ORIGINAL RESEARCH ARTICLE OPEN ACCESS

Identification of Restorers and Maintainers for the Development of Rice Hybrid Suitable for Himachal Pradesh

Parwinder Kaur and Pandey DP*

Rice & Wheat Research Centre, CSKHPKV, Malan (HP) Pin-176 047
* Corresponding author (email: pandeydp04@yahoo.co.in)

Received: 3rd March 2018, Accepted: 18th May 2018

Abstract

A set of ten traditional/improved varieties adapted to mid hill conditions of Himachal Pradesh were crossed with IR68897A to identify effective maintainers and restorers during *Kharif* 2015 at RWRC Malan. On the basis of spikelet fertility and pollen fertility genotype T 23 was categorized as effective maintainer and two genotypes *viz.* Ranbir Basmati and HPU 741 as effective restorers. Most of the genotypes were found partial restorer and partial maintainer. Three crosses IR68897A x HPR2880, IR68897A x Ranbir Basmati and IR68897A x HPU741 exhibited significant positive heterosis for grain yield per plant. .

Key words: Rice, maintainers, restorers, hybrids, spikelet fertility, pollen fertility

Introduction

To increase rice production, it is essential to improve rice yield because there will be little scope in further expanding the rice area. Hybrid rice is one of such innovation. Hybrid rice can out yield other varieties of rice. It is a key technology that meets the increasing global demand for rice. In Himachal Pradesh, rice occupies 770 thousand hectares and total production of 131.6 thousand metric tons with productivity of 17.05 quintals/hectare which is below the national productivity. So, there is need to advocate hybrid rice technology in Himachal Pradesh.

Rice hybrid for unfavorable environment can be developed using elite parental lines adapted to these environments. In heterosis breeding programme using cytoplasmic male sterility (CMS) system, identification of maintainers and restorers is prerequisite. Restorers for different cytosterile sources will increase the cytoplasmic diversification. The successful exploitation of hybrid vigour in rice using CMS system , identification of maintainers with higher adaptability and restorers with higher combining ability from elite breeding lines and landraces through test crossing and their use in further breeding programme are the initial steps in three-line heterosis breeding (Siddiq ,1996).

Cytoplasmic male sterility and the fertility restoration system have been primarily used to develop heterotic rice hybrids in and outside China. The need of increasing rice productivity and production encouraged rice scientists to develop and standardize the hybrid rice technology using CMS lines.

Materials and Methods

The present investigation was undertaken with the objective to identify different restorers and maintainers for a CMS line from among the local and high yielding rice using a CMS line. The present investigation was conducted at RWRC, Malan during 2015-2016. The experimental material comprised of ten hybrids and their male parents along with IR68897A and IR68897B. The experiment was laid out in a Randomised Block Design (RBD) with three replications. Recommended package of practices were followed during crop growth period. Pollen studies were carried out for their fertility/sterility responses. Five spikelets were selected from each plant before anthesis and fixed in 70% alcohol. Three anthers from each spikelet were placed together on a glass slide and squashed in 1% iodine solution. Slides were examined under microscope for fertile/sterile pollens. Estimates were based on five panicles from bagged hybrid plants. Maintainers and restorers for IR68897A were identified based on pollen and spikelet fertility. The criteria for classifying the parental lines as maintainers and restorers were done according to Virmani et al. (1997).

Results and Discussion

The pollen fertility and spikelet fertility are the important traits which directly influence the ultimate product i.e. grain yield. Pollen fertility and spikelet fertility and heterosis are used to to determine maintainers or restorers. None of the crosses showed 100% pollen sterility except IR 68897A xT 23 (0.00%). Among crosses IR 68897A x HPU 741, IR 68897A x IR 36 and IR 68897A x Ranbir Basmati had pollen fertility more than 90%. Cross IR 68897A x T 23 produced completely sterile F_1 (0.00%) Hybrids IR 68897A x HPU 741, IR 68897A x Ranbir Basmati, IR 68897A x IR 36, IR 68897A x Sabarmati and IR 68897A x Sukara Red had spikelet fertility above 75 %.

Hybrids exhibited higher mean values as compared to those of parents. This indicates the presence of heterosis for these characters. Heterosis expressed as per cent increase or decrease in the mean values of F_1 hybrid over better parent and standard check were observed for various characters. IR68897A x HPR 2880, IR68897A x Ranbir Basmati, IR68897A x HPU 741 showed significant positive heterosis for grain yield over better parent. Two crosses IR 68897A x Sukara red (43.33%) and IR 68897A x Ranbir Basmati (51.33%) showed positive heterosis for grain yield over the standard check

Hybrid rice is produced by crossing two-parental lines with very distinct genetic back ground. The success of hybrid rice programme depends upon the magnitude and direction of heterosis. A good hybrid should manifest high heterosis for commercial exploitation. Hybrid rice breeding programme exploits the phenomenon of heterosis. Hybrid rice development technology is different from those used for inbred rice varieties. Inbred line breeding accumulates productivity genes that perform well under homozygous conditions while hybrid breeding assembles genes under heterozygous conditios from the two parents. Heterosis for grain yield has been reported by Parihar and Pathak (2008), Roy et al. (2009), Tiwari et al. (2011) and Kumar et al. (2012). Both restorer crosses and maintainer cross showed resistance reaction to leaf and neck blast disease at RWRC, Malan under natural epiphytotic conditions. New CMS lines in diverse genetic backgrounds can be developed in locally adapted germplasm that is prerequisite for hybrid rice breeding. Restorer genes found in exotic genotypes can be transferred to elite high yielding and desirable genotypes through appropriate backcross breeding programme to develop new restorer lines.

Table 1: Mean performance of parents and crosses for yield and yield component traits

Parents/Crosses	Pollen fertility (%)	Spikelet fertility (%)	Grains/ panicle (Nos.)	Grain yield/plant (gram)
IR 68897A	0.00	0.00	-	-
IR 68897B	96.00	63.27	89.33	29.19
IR68897A X Sukara Red	53.33	75.53	144.53	25.41
Sukara Red	93.33	83.53	76.00	18.27
IR68897A X Sabarmati	66.33	75.74	145.60	23.29
Sabarmati	96.33	83.73	168.53	25.23
IR68897A X HPR 2880	75.00	70.50	109.97	21.84
HPR 2880	97.00	81.27	83.60	17.73
IR68897A X HPR 2656	56.00	51.87	70.57	15.07
HPR 2656	97.33	88.67	170.87	23.63
IR68897A X Ranbir Basmati	96.00	88.09	160.37	26.87
Ranbir Basmati	96.00	76.13	98.53	18.01
IR68897A X T 23	0.00	0.00	-	-
T 23	96.33	85.20	199.47	21.03
IR68897A X HPR 894	55.67	50.53	73.27	9.10
HPR 894	96.00	74.67	110.00	21.39
IR68897A X HPU 741	91.67	90.68	78.11	14.81
HPU 741	95.33	75.47	113.37	9.64
IR68897A X IR 36	92.00	85.20	124.47	18.88
IR 36	96.67	89.00	232.13	18.06
IR68897A X HPR 2373	53.33	43.03	57.50	11.45
HPR 2373	95.00	82.47	93.07	18.85
S.E (m)	2.39	4.39	12.09	2.02

Table 2: Magnitude of F_1 heterosis (%) over standard check (SC) with respect to yield and its components

Crosses	Grains/ panicle (Nos.)	Grain yield/plant (gram)
	SC	SC
IR68897A × HPR 2880	31.54	23.16
IR68897A × Ranbir Basmati	91.83*	51.53*
IR68897A × HPU 741	-6.57	-16.45
S.E	17.10	2.86

References

Kumar A, Chaurasia AK, Paikhomba N and Rai P. K. 2012. Evaluation of quantitative and qualitative analysis of aromatic fine grain rice (*Oryza sativa* L.) genotypes. *Progressive Research.* 133-136.

Parihar A and Pathak A. R. 2008. Heterosis for various quantitative traits in rice.*Oryza.* 45: 181-187

Roy S K, Senapati BK, Sinhamahapatra SP and Sarkar K. K. 2009. Heterosis for yield and quality traits in rice. *Oryza.* 46: 87-93

Siddiq EA. 1996. *Current status and future outlook for hybrid rice technology in India*. In: Ahmed M.I., Viraktamath, B.C., Ramesha, M.S. and Vijaya Kumar, C.H.M. (eds), Hybrid rice technology. Hyderabad: ICAR, Directorate of Rice Research. pp *;*1-27.

Tiwari D K, Pandey P, Giri S. and Dwivedi JL. 2011. Heterosis studies for yield and its components in rice hybrids using CMS system. *Asian Journal of Plant Sciences.* 10: 29-42

Virmani S S, Viraktamath BC, Casal CL, Toledo RS, Lopez MT and Monaldo J. O 1997. Hybrid rice breeding manual. Manila. *International Rice Research Notes*. pp ;151