Mutation breeding

From Wikipedia, the free encyclopedia

Mutation breeding is the process of exposing seeds to chemicals or radiation in order to generate mutants with desirable traits to be bred with other cultivars. Plants created using mutagenesis are sometimes called mutagenic plants or mutagenic seeds. From 1930–2007 more than 2540 mutagenic plant varietals have been released[1] that have been derived either as direct mutants (70%) or from their progeny (30%).[2] Crop plants account for 75% of released mutagenic species with the remaining 25% ornamentals or decorative plants.[3] However, it is unclear how many of these varieties are currently used in agricultural production around the world, as these seeds are not always identified or labeled as being mutagenic or having a mutagenic provenance.

Contents

Process

There are different kind of mutagenic breeding such as using chemical mutagens like EMS and DMS, radiation and transposons are used to generate mutants. Mutation breeding is commonly used to produce traits in crops such as larger seeds, new colors, or sweeter fruits, that either cannot be found in nature or have been lost during evolution.[4]

Radiation breeding

Exposing plants to radiation is sometimes called radiation breeding and is a sub class of mutagenic breeding. Radiation breeding was discovered in the 1920s when Lewis J. Stadler of the University of Missouri used X-rays on barley seeds. The resulting plants were white, yellow, pale yellow and some had white stripes.[5] During the period 1930–2004 Gamma rays were employed to develop 64% of the radiation-induced mutant varieties, followed by X-rays (22%).[3]

Radiation breeding may take place in atomic gardens;[6] and seeds have been sent into orbit in order to expose them to more cosmic radiation.[7]

History

According to garden historian Paige Johnson

> After WWII, there was a concerted effort to find 'peaceful' uses for atomic energy. One of the ideas was to bombard plants with radiation and produce lots of mutations, some of which, it was hoped, would lead to plants that bore more heavily or were disease or cold-resistant or just had unusual colors. The experiments were mostly conducted in giant gamma gardens on the grounds of national laboratories in the US but also in Europe and countries of the former USSR.[8]

Comparison to other agronomic techniques

In the debate over Genetically Modified foods, the use of transgenic processes is often compared and contrasted with mutagenic processes.[9] While the abundance and variation of transgenic organisms in human food systems, and their effect on agricultural biodiversity, ecosystem health and human health is somewhat well documented, mutagenic plants and their role on human food systems is less well known, with one journalist writing "Though poorly known, radiation breeding has produced thousands of useful mutants and a sizable fraction of the world's crops...including varieties of rice, wheat, barley, pears, peas, cotton, peppermint, sunflowers, peanuts, grapefruit, sesame, bananas, cassava and sorghum."[5] Mutagenic varieties tend to be made freely available for plant breeding, in contrast to many commercial plant varieties or germplasm that increasingly have restrictions on their use[3] such as terms of use, patents and proposed Genetic user restriction technologies and other intellectual property regimes and modes of enforcement.

Unlike genetically modified crops, which typically involve the insertion of one or two target genes, plants developed via mutagenic processes with random, multiple and unspecific genetic changes[10] have been discussed as a concern[11] but are not prohibited by U.S. or other country organic standards. Somewhat controversially,[12] several organic food and seed companies promote and sell certified organic products that were developed using both chemical and nuclear mutagenesis. Several certified organic brands, whose companies support strict labeling or outright bans on GMO-crops, market their use of branded wheat and other varietal strains which were derived from mutagenic processes without any reference to this genetic manipulation. These organic products range from mutagenic barley and wheat ingredient used in organic beers[13] to mutagenic varieties of grapefruits sold directly to consumers as organic.[14]

Mutagenic varietals

Japan

- Osa Gold Pear[15]

United States

- Rio Star Grapefruit[3]
- Todd's Mitcham Peppermint (*Verticillium* wilt tolerance)[3]
- Murray Mitcham Peppermint (*Verticillium* wilt tolerance)[3]
- Calrose 76 Rice (short height rice induced with gamma rays)[3]

People's Republic of China

- Purple Orchard 3 Sweet potato [16]
- Zhefu 802 (rice mutant)[17]
- 26Zhaizao (indica rice mutant created with gamma rays)[17]

India

- PNR-381 Rice [3]
- Sharbati Sonora wheat [3]
- 'MUM 2', 'BM 4', 'LGG 407', 'LGG 450', 'Co4', 'Dhauli' (TT9E), 'Pant moong-1' blackgram (YMC, (Yellow mosaic virus) resistance) [3]

Italy

- Creso wheat [18]

Pakistan

- Basmati 370 (short height rice mutant)[17]
- NIAB-78 (high yielding, heat tolerant, early maturing cotton mutant)[17]
- CM-72 (high yielding, blight resistant, desi type chickpea mutant created with 150 Gy of gamma rays)[19]
- NM-28 (short height, uniform and ealry maturing, high seed yield mungbean mutant)[19]
- NIAB Masoor 2006 (early maturing, high yield, resistant to disease lentil mutant created with 200 Gy of radiation)[19]

Thailand

- RD16 and RD6 (aromatic indica rice mutant created with gamma rays)[17]

Czech Republic

- Diamant barley (high yield, short height mutant created with X-Rays)[20]

United Kingdom

- Golden Promise barley (semi-dwarf, salt tolerant mutant created with gamma rays)[21] Is used to make beer and whiskey[22]

Release by nation

As of 2004 the percentage of all mutagenic varietals released globally, by country, were:[3]

- (26.8%) People's Republic of China
- (11.5%) India
- (9.3%) Soviet Union + Russia
- (7.8%) Netherlands
- (5.7%) United States
- (5.3%) Japan

See also

- Atomic gardening

References

1. ^ Schouten, H. J.; Jacobsen, E. (2007). "Are Mutations in Genetically Modified Plants Dangerous?". *Journal of Biomedicine and Biotechnology* **2007**: 1. doi:10.1155/2007/82612 (http://dx.doi.org/10.1155%2F2007%2F82612).
2. ^ Maluszynsk, M.K.; K. Nichterlein, L. van Zanten & B.S. Ahloowalia (2000). "Officially released mutant varieties – the FAO/IAEA Database". *Mutation Breeding Review* (12): 1–84.
3. ^ ***a b c d e f g h i j k*** Ahloowali, B.S. (2004). "Global impact of mutation-derived varieties" (http://www.iaea.org/programmes/nafa/d2/global-impact.pdf). *Euphytica* **135**: 187–204. Retrieved 20 April 2011.
4. ^ "New Citrus Variety Released by UC Riverside is Very Sweet, Juicy and Low-seeded" (http://newsroom.ucr.edu/news_item.html?action=page&id=2602).
5. ^ ***a b*** Broad, William J. (28 August 2007). "Useful Mutants, Bred With Radiation" (http://www.nytimes.com/2007/08/28/science/28crop.html). New York Times. Retrieved 20 April 2011.
6. ^ Atomic Gardens: Public Perceptions & Public Policy (http://www.lifesciencesfoundation.org/magazine-Atomic_Gardens.html), Life Sciences Foundation Magazine, Spring 2012.
7. ^ [Peter (http://www.good.is/community/peterandreysmith%7CSmith,)] (2011-04-12). "How Radiation is Changing the Foods that You Eat" (http://www.good.is/post/how-radiation-is-changing-the-foods-that-you-eat/). *GOOD*. GOOD Worldwide, Inc. Retrieved 2011-07-16.
8. ^ Johnson, Paige. "Atomic Gardens" (http://pruned.blogspot.com/2011/04/atomic-gardens.html). Retrieved 20 April 2011.
9. ^ UK Government Science Review First Report (http://www.gmsciencedebate.org.uk/report/pdf/gmsci-report1-full.pdf), Prepared by the GM Science Review panel (July 2003). Chairman Professor Sir David King, Chief Scientific Advisor to the UK Government, P 9: "...it is necessary to produce about 100 GM plants to obtain one that has the desirable characters for its use as a basis of a new GM crop variety. ...Most of these so-called conventional plant breeding methods (such as gene transfer by pollination, mutation breeding, cell selection and induced polyploidy) have a substantially greater discard rate. Mutation breeding, for instance, involves the production of unpredictable and undirected genetic changes and many thousands, even millions, of undesirable plants are discarded in order to identify plants with suitable qualities for further breeding."
10. ^ Useful Mutants, Bred With Radiation (http://www.nytimes.com/2007/08/28/science/28crop.html), by William J. Broad, New York Times, August 28, 2007.
11. ^ Discussion Document Excluded Methods Terminology (http://www.ams.usda.gov/AMSv1.0/getfile?dDocName=STELPRDC5102656), National Organic Standards Board GMO ad hoc Subcommittee paper, U.S. Agricultural Marketing Service, published February 6, 2013.
12. ^ Mendel in the Kitchen: A Scientist's View of Genetically Modified Foods (http://books.google.com/books?id=PwkOVO9BbnkC&dq), By Nina V. Fedoroff and Nancy Marie Brow, pg. 17, Joseph Henry Press, 2004.
13. ^ Golden Promise Organic Ale (http://beeradvocate.com/beer/profile/188/2697)
14. ^ Wasatch Organic Rio Red Grapefruit (http://www.wasatchorganics.com/products-page/grapefruit/organic-henderson-grapefruit-duplicate/)
15. ^ Kotobuki, Kazuo. "Japanese pear tree named `Osa Gold`" (http://www.google.com/patents?id=mKEGAAAAEBAJ). Retrieved 20 April 2011.
16. ^ "Lift-off for Chinese space potato" (http://news.bbc.co.uk/2/hi/6353403.stm). *BBC News*. 12 February 2007.
17. ^ ***a b c d e*** Ahloowalia, B. S.; Maluszynski, M. (2001). "Production Process in Old and Modern Spring Barley Varieties". *Euphytica* **118** (2): 167. doi:10.1023/A:1004162323428 (http://dx.doi.org/10.1023%2FA%3A1004162323428).

18. ^ "Genetic Improvement of Durum Wheat in Casaccia. The Creso Case" (http://www.sede.enea.it/produzione_scientifica/pdf_EAI/2010/6/CasoCreso.pdf).
19. ^ ***a b c*** (2008) NIAB - Plant Breed9ing & Genetics Division, Achievements (http://www.niab.org.pk/mutation.htm) Nulcear Institute for Agriculture and Biology, Faisalabad, Pakistan, Retrieved 16 May 2013
20. ^ Lipavsky, J. Petr, J. and Hradecká, D, (2002) "Production Process in Old and Modern Spring Barley Varieties" Die Bodenkultur, 53 (1) 2, Page 19
21. ^ Forster, B. P. (2001). "Mutation genetics of salt tolerance in barley: An assessment of Golden Promise and other semi-dwarf mutants". *Euphytica* **120** (3): 317–328. doi:10.1023/A:1017592618298 (http://dx.doi.org/10.1023%2FA%3A1017592618298).
22. ^ Broad, William (2007-08-28). "Useful Mutants, Bred With Radiation" (http://www.nytimes.com/2007/08/28/science/28crop.html?pagewanted=all&_r=1&). *New York Times*. Retrieved 2013-06-19.

External links

- Institute of Radiation Breeding (http://www.irb.affrc.go.jp/index-E.html)
- The FAO/IAEA Programme’s Database of Mutation Enhanced Technologies for Agriculture (META) (http://mvgs.iaea.org/Default.aspx)

Categories: Biotechnology | Breeding | Mutagenesis