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Research Article

Screening of tropical inbred lines for drought tolerance based on secondary traits in maize (*Zea mays* L.)

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Abstract
In the present study, 63 tropical maize inbred lines were screened for four drought related traits *viz*., relative water content, root volume, root length and anthesis silking interval at three different stages of induced stress at vegetative, pre anthesis and at anthesis stages. Where earliness for avoiding terminal drought is desired, the genotypes with short ASI could be used. In the present investigation, fourteen inbreds showed < 2 days, anthesis silking interval when compared with parental means (5.45 days). Among them seven inbreds *viz*., UMI 285, UMI 917, UMI 1024, UMI 1056, UMI 1060 and UMI 1096 had reduced ASI of one day. The anthesis silking interval became shorter under drought and selection seemed to have led to significantly faster spikelet and ear growth at flowering, but also to reduction in final spikelet number. Relative Water Content (%) was more during vegetative stage stress compared to pre anthesis and at anthesis stages. The comparison of RWC means in all three stages showed that the level of RWC of leaves were significantly increased in nine genotypes and UMI 233 recorded the highest RWC (87.27%). Considering root length and root volume across the stages, root length was increased slightly in pre and at anthesis stages but root volume decreased during post anthesis stage among the genotypes. In the present investigation, sixty three tropical inbreds screened for drought tolerance, a total of 14 inbred lines were selected based on RWC (%), root length, root volume and anthesis silking interval (<3 days) for utilizing in hybridization.

Key words
Maize, inbred lines, moisture stress, screening

Introduction

Today maize is one of the most important food and feed crops in the world. It is grown in more than 166 countries for diverse uses, in diverse seasons, in different agro-ecological conditions due to its high yield potential. In India, maize is grown in a wide range of climates, extending from extreme semi-arid to sub-humid to temperate conditions. So, 80 per cent of the maize area at present is confined to rainfed condition and often suffers from abiotic stresses. This is one of the major reasons for low productivity of maize in India. Abiotic stresses are integral part of any agro ecosystem, they affect crop plant in variety of ways *viz*., moisture stress (low/excess), temperature (high / low), salinity, sodicity and nutrient, etc.

In India, with the growth in demand of poultry feed, the demand for maize grains is also going up in recent years. Currently, in India, it is cultivated in an area of 8.28 million hectares with a production of 17.31 million tonnes having an average productivity of more than 2091 kilograms per hectare (2009 – 2010) contributing 8.5% to the Indian Food basket (Anonymous, 2010). Maize occupies an important place as a source of human food (25%), animal feed (12%), poultry feed (49%), starch (12%), brewery (1%) and seed (1%). The growth rate of area (2.83%), production (30.93%) and productivity (27.35%) over the past years, has shown a remarkable increase as compared to other principal cereal crops.

In Tamil Nadu, due to adoption of single cross hybrid technology, the area under maize has steadily increased compared to other millets. At present, the area under maize has exceeded 3.08 lakh hectares (2009 – 2010) with the production of 12.18 lakh tonnes and the productivity of 3,951 kg/ha. Though there is a steady increase in area, production and productivity, the average productivity of Tamil Nadu is higher (3951 kg / ha) than the national average productivity of 2,091 kg/ha (2009 – 2010). Due to gradual increase in area and the demand of maize grains for poultry and animal feed industries and also for industrial usage, the maize crop will influence the state agriculture in near future.

Intensive efforts to increase yield further in rainfed environment, the main impediment is drought which is a very common phenomenon. Throughout the rainfed situation in Tamil Nadu, periodic drought, caused by irregular rainfall distribution and accentuated by soils with low water holding capacity, causes sizeable reductions in maize yields. Based on experimental results, the agronomists and meteorologists have concluded that drought occurring around flowering has a major effect on grain yield. Deficits of water for periods lasting one to two days during tasseling or pollination may cause as much as 22 per cent reduction in yield (Robins and Domingo, 1953),while stress during the grain filling stages

(McPherson and Boyer, 1977) and vegetative stages (Denmead and Shaw, 1960) may have much less effect on yield.

Moisture deficit is the most common limiting abiotic stress among all stresses and it is one of the major constraints in maize productivity. Moisture stress is very common in the areas where maize is predominantly grown during kharif season under rainfed conditions. But, drought and low N stresses are major factors most frequently limiting the maize production in the tropics. Ribaut *et al*, (1997) reported that maize is susceptible to drought at flowering stage than any other crop. Baenziger *et al.* (2000) reported that drought leads to reduced leaf, silk, stem, root and grain development. Mangombe *et al.* (1996) found that varieties of maize exposed to unpredictable drought stress during the growing season produced low grain yield.

The cultivation of single cross hybrid maize has helped in mitigating severity of stresses to some extent because of their inherent ability to perform well under stress conditions compared to open pollinated varieties. The reasons for better performance of single cross hybrid over OPV's are *viz*., better root system, early vigour and quick growth competes with weeds. Improvement of productivity of maize cultivars under drought conditions becomes one of the objectives of breeding programmes in maize. Therefore screening to identify the drought tolerant source of genotype in order to develop drought tolerant hybrids for drought prone areas is a prerequisite.

Materials and Methods.

A total of sixty three tropical maize inbred lines were screened for drought tolerance during Dec-Jan'08 under screen house conditions at Regional Research Station, Paiyur imposing moisture stress at various growth stages *viz.*, vegetative, pre anthesis and at anthesis periods. Fourteen inbreds were selected based on shorter ASI, deeper roots, higher root volume and higher RWC and also considering the overall performance in all the three stages of imposed moisture stress. The procedure adopted for the above screening is described here under.

Screening for drought tolerance was carried out from December-January 2008 under screen house condition. Each set of experimental materials was evaluated under well watered condition and moisture deficit imposed at different growth stages in screen house. Soil used for the studiy was collected from the site of the field trials. For each trial, five seeds were initially planted in a mud pot but later thinned to two most vigorous plants per pot. Two additional pots were planted for each genotype for collecting data on days to tasseling and silking. Each experimental unit consisted of three mud pots. The design used for each experiment was a three replicate split plot with irrigation regime as the main plot and genotypes as sub plot but arranged in the completely randomized design (CRD) on glass house benches. The test materials were subjected to vegetative, pre and at anthesis moisture deficits. Moisture stress at vegetative phase was imposed for 2 weeks (7-21 days) beginning from one week after planting (WAP) followed by resumption of normal watering till the termination of the experiments. Pre (30-44 days) and at anthesis (44-68 days), moisture stress were also imposed for a 2 week period as soon as any one of the two plants in a pot either attained tassel initiation (by feeling the whorls of the leaves).Thereafter, normal watering was resumed for each treatment until the termination of the experiments.

Data were collected on individual plants in a pot and the mean of 6 values was recorded for root length, root volume, days to anthesis and silking for each stage of moisture stress.

ASI was measured as difference between 50% tassels have extruded the anthers (AD) and 50% cobs (SD) have emerged silks in days (CIMMYT, 2000).

$$ASI = SD\text{-}AD$$

The RWC of leaf from plants during moisture stress period at vegetative, pre anthesis and at anthesis stages were estimated, using the formula proposed by Barrs and Weatherley (1962). The RWC values were expressed in percentage.

$$RWC = \frac{\text{Fresh weight} - \text{Dry weight}}{\text{Turgid weight} - \text{Dry weight}} \times 100$$

Plants were uprooted during moisture stress period, roots were cut and washed and the length of the longest root was measured and expressed in centimeter.

Plants used for recording root length was used for measuring root volume

Roots were cut and washed and the volume was recorded adopting water displacement method and expressed in cubic centimeter.

Results and Discussion

Periodic drought caused by irregular rainfall accentuated by low water holding capacity soil of tropical condition as well as poor cultural practices and lack of appropriate varieties for cultivation under by farmers, often cause maize crop losses (Karrou *et al*, 1996; Ashley, 1999). Therefore, the essential first step in utilizing germplasm is to screen for specificd parameters and identify desirable characters based on breeding objective, which can then incorporated into existing cultivars. Drought tolerant maize germplasm can be assessed for drought tolerant capacity by evaluating them under moisture deficit condition (Menkir and Akintunde, 2001), using already identified traits that are directly or indirectly related to high grain yield under moisture deficit as index of selection in drought tolerant breeding programme. These include rooting characteristics (O'Toole and Band, 1987), barrenness (Bolanos and Edmeades, 1993) and short ASI (Edmeades *et al*, 1992).

In the present study, 63 tropical maize inbred lines were screened for four drought related traits *viz*., relative water content, root volume, root length and anthesis silking interval at three different stages of induced stress at vegetative, pre anthesis and at anthesis stages. The mean performance of sixty three tropical maize inbred lines screened under induced moisture stress are presented in Table 1.In vegetative stress (7-21days), the relative water content on 21st day varied from 77.59 (UMI 1097) to 95.66% (UMI 233) and 21 genotypes recorded significantly high mean value than grand mean (87.19 %)(Table 1). In pre anthesis stage (30-44 days), RWC ranged from 69.65 (UMI 1099) to 90.63 % (UMI 1069) on 44th day after sowing and 18 genotypes recorded highly significant mean value than grand mean (80.61%). At anthesis stage (44-68 days), RWC ranged from 45.17 (UMI 1098) to 77.70 % (UMI 285) on 68th DAS and sixteen genotypes recorded significantly high mean than grand mean (64.11%).Considering the overall mean, 17 genotypes recorded highly significant mean value than grand mean (77.31 %) which ranged from 69.60 (UMI 1097) to 87.27 % (UMI 233). In vegetative stress (7-21 days), the root length showed a range from 19.65 (UMI 1073) to 36.15 cm (UMI 233). Twenty two genotypes registered significantly higher root length in comparison with the grand mean (26.51 cm) (Table 1). During pre anthesis stage (30-44 days), the range was from 24.15 (UMI 1073) to 38.05 cm (UMI 233). In comparison with the grand mean (31.20 cm), ten genotypes showed higher root length. At anthesis stage (44-68 days), eight genotypes recorded higher root length when compared to the grand mean. The overall mean of genotypes, eighteen inbred lines recorded significantly higher root length during moisture stress at varied growth stages. The maximum value of root length was observed in UMI 233 (36.36 cm) and the lowest in UMI 1092 (17.98 cm).

Among the genotypes, the root volume in vegetative stress (14-21 days**)** ranged from 0.5 (UMI 350 and UMI 1072) to 7.0 cm^3 (UMI 233). Fifteen genotypes recorded significantly higher root volume when compared to the grand mean (2.35 cm$^{3)}$ (Table 1).

In pre anthesis stage (30-44 DAS), root volume ranged between 0.5 (UMI 1073 and UMI 1072) to 5.25 cm^3 (UMI 1029). Fourteen genotypes showed significantly higher volume when compared to the parental mean values (2.24 cm^3)

The mean performance of genotypes during anthesis period (44-68 DAS), varied between 0.25 (UMI 1074) to 5.75 cm^3 (UMI 1058). Thirteen genotypes registered significantly higher root volume than the overall grand mean (1.57 cm^3).

Considering the overall mean, 14 genotypes excelled the grand mean and it varied from 0.75 (UMI 1073 and UMI1072) to 5.33 cm ^{3} (UMI 233).

The mean performance of genotypes for anthesis silking interval ranged from one (UMI 285, UMI 917, UMI 1024, UMI 1056, UMI 1060 and UMI 1096) to 8 days (UMI 1026, UMI 1039, UMI 1041, UMI 1044, UMI 1059, UMI 1062, UMI 1073, UMI 1082, and UMI 1097) under moisture stress conditions during pre anthesis stage (30-44 days). Fourteen genotypes showed <2 days for anthesis silking interval when compared with parental mean (5.45 days) (Table1).

Where earliness for avoiding terminal drought is desired, the genotypes with short ASI could be used. In the present investigation fourteen inbreds showed <2 days for anthesis silking interval when compared with parental means (5.45 days). Among them seven inbreds *viz*., UMI 285, UMI 917, UMI 1024, UMI 1056, UMI 1060 and UMI 1096 had reduced ASI of one day. The anthesis silking interval became shorter under drought and selection seemed to have led to significantly faster spikelet and ear growth at flowering, but also to a reductions in final spikelet number.

The Relative Water Content (%) is more during vegetative stage stress compared to pre anthesis and at anthesis stages. The comparison of RWC means in all three stages showed that the level of RWC of leaves were significantly increased in nine genotypes and UMI 233 recorded the highest RWC (87.27%). Considering root length and root volume across the stages, root length was increased slightly in pre and at anthesis stages but root volume was decreased in post anthesis stage among the genotypes. In the present investigation, sixty three tropical inbreds screened for drought tolerance, a total of 14 inbred lines were selected based on RWC (%), root length, root volume and anthesis silking interval (<3 days) for mating in diallel fashion (Table 2).

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Table 1. Mean performance of inbreds for various traits under moisture stress in maize

Sl.No.	Genotypes	RWC %				Root Length (cm)				Root Volume (cm^3)				ASI (days)
		Vegetative (21 DAS)	Pre anthesis (44 DAS)	Post anthesis (68 DAS)	Mean	Vegetative (21 DAS)	Pre anthesis (44 DAS)	Post anthesis (68 DAS)	Mean	Vegetative (21 DAS)	Pre anthesis (44 DAS)	Post anthesis (68 DAS)	Mean	
1.	UMI 61	90.26	90.30	76.35	85.64	33.26	33.20	33.25	33.25	5.25	2.25	2.00	3.17	2.00
2.	UMI 99	83.30	79.90	67.70	76.97	21.60	25.95	29.15	27.53	1.75	0.75	0.50	1.00	5.50
3.	UMI 233	95.66	89.80	76.35	87.27	36.15	38.05	38.70	36.36	7.00	4.75	4.25	5.33	3.00
4.	UMI 285	88.27	84.60	77.70	83.52	33.17	33.19	33.18	33.18	5.75	1.25	3.25	3.42	1.00
5.	UMI 350	87.22	82.90	68.35	79.49	21.95	26.20	31.10	27.50	0.50	2.00	2.25	1.58	5.50
6.	UMI 901	82.90	77.25	67.35	75.83	25.05	29.75	32.25	27.54	1.75	2.00	1.25	1.67	6.00
7.	UMI 917	93.77	88.25	76.23	86.08	33.32	33.34	33.32	33.32	4.00	4.00	4.10	4.00	1.00
8.	UMI 920	80.05	78.40	66.55	75.00	22.60	26.10	31.80	27.03	0.75	1.25	0.75	0.92	5.50
9.	UMI 950	85.69	80.10	67.30	77.70	25.10	31.95	32.80	29.68	0.75	1.25	0.75	0.92	6.00
10.	UMI 955	82.30	76.75	57.80	72.28	27.80	31.15	34.55	31.02	2.25	1.75	0.50	1.50	6.00
11.	UMI 1009	95.60	86.59	75.75	85.98	33.55	36.20	39.65	34.22	4.75	4.75	4.00	4.50	2.00
12.	UMI 1011	85.60	80.60	57.50	74.57	26.20	28.80	32.45	28.61	1.75	1.50	1.25	1.50	6.00
13.	UMI 1013	80.60	78.35	55.15	71.37	28.95	31.85	31.40	29.46	2.50	1.75	1.25	1.83	5.50
14.	UMI 1019	93.27	88.16	75.80	85.74	33.37	33.39	33.38	33.38	4.25	4.00	3.00	3.75	2.00
15.	UMI 1020	85.07	79.40	59.25	74.57	21.15	27.80	28.70	25.32	1.25	2.25	1.25	1.58	5.00
16.	UMI 1024	91.01	90.65	64.99	82.21	33.75	35.60	36.65	33.60	5.50	5.00	1.25	3.92	1.00
17.	UMI 1025	80.95	74.40	67.35	74.23	26.80	28.70	29.85	28.03	3.00	1.25	0.75	1.67	7.50
18.	UMI 1026	90.12	79.35	55.31	74.93	29.20	32.90	28.10	29.19	1.75	1.75	0.75	1.42	8.00
19.	UMI 1027	88.30	80.30	58.30	75.63	23.80	27.30	27.70	26.70	2.75	1.25	1.50	1.83	6.00
20.	UMI 1028	85.10	75.10	65.61	75.27	29.35	30.10	33.70	31.13	2.25	1.75	2.25	2.08	5.50
21.	UMI 1029	93.47	89.30	76.77	86.51	33.36	33.36	33.38	33.36	4.75	5.25	3.25	4.42	2.00
22.	UMI 1030	82.85	79.45	68.94	77.08	26.75	34.10	34.10	29.45	2.25	3.75	0.50	2.17	5.00
23.	UMI 1031	82.52	76.85	66.60	75.32	21.85	27.35	28.65	26.10	3.00	1.75	1.25	2.00	7.00
24.	UMI 1033	78.01	75.25	61.80	71.69	25.45	32.10	32.85	30.34	2.00	1.25	0.75	1.33	6.50
25.	UMI 1034	82.06	76.20	52.54	70.26	28.70	32.00	27.30	27.77	1.25	1.25	0.75	1.08	5.50
26.	UMI 1036	77.94	77.25	64.55	73.25	26.15	29.45	32.00	30.39	1.50	1.75	0.50	1.25	6.00
27.	UMI 1038	82.33	79.90	66.30	76.18	20.30	25.20	28.35	27.49	2.25	1.25	0.50	1.33	7.00
28.	UMI 1039	82.03	75.15	60.89	72.69	22.55	31.15	33.10	27.43	1.75	1.50	2.25	1.83	8.00
29.	UMI 1041	84.17	80.90	76.40	80.49	32.90	32.88	32.91	32.90	1.50	3.75	0.50	1.92	8.00
30.	UMI 1042	78.85	75.60	63.00	72.48	21.25	29.85	33.05	27.79	1.00	1.50	1.00	1.17	7.00
31.	UMI 1044	87.21	76.25	65.24	76.23	32.00	35.20	33.65	33.02	1.75	2.00	1.25	1.67	8.00
32.	UMI 1047	86.13	80.40	57.80	74.78	28.35	33.55	36.90	32.71	1.75	1.50	0.75	1.33	6.00
33.	UMI 1048	88.15	79.09	64.65	77.30	23.15	30.70	31.85	27.32	2.00	2.25	1.25	1.83	6.50
34.	UMI 1049	81.06	71.05	64.55	72.22	19.85	33.95	34.05	27.18	1.25	1.25	0.50	1.00	6.00
35.	UMI 1051	89.40	85.88	62.75	79.34	25.00	30.10	33.70	29.08	0.75	1.75	0.50	1.00	7.00

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Table 1. Contd…

Sl.No.	Genotypes	RWC %				Root Length (cm)				Root Volume (cm^3)				ASI (days)
		Vegetative (21 DAS)	Pre anthesis (44 DAS)	Post anthesis (68 DAS)	Mean	Vegetative (21 DAS)	Pre anthesis (44 DAS)	Post anthesis (68 DAS)	Mean	Vegetative (21 DAS)	Pre anthesis (44 DAS)	Post anthesis (68 DAS)	Mean	
36.	UMI 1053	87.80	77.34	55.75	73.63	30.30	33.60	39.60	33.82	1.75	2.00	1.00	1.58	6.00
37.	UMI 1054	95.05	89.99	75.10	86.71	33.57	33.59	33.58	33.58	6.25	5.00	2.75	4.67	2.00
38.	UMI 1055	91.12	75.05	60.27	75.48	30.50	34.35	39.10	33.41	2.75	1.25	1.00	1.67	7.00
39.	UMI 1056	93.04	85.65	55.96	78.21	21.90	33.85	35.05	27.63	2.00	1.25	1.25	1.50	1.00
40.	UMI 1057	91.74	86.46	66.80	81.66	20.80	27.80	32.50	26.65	3.75	2.25	1.75	2.58	5.00
41.	UMI 1058	86.60	85.60	69.10	80.43	31.50	35.60	39.70	32.88	6.00	4.00	5.75	5.25	2.00
42.	UMI 1059	91.00	82.91	57.90	77.27	21.15	26.50	33.60	26.95	1.25	2.25	0.50	1.33	8.00
43.	UMI 1060	93.20	90.18	72.25	85.21	33.14	33.14	33.16	33.14	4.00	4.25	4.75	4.33	1.00
44.	UMI 1061	89.40	86.63	57.11	77.71	25.65	29.85	35.60	28.11	1.00	1.50	0.50	1.00	7.00
45.	UMI 1062	87.40	80.05	63.30	76.92	25.10	29.80	31.05	28.54	1.25	2.00	0.75	1.33	8.00
46.	UMI 1063	89.68	77.30	68.42	78.47	20.70	25.20	29.60	26.66	1.50	1.75	1.00	1.42	7.50
47.	UMI 1067	94.50	76.20	61.83	77.51	22.35	28.35	26.10	23.09	1.75	2.25	1.75	1.92	5.50
48.	UMI 1069	92.17	90.63	75.10	85.97	33.27	33.29	33.28	33.28	4.25	4.00	5.00	4.42	2.00
49.	UMI 1071	90.35	78.66	66.60	78.54	25.50	31.55	23.50	26.10	2.00	1.00	0.50	1.17	7.00
50.	UMI 1072	88.38	77.15	51.85	72.46	25.35	29.70	32.40	25.35	0.50	0.50	1.25	0.75	7.00
51.	UMI 1073	90.79	79.50	53.46	74.58	19.65	24.15	29.30	25.95	1.25	0.50	0.50	0.75	8.00
52.	UMI 1074	86.12	75.43	48.25	69.93	26.75	32.05	27.10	27.43	1.50	1.50	0.25	1.08	7.00
53.	UMI 1082	86.75	75.15	56.94	72.95	25.75	31.95	32.80	26.29	2.25	2.25	2.50	2.33	8.00
54.	UMI 1085	93.95	76.25	71.55	80.58	33.00	33.00	33.00	33.00	4.00	4.25	4.75	4.33	2.00
55.	UMI 1087	92.54	77.85	59.50	76.63	20.40	29.35	33.85	18.30	1.25	3.00	1.00	1.75	5.50
56.	UMI 1091	84.62	80.80	55.15	73.52	25.10	29.75	30.20	19.30	1.25	1.75	0.75	1.25	5.50
57.	UMI 1092	77.85	77.30	65.65	73.60	24.75	31.25	29.20	17.98	1.50	2.00	0.50	1.33	7.00
58.	UMI 1094	89.82	86.30	63.75	79.96	27.85	29.90	31.55	20.83	1.50	2.25	1.25	1.67	6.00
59.	UMI 1095	86.47	76.30	55.66	72.81	29.95	29.90	27.80	29.31	1.25	3.00	0.75	1.67	5.00
60.	UMI 1096	92.11	87.25	74.39	84.58	33.21	33.20	33.21	33.20	4.25	4.00	4.00	4.08	1.00
61.	UMI 1097	77.59	76.25	54.95	69.60	31.90	29.75	29.05	20.32	2.00	2.25	0.75	1.67	8.00
62.	UMI 1098	89.40	81.10	45.17	71.89	27.55	30.30	29.35	18.97	2.00	2.00	1.25	1.75	7.00
63.	UMI 1099	80.55	69.65	55.05	68.42	26.75	31.90	31.25	19.33	1.50	1.50	0.75	1.25	6.50
	GMean	87.19	80.61	64.11	77.31	26.51	31.20	32.85	30.18	2.35	2.24	1.57	2.05	5.45
	S.E.	0.99	0.99	1.25	1.08	0.88	0.85	1.07	0.65	0.31	0.31	0.27	0.30	0.54
	C.D.(5%)	2.77	2.78	3.49	3.01	2.47	2.37	2.99	2.61	0.86	0.87	0.76	0.83	1.51
	CV(%)	1.60	1.74	2.75	2.03	4.70	3.84	4.59	3.10	18.55	19.72	24.43	20.90	39.73

Table 2. Drought tolerant inbreds selected based on relative water content, root length and root volume over different stages in maize

Sl. No.	Mean of RWC%	ASI (days)	Mean of root length (cm)	ASI (days)	Mean of root volume (cm^3)	ASI	Genotypes selected based on RWC, RL, RV & ASI	ASI
1.	87.27 (UMI 233)	3.00	36.36 (UMI 233)	3.00	5.25 (UMI 1058)	2.00	UMI 233 (P4)	3
2.	86.71(UMI 1054)	2.00	34.22 (UMI 1009)	2.00	5.33 (UMI 233)	3.00	UMI 1009 (P12)	2
3.	86.51 (UMI 1029)	2.00	33.82 (UMI 1053)	6.00	4.67 (UMI 1054)	2.00	UMI 1024 (P10)	1
4.	86.08 (UMI 917)	1.00	33.60 (UMI 1024)	1.00	4.50 (UMI 1009)	2.00	UMI 1058 (P3)	2
5.	85.98 (UMI 1009)	2.00	33.58 (UMI 1054)	2.00	4.42 (UMI 1029)	2.00	UMI 285 (P1)	2
6.	85.97 (UMI 1069)	2.00	33.41 (UMI 1055)	7.00	4.42 (UMI 1069)	2.00	UMI 1096 (P5)	1
7.	85.74 (UMI 1019)	2.00	32.38 (UMI 1019)	2.00	4.30 (UMI 1085)	2.00	UMI 1069 (P6)	2
8.	85.64 (UMI 61)	2.00	33.36 (UMI 1029)	2.00	4.33 (UMI 1060)	1.00	UMI 1060 (P8)	1
9.	85.21 (UMI 1060)	1.00	33.32 (UMI 917)	1.00	4.08 (UMI 1096)	1.00	UMI 1029 (P9)	2
10.	84.58 (UMI 1096)	1.00	33.28 (UMI 1069)	2.00	4.00 (UMI 917)	1.00	UMI 1085 (P2)	2
11.	83.52 (UMI 285)	1.00	33.25 (UMI 61)	2.00	3.92 (UMI 1024)	1.00	UMI 1019 (P11)	2
12.	82.21 (UMI 1024)	1.00	33.20 (UMI 1096)	1.00	3.75 (UMI 1019)	2.00	UMI 917 (P13)	1
13.	81.66 (UMI 1057)	5.00	33.18 (UMI 285)	1.00	3.42 (UMI 285)	1.00	UMI 61 (P14)	2
14.	80.58 (UMI 1085)	2.00	33.14 (UMI 1060)	1.00	3.17 (UMI 61)	2.00	UMI 1054 (P7)	2
15.	80.49 (UMI 1044)	8.00	33.02 (UMI 1044)	8.00	0.75 (UMI 1091)	5.50		
16.	80.43 (UMI 1058)	2.00	33.00 (UMI 1085)	2.00	0.00 (UMI 955)	6.00		
			32.90 (UMI 1041)	8.00				
			32.88 (UMI 1058)	2.00				
GM	77.31		30.18		2.05		5.45	
CD 5%	3.01		2.61		0.83		39.73	

GM - Grand Mean