ON THE POSSIBLE USE OF COMPONENT ANALYSIS TECHNIQUE IN PEST AND DISEASE SURVEY DATA

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INTRODUCTION

SURVEYS on pests and diseases of crops are conducted generally to estimate their prevalence and degree of infestation and to relate such incidences with variations in yield. These data are also useful to relate variations in incidence with other factors such as use of fertilizer, method of sowing, topography, soil type, variety, etc. As the pests and diseases are likely to occur at any stage of crop growth, periodic observations have to be taken during the crop period leading to a number of variables to be considered for each field. One of the major problems, in such surveys, is therefore to reduce the number of variables ranging sometimes from 10 to 20 into fewer number of variables. For some purposes as will be illustrated later it is desirable to reduce to one variable. Similar situations needing reduction in the number of variables arise in Psychology, Sociology, Education, Industry, Economics, Agriculture, etc., and are sometimes tackled by preparing an index-number using the technique of component analysis. One example of this approach is given by Kendall,[6] who prepared, based on the acre yields of different crops, an index-number which he called productivity coefficient to measure the productivity of land. In the present paper an attempt has been made to prepare an index-number of overall incidences due to various pests and diseases by using the component analysis technique. Some of the applications of this index are also illustrated. A few other alternative indices have also been discussed and compared with the index based on component analysis.

TECHNIQUE OF COMPONENT ANALYSIS

Consider p variables with n observations on each. Let X_{ij} be the standardized observation on i-th variate for j-th field. The component analysis technique involves transformation of the original variates X's into an equivalent orthogonal system of variables ξ's of type

$$\xi_i = \sum_{j=1}^{p} l_{ij} x_j \qquad i = 1, 2, \dots p$$

choosing the coefficient l's in such a way that the first of our new variates ξ_1 has as large a variance as possible. We shall then choose ξ_2 so as to be uncorrelated with the first and to have as large a variance as possible from the residual and so on. Usually the first two or three of these variates account for most of the variation. We can then say that the variation is represented approximately by first two or three variates and in favourable circumstances may be able to neglect the remainder. Now to obtain the estimates of l's we have to solve the p equations

$$l_j (1 - \lambda) + \sum_{j'} l_{j'} r_{jj'} = 0 \qquad j \neq j' = 1, 2, \dots p$$

where λ is an undetermined multiplier and $r_{jj'}$ the correlation between the variates j and j'. This is done by first eliminating l's and solving for λ. The characteristics equation of the correlation matrix

$$| r - \lambda I | = 0$$

obtained after eliminating l's in general gives 'p' roots of λ. To each root corresponds a set of l's. Corresponding to a root λ_i (say) of λ we get the new variable

$$\xi_i = \sum_{j=1}^{p} l_{ij} x_j$$

The variance of this new variable is λ_i. The total variation on the transformed scale is p, the number of variables. Therefore $\sum_{i=1}^{p} \lambda_i = p$. The proportion of variation accounted by ξ_i is therefore equal to λ_i/p. If we choose λ_1 the largest characteristic root, the corresponding ξ_1 will remove the largest variation of λ_1/p. An index based on this transformation can be defined in the standardized form as $I = \sum_{j=1}^{p} l_{1j} x_j/\sqrt{\lambda_1}$. In pest and disease surveys generally a certain number say n, fields are selected from the tract by adopting a suitable sampling procedure and in each selected field periodic observations on incidences say p in number are taken. Then we have p, variates with n observations on each variable as mentioned above. The index-number I, calculated in the above manner with variables as pest and disease incidence, may be called 'Incidence coefficient' in our problem.

METHOD AND MATERIAL OF THE SURVEY

The survey was conducted in Cuttack District of Orissa State for 3 years beginning from 1959–60. For the purpose of the survey, the district was divided into 10 homogeneous zones and in each zone, 6 paddy-growing villages were selected at random, and in each selected village, 4 paddy-growing fields were selected at random. In each selected fields, 2 sampling units of 1 sq. yard each were fixed at random, and the observations on the incidence of various pests and diseases were taken periodically on these sampling units. In addition, 2 other sampling units were also located at random in each field, but these units were changed on each occasion of taking observations. Although the incidences of a number of pests and diseases were measured, it was found in the course of the survey that only Stem-borer (*Schoenobius incertulas*) and Gall-fly (*Pachydiplosis oryzae*) were the major pests and Blast (*Piricularia oryzae*) and Helminthosporium (*Helmintho-sporium oryzae*) were the major diseases. The observations on these pests and diseases were taken in the following manner. In each selected sampling unit, all the tillers were counted and those which were affected by Stem-borer or Gall-fly were noted. The percentage of tillers affected by the above pests was taken as a measure of their incidence. For estimating the incidence of Blast and Helminthosporium during the growth phase of the crop, 5 plants located at the 4 corners and the centre of each sampling unit were taken and the incidence was observed on the maximum infected leaf of each of these plants. The maximum infected leaf was scored instead of random leaves as the plant pathologist considered the maximum infection as a better index for estimating the severity of the incidence. Scores were given to those leaves according to standard charts prepared for this purpose by the Central Rice Research Institute. There were 10 such grades from 0 to 9 for Helminthosporium and 9 grades from 0 to 8 for Blast. At the time of harvest, percentage of white earheads due to borer attack and the number of earheads damaged by neck-infection were counted and expressed as a percentage of the total number of earheads in the sampling units for measuring the level of incidence. The yield of the sampling units were taken at harvest time. The observations were taken at monthly intervals beginning from about 4 weeks after planting.

The present investigations were carried out on the data collected during the three years of the survey on the main crop and were confined to the long duration variety. Such data were available from 103, 73 and 151 fields respectively in 1959–60, 1960–61 and 1961–62. Although periodical observations were taken during the survey on a number of pests and diseases, on scrutiny, it was found that during the seasons considered the incidences were negligible except for the following:

1. White earheads due to Borers at harvest (x_1);
2. Neck-infection earheads due to Blast at harvest (x_2);
3. Tillers attacked by Borers at pre-flowering stage (x_3);
4. Tillers attacked by Gall-fly at pre-flowering stage (x_4);
5. Helminthosporium infection at flowering stage (x_5); and
6. Partially borer-attacked earheads at harvest (x_6).

Data on x_1 to x_5 were taken for 1959–60 and x_1 to x_6 for 1960–61 and 1961–62. For changing into normal variates the data of all percentages were transformed into angular values and those of scores to logarithmic values before carrying out the analysis.

RESULTS OF COMPONENT ANALYSIS

The correlation coefficients between pairs of incidences on pests and diseases from the data mentioned above are given in matrix form in Table I for 1959–60, 1960–61 and 1961–62. These correlations were worked out within strata.

For calculating the values of l's we have to solve p equations.

$$l_j(1-\lambda) + \sum_{j'} l_{j'} r_{jj'} = 0 \qquad j \neq j' = 1, 2, \ldots p$$

For data of 1960–61 there will be six equations;

$$l_1(1-\lambda) + l_2\,0\cdot30 + l_3\,0\cdot01 + l_4\,0\cdot19 + l_5\,0\cdot12 - l_6\,0\cdot08 = 0$$

$$l_1\,0\cdot30 + l_2(1-\lambda) - l_3\,0\cdot18 + l_4\,0\cdot30 + l_5\,0\cdot41 - l_6\,0\cdot36 = 0$$

$$l_1\,0\cdot01 - l_2\,0\cdot18 + l_3(1-\lambda) + l_4\,0\cdot23 + l_5\,0\cdot40 - l_6\,0\cdot26 = 0$$

$$l_1\,0\cdot19 + l_2\,0\cdot30 + l_3\,0\cdot23 + l_4(1-\lambda) + l_5\,0\cdot22 - l_6\,0\cdot37 = 0$$

$$l_1\,0\cdot12 + l_2\,0\cdot41 + l_3\,0\cdot40 + l_4\,0\cdot22 + l_5(1-\lambda) - l_6\,0\cdot17 = 0$$

and $-l_1\,0\cdot08 - l_2\,0\cdot36 - l_3\,0\cdot26 - l_4\,0\cdot37 - l_5\,0\cdot17 + l_6(1-\lambda) = 0.$

If we estimate the l's we get the characteristic equation of the correlation matrix.

TABLE I

Correlation coefficients between the incidences of different pests and diseases during 1960–61 (*the values for* 1959–60 *and* 1961–62 *are given in brackets*)

r =

	x_1	x_2	x_3	x_4	x_5	x_6
x_1	1·00 (1·00) (1·00)	0·30 (0·38) (0·49)	0·01 (0·37) (−0·02)	0·19 (0·12) (−0·17)	0·12 (0·24) (−0·04)	−0·08 (−) (0·12)
x_2	0·30 (0·38) (0·49)	1·00 (1·00) (1·00)	−0·18 (0·35) (−0·17)	0·30 (0·00) (−0·03)	0·41 (0·25) (−0·59)	−0·36 (−) (0·22)
x_3	0·01 (0·37) (−0·02)	−0·18 (0·35) (−0·17)	1·00 (1·00) (1·00)	0·23 (0·05) (−0·27)	0·40 (0·12) (0·23)	−0·26 (−) (−0·17)
x_4	0·19 (0·12) (−0·17)	0·30 (0·00) (−0·03)	0·23 (0·05) (−0·27)	1·00 (1·00) (1·00)	0·22 (0·33) (−0·28)	−0·37 (−) (0·22)
x_5	0·12 (0·24) (−0·04)	0·41 (0·25) (−0·59)	0·40 (0·12) (0·23)	0·22 (0·33) (−0·28)	1·00 (1·00) (1·00)	−0·17 (−) (−0·05)
x_6	−0·08 (−) (0·12)	−0·36 (−) (0·22)	−0·26 (−) (−0·17	−0·37 (−) (0·22)	−0·17 (−) (−0·05)	1·00 (−) (1·00)

$$
\begin{vmatrix}
1-\lambda & 0\cdot30 & 0\cdot01 & 0\cdot19 & 0\cdot12 & -0\cdot08 \\
0\cdot30 & 1-\lambda & -0\cdot18 & 0\cdot30 & 0\cdot41 & -0\cdot36 \\
0\cdot01 & -0\cdot18 & 1-\lambda & 0\cdot23 & 0\cdot40 & -0\cdot26 \\
0\cdot19 & 0\cdot30 & 0\cdot23 & 1-\lambda & 0\cdot22 & -0\cdot37 \\
0\cdot12 & 0\cdot41 & 0\cdot40 & 0\cdot22 & 1-\lambda & -0\cdot17 \\
-0\cdot08 & -0\cdot36 & -0\cdot26 & -0\cdot37 & -0\cdot17 & 1-\lambda
\end{vmatrix} = 0
$$

We get

$$\lambda_1 = 2\cdot1396$$

$$l_{11} = 0\cdot2801$$

$$l_{12} = 0\cdot4563$$

$$l_{13} = 0\cdot2909$$

$$l_{14} = 0\cdot4653$$

$$l_{15} = 0\cdot4565$$

$$\text{and } l_{16} = -0\cdot4516$$

Similar calculations with the data for 1959–60 and 1961–62 gave the following values:

1959–60	1961–62
$\lambda_1 = 1\cdot9286$	$\lambda_1 = 1\cdot9852$
$l_{11} = 0\cdot5349$	$l_{11} = 0\cdot3181$
$l_{12} = 0\cdot5074$	$l_{12} = 0\cdot5915$
$l_{13} = 0\cdot4695$	$l_{13} = -0\cdot3436$
$l_{14} = 0\cdot2424$	$l_{14} = 0\cdot2379$
and $l_{15} = 0\cdot4211$	$l_{15} = -0\cdot5277$
	and $l_{16} = 0\cdot3096$

The corresponding indices

$$I = \frac{\Sigma\, l_{ij}\, x_j}{\sqrt{\lambda_1}}$$

are, therefore, given by

1960–61

$$I = 0\cdot1915x_1 + 0\cdot3120x_2 + 0\cdot1989x_3 + 0\cdot3181x_4 + 0\cdot3121x_5 - 0\cdot3087x_6$$

1959–60

$$I = 0\cdot3852x_1 + 0\cdot3654x_2 + 0\cdot3381x_3 + 0\cdot1746x_4 + 0\cdot3032x_5.$$

1961–62

$$I = 0\cdot2257x_1 + 0\cdot4198x_2 - 0\cdot2439x_3 + 0\cdot1689x_4 - 0\cdot3746x_5 + 0\cdot2197x_6.$$

N.B.—The values of indices for the fields, obtained from 1960–61 data, are given in the Appendix.

The proportion of total variation accounted by the index I, is given by λ_1/n where n is the number of variables included in the index. Therefore from the above calculations of the indices and λ's we get the following values for the percentage variation in the pest and disease incidence accounted by the index I in different years.

$$1959\text{–}60 = \frac{1\cdot 9286}{5} \times 100 = 38\cdot 6\%$$

$$1960\text{–}61 = \frac{2\cdot 1396}{6} \times 100 = 35\cdot 7\%$$

$$1961\text{–}62 = \frac{1\cdot 9852}{6} \times 100 = 33\cdot 1\%$$

The low values of λ, suggest the presence of other variables.

The weights for neck-infected earheads (x_2) do not differ much from year to year while for stem-borer incidence (x_3) and partially borer-attacked earheads (x_6), the weights are different in each year. For white earheads (x_1), weights for the years 1960–61 and 1961–62 are nearly same but different in 1959–60. For Gall-fly incidence (x_4), the weights are nearly same for the years 1959–60 and 1961–62 but it is much more in 1960–61. For Helminthosporium incidence (x_5), the weights are nearly same for the years 1959–60 and 1960–61 and differs much in 1961–62. Since x_6 was not included in 1959–60, weights for the several x's are strictly comparable between 1960–61 and 1961–62 only. This fact should be borne in mind in interpreting the variation in weights from year to year. The difference of weights from year to year as mentioned above is a consequence of the lack of stability of the correlation matrix and shows that it is necessary to work out the weights for each survey separately.

Application of Pest and Disease Index

(*a*) *Effect of pest and disease incidence on crop loss.*—The object of these surveys as mentioned above was to estimate the incidences due to pests and diseases and to find out the relationship of these incidences with the variations in yield. The best linear relationship of yield with incidences is given by the usual multiple regression equation which gives estimates of the effect of each variable on yield. However, when we are interested only in the oveall effect of pest and disease incidences on yield, we may use instead a simple regression of yield on the disease and pest index discussed above. For illustration the linear regression of yield on the incidence coefficients, obtained above for the year 1960–61, is given below as

$$\hat{Y} = \underset{(76)}{2707} - \underset{(76)}{243}\, I \quad \text{(kg./hectare)}$$

where the figures in the brackets are the standard errors, I is the index of incidence and Y is the yield of paddy. From this regression equation the loss in yield for an increase of one unit in the index value is estimated as about 8·98% with S.E. 2·82.

(*b*) *Association of pest and disease incidence with agronomic practices and other environmental factors*.—The indices can be used to study the association of pest and disease incidence in general with other agronomic or soil factors. As an illustration a study on the effect of the method of seeding on incidence is given below.

Taking the indices for broadcast and transplant fields in each zone separately for the year 1960–61, we get Table II of totals and means.

TABLE II

Method of sowing	Zone No. (Stratum)						Total	Mean	Adjusted mean	S.E.
	I	III	IV	V	VII	IX				
Broadcasting	−2·5056 (5)	−2·5079 (5)	−9·0592 (5)	−6·7106 (7)	13·5841 (13)	6·3472 (17)	−0·8520 (52)	−0·0164	−0·0617	0·06
Transplanting	−1·1785 (2)	−0·3038 (4)	−2·9765 (2)	−4·1758 (5)	8·8232 (7)	0·6506 (1)	0·8392 (21)	0·0400	0·1522	0·09

't' = 1·98 just significant.

N.B.—Figures given in brackets are the number of fields.

In order to make a proper comparison of broadcast with transplanting we have to remove the stratum differences. This has been done using the method given by Yates.[8] From the adjusted means and their standard errors we may conclude that the overall incidence due to various pests and diseases was significantly more in the fields where the transplantings were made than in the fields where broadcasting of seeds was adopted. Similar relationship between the variations in the overall incidences and other factors such as topography, fertilizer level, etc., can also be made.

SOME OTHER INDICES

Calculation of indices from component analysis involves a good deal of computation. Therefore it is worthwhile to examine the possibility of using simpler indices. Some of these are considered below:

(1) *Ranking coefficient* (C_1).—For each pest or disease incidence, the fields are ranked beginning at the lowest incidence. The ranks of fields which have equal incidences are assigned by splitting in the usual way, *i.e.*, if the r-th, $(r + 1)$-th, ... and $(r + s)$-th fields had equal incidences, each is given a rank $\{r + (r + 1) + \ldots + (r + s)\}/(s + 1)$ and the next field is ranked as $r + s + 1$. After working out ranks for incidence of each pest and disease, their arithmetic means are taken, the value of which may be called ranking coefficient (C_1) following Kendall.[6] For example for field No. 1 (1960–61) the figure obtained would be 37·42. A field with relatively low incidence will have low ranking and thus a low ranking coefficient and *vice-versa*. The values obtained for 1960–61 are given in the appendix.

(2) *Elston's index* (C_2).—Elston[7] has considered the problem of how to rank individuals with respect to measures on several traits jointly when nothing is to be assumed about what economic weights are appropriate. He developed a selection or ranking index on intuitive grounds and then shown to be in a certain sense weight-free. The use of that index has been illustrated for two traits measured on chickens. The index developed by Elston is also applied to the problem of ranking fields in respect of disease and pest incidence. The index is $\Pi_i(x_i - k_i)$ where x's are the incidences and

$$k_i = \frac{(n \min. x_i - \max. x_i)}{n - 1},$$

where n is the number of fields. The values thus obtained (Coefficients-C_2) are presented in the Appendix.

(3) Another approach to work out index numbers is to take the standardized values $(x_i - \bar{x}_i)/\sigma_i$ for each pest and disease incidence. Taking a simple average of these values of each pest and disease for each of the fields, we obtain the values (Coefficients-C_3) as given in the Appendix.

For the purpose of comparing these coefficients (C_1, C_2 and C_3) given above with the incidence coefficients earlier calculated based on component analysis, the correlation coefficients between these and each of the three coefficients C_1, C_2 and C_3 have been worked out and are given in Table III.

TABLE III

Correlation coefficients of incidence coefficient with

	1960–61	1959–60	1961–62
C_1 ..	0·79	0·95	0·50
C_2 ..	0·42	0·63	0·51
C_3 ..	0·80	0·98	0·37

The coefficients worked out by latter three systems, use different weights compared to those for component analysis. The above calculations show that C_1 is more consistently correlated with the incidence coefficients during all the years, and it is very simple to calculate as compared to the component analysis. It therefore appears that where a simple measure of the overall incidence of pests and diseases are needed a ranking coefficient as calculated above may serve the purpose instead of the complicated index based on component analysis.

CORRELATION WITH YIELD

One of the uses of indices of pest and disease incidence is to correlate yield with such incidences. The correlation coefficients of yield on the several indices proposed are given in Table IV.

TABLE IV

Correlation coefficient of yield and index of incidence

Type of index	1959–60	1960–61	1961–62
I ..	−0·06	−0·35	−0·32
C_1 ..	−0·05	−0·20	0·01
C_2 ..	−0·03	−0·19	−0·05
C_3 ..	−0·09	−0·24	0·12

Taking the results for all the three years it appears that the index based on component analysis gives the highest correlation with yield. In general, the correlations are small possibly on account of other factors such as fertility, variety, etc., determining the yield.

SUMMARY

In carrying out surveys on pests and diseases of crops, generally the objectives are:

(*a*) estimating the degree of incidence,

(*b*) correlating such incidence variations with yields, and

(*c*) studying the association of pests and diseases incidence with factors, such as: topography of the land, soil type, variety, fertilizer use, seeding method, etc. Often several pests and diseases occur simultaneously in the same field. Therefore, periodic observations on these pests and diseases lead to a number of variables, often exceeding 10 to 20 to be studied.

In this paper, an attempt has been made to reduce the number of variables and to form a single index of the level of incidence of pests and diseases in a field. The technique of component analysis has been used for this purpose. It was found that about 33 to 39% of the total variation has been accounted by the index in different years. Alternative indices based on (1) ranking methods, (2) method suggested by Elston and (3) standardized values were also worked out and compared with the index based on component analysis. The index based on simple ranking method was found to agree closely with the index based on the more complicated technique of component analysis. The correlation of yield with calculated indices were worked out. These correlations were found to be low ranging from 0·01 to 0·35. An example of the use of the index for studying association of pest and disease incidence with other agronomic factors has been given.

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APPENDIX

(1960–61)

Field No.	Incidence coefficient	Ranking coeffi-cient-1 (C_1)	Coefficient-2 (C_2)	Coefficient-3 (C_3)
1	—0·5880	37·42	84·0879	—0·2031
2	0·2506	47·92	46562·2211	0·2562
3	—0·6046	37·33	82·3133	—0·1990
4	—1·2510	33·92	57·4697	—0·4699
5	—0·4343	40·25	195·1533	0·1377
6	—0·5901	40·42	2082·1990	—0·0196
7	—0·4663	37·75	77·9564	—0·1363
8	—0·7845	27·25	2·0200	—0·5790
9	0·3783	43·58	134·0834	—0·1344
10	—0·5812	22·25	0·1934	—0·6624
11	—0·1851	34·50	283·6186	—0·2743
12	—0·3465	30·08	284·2740	—0·2954
13	—0·5527	31·00	151·6718	—0·4759
14	0·0932	30·58	76·2142	—0·2225
15	—1·0503	21·92	15·4610	—0·8235
16	0·2171	40·25	102·1846	0·1152
17	—2·2078	29·67	86·9795	—0·0341
18	—2·1320	28·50	66·3331	—0·1442

Field No.	Incidence coefficient	Ranking coeffi-cient-1 (C_1)	Coefficient-2 (C_2)	Coefficient-3 (C_3)
19	−1·8663	28·33	57·6504	−0·2538
20	−1·4489	33·08	0·4645	0·0155
21	−1·3418	34·25	4·1441	0·0756
22	−0·7687	40·69	11·7504	0·2839
23	−2·2702	23·50	0·2860	−0·4230
24	−1·3736	21·58	0·0570	−0·8738
25	−1·1013	22·50	0·6731	−0·7820
26	−1·4114	18·50	0·0377	−0·9585
27	−0·8794	23·42	0·4047	−0·6931
28	−0·8410	26·42	0·9813	−0·6255
29	−0·5288	25·50	0·6638	−0·4712
30	−0·5718	28·08	4·0280	−0·4410
31	−0·8268	23·42	0·3567	−0·6678
32	−1·3548	13·50	0·0043	−1·0692
33	−0·9102	23·33	0·6778	−0·6893
34	−0·6022	28·83	1·5720	−0·4502
35	−0·4850	23·50	0·1768	−0·5396
36	0·5668	36·75	60·8566	0·0002
37	1·4669	49·75	10368·2347	0·6091
38	1·5932	50·58	13251·7010	0·6616
39	1·2636	44·75	4608·4079	0·4660

APPENDIX—(*Contd.*)

Field No.	Incidence coefficient	Ranking coefficient-1 (C_1)	Coefficient-2 (C_2)	Coefficient-3 (C_3)
40	1·2673	49·58	7236·4360	0·5369
41	0·9395	47·92	3706·5718	0·3812
42	1·3205	47·33	4823·4101	0·5219
43	1·9047	49·50	30152·5805	0·9771
44	1·5609	47·75	14898·3886	0·6556
45	0·5411	42·92	465·8887	0·1229
46	0·5404	36·00	179·1631	0·0439
47	1·1293	50·33	7436·7560	0·4540
48	0·7884	42·17	2982·7883	0·2164
49	0·7969	33·42	179·3995	0·1448
50	0·7070	37·33	2259·7043	0·1208
51	1·4510	45·00	720·6264	0·7300
52	1·2679	43·83	8062·2423	0·4827
53	1·2393	48·08	11058·2276	0·5053
54	1·1711	42·67	5716·7797	0·4104
55	0·8915	42·08	4134·2928	0·2766
56	—0·0194	43·83	332·7873	0·2288
57	0·4505	48·33	6476·4670	0·4396
58	0·8850	42·42	380·5435	0·3472
59	—0·4817	34·25	59·0465	—0·1672
60	—0·1860	38·50	103·9454	0·0205

APPENDIX—(*Contd.*)

Field No.	Incidence coefficient	Ranking coefficient (C_1)	Coefficient-2 (C_2)	Coefficient-3 (C_3)
61	—0·0823	30·58	579·8857	—0·2029
62	1·1072	46·58	630·3966	0·5103
63	0·4505	48·17	599·3133	0·4802
64	0·7461	39·67	277·0861	0·2730
65	0·6437	53·33	8597·4830	0·5540
66	0·5615	39·33	223·2961	0·2053
67	0·4225	44·92	1985·8045	0·2754
68	0·4354	46·92	2813·0382	0·3427
69	0·3533	36·75	11·1214	—0·0103
70	0·2575	36·33	52·8337	0·0232
71	0·8077	40·50	288·2004	0·3150
72	0·6506	41·08	279·5811	0·2535
73	—0·0043	44·75	237·5475	0·2476