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Rice Cultivar 'Jewel'

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(54) **RICE CULTIVAR 'JEWEL'**

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None
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,281,416 B1   8/2001   Moldenhauer
7,429,697 B2   9/2008   Moldenhauer
9,877,452 B1 * 1/2018   Moldenhauer A01H 6/4636

OTHER PUBLICATIONS

Horsch, R. B., et al. "A simple and general method for hybridization revealed the expected " Science 227 (1985) 1229-1231.
Linscombe, S.D., et al. 1993. Registration of 'Bengal' rice. Crop Science 33:645-646.
Linscombe, S.D., et al. 2001. Registration of 'Earl' rice. Crop Science 41:2003-2004.
Registration of 'LaGrue' Rice. Crop science 34(4):1123-1124, 1994.
Registration of 'Lemont' Rice. Crop science 25(5):883-885, 1985.
Registration of Lebonnet Rice1 (Reg. No. 42). Crop science 15(6):886, 1975.
Registration of Dawn Rice1 (Reg. No. 33). Crop science 8(3):401, 1968.
Registration of Starbonnet Rice1 (Reg. No. 31). Crop science 8(3):400, 1968.
Registration of 'Wells' Rice. Crop science 47(1):442-443, 2007.

* cited by examiner

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(57)   **ABSTRACT**

A rice cultivar designated 'Jewel' is disclosed herein. The present invention provides seeds, plants, and plant parts derived from rice cultivar Jewel. Further, it provides methods for producing a rice plant by crossing Jewel with itself or another rice variety. The invention also encompasses any rice seeds, plants, and plant parts produced by the methods disclosed herein, including those in which additional traits have been transferred into Jewel through the introduction of a transgene or by breeding Jewel with another rice cultivar.

18 Claims, No Drawings

RICE CULTIVAR 'JEWEL'

BACKGROUND OF THE INVENTION

The present invention relates to a new and distinctive rice cultivar, designated 'Jewel'.

Rice is an ancient agricultural crop and is today one of the principal food crops of the world. There are two cultivated species of rice: *Oryza sativa* L., the Asian rice, and *O. glaberrima* Steud., the African rice. *O. sativa* L. constitutes virtually all of the world's cultivated rice and is the species grown in the United States. Three major rice producing regions exist in the United States: the Mississippi Delta (Arkansas, Mississippi, northeast Louisiana, southeast Missouri), the Gulf Coast (southwest Louisiana, southeast Texas), and the Central Valleys of California.

Rice is a semi-aquatic crop that benefits from flooded soil conditions during part or all of the growing season. In the United States, rice is grown on flooded soils to optimize grain yields. Heavy clay soils or silt loam soils with hard pan layers about 30 cm below the surface are preferred rice-producing soils because they minimize water losses from soil percolation. Rice production in the United States can be broadly categorized as either dry-seeded or water-seeded. In the dry-seeded system, rice is sown into a well-prepared seed bed with a grain drill or by broadcasting the seed and incorporating it with a disk or harrow. Moisture for seed germination is provided by irrigation or rainfall. Alternatively, the seed may be broadcast by airplane into a flooded field, which is promptly drained following seeding. With the dry-seeded system, when the plants have reached sufficient size (four- to five-leaf stage), a shallow permanent flood of water, 5 to 16 cm deep, is applied to the field for the remainder of the crop season.

In the water-seeded system, rice seed is soaked for 12 to 36 hours to initiate germination, and the seed is broadcast by airplane into a flooded field. The seedlings emerge through a shallow flood, or the water may be drained from the field for a short period of time to enhance seedling establishment. A shallow flood is maintained until the rice approaches maturity. For both the dry-seeded and water-seeded production systems, the fields are drained when the crop is mature, and the rice is harvested 2 to 3 weeks later with large combines. In rice breeding programs, breeders typically employ the production systems predominant in their respective region. Thus, a drill-seeded breeding nursery is used by breeders in a region where rice is drill-seeded and a water-seeded nursery is used in regions where water-seeding is prominent.

Rice in the United States is classified into three primary market types by grain size, shape, and chemical composition of the endosperm: long-grain, medium-grain and short-grain. Typical U.S. long-grain cultivars cook dry and fluffy when steamed or boiled, whereas medium and short-grain cultivars cook moist and sticky. Traditionally, in the southern states, long-grain cultivars have been grown and generally receive higher market prices.

Rice, *Oryza sativa* L., is an important and valuable field crop. A continuing goal of plant breeders is to produce stable, high yielding rice cultivars that are agronomically sound. To accomplish this goal, rice plants with traits that result in superior cultivars must be developed.

SUMMARY OF THE INVENTION

The present invention provides a novel rice cultivar designated Jewel. The invention encompasses the seeds, plants, and plant parts of rice cultivar Jewel, as well as plants with essentially all of the physiological and morphological characteristics of Jewel.

This invention also provides methods for producing a rice plant by planting a plurality of seeds or by crossing rice Jewel with itself or another rice line. Any plant breeding methods using rice cultivar Jewel are part of this invention, including selfing, backcrosses, hybrid production, and crosses to populations. All plants and seeds produced using rice cultivar Jewel as a parent are within the scope of this invention, including gene-converted plants of Jewel. Methods for introducing a gene into Jewel, either through traditional breeding or transformation, are provided herein.

In still another aspect, the present invention provides regenerable cells for use in tissue culture of rice plant Jewel, as well as rice plants regenerated from these tissue cultures.

DEFINITIONS

To provide a clear and consistent understanding of the specification and claims, the following definitions are provided:

Apparent starch amylose content. The amount of starch in the endosperm of milled rice that is amylose, provided in g/kg herein. Amylose content varies depending on the growth environment of the rice. It is an important grain characteristic used to describe cooking behavior.

Backcrossing. A process in which a breeder repeatedly crosses hybrid progeny back to a parental line. For example, a first generation (F_1) hybrid may be crossed with one of the parental lines used to produce the F_1 hybrids.

Breeding. The genetic manipulation of living organisms.

Cell. As used herein, this term includes isolated cells, cells grown in tissue culture, and cells that comprise a plant or plant part.

Cultivar. Used interchangeably with "variety". Refers to plants that are defined by the expression of the characteristics resulting from a given genotype or combination of genotypes, distinguished from any other plant grouping by the expression of at least one characteristic.

Days to 50% heading. The average number of days from emergence to the day when 50% of all panicles are exerted at least partially through the leaf sheath. A measure of maturity.

Embryo. The plant embryo is the part of a seed or bud that contains the earliest forms of the new plant's roots, stem and leaves.

Essentially all of the physiological and morphological characteristics. A plant having "essentially all the physiological and morphological characteristics" of the cultivar exhibits the characteristics of the cultivar with the exception of any characteristics derived from a converted gene.

F #. Denotes a filial generation, wherein the # is the generation number. For example, F1 is the first filial generation.

Gene. Refers to a unit of inheritance corresponding to a distinct sequence of DNA or RNA nucleotides that form part of a chromosome. A gene may encode a polypeptide or a nucleic acid molecule that has a function in the cell or organism.

Gene-converted. Describes a plant wherein essentially all of the desired morphological and physiological characteristics of a parental variety are maintained with the exception of a single trait that was transferred into the variety via backcrossing or genetic engineering.

Genotype. Refers to the genetic constitution of a cell or organism.

Grain yield. Measured in pounds per acre at 12.0% moisture content. The grain yield of rice is determined by the number of panicles per unit area, the number of fertile florets per panicle, and the grain weight per floret.

Haploid. A cell or organism having a single set of unpaired chromosomes.

Head rice. Kernels of milled rice in which greater than ¾ of the kernel is unbroken.

Herbicide resistant. Describes a plant that is tolerant or resistant to an herbicide at a level that would normally kill or inhibit the growth of a normal or wild-type rice plant.

Hybrid. Refers to the offspring or progeny of genetically dissimilar plant parents or stock produced as the result of controlled cross-pollination as opposed to a non-hybrid seed produced as the result of natural pollination.

Kernal length (L). Length of a rice grain, measured in millimeters.

Kernal width (W). Width of a rice grain, measured in millimeters.

Length/width (L/W) ratio. Determined by dividing the average length (L) by the average width (W).

Lodging. The percentage of plant stems that are leaning or have fallen to the ground before harvest. Lodging is determined by visual scoring, in which crops are rated from 0% (all plants standing) to 100% (all plant in plot lying flat on the soil surface). Lodged plants are difficult to harvest and reduce yield and grain quality. Lodging resistance is also called "straw strength".

Milling yield. The total amount of milled rice (whole and broken kernels) recovered after milling (i.e., removal of hulls, bran, and germ). In contrast, head rice yield is the total amount of whole kernels recovered after milling. Both values are expressed as a weight percentage of the original paddy or rough rice sample that was milled. For example, for a sample of 100 grams of rough rice, a milling yield of 65/70 indicates that 65 grams of head rice and 70 grams of total milled rice were produced.

Pedigree. Refers to the lineage or genealogical descent of a plant.

Plant. As used herein, the term "plant" includes plant cells, plant protoplasts, and plant cell tissue cultures from which rice plants can be regenerated; plant calli, plant clumps and plant cells that are intact in plants; and parts of plants, such as embryos, pollen, ovules, flowers, glumes, panicles, leaves, stems, roots, root tips, anthers, and pistils.

Plant height. Measured in centimeters from the soil surface to the tip of the extended panicle at harvest.

Plant parts. Includes, without limitation, protoplasts, leaves, stems, roots, root tips, anthers, pistils, seed, grain, embryo, pollen, ovules, cotyledon, hypocotyl, pod, flower, shoot, tissue, petiole, cells, and meristematic cells.

Progeny. Includes an F_1 rice plant produced from the cross of two rice plants, as well as plants produced from subsequent generational crosses (e.g., F_2, F_3, F_4, F_5, F_6, F_7, F_8, F_9, and F_{10}) with the recurrent parental line.

Regeneration. Refers to the development of a plant from tissue culture.

Seeds. Includes seeds and plant propagules of all kinds including, but not limited to, true seeds, seed pieces, suckers, corms, bulbs, fruit, tubers, grains, cuttings, cut shoots and the like. However, in preferred embodiments, it refers to true seeds.

Trait. Refers to an observable and/or measurable characteristic of an organism. For example, the present invention describes plants that have a trait that make them resistant to fluazifop herbicides.

Transgenic. Describes an organism or cell that contains genetic material that has been artificially introduced.

Wild-type. When made in reference to a gene, "wild-type" refers to a functional gene common throughout a plant population and, thus, arbitrarily designated the "normal" or "wild-type" form of the gene.

DETAILED DESCRIPTION OF THE INVENTION

The present invention provides a novel rice cultivar designated Jewel. The invention encompasses both the seeds of this cultivar and plants grown from these seeds. The invention further encompasses any rice plant having essentially all of the physiological and morphological characteristics rice cultivar Jewel.

As used herein, the term plant includes plant cells, plant protoplasts, plant cell tissue cultures from which rice plants can be regenerated, plant calli, plant clumps and plant cells that are intact in plants or parts of plants, such as embryos, pollen, ovules, flowers, glumes, panicles, leaves, stems, roots, root tips, anthers, pistils, and the like.

Development and Characterization of Rice Cultivar Jewel

Rice cultivar Jewel rice (Poaceae Oryzea *Oryza sativa* L.), is a high yielding, mid-season, long-grain rice cultivar. Jewel originated from the Cross number 20092592: 19991516/19951166/7/'Lebonnet'/CI9902/3/'Dawn'/CI9695//'Starbonnet'/4/'LaGrue'/5/'Wells'/6/RU9201179 made in Stuttgart, Ark., in 2009. Jewel is a complex line containing many different parents which include: 'Katy', 'Newbonnet', 'Drew', Lebonnet, Starbonnet, LaGrue, 'Lemont', Radiated Bonnet 73, Short Strawed Starbonnet, Dawn, 'Bluebonnet 50', 'Lacrosse', 'Zenith', 'Nira', 'Rexoro', Badkalamkati, 'Texas Patna', Supreme Blue Rose, 'L203', 'Bonnet73', Vegold, Zeawchanica Karatalski, and a sister line of Drew. Jewel was bred using hybridization, a combination of modified pedigree and bulk breeding methods, and is adapted to the Southern U.S. rice growing region. The experimental designation for early evaluation of Jewel was STG12L-36-206, starting with a bulk of F_6 seed from the 2012 panicle row L-36-206. Jewel was tested in the Arkansas Rice Performance Trials (ARPT) and the Cooperative Uniform Regional Rice Nursery (URRN) during 2017-2019 as entry RU1701087 (RU number indicates URRN; 17 indicates year entered was 2017; 01 indicates Stuttgart, Ark.; and 087 is its entry number).

Jewel is about 1 to 2 days earlier than 'Roy J' in maturity. Jewel has straw strength approaching that of Roy J, which is an indicator of lodging resistance. On a relative straw strength scale (0=very strong straw, 9=very weak straw) Jewel, 'Diamond', 'LaKast' and Roy J rated 3, 3, 4 and 1, respectively. Jewel has a canopy height of 37 inches, as compared to Diamond and LaKast with canopy heights of 36 inches. JEWEL has a nitrogen fertilizer requirement of 135 lbs/a.

In 14 ARPT tests (2017-2019), Jewel, Diamond, and LaKast, had rough rice grain yields of 187, 205, and 189, bushels/acre, respectively. Data from the URRN conducted at Arkansas during 2017-2019, showed that Jewel had an average grain yield of 229 bushels/acre, which compares favorably with those of Diamond, LaKast, and Roy J, at 239, 208, and 199 bushels/acre, respectively. Milling yields (mg g^{-1} whole kernel:mg g^{-1} total milled rice) at 120 mg g^{-1} moisture from the ARPT, 2017-2018, averaged 580:710, 540:690, 550:690, and 570:700 for Jewel, Diamond, LaKast, and Roy J, respectively. Milling yields for the URRN in Arkansas during the same period of time, 2017-2018, aver-

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aged 600:690, 600:690, 600:700, and 620:710 for Jewel, Diamond, LaKast, and Roy J, respectively.

Jewel has the Pi-ta and Pi-ks genes, which confer resistance to common rice blast (*Pyricularia grisea* (Cooke) Sacc) races IB-1, IB-17, IB-49, IC-17, and IE-1, with ratings of 0, 3, 0, 0, and 0, respectively. Jewel is susceptible to race IE-1K, rating 6 in greenhouse tests using the standard disease scale of 0=immune, 9=maximum disease susceptibility. JEWEL is rated MS to sheath blight (*Rhizoctonia solani* Kuhn), using the standard disease rating scale (R=resistant, MR=moderately resistant, MS=moderately susceptible, S=susceptible and VS=very susceptible to disease), which compares favorably with Diamond (S), LaKast (MS), Roy J (MS), and Wells (S). Jewel is rated S to false smut (*Ustilaginoidea virens* (Cooke) Takah). Jewel is rated MS to bacterial panicle blight, as compared to Roy J (S) and Diamond (MS).

Plants of Jewel have erect culms, dark green erect leaves, and glabrous lemma, palea, and leaf blades. The lemma and palea are straw colored with red to purple apiculi, most of which fade to straw at maturity. Milled kernels of Jewel are 7.07 mm compared to Diamond, LaKast, and Roy J, at 7.17, 7.56, and 7.31 mm, respectively, and individual milled kernel weights of Jewel, Diamond, LaKast, and Roy J, averaged 19.9, 21.4, 22.3, and 21.1 mg/kernel, respectively, in the ARPT 2017-2018.

The endosperm of Jewel is nonglutinous, nonaromatic, and covered by a light brown pericarp. Jewel has the L202 cook type with high amylose, a weak rapid viscosity analysis (RVA) rating, and intermediate gelatinization temperature. Together, these quality parameters indicate that Jewel has typical southern U.S. long-grain rice cooking quality characteristics, as described by Webb et al. 1985. Jewel has a high average apparent starch amylose content of 25.6 g kg^{-1} and an intermediate gelatinization temperature of 70.7° C.

The foundation seed field of Jewel was rogued several times throughout the season. The original release of breeder head row may contain the following variants in any combination: taller, shorter, earlier, later, glabrous or pubescent plants, as well as intermediate or very-long slender grains and grains with extremely long awns. Other atypical plants may still be encountered in the variety (medium and short grain). The total variants and/or off-types numbered less than 1 per 5000 plants.

The above-mentioned characteristics of rice cultivar Jewel are based primarily on data collected in Stuttgart, Ark. and are summarized in Table 1. The results of the rice performance trials (ARPT 2017-2019 and URRN 2017-2019) are detailed in the Tables 2-13. Tables 14-15 show grain quality data, Tables 16-17 show disease evaluation data, Tables 18-19 show preliminary results from a Planting Date Study, Table 20 shows the results of a Producer Rice Evaluation Program study, Table 23 shows pertinent agronomic information, and Table 24 shows nitrogen trial data.

TABLE 1

Distinguishing Characteristics of Morphology and Physiology

Plant:

Grain type: Long
Days to maturity (Seeding to 50% heading): 88 (range 79-90 days)
Plant height: 105 cm (range 102-107 cm)
Plant color (at booting): Dark green

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TABLE 1-continued

Distinguishing Characteristics of Morphology and Physiology

Culm:

Angle (degrees from perpendicular after flowering): Erect (less than 30°)
Flag leaf (after heading):

Pubescence: Glabrous
Leaf angle (after heading): Erect
Blade color (at heading): Dark green
Panicle:

Length: 20.8 cm
Type: Intermediate
Exsertion (near maturity): Moderately well
Axis: Droopy
Shattering (at maturity): Low (1-5%)
Grain (spikelet):

Awns (after full heading): Absent; may also be tip awns at high fertility
Apiculus color: Red
Stigma color: Purple
Lemma and palea color (at maturity): Straw
Lemma and palea pubescence: Glabrous
Grain (seed):

Seed coat color: Light brown
Scent: Nonscented
Shape class (length/width ratio):

Paddy: Long (3.4:1 and more)
Brown: Long (3.1:1 and more)
Milled: Long (3.0:1 and more)
Size: 19.9 g/1000 seeds milled rice
Disease resistance:

Rice blast (*Pyricularia grisea* (Cooke) Sacc.): Moderately susceptible-moderately resistant
Sheath blight (*Rhizoctonia solani* Kuhn): Moderately susceptible
False smut (*Ustilaginoidea virens* (Cooke) Takah.): Susceptible
Bacterial panicle blight (*Burkholderia glumae* and *B. gladioli*): Susceptible
Narrow brown leaf spot (*Sphaerulina oryzina*): Moderately resistant

TABLE 2

Jewel data summary from 2017 ARPT.
(Stuttgart, RREC; Colt, PTES; Keiser,
NEREC; Clay County & Desha County)

VARIETY	YIELD (BU/ AC)	HEIGHT[a] (IN.)	HEIGHT[b] (IN.)	MATURITY (50% HD)	MILLING HR:TOT
RU1701081	184	41	37	93	51:70
RU1701084	210	39	37	93	57:69
Jewel	192	41	38	91	59:71
Diamond	206	42	38	91	56:69
LaKast	188	44	39	89	56:70
Roy J	196	42	40	94	60:70

[a]Plant height measured from to the tip of the panicle
[b]Plant height is the canopy height not to tip of panicle

TABLE 3

Jewel data summary from 2018 ARPT.
(Stuttgart, RREC; Colt, PTES; Keiser,
NEREC; Clay County, & Desha County)

VARIETY	YIELD (BU/ AC)	HEIGHT[a] (IN.)	MATURITY (50% HD)	TEST WEIGHT LBS/BU	MILLING HR:TOT
RU1701081	183	36	85	39.6	49:70
RU1701084	201	35	87	40.0	54:69
Jewel	186	37	85	39.9	57:70

TABLE 3-continued

Jewel data summary from 2018 ARPT.
(Stuttgart, RREC; Colt, PTES; Keiser,
NEREC; Clay County, & Desha County)

VARIETY	YIELD (BU/ AC)	HEIGHT[a] (IN.)	MATURITY (50% HD)	TEST WEIGHT LBS/BU	MILLING HR:TOT
Diamond	206	36	83	39.9	52:69
LaKast	187	36	82	40.0	53:67
Roy J	189	38	90	39.4	54:69

[a]Plant height is the canopy height not to tip of panicle

TABLE 4

Jewel data summary from 2019 ARPT.
(Stuttgart, RREC; Colt, PTES; Keiser,
NEREC; Clay County and Desha County)

VARIETY	YIELD (BU/ AC)	HEIGHT (IN.)[a]	MATURITY (50% HD)	TEST WT (lbs/BU)	MILLING HR:TOT*
RU1701081	183	35	86	40.5	54:71
RU1701084	206	34	86	40.0	56:70
Jewel	182	36	85	40.0	61:71

TABLE 4-continued

Jewel data summary from 2019 ARPT.
(Stuttgart, RREC; Colt, PTES; Keiser,
NEREC; Clay County and Desha County)

VARIETY	YIELD (BU/ AC)	HEIGHT (IN.)[a]	MATURITY (50% HD)	TEST WT (lbs/BU)	MILLING HR:TOT*
Diamond	204	35	85	40.5	58:70
LaKast	193	34	82	41.1	56:71

[a]Plant height is the canopy height not to tip of panicle

TABLE 5

Jewel data summary from 2017-2019 ARPT.

VARIETY	YIELD (BU/ AC)	HEIGHT (IN.)[a]	MATURITY (50% HD)	TEST WT (lbs/BU)[c]	MILLING HR:TOT[d]
RU1701081	183	36	88	40.1	51:70
RU1701084	206	35	89	40.0	56:69
Jewel	187	37	87	40.0	59:71
Diamond	205	36	86	40.2	56:69
LaKast	189	36	84	40.6	56:69
Roy J[b]	193	39	92	—	57:70

[a]Plant height is the canopy height not to tip of panicle
[b]2107 & 2018 data
[c]test weight from 2018 & 2019
[d]2017 & 2018 data

TABLE 6

2017 ARPT mean by location (Stuttgart, RREC; Colt, PTES; Keiser, NEREC; Clay County and Desha County)

VARIETY	GRAIN YIELD (BU/AC)						HEAD RICE(%):TOTAL RICE(%)					
	RREC	NEREC	PTES	CLAY	CHICOT	AVG	RREC	NEREC	PTES	CLAY	CHICOT	AVG
RU1701081	183	192	163	197	184	184	61:72	57:70	47:69	53:72	37:69	51:70
RU1701084	201	205	201	229	217	210	59:70	61:68	54:67	61:70	50:68	57:69
Jewel	203	192	169	205	190	192	61:73	60:70	61:71	60:71	50:70	59:71
Diamond	214	204	177	227	208	206	60:68	61:71	60:69	61:71	43:68	56:69
LaKast	194	179	172	201	197	188	57:69	60:72	58:70	61:71	44:70	56:70
Roy J	197	205	184	209	186	196	61:69	65:72	60:69	65:72	50:70	60:70

TABLE 7

2018 ARPT mean by location (Stuttgart, RREC; Colt, PTES; Keiser, NEREC; Clay County and Chicot County)

VARIETY	GRAIN YIELD (BU/AC)						HEAD RICE(%):TOTAL RICE(%)					
	RREC	NEREC	PTES	CLAY	CHICOT	AVG	RREC	NEREC	PTES	CLAY	CHICOT	AVG
RU1701081	182	154	186	199	192	183	60:70	38:69	48:70	42:72	59:70	49:70
RU1701084	204	198	204	196	201	201	60:68	50:68	52:69	50:71	58:69	54:69
Jewel	183	157	183	204	202	186	58:69	53:68	57:70	59:72	59:71	57:70
Diamond	204	189	195	228	213	206	57:68	50:68	51:69	48:72	57:70	52:69
LaKast	191	161	190	213	181	187	58:70	42:54	52:70	54:72	58:71	53:67
RoyJ	193	178	190	204	178	189	52:66	55:69	54:70	50:72	58:71	54:69

TABLE 8

2019 ARPT mean by location (Stuttgart, RREC;
Colt, PTES; Keiser, NEREC; and Clay County)

	GRAIN YIELD (BU/AC)					HEAD RICE(%):TOTAL RICE(%)				
VARIETY	RREC	NEREC	PTES	CLAY	AVG	RREC	NEREC	PTES	CLAY	AVG
RU1701081	215	179	148	191	183	56:70	64:71	35:70	62:72	54:71
RU1701084	225	197	179	222	206	56:68	65:70	40:69	64:71	56:70
Jewel	211	171	156	189	182	57:69	60:68	61:72	64:72	61:71
Diamond	219	193	179	226	204	55:68	62:69	52:70	63:72	58:70
LaKast	213	202	161	203	195	57:70	60:69	49:70	64:72	58:70

TABLE 9

2017-2019 ARPT mean by location (Stuttgart, RREC; Colt, PTES;
Keiser, NEREC; Clay County and Desha or Chicot County)

	GRAIN YIELD (BU/AC)						HEAD RICE(%):TOTAL RICE(%)[a]					
VARIETY	RREC	NEREC	PTES	CLAY	CHICOT	AVG	RREC	NEREC	PTES	CLAY	CHICOT	AVG
RU1701081	193	175	166	196	188	183	61:71	48:70	48:70	48:72	48:70	51:71
RU1701084	210	200	195	216	209	206	60:69	56:68	53:68	56:71	54:69	56:69
Jewel	199	173	169	199	196	187	60:71	57:69	59:71	60:72	55:71	58:71
Diamond	212	195	184	227	211	205	59:68	56:70	56:69	55:72	50:69	55:70
LaKast	199	181	174	206	189	190	58:70	51:63	55:70	58:72	51:71	55:69
Roy J[a]	195	192	187	206	182	192	57:68	60:71	57:70	58:72	54:71	57:70

[a]2017-2018 data

TABLE 10

2017 Arkansas URN data

VARIETY	YIELD (BU/AC)	HEIGHT (IN.)	MATURITY (50% HD)	MILLING HR:TOT
RU1701081	219	43	84	59:69
RU1701084	238	42	83	60:69
Jewel	224	46	82	60:69
Diamond	245	43	82	58:68
LaKast	201	46	80	56:69
Roy J	211	46	87	60:69

TABLE 11

2018 Arkansas URN data

VARIETY	YIELD (BU/AC)	HEIGHT (IN.)	MATURITY (50% HD)	MILLING HR:TOT
RU1701081	230	42	81	59:71
RU1701084	220	41	83	62:69
Jewel	218	45	79	59:69
Diamond	219	45	80	62:70
LaKast	215	47	76	63:71
Roy J	187	45	85	64:72

TABLE 12

2019 Arkansas URN data

VARIETY	YIELD (BU/AC)	HEIGHT (IN.)	MATURITY (50% HD)	MILLING HR:TOT
RU1701081	228	45	91	65:73
RU1701084	234	41	93	59:73
Jewel	245	43	90	63:72
Diamond	253	44	89	59:72
Roy J	202	45	95	56:72

TABLE 13

2017-2019 Arkansas URN data

VARIETY[a]	YIELD (BU/AC)	HEIGHT (IN.)	MATURITY (50% HD)	MILLING HR:TOT[b]
RU1701081	226	43	85	59:70
RU1701084	231	41	86	61:69
Jewel	229	45	84	60:69
Diamond	239	44	84	60:69
LaKast	208	47	78	60:70
Roy J	199	46	86	62:71

[a]LaKast and Roy J are only from 2017 & 2018 not included in 2019 test. Maturity may not be comparable for the LaKast and Roy J Milling from 2017 and 2018 for all entries

TABLE 14

	Milling Data				Satake							
Cultivar	Head Yield	Total Yield	Hull Yield	Bran Yield	Whiteness	Milling Degree	Moisture (%)	Chalk (%)	Length (mm)	Width (mm)	Thickness (mm)	L:W Ratio
Diamond	64.7	69.9	17.7	12.4	41.0	96.1	9.1	1.41	7.17	2.12	1.74	3.4
LaKast	64.8	70.2	17.7	12.0	43.4	108.3	9.1	1.27	7.56	2.11	1.73	3.6
Roy J	64.6	69.9	17.7	12.4	40.7	96.4	9.4	1.09	7.31	2.08	1.74	3.5
RU1701081	62.8	69.9	17.1	13.0	41.9	99.6	9.3	1.29	7.13	2.16	1.67	3.3
RU1701084	64.9	69.8	18.2	12.1	39.0	86.4	9.4	2.53	6.86	2.22	1.77	3.1
Jewel	64.3	69.2	17.3	13.5	40.8	96.6	9.2	1.41	7.07	2.10	1.67	3.4

*These data are averages of the ARPT locations is a given year (2017 and 2018 five locations: Rice Research and Extension Center (RREC), Stuttgart, AR; Pine Tree Experiment Station (PTES) Colt, AR; Northeast Research and Extension Center, Keiser (NEREC), AR; Producer Field, Clay County (CLCO), AR; Producer Field, and Chicot County (CCO), AR.

TABLE 15

2017-2018 kernel characteristics.

	Weight (g)	Gel Temp (° C.)	Amylose (%)	RVA (rvu)				
Cultivar				Peak	Trough	Breakdown	Final	Setback
Diamond	21.4	69.3	23.7	263.2	134.0	129.2	271.0	7.9
LaKast	22.3	68.7	23.9	269.8	148.3	121.6	287.6	17.7
Roy J	21.1	68.8	24.2	259.0	132.0	126.9	267.7	8.8
RU1701081	21.0	69.3	23.1	255.5	139.3	116.3	274.5	19.0
RU1701084	21.8	68.8	23.5	250.3	129.4	120.8	263.7	13.4
Jewel	19.9	70.7	25.6	192.2	101.3	90.9	219.6	27.4

*These data are averages of the ARPT locations is a given year (2017 and 2018 five locations: Rice Research and Extension Center (RREC), Stuttgart, AR; Pine Tree Experiment Station (PTES) Colt, AR; Northeast Research and Extension Center, Keiser (NEREC), AR; Producer Field, Clay County (CLCO), AR; Producer Field, and Chicot County (CCO), AR.

Disease Evaluations of Rice Cultivar Jewel

Varietal resistance is the most efficient and reliable means of controlling rice diseases. Conservation and improvement of disease resistance is a continuous endeavor basic to varietal development. Incorporation of existing and new resistance sources is a complex process limited by several variables. The rice disease research program routinely evaluates breeding program entries to provide disease data required for superior variety development. Our objectives are to increase varietal disease resistance and to define disease liabilities of new varieties released for rice production in Arkansas.

Rice diseases are mostly rated visually on a 0-9 scale to estimate degree of severity. Numerical data is often converted to this scale. A rating of zero indicates complete disease immunity. A rating of one to three indicates resistance where little loss occurs and in the case of rice blast pathogen growth is restricted considerably. Conversely, a nine rating indicates maximum disease susceptibility, which typically results in near complete plant death and/or yield loss. Depending upon the disease in question, a disease rating of four to six is usually indicative of acceptable disease resistance under conditions slightly favoring the pathogen. Numerical ratings are sometimes converted to letter symbols where 0-3=R (resistant), 3-4=MR (moderately resistant), 5-6=MS (moderately susceptible) 7=S (susceptible) and 8-9 VS (very susceptible). Exceptions to established ratings do occur unexpectedly as disease situations change.

These data come from several sources. Advanced and promising breeding lines are normally evaluated by researchers in other states. It is not unusual for ratings to vary with location and year due to environmental differences and research procedures. Ratings within a source traditionally have been consistent.

Greenhouse blast tests are the primary means of screening large number of entries for varietal reaction to the many blast races occurring in the production areas. Although results are quite variable and testing conditions tends to overwhelm any field resistance present in the entry, this test provides an accurate definition of the fungus-variety genetics. Blast field nurseries, utilizing both natural and lab produced inoculum, are established in an effort to better define blast susceptibility under field conditions. Since field nursery is also quite variable, new techniques are currently being developed and evaluated to better estimate cultivar field resistance to blast.

Field nurseries are established and artificially inoculated to provide a uniform disease pressure for evaluations under field conditions. Grower nurseries are established operate in an effort to evaluate disease reactions in grower fields under current production practices. Over time these nurseries document variety performance under adverse disease conditions in Arkansas production fields.

Below, Tables 16-17 show disease evaluation data.

TABLE 16

Summary of available leaf blast rating data from plants inoculated with the indicated race using standard greenhouse techniques, 2019.

Year	IB-1	IB-17	IB-49	IC-17	IE-1K	IE-1
2019	0	0	0	0	6	0
2017	0, 0, 0, 4	0, 0, 5, 4,	0	0	4, 5	N/A

Note:
Jewel has the Pi-ta and Pi-ks genes for blast resistance.

TABLE 17

Rice variety reactions[1] to diseases (2018-2019).

Cultivar	Sheath Blight	Blast	Straighthead	Bacterial Panicle Blight	Narrow Brown Leaf Spot	Stem Rot	Kernel Smut	False Smut	Lodging	Black Sheath Rot
Jewel	MS	MS		MS	MR			S		
Diamond	S	S		MS		S	S	VS	MS	
LaKast	MS	S	MS	MS	MS	S	S	S	MS	MS
Roy J	MS	S	S	S	R	S	VS	S	MR	MS
RiceTec XL753	MS	R	MS	MR	R		MS	S	MS	S
RiceTec XP760	MS	MR		MR	R		MS	VS	S	
Wells	S	S	S	S	S	VS	S	S	MS	MS

[1]Reaction: R = Resistant; MR = Moderately Resistant; MS = Moderately Susceptible; S = Susceptible; VS = Very Susceptible. Reactions were determined based on historical and recent observations from test plots and in grower fields across Arkansas. In general, these reactions would be expected under conditions that favor severe disease development including excessive nitrogen rates (most diseases) or low flood depth (blast).

TABLE 18

Preliminary Data Summary of 2019 Planting Date Study in Stuttgart

Cultivar	21-Mar	3-Apr	16-Apr	29-Apr	17-May	4-Jun	Average
			Grain Yields				
Diamond	233	235	223	220			227
ARoma17	201	186	178	171			184
Jewel	222	221	219	211			219
ARX7-1121	253	243	225	231			238
CLARX19	244	255	231	226			239
CLL15	222	222	220	193			214
CLM04	230	209	226	208			218
'PVL01'	199	194	187	179			190
RT 3201	219	222	225	212			220
RT 7301	269	258	258	261			261
7321FP	237	239	256	257			247
RT 7501	261	263	277	265			266
7521FP	230	240	252	232			239
'CL153'	226	224	202	188			210
'CL272'	232	220	236	192			220
'Jupiter'	248	229	238	227			235
'Titan'	239	226	230	217			228
CLXL745	203	231	226	224			221
G214CL	250	260	271	243			256
XP753	259	251	271	264			261
Mean	234	231	233	221			230

TABLE 19

Preliminary Data Summary of 2019 Planting Date Study in Colt

Cultivar	2-Apr	24-Apr	8-May	28-May	12-Jun	Average
			Grain Yields			
Diamond	159	236	199			198
ARoma17	155	197	166			173
Jewel	160	215	185			187
ARX7-1121	199	245	227			224
CLARX19	169	230	204			201
CLL15	163	237	202			201
CLM04	167	208	210			195
PVL01	149	180	165			165
RT 3201	171	208	192			190
RT 7301	161	259	210			210
7321FP	157	266	215			213
RT 7501	177	234	197			203
7521FP	175	245	227			216
CL153	134	178	164			159
CL272	123	207	183			171
Jupiter	159	231	210			200
Titan	137	232	189			186

TABLE 19-continued

Preliminary Data Summary of 2019 Planting Date Study in Colt

Cultivar	2-Apr	24-Apr	8-May	28-May	12-Jun	Average
			Grain Yields			
CLXL745	147	231	207			195
G214CL	171	255	214			213
XP753	175	266	218			219
Mean	160	228	199			196

TABLE 20

Yield performance of selected cultivars in Producer Rice Evaluation Program trials in 5 fields in 2019

Cultivar	Grain Type	Greene	Lee	Poinsett	Prairie	Woodruff	AVG Grain Yield
Diamond	L	178	209	221	181	262	210
Jewel	L	177	216	211	186	228	204
RTXP753	L	190	231	257	240	275	239
Mean		182	219	230	203	255	218

TABLE 21

Test weight of selected cultivars in Producer Rice Evaluation Program trials in 5 fields in 2019

Cultivar	Grain Type	Greene	Lee	Poinsett	Prairie	Woodruff	AVG Test Weight
Diamond	L	39.4	40.0	39.2	38.3	47.5	40.9
Jewel	L	40.1	39.6	39.0	38.5	48.1	41.1
RTXP753	L	40.1	41.4	40.4	39.5	48.5	41.9
Mean			40.3	39.5	38.7	48.0	

TABLE 22

Grain yields in 2019 DD50* trial, Stuttgart, AR.

Cultivar	21-Mar	3-Apr	16-Apr	29-Apr	17-May	4-Jun	Average
				Grain Yields			
Diamond	233	235	223	220	205	201	219
Jewel	222	221	219	211	205	195	212

TABLE 22-continued

Grain yields in 2019 DD50* trial, Stuttgart, AR.

	Grain Yields						
Cultivar	21-Mar	3-Apr	16-Apr	29-Apr	17-May	4-Jun	Average
XP753	259	251	271	264	252	233	255
Mean	234	231	233	221	209	197	221

*The DD50 program was developed in the 1970's to help rice farmers accurately time mid-season nitrogen applications. The DD50 is a modification of the growing degree-day concept, which uses temperature data to predict rice development.

TABLE 23

Pertinent agronomic information for the Northeast Research and
Extension Center (NEREC), Pine Tree Research Station (PTRS),
and the Rice Research and Extension Center (RREC) during 2015.

PRACTICES	NEREC	PTRS**	RREC
Pre-plant Fertilizer			0-60-90 + 10 lbs Zn as ZnSO4
Planting Dates	5/4	6/5	5/1
Herbicide Spray Dates and Spray Procedures	5/6 40 oz/acre Facet L + 1.3 pt/acre Command + 0.75 oz/acre Permit Plus + 32 oz/acre RoundUp	6/5 1.0 pt/acre Command + 0.75 oz/acre Permit Plus	5/1 20 oz/acre Obey
Flush Dates			
Emergence Dates	5/20	6/11	5/10
Herbicide Spray Dates and Spray Procedures	6/11 4 qt/acre Stam + 1 pt/acre Grandstand	6/16 3 qt/acre Riceshot + 32 oz/acre Facet L	6/1 2 qt Prowl + 0.75 oz/acre Permit Plus
Herbicide Spray Dates and Spray Procedures		6/23 32 oz/acre Facet L + 1 pt/acre Bolero	
Herbicide Spray Dates and Spray Procedures			
Preflood N Dates	6/18	6/24	6/3
Flood Dates	6/19	6/25	6/4
Drain Dates	9/9	10/1	8/28
Harvest Dates	9/23	10/14	9/2

**Zinc EDTA applied (7/10)

TABLE 24

Influence of nitrogen (N) fertilizer rate on the grain
yield of JEWEL rice at three locations during 2019.

	Grain Yield		
N Fertilizer Rate (lbs N/A)	NEREC^a	PTRS (bushels/acre)	RREC
0	69	88	100
60	—	141	151
90	138	151	187
120	160	177	209
150	167	178	224
180	184	182	232
210	184	—	—

^a NEREC = Northeast Research and Extension Center, Keiser, AR; PTRS = Pine Tree Research Station, Colt, AR; RREC = Rice Research and Extension Center, Stuttgart, AR.
^b LSD = least significant difference, C.V. = coefficient of variation.

Methods

This present invention provides methods for producing rice plants. In some embodiments, these methods involve crossing a first parent rice plant with a second parent rice plant wherein either the first or second parent rice plant is a rice plant of the line Jewel. Further, both first and second parent rice plants can come from the rice cultivar Jewel. Still further, this invention also is directed to methods for producing a rice cultivar Jewel-derived rice plant by crossing

rice cultivar Jewel with a second rice plant and growing the progeny seed, and repeating the crossing and growing steps with the rice cultivar Jewel-derived plant from 0 to 7 times. Thus, any such methods using the rice cultivar Jewel are part of this invention: selfing, backcrosses, hybrid production, crosses to populations, and the like. All plants produced using rice cultivar Jewel as a parent are within the scope of this invention, including plants derived from rice cultivar Jewel. Advantageously, the rice cultivar is used in crosses with other, different, rice cultivars to produce first generation (F_1) rice seeds and plants with superior characteristics.

In some embodiments, a Jewel progeny plant is selected that has molecular markers, morphological characteristics, and/or physiological characteristics in common with Jewel (e.g., those listed in Table 1). Techniques such as RFLP-enhanced selection, genetic marker enhanced selection (e.g., SSR markers), and the making of double haploids may be utilized to identify progeny that share particular traits with Jewel.

Further, this invention provides methods for introducing a desired trait into rice cultivar Jewel. This may be accomplished using traditional breeding methods, such as back-crossing (see Breeding Methods section below). Alternatively, the desired trait may be introduced by transforming the rice cultivar with a transgene (see Transformation Methods section below). The transgenic cultivar produced by these methods may be crossed with another cultivar to produce a new transgenic cultivar. Alternatively, the transgene incorporated by these methods could be moved into another cultivar using traditional backcrossing techniques.

Optionally, any of the disclosed methods may further comprise additional steps involving producing rice seed from the resulting rice plants and/or planting the rice seed.

The present invention encompasses all plants, or parts thereof, produced by the methods described herein, as well as the seeds produced by these plants. Further, any plants derived from rice cultivar Jewel or produced from a cross

using cultivar Jewel are provided. This includes genetic variants, created either through traditional breeding methods or through transformation, as well as plants produced in a male-sterile form. Notably, this includes gene-converted plants developed by backcrossing. Any of the seeds, plants, or plant parts provided may be utilized for human food, livestock feed, and as a raw material in industry.

The present invention also encompasses progeny of rice cultivar Jewel comprising a combination of at least two Jewel traits selected from those listed in the Tables and Detailed Description of the Invention, wherein the progeny rice plant is not significantly different from Jewel for said traits, as determined at the 5% significance level when grown in the same environment. One of skill in the art knows how to compare a trait between two plant varieties to determine if there is a significant difference between them (Fehr and Walt, Principles of Cultivar Development, pp. 261-286 (1987)). Molecular markers or mean trait values may be used to identify a plant as progeny of Jewel. Alternatively, progeny may be identified through their filial relationship with rice cultivar Jewel (e.g., as being within a certain number of breeding crosses of rice cultivar Jewel). For example, progeny produced by the methods described herein may be within 1, 2, 3, 4, or 5 breeding crosses of rice cultivar Jewel.

Tissue Culture

The present invention provides tissue cultures of regenerable cells or protoplasts produced from rice cultivar Jewel. As is well known in the art, tissue culture of rice can be used for the in vitro regeneration of a rice plant. Thus, such cells and protoplasts may be used to produce plants having the physiological and morphological characteristics of rice variety Jewel. The rice plants regenerated by these methods are also encompassed by the present invention.

As used herein, the term "tissue culture" describes a composition comprising isolated cells or a collection of such cells organized into parts of a plant. Exemplary tissues for culture include protoplasts, calli, plant clumps, and plant cells that can be grown in culture, or parts of plants, such as embryos, pollen, flowers, seeds, pods, leaves, stems, roots, root tips, and anthers. Culture of various rice tissues and regeneration of plants therefrom is well known in the art.

Breeding Methods

The goal of rice breeding is to develop new, superior rice cultivars and hybrids. A superior cultivar is produced when a new combination of desirable traits is formed within a single plant variety. Desirable traits may include higher seed yield, resistance to diseases and insects, better stems and roots, tolerance to low or high temperatures, herbicide resistance, and better agronomic characteristics or grain quality.

The breeding methods used with the present invention may involve a single-seed descent procedure, in which one seed per plant is harvested and used to plant the next generation. Alternatively, the methods may utilize a multiple-seed procedure, in which one or more seeds harvested from each plant in a population is threshed together to form a bulk which is used to plant the next generation.

Use of rice cultivar Jewel in any plant breeding method is encompassed by the present invention. The choice of a breeding or selection method will depend on several factors, including the mode of plant reproduction, the heritability of the trait(s) being improved, and the type of cultivar used commercially (e.g., F1 hybrid cultivar, pureline cultivar). Popular selection methods include pedigree selection, modified pedigree selection, mass selection, recurrent selection, backcrossing, or a combination thereof.

Pedigree selection is commonly used for the improvement of self-pollinating crops. Two parents are crossed to produce an F_1 population. An F_2 population is produced by selfing one or several F_1's. Selection of the best individuals may begin in the F_2 population; then, beginning in the F_3 generation, the best individuals in the best families are selected. Replicative testing of families can begin in the F_4 generation to make selection of traits with low heritability more effective. At an advanced stage of inbreeding (e.g., F_6 or F_7), the best lines are tested for potential release as new cultivars.

Mass and recurrent selections can be used to improve populations of either self- or cross-pollinating crops. A genetically variable population of heterozygous individuals is either identified or created by intercrossing several different parents. The best plants are selected based on individual superiority, outstanding progeny, or excellent combining ability. The selected plants are intercrossed to produce a new population, which is often subjected to additional cycles of selection.

Backcrossing is commonly used to transfer genes for highly heritable traits into a desirable homozygous cultivar or inbred line. The term "backcrossing" refers to the repeated crossing of hybrid progeny back to one of the parental plants, referred to as the recurrent parent. The plant that serves as the source of the transferred trait is called the donor parent. After the initial cross, individuals possessing the transferred trait are selected and repeatedly crossed to the recurrent parent. The resulting plant is expected to have the attributes of the recurrent parent along with the trait transferred from the donor parent.

Transformation Methods

As is noted above, the present invention provides plants and seeds of rice cultivar Jewel in which additional traits have been transferred. While such traits may be selected for using traditional breeding methods, they may also be introduced as transgenes. "Transgenes" include both foreign genes and additional or modified versions of native genes. Plants can be genetically engineered to have a wide variety of traits of agronomic interest including, without limitation, male sterility, waxy starch, herbicide resistance, resistance for bacterial, fungal, or viral disease, insect resistance, male fertility, enhanced nutritional quality, industrial usage, yield stability, and yield enhancement. Many examples of genes that confer such traits have been described in the literature and are well known in the art. For example, the transgene may confer resistance to an herbicide selected from the group consisting of: glyphosate, sulfonylurea, imidazolinone, dicamba, glufosinate, phenoxy proprionic acid, L-phosphinothricin, cyclohexone, cyclohexanedione, triazine, 2,4-Dichlorophenoxyacetic acid, hydroxyphenyl-pyruvate dioxygenase (HPPD) inhibitors, and benzonitrile.

Transgenes are typically introduced in the form of an expression vector. As used herein, an "expression vector" is DNA comprising a gene operatively linked to a regulatory element (e.g., a promoter). The expression vector may contain one or more such gene/regulatory element combinations. The expression vector may also include additional sequences, such as a signal sequence or a tag, that modify the protein produced by the transgene. The vector may be a plasmid, and can be used alone or in combination with other plasmids.

Expression vectors include at least one genetic marker operably linked to a regulatory element (e.g., a promoter) that allows transformed cells containing the vector to be recovered by selection. In some embodiments, negative selection (i.e., inhibiting growth of cells that do not contain the selectable marker gene) it utilized. Negative selection

markers include, for example, genes that result in detoxification of a chemical agent (e.g., an antibiotic or an herbicide) and genes that result in insensitivity to an inhibitor. Exemplary negative selection genes include neomycin phosphotransferase II (nptII), hygromycin phosphotransferase, gentamycin acetyl transferase, streptomycin phosphotransferase, and aminoglycoside-3'-adenyl transferase. In other embodiments, positive selection (i.e., screening for the product encoded by a reporter gene) is utilized. Exemplary reporter genes include β-glucuronidase, β-galactosidase, luciferase, chloramphenicol acetyltransferase, and Green Fluorescent Protein (GFP).

Transgene expression is typically driven by operably linking the transgene to a promoter within the expression vector. However, other regulatory elements may also be used to drive expression, either alone or in combination with a promoter. As used herein, a "promoter" is a region of DNA upstream of a transcription start site that is involved in recognition and binding of RNA polymerase for transcription initiation. Any class of promoter may be selected to drive the expression of a transgene. For example, the promoter may be "tissue-specific", "cell type-specific", "inducible", or "constitutive". Those of skill in the art know how to select a suitable promoter based the particular circumstances and genetic engineering goals.

Methods for producing transgenic plants are well known in the art. General descriptions of plant expression vectors, reporter genes, and transformation protocols can be found in Gruber, et al., "Vectors for Plant Transformation", in *Methods in Plant Molecular Biology & Biotechnology* in Glich, et al., (Eds. pp. 89-119, CRC Press, 1993). General methods of culturing plant tissues are provided for example by Maki, et al., "Procedures for Introducing Foreign DNA into Plants" in *Methods in Plant Molecular Biology & Biotechnology*, Glich, et al., (Eds. pp. 67-88 CRC Press, 1993); and by Phillips, et al., "Cell-Tissue Culture and In-Vitro Manipulation" in *Corn & Corn Improvement*, 3rd Edition; Sprague, et al., (Eds. pp. 345-387 American Society of Agronomy Inc., 1988). Methods of introducing expression vectors into plant tissue include direct gene transfer methods, such as microprojectile-mediated delivery, DNA injection, and electroporation, as well as the direct infection or co-cultivation of plant cells with *Agrobacterium tumefaciens*, described for example by Horsch et al., *Science,* 227:1229 (1985). Descriptions of *Agrobacterium* vector systems and methods for *Agrobacterium*-mediated gene transfer are provided by Gruber, et al., supra.

REFERENCES

Webb, B. D., C. N. Bollich, H. L. Carnahan, K. A. Kuenzel., and K. S. McKenize. 1985. Utilization characteristics and qualities of United States rice. p. 25-35. In: Rice grain quality and marketing. IRRI, Manila, Philippines

DEPOSIT INFORMATION

A deposit of the University of Arkansas Division of Agriculture Rice Research and Extension Center proprietary rice cultivar 'Jewel' disclosed above and recited in the appended claims has been made with the American Type Culture Collection (ATCC), 10801 University Boulevard, Manassas, Va. 20110. The date of deposit was Jan. 4, 2021. The deposit of 2,500 seeds was taken from the same deposit maintained by the University of Arkansas Division of Agriculture Rice Research and Extension Center (2900 Hwy 130 E., Stuttgart, Ark. 72160) since prior to the filing date of this

application. All restrictions will be irrevocably removed upon granting of a patent, and the deposit is intended to meet all of the requirements of 37 C.F.R. §§ 1.801-1.809. The ATCC Accession Number is PTA-126946. The deposit will be maintained in the depository for a period of thirty years, or five years after the last request, or for the enforceable life of the patent, whichever is longer, and will be replaced as necessary during that period.

What is claimed is:

1. A rice seed of the cultivar 'Jewel', a representative sample of seed of said cultivar having been deposited under ATCC Accession No. PTA-126946.

2. A rice plant, or a part thereof, produced by growing the seed of claim **1**.

3. A rice plant, or a part thereof, having all of the physiological and morphological characteristics of the rice plant of claim **2**.

4. Pollen or an ovule of the plant of claim **2**.

5. A method for producing rice plants, said method comprising planting a plurality of rice seeds as recited in claim **1** under conditions favorable for the growth of rice plants.

6. The method of claim **5**, further comprising the step of producing rice seed from the resulting rice plants.

7. A rice seed produced by the method of claim **6**.

8. A tissue culture of regenerable cells or protoplasts produced from the rice plant of claim **2**.

9. The tissue culture of claim **8**, wherein said cells or protoplasts are produced from a tissue selected from the group consisting of embryos, meristematic cells, pollen, leaves, anthers, roots, root tips, pistils, anthers, cotyledon, hypocotyl, panicles, flowers, seeds, and stems.

10. A rice plant regenerated from the tissue culture of claim **8**, said rice plant having all of the morphological and physiological characteristics of 'Jewel'.

11. A method for producing an F_1 hybrid rice plant, said method comprising crossing a first parent rice plant with a second parent rice plant, wherein the first parent rice plant or the second patent rice plant is the rice plant of claim **2**.

12. The method of claim **11**, further comprising the step of producing rice seed from the resulting rice plant.

13. The method of claim **11**, wherein the second parent rice plant is transgenic.

14. A method comprising transforming the rice plant of claim **2** or cell thereof with a transgene, wherein the transgene confers at least one trait selected from the group consisting of: herbicide resistance; insect resistance; resistance to bacterial, fungal, or viral disease; modified fatty acid metabolism; modified carbohydrate metabolism; and male sterility.

15. A rice plant or part thereof, or rice seed, produced by the method of claim **14**.

16. An herbicide resistant rice plant produced by the method of claim **14**, wherein the gene confers resistance to a herbicide selected from the group consisting of glyphosate, sulfonylurea, imidazolinone, dicamba, glufosinate, phenoxy proprionic acid, L-phosphinothricin, cyclohexone, cyclohexanedione, triazine, 2,4-Dichlorophenoxyacetic acid, hydroxyphenyl-pyruvate dioxygenase (HPPD) inhibitors and benzonitrile.

17. A method of introducing a desired trait into rice cultivar 'Jewel,' said method comprising the steps of:
   (a) crossing plants as recited in claim **2** with plants of another rice line expressing the desired trait, to produce progeny plants;
   (b) selecting progeny plants that express the desired trait, to produce selected progeny plants;

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(c) crossing the selected progeny plants with plants from the 'Jewel' parental line to produce new progeny plants;

(d) selecting new progeny plants that express the desired trait; and

(e) repeating steps (c) and (d) three or more times in succession, to produce selected higher generation backcross progeny plants that express the desired trait.

18. The method of claim **17**, additionally comprising the step of planting a plurality of rice seed produced by selecting higher generation backcross progeny plants under conditions favorable for the growth of rice plants and optionally comprising the step of producing rice seed from the resulting rice plants.

* * * * *