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|  |  | **THE A-LINE, B-LINE, R-LINE MODEL FOR HYBRID SEED PRODUCTION** |  |  |
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|  | The onion model for producing single-cross hybrid seed was developed utilizing cytoplasmic male-sterile lines called A-lines; male-fertile maintainer lines called B-lines; and male-fertile, fertility-restoring lines called R-lines. The procedure is accomplished in these steps: |  |
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|  | * Introduction of a male-sterile cytoplasm into the A-line by the backcross procedure, | | | | |  |  |
|  | * Maintenance of the male-sterile A-line by pollination from a male-fertile maintainer line with identical genotype, the B-line, | | | | | | |  |  |
|  | * Development of fertility-restorer lines called, R-lines, and | | |  |  |
|  | * Crossing A-lines × R-lines to produce hybrid seed. |  |  |
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|  | The A-line, B-line, R-line procedure for onion is illustrated in Figure 11.5. |  |
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|  | Normally two or more nuclear, fertility-restorer genes and some modifying genes are required to restore complete fertility to the cytoplasmic male sterile A-line. The cytoplasm and a two-gene (*Rf1, Rf2*) fertility-restorer system are shown for the different breeding lines in the example below: |  |
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|  | 0210-001.gif |  |
|  | A LINE seed for next generation is produced by pollinated male sterile a Line with B-Line (isoline of A Line) This A-Line seed can be used for next year Hybrid seed Production. B-Line seed for next generation is produced by selfing  0210-001.gif  Fertily hybrid seed can be produced by pollinating A-line with R-Line (that have fertility restorer gene). |  |
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|  | **A-LINES AND B-LINES**. In the cross to produce hybrid seed, the A-line is the female or seed-producing parent line. It contains recessive, nonrestorer (*rf1, rf2)* genes. Inbred lines that do not contain dominant, fertility-restorer genes are crossed to a source of cytoplasmic male sterility and successively backcrossed until the genotype of the A-line is recovered in the male sterile cytoplasm. The line with the cytoplasmic male sterility is used as the female parent in the crosses because the cytoplasm is transmitted through the egg, not the pollen. Normally five to seven backcrosses are required to transfer the A-line chromosomes into sterile cytoplasm and fully recover the genotype of the recurrent parent. The genotype of the A-line must combine with that of an R-line to produce a productive hybrid.  The cytoplasmic male sterile A-line is maintained by pollination from a male-fertile counterpart, called the B-line. The B-line has the same genotype as the A-line, with normal instead of sterile cytoplasm, and recessive, nonrestorer (*rf1*, *rf2*) genes like the A-line. |  |
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| Fig. 11.5. The A-line, B-line, and R-line model for producing single-cross  hybrid seed in onion. The male-sterile A-line is maintained by  pollination from a male fertile, genetically identical, nonrestorer  B-line. Hybrid seed is produced by pollination of the A-line from  the fertility-restoring R-line. |

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|  | **R-LINES**. The R-line is the pollen parent in the cross to produce hybrid seed. The function of the R-line is to:   1. Pollinate the A-line, |  |
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|  | 1. Restore fertility in the hybrid seed, and |  |
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|  | 1. Combine with the A-line to produce a vigorous and productive hybrid. |  |
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|  | Abundant pollen production and complete anther extrusion to aid in pollen dissemination are essential characteristics of the R-lines. Because the R-line has dominant genes for fertility restoration, it may have either fertile cytoplasm or sterile cytoplasm. It may be advantageous to develop restorer lines with sterile cytoplasm, because presence of restorer genes can then be confirmed without testcrossing to male sterile lines. Two restorer genes are shown in this example, but a third restorer gene and additional modifying genes are often required to completely restore fertility to the hybrid progeny in different species. |  |
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|  | Another requisite of the R-line is ability to combine with the A-line to produce a superior yielding hybrid. The combining ability of potential R-lines is evaluated by crossing with A-line testers and growing the hybrid progenies in yield trials. If a line with superior combining ability is identified, restorer genes may be added by the backcross procedure. Modifier genes usually are not added with the backcross but must be present in the potential R-line for it to be a successful parent line. |  |
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|  | **CROSSING A- AND R-LINES**. The hybrid seed is produced on the A-line after pollination from the R-line. In commercial seed production, the A- and R-lines are planted in alternate strips in the hybrid seed production field, with the male sterile A-line being pollinated by wind-blown pollen from the R-line. In corn, sunflower, and wheat, the symbol *Rf* is used to designate the fertility-restoring gene. The symbol *Ms* is used for the fertility-restoring gene in onion, millet, and sorghum. |  |
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|  | *An important feature of the cytoplasmic-male sterility/fertility-restorer gene system is that it made possible the production of hybrid cultivars in crop species in which male and female floral organs are contained in the same floral structures*. Hybrid seed could now be produced in crop plants such as faba bean, millet, rice, sorghum, sugarbeet, sunflower, wheat, and other field and vegetable crops that, unlike corn, do not have the luxury of detasseling for pollen control. |  |