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Climate Resilient Varieties and Genetic Stocks in Rapeseed-Mustard

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Abstract

The crop *brassica species* cultivated in India includes; *Brassica juncea, B. rapa, B. napus, B. carinata, B. oleracea and B. nigra. Among these, Indian mustard, is holding sizable contribution in terms of area and production of oilseeds, and edible oils.* Rapeseed–mustard crops are grown in diverse agro-climatic conditions ranging from north-eastern/ north-western hills to down south under irrigated/rainfed, timely/late-sown, saline soils and mixed cropping. Drought, heat and salt, are the major abiotic stresses which significantly affect the productivity of rapeseed-mustard crops. Therefore, development of rapeseed-mustard varieties tolerant/resistant these stresses are imperative to increase the productivity and production of rapeseed-mustard.

Keywords: Rapeseed-mustard, Drought tolerance, Heat tolerance, Salinity

Introduction

The major rapeseed-mustard species cultivated in India includes; Brassica juncea, B. rapa, B. napus, B. carinata, Eruca sativa (used for edible oil), B. oleracea (use for vegetables) *and B. nigra (used as seed condiment). Among these, Indian mustard [B. juncea (L.) Czern], is holding sizable contribution in terms of area and production of oilseeds and edible oils.* Rapeseed-mustard crops are grown in diverse agro-climatic conditions ranging from north-eastern/ north-western hills to down south under irrigated/rainfed, timely/late-sown, saline soils and mixed cropping. The different landraces of Brassica species have different ecological niches and developed the varieties as per their agro-ecological suitability. Indian mustard (*B. juncea*) is predominantly cultivated in western to central parts of North India and in some non-traditional areas of southern India. Yellow mustard (*B. rapa var. yellow sarson*) and toria (*B. rapa var. toria*) are short-duration crops and cultivated in north-eastern India as catch crop. Taramira/rocket salad (*Eruca sativa*) is a drought-tolerant species

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grown in the drier parts of northwest India. Gobhi mustard (*B. napus*) and Ethopian mustard/Karan rai (*B. carinata*) are the new emerging oilseed crops having a limited area under cultivation in northern India. Rapeseed-mustard crops fit well in the rainfed cropping system of resource-poor farmers, because of their low water requirement (80-240 mm) (Jat et al., 2019).

A quantum jump *in production of Rapeseed-mustard was recorded from a mere 0.76 million tonnes in 1950-51 to 10.11 million tonnes in 2020-21 (Fig. 1). Similarly, productivity levels increased from 368 kg/ha in 1950-51 to 1511 kg/ha in the year 2020-21 (*Agricultural Statistics at a Glance, 2021*). Among different states,* Rajasthan, Madhya Pradesh and Uttar Pradesh are the major rapeseed-mustard producer in India with 44.57%, 12.98% and 12.64% contribution, respectively, to the national production. Haryana recorded the highest yield, 2027 kg/ha during 2020-21 (Agricultural Statistics at a Glance, 2021). Drought, heat and salt, are the major abiotic stresses which significantly affect the productivity of rapeseed-mustard crops. Genetic improvement of rapeseed-mustard crops for traits conferring resistance/tolerance against these stresses is, therefore, imperative to enhance the production of rapeseed-mustard.

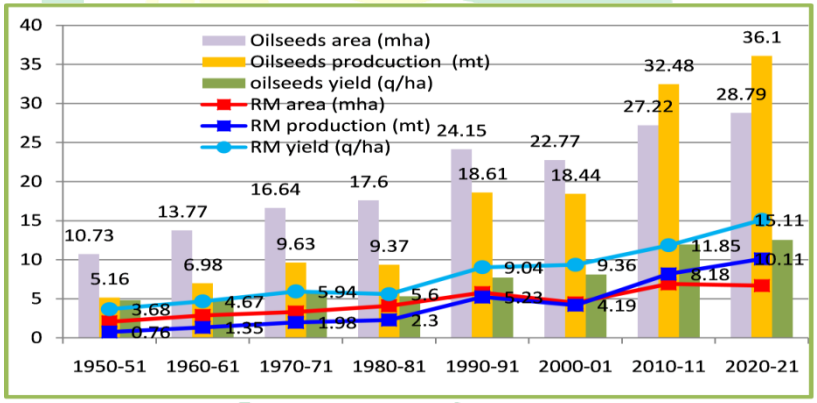

Fig. 1: Rapeseed-mustard growth over the year in comparison to oilseeds

Drought

Rapeseed-mustard crops fit well in the rainfed cropping system due to their low water requirements. About 17 % of the total rapeseed-mustard area is rainfed. Predominantly these are crops of marginal, small and resource-poor farmers in rainfed areas. Assam (83.6 %), Jharkhand (36.2%), and Madhya Pradesh (29.7 %) have substantial area under rainfed production system. In other major rapeseed-mustard growing states like Rajasthan, Uttar Pradesh and Haryana, the rainfed area is 5%, 16.7%, 15.4%, respectively (Agricultural

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Statistics at a Glance, 2021). Moisture stress (drought) in Indian mustard caused 17 to 94 % reduction in seed yield due to effect on yield components. Mustard genotypes with drought tolerance trait(s) yields better under water stress condition. Many physiological parameters like, high water use efficiency, transpiration efficiency, osmotic adjustment, transpiration cooling, epicutlar wax, canopy temperature difference, moisture loss from the excised leaves and drought susceptibility index have been reported to be associated with drought tolerance (Chauhan *et al*. 2011).

The concerted breeding efforts under drought/rainfed condtions, has led to the development of many drought tolerant varieties in mustard: Aravali, Geeta, GM 1, PBR 97, Pusa Bahar, Pusa Bold, RH 781, RH 819, RGN 48, RB 50, Shivani, TM 2, TM 4 and Vaibhav (Chauhan *et al.* 2011) (Table 1). During 2020-21, two variety of Indian mustard DRMR 150-35, DRMR 1165-40 were notified for rainfed conditions. For high water use efficiency and drought tolerance six genetic stocks (BPR-541-4, BPR-543-2, BPR-549-9, DRMR-541-44, DRMR10-40, DRMR 4001) of Indian mustard have been registered with NBPGR, New Delhi (Table 2). A list of drought tolerant varieties developed in toria and taramira crops is presented in table 1.

Table 1: Climate resilient varieties of Rapeseed-mustard developed during last 10 years (2010 onwards)

Specific trait	**Varieties**
Indian Mustard (*Brassica juncea*)	
High temperature tolerant at seedling stage	Pusa Mustard 25, Pusa Tarak, Pusa mustard 27 (EJ17), Pusa Mustard 28 (NPJ 124), Pant Rai 19, Azad Mahak
Late sown/ High temperature tolerant at terminal stage	RGN 145, NRCHB 101, Pusa mustard 26 (NPJ113), CS 58, Radhika, Brijraj
Rainfed/ Drought tolerant	RB 50, RH 406, RH 725, RGN 229, Raj Vijay Mustard 1, RVM 2, Pant Rai-20, RGN 298, GM-3 (Gujarat Mustard-3), PBR 378, RH 761, RSPR-69 (MCN-04-35), DRMR 150-35, DRMR 1165-40, Birsa Bhabha Mustard 1(BBM1)
Salinity tolerant	CS 58, CS 60, CS 61, CS 62

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Toria (*Brassica rapa var. toria*)	
Rainfed/ Drought tolerant	Sushree, Pant Hill Toria-1 (PT-2006-4), Raj Vijay Toria 1, Tapeshwari (TK 06-1), Tripura toria 1, Raj Vijay Toria 2, Raj Vijay Toria 3, AAU TS 38
Early sowing	Azad Chetna (TKM 14-2)
Brown sarson (*Brassica rapa* var. *brown sarson*)	
Rainfed conditions	HPBS-1
Cold tolerant	Shalimar Sarsaon-3 (KBS-3)
Karan Rai (*Brassica carinata*)	
Drought tolerant	BJC 1 (PC 6)
Taramira (*Eruca sativa*)	
Rainfed/ Drought tolerant	Vallabh Taramira 1 (PUT93-11), Jobner Tara (RTM-1351), Jwala Tara (RTM 1355), Krishna Tara (RTM 1624)

(Source: Updated from Chauhan et al., 2011)

Table 2: Climate resilient donors developed in Indian mustard

(Source: NBPGR website; Sharma et al., 2022a)

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Sl.	Germplasm	IC No.	Unique traits
1	RH-8814	IC401570	Resistance to salinity
2	BPR-541-4	IC0583386	High water use efficiency, thermo tolerance at terminal stage, salinity tolerance
3	BPR-543-2	IC0583448	High water use efficiency, thermo-tolerance at juvenile stage
4	RH 0116	IC0584669	Tolerance to salinity at 10 ds/m at seedling stage
5	BPR-349-9	IC0589778	Only for thermo- tolerance at juvenile stage
6	BPR-549-9	IC0595525	Salinity tolerance at juvenile stage, high water use efficiency
7	BPR-540-6	IC0593927	Salinity tolerance and Thermo tolerance at juvenile stage
8	CS 1100-1-2-2-3	IC0511389	Salinity tolerant. High level of Alkalinity tolerant.
9	DRMR-541-44	IC0598624	Drought tolerance (high water use efficiency under rainfed)
10	CS 15000-1-2-2-2-1	IC0624502	High tolerance to salinity (EC 12 dS/m) and alkalinity (pH9.4).
11	CS 52-SPS-1-2012	IC0630607	High tolerance to Salinity (EC 14-15 dS/m) and Alkalinity (pH 9.4-9.5)
12	DRMR10-40	IC0632085	Drought tolerance
13	DRMR 2059	IC0520764	High temperature tolerance at seedling and terminal heat stress
14	DRMR 4001	IC0632086	Drought tolerance
15	DRMR 4005	IC0632087	Thermo tolerance at juvenile stage coupled with high seed yield
16	DRMR 2300	IC0609646	High temperature tolerance at seedling stage
17	DRMRHT-13-22-10	IC0640708	Heat tolerant at juvenile stage under field conditions
18	DRMR 2018-27	IC0645774	High temperature tolerance at seedling stage and drought tolerance

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High temperature

High temperature is the second most important stress next to drought, which can affects crop growth and development. Heat stress is defined as the rise in temperature beyond a threshold level for a period of time which causes irreversible damage to plant growth and developments. In general, a transient elevation in temperature, usually 10-15^{o}C above ambient, is considered heat stress (Wahid *et al*. 2007). Heat stress is a complex function of intensity (temperature in degrees), duration and rate of increase in temperature. In India, Indian mustard faces high temperature (heat) stress at terminal stage, especially in eastern and northeastern parts, as well as central part due to delayed sowing after paddy and mixed/intercropping of mustard with wheat crop. However, Indian mustard can tolerate, annual temperature of 6 to 27^{o}C, but it has efficient photosynthetic response at 15–20^{o}C temperature. However, high temperature at reproductive stage severely affects the flowering, siliqua formation and seed development which lead to seed yield reduction due to forced maturity in Indian mustard (Young *et al.*, 2004; Chauhan *et al.*, 2011). In Indian mustard, high temperature can cause yield reduction upto 33.92% when sown under late sown conditions (Sharma et al., 2022b). High temperature at the time of crop establishment mainly seedling stage, has been increasingly becoming an important impediment in rapeseed-mustard cultivation in India. Therefore, it is imperative to develop thermo-tolerant varieties in Indian mustard which can yield better than the susceptible varieties (Chauhan et al., 2011).

Some varieties of Indian mustard, viz., Kanti, Pusa Agrani, RGN 13, Urvashi, NRCDR 02, Pusa mustard 25, and Pusa mustard 27 showed good thermo tolerance at seedling stage. For high temperature tolerance at terminal stage, Indian mustard varieties viz., Ashirwad, Swarn Jyoti, Vardan, Navgold (YRN 6), RGN 145, NRCHB 101, CS 56 (CS 234-2) and Pusa mustard 26 (NPJ 113) have been developed which are suitable for sowing under late-sown conditions. During 2021-22 two varieties of Indian musard namely, Radhika and Brijraj were notified for late sown irrigated conditions. Further, nine genetic stocks (BPR-541-4, BPR-543-2, BPR-349-9, BPR-540-6, DRMR 2059, DRMR 4005, DRMR 2300, DRMRHT-13-22-10, DRMR 2018-27) of Indian mustard were registered with NBPGR, New Delhi, for thermo-tolerance (juvenile/terminal stage) which can be used as donors for utilization in mustard breeding programme.

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Salinity

Rapeseed-mustard crops are also grown in substantial area affected by problem saline soils and poor quality brackish irrigation water. For salinity tolerance some genetic stocks namely, RH 8814, BPR 541-4, RH 0116, BPR-549-9, BPR-540-6, CS 1100-1-2-2-3 and CS 52-SPS-1-2012 have been developed and registered in Indian mustard. Salinity tolerant varieties namely, Narendra Rai 1, CS 52, CS 54, CS 56, CS 60, CS 61 and CS 62 were developed in Indian mustard.

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