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# SOFTWARE STABSTAT : A BASIC PROGRAMME FOR STABILITY ANALYSES

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Increased concern with the importance of homeostasis in living organisms has stimulated plant breeders awareness for the need to develop well-buffered cultivars. This has led to a greater emphasis on phenotypic stability in breeding programmes. However, the concept of stability is by no means unambigous; it is defined in may ways depending on how the scientist whishes to look at the problem, while the statistics that parameterize these various concepts are also numerous. The nine stability statistics most frequently cited are given below :

1. Wricke's (1962) ecovalance
2. Finlay and Wilkinson's (1963) regression coefficient
3. Eberhart and Russell's (1966) deviation parameter $S^2d$) from regression
4. Stability factor of Lewis (1954)
5. Phenotypic index of Ram *et al.* (1970).
6. Coefficient of determination of Bilbro and Ray (1976).
7. Variance of a genotype across environments
8. Coefficient of variability (CV) of each genotype (Francis and Kannenberg, 1978).
9. Shukla's (1972) stability variance.

Kang (1988), Kang and Pham (1991), Kang (1993) and Kang and Magari (1995) developed programmes for stability analyses. This paper aims to report a programme to calculate all these stabilities. This programme, called STABSTAT, should be useful for breeders and also as a handson teaching tool for elaborating discussion on GE interaction and stability analysis in plant breeding.

## DESCRIPTION AND OPERATION

STABSTAT was written in Microsoft Quick Basic (DOS version) and can be operated on an IBM-PC or compatible computers. This programme

Table 1. Replicated data for five genotype from six environments (Sample data)

| Environment | Genotype | R1 | R2 | R3 |
|---|---|---|---|---|
| E1 | G1 | 512 | 571 | 617 |
| | G2 | 569 | 580 | 598 |
| | G3 | 245 | 301 | 351 |
| | G4 | 493 | 470 | 516 |
| | G5 | 240 | 245 | 144 |
| E2 | G1 | 530 | 566 | 566 |
| | G2 | 446 | 422 | 412 |
| | G3 | 244 | 330 | 292 |
| | G4 | 220 | 236 | 196 |
| | G5 | 404 | 316 | 346 |
| E3 | G1 | 220 | 350 | 405 |
| | G2 | 330 | 230 | 445 |
| | G3 | 470 | 320 | 375 |
| | G4 | 220 | 330 | 265 |
| | G5 | 575 | 625 | 610 |
| E4 | G1 | 140 | 235 | 225 |
| | G2 | 120 | 110 | 220 |
| | G3 | 80 | 90 | 70 |
| | G4 | 165 | 135 | 165 |
| | G5 | 270 | 295 | 300 |
| E5 | G1 | 985 | 955 | 940 |
| | G2 | 1200 | 1100 | 1000 |
| | G3 | 940 | 940 | 910 |
| | G4 | 870 | 860 | 850 |
| | G5 | 850 | 845 | 810 |
| E6 | G1 | 980 | 980 | 950 |
| | G2 | 1200 | 1000 | 800 |
| | G3 | 950 | 930 | 895 |
| | G4 | 890 | 875 | 860 |
| | G5 | 840 | 840 | 810 |

**Fig. 1. Sample output from STABSTAT using data from Table 1.**

ANALYSIS OF VARIANCE OF MULTI-ENVIRONMENT DATA BASED ON THE REGRESSION APPROACH OF FINLAY AND WILKINSON, 1963.

| SOURCE | DF | S6 | MSS | F ratio |
|---|---|---|---|---|
| FROM POOLED ANALYSIS | | | | |
| REPL (with in environments) | 12 | 58133.22 | 4844.435 | 4.610113 |
| TOTAL | 89 | 8718994 | | |
| FROM MEAN ANALYSIS | | | | |
| VARIETIES | 4 | 82082 | 20520.5 | 19.52794 |
| ENVIRON | 5 | 2505088 | 501017.6 | 476.7837 |
| G X E | 20 | 249343 | 12467.15 | 11.86412 |
| REGRESSION | 4 | 2558662 | 639665.5 | 52.27915 |
| REMINDER | 16 | 195769.2 | 12235.58 | 11.64375 |
| ERROR (pooled) | 48 | 151319.2 | 3152.484 | ME = 1050.828 |
| TOTAL | 89 | 2836513 | | |

ANALYSIS OF VARIANCE OF MULTI-ENVIRONMENTAL DATA WHEN STABILITY PARAMETERS ARE ESTIMATED FOLLOWING EBERHART AND RUSSEL (1966)

| SOURCE | DF | S6 | MSS | F |
|---|---|---|---|---|
| FROM POOLED ANALYSIS | | | | |
| REPL | 12 | 58133.22 | 4844.435 | |
| TOTAL | 89 | 8718994 | | |
| FROM MEAN ANALYSIS | | | | |
| TOTAL | 29 | 2836513 | | |
| VARIETIES | 4 | 82082 | 20520.5 | 19.52794 |
| ENV + G X E | 25 | 2754431 | 110177.2 | 104.848 |
| ENV (linear) | 1 | 2505088 | 2505088 | 2383.919 |
| G X E (linear) | 4 | 53574 | 13393.5 | 12.74567 |
| POOLED DEV | 20 | 195769.2 | 9788.461 | 9.314999 |
| VARIETY 1 | 4 | 38033.31 | 9508.328 | 9.048416 |
| VARIETY 2 | 4 | 23641.75 | 5910.438 | 5.624553 |
| VARIETY 3 | 4 | 10038.88 | 2509.719 | 2.388325 |
| VARIETY 4 | 4 | 28232.85 | 7058.211 | 6.71681 |
| VARIETY 5 | 4 | 95822.44 | 23955.61 | 22.79689 |
| ERROR (pooled) | 48 | 151319.2 | 3152.484 | ME = 1050.828 |

ANOVA AND STABILITY VARIANCE (SHUKLA (1972))

| SOURCE | DF | S6 | MSS | F ratio |
|---|---|---|---|---|
| FROM MEAN ANALYSIS (units of single plot ** (div by EN)) | | | | |
| ENV | 5 | 417514.7 | 83502.93 | |
| VAR | 4 | 13680.33 | 3420.083 | |
| E X G | 20 | 41557.17 | 2077.858 | |
| | MSS | F ratio | b (shukla) | |
| 1 Z^2 | | 1453.133 | 8.297073 | -3.431807E-02 |
| 2 Z^2 | | 1454.441 | 8.304546 | .1730584 |
| 3 Z^2 | | 263.6848 | 1.505583 | .1196622 |
| 4 Z^2 | | 879.0612 | 5.01925 | -1.068142E-02 |
| 5 Z^2 | | 6338.928 | 36.19391 | -.2477212 |
| HETEROGENITY | 4 | 8928.626 | 2232.157 | |
| BALANCE | 16 | 32628.54 | 2039.284 | |
| 1 S^2 | | 1961.452 | 11.19947 | |
| 2 S^2 | | 962.0452 | 5.49307 | |
| 3 S^2 | | 17.41808 | 9.945345E-02 | |
| 4 S^2 | | 1280.87 | 7.313489 | |
| 5 S^2 | | 5974.582 | 34.11357 | |
| ERROR | 48 | ME = 1050.828 | MEI=ME/EN=175.138 | |

GENO X ENVIRONMENT MEANS

| | | | | | | |
|---|---|---|---|---|---|---|
| GENO 1 | 566.67 | 554.00 | 325.00 | 200.00 | 960.00 | 970.00 |
| GENO 2 | 582.33 | 426.67 | 335.00 | 150.00 | 1100.00 | 1000.00 |
| GENO 3 | 299.00 | 288.6 | 388.33 | 80.00 | 930.00 | 925.00 |
| GENO 4 | 493.00 | 217.33 | 271.67 | 155.00 | 860.00 | 875.00 |
| GENO 5 | 209.67 | 355.33 | 603.33 | 288.33 | 835.00 | 830.00 |

EI = ENVIRONMENT INDEX

| | |
|---|---|
| Envi 1 | -105.6778 |
| Envi 2 | -167.4112 |
| Envi 3 | -151.1445 |
| Envi 4 | -361.1445 |
| Envi 5 | 401.1889 |
| Envi 6 | 384.1889 |

REGRESSION ANALYSIS OF VARIETIES GROWN IN MANY ENVIRONMENTS

| VAR | MEAN | PI | b | SE (b) | R SQUARE | t (b=0) | t (b=1) |
|---|---|---|---|---|---|---|---|
| 1 | 595.9445 | 60.1333 | 0.9657 | 0.1378 | 0.9247 | 7.01 | 1.12 |
| 2 | 599.0000 | 63.1888 | 1.1731 | 0.1086 | 0.9668 | 10.80 | 1.32 |
| 3 | 485.1667 | -50.6445 | 1.1197 | 0.0708 | 0.9843 | 15.82 | 1.20 |
| 4 | 478.6667 | -57.1445 | 0.9893 | 0.1187 | 0.9456 | 8.34 | 1.12 |
| 5 | 520.2778 | -15.5334 | 0.7523 | 0.2187 | 0.7474 | 3.44 | 0.96 |
| SE | 49.46833 | .1562736 | | | | | |

| SOURCE | SPxy | REG MS | REMINDER | MS | Sd^2 |
|---|---|---|---|---|---|
| 1 | 0.9616 | 483823.8000 | 467220.0000 | 9508.3280 | 8457.5000 |
| 2 | 0.9833 | 587723.1000 | 689433.8000 | 5910.4380 | 4859.6100 |
| 3 | 0.9921 | 560970.9000 | 628098.3000 | 2509.7190 | 1458.8910 |
| 4 | 0.9724 | 495666.3000 | 490372.1000 | 7058.2110 | 6007.3830 |
| 5 | 0.8645 | 376905.3000 | 283538.1000 | 23955.6100 | 22904.7800 |

S. FACTOR = STABILITY FACTOR (LEWIS, 1954)
ECOVALENCE (WRICKE, 1962)

| GENO | VARIANCE | S.D. | S. FACTOR | ECOVALENCE | CV% |
|---|---|---|---|---|---|
| 1 | 91018.5300 | 301.6928 | 4.8000 | 309.8021 | 50.6243 |
| 2 | 133577.4000 | 365.4824 | 7.3333 | 309.9909 | 61.0154 |
| 3 | 113977.4000 | 337.6055 | 11.6250 | 138.0703 | 69.5855 |
| 4 | 92061.7700 | 303.4168 | 5.5484 | 226.9179 | 63.3879 |
| 5 | 67761.6200 | 260.3106 | 2.8960 | 1015.2100 | 50.0330 |

requires data of genotypes from individual environment. The data file (Input file) can be created by any Text-editor software and separate file should be created for each character. After the programme has been accessed, the programme prompts the user to provide the following information. (i) name of input file (data file), (ii) name of output file (results file), (iii) number of environments, genotypes and replications and (iv) title for the experiment. The results are stored in a separate file (output) and can be printed using any editor software. The result file (output) provides the following information: (i) Analysis of variance (ANOVA) for Finlay and Wilkinson (1963), Eberhart and Russel (1966) and Shukla (1972) models, (ii) mean, phenotypic index (PI), regression coefficient, standard error of regression coefficient, calculated 't' value for b=1 and b=0, coefficient of determination ($R_2$), deviation from regression ($S^2d$), variance, ecovalance (Wricke, 1962), stability factor (Lewis, 1956) and coefficient of variation for each genotype. This programme also provide environmental index for each environment. The Fisher's (F) table and Student 't' table should be referred to determine the significance of various parameters.

## OUTPUT EXAMPLE

A sample replicated data for genotypes on each environment is given in Table 1 as input data. Data alone should be typed. The output from this programme is presented in Fig. 1.

## SOFTWARE SPECIFICATIONS AND AVAILABILITY

STABSTAT requires (i) an IBM-PC or compatible with DOS version 3.1 or higher, (ii) 640 Kb RAM and (iii) a 5 1/4 or 3 1/2 inch (13.1 and 8.75 cm) floppy disk drive but require no other software or pheripherals to run the programme. This programme can be run using a floppy programme diskette, but a hard drive is recommended for greater speed. The programme for all the analyses of stability parameters was written in a single file. To address input and output file, path can be used in these files are in different directory or drive.

STABSTAT programme listing will be provided free of cost upon request to the author. Please also include a formatted diskette (3 1/2 inch) along with sufficient postages to send through post.

## REFERENCES

BILBRO, J.D. and RAY, L.L. (1976). Environmental stability and adaptation of several cotton cultivars. **Crop Sci., 16 :** 821 - 824.

EBERHART, A. and RUSSELL, W.A. (1966). Stability parameters for comparing varieties. **Crop. Sci., 6 :** 36-40.

FINLAY, K.W. and WILKINSON, W.A. (1963). The analysis of adaptation in a plant breeding programme. **Australian J. Agric. Res., 14 :** 742-754.

FRANCIS, T.R. and KANNENBERG, L.W. (1978). Yield stability studies in short season maize. I. A descriptive method for grouping genotypes. **Canadian J. Plant Sci., 58 :** 1029 - 1034.

KANG, M.S. (1988). Interactive BASIC programme for calculating stability variance parameters. Letter to the editor. **Agron. J., 80 :** 153.

KANG, M.S. (1993). Simultaneous selection for yield and stability in crop performance trials : Consequences for growers. **Agron J., 85 :** 754 - 757.

KANG, M.S. and MAGARI, R. (1995). STABLE : A BASIC programme for calculating stability and yield-stability statistics. **Agron. J., 87 :** 276-277.

KANG, M.S. and PHAM, H.N. (1991). Simultaneous selection for high yielding and stable crop genotypes. **Agron. J., 83 :** 161-165.

LEWIS, D. (1954) Gene-environment interaction. A relationship between dominance, heterosis, phenotypic stability and variability. **Heredity, 8 :** 333 - 356.

RAM, J., JAIN, O.P. and MURTY, B.R, (1970). Stability of performance of some varieties and hybrid derivatives of rice under high yielding varieties programme. **Indian J. Genet., 30 :** 187-198.

SHUKLA, G.K. (1972). Some statistical aspects of partioning genotypes-environmental components of variability. **Heredity, 29 :** 237-245.

WRICKE, G. (1962). Uber eine Methode Zur Erfassung der okologischen Streubreite in Feldversuchen. **Z. Pflanzenzuecht., 47 :** 92-96.


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# EFFECT OF MAJOR NUTRIENTS, SALT STRESS AND TEMPERATURE ON NODULATION AND NITROGENASE ACTIVITY OF *Sesbania rostrata*

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## ABSTRACT

The effect of major nutrients, salt stress and temperature on the nodule number and nitrogenase activity were studied with *Sesbania rostrata*. Different levels of NPK (25, 50 and 75 kg/ha), NaCl (0.5, 1.0 and 1.5 and 2.0 per cent) and temperature (20, 25, 30 and 35° C) were attempted. *Sesbania rostrata* responded significantly to NPK at 75 kg/ha compared to 25 and 50 kg/ha levels and control. Application of NaCl irrespective of the level resulted in the lower number of nodules and nitrogenase activity. The highest number of nodules and nitrogenase activity was observed when *S. rostrata* exposed to 30°C.


KEY WORDS : Sesbania rostrata, Stress condition, Nodulation

Biological nitrogen fixation is a cheap source to complement the inorganic nitrogen requirement of a crop. Biological nitrogen fixation plays a key role in maintaining soil fertility in tropics. Legume - rhizobium symbiosis occupies major portion in biological nitrogen fixation. Most nitrogen fixing legumes have nodules on their root system. However, some species possess nodules on the stem as well as roots and they are called as stem nodulating legumes. Several of these plants *viz.* Sesbania, Aeschynomene and Neptunia are not only characterized by an usually good nitrogen fixing potential but also have unique capacity to absorb combined nitrogen through their roots. They can also fix nitrogen through their stem nodules, even in the presence of high soil mineral nitrogen. *Sesbania rostrata* is an annual plant thrives well in flooded conditions and has rich nitrogen