Chapter 6

General Discussion

In developing hybrid rice, A-line or CMS line and R-line or restorer line are considered as special materials of breeding lines. The superiority or hybrid vigor obtained from both important components consideration will give the opportunity of success in hybrid rice improvement. Yuan and Virmani (1988) summarized three-line breeding development as follow:

1. The effective way to breed a cytogenetic system of CMS lines is through distant hybridization, using primitive types as cytoplasmic sources and advanced breeding lines as nuclear sources.
2. Screening elite varieties or lines by test crossing with CMS lines is a convenient way to obtain restorer lines for Indica rice.
3. Restorer genes and male sterile-inducing cytoplasm can be transferred to any variety through breeding.

Yuan *et al.* (2003) described that characteristic of A-lines or CMS line compared with B-lines or maintainer line should be in terms of stronger and longer tiller, basal part of the panicle is enclosed in the flag leaf sheath, daily flowering time is later and lasts longer, anther shape is slender, thin milky white or yellowish in color. Pollen of A-line is irregular in shape, round and unstained with I-KI. To be suitable for developing F1 hybrids, Virmani and Banghu, (1988) also further suggested that A-line or CMS source should be stable for complete pollen sterility over environment, easy to maintain, not weakened agronomic characteristics of the

hybrids and enhanced flowering behavior and characteristics influencing outcrossing, so that bulk hybrid seeds can be economically produced.

More than 95% of A-line utilized in the production of commercial and experimental hybrids have WA cytoplasm which are identified naturally in wild rice (*Oryza sativa* f. *spontanea*) population. This A-line possesses aborted pollen (WA) (Ahmed and Siddiq, 1988).

Li and Yuan (2000) categorized requirement for elite A-line or CMS line as:

1. Stable performance of male sterility with no risk of recovering the self fertility after generations of backcrossing or due to different ecological conditions.
2. Easy restorability of male sterility with ease of identifying or developing R-line for which the F1 has normal seed set with minimal influence by environmental condition.
3. High outcrossing potential with little enclosure of the panicle within the flag leaf sheath, daily blooming time essentially synchronized with the normal B and R-lines, long floret opening duration, large floret opening angle, high stigma extortion proportion, short and narrow flag leaf and thus a high yield potential for F1 seeds production.
4. Good grain quality and resistance to diseases and the insect pests.
5. Good combining ability.

For R-line consideration, it has been found that effective restorer lines are mainly distributed in the tropic where indica rice are grown since several excellent restorers could be isolated from different CMS sources in many countries in southeast Asia (Ahmed and Siddiq, 1998). Zebing and Yingguo (1988) reported that main

factors affecting fertility restoration of R- line consisted of (a) difference in genetic diversity including differences in sterile cytoplasm and backgrounds of maintainers and restorers and (b) due to environmental variation. Environmental factors, particularly temperature, greatly influence fertility restoration, seed setting rate may drop when unfavorable high or low temperature occurs during the pollen mother cell meiosis stage or heading stage. So that, elite restorer line should have strong restoring ability, good agronomic characters and combining ability, well-developed anthers with heavy pollen load, good flowering habits and normal dehiscence (Yuan *et at.*, 2003).

Results obtained from A-line and R-line evaluation in Chapter 3 indicated obviously that variation of pollen sterility of A-line and fertility restoration of R-line were observed and gave similar results to literature reviewed.

As the result shown in Table 4.2, most of A-line and R-line performed good general combining ability and a few lines expressed good specific combining ability. The good combination of inbred lines to produce hybrids play a major role in the improvement of rice production. Combining ability of inbred lines can be used as a powerful tool for making decision to select parent lines.

Falconer and Mackay (1996) suggested that improvement of inbred line can be made by preliminary selection of the lines for their general combining ability which observed from the analysis of additive variance in the population. Any further improvement can be made by considering additive genetic variance, that obtain from selecting particular inbred line for specific combining ability. The general combining ability of parents has great effect on yield potential and certain economic characters of hybrid. Vasal *et al.* (1993) reported that general combining ability in maize had

significant effect on plant height and broad genetic base provided opportunity for developing intra population interline hybrid. Betran *et al.* (2003) pointed out that specific combining ability in maize had strongest correlation with genetic distance. Environmental effects which gave lower value of genetic distance and significantly affected specific combining ability and high-parent heterosis, suggested that the stressed environmental conditions had an influence on the expression of specific combining ability.

Yuan *et al*. (2003) suggested that it is necessary to select parents with high effective value in combining ability for tillering ability, number of panicles/plant, filled grain/panicle, 1000-grain weight, and grain weight/plant. Parents with low effective value of plant height and percentage of empty grains were useless.

Superiority of F1 hybrids derived from crossing of inbred lines with their good performances can be measured on grain yield, yield components and growth that exhibited better heterosis. The amount of heterosis was different among the hybrid and did not give as high as expected as shown in Chapter 4, probably due to level of inbreeding depression of individual inbred line (Falconer and Mackay, 1996). Naturally, rice plant is nearly complete self-pollination, so effect resulted from inbreeding depression is generally not higher than the cross-pollination plant. Although, it is difficult to raise degree of heterosis in rice, many countries had reported that degree of heterosis could be increased more than 30% over standard varieties.

The degree of heterosis in different kinds of hybrid rice varieties has the general trends: indica/japonica>indica/javanica>japonica/javanica>indica/indica> japonica/japonica. Indica/japonica hybrids possess very good sink and rich source, the

yield potential of which is 30% higher than inter-varietal indica hybrids (Yuan *et al.* 2003).

In rice breeding program, yield trial must be manipulated for evaluating adaptability, yield ability or other desirable trait expressed by function of gene, environment and its interaction. Although some promising hybrids IR62829A/ RD7 and RD23A-23/IR58110-144-2-2-2R gave higher grain yield over standard varieties, they are required to gain adoption from farmers. Adoption of hybrid rice by farmers and seed industry companies must be together considered. Yuan and Virmani (1988) described that the adoption of hybrid rice technology generally depended upon yield advantage shown by hybrids over best available conventional varieties and the country's capacity to organize efficient seed production, processing certification, and distribution program in the public or private sector.

However, the results gained from this study can be used as a guideline for developing promising R-line from elite conventional varieties. Combining ability was identified predominantly among parental lines and high level of heterotic effects were expressed in crosses if their parents were specifically combined. In addition, results of this study had further suggestions that hybrid variety could be produced more successfully and efficiently if advanced biotechnological technique is considered to be used with standard hybrid development procedure. As well, utilization of parents must be more diversed in genetic germplasm base.