	17.08	72.36	12.36
	90DAS	39.71	10.52	45.52	0.88	23.52	28.93	80.36	25.52
	120DAS	67.25	15.63	88.56	1.08	36.45	51.73	70.45	31.78
GKVK-13 × KCG-2	60DAS	17.68	7.28	22.89	0.88	16.89	21.48	78.63	20.12
	90DAS	36.41	12.75	48.18	0.97	25.63	29.95	85.56	34.52
	120DAS	69.07	14.64	83.12	0.99	32.52	41.98	77.45	22.56
GKVK-6 × KCG-2	60DAS	16.44	4.25	18.22	0.84	25.36	33.61	75.45	13.45
	90DAS	40.01	11.74	42.75	0.77	33.52	50.36	66.56	23.45
	120DAS	71.45	16.28	87.12	0.99	42.52	53.74	79.12	27.45

Field view of control plot of F_7generation

Field view of disease plot of F_7 generation

Figure 1: Images of control and disease plot in F_7 generation during *kharif*2017

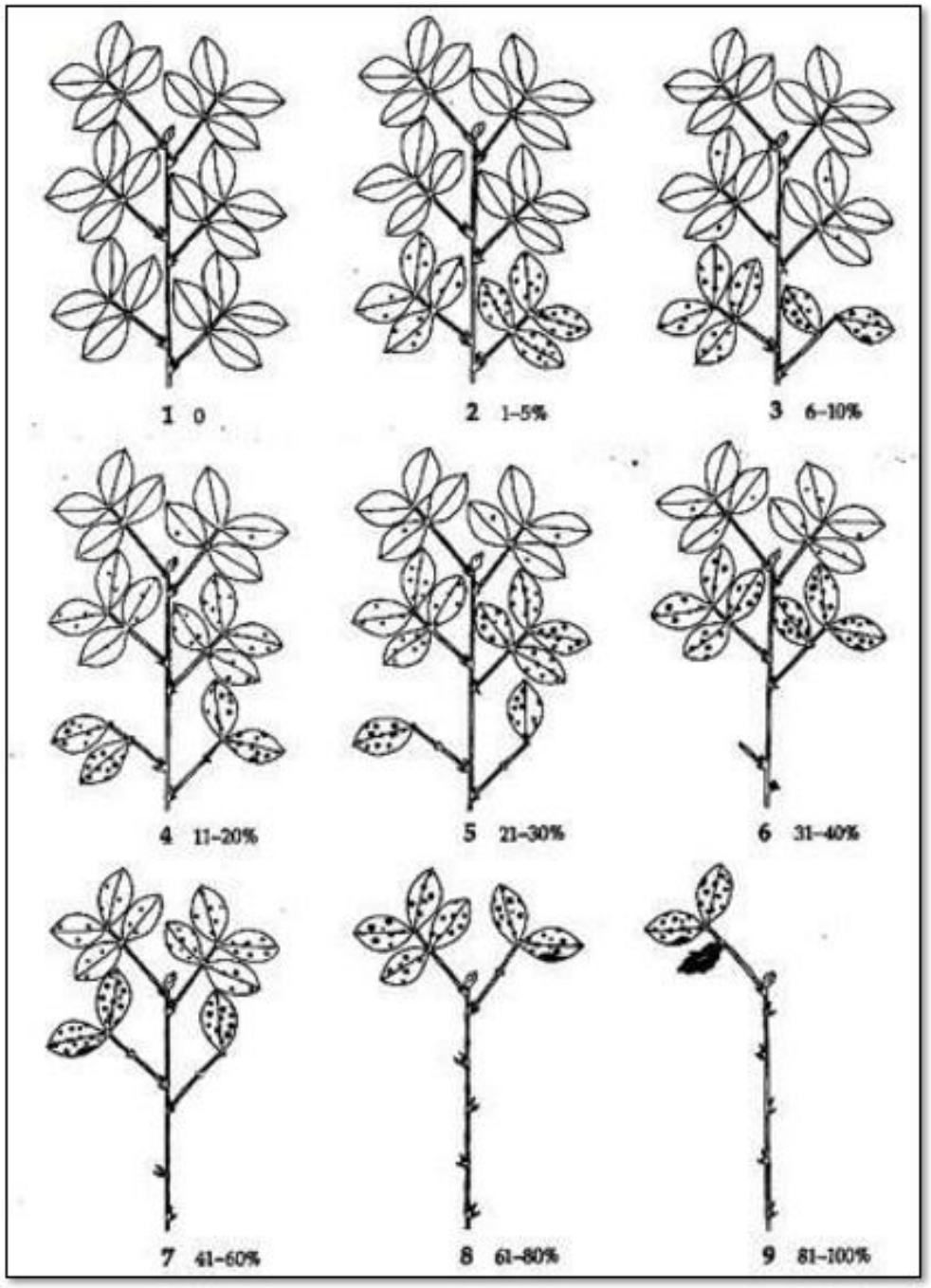

Figure 2: Standard reference for scoring late leaf spot disease resistance

(Subrahmanyam*et al*., 1995)

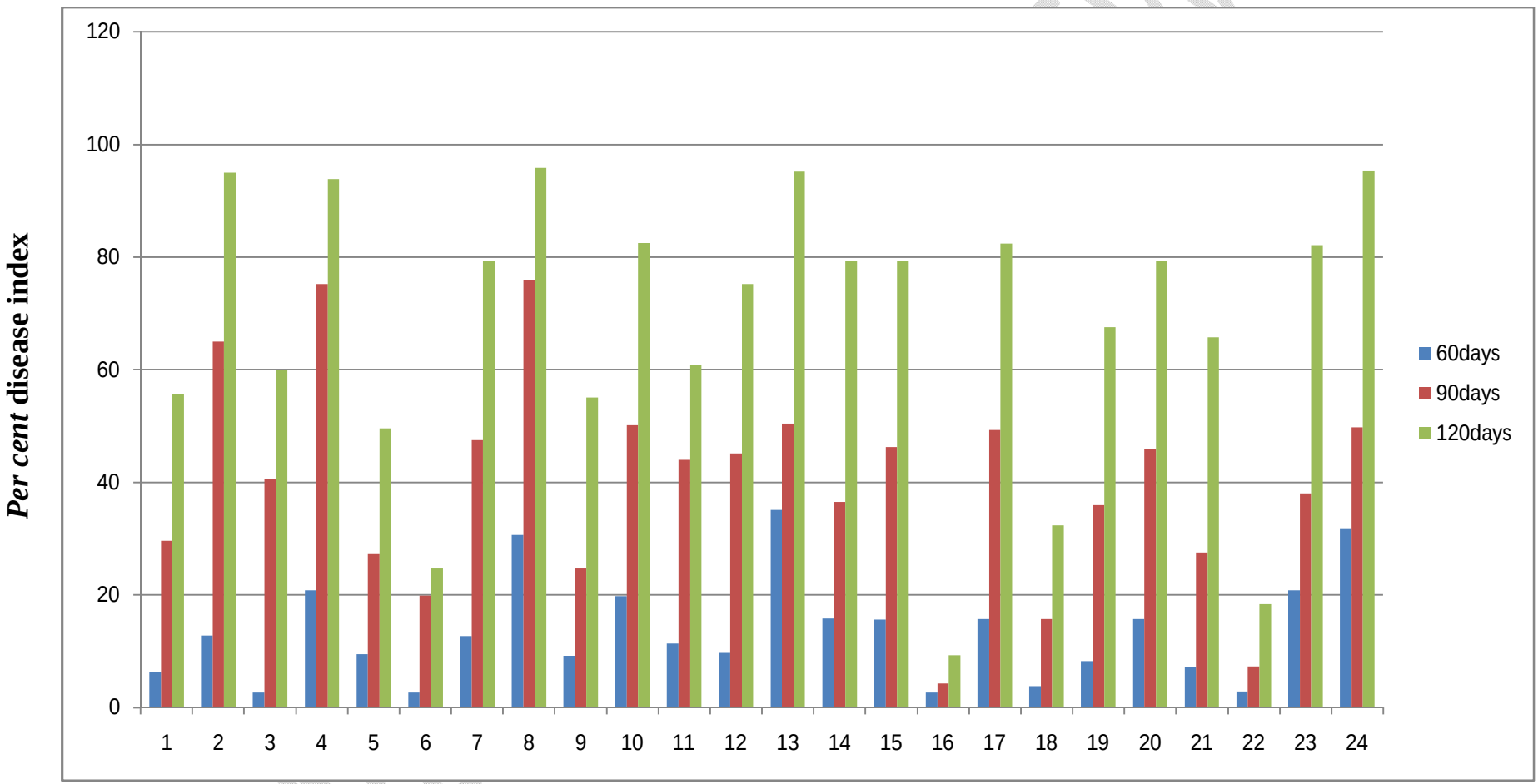

Figure 3:Rate of infection of LLS disease at different DAS during cropping period in F_7 generation of the Cross GKVK-16×KCG-2

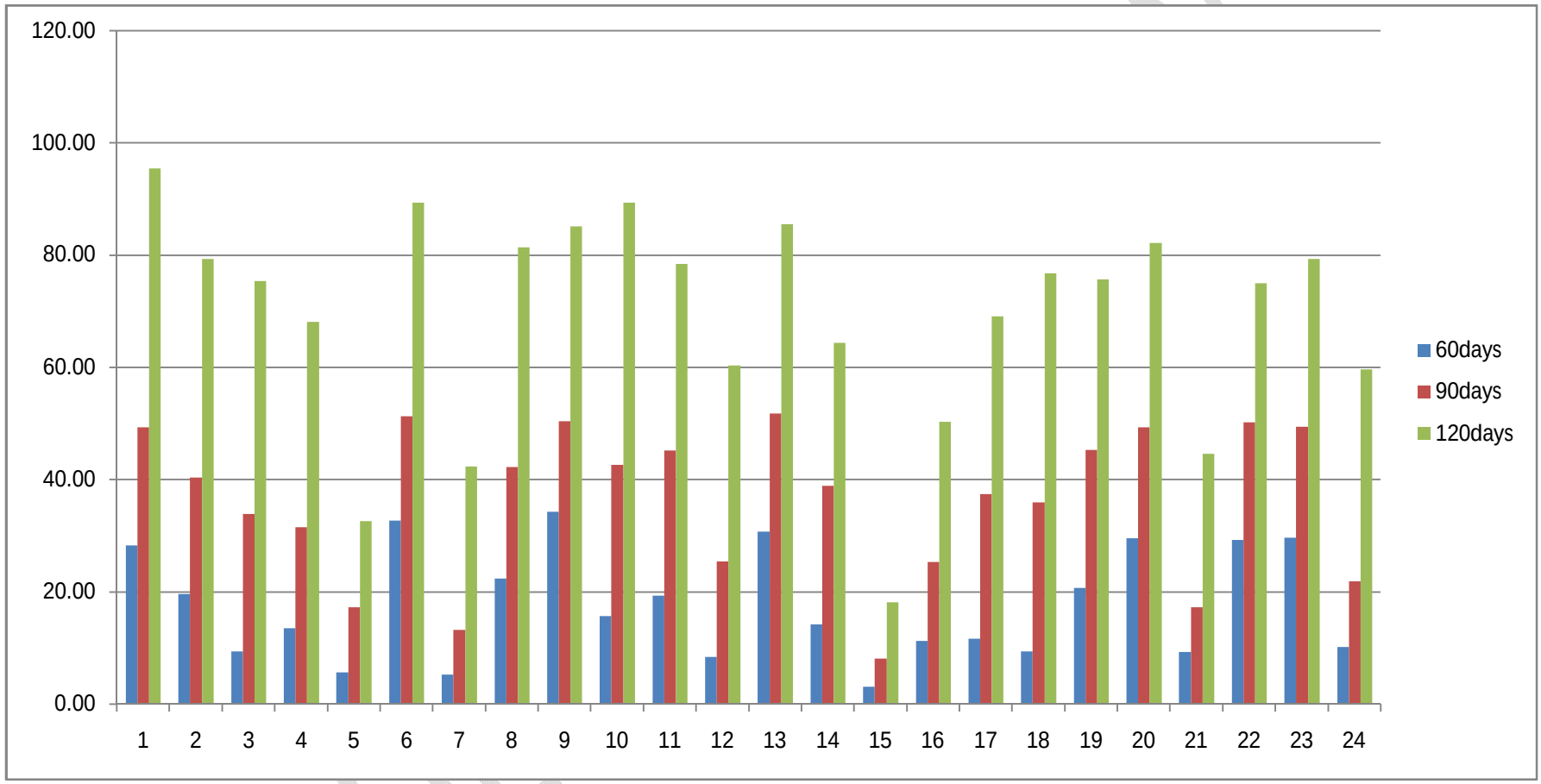

Figure 4:Rate of infection of LLS disease at different DAS during cropping period in F_7 generation of the Cross GKVK-13×KCG-2

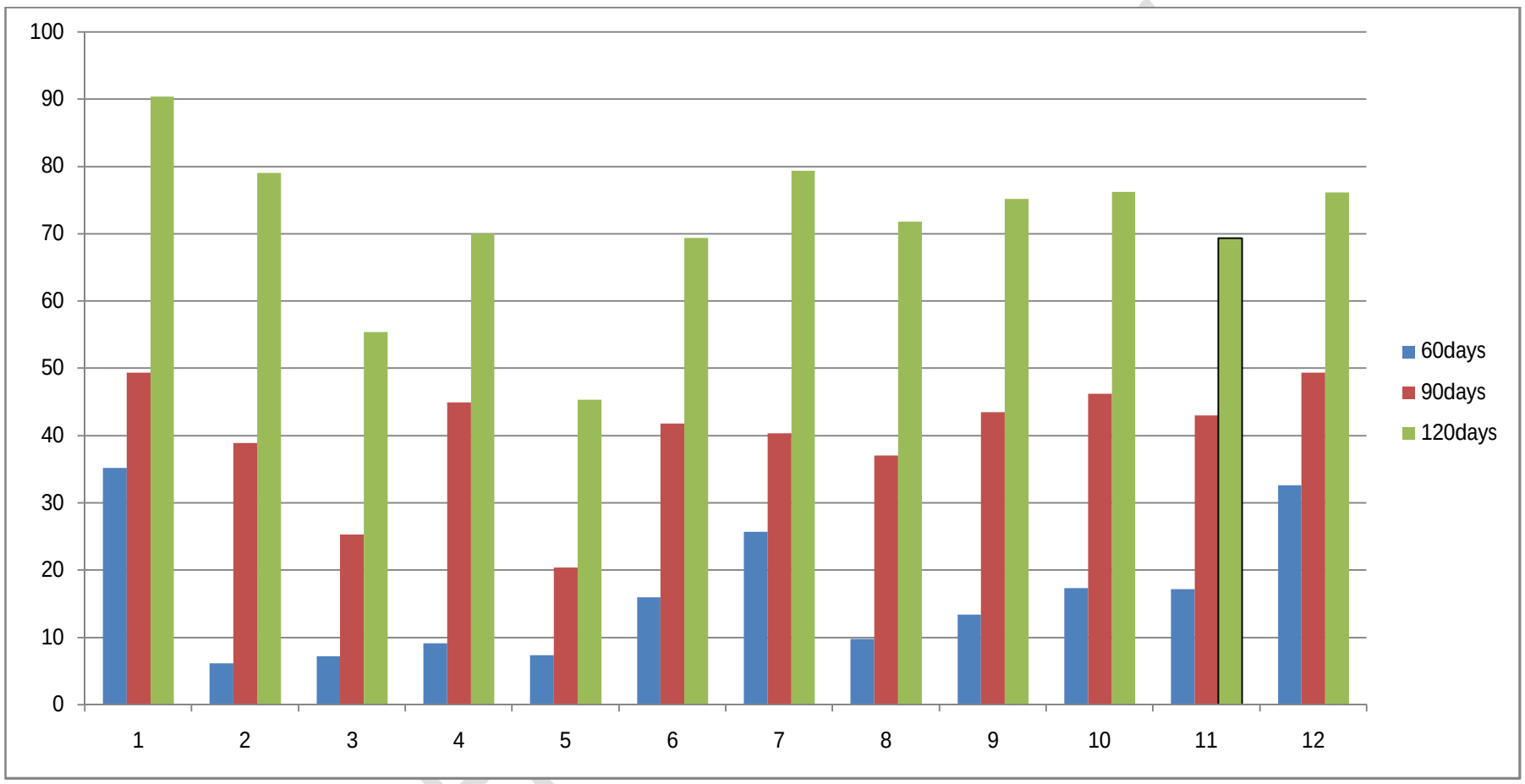

Figure 5:Rate of infection of LLS disease at different DAS during cropping period in F_7 generation of the Cross GKVK-6×KCG-2