Effect of combined stresses in crop plants: Indian Perspective

Presented by

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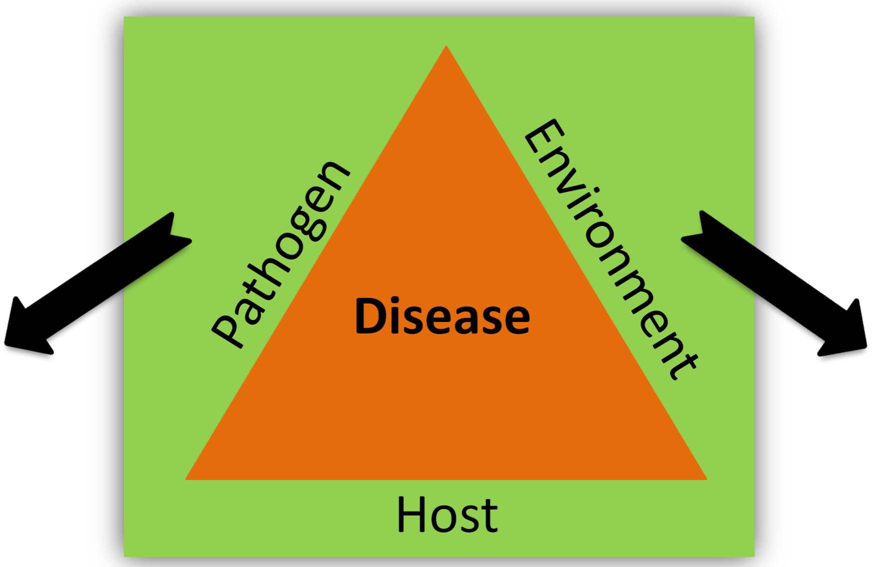
National Institute of Plant Genome Research, Aruna Asaf Ali Marg, New Delhi, 110067, India

Bacteria
Fungi
Virus
Nematode



Light
Water
Salinity

Abiotic- Abiotic

Biotic- Biotic

Abiotic- Biotic

Research groups working on combined stress in India

Abiotic- Abiotic

CSIRO PUBLISHING
Crop & Pasture Science, 2017, **68**, 823–841
https://doi.org/10.1071/CP17028

Effects of individual and combined heat and drought stress during seed filling on the oxidative metabolism and yield of chickpea (*Cicer arietinum*) genotypes differing in heat and drought tolerance

Rashmi Awasthi[A], *Pooran Gaur*[B], *Neil C. Turner*[C], *Vincent Vadez*[B], *Kadambot H. M. Siddique*[C], *and Harsh Nayyar*[A,D]

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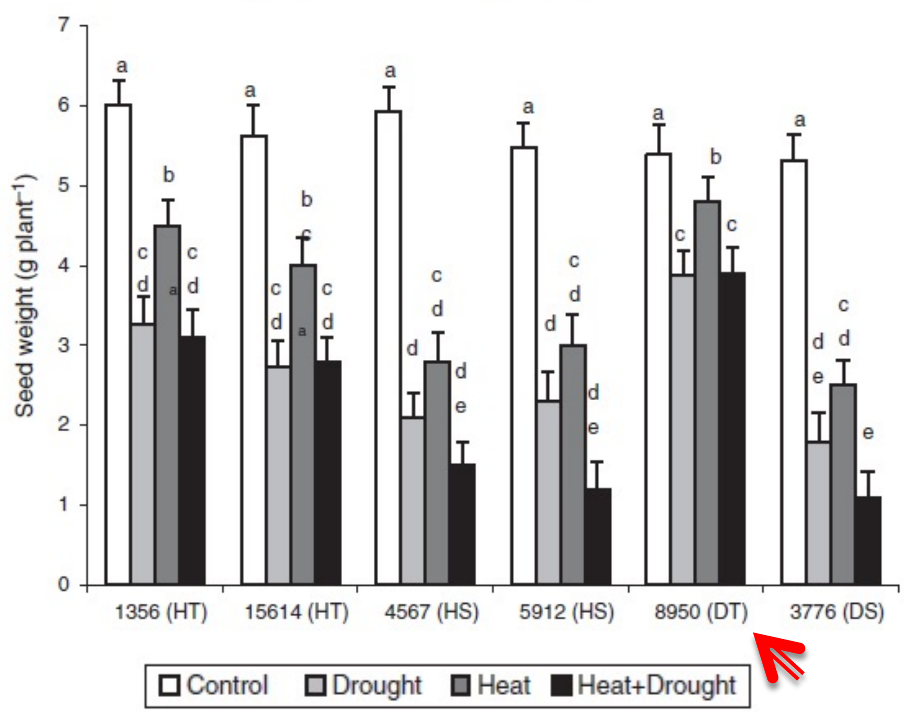
[D]Corresponding author. Email: harshnayyar@hotmail.com



- A **drought-tolerant genotype ICC8950** produced more seed yield under the combined heat + drought stress than other genotypes
- Stress damaged membranes, and decreased PSII function and chlorophyll content
- The levels of oxidative molecules (malondialdehyde (MDA) and H_2O_2) increased in all stress treatments, especially under combined heat + drought stress

CSIRO PUBLISHING
Functional Plant Biology
http://dx.doi.org/10.1071/FP13340

Individual and combined effects of transient drought and heat stress on carbon assimilation and seed filling in chickpea

Rashmi Awasthi[A], *Neeru Kaushal*[A], *Vincent Vadez*[B], *Neil C. Turner*[C,D], *Jens Berger*[E], *Kadambot H. M. Siddique*[D] *and Harsh Nayyar*[A,F]

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[C]Centre for Legumes in Mediterranean Agriculture, The University of Western Australia, Crawley, WA 6009, Australia.
[D]The Institute of Agriculture, The University of Western Australia, Crawley, WA 6009, Australia.
[E]CSIRO Plant Industry, Private Bag No. 5, Wembley, WA 6913, Australia.
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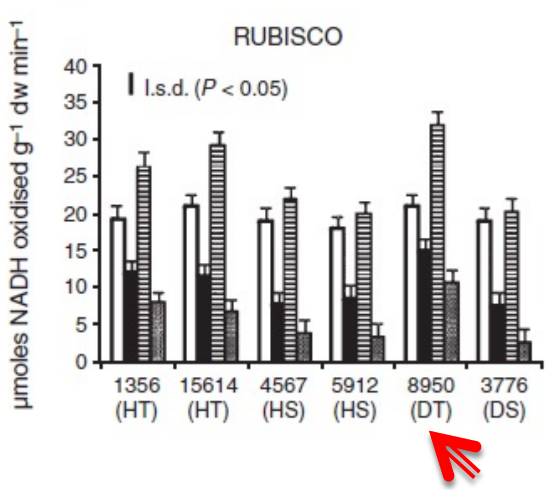

- Stress damaged membranes, and decreased cellular oxidizing ability, stomatal conductance, PSII function and chlorophyll content; damage was greater under combined stress.
- Leaf Rubisco activity decreased severely with combined stress.

- Sucrose, starch and their biosynthetic enzymes level decreased in all treatments; reductions were greater under combined stress.
- These effects were more severe in heat- and drought-sensitive genotypes compared with drought tolerant genotypes.

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DOI: 10.1111/pce.13328

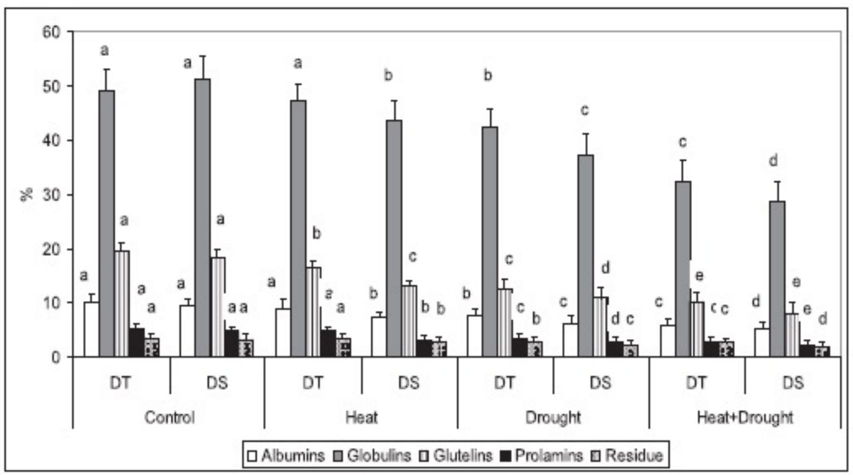
Check for updates

ORIGINAL ARTICLE

WILEY Plant, Cell & Environment

Influence of drought and heat stress, applied independently or in combination during seed development, on qualitative and quantitative aspects of seeds of lentil (*Lens culinaris* Medikus) genotypes, differing in drought sensitivity

Akanksha Sehgal[1] | Kumari Sita[1] | Kalpna Bhandari[1] | Shiv Kumar[3] | Jitendra Kumar[2] | P.V. Vara Prasad[4] | Kadambot H.M. Siddique[5] | Harsh Nayyar[1]



DT - Drought tolerant DPL 53
DS - Drought sensitive LL699

- Both heat and drought resulted in marked reduction in the rate and duration of seed filling to decrease the final seed size.
- Combined stresses accentuated the damage to seed starch, storage proteins and their fractions, minerals, and several amino acids.

frontiers in Plant Science

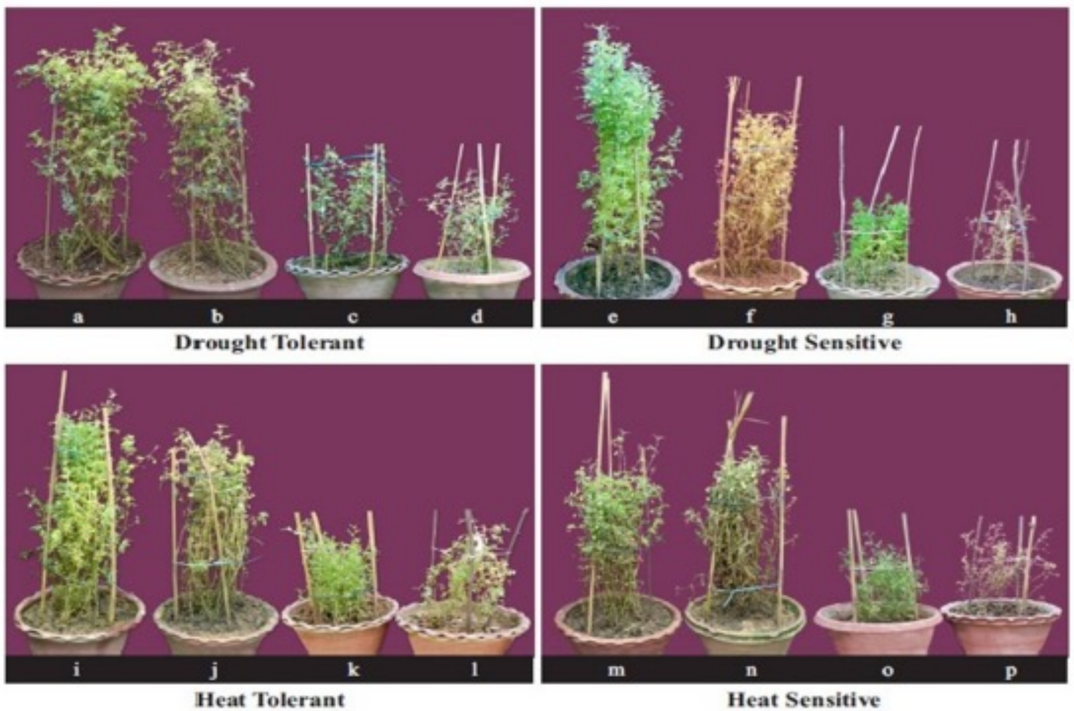
ORIGINAL RESEARCH
published: 17 October 2017
doi: 10.3389/fpls.2017.01776

OPEN ACCESS

Effects of Drought, Heat and Their Interaction on the Growth, Yield and Photosynthetic Function of Lentil (*Lens culinaris* Medikus) Genotypes Varying in Heat and Drought Sensitivity

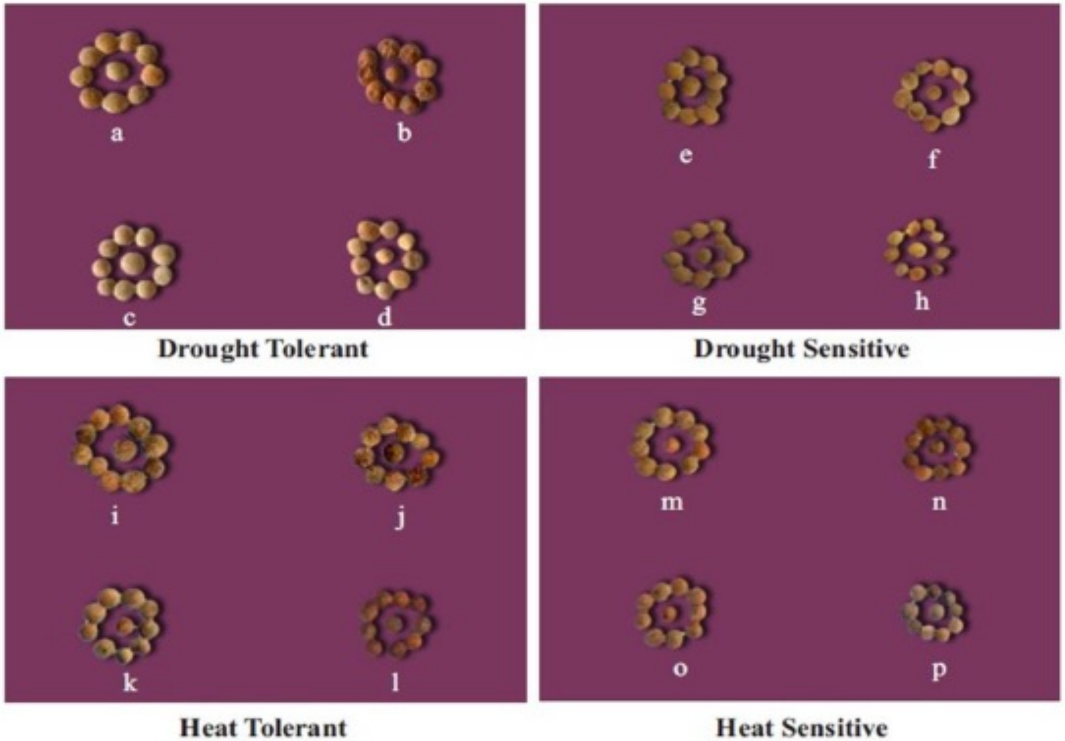
*Akanksha Sehgal[1], Kumari Sita[1], Jitendra Kumar[2], Shiv Kumar[3], Sarvjeet Singh[4], Kadambot H. M. Siddique[5] and Harsh Nayyar[1]**

[1] Department of Botany, Panjab University, Chandigarh, India, [2] Indian Institute of Pulses Research, Kanpur, India, [3] International Center for Agricultural Research in the Dry Areas, Rabat, Morocco, [4] Plant Breeding and Genetics, Punjab Agricultural University, Ludhiana, India, [5] The UWA Institute of Agriculture, The University of Western Australia, Perth, WA, Australia



Control - drought - heat - heat + drought

Drought tolerant genotype (DPL53)
Drought-sensitive genotype (ILL 2150)
Heat tolerant genotype (1G 2507)
Heat sensitive genotype (1G 3973)



Control - drought

heat - heat + drought

Drought tolerant genotype (DPL53)
Drought-sensitive genotype (ILL 2150)
Heat tolerant genotype (1G 2507)
Heat sensitive genotype (1G 3973)

Seed sucrose decreased with each stress together with its biosynthetic enzyme

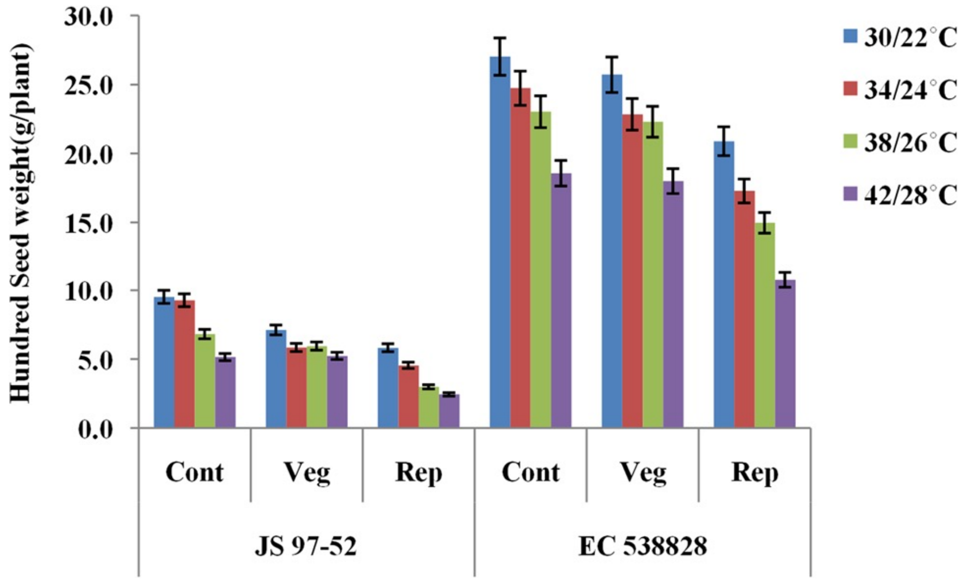
Physiol Mol Biol Plants (January–February 2018) 24(1):37–50
https://doi.org/10.1007/s12298-017-0480-5

RESEARCH ARTICLE

Impact of combined stress of high temperature and water deficit on growth and seed yield of soybean

Kanchan Jumrani[1] · Virender Singh Bhatia[1]

Indian Institute of Soybean Research, Indore, India



Observed an overall reduced growth and yield upto 70% under combined stress condition compared to individual stress.

Science of the Total Environment 714 (2020) 136837

Contents lists available at ScienceDirect

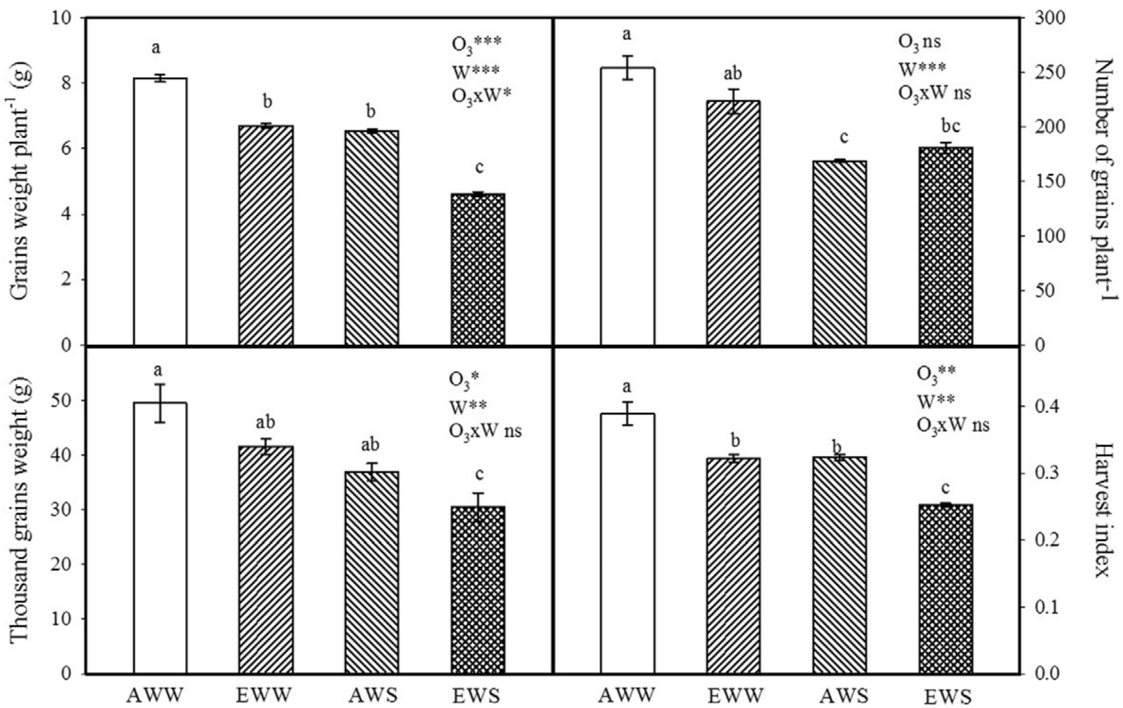
Science of the Total Environment

journal homepage: www.elsevier.com/locate/scitotenv

Effect of water deficit stress on an Indian wheat cultivar (*Triticum aestivum* L. HD 2967) under ambient and elevated level of ozone

Annesha Ghosh, Madhoolika Agrawal, Shashi Bhushan Agrawal *

Laboratory of Air Pollution and Global Climate Change, Department of Botany, Institute of Science, Banaras Hindu University, Varanasi 221005, India.



AWW ambient well watered;
EWW elevated well watered;
AWS ambient water deficit stress;
EWS elevated water deficit stress;

Indian Journal of Experimental Biology
Vol. 55, May 2017, pp. 321-328

Tolerance to combined boron and salt stress in wheat varieties: Biochemical and molecular analyses

Charu Lata[1], Ashwani Kumar[1]*, SK Sharma[1], Jogendra Singh[1], Shital Sheokand[2], Pooja[2], Anita Mann[1] & Babita Rani[2]

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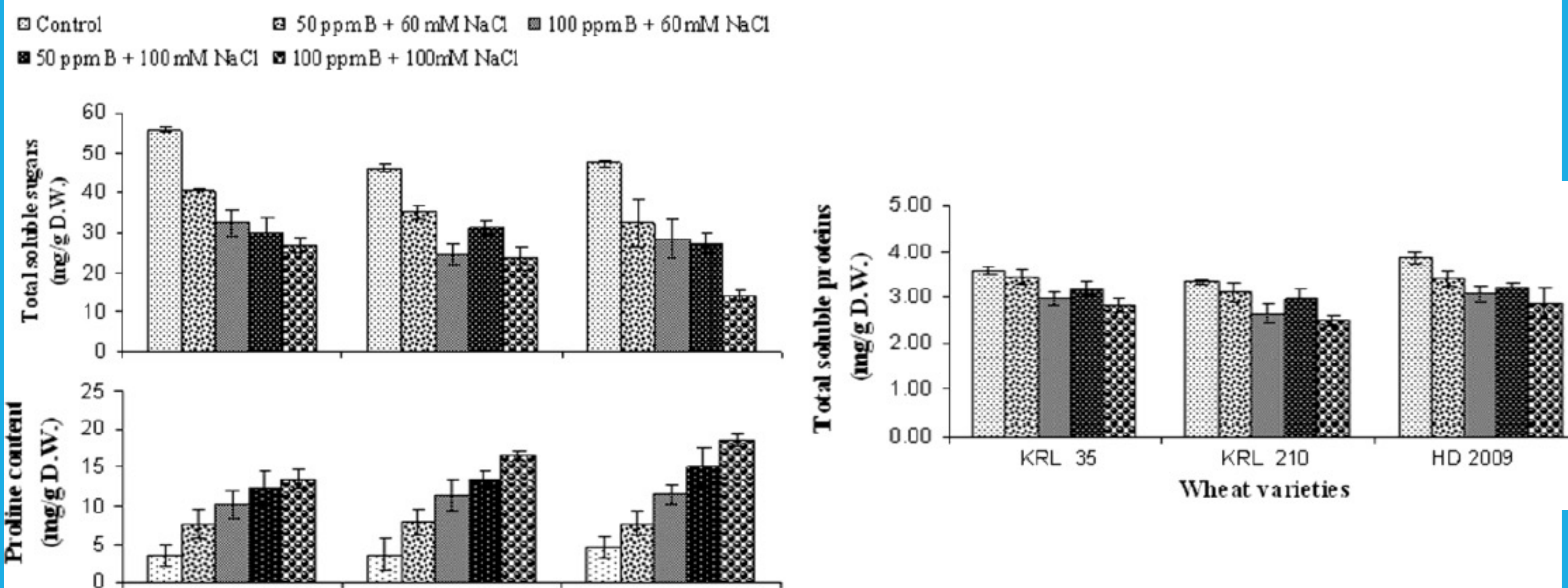
[2]Chaudhary Charan Singh Haryana Agricultural University, Hisar (Haryana) India

Received 05 December 2015; revised 27 April 2016



Research groups working on combined stress in India

Biotic- Biotic

International Journal of Fauna and Biological Studies 2019; 6(3): 01-05

International Journal of Fauna and Biological Studies
Available online at www.faunajournal.com

International Journal of Fauna And Biological Studies

ISSN 2347-2677
IJFBS 2019; 6(3): 01-05
Received: 01-03-2019
Accepted: 05-04-2019

Ramalingam K
Department of Plant Pathology, Centre for Plant Protection Studies, Tamil Nadu Agricultural University, Coimbatore, Tamil Nadu, India

Exploring the disease severity by the interaction of *Fusarium* wilt and root knot nematode in tomato

Ramalingam K, Parthasarathy S, C Ushamalini and N Swarnakumari

T. No.	Treatments	Wilt incidence (%)	Vascular infection (%)	Galls present in g^{-1} of roots
T1	Soil inoculation of *F. o.* f. sp. *lycopersici* alone @ 50g kg^{-1} of soil	69.2^{b} (55.60)	42.6^{bc} (40.72)	0.0^{c}
T2	Soil inoculation of *M. incognita* alone @ 1 J_2/g of soil	0.0^{c} (0.52)	0.0^{d} (0.68)	175.5^{a}
T3	Soil inoculation of *F. o.* f. sp. *lycopersici* @ 50g kg^{-1} of soil and *M. incognita* @ 1 J_2/g of soil (10 days later)	50.0^{ab} (43.99)	34.9^{bc} (36.16)	89.53^{b}
T4	Soil inoculation of *M. incognita* @ 1 J_2/g of soil and *F. o.* f. sp. *lycopersici* @ 50g kg^{-1} of soil (10 days later)	87.5^{a} (43.63)	53.2^{a} (46.84)	168.3^{a}
T5	Soil inoculation of *F. o.* f. sp. *lycopersici* @ 50g kg^{-1} of soil and *M. incognita* @ 1 J_2/g of soil (simultaneous)	54.5^{ab} (44.81)	44.6^{b} (41.89)	111.33^{b}
T6	Control	0.0^{c} (0.52)	0.0^{d} (0.68)	0.0^{c}

Phytopathologia Mediterranea (2013) 52, 1, 157–165

RESEARCH PAPER

Combining Ascochyta blight and Botrytis grey mould resistance in chickpea through interspecific hybridization

Livinder KAUR[1], Asmita SIRARI[1], Dinesh KUMAR[1], Jeet SINGH SANDHU[2], Sarvjeet SINGH[1], Karan KAPOOR[1], Inderjit SINGH[1], C.L. Laxmipati GOWDA[3], Suresh PANDE[3], Pooran GAUR[3], Mamta SHARMA[3], Muhammad IMTIAZ[4] and Kadambot H.M. SIDDIQUE [5]

[1] Punjab Agricultural University (PAU), Ludhiana 141004, Punjab, India
[2] Indian Council of Agricutural Research, New Delhi 110114, India
[3] International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, A.P., India
[4] International Centre for Agricultural Research in Dry Areas (ICARDA), Aleppo, Syria
[5] The UWA Institute of Agriculture, The University of Western Australia, 35 Stirling Highway, Crawley, WA 6009, Australia

For introgression of high levels of AB and BGM resistance in cultivated chickpea from wild relatives, accessions of seven annual wild Cicer spp. were evaluated and identified: C. judaicum accessions 185, ILWC 95 and ILWC 61, C. pinnatifidum accessions 188, 199 and ILWC 212 as potential donors. C. pinnatifidum accession I88 was crossed with ICCV 96030 and 62 F9 lines resistant to AB and BGM were derived.

Indian Phytopath. 52 (1) : 84-85 (1999)

Reaction of some chickpea cultivars to *Fusarium oxysporum* f.sp. *ciceri* and *Meloidogyne incognita* disease complex*

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Department of Plant Pathology, University of Agricultural Sciences, GKVK, Bangalore 560 065

Table 1. Reaction of chickpea cultivars to *Meloidogyne incognita* and *Fusarium oxysporum* f.sp. *ciceri* alone and in combination

(Mean of five replications)

Cultivar	*Reaction: Root-knot		Fungal wilt	
	N	N–F	F	N–F
Annegiri-1	HS	HS	S	S
Radhey	HS	HS	R	R
H-208	HS	HS	S	S
Chaffa	HS	HS	S	S
L-550	HS	HS	MS	S
JG-62	HS	HS	S	S
Avrodhi	HS	HS	R	R
BEG-482	HS	HS	T	MS
BDN-9-3	HS	HS	R	MS
ICCC-4	HS	HS	R	MS
Jyothi	HS	HS	T	MS
ICCC-37	HS	HS	T	MS
ICCV-2	HS	HS	T	MS

N = *Meloidogyne incognita;* F = *Fusarium oxysporum* f.sp. *ciceri;* N-F - *Meloidogyne incognita* followed by *Fusarium oxysporum* f.sp. *ciceri* after seven days; HS = Highly susceptible; S = Susceptible; R = Resistant; MS = Moderately susceptible; T = Tolerant

Research groups working on combined stress in India

Abiotic- Biotic

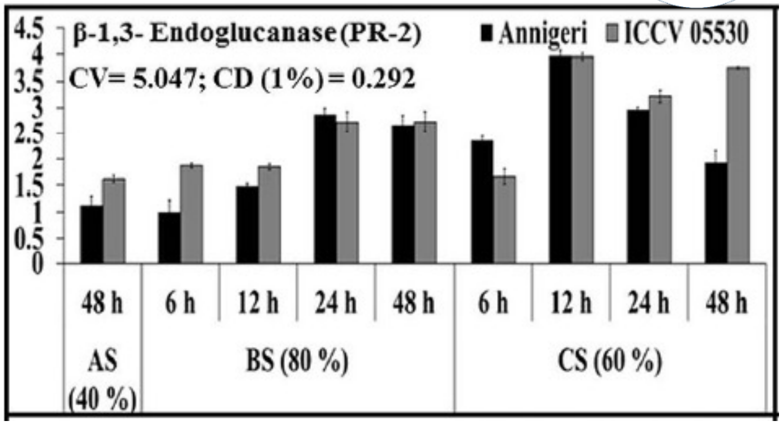
frontiers in Plant Science

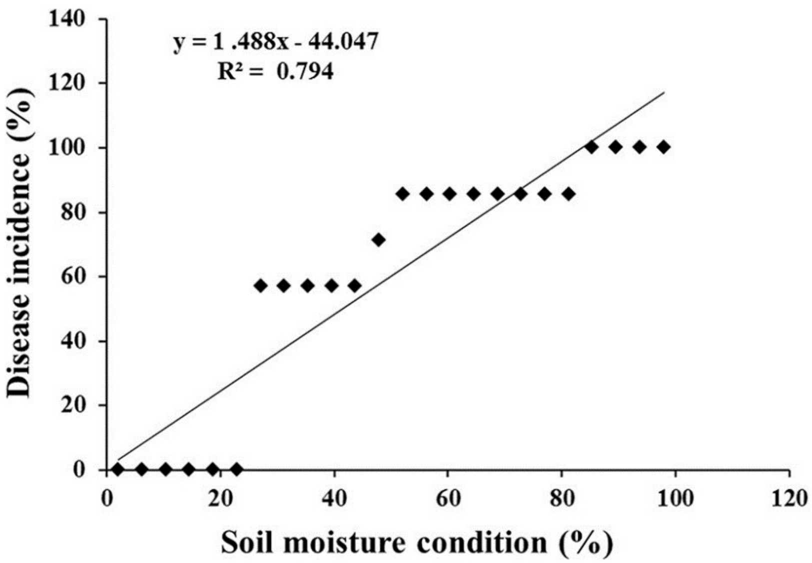
ORIGINAL RESEARCH
published: 15 August 2018
doi: 10.3389/fpls.2018.01154

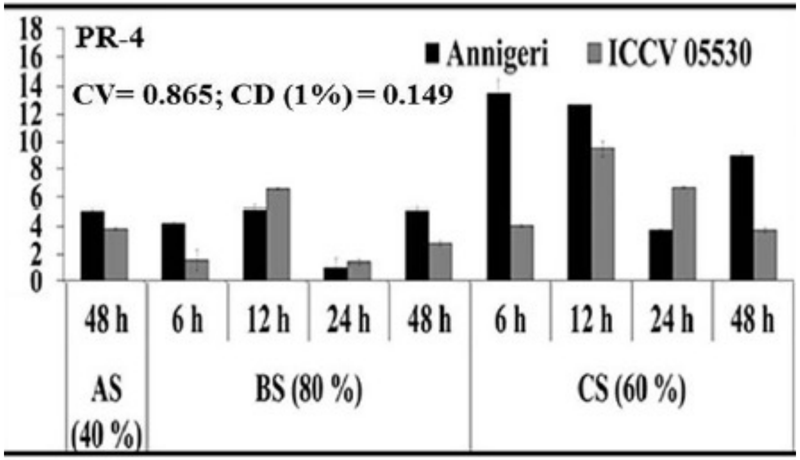
Exploring Combined Effect of Abiotic (Soil Moisture) and Biotic (*Sclerotium rolfsii* Sacc.) Stress on Collar Rot Development in Chickpea

*Avijit Tarafdar†, T. Swaroopa Rani†, U. S. Sharath Chandran, Raju Ghosh, Devashish R. Chobe and Mamta Sharma**

Legumes Pathology, Integrated Crop Management, International Crops Research Institute for the Semi-Arid Tropics, Patancheru, India







International Journal of Agriculture, Environment and Biotechnology
Citation: IJAEB: 13(1): 59-70, March 2020
DOI: 10.30954/0974-1712.1.2020.7

PLANT PATHOLOGY

Outbreak of Rice Blast on the Coastal Region of South-Eastern India

Sudeepta Pattanayak and Siddhartha Das*

Department of Plant Pathology, MS Swaminathan School of Agriculture, Centurion University of Technology and Management, Odisha, India

*Corresponding author: siddhartha.das10@gmail.com (**ORCID ID:** 0000-0002-7482-2555)

Paper No. 08 **Received:** 14-10-2019 **Revised:** 23-01-2020 **Accepted:** 28-02-2020

Table 3: Construction of heat map based on percent disease index from 2015-16 and 2017-18

Year	Disease severity in average Percent Disease Index (PDI)						Mean
	Month						
	July	August	September	October	November	December	
2015-2016	1.2 (9.2)	4.4 (12.8)	6.4 (14.3)	21.2 (26.1)	24.5 (28.3)	8 (15.4)	10.9 (17.6)[c]
2016-2017	0.2 (7.5)	5.5 (14.0)	12.2 (19.7)	23.1 (27.4)	18.4 (24.2)	9.2 (17.1)	11.4 (18.3)[b]
2017-2018	1.5 (9.6)	6.3 (14.7)	13.8 (21.2)	25.3 (28.5)	20.2 (25.5)	10.9 (18.7)	13.0 (19.7)[a]
PDI/month	0.96 (8.76)[f]	5.4 (13.83)[e]	10.8 (18.4)[c]	23.2 (27.33)[a]	21.0 (26.0)[b]	9.36 (17.0)[d]	-

* Colour notations	Highest value	Median value	Lowest value

SCIENTIFIC REPORTS

OPEN

Impact of drought stress on simultaneously occurring pathogen infection in field-grown chickpea

Received: 9 November 2018
Accepted: 11 March 2019
Published online: 03 April 2019

Ranjita Sinha[1], Vadivelmurugan Irulappan[1], Basavaiah Mohan-Raju[2], Angappan Suganthi[3,4] & Muthappa Senthil-Kumar[1]

Treatment	2014-15	2015-16		2016-2017		2017-2018	
	Field-1	Field-1	Field-2	Field-1	Field-2	Field-1	Field-2
Control	4.167^{a}	1.938^{a}	8.571^{a}	0.625^{a}	35.14^{a}	0^{a}	11.588^{a}
Mild DS	9.167^{ab}	2.908^{a}	9.524^{ab}	1.78^{ab}	47.98^{bc}	10.041^{bc}	14.52^{ab}
Moderate DS	10^{b}	3.531^{a}	9.524^{ab}	6.78^{bc}	56.48^{de}	11.968^{cd}	25.906^{cd}
Severe DS	14.167^{bc}	7.9^{c}	10.476^{ab}	8.96^{c}	63.29^{ef}	15.641^{de}	31.824^{de}
Pathogen	10^{b}	3.851^{ab}	9.048^{ab}	1.11^{a}	42.85^{ab}	6.2723^{b}	19.885^{bc}
Mild CS	15.833^{c}	6.544^{bc}	11.905^{ab}	6.81^{bc}	54.73^{cd}	10.597^{bc}	20.56^{bc}
Moderate CS	24.167^{d}	7.151^{c}	12.857^{ab}	7.51^{c}	65.59^{f}	19.111^{ef}	27.97^{de}
Severe CS	26.667^{d}	14.123^{d}	16.667^{b}	18.6^{d}	66.36^{f}	20.46^{f}	35.203^{e}
Grand mean	**14.271**	**5.9932**	**11.071**	**6.5243**	**54.057**	**11.761**	**23.433**
CV	**16.18**	**19.8**	**41.7**	**35.46**	**8.29**	**15.71**	**17.66**
LSD at $p < 0.05$	**5.4604**	**2.8066**	**8.0858**	**5.4711**	**7.8507**	**4.3702**	**7.2458**

Incidence of black root rot disease

SCIENTIFIC REPORTS

OPEN

Impact of drought stress on simultaneously occurring pathogen infection in field-grown chickpea

Received: 9 November 2018
Accepted: 11 March 2019
Published online: 03 April 2019

Ranjita Sinha[1], Vadivelmurugan Irulappan[1], Basavaiah Mohan-Raju[2], Angappan Suganthi[3,4] & Muthappa Senthil-Kumar[1]

Treatment	2014-15		2015-16		2016-2017		2017-2018	
	Field-1	Field-2	Field-1	Field-2	Field-1	Field-2	Field-1	Field-2
Control	3.75[a]	12.00[a]	0[a]	1.47[a]	0[a]	0[a]	0[a]	4.387[a]
Mild DS	7.083[ab]	NA	4.81[a]	1.84[a]	0[a]	1.5278[a]	0[a]	9.583[ab]
Moderate DS	11.25[bc]	NA	0[a]	2.39[a]	0[a]	2.2276[a]	0[a]	19.558[bc]
Severe DS	14.583[cd]	NA	32.5[c]	7.04[ab]	0[a]	33.815[bc]	4.1729[ab]	40.396[de]
Pathogen	8.75[abc]	12.80[a]	0[a]	1.59[a]	7.605[ab]	4.8544[ab]	1[a]	9.065[ab]
Mild CS	10.833 [bc]	18.86[a]	0[a]	4.32[ab]	0[a]	7.522[ab]	0[a]	16.854[abc]
Moderate CS	11.667[bc]	30.45[b]	18.119[b]	10.00[bc]	14.95[b]	11.828[ab]	10.157[ab]	28.592[cd]
Severe CS	19.583[d]	36.77[b]	35.294[c]	15.964[c]	42.23[c]	53.23[d]	13.333[b]	42.414[e]
Grand mean	**10.937**	**22.184**	**11.34**	**5.5801**	**8.0985**	**14.376**	**3.5829**	**21.356**
CV	**41.71**	**18.29**	**22.5**	**64.58**	**53.02**	**88.06**	**132.14**	**35.51**
LSD at $p < 0.05$	**6.7093**	**11.268**	**6.0335**	**6.3109**	**10.153**	**29.933**	**11.195**	**13.282**

Incidence of dry root rot disease

Future perspective

Combined stress in crops results in yield loss. To overcome this loss, mitigation strategies are required

- Plant Growth Promoting Rhizobacteria (PGPR)
- Developing tolerant crop cultivars
- Use of Fertilizers
- Deployment of biocontrol species (new species should be experimentally tested under different stress conditions)
- Meteorological correlations studies are important to understand relationship between weather condition and field grown crop health.

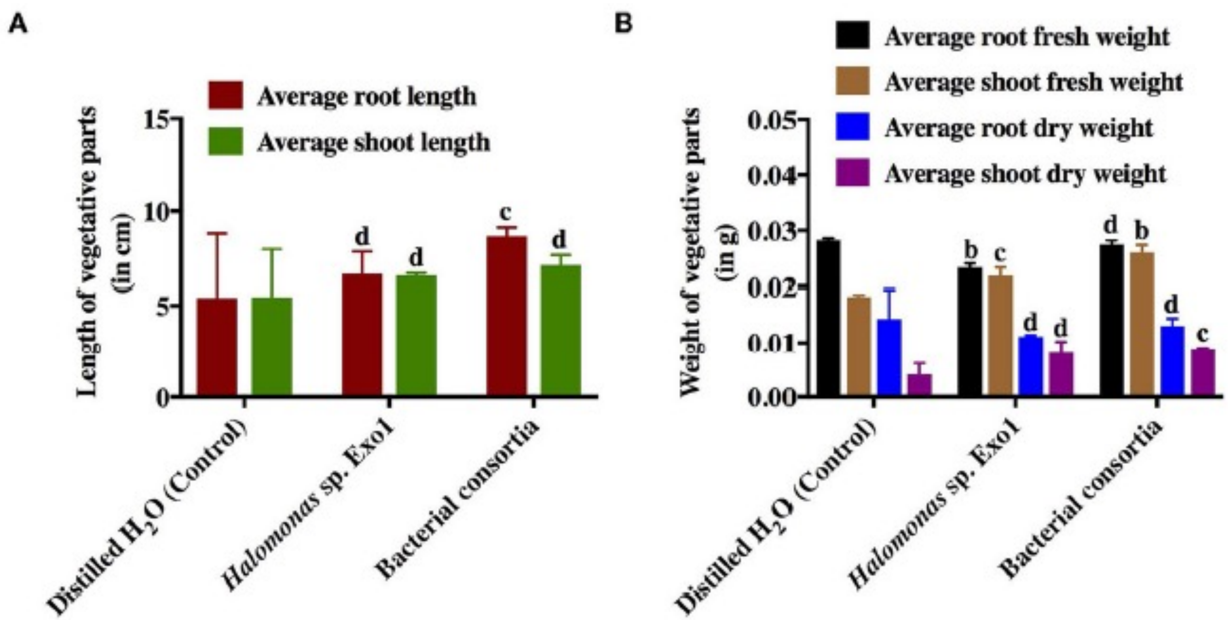
frontiers in Microbiology

ORIGINAL RESEARCH
published: 29 May 2019
doi: 10.3389/fmicb.2019.01207

Halomonas Rhizobacteria of *Avicennia marina* of Indian Sundarbans Promote Rice Growth Under Saline and Heavy Metal Stresses Through Exopolysaccharide Production

Pritam Mukherjee[1], Abhijit Mitra[2] and Madhumita Roy[3]*

[1] Department of Biotechnology, Techno India University, Kolkata, India, [2] Department of Marine Science, University of Calcutta, Kolkata, India, [3] Department of Microbiology, Bose Institute, Kolkata, India



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