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Short Communication

Evaluation of male sterility-based chilli hybrids for tolerance to high temperature and resistance to seedling blight

B. V. Tembhurne[1]* and S. K. Rao

Department of Plant Breeding and Genetics, Jawaharlal Nehru Krishi Vishwa Vidyalaya (JNKVV), Jabalpur 482 004, Madhya Pradesh; [1]College of Agriculture, University of Agricultural Sciences, Raichur 584 101

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Chilli (*Capsicum annuum* L.) is one of the most important commercial crops of India. It is also valued for its industrial (oleoresin extraction) product. Productivity of chilli is low in the months of March to June in summer season because, high temperature causes flower and fruit drop and hence poor fruit set. Fruit set in chilli particularly sensitive to the high night temperatures. Ideal night temperature for fruit set in chilli is between 18.33^{o}C and 26.66^{o}C. At 38^{o}C a large decrease in pollen fertility and germination is observed as compared to 33^{o}C [1]. Fruit is unable to set between 32 and 38^{o}C [2]. If day temperature exceeds 35^{o}C, pollen abort and the fruitset is reduced. Two species, namely *Colletotrichum capsici* and *C. gloeosporioides* are the known causes of anthracnose in chilli [3] of which *Colletotrichum capsici* is more important [4]. It causes the symptoms namely dieback and fruit rot. The fungus is known to be seed borne and can cause death of seedling and reduces the vigor of infected seedlings [5]. Fungicides are mainly used to manage the disease. Hence, present study was with an objective to identify suitable cytoplasmic male sterility (CMS) based hybrid for high temperature tolerance as well as resistance to seedling blight.

Three Cytoplasmic Male Sterile lines *viz.*, JNKVVA1, ACBGA1 and ACBGA2 along with respective maintainers and fifty male parents were used in the present investigation. The lines used as male parents were self pollinated for two generations before crossing with each of the three male sterile lines. In all, 150 F_1 hybrids were developed during July to August months of *kharif* 2008 following line x tester design. These hybrids and respective maintainer lines were evaluated in earthen pots of size 30cm x 30cm x 45cm in shade house covered with green polynet during March to June months of summer season of the years 2009 and 2010 for high temperature tolerance. The seedlings were transplanted in shade houses and field condition and screened for seedling blight resistance during August to September months of *kharif* season of the year 2009-2010 at the Department of Plant Breeding and Genetics, JNKVV, Jabalpur. The shade house was selected to see the possibility of fruit set by providing 50 per cent shade during high temperature. The earthen pots were filled with the mixture of soil and vermicompost. 25 seeds of each hybrid and respective maintainer line in each pot were sown inside the shade house (green polynet 50 per cent) with two replications to evaluate high temperature tolerant hybrids. Sixteen seedlings of each hybrid were kept in each pot. The temperature measured in open field condition from last week of April to last week of May, 2009 and 2010 during peak period of flowering and fruit setting (Table 2). The plant fruit set percentage was calculated on the basis of number of plants set fruits out of total number of plants in the range of temperature (38.80^{o}C-44.70^{o}C (day) and 14.9^{o}C-28.90^{o}C (night)).

Screening for seedling blight resistance was done under natural epiphytotic condition during August to September months of *kharif* season of the year 2009.

*Corresponding author's e-mail: bvtembhurne@gmail.com
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The average temperature and humidity and total rainfall recorded 31.95^{0}C (day) -22.95^{0}C (night) and 88.95 (morning) -66.3 (evening) and 790.90 mm respectively in these months. The fungus *Colletotrichum capsici* and *Colletotrichum gloeosporioides* were isolated by following standard tissue isolation method under aseptic condition using laminar flow. Numbers of plants survived after the severe attack of pathogen were counted to calculate survival percentage during seedling stage, after transplanting in shade house, field condition and pots in shade house. Seeds of resistant lines along with susceptible check were inoculated with inoculums by dipping in the spore suspension of pathogen prepared by collecting the infected fruits of susceptible plants. Sick pots were developed by incorporating remains of diseased plants and adding spore suspension uniformly in earlier infected area under shade house condition and final screeding was done at seedling stage (67 days).

Among the 150 hybrids tested 30 hybrids sets fruit. The 18 hybrids with 25-100 per cent fruit set are presented in Table 1. Among them JNKVVA1/LCA 310A, ACBGA1/H0413 and ACBGA1/D.DABBI recorded 100 per cent fruit setting followed by ACBGA1/ KDC1 (50 per cent). Remaining hybrids recorded less than 50 per cent fruit setting. Interestingly three hybrids ACBGA1/H0413, ACBGA2/H0413 and JNKVVA1/ H0413 set fruits which has common male parent (H0413). However, none of the maintainer line set fruits.

Evaluation of chilli genotypes encompassing commecial hybrids, popular genotypes and newly developed hybrids under natural epiphytotic conditions against *Colletotrichum capsici* and *Colletotrichum gloeosporioides* causing seedling blight of chilli revealed that maximum death of seedlings was observed in the experiments indicating the ideal conditions for the disease development in all the four situations *viz.,* nursery, transplanted shade house, pot in shade house and field conditions. The disease severity was uniform in all the situations (Table 3).

The severity of disease is expressed with percent survival of seedling. In the JCH series 24 hybrids, BCH series 37 hybrids and RCH series 30 hybrids recorded zero per cent survival of seedling. Further 6 hybrids recorded more than 50 per cent survival of seedling indicating the moderate resistance to seedling blight. Among the 59 genotypes including parents of crosses and commercial varieties screened after 59 days of sowing, fourteen genotypes showed zero per cent survival while 23 genotypes recorded more than 50 per cent survival.

Table 1. Fruiting ability of CMS based hybrids in chilli (*Capsicum annuum* L.)

Hybrids	No. of plants set fruits		Plants setting fruits(%)
	2009-10	2010-11	
JNKVVA1/LCA310A	16	16	100.00
ACBGA1/H0413	16	16	100.00
ACBGA1/D. DABBI	16	16	100.00
ACBGA1/KDC1	8	8	50.00
ACBGA1/HCS-3	6	5	34.37
JNKVVA1/Sankeswar	5	6	34.37
JNKVVA1/G-4	5	6	34.37
JNKVVA1/GUK-2-1	5	5	31.35
JNKVVA1/GCV 111	5	5	31.35
ACBGA1/PANTC-1	4	6	31.25
ACBGA1/K1-4D	4	6	31.25
JNKVVA1/H0413	4	6	31.35
JNKVVA1/K1-4D	4	5	28.13
ACBGA1/G-4	4	5	28.13
ACBGA1/GUK2-1	4	5	28.13
ACBGA1/BVC-1	4	4	25.00
JNKVVA1/LCA310	4	4	25.00
ACBGA2/H0413	4	4	25.00

After transplanting under shade house, 17 crosses of JCH series, 28 crosses of BCH series and 32 crosses of RCH series exhibited zero per cent survival of plants. However, seven crosses recorded more than 50 per cent survival indicating their resistance to seedling blight. In field condition, 3 crosses in JCH series, 36 crosses in BCH series and 30 crosses of RCH series showed zero per cent survival of plants. Further six crosses and seven genotypes recorded more than 50 per cent survival indicating moderate resistance against seedling blight. In pots under shade house 7 crosses of JCH series 18 crosses of BCH series and 15 crosses of RCH series recorded zero percent survival of plants while 53 crosses showed more than 50 per cent survival (Table 3).

Final testing of selected hybrids/genotypes resistance to *Colletotrichum capsici* and *Colletotrichum gloeosporioides* sown after treating the seeds with suspension of pathogen along with susceptible

Table 2. Range of temperature during chilli growing season

Day and month	Temperature ^{0}C			
	2009		2010	
	Max	Min	Max	Min
21st April	42.70	21.40	40.40	28.10
22nd April	41.70	24.40	41.20	21.60
23rd April	39.80	17.40	40.70	23.00
24th April	38.80	16.30	41.20	21.10
25th April	39.60	15.90	40.20	23.20
26th April	41.20	17.90	41.20	20.80
28th April	39.20	14.90	41.90	23.20
29th April	40.80	18.40	42.70	25.00
30th April	43.20	20.00	42.40	26.20
1st May	44.20	22.40	41.40	27.80
2nd May	44.70	22.90	37.70	24.70
3rd May	43.20	24.30	38.80	24.80
4th May	43.20	23.90	40.40	26.20
5th May	42.80	27.90	40.70	26.80
6th May	41.20	27.30	42.20	25.20
7th May	41.20	20.40	42.40	28.70
8th May	40.70	22.60	41.80	25.70
9th May	42.20	21.80	41.60	24.70
10th May	42.70	25.90	42.20	23.50
11th May	42.20	25.90	42.20	25.20
12th May	41.20	28.90	42.20	21.70
13th May	42.70	25.40	43.40	23.20
14th May	41.80	24.40	43.90	28.20
15th May	42.60	24.40	44.20	29.70
16th May	41.70	24.10	42.70	24.70
17th May	41.60	26.30	43.20	27.20
18th May	43.20	24.40	45.00	25.70
19th May	40.70	26.10	45.70	29.20
20th May	43.20	24.90	42.20	29.00
21st May	42.20	28.70	43.20	26.20

genotypes in sick pots under shade house condition (Table 4) revealed that 53 genotypes recorded more than 50 per cent survival of which 13 genotypes showed 100 per cent survival. Further, 3 genotypes, JCH31F2, JCH46-1F2 and KDSC210-10-1 registered 25-50 per cent survival and 6 genotypes used as check *viz*., P.Mukti, BVC-1, KDSC210-10-1-1, GUK-2-1-1, RCH26F2 and PALEOF2 showed complete death of

Table 3. Overall survival of genotypes and newly developed CMS based crosses against *Colletotrichum capsici* and *C. gloeosporioides*

Crosses/ genotypes	Total	Survival of seedlings (%)				
	0	1-10	10.1-25.0	25.1-50.0	>50.0	
Crosses	Nursery (59 days after sowing)					
JCH	44	24	6	4	8	2
BCH	41	37	1	1	2	0
RCH	44	30	3	4	3	4
Genotypes	59	14	4	5	13	23
Crosses	Transplanted in shade house					
JCH	44	17	5	10	8	4
BCH	43	28	3	6	4	2
RCH	45	32	2	4	6	1
Crosses	Field condition					
JCH	43	3	4	10	23	3
BCH	42	36	0	1	3	2
RCH	44	30	4	1	8	1
Genotypes	59	13	3	5	27	11
Crosses	Pots in shade house					
JCH	43	7	2	3	15	16
BCH	43	18	2	2	4	17
RCH	45	15	1	1	8	20
Total	521	271	33	47	92	72

seedlings suggesting that the genotypes were susceptible to *Colletotrichum capsici* and *Colletotrichum gloeosporioides* causing seedling blight in chillies.

It could be concluded from this study that three hybrids ACBGA1/H0413, ACBGA2/H0413 and JNKVVA1/H0413 sets fruit which has common male parent (H0413). However, none of the respective maintainer line (B-line) set fruit at high temperature (38.80^0C-44.70^0C). Hence, male parents used for producing these hybrids can be utilized in breeding high temperature tolerant chilli. The better performance of new hybrids born fuits under high temperature can open avenues for farmers to fetch high price for their produce and consumers to get nutritionally rich fresh green chilli in summer by providing the 50 per cent shade using green polynet. Although, the study has been conducted in earthen pots by providing 50 per cent shade, farmers would not grow chilli in pots commercially hence, further

Table 4. Testing of selected final screened F_1 hybrids/genotypes at seedling stage for *C. capsici C. gloeosporioides* under shade house (67 days old)

Genotypes	Total seeds germinated	Plants survived	% survival	Genotypes	Total seeds germinated	Plants survived	% survival
BVC-37	1	1	100	JCH23F2	28	28	100
LCA960	1	1	100	BCH22F2	6	6	100
K1-4D	16	16	100	BCH46F2	17	17	100
JCH06F2	19	19	100	BCH46-1F2	51	51	100
JCH07F2	40	40	100	RCH11F2	10	10	100
JCH09F2	33	33	100	RCH24F2	1	1	100
JCH14F2	41	41	100	JCH24F2	41	40	97.56
JCH02F2	57	56	98.25	RCH05F2	32	31	96.88
HCS-3	42	41	97.62	BCH24F2	27	26	96.30
GCV121	23	22	95.65	JCH24F2	70	67	95.75
LCA310AU	44	42	95.45	JCH32F2	20	19	95.00
GUK-2-2	43	41	95.35	JCH28F2	52	49	94.23
IC119561-2	21	20	95.24	BCH40F2	50	47	94.00
IC119561-1	50	47	94.00	RCH03F2	16	15	93.75
Rajput	25	23	92.00	JCH30F2	58	54	93.10
H0413	50	46	92.00	BCH24F2	9	8	88.89
GUK-2	30	27	90.00	JCH22F2	46	40	86.96
IC119561	36	32	88.89	JCH26F2	35	30	85.75
JCH10F2	23	20	86.96	RCH22-1F2	7	6	85.71
LCA310	20	17	85.00	JCH31-1F2	52	40	76.92
GCV121-2	38	32	84.21	JCH46F2	52	40	76.92
GUK-1	17	14	82.35	JCH48F2	42	31	73.81
BVC-37-1	27	22	81.48	LCA310A	16	15	73.75
P.jyoti	15	12	80.00	BCH22-1F2	14	10	71.43
GCV121-1	5	4	80.00	RCH01F2	31	21	67.74
JCH05F2	38	30	78.95	RCH46F2	12	8	66.67
KDSC210-10-1	10	4	40.00	RCH22F2	5	3	60.00
Pant-C1	35	32	19.43	JCH31F2	30	13	43.33
P.MUKTI(c)	3	0	0.00	JCH46-1F2	31	8	25.81
BVC-1(c)	0	0	0.00	RCH26F2	0	0	0.00
KDSC210-10-1-1(c)	0	0	0.00	PALEOF2	15	0	0.00
GUK-2-1-1 (c)	0	0	0.00				

study in field condition by providing shade as well as open condition is suggested. Male parents LCA310A, LCA960 and GCV121 showed resistance against seedling blight were common to produce resistant hybrids JCH22 & RCH22, JCH24 & RCH24 and JCH46 & RCH46 respectively (data not given) should be utilized for resistance breeding programme against *Colletotrochum capsici* and *Colletotrochum gloeosporioides*.

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