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## Study of drought stress using PEG-6000 on germination stage of sesame germplasm (*Sesamum indicum* L.) under laboratory conditions

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### Abstract

Sesame is a drought tolerant oilseed crop, but it is sensitive to drought at germination stage. This study was conducted to determine the effect of drought stress on germination of Eight hundred twenty nine sesame germplasm. The experiment was conducted in the laboratory of the Project Co-ordinating Unit, All India Coordinated Research Project on Sesame and Niger (Indian Council of Agricultural Research), JNKVV Campus, Jabalpur (MP). Eight hundred twenty nine sesame germplasm and two levels of drought (0.0 (control) and -4.9 bar) were the treatment tested in the experiment. Study of boxplot analysis results which is used to visually summarize and compare groups of data. On considering the values of germination percent were found maximum in SI-1116, followed by IS-158-3-84, PCU-130, PCU134, NIC-17257, NIC-8399-I, S-0534, RJS-194, JLT-8, IS-130, NIC-17868, NIC-7795-A, ES-10-A and EC-138836-A at -4.9 bar and being identified as the most tolerant germplasm among those tested in this experiment. Distinction of significant difference in germination of germplasm in induced water stress suggested that this parameter could be used as criteria in to screen germplasm to identify those most drought stress at germination stage.

**Keywords:** Boxplot analysis, drought stress, germination and sesame

### Introduction

Sesame (*Sesamum indicum* L.) is one of the world's oldest oilseed crop and is under cultivation in Asia for over five thousand years (Revathi *et al.*, 2012) [11]. Sesame seed is highly nutritive (50% oil and 25% protein) and its oil contains an anti-oxidant called sesamol which imparts to it a high degree of resistance against oxidative rancidity (Ashri, 1989) [1]. Sesame is a resilient crop with a strong adaptation to drought-prone environments. As compared to other major food crops, sesame better survives drought (Islam *et al.*, 2016) [7]. However, it remains particularly sensitive to drought occurring during the germination stages (Sun *et al.*, 2010; Boureima *et al.*, 2011) [12, 5] While sesame has a high resistance level in drought stress condition but germination stage make it more sensitive (Orruno and Morgan, 2007) [10], whereas water is usually one of the most significant factors to limit crop production (Bahrami *et al.*, 2012) [3]. It has been reported that water stress can reduce or delay germination and to effect a decrease in germination rate using PEG reported that sesame germination rate and percent reduced as drought level increased (Turk *et al.*, 2004; Hamidi and Safarnejad 2010) [13, 6]. Polyethylene glycol (PEG) with 6000 higher molecular weight cannot enter the pores of plant cells and it is not toxic to plant cells (Verslues *et al.*, 2006) [14]. Therefore, Experimental treatment using PEG for producing osmotic potential at germination stage can determine drought tolerant genotypes. A simple graphic method called the "box plot" (also called a schematic plot or box-and-whiskers plot) to rapidly summarize and interpret tabular data. The box plot is one of a diverse family of statistical techniques, called exploratory data analysis, used to visually identify patterns that may otherwise be hidden in a data set.

### Materials and Methods

The experiment was conducted in the laboratory of the Project Co-ordinating Unit, All India Coordinated Research Project on Sesame and Niger (Indian Council of Agricultural Research), JNKVV Campus, Jabalpur, Madhya Pradesh, India. Experimental treatments included osmotic potential in -4.9 bars or -0.49 Mpa which was produced by polyethylene glycol 6000 and 829

white sesame germplasm accessions were tested and distilled water served as a control. Two levels of drought (distilled water and -4.9 bar o -0.49 Mpa) were the treatments in the experiment. Drought stress levels were prepared by dissolving 0 and 200 g L<sup>-1</sup> of PEG 6000 in distilled water at 25°C to obtain 0 and -4.9 bar drought levels and described by Michel and Kaufmann (1973)<sup>[9]</sup>. All petri dishes (100 mm diameter and 15 mm height) and filter papers (Whatmann's No. 1) were disinfected at 120°C for 2hrs. The seeds were surface sterilized with 0.01% HgCl<sub>2</sub> solution for 1 min. For each treatment, 20 seeds of each germplasm accessions were put in to each petri dish on filter paper moistened with 10 ml of appropriate levels of PEG 6000. The experiment was conducted at 25°C in an incubator for 7 days and 2 ml of each solution was added to petri dish every 24 hrs. When the radicle reached up 2mm length, the seed was considered germinated (ISTA, 1985)<sup>[8]</sup>. The germination percentage (Belcher and Miller, 1974)<sup>[4]</sup> was calculated as follow:-

$$\text{Germination \%} = \frac{n}{N} \times 100$$

#### Where

n = number of germinated seeds

N= total number of seeds

#### Boxplot analysis

In the box plot of the germination percent in Figure 1, the box represents the middle 50% of the data. The horizontal line inside the box is the middle or median value of the distribution of germination percent. The upper and lower ends of the box are the hinges (the approximate upper and lower quartiles) of the distribution of germination percent. The vertical lines from the ends of the box connect the extreme data points to their respective hinges. To calculate the median:

1. Rank the data values from lowest to highest.
2. Choose the value with the middle rank. If there are n data values, the median value has rank equal to (n + 1)/2.

## Result and Discussion

#### Boxplot analysis

Study using boxplot analysis in Figure 1 the two box plots show the horizontal line inside the box is the middle or median value of the distribution of germination percent in which drought level, control and PEG at -4.9 bar are 90% and 25% germination of seed respectively (Table 1). The lower and upper ends of the box are the hinges (the approximate first and third quartiles) of the distribution of germination percent in which drought level, control and PEG at -4.9 bar are 80% and 10% germination of seed respectively for first quartile (Q1) and 95% and 50% germination of seed respectively for third quartile (Q3) (Table 1). The vertical lines from the ends of the box connect the extreme data points to their respective hinges show the minimum seed germination percent in which drought level, control and PEG at -4.9 bar are 15% and 0% germination of seed respectively as well as the maximum seed germination percent is 100% on the both drought level (Table 1).

The impact of drought on germination percent of eight hundred twenty nine germplasm were depicted in Table 2. Under PEG condition minimum seed germination per cent were found in 15 germplasm (EC-334952, IC-132408, SI-1032, NIC-8202, IC-43110, IC-43177, IC-204842, SI-254, IS-242, NIC-16195, KMR-89, KMS-326, IC-131546, S-0565

and SI-233) at -4.9 bar osmotic potential and those germplasm are highly drought susceptible with maximum seed germination in control condition (Table 2). It shows that germination stage more sensitive regarding drought stress. Decrease of seed germination under water stress condition could also be due to metabolic disorders such as slower hydrolysis of storage compounds in endosperms and/or slower transportation of hydrolyzed material to developing embryo axis (Ayaz *et al.* 2000)<sup>[2]</sup>. Such as, maximum seed germination per cent were found in 14 germplasm those germplasm germinated well in control and PEG (-4.9 bar) condition are considered as highly drought tolerant germplasm namely SI-1116, followed by IS-158-3-84, PCU-130, PCU134, NIC-17257, NIC-8399-I, S-0534, RJS-194, JLT-8, IS-130, NIC-17868, NIC-7795-A, ES-10-A and EC-138836-A (Table 2). These result may be due to high tolerance regarding water absorption/enzymatic hydrolysis of stored material or cell elongation of seed of genotypes (Bahrami *et al.* 2012)<sup>[3]</sup>.

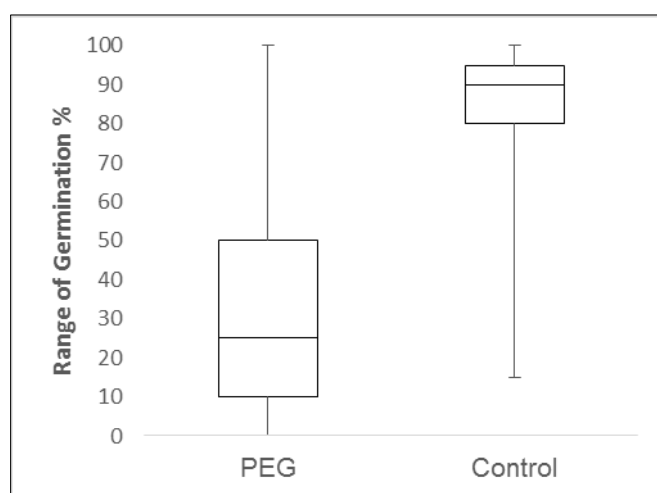


Fig 1: Comparative boxplots of seed germination (%)

Table 1: Summarized range of drought tolerance accordance to boxplots of seed germination (%)

Drought tolerance	PEG	Control
Minimum	0	15
First quartile (Q1)	10	80
Median	25	90
Third quartile (Q3)	50	95
Maximum	100	100

#### Conclusion

Drought stress with osmotic materials for producing osmotic potential is one of the important approaches to study the drought stress effects on germination. Polyethylene glycol (PEG) helps in making semi natural environment under laboratory conditions, used for adjusting water potential at germination stage. With an increased level of drought stress the germination percentage reduced, however there was no significant difference between the control and level of stress. Study using boxplot analysis the values of germination percent were found maximum in SI-1116, followed by IS-158-3-84, PCU-130, PCU134, NIC-17257, NIC-8399-I, S-0534, RJS-194, JLT-8, IS-130, NIC-17868, NIC-7795-A, ES-10-A and EC-138836-A at -4.9 bar and being identified as the most tolerant germplasm among those tested in this experiment.

**Table 2:** Effect of Osmotic potential (-4.9 bar) induced by PEG 6000 on seed germination (%)

Line No.	Germplasm	PEG	Control	Line No.	Germplasm	PEG	Control	Line No.	Germplasm	PEG	Control
1	KIS-357-A	0	90	64	SI-772	65	95	127	SI-1033	45	85
2	KIS-297-2	5	95	65	SI-775	85	100	128	PCU-127	80	100
3	RJS-29	5	85	66	SI-43	75	90	129	PCU-128	90	100
4	EC-100043	15	80	67	SI-3315-5	40	75	130	PCU-129	40	95
5	SP-41	35	90	68	SI-1148	55	95	131	PCU-130	100	100
6	VOSI-5846	15	95	69	SI-3291	75	90	132	PCU-131	70	100
7	VOSI-8458	5	95	70	SI-780	60	85	133	PCU-132	90	100
8	EC-31045	0	90	71	SI-11	95	100	134	PCU-133	50	90
9	EC-14121	0	95	72	SI-1245	65	90	135	PCU134	100	100
10	EC-334952	0	100	73	SI-1003	10	80	136	PCU-135	50	85
11	IC-132408	0	100	74	SI-269	0	85	137	PCU-136	70	95
12	NIC-8202	0	100	75	SI-1025	90	100	138	PCU-137	55	100
13	IS-445	30	90	76	SI-371	75	95	139	NIC-16326	30	85
14	IS-172	0	85	77	SI-1671	10	40	140	NIC-17379-I	5	75
15	NIC-8025	0	95	78	SI-3299	45	85	141	NIC-8401	50	80
16	IS-101	0	95	79	SI-85	40	90	142	SI-3279	70	70
17	IS-136	0	95	80	SI-17	60	100	143	NIC-9874	20	70
18	IS-200	0	90	81	IS-684	50	90	144	NIC-7866	45	85
19	IS-750-1-84	0	80	82	SI-870-1	35	100	145	KMR-115	10	95
20	IS-184-1	0	85	83	SI-339	25	95	146	NIC-16122	85	100
21	IS-92-2	45	95	84	SI-2584	85	85	147	NIC-8440	40	85
22	IS-146	0	90	85	SI-2	70	100	148	KMR-13	55	90
23	IS-113	0	90	86	SI-771	20	75	149	NIC-16146	40	80
24	SI-1032	0	100	87	SI-554	75	95	150	T-13-3-I	50	95
25	SI-931	50	100	88	SI-553	35	70	151	NIC-16347-I	25	95
26	SI-3265-5	40	95	89	NIC-17508	60	95	152	NIC-17257	100	100
27	SI-44	25	100	90	SI-100	0	75	153	IC-96222	65	95
28	SI-205-1	40	95	91	SI-1585	85	100	154	NIC-8261-I	55	100
29	SI-199-2-84	30	95	92	SI-75	15	90	155	NIC-7798	70	90
30	SI-983	30	100	93	SI-46-1	65	95	156	NIC-16220	35	95
31	IS-118	25	90	94	SI-205	35	90	157	NIC-8252-I	65	95
32	IS-107	40	75	95	SI-3296	15	65	158	NIC-8584	40	100
33	SI-982	30	85	96	SI-7212	45	90	159	BUC-8357	50	90
34	PCU-34	25	90	97	NIC-16325	55	95	160	NIC-16189	25	85
35	PCU-35	15	95	98	NIC-8350	10	65	161	NIC-8340	60	90
36	PCU-36	15	95	99	NIC-17921	5	50	162	NIC-16115	85	100
37	PCU-37	60	90	100	EC-303427	5	35	163	NIC-16393	50	90
38	PCU-38	20	95	101	NIC-16387	90	100	164	NIC-8400	95	100
39	PCU-39	10	95	102	NIC-16359	5	65	165	NIC-8371	60	85
40	PCU-40	5	95	103	NIC-8262-I	75	95	166	NIC-8181	45	80
41	PCU-41	25	90	104	NIC-8257	70	100	167	NIC-16223	55	85
42	PCU-42	5	95	105	NIC-16358	70	95	168	NIC-17849	75	85
43	PCU-43	10	85	106	NIC-10646-I	5	65	169	NIC-8432	45	95
44	NIC-8322	15	95	107	NIC-8339	5	40	170	NIC-16204	30	90
45	RJS-44	20	95	108	NIC-16409	55	90	171	NIC-8414	40	80
46	SI-3265	5	85	109	KMR-6	5	45	172	NIC-8286	0	50
47	IS-207	60	95	110	IC-204979	5	35	173	NIC-16340	10	60
48	SI-3270	35	100	111	KMR-11	5	75	174	NIC-16414	85	100
49	SI-3281	10	45	112	IC-1634-3	75	90	175	EC-334985	65	95
50	SI-205	50	85	113	KIC-8211	5	50	176	NIC-8254	80	95
51	SI-329	25	90	114	IS-158-3-84	100	100	177	NIC-16415	30	90
52	SI-1143	5	65	115	NIC-8214	5	85	178	NIC-8268	15	75
53	SI-1147	0	65	116	IS-154	80	95	179	NIC-8394	50	85
54	SI-1074-I	0	55	117	IS-184-1	55	85	180	ES-120-1-84-A	45	95
55	SI-42	35	80	118	KM-13	30	80	181	NIC-8488	70	100
56	SI-1116	100	100	119	NIC-16332	70	90	182	NIC-7869	0	25
57	SI-7650	60	90	120	NIC-7905	85	100	183	NIC-16096	40	95
58	SI-1114	75	95	121	IC-204137	10	45	184	NIC-16214	50	95
59	SI-25	5	90	122	S-0157	25	70	185	NIC-7897	35	80
60	SI-3264-2	70	95	123	PCU-123	15	70	186	NIC-7903	40	100
61	SI-2174-I	50	90	124	PCU-124	25	50	187	NIC-8031	10	60
62	SI-212	40	80	125	PCU-125	85	95	188	NIC-16104	25	70
63	SI-1169	25	90	126	PCU-126	55	95	189	NIC-8165	20	90
Line No.	Germplasm	PEG	Control	Line No.	Germplasm	PEG	Control	Line No.	Germplasm	PEG	Control
190	NIC-16208	15	85	253	SI-72-A	60	100	316	ES-13	20	65
191	NIC-7925	20	90	254	SI-1036	15	60	317	KM-8	0	55

192	NIC-7834	30	70	255	NIC-8011	20	95	318	KMS-4-326	10	80
193	NIC-8263	70	85	256	SI-253	5	55	319	KMS-5-351	20	35
194	NIC-10645-I	85	95	257	SI-1125	25	85	320	KMR-64	40	80
195	NIC-9365	65	100	258	ES-5	20	70	321	IS-46-1	0	75
196	NIC-7837	65	100	259	SI-1052	10	50	322	S-0309	20	60
197	NIC-7899	45	85	260	KMR-14-A	20	65	323	IC-56162	10	90
198	NIC-7875	25	70	261	ES-15	20	95	324	KMS-5-3048	5	75
199	NIC-7884	30	90	262	ES-10	10	60	325	IC-204354	5	65
200	NIC-8454	40	80	263	NIC-16226	70	100	326	IS-347-1	20	85
201	NIC-8554	5	75	264	SI-248	5	55	327	KMS-5-371	15	80
202	NIC-8555	75	95	265	SI-72	50	85	328	Chandgaon	20	85
203	IC-14121-B	40	95	266	EC-334963	0	75	329	KM-89	25	60
204	NIC-8399	35	80	267	SI-918	75	95	330	KMS-5-352	60	85
205	NIC-8316	35	90	268	ES-2401-84	65	100	331	IS-95	35	80
206	NIC-16194	20	90	269	KMR-12	70	95	332	RJS-739-1-84	20	45
207	NIC-16408	25	90	270	ES-107	50	90	333	KM-12	15	60
208	NIC-17919	20	65	271	NIC-9838-B	15	95	334	IS-78-1-1	10	80
209	NIC-7921	25	90	272	SI-1050	35	100	335	ES-108-3-84-A	10	70
210	NIC-8232	65	60	273	NIC-8427	50	85	336	KMS-5-360	5	75
211	NIC-16346	35	85	274	KMR-3	65	95	337	SI-2323-3	5	55
212	NIC-8223	40	75	275	GAG-15-A	85	100	338	KMS-4-303	10	75
213	SI-56	80	100	276	SI-15	60	95	339	KM-40	0	75
214	NIC-7811	35	90	277	SI-260	30	100	340	RJS-8331	25	75
215	S-0644-A	5	85	278	NIC-16379	25	75	341	KMS-4-254	10	70
216	NIC-8296	45	85	279	SI-251	85	100	342	S-0365	20	55
217	NIC-7941	25	80	280	KMR-66	45	95	343	KMS-5-381	15	80
218	NIC-8167	0	65	281	DLSG-9	20	90	344	IC-132283	10	85
219	NIC-8361	30	85	282	NIC-8399-I	100	100	345	IC-157-B	10	55
220	NIC-8055	5	35	283	KMR-46	95	100	346	NAL-78-304-40-2A	15	95
221	NIC-16407-I	15	85	284	KMR-107	20	85	347	KMS-5-330	0	40
222	NIC-8541	15	55	285	IS-41	70	95	348	KMR-36	10	90
223	NIC-16416	25	90	286	KMR-52	35	95	349	ES-84-1-84-A	20	80
224	NIC-8289	20	90	287	KMR-88	50	90	350	S-0480	10	80
225	NIC-17918	15	90	288	NIC-17848-A	70	100	351	KMR-61-I	15	85
226	SI-1074-A	30	80	289	KMR-27	85	100	352	GRT-8637	10	85
227	NIC-8292	15	95	290	KMR-112	55	90	353	GJG-30	10	80
228	NIC-7855	40	90	291	ES-20	45	90	354	ES-111-2-84	10	70
229	NIC-8390	45	95	292	KMR-35	50	85	355	KM-9	5	70
230	NIC-8486	50	80	293	KMR-10	30	70	356	KMS-5-343	15	70
231	NIC-16360	15	80	294	KMR-33	40	80	357	KMS-5-873	5	65
232	NIC-7836	30	90	295	KMR-114	25	70	358	NIC-14730-A	20	70
233	IS-395	55	100	296	KMR-22	50	95	359	KMR-116	20	85
234	NIC-7888	35	90	297	S-0579	90	100	360	IS-203	15	85
235	NIC-8222	25	95	298	KMS-04-262	80	100	361	IS-99	15	80
236	NIC-8494	55	100	299	IS-199	60	90	362	IS-189-1-84	10	100
237	NIC-8354	30	90	300	SI-3315-5	70	100	363	IS-421-1-84	25	100
238	KMS-5-393	35	95	301	S-0534	100	100	364	KMS-5-379	20	95
239	NIC-8265	5	95	302	KMS-4-235	85	100	365	ES-8	25	90
240	NIC-7808	5	85	303	KM-90	60	95	366	IC-43154	30	85
241	SI-1053	5	65	304	IS-653	70	95	367	KMS-5-361	45	95
242	ES-302	25	85	305	IS-201	65	90	368	KMS-5-347	25	100
243	SI-1029	10	80	306	KM-76	55	100	369	KMS-5-395	25	85
244	SI-118	10	65	307	KM-86	60	95	370	ES-32-C	40	95
245	ES-58-I	40	80	308	ES-110	25	75	371	IS-423-A	15	95
246	060-7-11-5	25	60	309	RJS-183	85	100	372	IC-204063	10	95
247	SI-99	65	95	310	S-0169	50	85	373	IS-290	30	95
248	SI-992	20	90	311	IS-255-2-84	90	100	374	KMS-4-295	60	90
249	SI-341	25	80	312	EC-303433	95	100	375	IC-204741	10	95
250	ES-7	10	55	313	IS-227-I	25	65	376	KMS-5-346	40	95
251	SI-885	40	80	314	KMS-4-386	10	65	377	SI-1782	35	95
252	SI-9050	10	90	315	KM-49	20	75	378	SI-249	35	100

Line No.	Germplasm	PEG	Control	Line No.	Germplasm	PEG	Control	Line No.	Germplasm	PEG	Control
379	KMS-5-358	10	100	442	IC-203987	15	90	505	NIC-7835	0	30
380	S-0490	15	90	443	KMS-4-257	5	95	506	NIC-8315	25	85
381	IC-204159	35	95	444	IC-51692	5	95	507	NIC-8507	0	90
382	IC-205576	35	95	445	KSM-5-372	5	100	508	NIC-8283	10	60
383	S-0320	70	100	446	IC-43177-A	0	75	509	NIC-8512	10	85
384	IC-17477	30	95	447	IC-204063	10	95	510	ES-106-B	15	85

385	S-0238	5	60	448	IC-43110	0	100	511	NIC-7795	10	85
386	KMS-4-278	0	70	449	IC-43177	0	100	512	NIC-16126	5	85
387	IC-204836	10	75	450	IC-204842	0	100	513	NIC-7902	0	40
388	IC-52887	85	100	451	SI-254	0	100	514	KMR-59	10	75
389	KM-50	20	75	452	03/02/2001	0	95	515	NIC-16394	40	95
390	GRT-83136	15	75	453	IS-242	0	100	516	NIC-7800	25	65
391	IC-131499	30	75	454	KMS-5-587	5	100	517	NIC-16104-I	5	65
392	ES-119-1-84	10	65	455	KMS-5-390	0	95	518	NIC-17434	30	75
393	SI-266	10	85	456	S-0622	10	100	519	KMR-20	20	60
394	IC-132181	55	95	457	RJS-194	100	100	520	KM-7-A	10	60
395	EC-303305	25	80	458	IC-205166	10	85	521	NIC-8354-I	10	70
396	IC-132167	5	20	459	IC-203983	25	60	522	NIC-16211	45	90
397	IS-7818-B-I	30	85	460	KMS-5-396	10	60	523	NIC-8573	30	85
398	SI-284	25	95	461	NIC-10621-B	15	75	524	NIC-8582	10	45
399	S-0199	10	70	462	IS-116-B	15	80	525	NIC-16410	0	55
400	IC-110315	30	85	463	KMS-5-367	10	85	526	NIC-17380	5	40
401	S-0022	30	70	464	SI-145	0	85	527	NIC-8583	0	85
402	S-0192	85	100	465	IC-204622	80	100	528	NIC-16207	0	25
403	B-24	0	70	466	KMS-5-373	10	85	529	IS-109-A	20	100
404	NIC-8290	0	80	467	KMS-5-355	10	80	530	NIC-7810	15	100
405	S-0265	20	95	468	IC-26304	0	50	531	NIC-8498	45	100
406	S-0994	45	80	469	KMS-5-388	20	85	532	NIC-8360	10	95
407	IC-32-C	35	65	470	IS-263	35	90	533	NIC-10612	55	100
408	IC-14053	25	60	471	NIC-16109	25	85	534	KMR-24	25	80
409	S-0182	10	100	472	IS-463902	10	45	535	NIC-9627-B	15	90
410	IS-653-B	5	55	473	NIC-8492	40	80	536	NIC-17293	0	90
411	GRT-83103	15	100	474	NIC-8400	5	85	537	IS-195-A-84	0	95
412	IC-23253	20	45	475	NIC-16396-A	0	85	538	NIC-16195	0	100
413	S-0291	25	95	476	NIC-16386	20	80	539	NIC-16281	20	100
414	IS-10	25	65	477	NIC-8365	10	85	540	IC-41923-B	10	90
415	IS-8-B	55	90	478	KMS-4-251	10	95	541	NIC-16381	30	95
416	EC-303439	90	100	479	NIC-17867	20	95	542	KMS-4-301	5	85
417	RJS-190	50	70	480	NIC-8279	35	90	543	IC-14136	5	85
418	IS-187	30	55	481	NIC-16370	15	90	544	IC-73518	5	70
419	IS-359	20	40	482	NIC-16437	10	90	545	NIC-16087	30	75
420	RJS-147	25	90	483	NIC8222	55	95	546	IC-205312	0	95
421	Murg-1	70	100	484	NIC-8462	20	90	547	KM-28	20	95
422	ES-123-3-84	25	95	485	NIC-8457	15	100	548	S-0174-A	35	90
423	MT-67-141	10	95	486	NIC-16191	20	100	549	NIC-16239	65	100
424	RJS-148-1-80	70	95	487	NIC-17859	5	90	550	S-0160-A	35	95
425	IS-238	15	90	488	KMR-62	20	90	551	N-60-276	30	95
426	KM-25	5	70	489	NIC-8425	5	90	552	IC-204843	25	95
427	IC-132410	75	100	490	KMR-55	0	90	553	NIC-16143	15	70
428	IC-27066	25	80	491	NIC-13591	0	75	554	NIC-13586-A	5	85
429	KMR-93	45	85	492	NIC-8496	20	90	555	IS-8-B	15	95
430	IC-23274	0	40	493	NIC-9833	5	85	556	KMR-18	10	100
431	KMS-5-384	10	85	494	NIC-8578	0	80	557	KMR-3-I	75	100
432	Kandu	0	70	495	NIC-8485	5	90	558	IC-205649	25	85
433	IC-204769	0	85	496	NIC-8059-B	0	70	559	IS-113-A	60	90
434	KMS-4-247	10	95	497	SI-7618-A	0	25	560	NIC-6586	5	90
435	KMS-4-299	0	95	498	IS-351	25	90	561	NIC-8484	20	85
436	KMS-4-267	5	90	499	NIC-9978	5	60	562	NIC-8591	30	95
437	ES-69	10	90	500	NIC-8474	5	95	563	NIC-16130	10	100
438	KM-10	20	85	501	NIC-16333	5	65	564	NIC-8397	20	100
439	KM-33	0	90	502	NIC-16403	25	90	565	NIC-7909	30	95
440	TC-320	0	95	503	NIC-8544	40	90	566	NIC-16309	10	70
441	IC-96245	5	85	504	KMS-4-302	15	75	567	KMR-37	25	90
<b>Line No.</b>	<b>Germplasm</b>	<b>PEG</b>	<b>Control</b>	<b>Line No.</b>	<b>Germplasm</b>	<b>PEG</b>	<b>Control</b>	<b>Line No.</b>	<b>Germplasm</b>	<b>PEG</b>	<b>Control</b>
568	NIC-7908	0	90	631	SI-219	35	85	694	KMR-4	95	100
569	NIC-7817	40	95	632	IS-191-A	10	55	695	NIC-10643-A	0	40
570	KMS-5-363-As	25	100	633	SI-958-A	30	85	696	NIC-B-240-A	55	85
571	NIC-8600	20	95	634	N-66-39-A	0	50	697	ES-124-B-B	0	25
572	NIC-9853	35	95	635	MSS-A	20	85	698	IS-101-1-84	65	60
573	NIC-7981	15	80	636	JL-1-1	30	85	699	IC-14160	80	95
574	NIC-8057	0	80	637	IC-56149-A	0	50	700	RJS-109-2-B	25	90
575	KMR-5	20	90	638	SI-66-A	30	85	701	EC-310423	25	90
576	SI-1004-A	30	100	639	ES-22-B	20	100	702	IS-295	25	85
577	NIC-7907	0	90	640	EC-303421-A	20	85	703	SI-889	75	85
578	GRT-8385-A	0	65	641	IS-469-1-84-A	5	55	704	IS-431-4-84	55	95

579	NIC-8489	0	75	642	SI-27	35	90	705	NIC-8600-A	55	95
580	KMR-89	0	100	643	IS-157-A-1	5	20	706	SP-1184-A	25	85
581	NIC-17912-B	15	100	644	IS-491-A	45	90	707	IS-93-B	50	90
582	NIC-8588	0	80	645	IS-299-A	25	70	708	NIC-10621	10	95
583	KMR-28	0	85	646	SP-1162	25	70	709	JLT-8	100	100
584	IS-102-A	0	95	647	NIC-17912	50	95	710	IS-24-A	25	90
585	KMR-87	0	85	648	SI-3315-10	10	90	711	IS-153-B	30	85
586	NIC-17386	0	90	649	KMR-23	10	70	712	IS-471	60	95
587	NIC-10644	10	95	650	NIC-8439-B	0	55	713	SI-506-A	5	85
588	IC-43142	5	95	651	SI-8008-A	10	75	714	IS-184	65	95
589	KMS-342	0	90	652	SI-1847	10	95	715	IS-205	35	100
590	KMS-349	0	90	653	EC-334983-B	5	90	716	IS-562-A	0	85
591	KMS-4-258	0	90	654	IS-723-A	35	90	717	IS-364	30	75
592	KMS-338	0	95	655	KMR-32-B	5	75	718	IS-2	25	85
593	S-8030	0	75	656	KMR-4-259-A	15	95	719	IS-85-1	10	85
594	S-0195	10	100	657	KMS-423	15	100	720	IS-205-1	70	100
595	KMS-337	5	95	658	KMS-5-380	30	80	721	SI-107-B	50	90
596	KMS-326	0	100	659	EC-303423-A	35	95	722	IC-14146-C-II	80	100
597	IS-35-1	0	95	660	GRT-8628	0	80	723	SI-2531-C	55	90
598	NIC-8392	0	90	661	NIC-8538-A	5	70	724	SI-178-B	40	75
599	IS-195-A	0	95	662	IS-56-B	5	75	725	IS-80-B	0	55
600	IC-131546	0	100	663	NIC-17890-A	60	90	726	SI-1170-A	20	95
601	SI-3166	5	70	664	ES-36-A	0	70	727	EC-182832-A	35	90
602	KMR-60	25	90	665	KMR-30-A	0	55	728	SI-967	55	100
603	KMR-31	5	85	666	IS-731	45	90	729	IS-157-A	70	100
604	NIC-8446	15	80	667	SI-3315	25	80	730	IS-405	75	95
605	S-0565	0	100	668	SI-3273-A	0	75	731	IS-347-1-A	70	100
606	IS-284-A	0	95	669	NIC-16190-A	10	35	732	NIC-16314	90	100
607	SI-264	0	95	670	IS-255-2-84-A	30	80	733	IS-8	30	90
608	NIC-8396	10	90	671	IS-3197-A	0	70	734	IS-35-1-A	55	95
609	IS-216-1	0	60	672	NIC-16327	70	95	735	KIS-347-A	35	70
610	SI-233	0	100	673	NIC-16227-A	35	85	736	NIC-8321	45	80
611	GRT-8607	0	40	674	KMR-74	0	90	737	EC-303434	70	95
612	KMS-331	5	60	675	NIC-8224-A	55	90	738	IS-130	100	100
613	KMR-51	0	80	676	KMR-48-A	0	75	739	EC-303311-A	25	90
614	SI-3263-1	0	95	677	SI-3100	75	100	740	NIC-1615-B	50	80
615	KMR-61	0	95	678	S-0242	40	90	741	NIC-54-164-B	40	100
616	SI-241	0	85	679	NIC-16387-A	30	90	742	SI-2039-A	50	80
617	IS-47-B	0	90	680	IC-1025-A	40	90	743	SI-1782-A	75	100
618	KMS-394	0	85	681	IC-204832-A	0	55	744	SI-8459	55	80
619	R-16-6	0	80	682	NIC-8423-B	25	85	745	KIS-352-A	10	95
620	X-99-99-8	0	75	683	S-0484	50	95	746	EC-303304-A	25	85
621	NP-6-1	0	75	684	IC-132186-A	40	90	747	SI-770	30	75
622	PKD-31	20	75	685	IC-204550	55	95	748	IC-24981	0	50
623	EC-334965-I	0	90	686	GRT-839-A	40	85	749	EC-303446	20	75
624	RCR-1	0	80	687	GRT-8330-B	90	95	750	IS-187-A	0	80
625	IS-101-3-B	15	80	688	NIC-8368	0	70	751	IS-8484	15	45
626	SI-157	35	85	689	SI-3315-6-I	45	100	752	EC-52000145	5	80
627	IS-319-A	10	80	690	RJS-146-1-84	0	25	753	NIC-9852-A	10	90
628	IS-112	25	90	691	EC-303441-B	0	15	754	KMS-5-368	25	85
629	B-240-A	10	85	692	EC-334981-A	30	40	755	S-01159-B	15	85
630	IS-264-B-1	20	85	693	KMR-83-A	0	15	756	KMR-39	15	90

Line No.	Germplasm	PEG	Control	Line No.	Germplasm	PEG	Control	Line No.	Germplasm	PEG	Control
757	IS-127-B	20	70	782	IS-222-2-84-A	10	95	807	SI-3299-A	85	100
758	KMS-5-332	60	90	783	IS-673	55	100	808	S-0589	50	95
759	IC-131607-A	55	85	784	GRT-8602-A	85	100	809	NIC-16391	75	100
760	T-1-A	25	85	785	Tirendre local	80	95	810	S-0561-A	60	95
761	KMS-4-264-A	50	90	786	NIC-16207-A	25	95	811	IC-43102-A	0	95
762	KIS-300-A	80	100	787	S-0233	40	95	812	S-0576-B	85	100
763	IS-390	30	85	788	IC-52359-A-I	65	90	813	NIC-7835-A	55	90
764	GRT-8622	35	95	789	SI-3271-A	70	100	814	KMR-302-A	35	80
765	KIS-357-A	40	75	790	IC-52559-A	15	95	815	IS-113-A	90	95
766	ES-109-A	50	80	791	IC-132089	35	80	816	NIC-7795-A	100	100
767	IC-42952	45	90	792	IS-305-A	25	85	817	S-0565-A	45	85
768	IS-332	40	70	793	NIC-16120	75	95	818	KMS-324-A	70	95
769	ES-46-A	25	90	794	NIC-17868	100	100	819	NIC-16170-B	55	100
770	NIC-8080-A	55	80	795	IS-520	70	95	820	IS-347-1-A	80	95
771	IC-110613	65	95	796	SI-250-A	0	65	821	NIC-9840-B	70	90

772	IC-23279-A	50	90	797	IC-44045	30	85	822	ES-10-A	100	100
773	RJS-147-1-84-A	30	95	798	NIC-16319-A	25	80	823	S-300-A	85	100
774	SI-3278	40	90	799	NIC-16238	45	90	824	S-0296	75	95
775	RJS-149-1-84	30	80	800	ES-112	70	100	825	NIC-11008-A	60	95
776	KMS-4-323-A	30	100	801	NIC-8393-A	60	90	826	S-0613-A	75	100
777	R-251011	45	95	802	B-45-A	70	95	827	EC-303443-A	50	75
778	IS-486-A-A	65	100	803	NIC-2521-A	10	80	828	EC-138836-A	100	100
779	IC-74188-A	45	100	804	BS-27-A	85	90	829	SI-1718-B	80	100
780	IS-85-A	80	100	805	NIC-16391	10	85				
781	KMS-4-313	40	85	806	GGK-36	60	100				

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