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RESEARCH ARTICLE

Parental lines and advanced breeding material of castor resistant to wilt disease

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ABSTRACT: Castor is cultivated around the world because of its commercial importance while India is the largest producer of castor. Wilt disease of castor caused by *Fusarium oxysporum* f.sp. *ricini* is one of the major diseases influencing serious yield losses. Host plant resistance is one of the best options for managing the wilt disease. Parental lines and advanced breeding material were screened against wilt under sick plot conditions for identification of resistance for three years (2012-13 to 2014-15). Among advanced breeding material screened, 17 preliminary hybrids were highly resistant without wilt incidence and 51 advanced breeding material have shown resistant reaction with < 20% wilt. Out of 167 parental lines screened against wilt disease under sick plot, six lines *ie* Kh 12-317-2, Kh 12-1498-1, DCS-81, DCS-89, DCS-108 and DCS 120 were highly resistant to wilt with no wilt incidence and 73 parental lines showed resistance. Parental lines DCS-86, DCS-105, DCS-107, DCS-118, DPC-23 and M-571 consistently showed wilt resistance for two consecutive years. These parental lines can be utilized in breeding programme for development of wilt resistant castor hybrids.

Key words: Castor, parental lines, preliminary hybrids, resistance, sick plot, wilt

Castor (*Ricinus communis* L.) is one of the ancient non-edible oilseed crops of the world. India accounts for nearly 68% of the world's castor area and 76% of world castor production, and ranks first both in area and production. The area under castor crop slightly increased to 11.05 lakh ha during 2014-2015, 3 percent higher than that during 2013-2014. The total production under castor crop was 17.33 lakh tons with a productivity of1568 kg/ha (Anonymous, 2016). *Fusarium* wilt caused by *Fusarium oxysporum* f. sp. *ricini* (*F.o.ricini*) is a destructive disease resulting in 39-77% loss in production (Pushpavathi *et al.,* 1997). Chemical control of wilt is not feasible and economical, because of the soil as well as seed-borne nature of the pathogen. Developing a resistant variety is imperative to combat the wilt disease under field conditions (Dubey, 2016). Identification of sources of resistance is the prerequisite in any breeding program for developing a resistant variety. Castor being a monotypic genus, sources of resistance are limited to the existing variability among germplasm accessions, intra specific and inter varietal variability generated through conventional breeding. Several workers identified resistant sources to castor wilt by screening a large number of diverse germplasm accessions, breeding lines, varieties and hybrids in sick plot and artificial inoculation conditions in pot culture in AICRP (Castor) system (Raoof and Nageshwar Rao, 1996; Pushpavathi *et al*., 1997; Pathak, 2003; Santha lakshmi *et al.,* 2014). However, the efficiency of resistant cultivars in disease management can be seriously limited by variability occurring in pathogen population, including the existence of pathogenic races (Jimenez-Gosco *et al.,* 2004). Resistant cultivars have been released, but became susceptible after only few growing seasons due to the appearance of new variants which limits the effectiveness of resistance (Honnareddy and Dubey**,** 2006). Studies on the genetics of wilt resistance indicated that for the development of a wilt resistant castor hybrid, both the parents should be resistant to wilt (Desai *et al*., 2001; Lavanya *et al.,* 2011). A systematic programme on development of wilt resistant parents was strengthened with the standard screening procedures and identification of wilt resistant sources. In this study, different parental lines and advanced breeding material developed by breeders were evaluated against Fusarium wilt under sick plot conditions to identify wilt resistant parents.

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MATERIALS AND METHODS

Field trials were carried out during *kharif* season for three years *i.e.* 2012-2013,2013-2014 and 2014-2015 in wilt sick plot maintained at Indian Institute of Oilseeds Research, Rajendranagar, Hyderabad and sowing was done in the first week of July, every year. Thirty three advanced breeding material during 2012-13, 72 advanced breeding material during 2013-14, while 86 parental lines during 2013-14 and 81 parental lines during 2014-15 were sown in wilt sick plot.The susceptible check JI-35 and resistant check 48-1 were sown after every 5 rows of test entries to determine the uniform spread of inoculum across the sick plot and three replications of each entry was maintained. *F. oxysporum* f. sp. *ricini* culture was isolated and maintained at 25^{0}C. The fungus culture was multiplied on sorghum grain medium for 14 days in bulk amount and applied in the field before sowing and also near seedlings 20 days after sowing.

Recommended dose of fertilizers and irrigation were provided and pest (other than wilt) control measures were taken as and when required. The inoculum load of *F. oxysporum* f. sp. *ricini* in soil was tested before and after sowing and also at the end of the trial by following standard soil dilution method. The observations on germination, wilt incidence were recorded at 30 days interval upto 150 days after sowing. The data on total plant count and infected plants were recorded and percent wilt incidence was calculated. Based on wilt incidence, the castor lines were graded as 0% wilt = Highly resistant; <20% wilt = Resistant and > 20.5% wilt = susceptible.

RESULTS AND DISCUSSION

The wilt incidence varied among advanced breeding material and parental lines. Wilt inoculum maintained at 2 x 10^3 cfu/g of *Fusarium* colonies during the testing period throughout sick plot. The susceptible cultivar JI-35 showed wilt incidence at 20 days after sowing onwards and most of the plants of JI-35, wilted by 60 days after sowing.

During 2012-13, of 33 advanced breeding lines evaluated against wilt under sick plot conditions, 15 entries PHT-10-6, PHT- 10- 9, PHT- 12-6 , PHT- 12-10 , PHT- 12- 11, PHT- 12- 12, PHT- 12- 14, PHT- 12- 15, PHT- 12- 18, PHT- 12- 19, DCS-112, DCS-109, DCS-118, DCS-117 and DCH- 1551 recorded resistant reaction to wilt (<20%) and remaining lines showed >20.5% wilt incidence. During 2013-14, among 72 advanced breeding lines evaluated, 22 lines recorded susceptible reaction. 17 lines *ie*PHT-2013-11, PHT-2013-15, PHT-2013-23, PHT-2013-27, PHT-2013-32, PHT-2013-46, PHT-II-13-56, PHT- II-13-60, PHT- II -13-62, PHT- II -13-72, PHT- II-13-73, PHT- II-13-77, PHT- II-13-78,PHT- II-13-79,PHT- II -13-80, PHT- II-13-81,PHT 13-2 were free from wilt disease and 36 lines showed less than 20% wilt disease (Table 1).

Different inbred lines are developed by intra specific hybridization involving wilt resistant sources either in single, double, triple or back cross followed by the pedigree method of selection (Lavanya and Raoof, 2006). During 2013-14, among 86 parental lines, 45 lines showed susceptible reaction while six lines *i.e.* Kh 12-317-2, Kh 12-1498-1, DCS-81, DCS-89, DCS-108, DCS 120 were free from wilt disease. 35 lines *i.e.* Kh 12-77-2, Kh 12-86-2, Kh 12-91-2, Kh 12-91-3, Kh 12-98-2, Kh 12-111-2, Kh 12-130-3, Kh 12-320-1, Kh 12-339-2, Kh 12-367-1, Kh 12-367-4, Kh 12-1373-1, Kh 12-1422-1, Kh 12-1422-2, Kh 12-1522-2, Kh 12-1555-1, Kh 12-1841-1. DCS 86, DCS 94, DCS 64, DCS 78, DCS-102, DCS 104, DCS 105, DCS 106, DCS 107, DCS 110, DCS 118, DPC-17, M-571, M-574, DPC-23, DPC-24, DPC-25,M-DPC-9-1 recorded less than 20% wilt disease (resistant). In the year 2014-15, among 83 parental lines evaluated against wilt in wilt sick plot, 44 lines were susceptible to wilt with more than 20.5% wilt and wilt incidence was not observed in three lines *ie* PMC 40, DCS 86 and DCS 118. Thirty six lines showed resistant reaction with <20% wilt incidence (Table 2). Susceptible check JI-35 showed 93.3 to 100% wilt incidence at different places in sick plot which indicates that sick plot maintains sufficient inoculum to cause wilt incidence. Resistant check 48-1 showed less wilt incidence of 0 to 5.3% in all years through out the plots.

In general, castor hybrids of susceptible and resistant parents had a tendency to show the disease incidence in the direction towards susceptible parent, indicating that the susceptible parents seem to have greater influence on deciding the wilt reaction (Golakia *et al*., 2005). Inheritance of resistance to castor wilt appear to be governed by polygenes with dominance and epistasis, therefore, heterosis breeding with choice of superior parents would be advantageous for enhancing the wilt resistance along with yield. However, for developing wilt resistant hybrids, both the parents should be wilt resistant and such heterotic crosses can also be further exploited through breeding following recurrent selection and inter se mating in segregating generations for developing wilt resistant high yielding pistillate and inbred male lines of castor (Patel and Pathak, 2011). In these studies, DCS-86, DCS-105, DCS-107, DCS-118, DPC-23 and M 571 showed resistance over two years under sick plot conditions (Table 3).

Table 1. Resistant advanced breeding material against wilt under sick plot conditions

Year	Highly resistant	Resistant
2012-13	Nil	PHT-10-6, PHT- 10- 9, PHT- 12-6 , PHT- 12-10 , PHT- 12- 11, PHT- 12-12, PHT- 12- 14, PHT- 12- 15, PHT- 12- 18, PHT- 12- 19, DCS- 112, DCS- 109, DCS- 118, DCS- 117 and DCH- 1551
2013-14	PHT-2013-11, PHT-2013-15, PHT-2013-23, PHT-2013-27, PHT-2013-32, PHT-2013-46, PHT-II-13-56, PHT- II -13-60, PHT- II-13-62, PHT- II -13-72, PHT- II-13-73, PHT- II -13-77, PHT-II-13-78,PHT- II-13-79,PHT- II-13-80,PHT- II -13-81,PHT 13-2 (**17**)	PHT-2013-2, PHT-2013-3, PHT-2013-8, PHT-2013-9, PHT-2013-10, PHT-2013-13, PHT-2013-14, PHT-2013-18, PHT-2013-21, PHT-2013-22, PHT-2013-26, PHT-2013-29, PHT-2013-30, PHT-2013-33,PHT-2013-34, PHT-2013-36, PHT-2013-38, PHT-2013-39, PHT-2013-40, PHT-2013-41, PHT-2013-42, PHT-2013-43, PHT-2013-44, PHT-2013-47, PHT-2013-48, PHT-2013-49, PHT-2013-51, PHT-2013-54, PHT-2013-61, PHT-2013-63, PHT- II -13-64, PHT-2013-66, PHT- II -13-67, PHT-2013-68, PHT-2013-70, PHT-2013-71
JI-35 (Susc. check): 100% (2012-13); 93.3% (2013-14) 48-1 (Res. check): 3.3% (2012-13); 5.3% (2013-14)		

Highly resistant: 0% wilt; Resistant: < 20% wilt.

Table 2. Resistant parental lines against wilt under sick plot conditions

Year	Highly resistant	Resistant
2013-14	Kh 12-317-2, Kh 12-1498-1, DCS-81, DCS-89, DCS-108, DCS 120 (6)	Kh 12-77-2, Kh 12-86-2, Kh 12-91-2, Kh 12-91-3, Kh 12-98-2, Kh 12-111-2, Kh 12-130-3, Kh 12-320-1, Kh 12-339-2, Kh 12-367-1, Kh 12-367-4, Kh 12-1373-1, Kh 12-1422-1, Kh 12-1422-2, Kh 12-1522-2, Kh 12-1555-1, Kh 12-1841-1, DCS-78, DCS 86, DCS 94, DCS 64, DCS 78, DCS-102, DCS 104, DCS 105, DCS 106, DCS 107, DCS 110, DCS 118, DPC-15,DPC-17, M-571, M-574, DPC-23, DPC-24, DPC-25
2014-15	PMC -40, DCS-86, DCS-118	PMC -6, PMC-9, PMC -11, PMC -14, PMC -15, PMC -16, PMC -17, PMC -18, PMC -19, PMC -21, PMC -24, PMC -25, PMC -33, PMC -34, PMC -35, PMC -36, PMC -38, PMC -39, PMC -50, PMC -51, PMC -55, PMC -60, DCS-105, DCS-107, DCS-108, DCS-112, DCS-119, 48-1, DCS-123, DPC-23, DPC-21, M 571
JI-35(Susc. check): 96.4%(2013-14);94.6% (2014-15) 48-1(Res. check):0.0% (2013-14); 5.3% (2014-15)		

Highly resistant: 0% wilt; Resistant: < 20% wilt.

Table 3. Wilt incidence in promising parental lines of castor

Parental lines	Wilt incidence (%) at 150 days after sowing	
	2013-14	2014-2015
DCS-86	16.7	0.0
DCS-105	16.0	16.6
DCS-107	15.5	6.6
DCS-118	18.5	0.0
DPC-23	9.4	7.6
M 571	14.7	6.6

These lines could be utilized for breeding wilt resistant hybrids.

CONCLUSION

Parental lines and advanced breeding material resistant to wilt were identified and DCS-86, DCS-105, DCS-107, DCS-118, DPC-23 and M 571 showed consistent resistance against wilt.

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REFERENCES

Anjani, K., Raoof, M.A. and Desai, G. (2014).Evaluation of world castor (*Ricinus communis* L.) germplasm for resistance to Fusarium wilt (*Fusarium oxysporum* f. sp. *ricini*). *Eur J. Plant Pathol.* **139**: 567-578.

Anonymous (2016). Annual Report – Castor. All India Coordinated Research Project on Castor (2015-2016), ICAR-Indian Institute of Oilseeds Research pp 1-2.

Dange, S.R.S. (2003). Wilt of castor - An overview. *J. Mycol. Plant Pathol*. **33**: 333-339.

Damodaram,T. and Hegde, D.M. (2007). Oilseeds situation: A statistical compendium, Directorate of Oilseeds Research, Indian Council of Agricultural Research.

Desai, A.G., Dange, S.R.S. and Pathak, H.C. (2001). Genetics of resistance to wilt in castor caused by *Fusarium oxysporum* f. sp. *ricini*. Nanda and Prasad. *J. Mycol. Plant Pathol.* **31**: 322-326.

Dubey, S.C. (2016). Race profiting, genetic diversity, diagnostics and management of *Furarium oxysprum* f.sp. ciceris causing wilt in chickpea. *India Phytopath.* **69**: 210-217.

Golakia, P.R., Kavani, R.H., Madaria, R.B., Monpara, B.A. and Savalia, R.L. (2005). Reaction of newly developed pistillate and inbred lines and their hybrids of castor to *Fusarium oxysporum* f. sp. *ricini* Nanda and Prasad. *J. Oil seeds Res.* **22**: 422-423.

Honnareddy, N. and Dubey, S.C. (2006). Pathogenic and molecular characterization of Indian isolates of *Fusarium oxysporum* f. sp. ciceri causing chickpea wilt. *Curr. Sci.* **91**(5): 661-666

Jiménez-Gasco, M.M., Navas-Cortes, J.A. and Jiménez-Diaz, R.M. (2004). The *fusarium oxysporum* f.sp. *ciceris/cicer* arietinum pathosystem: a case study of evaluation of plant-pathogenic fungi into races and pathotypes. *Int. Microbiol.* **7**: 95-104.

Lavanya, C. and Raoof, M.A. (2006). Development of male lines resistant to *Fusarium* wilt in castor (*Ricinus communis* L.). II National Plant Breeding Congress on Plant Breeding in post genomic era. pp. 238-243.

Lavanya,C., Raoof, M.A. and Santha Lakshmi Prasad, M. (2011). Genetics of resistance to Fusarium wilt in castor caused by *Fusarium oxysporum* f. sp. *ricini*. *Indian Phytopath.* **64**: 151-153

Nanda, S. and Prasad N. (1974). Wilt of castor a new record. *Indian J. Mycol. Plant Pathol.* **4**: 103-105.

Patel, D.R., Patel, P.S. and Patel, I.D. (1991). High-yielding 'GCH-4' castor hybrid is resistant to wilt. *Indian Farming*, June:11-12.

Patel, P.B. and Pathak, H.C. (2011). Genetics of resistance to wilt in castor caused by *Fusarium oxysporum* f.sp. *ricini* Nanda and Prasad. *Agricultural Science Digest.* **31**: 30-34.

Pathak, H.C. (2003). Emerging trends in castor seed development. In: Proc of National seminar on castor seed, castor oil and its value added products. 22nd May, 2003 Solvent extraction Association of India, Ahmadabad, India. pp. 54-62.

Pushpavathi, B., Sarwar, H.A.K., Raoof, M.A. and Ravindra Babu, R. (1997). Management of wilt disease in castor. *Indian J. Plant Protec.* **26**: 177-180.

Raoof, M.A. and Nageshwar Rao, T.G. (1996). A simple screening technique for early detection of resistance to castor wilt. *Indian Phytopath.* **49**: 389-392

Santha Lakshmi Prasad, M.,Raoof, M.A., Giribabu, P., Anjani, K., Lavanya, C. and Varaprasad, K.S. (2014). Castor Wilt. Directorate of Oilseeds Research, Hyderabad. p. 36.