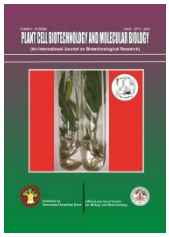

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Impact of Urdbean Leaf Crinkle Disease on Growth and Yield of Urdbean (*Vigna mungo* L. Hepper) Genotypes

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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ABSTRACT

Blackgram (*Vigna mungo* (L.) Hepper), also known as urdbean, stands as a significant pulse crop cultivated globally. Among the viral diseases documented in blackgram, Urdbean Leaf Crinkle Disease (ULCD) emerges as particularly devastating, leading to substantial economic losses contingent upon factors such as seasonal variations and cultivated varieties. In this study, six cultivars of urdbean (M114, M218, M338, T9, N7, and M1008) were subjected to scrutiny regarding their growth and yield-related attributes under ULCD infection. Employing a randomized block design (RBD), data pertaining to each yield-contributing factor were meticulously recorded from

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both healthy and infected urdbean plants and analysed using two way ANOVA. A pronounced reduction across all yield parameters was noted in virus-infected plants, manifesting in diminished plant height by 2.02-37.01%, pod size by 1.10-51.30%, seed/pod ratio by 4.41-61.46%, 100-seed weight by 2.73%-51.37%, pod number per plant by 3.72-63.86%, and number of branches per plant ranging from 0.84 to 48.43%. Upon comparative analysis of all urdbean genotypes, it can be deduced that genotypes M114, M218, and M338 exhibit lesser susceptibility to urdbean leaf crinkle disease, thereby positioning them as promising candidates for breeding programs and cultivation endeavors aimed at achieving higher yields.

Keywords: Biotic stress; vigna mungo; Urdbean Leaf Crinkle Disease (ULCD); yield loss; yield components; resistant genotypes.

1. INTRODUCTION

Black gram (*Vigna mungo* (L.) Hepper), commonly known as urdbean is an important short-duration leguminous crop grown widely after chickpea in India. Black gram is rich source of protein, minerals and energy [1]. In India, it is mostly cultivated as a summer, *kharif,* and winter crop. India is the largest producer as well as consumer of black gram. During 2020–2021 the crop was cultivated over 4.63 million hectares of area with an annual production of 2.78 million tonnes and average productivity of 600 kg/hectare [2]. Although India accounts largest acreage but the yield is very low due to various abiotic and biotic stresses. Among the biotic stresses, Urdbean Leaf Crinkle Disease (ULCD) complex is economically important disease and cause huge yield losses. ULCD is characterized by the appearance of crinkling, curling, puckering, rugosity of leaves, enlargement of leaf lamina, stunting of plants and malformation of floral organs [3,4,5]. The incidence of ULCD is greatly influenced by the cropping seasons and genotype used [6,7]. Kolte and Nene (1979) [7] found that the occurrence of ULCD depends upon the plant growth stage. Early stage plant infection cause more yield losses as compared to late stage infection [6,8]. The vegetative growth and yield-related traits were also severely affected in diseased plants. The infected plant possess reduction in pod number and few seeds which were smaller in size, deformed, wrinkled, shriveled and light in weight which attributed to yield losses [6,8,9]. It has been found that most of the high-yielding varieties (VBN 6, Uttara, Pant U-40 and T9) were susceptible to this virus [10]. On average, the virus infection results in grain yield loss of 35-81% and it may go up to 100% during the epidemic years [11,4]. Additionally, the virus infection causes significant reduction in yield components in ULCD infected T-9 cultivar as compared to healthy one [9]. Based upon the above facts the present investigation was undertaken to study yield parameters in healthy and ULCD infected urdbean cultivars. This study would be helpful in further screening of urdbean cultivars which could be exploited in breeding programs and in farmer's field for better yield results.

2. MATERIALS AND METHODS

2.1 Planting Material

The investigation was carried out at the experimental farm of the Department of Agriculture, DAV University, Jalandhar, Punjab, during the kharif season of 2018. Seeds of six urdbean cultivars -M114, M228, M338, N7, T9, and M1008 - were procured from the Punjab Agriculture University (PAU), Ludhiana and the CSK Himachal Pradesh Agricultural University, Palampur.

2.2 Planting Design and Field Management

Experimental material was planted in plots measuring 4.0×3.0m with a spacing of 40 X 10 cm. Employing a Randomized Block Design (RBD), all cultivars were planted in triplicate. The crop was managed according to standard agronomic practices. Following germination, plants were monitored weekly for signs of Urdbean leaf crinkle disease symptoms and disease rating was done 0-5 scale as given by Ashfaq et al. [3].

2.3 Data Recording and Statistical Analysis

Observations were recorded from each plot, five healthy and infected plants were randomly selected. Data were collected for plant height (cm), pods per plant, pod length (cm), seeds per pod, 100-seed weight per plant (g), number of

pods per plant, and number of branches per plant, for both healthy and ULCD-infected plants. Reductions in growth and yield-contributing components were calculated using the formula:

%Reduction=Healthy-Diseased/Healthy×100

The data collected for each yield parameter was statistically analyzed using a two-way Analysis of Variance (ANOVA) performed with OP STAT software. To enhance result interpretation, the standard error (SE), critical difference (CD), and mean values for each yield parameter across the three replicates were computed.

3. RESULTS AND DISCUSSION

The virus infections in urdbean at different stages of crop growth severely affect the several yield parameters both in glasshouse as well as in natural conditions. The season, genotype and plant age at the time of virus infection plays a major role in disease severity and yield losses [6,8, 12] reported that in urdbean crop intial 4 weeks were very crucial for Urdbean leaf crinkle disease incidence and yield losses. Crop infected at early stage affected more as compared to later stage [8]. In present study six urdbean cultivars were screened morphologically against urdbean leaf crinkle disease. The growth and yield parameters of urdbean cultivar in both healthy and infected plants were investigated.

3.1 Plant Height

The plant height in infected plants were decreased by 2.02- 37.01% over the healthy one. The infected plants of M1008 genotype showed maximum reduction in mean height 22.06 cm as compared to 35.02 cm in healthy plants. Average reduction in all the cutivars was 18.06% (Fig. 1, Table 1). The stunting may be the outcome of decreased chlorophyll content due to virus infection [13] and also depends on time of infection and genotype. Similar results were also reported by Kolte [14], Nene [15], Singh [16]. Bashir *et al.* [17] and Sharma *et al*. [9] documented 8% as well as 23.8% reduction in plant height in ULCV infected T9 urdbean genotype respectively. Achanta *et al.* [18] also observed 45.09% decrease in plant height in urdbean infected with leaf crinkle disease.

3.2 Pod Length

The ULCD infection shows highly significant reduction in pod length in infected urdbean plant than healthy one (Fig. 2). The pod length reduction in infected plants ranged from 1.10-51.30% with an average decrease of 24.22%. The variety wise comparison shows maximum reduction in mean pod length (2.24 cm) reported in infected plant of N7 genotype and minimum (4.48cm) in M338 as compared to healthy one. (Fig. 3, Table 1). Mishra *et al*. [19] reported that ULCV cause severe reduction in pod length of T9 urdbean genotype. Sharma *et al*. [9] also documented 18.8% reduction in ULCV infected blackgram.

3.3 Seeds/Pod

The seed size and number was highly reduced in ULCV infected plants (Fig. 4). The reduction in number of seed/pod ranged between 4.41-61.46% with average of 31.09% in all infected urdbean cultivars. Maximum reduction in mean seeds/pod was recorded infected T9 genotype (3.26) and minimum in M338 (8.22) over the healthy one. (Fig. 5, Table 2). This decline may be as a consequence of abortion of ovules due to the viral infection and this may be attributed to decrease seed size as well as seed/pod. The results are in conformity with Beniwal and Chaubey [6]; Mishra *et al*. [19]. Bashir *et al*. [17] and Sharma *et al*. [9] documented that number of seeds/ pod was reduced by 26% and 37.5% respectively in ULCD infected urdbean plants. Based up on the plant age at the time of infection several researches documented different degree of pollen sterility in ULCD infected urdbean plants [20,21].

3.4 Test Weight (100 Seed Weight)

Overall test weight in infected urdbean was 26.08% less than healthy plants. The average reduction was recorded between 2.73%-51.37% in ULCD infected urdbean cultivar. The infected genotype N7 exhibited maximum mean reduction in test weight (1.41gm) and M-218 was least affected (3.55gm) over the healthy plant (Fig. 6 Table 2). The virus infection may attribute to lesser flowering and sterile inflorescence that results in reduction of seed weight as well as pod number in infected plants. Mishra *et al.* [19] reported the decline in seed weight in T9 urdbean genotype infected with ULCD. Achanta *et al*. [18] documented 58.14% reduction in test weight in ULCD infected urdbean plants. Significant reduction in 100 seed weight was also documented by other virus i.e. *Bean common mosaic virus* in blackgram [22].

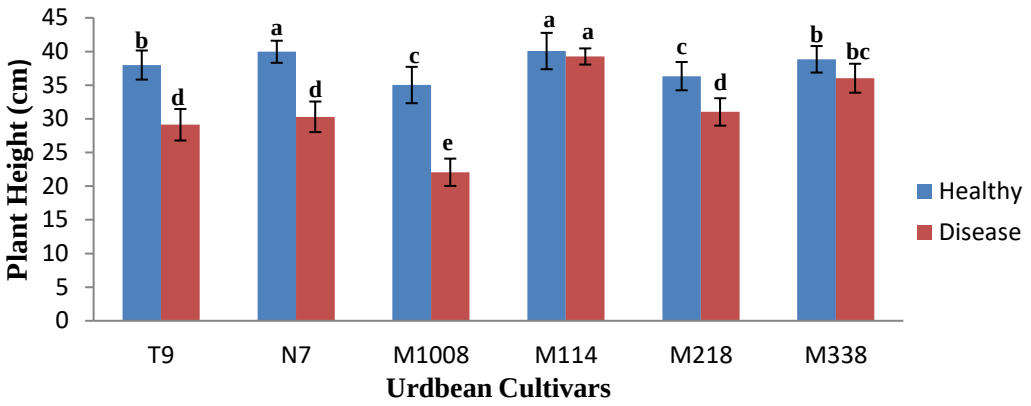

Fig. 1. Effect of ULCD on plant height. Bar in column showed the mean (±SD) of five plants in each replication

Fig. 2. Comparison between healthy and ULCD infected pods

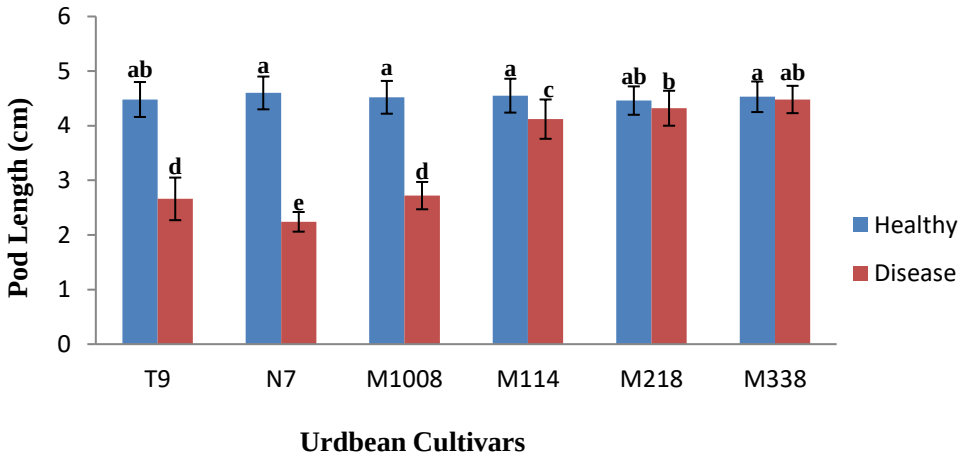

Fig. 3. Effect of ULCD on pod length. Bar in column showed the mean (±SD) of five plants in each replication

Table 1. Effect of ULCV on plant height and pod length

Varieties	Plant Height (cm)			Pod length (cm)		
	Healthy	Diseased	% Decrease	Healthy	Diseased	% Decrease
T9	37.99	29.12	23.34	4.48	2.66	40.62
N7	39.96	30.3	24.17	4.60	2.24	51.30
M1008	35.02	22.06	37.01	4.52	2.72	39.73
M114	40.07	39.26	2.02	4.55	4.12	9.45
M218	36.34	31.02	14.63	4.46	4.32	3.13
M338	38.84	36.03	7.23	4.53	4.48	1.10
Overall decrease (%)		18.06		24.22		

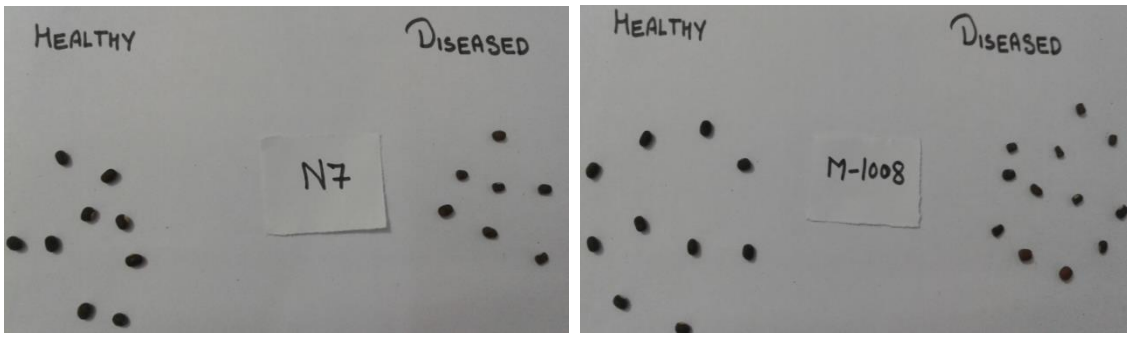

Fig. 4. Comparison between healthy and ULCD infected seeds (N7 & M1008 genotype)

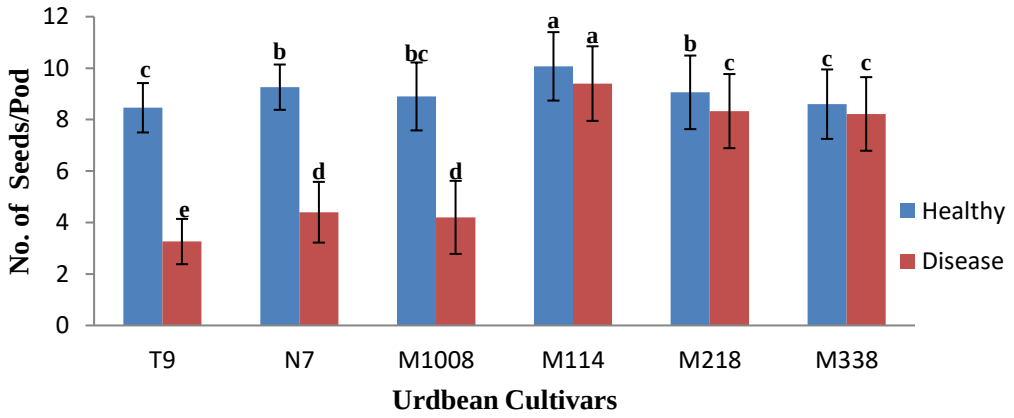

Fig. 5. Effect of ULCD on seeds/pod. Bar in column showed the mean (±SD) of five plants in each replication

Table 2. Effect of ULCD on number of seeds/pod and 100 seed weight

Varieties	Number of seeds/pod			Test weight (100 seed wt. gm)		
	Healthy	Diseased	% Decrease	Healthy	Diseased	% Decrease
T9	8.46	3.26	61.46	2.92	1.45	50.34
N7	9.26	4.40	52.48	2.90	1.41	51.37
M1008	8.90	4.20	52.80	3.19	1.86	41.69
M114	10.07	9.40	6.65	3.77	3.53	6.36
M218	9.06	8.33	8.76	3.65	3.55	2.73
M338	8.60	8.22	4.41	3.85	2.31	4.00
Overall decrease (%)		31.09		26.08		

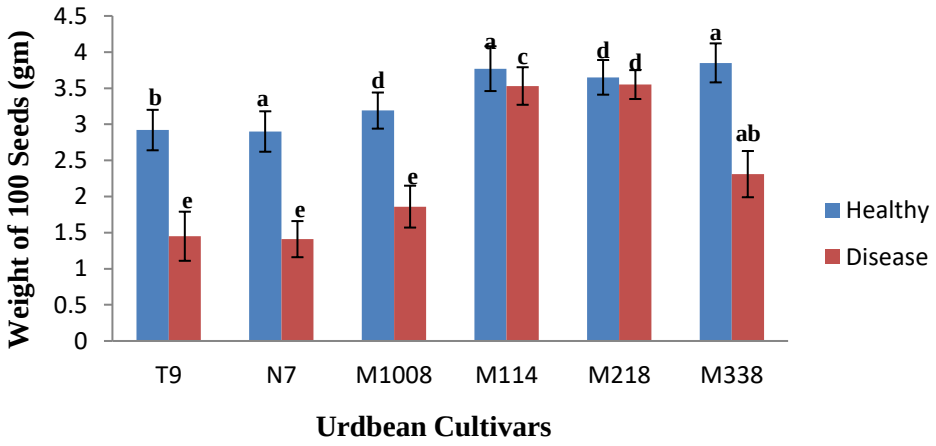

Fig. 6. Effect of ULCD infection on 100 seeds weight. Bar in column showed the mean (±SD) of five plants in each replication

Table 3. Effect of ULCD on number of pods/plant and number of branches/plant

Varieties	Number of pods/plant			Number of branches/plant		
	Healthy	Diseased	% Decrease	Healthy	Diseased	% Decrease
T9	27.87	10.07	63.86	6.33	4.06	35.86
N7	31.73	13.27	58.17	6.40	3.3	48.43
M1008	25.47	15.20	40.32	7.06	4.33	38.66
M114	28.4	26.2	7.7	7.33	7.06	3.68
M218	25.2	24.07	4.4	6.80	6.13	9.85
M338	30.33	29.2	3.72	7.06	7.0	0.84
Overall decrease (%)		29.69		22.88		

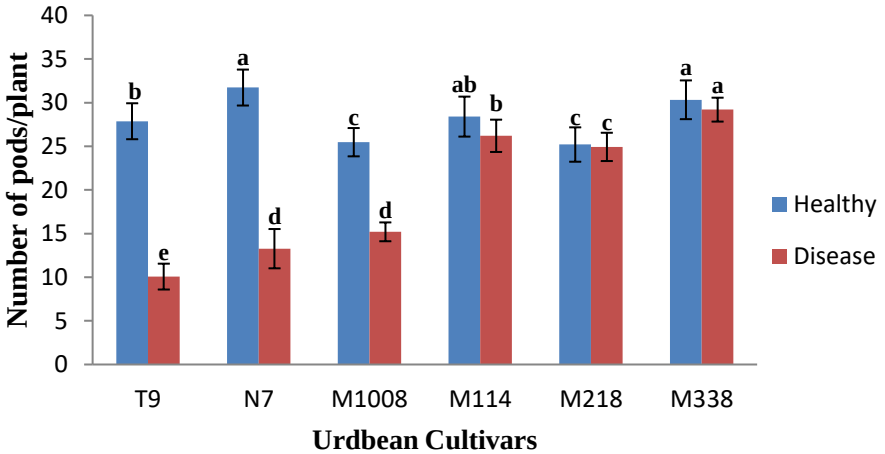

Fig. 7. Effect of ULCD infection on number of pods/plant. Bar in column showed the mean (±SD) of five plants in each replication

Table 4. Comparison of yield parameters between healthy and ULCD infected plants of urdbean genotypes by using two-way ANOVA

Parameters → / Genotypes ↓	Plant Height (cm)		Pod length (cm)		Number of seeds/pod		100 Seed weight (gm)		Number of pods/plant		Number of branches/plant	
	H	I	H	I	H	I	H	I	H	I	H	I
T9	37.99	29.12	4.48	2.66	8.46	3.26	2.92	1.45	27.87	10.07	6.33	4.06
N7	39.96	30.30	4.60	2.24	9.26	4.40	2.90	1.41	31.73	13.27	6.40	3.30
M1008	35.02	22.06	4.52	2.72	8.90	4.20	3.19	1.86	25.47	15.20	7.06	4.33
M114	40.07	39.26	4.55	4.12	10.07	9.40	3.77	3.53	28.40	26.20	7.33	7.06
M218	36.34	31.02	4.46	4.32	9.06	8.33	3.65	3.55	25.20	24.07	6.80	6.13
M338	38.84	36.03	4.53	4.48	8.60	8.22	3.85	2.31	30.33	29.20	7.06	7.00
F Test	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig	Sig
SE(m±)	Factor (A) =0.575		Factor (A) =0.054		Factor (A) =0.220		Factor (A) =0.188		Factor (A) = 0.336		Factor (A) = 0.127	
	Factor (B) =0.332		Factor (B) = 0.031		Factor (B) =0.127		Factor (B) =0.109		Factor (B) =0.194		Factor (B) =0.073	
CD, ($P \leq 0.05$)	Factor (A) =1.698		Factor (A) = 0.161		Factor (A) =0.649		Factor (A) =0.556		Factor (A) =0.993		Factor (A) = 0.374	
	Factor (B) =0.981		Factor (B) =0.093		Factor (B) =0.374		Factor (B) =0.321		Factor (B) =0.573		Factor (B) = 0.216	

SE= Standard error, CD=Critical difference, Factor (A) = Varieties, Factor (B) = Healthy and Infected plant; H= Healthy, I= Infected. Experiments were performed in triplicate.

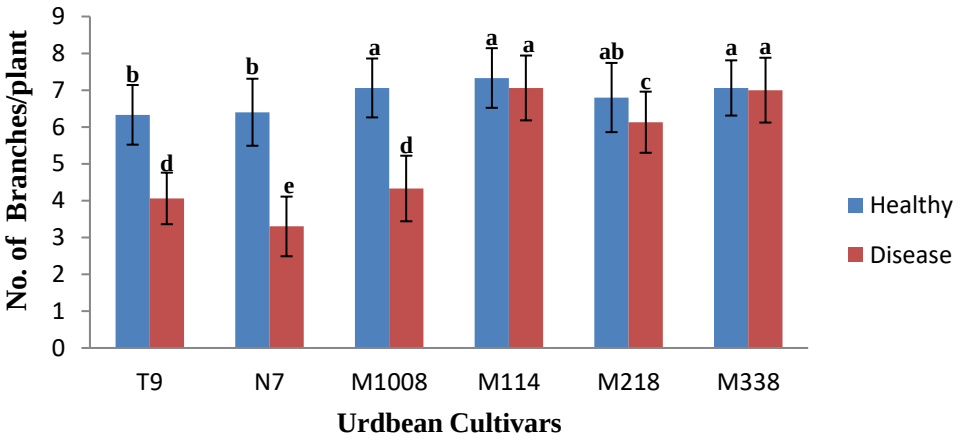

Fig. 8. Effect of ULCV infection on number of branches/plant. Bar in column showed the mean (±SD) of five plants in each replication

3.5 Number of pods/plant

The infected plants show reduction in pod number/plant ranged from 3.72-63.86% than healthy one. Average reduction of 29.69% was observed in all infected urdbean cultivar. Individually the most affected cultivar was T9 with 10.07 mean pods/plant reduction and M338 was least affected with 29.2 mean reduction over the healthy one (Fig. 7, Table 3). Similar results were also reported by Beniwal and Chaubey [6], Bashir *et al.* [17] in ULCV infected urdbean plants. Sharma *et al*. [9] recorded 70% reduction in pods number/plant due to ULCV infection.

3.6 Number of Branches/Plant

The ULCV infected plants exhibited reduction in number of branches/plant ranged from 0.84% - 48.43 over the healthy plants in different genotypes. The average decrease was recorded as 22.88%. The variety wise comparison shows maximum reduction in mean of number of branches/plant reported in infected plant of in N7 genotype (3.30) and minimum in M338 (7.0) as compared to healthy one. (Fig. 8, Table 3). Achanta *et al*. [18] reported that ULCV cause 49.30% and 83.10% reduction in number of branches/plant in moderately as well as completely infected urdbean plant.

The total data for each parameter mentioned in above tables were statistically analyzed and analysis of variance (two-way ANOVA) was performed as given in Table 4.

4. CONCLUSION

All the growth and yield contributing factors were analyzed in healthy and ULCD infected urdbean cultivars. The study revealed that the ULCD infection significantly reduced all yield components (plant height, pod length, number of seeds/pod, 100 seed weight, Number of pods/plant, Number of branches/plant). Bashir *et al*., [17] and Achanta *et al*., [18] also reported significant decrease in ULCD infected plants. Sharma *et al.*, also reported 70% reduction in pod number/plant in ULCD infection.

In present study the alteration in yield parameters in urdbean genotypes may be due to their different genetic makeup. These variations could also be explained on the basis of time of infection. The infection occurs at early stage of plant growth cause high disease incidence which attributed to more yield loss as well as yield components in urdbean cultivars. The variation in photoassimilates production by different urdbean cultivars could be the reason of reduction in yield contribution factors [23]. Studies revealed that chlorophyll contents get decreased in virus infected plant. The reduced concentration of chlorophyll restricts the photosynthetic rate which ultimately leads to decline in growth and yield related components [24]. The variation in ULCD disease incidence in different seasons also a major factor in alteration in yield related component in urdbean. As compared to the summer, the disease incidence was more

prevalent in *kharif* season which ultimately results in variation in crop yield [8].

From present investigation it was found that genotype M338 shows minimum reduction in pod length, seed /pod, Number of pods/plant, while M114 and M218 shows minimal reduction in plant height, 100 seed weight respectively. From obtained results it has been concluded all yield contributing traits were less affected in genotype M114, M218, M338 against urdbean leaf crinkle disease as compared to other one. Therefore, these urdbean varieties can be utilized in further breeding programs as well as in farmer's field for more crop production.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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