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UPOV

INTERNATIONAL UNION FOR THE PROTECTION OF NEW VARIETIES OF PLANTS

GENEVA

Associated Document
to the
General Introduction to the Examination
of Distinctness, Uniformity and Stability and the
Development of Harmonized Descriptions of New Varieties of Plants (document TG/1/3)

DOCUMENT TGP/10

"EXAMINING UNIFORMITY"

Section TGP/10.3.1: Recommended Statistical Methods: COYU

Document prepared by experts from the United Kingdom
to be considered by the

Technical Working Party on Automation and Computer Programs (TWC), at its twentieth session to be held in Texcoco, Mexico, from June 17 to 20, 2002

SECTION 10.3.1
RECOMMENDED STATISTICAL METHODS:
THE COMBINED-OVER-YEARS UNIFORMITY (COYU) CRITERION

SUMMARY

1. When the uniformity of plants of a variety is to be judged on the basis of measurements then the standard deviation (SD) can be used to summarise the spread of the observations. A new variety can then be tested for uniformity by comparing its SD with that of reference varieties. There are several possible ways of assessing uniformity based on the SD. Here the Combined-Over-Years Uniformity (COYU) criterion is described.

2. Uniformity is often related to the expression of a characteristic. For example, in some species, varieties with larger plants tend to be less uniform in size than those with smaller plants. If the same standard is applied to all varieties then it is possible that some may have to meet very strict criteria while others face standards that are easy to satisfy. COYU addresses this problem by adjusting for any relationship that exists between uniformity, as measured by the plant-to-plant SD, and the expression of the characteristic, as measured by the variety mean, before setting a standard.

3. The technique involves ranking reference and candidate varieties by the mean value of the characteristic. Each variety's SD is taken and the mean SD of the most similar varieties is subtracted. This procedure gives, for each variety, a measure of its uniformity expressed relative to that of comparable varieties.

4. The results for each year are combined in a variety-by-years table of adjusted SDs and analysis of variance is applied. The mean adjusted SD for the candidate is compared with the mean for the reference varieties using a standard t-test.

5. COYU, in effect, compares the uniformity of a candidate with that of the reference varieties most similar in relation to the characteristic being assessed. The main advantages of COYU are that all varieties can be compared on the same basis and that information from several years of testing may be combined into a single criterion.

INTRODUCTION

6. Uniformity is sometimes assessed by measuring individual characteristics and calculating the standard deviation (SD) of the measurements on individual plants within a replicate. The SDs are averaged over all replicates to provide a single measure of uniformity for each variety in a trial.

7. This paper outlines a procedure known as the combined-over-years uniformity (COYU) criterion. COYU assesses the uniformity of a variety relative to reference varieties based on SDs from trials over several years. A feature of the method is that it takes account of possible relationships between the expression of a characteristic and uniformity.

8. This paper describes:

- The principles underlying the COYU method.
- UPOV recommendations on the application of COYU to individual species.
- Mathematical details of the method with an example of its application.
- The computer software that is available to apply the procedure.

THE COYU CRITERION

9. The application of the COYU criterion involves a number of steps as listed below. These are applied to each characteristic in turn. Details are given under MATHEMATICAL DETAILS below.

Step 1: Calculation of within-plot SDs for each variety in each year.

Step 2: Transformation of SDs by adding 1 and converting to natural logarithms.

Step 3: Estimation of the relationship between the SD and mean in each year. The method used is based on moving averages of the log SDs of reference varieties ordered by their means.

Step 4: Adjustments of log SDs of candidate and reference varieties based on the estimated relationships between SD and mean in each year.

Step 5: Averaging of adjusted log SDs over years.

Step 6: Calculation of the maximum allowable SD (the uniformity criterion). This uses an estimate of the variability in the uniformity of reference varieties derived from analysis of variance of the variety-by-year table of adjusted log SDs.

Step 7: Comparison of the adjusted log SDs of candidate varieties with the maximum allowable SD.

10. The advantages of the COYU criterion are:

- It provides a method for assessing uniformity that is largely independent of the varieties that are under test.
- The method combines information from several trials to form a single criterion for uniformity.
- Standards based on the method are likely to be stable over time.
- The statistical model on which it is based reflects the main sources of variation that influence uniformity.

UPOV RECOMMENDATIONS ON COYU

11. COYU is recommended for use in assessing the uniformity of varieties

- When observations are made on a plant (or plot) basis over two or more years.

- When there are some differences between plants (or plots) of a variety, representing quantitative variation rather than presence of off-types.

12. A variety is considered to be uniform for a characteristic if its mean adjusted log SD does not exceed the uniformity criterion.

13. The UPOV recommended probability level "p" used to determine the uniformity criterion depends on the crop and, for some crops, on whether the test is normally applied over two or three years. If the test is normally applied over three years, it is possible to choose make an early acceptance or rejection of a variety using an appropriate selection of probability values. Recommended probability levels are given in the Annex to TGP/10.3.

MATHEMATICAL DETAILS

Step 1: Derivation of the within-plot standard deviation

14. Within-plot standard deviations for each variety in each year are calculated by averaging the plot between-plant standard deviations, SD_j, over replicates:

$$SD_j = \sqrt{\frac{\sum_{i=1}^{n}\left(y_{ij} - \mathbf{y}_j\right)^2}{(n-1)}}$$

$$SD = \sum_{j=1}^{r} SD_j$$

where y_{ij} is the observation on the i^{th} plant in the j^{th} plot, $\mathbf{y}_j$ is the mean of the observations from the j^{th} plot, n is the number of plants measured in each plot and r is the number of replicates.

Step 2: Transformation of the SDs

15. Transformation of SDs by adding 1 and converting to natural logarithms. The purpose of this transformation is to make the SDs more amenable to statistical analysis.

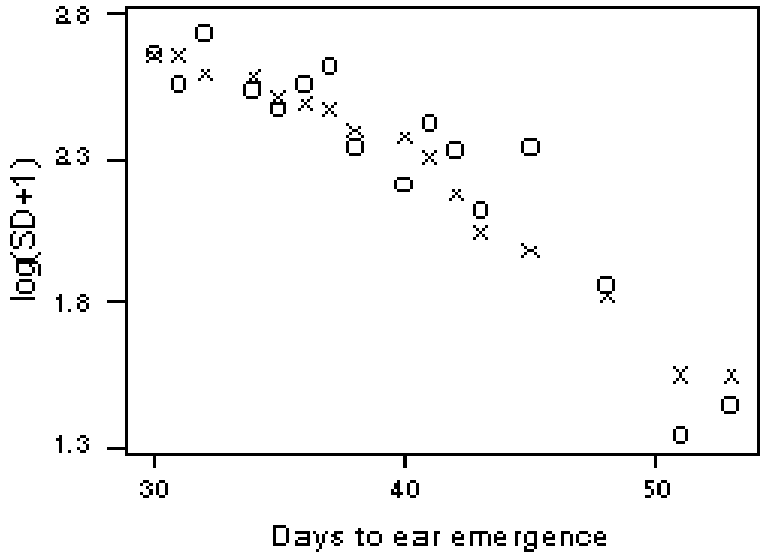
Step 3: Estimation of the relationship between the SD and mean in each year

16. For each year separately, the form of the average relationship between SD and characteristic mean is estimated for the reference varieties. The method of estimation is a 9-point moving average. The log SDs (the Y variate) and the means (the X variate) for each variety are first ranked according to the values of the mean. For each point (X_i, Y_i) take the trend value T_i to be the mean of the values Y_{i-4}, Y_{i-3}, ... , Y_{i+4} where i represents the rank of

the X value and Y_i is the corresponding Y value. For X values ranked 1st and 2nd the trend value is taken to be the mean of the first three values. In the case of the X value ranked 3rd the mean of the first five values are taken and for the X value ranked 4th the mean of the first seven values are used. A similar procedure operates for the four highest-ranked X values.

17. A simple example in Figure 1 illustrates this procedure for 16 varieties. The points marked "0" in Figure 1a represent the log SDs and the corresponding means of 16 varieties. The points marked "X" are the 9-point moving-averages, which are calculated by taking, for each variety, the average of the log SDs of the variety and the four varieties on either side. At the extremities the moving average is based on the mean of 3, 5, or 7 values.

Figure 1: Association between SD and mean – days to ear emergence in cocksfoot varieties (*symbol O is for observed SD, symbol X is for moving average SD*)



Step 4: Adjustment of transformed SD values based on estimated SD-mean relationship

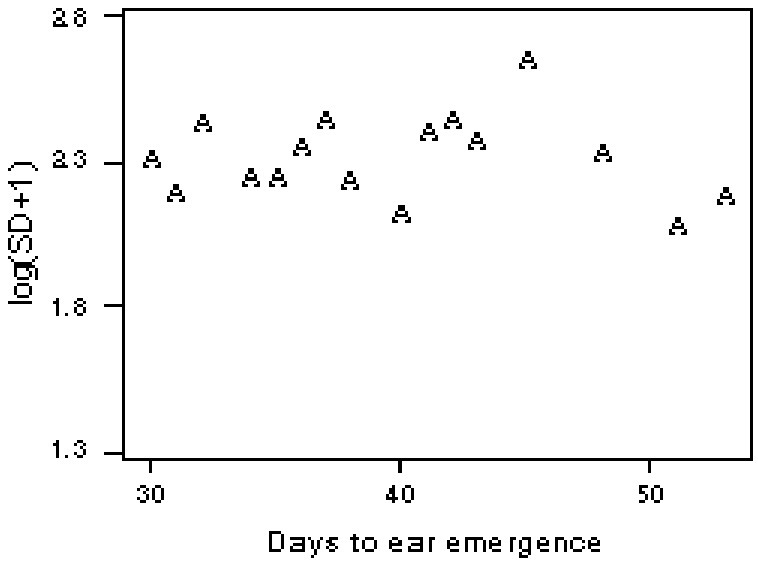
18. Once the trend values for the reference varieties have been determined, the trend values for candidates are estimated using linear interpolation between the trend values of the nearest two reference varieties as defined by their means for the characteristic. Thus if the trend values for the two reference varieties on either side of the candidate are T_i and T_{i+1} and the observed value for the candidate is X_c, where $X_i \leq X_c \leq X_{i+1}$, then the trend value T_c for the candidate is given by

$$T_c = \frac{(X_C - X_i)T_{i+1} + (X_{i+1} - X_C)T_i}{X_{i+1} - X_i}$$

19. To adjust the SDs for their relationship with the characteristic mean the estimated trend values are subtracted from the transformed SDs and the grand mean is added back.

20. The results for the simple example with 16 varieties are illustrated in Figure 2.

Figure 2: Adjusting for association between SD and mean – days to ear emergence in cocksfoot varieties (*symbol A is for adjusted SD*)



Step 6: Calculation of the uniformity criterion

21. An estimate of the variability in the uniformity of the reference varieties is derived by applying a one-way analysis of variance to the adjusted log SDs, i.e. with years as the classifying factor. The variability is estimated from the residual term in this analysis of variance.

22. The maximum allowable standard deviation (the uniformity criterion), based on k years of trials, is

$$UC_p = SD_r + t_p\sqrt{V\left(\frac{1}{k}+\frac{1}{rk}\right)}$$

where SD_r is the mean of adjusted log SDs for the reference varieties, V is the variance of the adjusted log SDs after removing year effects, t_p is the one-tailed t-value for probability p with degrees of freedom as for V, k is the number of years and r is the number of reference varieties.

EXAMPLE OF COYU CALCULATIONS

23. An example of the application of COYU is given here to illustrate the calculations involved. The example consists of days to ear emergence scores for perennial ryegrass over three years for 11 reference varieties (R1 to R11) and one candidate (C1). The data is tabulated in Table 1.

Table 1: Example data-set – days to ear emergence in perennial ryegrass

	Character Means			Within Plot SD			Log (SD+1)		
Variety	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3	Year 1	Year 2	Year 3
R1	38	41	35	8.5	8.8	9.4	2.25	2.28	2.34
R2	63	68	61	8.1	7.6	6.7	2.21	2.15	2.04
R3	69	71	64	9.9	7.6	5.9	2.39	2.15	1.93
R4	71	75	67	10.2	6.6	6.5	2.42	2.03	2.01
R5	69	78	69	11.2	7.5	5.9	2.50	2.14	1.93
R6	74	77	71	9.8	5.4	7.4	2.38	1.86	2.13
R7	76	79	70	10.7	7.6	4.8	2.46	2.15	1.76
R8	75	80	73	10.9	4.1	5.7	2.48	1.63	1.90
R9	78	81	75	11.6	7.4	9.1	2.53	2.13	2.31
R10	79	80	75	9.4	7.6	8.5	2.34	2.15	2.25
R11	76	85	79	9.2	4.8	7.4	2.32	1.76	2.13
C1	52	56	48	8.2	8.4	8.1	2.22	2.24	2.21

24. The calculations for adjusting the SDs in year 1 are given in Table 2. The trend value for candidate C1 is obtained by interpolation between values for varieties R1 and R2, since the characteristic mean for C1 (i.e. 52) lies between the means for R1 and R2 (i.e. 38 and 63). That is

$$T_c = \frac{(X_C - X_i)T_{i+1} + (X_{i+1} - X_C)T_i}{X_{i+1} - X_i} = \frac{(52-38)\text{x}2.28 + (63-52)\text{x}2.28}{63-38} = 2.28$$

Table 2: Example data-set – calculating adjusted log(SD+1) for year 1

Variety	Ranked mean (X)	Log (SD+1) (Y)	Trend Value T	Adj. Log (SD+1)
R1	38	2.25	(2.25 + 2.21 + 2.39)/3 = 2.28	2.25 - 2.28 + 2.39 = 2.36
R2	63	2.21	(2.25 + 2.21 + 2.39)/3 = 2.28	2.21 - 2.28 + 2.39 = 2.32
R3	69	2.39	(2.25 + . . . + 2.42)/5 = 2.35	2.39 - 2.35 + 2.39 = 2.42
R5	69	2.50	(2.25 + . . . + 2.48)/7 = 2.38	2.50 - 2.38 + 2.39 = 2.52
R4	71	2.42	(2.25 + . . . + 2.32)/9 = 2.38	2.42 - 2.38 + 2.39 = 2.43
R6	74	2.38	(2.21 + . . . + 2.53)/9 = 2.41	2.38 - 2.41 + 2.39 = 2.36
R8	75	2.48	(2.39 + . . . + 2.34)/9 = 2.42	2.48 - 2.42 + 2.39 = 2.44
R7	76	2.46	(2.42 + . . . + 2.34)/7 = 2.42	2.46 - 2.42 + 2.39 = 2.43
R11	76	2.32	(2.48 + . . . + 2.34)/5 = 2.43	2.32 - 2.43 + 2.39 = 2.28
R9	78	2.53	(2.32 + 2.53 + 2.34)/3 = 2.40	2.53 - 2.40 + 2.39 = 2.52
R10	79	2.34	(2.32 + 2.53 + 2.34)/3 = 2.40	2.34 - 2.40 + 2.39 = 2.33
Mean	70	2.39		
C1	52	2.22	2.28	2.22 – 2.28 + 2.39 = 2.32

25. The results of adjusting for all three years are shown in Table 3.

Table 3: Example data-set – adjusted log(SD+1) for all three years with over-year means

	Over-Year Means		Adj. Log (SD+1)		
Variety	Char. mean	Adj. Log (SD+1)	Year 1	Year 2	Year 3
R1	38	2.26	2.36	2.13	2.30
R2	64	2.10	2.32	2.00	2.00
R3	68	2.16	2.42	2.10	1.95
R4	71	2.15	2.43	1.96	2.06
R5	72	2.20	2.52	2.14	1.96
R6	74	2.12	2.36	1.84	2.16
R7	75	2.14	2.43	2.19	1.80
R8	76	2.02	2.44	1.70	1.91
R9	78	2.30	2.52	2.16	2.24
R10	78	2.22	2.33	2.23	2.09
R11	80	2.01	2.28	1.78	1.96
Mean	70	2.15	2.40	2.02	2.04
C1	52	2.19	2.32	2.08	2.17

26. The analysis of variance table for the adjusted log SDs is given in Table 4 (based on reference varieties only). The variability in the uniformity of reference varieties is estimated from this (V=0.0202).

Table 4: Example data set – analysis of variance table for adjusted log (SD+1)

Source	Degrees of freedom	Sums of squares	Mean squares
Year	2	1.0196	0.5098
Varieties within years (=residual)	30	0.6060	**0.0202**
Total	32	1.6256	

27. The uniformity criterion for a probability level of 0.002 is calculated thus:

$$UC_p = SD_r + t_p\sqrt{V\left(\frac{1}{k}+\frac{1}{rk}\right)} = 2.15 + 3.118x\sqrt{0.0202x\left(\frac{1}{3}+\frac{1}{3x11}\right)} = 2.42$$

where t_p is taken from Student's t table with p=0.002 (one-tailed) and 30 degrees of freedom.

28. Varieties with mean adjusted log (SD + 1) less than, or equal to, 2.42 can be regarded as uniform for this characteristic. The candidate variety C1 satisfies this criterion.

IMPLEMENTING COYU

29. The COYU criterion can be applied using the DUST software package for the statistical analysis of DUS data. This is available from the Biometrics Division, Department

of Agriculture for Northern Ireland, Newforge Lane, Belfast BT9 5PX, UK (S. Watson, S.T.C. Weatherup). Sample outputs are given in Appendix A.

APPENDIX A : COYU SOFTWARE

DUST COMPUTER PROGRAM

30. The main output from the DUST COYU program is illustrated in Table A1. This summarises the results of analyses of within-plot SDs for 49 perennial ryegrass varieties assessed over a three-year period. Supplementary output is given in Table B2 where details of the analysis of a single characteristic, date of ear emergence, are presented.

31. In Table A1, the adjusted SD for each variety is expressed as a percent of the mean SD for all reference varieties. A figure of 100 indicates a variety of average uniformity; a variety with a value less than 100 shows good uniformity; a variety with a value much greater than 100 suggests poor uniformity in that characteristic. Lack of uniformity in one characteristic is often supported by evidence of poor uniformity in related characteristics.

32. The symbols “*” and “+” to the right of percentages identify varieties whose SDs exceed the COYU criterion after 3 and 2 years respectively. The symbol “:” indicates that after two years uniformity is not yet acceptable and the variety should be considered for testing for a further year. Note that a probability level of 0.002 is used for the three-year test. For early decisions at two years, probability levels of 0.02 and 0.002 are used to accept and reject varieties respectively. All of the candidates had acceptable uniformity for the 8 characters using the COYU criterion.

33. The numbers to the right of percentages refer to the number of years that a within-year uniformity criterion is exceeded. This criterion has now been superseded by COYU.

34. The program will operate with a complete set of data or will accept some missing values.

Table A1: Example of summary output from COYU program

**** OVER-YEARS UNIFORMITY ANALYSIS SUMMARY ****

WITHIN-PLOT STANDARD DEVIATIONS AS % MEAN OF REFERENCE VARIETY SDS

CHARACTERISTIC NUMBER

	5	60	8	10	11	14	15	24
R1	100	100	95 1	100	97	97	103	98
R2	105	106	98	99	104	101	106	104
R3	97	103	92 1	103	96	98	101	109
R4	102	99	118 2	105	101	101	99	105
R5	102	99	116 3	95	104	110	100	98
R6	103	102	101	99	97	104	98	103
R7	100	95	118 2	102 1	98	99	108 1	100
R8	97	98	84	95	97	93	99	96
R9	97	105	87	99	101	99	93	94
R10	104	100	96	105 1	96	102	95	99
R11	99	96	112	99	101	98	108	105
R12	100	97	99 1	103	105	106	103	98
R13	95	96	101	100	96	101	94	101
R14	105	103	90	97	101	97	105	99
R15	102	100 1	89	105	105 1	101	98	104
R16	99	98	92 1	98	102	98	96	96
R17	97	101	98	101	101	95	98	96
R18	99	97	96	96	102	99	93	95
R19	103	101	105	102	100	98	103	104
R20	104	99	93	91	100	102	92	102
R21	97	94	103	97	100	102	99	100
R22	101	110*1	112	107 1	103 1	101	104	100
R23	94	101	107	99	104	97	103	92
R24	99	97	95	99	100	103	103	101
R25	104 1	103	93 1	99	101	96	99	101
R26	98	97	111 2	96	102 1	106 2	101 1	100
R27	102	99	106 1	99	103	107	103	106
R28	101	106	90	95	101	101	96	94
R29	101	105	83	102	94	93	97	93
R30	99	96	97	99	95	100	92	97
R31	99	102	107	107 1	102	99	101	104 1
R32	98	93	111 2	102	98	103	99	102
R33	104	102 1	107 1	103	100	97	98	100
R34	95	94	82	95	97	96	99	98
R35	100	102	95	100	99	94	105	100
R36	99	98	111 1	99	100	103	105 1	99
R37	100	107 1	107	101	100	107 1	98	100
R38	95	97	102	107 1	97	101	103	100
R39	99	99	90	98	101	100	102	101
R40	104	102	112 1	100	101	97 1	101 1	108 2
C1	100 1	106	113 2	104 1	106 1	106 1	95	104 1
C2	103	101	98	97	101	109 2	99	96
C3	97	93	118 2	98	99	109	111	109 1
C4	102	101	106	103	99	101	97	105
C5	100	104	99	103	100	107 1	107 1	106 1
C6	101	102	103	100	103	107	105	100
C7	96	98	106	97	102	103	108	98
C8	101	105 1	116 2	103	103	93	97	106
C9	99	99	90 2	91	97	98	98	101

CHARACTERISTIC KEY :

5	SPRING HEIGHT	60	NATURAL SPRING HEIGHT
8	DATE OF EAR EMERGENCE	10	HEIGHT AT EAR EMERGENCE
11	WIDTH AT EAR EMERGENCE	14	LENGTH OF FLAG LEAF
15	WIDTH OF FLAG LEAF	24	EAR LENGTH

SYMBOLS :

* - SD EXCEEDS OVER-YEARS CRITERION AFTER 3 YEARS WITH PROBABILITY 0.002
\+ - SD EXCEEDS OVER-YEARS CRITERION AFTER 2 YEARS WITH PROBABILITY 0.002
: - SD NOT YET ACCEPTABLE AFTER 2 YEARS WITH PROBABILITY 0.020
1,2,3 - THE NUMBER OF OCCASIONS THE WITHIN-YEARS SD EXCEEDS THE UPOV CRITERION

Table A2: Example of supplementary DUST output for date of ear emergence (char. 8)

**** UNIFORMITY ANALYSIS OF BETWEEN-PLANT STANDARD DEVIATIONS (SD) ****

	OVER-YEARS			INDIVIDUAL YEARS								
VARIETY	CHAR.	ADJ.	UNADJ	---- CHAR. MEAN ----			--- LOG (SD+1) ---			-- ADJ LOG(SD+1)--		
	MEAN	LOG SD	LOG SD	88	89	90	88	89	90	88	89	90
REFERENCE												
R3	38.47	1.823	2.179	39.07	41.21	35.12	2.02	2.18	2.34X	1.73	1.78	1.96
R5	50.14	2.315	2.671	48.19	53.69	48.54	2.52X	2.74X	2.76X	2.23	2.33	2.39
R16	59.03	1.833	2.179	57.25	63.33	56.50	2.28X	2.24	2.01	1.96	1.73	1.81
R26	63.44	2.206	2.460	61.00	66.53	62.81	2.50X	2.75X	2.13	2.18	2.33	2.11
R9	63.99	1.739	1.994	62.92	68.32	60.72	2.21	2.03	1.74	1.96	1.64	1.62
R12	66.12	1.964	2.086	67.89	65.35	65.12	2.07	2.58X	1.60	1.97	2.14	1.78
R33	67.58	2.124	2.254	66.66	71.54	64.53	2.55X	2.26	1.95	2.32	1.92	2.12
R1	67.87	1.880	1.989	69.07	70.64	63.90	1.60	2.45X	1.93	1.60	2.08	1.96
R20	68.74	1.853	1.893	67.17	74.31	64.74	2.05	1.95	1.68	1.92	1.75	1.89
R25	68.82	1.853	1.905	68.28	72.38	65.81	1.83	2.39X	1.49	1.75	2.09	1.72
R18	69.80	1.899	1.853	68.61	75.22	65.58	1.88	1.84	1.84	1.82	1.80	2.08
R30	70.53	1.919	1.864	70.36	75.08	66.15	2.04	1.84	1.71	2.00	1.78	1.98
R13	70.63	2.005	2.000	70.23	75.00	66.66	1.97	2.03	2.01	1.91	1.86	2.24
R32	71.49	2.197	2.238	70.03	74.98	69.44	2.32X	2.45X	1.94	2.31	2.27	2.01
R34	72.09	1.630	1.545	71.32	77.35	67.59	1.57	1.49	1.58	1.54	1.58	1.78
R40	72.24	2.222	2.178	72.71	75.07	68.95	2.25X	2.26	2.03	2.29	2.16	2.22
R23	72.40	2.122	2.058	69.72	78.39	69.10	2.11	2.14	1.93	2.16	2.14	2.06
R29	72.66	1.657	1.580	73.13	75.80	69.04	1.46	1.63	1.65	1.47	1.69	1.81
R7	73.19	2.341	2.342	72.23	75.80	71.52	2.62X	2.30X	2.10	2.61	2.30	2.11
R24	73.19	1.888	1.796	74.00	76.37	69.20	1.62	1.84	1.93	1.71	1.91	2.04
R19	73.65	2.083	2.049	73.32	76.06	71.57	1.96	2.05	2.14	1.96	2.13	2.16
R2	73.85	1.946	1.897	72.98	78.16	70.42	1.76	1.96	1.97	1.79	2.02	2.03
R31	74.23	2.119	2.012	73.73	78.23	70.71	2.05	1.86	2.13	2.25	1.94	2.17
R37	74.38	2.132	2.020	74.87	76.95	71.32	1.97	2.04	2.04	2.23	2.11	2.06
R11	74.60	2.224	2.150	73.87	78.07	71.87	2.21	2.08	2.16	2.36	2.10	2.21
R38	74.76	2.029	1.916	76.11	78.24	69.93	1.84	2.15	1.75	1.98	2.24	1.87
R8	74.83	1.677	1.593	74.27	78.77	71.45	1.62	1.55	1.61	1.75	1.64	1.64
R15	75.54	1.760	1.682	75.72	78.68	72.22	1.53	1.79	1.73	1.64	1.84	1.80
R10	75.64	1.915	1.847	73.47	79.24	74.23	1.87	1.66	2.00	1.99	1.78	1.98
R22	75.68	2.228	2.133	74.57	79.17	73.32	2.18	2.21	2.01	2.40	2.26	2.03
R14	75.84	1.797	1.688	74.53	79.56	73.43	1.54	1.63	1.90	1.70	1.76	1.93
R17	76.13	1.942	1.832	75.34	79.09	73.96	1.65	2.04	1.81	1.90	2.10	1.83

R39	76.83	1.781	1.676	75.49	80.50	74.50	1.56	1.51	1.96	1.72	1.70
1.92											
R35	77.22	1.886	1.773	76.67	80.85	74.15	1.73	1.67	1.92	1.88	1.85
1.93											
R4	77.78	2.349	2.268	76.80	81.22	75.33	2.36X	2.13	2.31X	2.52	2.33
2.20											
R36	77.98	2.209	2.173	78.97	79.85	75.11	2.13	2.15	2.25X	2.24	2.21
2.18											
R6	78.73	2.009	1.935	77.53	82.88	75.78	2.00	1.75	2.06	2.03	2.09
1.91											
R27	78.78	2.116	2.098	77.61	80.03	78.69	1.80	2.25	2.24X	1.87	2.39
2.09											
R28	79.41	1.785	1.722	78.28	81.99	77.97	1.68	1.43	2.05	1.79	1.67
1.89											
R21	80.52	2.045	1.950	77.43	85.02	79.11	1.98	1.75	2.13	2.07	2.09
1.98											
CANDIDATE											
C1	64.03	2.252	2.438	63.85	63.33	64.92	2.49X	2.81X	2.02	2.25	2.29
2.21											
C2	86.11	1.940	1.837	84.83	88.63	84.85	1.79	1.71	2.01	1.90	2.05
1.87											
C3	82.04	2.349	2.248	82.26	87.45	76.40	2.37X	2.03	2.35X	2.48	2.37
2.20											
C4	78.63	2.104	2.033	78.01	82.17	75.72	2.05	2.01	2.04	2.15	2.27
1.90											
C5	72.99	1.973	1.869	71.98	79.40	67.59	1.95	1.78	1.88	1.93	1.90
2.08											
C6	83.29	2.050	1.947	84.10	85.57	80.21	2.05	1.69	2.10	2.16	2.03
1.96											
C7	83.90	2.100	1.997	84.12	87.99	79.60	1.93	1.95	2.11	2.04	2.29
1.97											
C8	83.50	2.304	2.201	82.43	85.98	82.08	2.27X	2.00	2.34X	2.38	2.33
2.20											
C9	51.89	1.788	2.157	52.35	55.77	47.56	1.83	2.34X	2.31X	1.52	1.91
1.93											
MEAN OF											
REFERENCE	71.47	1.988		70.78	74.97	68.65	1.97	2.03	1.96	1.99	1.99
1.99											

UNIFORMITY CRITERION

		PROB. LEVEL
3-YEAR REJECTION	2.383	0.002
2-YEAR REJECTION	2.471	0.002
2-YEAR ACCEPTANCE	2.329	0.020

**** ANALYSIS OF VARIANCE OF ADJUSTED LOG(SD+1) *** *

	DF	MS	F RATIO
YEARS	2	0.06239	
VARIETIES	39	0.11440	5.1
RESIDUAL	78	0.02226	
TOTAL	119	0.05313	

SYMBOLS

* - SD EXCEEDS OVER-YEARS UNIFORMITY CRITERION AFTER 3 YEARS.
\+ - SD EXCEEDS OVER-YEARS UNIFORMITY CRITERION AFTER 2 YEARS.
: - SD NOT YET ACCEPTABLE ON OVER-YEARS CRITERION AFTER 2 YEARS.
X - SD EXCEEDS 1.265 TIMES MEAN OF REFERENCE VARIETIES

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