IJPS INTERNATIONAL JOURNAL OF PLANT SCIENCES
e ISSN-0976-593X Volume **13** | Issue 1 | January, 2018 | 76-81

DOI: 10.15740/HAS/IJPS/13.1/76-81
Visit us - *www.researchjournal.co.in*

RESEARCH ARTICLE

Cost effective techniques for enhancing hybrid rice seed production

■ **Ashish Goswami and Vishal Seth**

SUMMARY

Rice (*Oryza sativa* L.) is one of the most important staple cereal crops. Among the various possible approaches, hybrid rice cultivation is the most feasible and practical one in view of its 10-15 per cent yield advantage over the high yielding varieties. To obtain the benefits of hybrid rice cultivation, it is essential to develop effective hybrid seed production techniques. Poor panicle exertion of CMS lines of most of the released hybrids of rice is affecting the seed yield considerably. To overcome this problem, gibberellic acid (GA_3) is being used in hybrid seed production. But the high cost of it in India, limits its use in large quantity. Therefore, the aim of the present investigation was to test the effectiveness of GA_3 and search for other-cheaper alternatives and to enhance the effectiveness of GA_3. Various chemicals such as, GA_3, boric acid, urea, glycine, etc. were twice applied either individually or in combination of various concentrations at 10% heading and 50% heading by hand sprayer. Total 9 different treatments were used and data were recorded on ten floral and yield traits. The percentage of exserted stigma (%), anther length(mm), panicle length (cm), filled spikelets per panicle, plat height (cm), grain yield /plant(g) were highest found in application of GA_3 80ppm + glycine 80ppm coupled with flag leaf clipping and rope pulling. Panicle exsertion (%), and spikelets length (cm) were highest found in glycine 80ppm coupled with flag leaf clipping and rope pulling. The panicle exertion was higher to the extent of 40 per cent with glycine 80ppm coupled wih coupled with flag leaf clipping and rope pulling. The increases in seed yield with GA_3 80ppm and glycine 80ppm coupled with flag leaf clipping and rope pulling was to the extent of 200 per cent, over control. Spraying of GA_3 80ppm in combination with glycine 80ppm coupled with flag leaf clipping and rope pulling resulted in higher profits. Results showed that glycine 80ppm was found be alternative of gibberellic acid.

Key Words : Rice, Hybrids, Seed yield, Floral traits

How to cite this article : Goswami, Ashish and Seth, Vishal (2018). Cost effective techniques for enhancing hybrid rice seed production . *Internat. J. Plant Sci.*, **13** (1): 76-81, **DOI: 10.15740/HAS/IJPS/13.1/76-81**.

Article chronicle : Received : 27.09.2017; **Revised :** 19.11.2017; **Accepted :** 02.12.2017

MEMBERS OF THE RESEARCH FORUM

Author to be contacted :
Ashish Goswami, Department of Genetics and Plant Breeding, Udai Pratap Autonomous College, Varanasi (U.P.) India
Email : ashishgoswamiupc2013@gmail.com

Address of the Co-authors:
Vishal Seth, Department of Genetics and Plant Breeding, Udai Pratap Autonomous College, Varanasi (U.P.) India

Rice (*Oryza sativa* L.) is one of the most important staple cereal crops. Increasing the productions of rice is necessary to meet out the food requirement of growing population. Among the various possible approaches, hybrid rice cultivation is the most feasible and practical one in view of its 10-15 per cent yield advantage over the high yielding varieties. To obtain

the benefits of hybrid rice cultivation, it is essential to develop effective hybrid seed production techniques.

To enhance the efficiency of hybrid seed production, it is necessary to increase the yield of hybrid seed by improving the out crossing capacity of CMS lines. The female parent of most of the released rice hybrids have problem of poor panicle exertion because of which nearly 25-30 per cent of the spikelets remain inside the flag leaf, resulting poor outcrossing and reduced hybrid seed yield. In China, application of gibberellic acid (GA_3) at fairly high concentration (150-225 g/ha) plays an important role in solving the problem of poor panicle exertion, besides enhancing wider glume opening, better stigma exertion and stigma receptivity, thereby increasing the outcrossing rate (Duan and Ma, 1992). But, the higher cost of GA_3 in India, is a limiting factor for its use at higher concentration in hybrid rice seed production. Thus, there is a need to findout the suitable substitutes for GA_3. Several cheaper chemicals like urea and boric acid are found to be promising to some extent in this regard (Prasad *et al.*, 1988). However, effect of alternate chemicals alone or in combination with GA_3 at lower concentration on hybrid seed yield and quality need to be studied. The aim of the present investigation was to test the effectiveness of GA_3 and search for other-cheaper alternatives and to enhance the effectiveness of GA_3. This experiment was conducted to study the artificial parameters which may increase the outcrossing on CMS line IR 58025A and thus, seed yield of A line in seed multiplication plots.

MATERIAL AND METHODS

The experiment was conducted at Udai Pratap Autonomous College, Varanasi, U.P. during *Kharif* season in Randomized Block Design with three replications. Various chemicals such as, GA_3, boric acid, urea, glycine, etc. were twice applied either individually or in combination of various concentrations. Physical Barriers were applied to prevent pollen contamination between the different combinations block. Total twelve treatment combinations included, flag leaf clipping (FLC), rope pulling (RP), spraying of urea 2%, boric acid 1.5%, urea 2% and boric acid 1.5% along with FLC and RP, gibberellic acid (40ppm and 80ppm) along with FLC and RP, glycine (60ppm, 80ppm and 100ppm) along with FLC and RP, GA_3 80ppm plus glycine 80ppm along with FLC and RP and a control were used in experiment which is given in Table A.

Table A : Treatment combinations

T_0	Control
T_1	Flag leaf cutting (FLC)
T_2	Rope pulling (RP)
T_3	Urea spray 2%
T_4	Boric acid spray 1.5%
T_5	Urea spray 2% + Boric acid spray 1.5% + FLC + RP
T_6	GA3 40ppm + FLC + RP
T_7	GA3 80ppm + FLC + RP
T_8	Glycine 60ppm + FLC + RP
T_9	Glycine 80ppm + FLC + RP
T_{10}	Glycine 100ppm + FLC + RP
T_{11}	GA3 80ppm + Glycine 80ppm + FLC + RP

The seedlings of female (IR 58025A) and male (IR 58025B) parents were raised on wet bed nursery. The male parent was staggered sown, three and seven days earlier to female parent to achieve synchronization in flowering. The 25 days old seedlings were transplanted at 4:2 row ratio with row to row and plant to plant spacing of 20 cm x 15 cm. Planting of A and B lines was done across the prevailing wind direction The recommended dose of 100:50:50 kg N, P_2O_5 and K_2O per ha was applied. The nitrogen was applied in three split doses, 50 per cent along with entire P_2O_5 and K_2O, 25 per cent at active tillering and remaining 25 per cent at panicle initiation stage. Flag leaf clipping treatment was imposed by cutting two third of the flag leaves of female parent at boot leaf stage of primary tiller. The chemicals were spayed at 10% heading and 50% heading by hand sprayer. A supplementary pollination with rope pulling was done on male parent during flowering. Observations on growth and yield parameters were recorded on five randomly selected plants. Mean values were subjected to analysis of variance to test the singnificannce for each characters as per methodology advocated by Panse and Sukhatme (1967).

RESULTS AND DISCUSSION

The analysis of variance was significant for all the characters except plant height under various treatments (Table 1). The result reveals significant influence of the treatments on floral traits and seed yield compared to control. Remarkable increase in growth and yield characteristics with the exogenous application of gibberellic acid, boric acid and other growth hormones were also reported by earlier workers such as Yogesha *et al.* (2000); Kalavathi *et al.* (2000) and Tiwari *et al.*

(2011) in rice, Naeem *et al*. (2001) in tomato, Muthukumar *et al*. (2007) in baby corn, Finongar (2007) in cowpea and Mobin *et al*. (2007) in mustard. Incomplete panicle exertion in CMS lines is one of the bottle neck in hybrid seed production. In the present study, better exertion of panicle was observed with glycine and other chemical spray over control (Table 2). The data of panicle exertion (86.57%), spikelets length (1.11cm) and seed yield per plant (29.6g) were highest found in glycine 80ppm spray along with FLC and RP, followed by combination of GA_3 80ppm and glycine 80 ppm along with FLC and RP with panicle exertion (84.8%), spikelets length (1.09cm) and seed yield per plant (28.9g). The application of GA_3 80ppm in combination with glycine 80ppm along with FLC and RP was the next best treatments to increase the all other traits under investigation. The highest angle of open spikelet (26.8°), panicle length (32.67cm) and plant height (108.67cm) were recorded with combine spray of GA_3 80ppm and glycine 80ppm along with FLC and RP, followed by spray of GA_3 80ppm along with FLC and RP which showed 26.6° angle of open spikelet, 32.43cm panicle length and 106.53cm plant height. These chemicals individually also increased these parameters significantly over unsprayed control. The results are in line with findings of Jagadeesha (1997) and Singh and Sahoo (1998). Plant height significantly increased from 131cm to 162cm with the combine spray of glycine 80ppm and GA_3 80ppm along with FLC and RP over control which is followed by alone spray of GA_3 80ppm and 40ppm along with FLC and RP having plant height of 106.53cm and 100.9 cm, respectively. GA_3 alone or in combination both also significantly increased the panicle length and spikelets length in different concentration. These findings are in closely agreement with that of Dunand (1998) who also reported significant increase in plant height, stem elongation and yield in response to gibberellic acid application. Virmani *et al*. (2007) reported that

Table 1 : ANOVA table

Characters	Source of variation		
	Replication (df-2)	Treatments (df-11)	Error (df-22)
Panicle exsertion (%)	0.008	10.22**	3.243
Angle of open spikelet(^{0})	0.003	11.683**	1.864
Percentage of exserted stigma (%)	0.001	12.998**	0.868
Spikelets length (cm)	0.005	13.77**	6. 788
Panicle length (cm)	0.11	16.006**	2.987
Filled Spikelets / panicle	0.075	23.219**	4.676
Plat height (cm)	0.087	16.567**	1.112
Seed yield /plant (g)	0.14	28.452**	1.897

** indicates significance of value at P=0.01

Table 2 : Mean performance of eight floral and seed traits under different treatments

Treatments	Panicle exsertion (%)	Angle of open spikelet (^{0})	Percentage of exserted stigma (%)	Spikelets length (cm)	Panicle length (cm)	Filled spikelets / panicle	Plat height (cm)	Seed yield / plant (g)
Control	58.0	19.63	22.23	0.97	26.97	131	91.33	18.8
Flag leaf clipping (FLC)	65.33	21.1	24.6	0.95	26.03	138	90.03	19.9
Rope pulling (RP)	60.2	20.6	24	0.94	24.8	129	89.03	22
Urea spray 2%	68.6	22.1	26.13	0.96	25.47	135	90.67	20.6
Boric acid spray 1.5%	70.2	21.8	27.43	0.98	25.8	138	91.83	23.27
Urea spray 2%+Boric acid spray 1.5%+FLC+RP	71.77	23.83	28.2	0.99	30.2	145	93.37	26.4
GA_3 40ppm + FLC + RP	78.6	23.0	27.6	1.02	30.67	142	100.9	25.5
GA_3 80ppm + FLC + RP	84.33	26.6	32.2	1.08	32.43	156	106.53	28.8
Glycine 60ppm + FLC + RP	76.8	23.0	26.6	0.98	27.3	140	92.13	24.6
Glycine 80ppm + FLC + RP	86.57	24.8	33.3	1.11	28.8	158	94.87	29.6
Glycine 100ppm + FLC + RP	84.2	24.2	32.6	0.99	30.33	155	94.6	28.7
GA_3 80ppm+Glycine 80ppm+FLC+RP	84.8	26.8	34.6	1.09	32.67	162	108.67	28.9
Mean	74.11	23.12	28.29	1.00	28.45	144.08	95.33	24.75
S.D.±	9.92	2.24	4.00	0.05	2.76	11.09	6.51	3.83

differential application of GA_3 also increases the relative height of the pollen over the seed parent. The GA_3 and other chemicals might have triggered the metabolic activities involved in cell division and cell elongation in the upper most internode to grow taller than flag leaf resulting in increased panicle length, panicle exertion and plant height (Buu and Huang, 1980; Yuan and Virmani, 1988; Jagadeeshwari *et al*., 1998; Ponnuswamy *et al*., 1998). Highest percentage of exerted stigma (34.6%) and number of filled spikelets per panicle (162) were also found with the spray of GA_3 80ppm in combination with glycine 80ppm along with FLC and RP, followed by spray of glycine 80ppm along with FLC and RP which showed 33.3% exserted stigma and 158 filled spikelets per panicle. Number of filled spikelets per panicle was increased with better exposer of stigma to outcrossing due to increased angle of open spikelets. Supplementary techniques such as flag leaf clipping (FLC) and rope pulling (RP) increased the seed yield per plant in some extent in alone and in combinations with different chemicals. These treatments also increased percentage of panicle and stigma exertion and angle of open spikelet.

The success of hybrid rice seed production depends upon the potential outcrossing rate to get higher seed yield. In hybrid rice seed production seed yield mainly depend upon various floral traits of CMS lines like better exertion of panicle, increased angle of open spikelets and percentage of exerted stigma and also agro morphological traits of pollen parents. Therefore, to achieve higher yield improvements in these traits is a necessary requirement. The application of GA_3 influences panicle exertion, spikelet opening angle and other floral traits which increases outcrossing rate of CMS lines leading higher yield. Xu and Li (1988) reported 18% higher seed yield with application of GA_3 in rice. Similarly, Elankavi *et al*. (2009) observed upto 50.52% increase in grain yields over control. [Realizing higher seed yield on CMS lines is the main target in hybrid rice seed production Prasad *et al*. (1988) and Ponnuswamy *et al*. (1998) also observed similar results]. The seed yield is very complex trait. It is multiplicative end product of several basic components of yield. In the present investigation the seed yield per plant increased significantly from 18.8g (control) to 29.6g with glycine 80ppm along with FLC and RP, followed by combination treatment of glycine 80ppm and GA_3 80ppm along with FLC and RP (28.9g) which is close to alone spray of GA_3 80ppm along with FLC and RP (28.8g) and glycine 80ppm along with FLC and RP

Fig. 1 : Spikelets of IR 58025A (Glycin 80 ppm + FLC+RP)

(28.7g). The increase in seed yield with these treatments was to the extent of 57.4, 53.7, 53.1 and 52.6 per cent over control, respectively. It is obvious from results that the higher seed yield per plant in these treatments was due to increased panicle exertion, wider angle of spikelet, percentage of exerted stigma and number of filled spikelets per panicle. The flag leaf clipping alone or in combination with GA_3 @ 50 g per ha enhanced the seed set rates due to increased exposer of panicles to outcrossing (Mishra and Pandey, 1994). These chemicals might have facilitated better translocation and mobilization of metabolites from source to sink, resulting in better seed filling. These results are in conformity with a number of workers such as Garg *et al*. (1980); Kaur and Singh (1986); Know *et al*. (1990); Pandey *et al*. (1996); Singh and Sahoo (1998); Kalavathi *et al*. (2000);

Yogesha *et al*. (2000); Elankavi *et al.* (2009) and Tiwari *et al*.(2011). Results showed that spray of GA_3 80ppm in combination with glycine 80ppm along with FLC and RP was better than treatments of GA_3 alone in different concentrations. Results also showed that glycine 80ppm along with FLC and RP was best alternative of gibberellic acid which can be useful in increasing seed yield in hybrid rice.

Acknowledgement :

The authors are grateful to UGC for the funding of project.

REFERENCES

Buu, R.H. and Huang, C.S. (1980). Effect of the application of plant growth regulators on yield components of early maturing rice. *J. Agric. Res. China*, **29**: 115-130.

Duan, X.M. and Ma, H.S. (1992). Effect of gibberrellic acid application on seed yield and quality of hybrid rice. *Seed Sci. & Technol.*, **9**: 379-409.

Dunand, R.T. (1998). Effects of preheading applications of gibberellic acid on rice growth and production. Proceedings of the 27th Rice Tech. Working Group, (RTWG`98), Reno, NV, pp: 211-211.

Elankavi, S., Kappaswamy, G., Vaiyapuri, V. and Raman, R. (2009). Effect of phytoharmones on growth and yield of rice. *Oryza*, **46** : 310-313.

Finongar, V. (2007). Gibberellic acid (GA3) influence on vegetative growth nodulation and yield of cowpea [*Vigna unguiculata* (L.) Walp]. *J.Agron.*, **6**:509-517.

Garg, O.K., Sharma, A.N. and Kona, G.R.S.S. (1980). Effect of boron on the pollen vitality and yield of rice plants. *Plant & Soil*, **52** : 591-594.

Jagadeesha, H. (1997). Studies on morphological traits and flower synchronization problems in hybrid rice seed production. M.Sc. (Ag.) Thesis, University of Agricultural Sciences, Bangalore, India.

Jagadeeshwari, P., Sudheerkumar, S., Ganesh, M. and Anuradha, G. (1998). Effect of foliar application of gibberellic acid on seed yield and quality of hybrid rice. *Oryza*, **35** : 26-30.

Kalavathi, O., Ananthakalaiselvi, A. and Vijaya, J. (2000). Econonomization of GA3 use in hybrid rice seed production by supplementing with other nutrients. *Seed Res.*, **28**: 10-12.

Kaur, J. and Singh, G. (1986). Harmonal regulation of grain filling in relation to peduncle anatomy in rice cultivars. *Indian J. Experi. Biol.*, **37** : 146-149.

Know, O.K., Kim, K.S., Hong, Y.P. and Han, I.S. (1990). Effect of day length and GA3 on the conservation from cliestogamy to clasmogamy in Violu mandshurica W. Becker. *J. Korean Soc. Hort. Sci.*, **31**: 305-310.

Mishra, M. and Pandey, M.P. (1994). Effect of certain treatments on out pollination and seed production of cytosterile rice (*Oryza sativa* L.). *Oryza*, **31**: 58-60.

Mobin, M., Rahman, A.H. and Ahmad, K.K. (2007). Timing of GA_3 application to Indian mustard (*Brassica juncea* L.): Dry matter distribution, growth analysis and nutrient uptake. *J. Agron.*, **6** : 55-60.

Muthukumar, V.B., Velayucham, K. and Thavaprakaash, N. (2007). Plant growth regulatorsand split application of nitrogen improves the quality parameters and green cob yield of baby corn (*Zea mays* L.). *J. Agron.*, **6** : 208-211.

Naeem, N., Ishtiaq, M., Khan, P., Mahammad, N., Khan, J. and Jamiher, B. (2001). Effects of gibberellic acid on growth and yield of tomato cv. Roma. *J. Biol. Soi.*, **1**:448-450.

Pandey, M.P., Mani, M.C., Singh, H. and Singh, J.P. (1996). *Hybrid rice seed production. A technology manual*. power printers, New Delhi, India, pp. 44.

Panse, V.G. and Sukhatme, P.V. (1967). *Stastical methods for agriculkture workers*. 2nd Ed., ICAR Publication, New Delhi, India, pp. 44.

Ponnuswamy, A.S., Rangaswamy, M., Rangaswamy, P. and Thiyagarajan, K. (1998). Adapting hybrid rice seed production technology. *Internat. Rice Res. Notes*, **23**(2): 26.

Prasad, M.N., Virmani, S.S. and Gutuman, A.D. (1988). Substituting urea and boric acid for GA_3 in hybrid rice seed production. *Internat. Rice Res. Newsletter*, **13** : 9-10.

Shivaraju, G. (1993). Effect of boron on seed yield and quality parameters in sunflower populations and its parents. M.Sc. (Ag.) Thesis, University of Agricultural Sciences, Bangalore, India.

Singh, R. and Sahoo, S.K. (1998). Evaluating hybrid seed production technology along with the new growth harmone mangiferin. *Internat. Rice Res. Notes*, **23** (1): 23.

Tiwari, D.K., Pandey, P., Giri, S.P. and Diwedi, J.L. (2011). Effect of GA_3 and other plant growth regulators on hybrid rice seed production. *Asian J. Plant Sci.*, **10**:1-7.

Virmani, S.S., Mao, C.X., Toledo, R.S., Hossain, M. and Janaiah,

A. (2007). Hybrid rice seed production technology and its impact on seed industries and rural employment opportunities in Asia. http:// www.agnet.org/library/tb/156/tb156.pdf.

Xu, S. and Li, B. (1988). Managing hybrid rice seed production. Proceedings of the 1st International Symposium on Hybrid Rice, Oct. 6-10, International Rice Research Institute, Manila, Philippines, pp: 157-163.

Yogesha, H.S., Pandey, S. and Sharma, S.P. (2000). GA3 to obtain synchrony in hybrid seed production. *Seed Res.*, **28**: 87-89.

Yuan, L.P. and Virmani, S.S. (1988). Status of hybrid rice research and development. In : *Hybrid rice*, International Rice Research Institute, Manila, Philippines, pp. 7-24.