

Physiological basis of heterotic vigour in rice seeds

D. VIJAYALAKSHMI, C. VIJAYALAKSHMI, M. DJANAGUIRAMAN AND U. BANGARUSAMY
Dept. of Crop Physiology, Tamil Nadu Agricultural University, Coimbatore - 641 003, Tamil Nadu

The phenomenon of heterosis in rice was first reported by Jones (1926). Hybrid rice breeding seems to provide significant yield increase and further enhance the productivity of rice. Despite the high cost, the hybrid seeds show superiority compared to its parents and other varieties. Expression of heterosis even to a small magnitude for individual component characters is a desirable factor (Hatchcock and McDaniel, 1973). The present study was, therefore, carried out during June-September 2002 at the Dept. of Crop Physiology, TNAU, Coimbatore to study the heterosis in germination percentage, vigour index, rate of water uptake and other initial seed characters.

Hundred seeds of the rice CORH2 and its parents (IR 58025A and C20R) were sown in trays with 7 replications. Observations on germination percentage, root length, shoot length and plant height were taken. The dry matter production namely root dry weight, shoot dry weight and whole plant dry weight of 20 days old seedlings was estimated by drying the seedlings first in open air and then in hot air oven at 75°C till a constant weight was obtained. The vigour index both on dry weight basis and height basis was estimated. The data were analyzed statistically in a completely randomized block design with seven replications.

- (i) The germination percentage was worked out using the formula:

$$\text{Germination percentage} = \frac{\text{Number of seeds germinated}}{\text{Total number of seeds sown}} \times 100$$

- (ii) Vigour index (height basis) = Germination percentage \times Plant height
(iii) Vigour index (dry wt. basis) = Germination percentage \times Plant dry weight

- (iv) The rate of water uptake in seeds of the hybrid rice and its parents were calculated separately by taking the initial weight of fifty seeds of hybrids and parents. Likewise fifteen sets of fifty seeds were soaked in water. Each time three sets comprising of one hybrid and two parents were weighed at intervals of 2, 4, 8, 12 and 24 hours. The rate of water uptake by seeds were found out using the formula:

$$\text{Rate of water uptake} = \frac{\text{Wet weight} - \text{Dry weight}}{\text{Dry weight}} \times 1000 \text{ mg of water/g of seed}$$

From the data relative heterosis and heterobeltiosis were assessed.

From Table 1 it is clear that all the parameters showed a positive heterosis. The germination percentage, root length, shoot length and vigour index were higher in the hybrid CORH 2 compared to its parents. Similar findings in rice were reported by Li *et al.* (1990) who found that F₁ hybrids had better germination, root length and vigour index when compared to their parents. Highly significant variations in root dry weight and shoot dry weight between the hybrid and parents were also obtained. The hybrids were taller than the parents and showed a positive heterosis for plant height. Veeraswamy *et al.* (1973) also reported positive heterosis for plant height in *Cajanus cajan*. The F₁ showed 50.0 per cent vigour over the better parent. Prabakaran (1996), in hybrid rice found minimum reduction in germination percentage root length, shoot length, dry matter production and vigour index compared with the parents, in which the reduction was maximum.

Regarding the rate of water uptake, the hybrids showed positive heterosis (Table 2).

Table 1. Heterosis in initial seeds characters of hybrid rice CORH-2 and its parents

Parents/ Hybrids	Germi- nation (%)	Root length (cm)	Shoot length (cm)	Plant height (cm)	Vigour index (length basis)	Root dry weight (g)	Shoot dry weight (g)	Whole plant dry wt. (g)	Vigour index (dry wt. basis)
CORH 2	85.7	2.3	13.7	16.23	1372.2	0.230	0.066	0.296	25.37
C20R	60.0	2.1	12.01	14.02	851.4	0.189	0.055	0.242	14.52
IR 58025 A	51.2	0.77	6.87	7.91	382.4	0.090	0.023	0.113	5.65
Heterosis	54.14	60.28	45.13	48.02	122.43	64.87	69.23	66.76	151.56
SEd	0.4014	0.0843	0.0515	0.1218	0.7893	0.0051	0.0012	0.0054	0.1051
CD (P=0.05)	1.634**	0.2428**	0.1483**	0.3508**	2.2464**	0.0145**	0.0038**	0.0156**	0.3026**

Table 2. Heterosis and heterobeltiosis on rate of water uptake of hybrid rice CORH-2

Rate of water uptaker after	Parents/ Hybrids	Initial weight of the seeds (g)	Net wt. of seeds at 2,4,8, 12 and 24 hrs (g)	Rate of water up- taker by seeds (mg/ g of seed)	Heterosis (%)	Hetero- beltiosis (%)
Two hours	CORH 2	1.002	1.252	24.95	23.26	15.99
	C20R	1.112	1.323	189.75		
	IR 58025 A	0.967	1.175	215.09		
Four hours	CORH 2	0.899	1.22	357.06	48.19	22.64
	C20R	1.169	1.392	190.76		
	IR 58025 A	0.948	1.224	291.14		
Eight hours	CORH 2	0.926	1.314	419.00	52.52	19.41
	C20R	1.093	1.310	198.54		
	IR 58025 A	0.912	1.232	350.88		
Twelve hours	CORH 2	0.959	1.232	350.88	52.27	17.58
	C20R	1.111	1.341	209.02		
	IR 58025 A	0.879	1.246	384.00		
Twenty four hours	CORH 2	0.917	1.399	525.63	31.21	17.15
	C20R	1.007	1.362	352.53		
	IR 58025 A	0.945	1.369	448.68		

There was an increase in the percentage of heterosis upto 8 hours and thereafter the percentage of heterosis dropped from 12 to 24 hours. The hybrid also exhibited a positive heterobeltiosis. The increase in water uptake in hybrid seeds may be due to high matrix force. The matrix potential of air-dried seeds such as cocklebur may approach 1000 bars (Meidner and Sheriff, 1976). The volume of an absorbent increases as a result of imbibition. However, the total volume of the system is always less after imbibition,

than before imbibition starts. The reason for this difference in volume is that water molecules adsorbed to the surface of colloidal material present in the adsorbent are held relatively tightly as given by Devlin and Witham (1999). This increased water uptake may enhance the α -amylase activity. The increased activity may trigger the mobilization of reserves towards the growth of the seedling. This mobilization efficiency is a direct interpretation of the overall biochemical and physiological process, which

seems to be an accurate index for detecting deterioration and finally the loss of viability in rice seeds. Similar findings were reported in soyabean seeds (Srivastava and Sareen, 1974).

References

- Devlin, M. and Witham, F.H. (1999). Plant Physiology, pp.49-51.
- Hatchcock, R. and McDaniel (1973). Yield and yield component heterosis in Avena hybrids. *Crop Sci.* 13: 8-18.
- Jones, J.W. (1926). Hybrid vigour in rice. *J.Am. Soc. Agron.* 18: 423-28.
- Li, P., Wang, Y.R. and Lie, H.X. (1990). Physiological basis of high yielding heterosis in F₁ hybrids of indica rice. *Scientia Agricultura Sinica*, 23: 39-44.
- Meidner, J. and Sheriff, D.W. (1976). Water and plants. New York, Wiley.
- Prabakaran, S.R. (1996). Studies on seed technological aspects in hybrids rice. Unpub. M.Sc.(Ag.) Thesis, TNAU, Coimbatore.
- Srivastava, A.K. and Sareen, K. (1974). Physiology and biochemistry of deterioration of soyabean seeds during storage. I. Mobilization efficiency and N-metabolism. *Seed Res.* 3: 39-44.
- Veeraswamy, R., Rangasamy, P., Fazlullah Khan, A.K. and Mohammed Sheriff, N. (1973). Heterosis in *Cajanus cajan* L. Mill. sp. *Madras Agric. J.* 60: 1317-1319.

(Received: August 2002; Revised: April 2003)

Madras Agric. J. 90 (7-9) : 547-549 July-September 2003

Research Notes

Effect of certain growth regulators on growth and yield of greengram

S. RAMA RAO

Department of Plant Physiology, S.V. Agricultural College, Tirupati - 517 502, Andhra Pradesh

The importance of phenolics as plant growth regulators is well recognized. Though phenolics play a very significant role in regulating the growth and development of plants, they remain an almost untapped potential for increasing crop productivity (Nanda and Kumar, 1982). Only few attempts have been made. Phenolic compounds have been reported to act as analogues of growth hormones (Vendaring and Buffel, 1961). Application of salicylic acid increased yield parameters in Cheena millet (Datta and Nanda, 1985), while 1% triacontanol significantly increased the growth and grain yield in rice (Datta, 1996). Much work was not done on the effect of growth regulators on growth and yield of greengram. Hence, the present investigation was carried out to study the effect of certain growth regulators on the growth and yield of greengram.

The present experiment was carried out at Regional Agricultural Research Station, Lam, Guntur, Andhra Pradesh during *rabi* 2000 and 2001. The experiment was carried out in black

soil under rainfed conditions in a randomized block design with 8 treatments, replicated thrice. Cultivar LGG 460 was sown in an individual plot size of 3.0m x 3.6m with a spacing of 30cm x 10cm. The treatments consisted of foliar application of salicylic acid (0.1% and 0.2%) triacontanol (0.1 and 0.2%) mixtalol (0.1% and 0.2%), water spray and control. The treatments were imposed at the vegetative and flowering stage. Recommended package of practices were followed. The data on plant height, number of branches, leaf area index, dry matter, yield and yield components and harvest index were recorded at the time of harvest.

All the treatments significantly increased the growth in terms of plant height, number of branches, leaves and dry matter production over water spray and control (Table 1). Among the treatments, foliar application of triacontanol at 0.2% and mixtalol at 0.1% were on par with each other regarding plant height, number of branches and dry matter production. Application