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A new semidwarf cultivar "Uruq" developed from irradiated stored seeds of soft wheat cv. "Inia-66"

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ABSTRACT

A new semidwarf cultivar Uruq was developed by irradiated storage seeds of Inia-66 cultivar. Cultivar Uruq has many quantitative and qualitative characters which surpassed its parent (Inia-66), first of all, by reduction of height by 25 cm, which leads to lodging resistant character and, the locally desirable amber seeds color instead of red seeds color which characterize the seeds of parent plant (Inia-66).
Uruq cultivar also surpassed its origin in yield components at different environmental conditions, resistant to brown leaf rust, and suitable for bread making according to their physical and chemical characters and baking test.
The techniques at the molecular level showed that Uruq cultivar has the dwarf gene Rht-D1b which is responsible for the semidwarfism.

Keywords: bread wheat, semidwarf, induced mutation, breeding

Introduction

The semidwarfism in wheat has an important role in selection for new cultivars. This character is usually associated with stiffer straw (Djelepov 1976). Short stem is considered to be one of the most efficient means for further increase in yield capacity of wheat (Konzak et al., 1984).

A tremendous success in wheat breeding was achieved in early 80's, with the introduction of semidwarf genes: Rht1 and Rht2 (Sial, et al. 2010). Norman Borlaug, who is known as the father of "the green revolution", was awarded the Nobel prize in 1970 for developing new strains of wheat in Mexico. He began working with wheat in Rockefeller-Mexico in 1945 (Stern et al., 2008), accelerate his wheat breeding on disease resistance; later he sought to reduce lodging.

The semidwarf cultivars utilize more efficiently the soil moisture and the applied fertilizers, this being especially true in the areas of higher rainfall or irrigation production (Kubba and Ishu, 1989). Most of the genetic sources of semidwarfism for wheat breeding programs were originated from induced mutations. About 16 semidwarf mutant cultivars have been released directly, and 11 cultivars were modified by cross-breeding (Konzak et al., 1984).

The genes associated with a semidwarf growth habit in wheat are known as reduced height (Rht) and many of them are dominant or semi-dominant. Two genes in particular, Rht-B1b and Rht-D1b are used in much commercial wheat.

This study aims to through a light on how to produce cultivar Uruq from irradiated stored seed of soft wheat cultivar Inia-66.

Materials and methods

Seeds of bread wheat Triticum aestivum L. cv. Inia-66 were stored for 0,5 and 10 years under

prevailing room conditions of Grain Department-State Board for applied Agriculture Research, Abu-Ghraib, Baghdad. Their moisture contents at the end of storage periods were 8.1%, 7.5% and 6.3% respectively.

Samples of 1500 seeds were irradiated with doses of 5, 10 and 15 k rad of gamma rays emitted from Co-60 source using gamma cell-220 (Atomic Energy of Canada Ltd.) at a dose rate of 81 rad/sec.

The experiment was arranged in a split plots design with four replications. The main plots were the storage periods and the sub plots were the doses of gamma rays.

The plot dimensions were 2.5x4m., and the space between rows was 30 cm. The electric conductivity (Ec) of the soil was 5.4 mmhos/cm.

Super phosphate and urea fertilizer were added at a rate of 200 kg/ha. Urea fertilizer was added at the time of planting and at tillering.

Germination, plant height, spike length, number of kernels per spike and weight of 1000 seeds for M1 plants were recorded.

In the M2 plants, all variant plants during the developmental stages were isolated and labeled.

The seeds of the semidwarf plants were planted with their parent Inia-66 for 3 successive generations (M3, M4, and M5) in comparative studies. At maturity stage: plant height, spike length, stem diameter and number of kernels per spike were measured (Kubba, et al., 1988).

Lately, we have performed DNA extraction, PCR assay and RAPD-PCR assay techniques to detect the genes responsible for reducing heights of semidwarf wheat cultivar Uruq and its parents, cultivar Inia-66 (Kubba, et al, 2013).

Results and discussion

Table 1. showed that the storage periods and gamma rays and their interaction had significantly influence by all tested parameters of the M1 plants. These results indicated that germination reduced with longer storage time and higher dose of gamma rays.

The reduction in the height of M1 plants increased with the increase of storage periods and dose of gamma rays. This reduction can be used as a parameter to measure the alteration and has direct relationship with the increase of mutation frequency in the next generations.

Table 2 showed that the two plants with reduced height accompanied by change in seed color (from red to amber) have been isolated and used as genetic source to breed semidwarf plants which are mostly stiff straw.

The seeds of the two semidwarf plants (variants): ZB103 and ZC115 were planted in order to study some of their morphological characters in M3 plants. It appears from Table 3 that there was significant reduction in the height of the two mutant plants ZB103 and ZC115 by 31.5 cm. and 29.7 cm respectively, compared with their parent (cv. Inia-66).

In M4 generations, Table 4 showed those mutants showed the same behavior as in M 3 generation. This indicates that the two mutants, ZB103 and ZC115 have genetic stability in the studied characters (Kubba, et al., 1988).

The results of the techniques at the molecular level (Kubba, et al, 2013) showed that the allelic difference between cultivars Inia-66 and Uruq is that Uruq has the dwarf gene Rht-D1b and it is responsible for the semi dwarfism (Table 5). This result agreed with (Knopf, et al, 2008) who found out that wheat varieties with the Rht-D1b were shorter and produces higher yield than varieties without this allele (figure 1 and 2).

ZB103 mutant has been registered in the National Committee for Registration and Release of Agricultural Varieties / Ministry of Agriculture in the name of URUQ cultivar. Lately, Uruq cultivar has been taken patent and release from the National Committee for patent and release of Agriculture Varieties / Ministry of Agriculture.

Table 1. The storage periods, gamma rays and their interaction on some characteristics of M1 plants

Storage periods (years)	Treatments (Doses of gamma rays)	Germination percent	Plant height (cm)	Spike length (cm)	No. of kernels per spike	Weight of 1000 kernels (g)
0 (seeds harvested from the same year)	Control (untreated seeds)	80.8	101.2	12.8	69.3	34.0
	5 krad	65.0	89.0	12.2	58.0	41.7
	10 krad	58.3	86.8	11.7	50.2	43.1
	15 krad	48.5	84.2	11.0	39.8	46.6
5 (Five years)	Control (untreated seeds)	75.5	96.3	11.5	62.1	35.8
	5 krad	56.3	85.3	11.0	52.0	40.2
	10 krad	50.8	82.7	10.1	46.4	42.9
	15 krad	42.0	79.0	9.3	36.0	48.5
10 (Ten years)	Control (untreated seeds)	68.0	87.6	10.3	48.1	37.4
	5 krad	52.5	80.4	9.5	36.5	44.0
	10 krad	33.0	79.1	8.8	33.2	48.3
	15 krad	22.3	76.8	8.1	25.0	50.1
L. S. D. (5% level)		4.8	3.2	0.5	2.2	2.5

Table 2. No. of observed variants in M2 plants

Storage periods (years)	Treatments	Number of selected variants in M2 plants			
		Chlorophyllous mutation	Earliness	Semidwarf (70cm-80cm)	Spike with more than 98 seeds
0	Control (untreated seeds)	0	0	0	0
	5 krad	0	0	0	0
	10 krad	0	1	0	0
	15 krad	1	1	0	1
5	Control (untreated seeds)	0	0	0	0
	5 krad	1	0	0	0
	10 krad	2	4	0	2
	15 krad	2	2	0	2
10	Control (untreated seeds)	0	0	0	1
	5 krad	1	1	1	2
	10 krad	1	1	1	2
	15 krad	3	3	0	5
Total		11	13	2	15

Table 3. Some morphological characters of the two mutants: ZB 103 and ZC 115 in M3 generation

Characters	Parent (Inia-66)	Semidwarf mutants		L. S. D. (5% level)
		Inia-ZC115	Inia-ZB103	
Plant height (cm)	103.8	74.1	72.3	15.62
Spike length (cm)	14.0	15.1	15.6	0.38
Stem diameter (m.m)	4.2	5.0	5.2	0.18
No. of kernels per spike	71.0	78.5	80.9	6.42

Table 4. Some morphological characters of the two mutants: ZB 103 and ZC 115 in M4 generation

Characters	Parent (Inia-66)	Semidwarf mutants		L. S. D. (5% level)
		Inia-ZC115	Inia-ZB103	
Plant height (cm)	104.5	76.2	73.0	15.24
Spike length (cm)	13.7	14.9	15.3	0.32
Stem diameter (m.m)	4.3	5.2	5.5	0.29
No. of kernels per spike	69.6	80.2	81.3	5.26

Table 5. Rht-alleles found in Inia-66 and Uruq cultivars

Genotype		Inia-66	Uruq
Tall	**Rht-B1a**	+	+
	Rht-D1a	+	+
Dwarf	**Rht-B1b**	+	+
	Rht-D1b	-	+

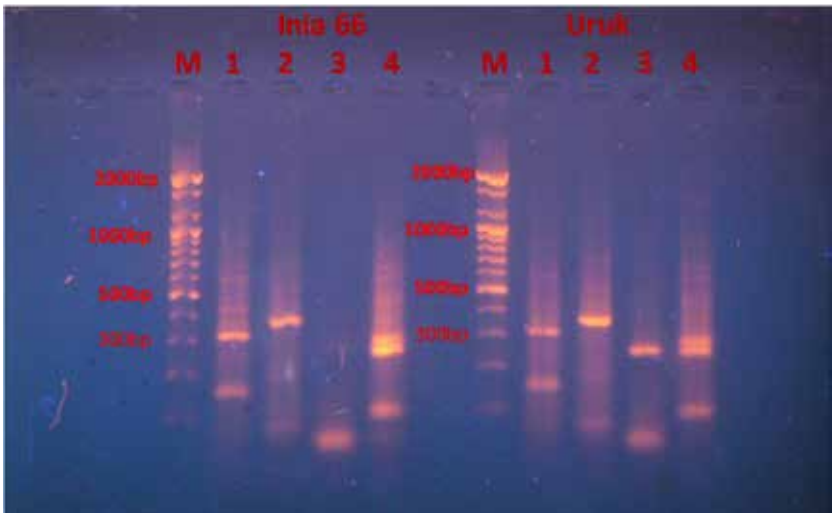

Figure 1. Ethidium bromide stained agarose gel electrophoresis of the PCR detection of Rht allele using specific primers: 1-Rht B1a 2-Rht B1b 3-Rht D1a 4-Rht D1b M DNA ladder 100bp.

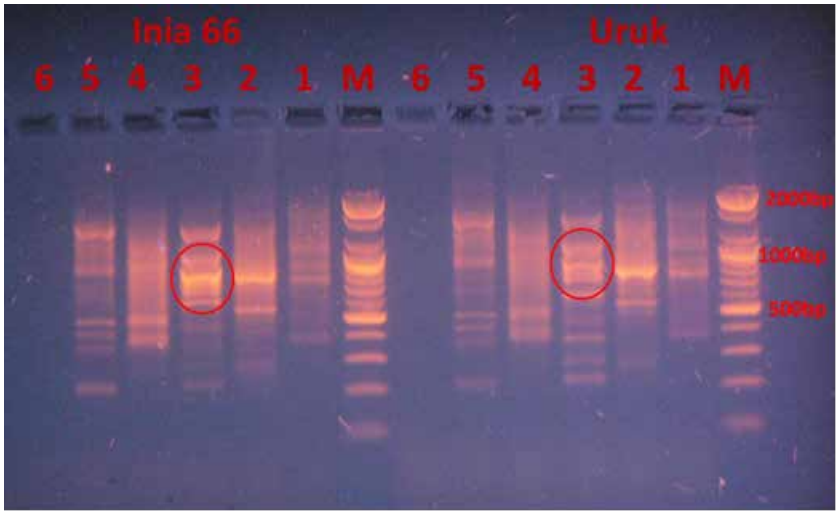

Figure 2. Ethidium bromide stained agarose gel electrophoresis of the RAPD-PCR product banding pattern obtained from six rapd primer as in table1, separated on 1.8% agarose gel, 5V/cm at 3hr., lane M represented the molecular marker 100bp DNA Ladder.

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