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Rectification of modified AMMI stability value (MASV)

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Abstract

Additive main effects and multiplicative interaction (AMMI) analysis is widely used for analyzing data of multi-environment trials (METs) to model the genotype-by-environment interactions (GEIs). However, AMMI model do not rank genotypes which is required for aiding selection. In order to overcome these lacunae a stability index titled AMMI stability value (ASV) was proposed by Purchase et al. (1997) using first two interaction principal components (IPCA) from the results of AMMI analysis. Later, Zali et al. (2012) modified it and proposed Modified ASV (MASV) which used all significant IPCAs. However, Zali et al. (2012) read the original formula of ASV incorrectly while proposing MASV thus rendering it erroneous. Use of this erroneous MASV impacted genotype ranking significantly. Corrected version of MASV, i.e. MASV2 showed significant correlation with other stability models. Hence, we propose MASV2 as a correct formula for modified AMMI stability Value (MASV) and this correct version of MASV may be used instead of earlier formula proposed by Zali et al. (2012)

Key words: AMMI, ASV, GEI, MASV, stability

Introduction

Presence of considerable genotype and genotype-by-environment interactions (GEIs) complicate the selection process and warrant the use of multi-environment trials (METs) to evaluate the relative performance of genotypes over the environments. Additive main effects and multiplicative interaction (AMMI) analysis is one of the most popular multivariate methods to predict adaptation and stability of cultivars over multiple environments (Chuni Lal et al. 2019). AMMI analysis is a combination of ordinary ANOVA to analyze the main effects (additive part) of the genotypes and the environment together with principal components analysis of the genotype-by-environment interaction (Chuni Lal et al. 2019). AMMI analysis represents a potential tool that can be used to deepen the understanding of factors involved in the manifestation of the GEI.

Pattern of relationship between genotypes and environments can be clearly visualized using the AMMI biplots, where the X-axis denotes the mean yield of genotypes over the environments and Y-axis denotes mean scores of the first genotypic-by-environment interaction principal component axis (IPCA1). Genotypes with lower absolute IPCA1 scores will produce less GEI effect than the cultivar with higher absolute IPCA1 score and such genotypes are regarded as highly stable. Genotypes which are located farthest along the X-axis are high yielders whereas along the Y-axis genotypes closer to zero are more stable. Nevertheless, the AMMI model per se does not make provision for a quantitative stability measure, which is essential in order to quantify and rank genotypes according to their yield stability. The ASV measure was proposed by Purchase et al. (2000) to cope with this problem and is calculated using relative weight of IPCA1 and IPCA2 scores in order to compensate for their relative contribution to GEI sum of squares. Later Zali et al. (2012) proposed a modified version of ASV i.e. Modified AMMI Stability Value (MASV) which considers relative weight of all significant IPCA's to calculate stability measure. However, in Zali et al. (2012), the formula of ASV used was found to be erroneous, when compared with the

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original publications (Purchase 1997; Purchase et al. 1999, 2000).

$$ASV = \sqrt{\left(\frac{SSIPC_1}{SSIPC_2}\right) \times (PC_1)^2 + (PC_2)^2}$$ Zali et al. 2012

$$ASV = \sqrt{\left(\frac{SSIPC_1}{SSIPC_2} \times PC_1\right)^2 + (PC_2)^2}$$ Purchase 1997; Purchase et al. 1999, 2000.

Where, $SSIPC_1$ and $SSIPC_2$ are the sum of squares of the 1st and 2nd interaction principal component (IPC); and PC_1 and PC_2, are the scores of 1^{st} and 2^{nd} IPC.

Modified AMMI stability value (MASV) is an extension of ASV as implied by Zali et al. (2012). So authors submit that MASV proposed by Zali et al. (2012) is also erroneous. Hence, objective of the present study is to (i) propose the correct version of MASV formula and (ii) to show that corrected version significantly improves ranking of genotypes.

Material and methods

In the present study, MASV formula proposed by Zali et al. (2012) is denoted as MASV1, and corrected version of MASV being proposed in the present study is denoted as MASV2 and formulas are as below.

$$MASV1 = \sqrt{\sum_{n=1}^{Nt-1} \left(\frac{SSIPC_n}{SSIPC_{n+1}}\right) \times (PC_n)^2 + (PC_{N'})^2}$$ Zali et al. 2012

$$MASV1 = \sqrt{\sum_{n=1}^{Nt-1} \left(\frac{SSIPC_n}{SSIPC_{n+1}} \times PC_n\right)^2 + (PC_{N'})^2}$$

Proposed

Where, $SSIPC_1$, $SSIPC_2$, …, $SSIPC_n$ are the sum of squares of the 1st, 2nd, ..., and *n*th IPC; and PC_1, PC_2, …, PC_n are the scores of 1st, 2nd, ..., and *n*th IPC.

Experiment 1

Experiment 1 consisted of 52 groundnut genotypes comprising of 47 advanced breeding lines; two cultivated varieties of different seed size (BAU 13, Somnath); two P-efficient (ICGV 86590, SP250A) and a P-inefficient (NRCG7320) lines (Singh et al. 2015; Ajay et al. 2017) were evaluated during 2013 and 2014 rainy seasons under two levels of P i.e. without P application of 0 kg/ha (low phosphorus, LP) and with application of 50 kg/ha P_2O_5 (as single super phosphate) (moderate phosphorus, MP). Nitrogen (as urea) and potash (as murate of potash) were applied at 50 kg/ha N and 60 kg/ha K_2O equally for both the treatments. The recommended crop management practices were adopted for raising a healthy crop. Field screening, was conducted at ICAR-Directorate of Groundnut Research, Junagadh (lat. 21°31'N, long. 70°36'E), India.

Experiment 2

Experiment 2 consisted of186 recombinant inbred lines (RILs) of groundnut developed for drought-tolerance-traits from a cross of TAG-24 × TMV-2NLM and successive generations from F_2 onward were advanced through single-seed descent method in the succeeding *kharif* and summer seasons until *kharif* 2010 when the homogeneity in the material was attained. These RILs along with their parents were evaluated under treatments involving water stress treatment (WS) imposed during flowering to pod development stage and the other without water stress (WWS). All the management practices recommended for the region were followed. Further details of this experiment may be obtained from Chuni Lal et al. (2019).

Statistical analysis

In order to show the difference in ranking between MASV1 and MASV2, AMMI analysis for both the experiments was performed in R (R core team 2018) using package 'agricolae' (de Mendiburu 2017). The correct version of MASV being proposed i.e MASV2 has been implemented in the R package '*ammistability*' (Ajay et al. 2018, 2019). For experiment 2 AMMI analysis has already been studied in our earlier article (Chuni Lal et al. 2019) and only the results of MASV 1 and MASV 2 will be highlighted here. Stability analysis based on Shukla's (1972) stability variance statistics, Wrick's ecovalence (1962) were calculated using package 'agricolae' (de Mendiburu 2017) and Eberhart and Russel models (1966) using package 'plantbreeding' (Rosayara 2012). Ranks were assigned for all stability models (i.e., Shukla, Wricks, Eberhart and Russel, MASV1 and MASV2) and correlation between them was compared using spearman's rank correlation (Spearman 1904) and plotted using package 'PerformanceAnalytics' (Brian et al. 2019).

Results and discussion

AMMI stability value (ASV) was initially proposed by Purchase (1997) to quantify the stability measure by considering relative weight of $IPCA_1$ and $IPCA_2$ scores. In certain cases where more than two IPCAs were significant, ASV failed to encompass all the variability explained by GEI. In order to overcome this difficulty, Zali et al. (2012) attempted to present a modified version ASV i.e., Modified ASV which would cover all available IPCAs. But in doing so, Zali et al. (2012) interpreted the formula of ASV incorrectly compared to the original formula of Purchase (1997) and Purchase et al. (1999, 2000). Originally, as shown in the formula of ASV above, Purchase (1997) proposed a square of multiple of 'weight equivalent of the proportion of $IPCA_1$ and $IPCA_2$ variance (i.e $SSIPC_1/SSIPC_2$)' and $IPCA_1$ scores i.e., $\left(\frac{SSIPC_1}{SSIPC_2}\times PC_1\right)^2$ which is equal to $(SSIPC_1/SSIPC_2)^{2}*(PC_1)^2$. Zali et al. (2012) interpreted this formula incorrectly as $(SSIPC_1/SSIPC_2)*(PC_1)^2$. This error is very significant when large number of genotypes were evaluated. In the present study we are correcting the original MASV formula of Zali et al. (2012) and suggesting a revised version of MASV.

Experiment 1

Analysis of variance based on AMMI model for experiment 1 is presented in Table 1. In the present model, three interaction principal component axis (IPCA) were significant which together explained 100% variability explained by GEI in the data. Ranking of genotypes based on pod yield, stability measures MASV1 and MASV2 and Simultaneous selection index of yield and stability (SSI, Farshadfar et al. 2011) is presented in Table 2. SSI ranks genotypes considering ranks of both yield and stability in a single criterion. Comparison of genotype ranking for MASV1 and MASV2 showed improved ranking for 25 genotypes, decreased for 22 genotypes whereas there was no change in ranking for 5 genotypes. This in turn affected the ranking of genotypes on the basis of SSI.

Experiment 2

For experiment 2, AMMI model has already been discussed in our earlier article (Chuni Lal et al. 2019) and only results of MASV1 and MASV2 will be discussed here. Ranking of genotypes based on pod yield, stability measures MASV1 and MASV2 and Simultaneous selection index of yield and stability (SSI, Farshadfar et al. 2011) is presented in Supplementary Table S1. Comparison of genotype ranking for MASV1 and MASV2 showed improved

Table 1. Analysis of variance based on AMMI model

	Df	Sum Sq	Mean Sq	F value	% GEI ss
Experiment 1					
Environment (E)	3	3871.2	1290.4**	366.0	59.93
Rep(E)	4	14.1	3.5	2.3	0.22
Genotype (G)	51	998.4	19.6**	12.6	15.46
G*E	153	1259.7	8.2**	5.3	19.50
IPCA1	53	628.4	11.9**	6.0	49.88
IPCA2	51	364.3	7.1**	3.8	28.92
IPCA3	49	267.0	5.4**	4.2	21.20
Residuals	204	316.1	1.6		4.89

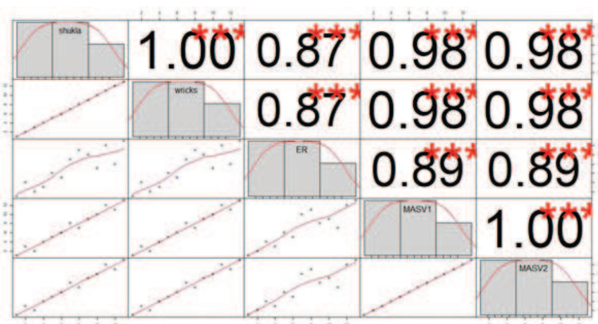

Fig. 1. Correlation comparison of MASV1 and MASV2 with other stability models such as Shukla's (1972) stability variance, Wricke's ecovalence (1962) and Eberhart and Russel model (ER)(1966) for data in experiment 1

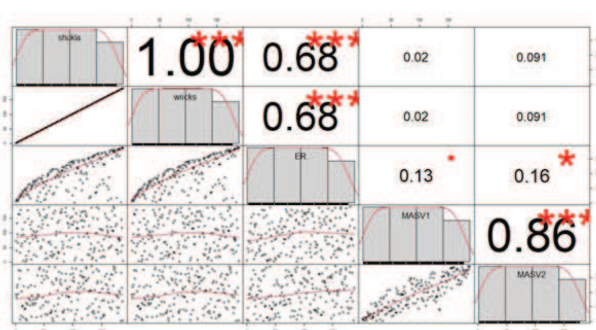

Fig. 2. Correlation comparison of MASV1 and MASV2 with other stability models such as Shukla's (1972) stability variance, Wricke's ecovalence (1962) and Eberhart and Russel model (ER) (1966) for data in experiment 2

Table 2. Mean yield and ranking of genotypes based on both forms of MASV in experiment 1

S.No.	Genotype	Pod yield		MASV1		MASV2		SSI	
		Mean	Rank	MASV1	Rank	MASV2	Rank	MASV 1	MASV 2
1	BAU13	11.7	33	1.33	34	1.49	34	67	67
2	ICGV 86590	14.5	5	2.00	51	1.79	46	56	51
3	M 13	13.3	12	2.00	52	2.02	51	64	63
4	NRCG 7320	10.0	49	1.00	25	0.97	19	74	68
5	PBS 22075	10.2	48	0.91	21	0.92	18	69	66
6	PBS 22076	12.9	17	0.59	6	0.68	6	23	23
7	PBS 22077	14.3	6	1.63	46	1.76	43	52	49
8	PBS 22080	15.4	3	0.77	12	0.75	9	15	12
9	PBS 22081	13.1	15	0.87	16	0.84	13	31	28
10	PBS 22082	10.5	46	0.60	7	0.78	10	53	56
11	PBS 22083	13.0	16	0.18	1	0.23	1	17	17
12	PBS 22084	14.9	4	1.53	43	1.97	50	47	54
13	PBS 22086	15.9	2	1.36	37	1.77	45	39	47
14	PBS 22088	9.5	52	0.49	2	0.49	2	54	54
15	PBS 22091	11.8	32	1.43	39	1.67	40	71	72
16	PBS 29017	11.4	37	0.59	5	0.71	7	42	44
17	PBS 29035	13.5	9	1.03	27	1.10	24	36	33
18	PBS 29067	12.3	26	1.20	30	1.58	38	56	64
19	PBS 29077	10.7	43	1.34	36	1.45	32	79	75
20	PBS 29080	12.1	27	1.51	41	1.87	48	68	75
21	PBS 29083	13.4	11	1.56	44	1.62	39	55	50
22	PBS 29087	12.1	29	0.84	13	0.80	12	42	41
23	PBS 29098	11.5	35	0.53	4	0.54	3	39	38
24	PBS 29115	13.5	10	1.01	26	1.24	30	36	40
25	PBS 29124	15.9	1	1.52	42	1.47	33	43	34
26	PBS 29125	12.8	19	1.05	28	1.15	26	47	45
27	PBS 29137	12.0	30	0.74	10	0.80	11	40	41
28	PBS 29138	12.8	21	1.89	50	1.69	42	71	63
29	PBS 29143	11.3	39	1.69	48	1.53	36	87	75
30	PBS 29145	12.4	24	0.53	3	0.62	4	27	28
31	PBS 29148	13.9	8	1.89	49	2.23	52	57	60
32	PBS 29149	10.2	47	0.88	17	0.84	14	64	61
33	PBS 29150	11.4	36	1.65	47	1.68	41	83	77
34	PBS 29151	12.8	20	0.87	15	1.01	21	35	41
35	PBS 29152	12.4	23	0.95	23	0.89	17	46	40
36	PBS 29153	12.6	22	0.85	14	1.10	23	36	45
37	PBS 29157	10.5	44	0.89	19	1.13	25	63	69
38	PBS 29158	13.2	14	0.93	22	1.17	28	36	42
39	PBS 29159	12.8	18	1.05	29	1.16	27	47	45
40	PBS 29160	11.3	38	1.21	31	1.52	35	69	73
41	PBS 29161	10.5	45	0.88	18	1.08	22	63	67
42	PBS 29162	11.6	34	1.22	32	1.20	29	66	63
43	PBS 29164	12.1	28	1.56	45	1.89	49	73	77
44	PBS 29165	12.3	25	1.24	33	1.30	31	58	56
45	PBS 29166	11.2	40	0.75	11	0.86	15	51	55
46	PBS 29168	11.1	41	0.89	20	1.00	20	61	61
47	PBS 29169	13.2	13	1.42	38	1.84	47	51	60
48	PBS 29170	11.0	42	0.69	9	0.73	8	51	50
49	PBS 29171	9.8	50	0.98	24	0.88	16	74	66
50	PBS 29172	9.8	51	1.34	35	1.55	37	86	88
51	Somnath	14.2	7	0.69	8	0.65	5	15	12
52	SP 250A	11.8	31	1.48	40	1.76	44	71	75

ranking in MASV2 for 77 genotypes, decreased for 108 genotypes whereas there was no change in ranking for 3 genotypes. This in turn affected the ranking of genotypes on the basis of SSI.

Correlation

Correlation analysis was performed to compare MASV1 and MASV2 with other stability models such as Shukla's (1972) stability variance, Wricke's ecovalence (1962) and Eberhart and Russel model (ER) (1966) for experiment 1 and experiment 2 are presented in Fig. 1 and Fig. 2 respectively. In experiment 1, both MASV1 and MASV2 had significant positive correlation with Shukla's (1972) stability variance, Wricke's ecovalence (1962) and Eberhart and Russel model (ER) (1966). In experiment 2, MASV2 had significant correlation only with Eberhart and Russel model (ER) model whereas ranks of MASV1 did not correlate with ranks of any other stability models. In both the experiments MASV2 had significant correlation with other stability models, was superior over MASV1. Correlation analysis from both the experiments also indicate that, both MASV1 and MASV2 gives almost similar results in cases where number of genotypes used in the experiments are small, but when large number of genotypes were used only MASV2 correlated with other stability models but not MASV1. This indicates the superiority of MASV2 over MASV1.

Modified AMMI stability Value (MASV2) formula presented in the present study may be considered as correct version for calculating stability based on AMMI model instead of MASV1 proposed by Zali et al. (2012).

Authors' contribution

Conceptualization of research (JA, BCA, RAF); Designing of the experiments (BCA, CL); Contribution of experimental materials (NK, MCD, CL); Execution of field/lab experiments and data collection (BCA, SKB, CL); Analysis of data and interpretation (BCA, JA); Preparation of manuscript (KG, PK).

Declaration

The authors declare no conflict of interest.

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References

Ajay B. C., Meena H. N., Singh A. L., Bera S. K., Dagla M. C., Narendra Kumar and Makwana A. D. 2017. Response of different peanut genotypes to reduced phosphorus availability. Indian J. Genet., **77**: 105-111.

Ajay B. C., Aravind J. and Fiyaz R. A. 2018. ammistability: Additive Main Effects and Multiplicative Interaction Model Stability Parameters. Available at: https://CRAN.R-project.org/package=ammistability.

Ajay B. C., Aravind J. and Fiyaz R. A. 2019. ammistability: Additive Main Effects and Multiplicative Interaction Model Stability Parameters. Indian J. Genet., **79**: 460-466.

Bavandpori F., Ahmadi J. and Hossaini S. M. 2015. Yield Stability Analysis of Bread Wheat Lines using AMMI Model. Agr. Com., **3**: 8-15.

Brian G. P., Peter C., Kris B., Ross B., Joshua U., Eric Z., Dries C., Eric H., Matthieu L., Kyle B. and Diethelm W. 2019. Performance Analytics: Econometric Tools for Performance and Risk Analysis.

Chuni Lal, Ajay B. C., Chikani B. M. and Gor H. K. 2019. AMMI and GGE biplot analysis to evaluate the phenotypic stability of recombinant inbred lines (RILs) of peanut under mid-season water stress conditions. Indian J. Genet., **79**: 420-426.

de Mendiburu F. 2017. agricolae: Statistical Procedures for Agricultural Research. https://cran.r-project.org/web/packages/agricolae/index.html.

Eberhart S. A. and Russell W. A. 1966. Stability parameters for comparing varieties. Crop Sci., **6**: 36-40.

Farshadfar E., Mahmodi N. and Yaghotipoor A. 2011. AMMI stability value and simultaneous estimation of yield and yield stability in bread wheat (*Triticum aestivum* L.). Aust. J. Crop. Sci., **5**: 1837-1844.

Purchase J. L. 1997. Parametric Analysis to Describe Genotype × Environment Interaction and Yield Stability in Winter Wheat. Available at: http://hdl.handle.net/11660/1966.

Purchase J. L., Hatting H. and van Deventer C. S. 1999. "The use of the AMMI model and AMMI stability value to describe genotype x environment interaction and yield stability in winter wheat (*Triticum aestivum* L.)," in Proceedings of the Tenth Regional Wheat Workshop for Eastern, Central and Southern Africa, 14-18 September 1998 (South Africa: University of Stellenbosch).

Purchase J. L., Hatting H. and van Deventer C. S. 2000. Genotype × environment interaction of winter wheat (*Triticuma estivum* L.) In South Africa: II. Stability analysis of yield performance. South African J. Plant. Soil., **17**: 101-107.

R Development Core Team. 2018. R: A Language and Environment for Statistical Computing. R Foundation for Statistical Computing, Vienna.

Rosayara U. R. 2012. plantbreeding: Analysis and visualization of data from plant breeding and genetics experiments.

Singh A. L., Chaudhari V. and Ajay B. C. 2015. Screening of groundnut genotypes for phosphorus efficiency under field conditions. Indian J. Genet., **75**: 363-371.

Shukla G. K. 1972. Some statistical aspects of partitioning genotype-environment components of variability. Heredity, **29**: 237-245.

Spearman C. 1904. The Proof and Measurement of Association between Two Things. Am. J. Psychol., **15**: 72-101.

Wricke G. 1962. Uber eine Methode zur Erfassung der okologischen Streubreite in Fieldversuchen. Z. Pflanzenzuecht, **47**: 92-96.

Zali H., Farshadfar E., Sabaghpour S. H. and Karimizadeh R. 2012. Evaluation of genotype × environment interaction in chickpea using measures of stability from AMMI model. Ann. Biol. Res., **3**: 3126-3136.

Supplementary Table S1. Mean yield and ranking of genotypes based on both forms of MASV in experiment 2

S.No.	Genotype	Pod yield		MASV1		MASV2		SSI	
		Mean	Rank	MASV1	Rank	MASV2	Rank	MASV1	MASV2
1	PBS-40101	2406.94	143	16.62	158	19.81	182	301	325
2	PBS-40102	2197.70	163	11.93	112	10.80	122	275	285
3	PBS-40103	2479.28	135	25.14	186	18.01	178	321	313
4	PBS-40104	3276.19	21	29.49	188	24.01	186	209	207
5	PBS-40105	3347.11	18	13.82	135	5.32	42	153	60
6	PBS-40106	3338.16	19	14.56	144	8.76	97	163	116
7	PBS-40107	3840.76	2	28.79	187	26.91	187	189	189
8	PBS-40108	3597.09	8	19.64	176	17.45	175	184	183
9	PBS-40109	2895.50	74	10.42	83	11.85	138	157	212
10	PBS-40110	3759.08	4	13.86	136	5.21	39	140	43
11	PBS-40111	2455.66	138	7.17	34	6.19	57	172	195
13	PBS-40113	3071.43	49	9.32	65	8.66	93	114	142
14	PBS-40114	3797.35	3	11.67	106	7.24	73	109	76
15	PBS-40115	2485.51	134	10.37	81	5.44	45	215	179
16	PBS-40116	3218.16	29	7.39	36	0.93	2	65	31
17	PBS-40117	3175.19	34	17.50	162	12.59	146	196	180
18	PBS-40118	2439.35	140	10.94	91	12.29	145	231	285
19	PBS-40119	2735.79	107	8.12	46	6.63	64	153	171
20	PBS-40120	3195.53	30	1.97	1	2.19	8	31	38
21	PBS-40121	3222.66	27	4.64	11	4.35	24	38	51
22	PBS-40122	3173.33	35	8.92	58	4.65	29	93	64
23	PBS-40123	2854.90	80	18.10	165	18.25	179	245	259
24	PBS-40124	2421.48	141	18.73	168	12.10	143	309	284
25	PBS-40125	2855.69	79	11.77	109	9.87	110	188	189
26	PBS-40126	2057.40	174	7.90	44	9.38	106	218	280
27	PBS-40127	4044.55	1	25.06	185	28.21	188	186	189
28	PBS-40128	1997.51	176	12.67	120	13.81	159	296	335
29	PBS-40129	3400.34	15	18.30	166	11.31	126	181	141
30	PBS-40130	2601.20	122	13.25	126	6.99	71	248	193
31	PBS-40131	3043.49	52	21.36	179	14.48	163	231	215
32	PBS-40132	2521.10	131	2.99	2	1.87	6	133	137
33	PBS-40133	3007.74	57	6.70	28	5.18	38	85	95
34	PBS-40134	2803.45	92	5.30	16	6.35	59	108	151
35	PBS-40135	2677.49	115	3.04	4	2.83	14	119	129
36	PBS-40136	2849.36	83	7.14	32	7.78	78	115	161
37	PBS-40137	3241.44	26	9.79	73	9.19	104	99	130
38	PBS-40138	2737.68	106	11.14	95	10.96	124	201	230
39	PBS-40139	2081.23	171	12.88	124	9.07	102	295	273
40	PBS-40140	2525.58	130	13.53	129	6.80	66	259	196

41	PBS-40141	2878.43	75	10.30	80	6.33	58	155	133
42	PBS-40142	2797.25	96	12.34	115	8.93	100	211	196
43	PBS-40143	3183.48	31	11.83	111	5.78	53	142	84
44	PBS-40144	3262.50	23	12.42	117	11.48	131	140	154
45	PBS-40145	3291.91	20	11.95	113	8.81	98	133	118
46	PBS-40146	2786.86	99	7.61	40	4.26	23	139	122
47	PBS-40147	2971.85	65	19.04	171	16.82	171	236	236
48	PBS-40148	2798.13	95	10.88	90	8.31	87	185	182
49	PBS-40149	2402.33	145	15.16	149	15.00	166	294	311
50	PBS-40150	3092.80	45	11.39	99	5.33	43	144	88
51	PBS-40151	2451.10	139	9.20	64	5.61	50	203	189
52	PBS-40152	3488.55	10	11.79	110	11.74	134	120	144
53	PBS-40153	3158.98	38	12.82	123	15.11	167	161	205
54	PBS-40154	3159.91	37	10.79	89	6.45	62	126	99
55	PBS-40155	2257.21	159	7.53	38	8.07	83	197	242
56	PBS-40156	2534.34	129	9.41	68	8.49	90	197	219
57	PBS-40157	3479.63	11	18.55	167	17.91	177	178	188
58	PBS-40158	2937.95	70	16.32	155	18.87	181	225	251
59	PBS-40159	3677.49	6	11.42	100	9.48	108	106	114
60	PBS-40160	2306.15	155	3.92	8	0.97	3	163	158
61	PBS-40501	3402.30	14	6.87	30	6.80	67	44	81
62	PBS-40502	3072.13	48	4.63	10	4.81	31	58	79
63	PBS-40503	2826.76	87	16.12	152	14.45	161	239	248
64	PBS-40504	3098.93	43	11.24	97	7.69	76	140	119
65	PBS-40505	2627.04	121	16.80	159	20.28	183	280	304
66	PBS-40506	2969.28	66	6.31	23	5.74	51	89	117
67	PBS-40507	1181.91	187	21.59	180	17.04	173	367	360
68	PBS-40508	2794.50	98	10.76	88	11.32	127	186	225
69	PBS-40509	2816.54	89	11.04	93	6.37	61	182	150
70	PBS-40510	2944.96	69	16.22	154	18.29	180	223	249
71	PBS-40511	2759.36	102	9.14	62	9.09	103	164	205
72	PBS-40512	1895.90	181	8.64	55	3.80	19	236	200
73	PBS-40513	1878.69	183	8.15	47	4.87	33	230	216
74	PBS-40514	2977.75	63	5.39	17	3.80	20	80	83
75	PBS-40515	2848.66	84	14.47	143	13.20	154	227	238
76	PBS-40516	3165.46	36	8.37	50	5.13	36	86	72
77	PBS-40517	2366.41	149	10.39	82	7.64	75	231	224
78	PBS-40518	2567.86	126	3.74	6	2.63	12	132	138
79	PBS-40519	2995.68	59	9.58	70	8.60	91	129	150
80	PBS-40520	2317.25	154	3.79	7	2.25	9	161	163
81	PBS-40521	3476.43	12	13.56	130	8.30	86	142	98
82	PBS-40522	2402.16	146	21.84	181	12.95	150	327	296
83	PBS-40523	2569.85	125	9.04	59	9.95	112	184	237

84	PBS-40524	3386.00	16	7.56	39	5.57	49	55	65
85	PBS-40525	3263.21	22	9.11	61	8.66	94	83	116
86	PBS-40526	2974.44	64	5.49	19	2.68	13	83	77
87	PBS-40527	2122.69	170	11.21	96	11.92	140	266	310
88	PBS-40528	3041.08	53	7.64	41	5.47	47	94	100
89	PBS-40529	1932.18	178	8.60	52	3.75	17	230	195
90	PBS-40530	2576.74	124	8.62	54	6.83	70	178	194
91	PBS-40531	2823.84	88	10.46	84	12.65	147	172	235
92	PBS-40532	2949.78	68	13.56	131	8.19	84	199	152
93	PBS-40533	2986.00	61	20.73	178	13.50	157	239	218
94	PBS-40534	2776.19	101	15.34	150	14.39	160	251	261
95	PBS-40535	2865.01	77	9.15	63	5.92	55	140	132
96	PBS-40536	2268.89	157	12.91	125	12.69	148	282	305
97	PBS-40537	2335.11	151	7.30	35	5.17	37	186	188
98	PBS-40538	2510.91	132	23.40	183	17.47	176	315	308
99	PBS-40539	2928.88	71	5.51	20	3.27	16	91	87
100	PBS-40540	1893.44	182	14.72	145	14.73	165	327	347
101	PBS-40541	2657.35	117	12.39	116	10.01	114	233	231
102	PBS-40542	2176.68	164	7.87	43	4.52	26	207	190
103	PBS-40543	2329.28	152	6.61	27	4.19	21	179	173
104	PBS-40544	2686.10	114	8.88	57	6.83	69	171	183
105	PBS-40545	3061.85	50	9.95	75	8.72	96	125	146
106	PBS-40546	2956.53	67	10.57	86	11.33	129	153	196
107	PBS-40547	2461.00	136	8.22	48	9.45	107	184	243
108	PBS-40548	2148.46	167	16.16	153	12.08	142	320	309
109	PBS-40549	1951.33	177	13.76	133	9.36	105	310	282
110	PBS-40550	2731.35	109	11.55	103	11.94	141	212	250
111	PBS-40551	2063.33	173	16.91	160	15.39	168	333	341
112	PBS-40552	2713.55	111	9.34	66	4.86	32	177	143
113	PBS-40553	2983.84	62	12.65	119	12.90	149	181	211
114	PBS-40554	2408.36	142	6.53	26	5.74	52	168	194
115	PBS-40555	3154.36	39	9.77	72	8.65	92	111	131
116	PBS-40556	2852.28	81	11.00	92	9.03	101	173	182
117	PBS-40557	2867.59	76	9.11	60	4.66	30	136	106
118	PBS-40558	2171.34	165	11.65	105	10.78	121	270	286
119	PBS-40559	2134.65	168	5.22	15	2.44	11	183	179
120	PBS-40560	2999.88	58	11.96	114	7.38	74	172	132
121	PBS-40561	2803.09	93	19.25	174	21.36	185	267	278
122	PBS-40562	2399.88	147	3.02	3	1.01	4	150	151
123	PBS-40563	2843.53	85	11.37	98	11.35	130	183	215
124	PBS-40564	3031.43	54	22.97	182	16.28	170	236	224
125	PBS-40565	2268.40	158	10.70	87	9.94	111	245	269
126	PBS-40566	2382.70	148	6.72	29	4.54	27	177	175

127	PBS-40567	3176.83	33	13.69	132	10.09	115	165	148
128	PBS-40568	2705.64	112	4.24	9	3.10	15	121	127
129	PBS-40569	3177.68	32	7.44	37	7.69	77	69	109
130	PBS-40570	1920.43	180	15.59	151	13.30	155	331	335
131	PBS-40571	1932.06	179	18.90	170	11.20	125	349	304
132	PBS-40572	2754.64	104	14.23	140	10.40	118	244	222
133	PBS-40573	3348.48	17	9.79	74	10.24	117	91	134
134	PBS-40574	2754.86	103	14.42	142	12.98	152	245	255
135	PBS-40575	3143.81	41	4.71	13	4.26	22	54	63
136	PBS-40576	2458.34	137	12.53	118	8.05	82	255	219
137	PBS-40577	2800.54	94	4.97	14	4.40	25	108	119
138	PBS-40578	2279.60	156	19.10	173	11.78	136	329	292
139	PBS-40579	2553.90	128	23.90	184	14.46	162	312	290
140	PBS-40580	2200.50	162	8.73	56	5.24	41	218	203
141	PBS-40581	2358.86	150	3.10	5	1.81	5	155	155
142	PBS-40582	2754.33	105	10.07	78	7.00	72	183	177
143	PBS-40583	2986.96	60	8.60	53	5.23	40	113	100
144	PBS-40584	2405.35	144	13.45	128	7.81	80	272	224
145	PBS-40585	2640.08	118	16.58	157	13.34	156	275	274
146	PBS-40586	2851.21	82	14.85	146	11.79	137	228	219
147	PBS-40587	3088.95	46	5.47	18	2.30	10	64	56
148	PBS-40588	2728.29	110	10.00	76	5.84	54	186	164
149	PBS-40589	3127.74	42	15.03	148	11.65	133	190	175
150	PBS-40590	2781.90	100	19.33	175	13.60	158	275	258
151	PBS-40591	3082.75	47	13.92	139	12.95	151	186	198
152	PBS-40592	2074.84	172	6.96	31	1.98	7	203	179
154	PBS-40594	2132.79	169	11.43	101	10.72	120	270	289
155	PBS-40595	3147.01	40	9.73	71	5.44	44	111	84
156	PBS-40596	3054.91	51	17.55	163	13.18	153	214	204
157	PBS-40597	2828.99	86	8.28	49	4.90	35	135	121
158	PBS-40598	2896.60	73	7.73	42	8.45	89	115	162
159	PBS-40599	2169.84	166	15.01	147	10.15	116	313	282
160	PBS-40600	2864.64	78	13.91	138	11.75	135	216	213
161	PBS-40601	2689.80	113	4.69	12	3.76	18	125	131
162	PBS-40602	2811.61	91	11.69	107	6.82	68	198	159
163	PBS-40603	2497.83	133	14.38	141	16.19	169	274	302
164	PBS-40604	3010.05	56	9.35	67	6.63	65	123	121
165	PBS-40605	3250.75	25	13.89	137	8.36	88	162	113
166	PBS-40606	3028.75	55	6.14	22	6.55	63	77	118
167	PBS-40607	1710.04	185	12.67	121	10.86	123	306	308
168	PBS-40608	2636.19	119	6.37	24	6.36	60	143	179
169	PBS-40609	2012.96	175	5.61	21	4.56	28	196	203
170	PBS-40610	2248.30	161	11.44	102	11.59	132	263	293

171	PBS-40611	1626.68	186	17.90	164	17.05	174	350	360
172	PBS-40612	2326.83	153	13.80	134	9.55	109	287	262
173	PBS-40613	2560.55	127	10.54	85	12.12	144	212	271
174	PBS-40614	2250.78	160	18.80	169	11.89	139	329	299
175	PBS-40615	3667.96	7	11.62	104	7.79	79	111	86
176	PBS-40616	3528.15	9	6.40	25	0.38	1	34	10
177	PBS-40617	2576.89	123	11.13	94	10.62	119	217	242
178	PBS-40618	2795.11	97	16.95	161	20.56	184	258	281
179	PBS-40619	2735.23	108	10.01	77	6.04	56	185	164
180	PBS-40620	1850.09	184	9.56	69	8.67	95	253	279
181	PBS-40621	2634.45	120	19.09	172	11.32	128	292	248
182	PBS-40622	2676.84	116	16.46	156	9.98	113	272	229
183	PBS-40623	3095.39	44	11.72	108	8.89	99	152	143
184	PBS-40624	3258.78	24	8.56	51	5.48	48	75	72
185	PBS-40625	2921.39	72	12.69	122	8.24	85	194	157
186	PBS-40626	2815.90	90	7.15	33	4.89	34	123	124
187	PBS-40627	3220.41	28	8.02	45	5.45	46	73	74
188	PBS-40628	3430.14	13	10.12	79	7.92	81	92	94
189	TAG24	3686.10	5	20.68	177	16.97	172	182	177
190	TMV-2NLM	806.44	188	13.27	127	14.58	164	315	352