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MULTI-LOCATION TRAILS OF SMALL RAIN-FED WHEAT OF PAKISTAN USING PARAMETRIC METHODS

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ABSTRACT-Six parametric methods carried out form twenty genotypes yield of wheat throughout sixteen Environments within the rain fed areas of Pakistan for the year of 2016-17, developing seasons have been used to principal cause of analyzing GEI throughout 16 Environments. We study a few parametric method were used for the Genotype's Stability based of mean yield ($\bar{Y}$), Geometric adaptability index (GAI), Environmental variance (Si^2), Wricke's Ecovalence (Wi^2), Shukla variance (σi^2) and Co-efficient of variation (CV). The parametric measures result obtained by using wricke'secovelance and shukla's results are same of stable genotype is G10 (AZRC-20), G5 (QS-3) and G17 (NW-520-1), unstable genotype is G2 (1V-11) and G16 (NW-1-8183-8). Environmental variance and Co-efficient of variation (CV) results are same stable genotype is G2 (1V-11) and G1 (1V-1), unstable genotype is G14 (NR-488) and G11 (NR-443). Geometric adaptability index (GAI) results stable genotype is G8 (AZRC-11) and G4 (14C036), unstable genotype is G7 (KT-325) and G19 (SD-1013). Genotype's Stability based of mean yield ($\bar{Y}$) results stable genotype is G11 (NR-443) and 16 (NW-1-8183-8), unstable genotype is G19 (SD-1013) andG7 (KT-325).

Keywords: Genotypes, Multi-location Trails, Pakistan, wricke's ecovelance, shukla's parameter, Stability, mean yield

1. INTRODUCTION

Pakistan is primarily an agricultural country; approximately 68 percent of the population lives in rural areas, and the country is entirely reliant on agriculture for its subsistence (Chaudhry et al. 2006). Pakistan's agriculture sector plays a central role in the economy as it contributes 18.9 percent to GDP and absorbs 42.3 percent of labour force. It is also an important source of foreign exchange earnings and stimulates growth in other sectors(Ahmed and Ahsan 2014). Agriculture employs 45 percent of the country's total labor force, according to official figures. Furthermore, it is the most important source of foreign currency in the world. When it comes to contributing to Pakistan's Gross Domestic Product, the agriculture industry is the most important (GDP). Agriculture contributes for around 24 percent of the country's gross domestic product. Agriculture contributed RS

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2210647 million to the country's GDP in 2015, but this figure dropped to RS 2206357 million the following year. In the period 2006-2016, agriculture contributed an average of RS 2005208 million per year to the country's gross domestic product (GDP) (Usman 2016). The provincial government of Pakistan places a high value on increasing agricultural productivity. Agriculture provides a significant portion of the raw materials used in downstream industry production. Agriculture's primary role is to alleviate poverty and create jobs, which is exactly what the country desires. The primary goal of our agricultural sector is to transition from self-sufficiency to profitability. Pakistan's main crops are wheat, rice, maize, sugarcane, and cotton. According to Pakistan's economic survey, major crops account for approximately 25.6 percent of agricultural output and nearly 5.4 percent of GDP. Wheat accounts for about 10.3 percent of agricultural output and 2.2 percent of GDP. Rice is a cash crop as well as a food crop. Pakistan produces high-quality rice that is widely regarded as the best and most popular in the world. Pakistan has experience in, however due to a number of intrinsic issues, we lack the expertise necessary to export large quantities of high-quality rice, which has a negative impact on our foreign exchange reserves. Rice accounts for over 3.1 percent of agriculture in our country and 0.7% of GDP. Cotton is a cash crop that provides raw materials for the textile sector, accounting for around 1.4 percent of GDP. Additionally, sugarcane is a cash crop and a food crop. (ul Haq et al. 2011). Our sugar business is based on sugarcane as a raw resource. Sugarcane contributes 3.4 percent to agriculture and 0.7 percent to GDP. Pulses, mustard, gramme, jawar, bajra, oil seeds, and barley are among our minor crops. (Saima et al. 2011). Minor crops contributing in agriculture sector is 11.6% (Usman 2016).

Pakistan has an area of 803,940 square kilometers, which is the largest in the world. Around 48 million hectares, or 60 percent of the land, is under cultivation, with Punjab cultivating approximately 70 percent of the land, Sindh 20 percent, KPK less than 10 percent, and Baluchistan cultivating less than 1 percent of the land. Pakistan produces a total of 26.3 million metric tons of wheat per year (Nazli et al. 2012).

In Pakistan wheat is the most important crop. It covers 6.979 million hectare in Punjab with production of 1.8 million tonnes. Most of the dietary requirement of the peoples is met from the wheat because it is the staple food for the people of Pakistan. Biotic and abiotic stresses are most important factors and play vital role in the production of wheat. Following the results of the National Uniform Wheat Yield Trials (NUWYT), wheat yield area in the 2015-16 wheat planting season was 9.2 million hectares, with an output of 25.47 million tons and an average yield of 2753 kilograms per hectare (kg/ha) (council 2017-18).

2. MATERIALS AND METHODS

For this study, data on genotype production were obtained from ten settings during 2016-17, with the assistance of the National Uniform Wheat Yield Trials programs coordinated by the National Agricultural Research Center in Islamabad.The variations were donated by a small number of plant breading experts from around the nation who were doing study

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at various research institutions. In each site, 20 cultivars were sowed in an RCBD with two or more than two replicates of each cultivar. In contrast to one another, the numerous research institutions where a single factor (RCBD) was applied across sixteen habitats were not identical. They varied in terms of soil type, annual rainfall average, and altitude, among other things. 20 varieties have been applied to sixteen (16) areas, nine of which were in Punjab, three of which were in Sindh, four of which were in KPK.

2.1. Parametric Stability Methods

Researchers in the fields of statistics and biometrics have developed a range of parametric stability methodologies for measuring the genotype's stability as well as the effect of genotype-environment interaction on yield. In this study, we utilized the techniques to parametric stability that are the most often used.

2.2. Wricke's Method

When analyzing the impacts of genotypes on their environment, (Wricke 1962) recommended that the Equivalence (Wi^2) or the ith genotype be used, which is the effects of genotypes on their environment squared and summed up across all environments stated as

$$W_i^2 = \sum_{j=1}^{e}(Y_{ij} - \bar{Y}_{i.} - \bar{Y}_{.j} - \bar{Y}_{..})^2 \qquad \text{Where } i = 1,2,\ldots,g \quad j=1, 2\ldots e$$

Where all Y's have the same significance

As a result, a genotype through the lowest Equivalence is considered as the most stable of all. Of course, the metric has limitations, such as the fact that it cannot be used to quantify the performance of genotypes across different geographical regions.

2.3. Shukla's Measure

(Shukla 1972) suggested that the variance component of each genotype across contexts may be another useful indicator of phenotypic stability. It is stability metric rather than a performance metric. Shukla's stability variance GE (σi^2), G×E sum of square into components, one for each component of genotype and is given as:

$$\sigma_i^2 = \frac{g}{(g-2)(e-1)}\sum_{j=1}^{e}(Y_{ij} - \bar{Y}_{i.} - \bar{Y}_{.j} - \bar{Y}_{..})^2 - \frac{SS(GEI)}{(g-1)(g-2)(e-1)} \qquad i = 1,2,\ldots,g$$

Where g = Number of genotypes and

e = Number of locations
SS (GEI) = Sum of the W_i^2

2.4. Environmental variance (Si^2)

Environmental variation (Si^2) is defined biologically/statically, implying that a stable genotype is one with minimal variance across studied contexts (Lin et al. 1986). The

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genotype with the least variation across many places was designated as stable. This estimate was arrived at in the following manner:

$$S_i^2 = \frac{\sum(Y_{ij} - \bar{Y}_{i.})^2}{(e-1)} \qquad \text{where } i = 1,2,\dots,g \quad j = 1,2,\dots,e$$

Where, Yij = Grain yield of genotype i in environment j, $\overline{Yi}$. = Mean yield of genotype I and e is the number of locations.

2.5. Coefficient of variation (CV)

The coefficient of variation (CV) is a statistic that quantifies the dispersion of data points in a series relative to the mean. Even when the means are considerably different, the coefficient of variation is a useful statistic for measuring the degree of variation among data sets.

When compared to the population mean, data in a sample is more variable than data in a population, according to the coefficient of variation. The coefficient of variation is a financial metric that shows how much volatility, or risk, is anticipated in relation to the projected return on investment. The lower the ratio of standard deviation to mean return calculated by the coefficient of variation formula, the better the risk-reward trade-off. Please bear in mind that if the denominators anticipated return is negative or zero, the coefficient of variance may seem to be low.

Stability is defined by a combination of CV and mean yield (Francis and Kannenberg 1978). We judged genotypes with a low CV and a high $\overline{Yi}$ to be favorable.

$$CV_i = \frac{S_i}{\bar{Y}} \times 100 \qquad i=1, 2\dots g$$

2.6. Geometric adaptability index (GAI)

The GAI is applied to estimate the genotype's adaptability and is computed as:

$$GAI_i = \sqrt[e]{(\bar{Y}_{i1})(\bar{Y}_{i2})\dots(\bar{Y}_{ie})}$$

Where, $\bar{Y}i1$, $\overline{Yi}2$, … $\bar{,i^e}$ are the yields of means of the first, second and ith genotypes through environments and 'e' is the environments.

The Genotypes with high GAI will be more stable as compared to those having low GAI.

3. RESULTS AND DISCUSSIONS

3.1. Univariate parametric Stability methods

Various Univariate parametric procedures were applied for the analysis of stability for wheat genotypes through sixteen locations (Table: 5.4).

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3.2. Average yield and Stability performance ($\bar{Y}$)

Based on results of (Table: 5.5) $\bar{Y}$ (Kg/hec) of environments where combined mean of overall environments was obtained 1579.403 eight environments averages were larger than the combined mean of all environments. Which were not indicated symmetrical but it showed positive skewness distribution of the given environments? In this method E15 was identified as stable environment because E12 (2055) was a maximum mean yield obtained; the 2nd maximum mean yield was obtained by E8 (2038) and the 3rd maximum mean yield was obtained by E11 (2034). By this method E35 was identified as unstable environment because the minimum mean yield was obtained by E35 (500), the 2nd minimum mean yield was obtained by E34 (1173) and the 3rd minimum mean yield was obtained by E14 (1325).

3.3. Genotype's Stability based of mean yield ($\bar{Y}$)

Genotypes with highest mean yield ($\bar{Y}$) will be superior (Mohammad et al., 2008). Taking $\bar{Y}$(mean yield) as a first method for estimating the genotypes and ranged from 1440.43 to 1693.5 kg/hec. There are 10 wheat genotypes for which $\bar{Y}$ was larger than overall average of cultivars among sixteen locations. Depending the result of mean yield, G11, G16, G14 and G8 were identified as stable genotypes because of high average yield and G19, G17, G6 and G12 were declared as poorest genotypes across sixteen environments because of low yields.

3.4. Geometric adaptability index (GAI)

This method is used to estimate adaptability of varieties. Varieties with highest GAI will be more stable (Mohammad et al., 2008). Based on the result of this technique, G8 identified as superior genotype because it gave the highest estimate of GAI and followed by G4, G11and G3 identified as unstable genotype because it had low value of GAI and followed by G7, G19, G6 and G12. Important point to be noted is that the GAI and mean yield displayed identical results because both methods declared G8, G11 as stable G12 and G19 as unstable genotype.

3.5. Environmental variance (Si^2)

Environmental variance (Si^2) is an important stability procedure and it is used for the concept of static stability for each genotype across all areas (Fasahat et al., 2015). Based on the result of Si2, G2, G1, G3 and G19 were declared as stable genotypes because of lowest estimate of the Si2 and G14, G11, G15 and G17 identified as unstable genotypes because of high values across overall environments.

3.6. Wricke'sEcovalence (Wi^2)

In this study, based on the result of Wi^2, G10, G5, G17, and G13 were identified as stable genotypes because of minimum value of Wi^2 and G2, G16, G12, G14 were declared as unstable genotypes because of maximum estimate of Wi^2.

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3.7. Shukla variance (σi^2)

Based on the result of σi^2, G10, G5, G17 and G13 were known as stable genotypes among sixteen environments because of small statistic of σi^2. G2 was identified as unstable genotype and followed by G16, G12 and G14 and G1.

3.8. Co-efficient of variation (CV)

In this research, according to the result of this method G2, G1, G3 and G10 were identified as stable genotypes. And the genotypes of wheat G7, G6, G19 and G12 were declared as unstable. Wheat genotypes G11, G14, G16 and G15 average yield were more than the combined mean yield but gave maximum CV which declared least stability. The G1 gave maximum average yield and minimum CV declared as a more stable genotype and G14 was recommended as unstable genotype across overall areas because it gave high CV with small average yield.

Table 1: Twenty wheat genotypes data from 16 environments were analyzed GE Interaction and stability using different parametric methods

Genotype	$\bar{Y}$	Si^2	CV	GAI	Wi^2	σi^2
G1	1541.438	151283.6625	25.23307	1492.423	913371.1	63132.8
G2	1575.438	81105.7625	18.07693	1548.628	5594210	409861.6
G3	1612.156	166554.524	25.3146	1562.032	968992.4	67252.89
G4	1637.063	193293.4958	26.85613	1575.439	728820.4	49462.38
G5	1560.625	245269.5167	31.73388	1474.549	468337.3	30167.33
G6	1460.25	180934.3	29.12951	1364.621	1030340	71797.14
G7	1459.969	264660.3823	35.23716	1306.458	1153792	80941.76
G8	1662.25	242991.7	29.6551	1594.679	738254	50161.16
G9	1582.938	266039.6292	32.58438	1462.457	1317015	93032.33
G10	1608.344	185792.924	26.80006	1526.351	272682.7	15674.4
G11	1693.5	371708.8	36.00114	1574.632	1088442	76101.03
G12	1509.406	206145.5073	30.08021	1413.521	1401632	99300.24
G13	1618.813	246348.2292	30.66043	1529.52	622415.5	41580.53
G14	1664.75	409052.4333	38.41851	1534.768	1341487	94845.07

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G15	1653.844	327969.4573	34.62759	1550.308	1250365	88095.32
G16	1675.844	326601.0906	34.10164	1547.37	1484488	105437.8
G17	1539.219	257001.299	32.93573	1424.093	474826.3	30648
G18	1517.281	198217.3323	29.34301	1443.209	629242.2	42086.21
G19	1440.438	175461.2958	29.08012	1353.073	1030801	71831.32
G20	1574.5	287009.9667	34.0256	1419.471	700245.8	47345.74

Table 2: Ranks of twenty wheat genotypes data from 16 environments were analyzed GEI and stability models using different parametric methods.

Genotype	**Rank mean**	**Si^2**	**Cv**	**GAI**	**Wi^2**	**σi^2**
G1	14	2	2	11	9	9
G2	11	1	1	6	20	20
G3	8	3	3	4	10	10
G4	6	7	5	2	7	7
G5	13	11	12	12	2	2
G6	18	5	7	18	11	11
G7	19	14	18	20	14	14
G8	4	10	9	1	8	8
G9	10	15	13	13	16	16
G10	9	6	4	10	1	1
G11	1	19	19	3	13	13
G12	17	9	10	17	18	18
G13	7	12	11	9	4	4
G14	3	20	20	8	17	17
G15	5	18	17	5	15	15
G16	2	17	16	7	19	19
G17	15	13	14	15	3	3
G18	16	8	8	14	5	5
G19	20	4	6	19	12	12
G20	12	16	15	16	6	6

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4. CONCLUSION

Owing to different stability as well as adaptability methods researchers face problems to determine which stability methods are appropriate for the evaluation of Multi-Environmental trials numbers and to select of desirable varieties. Numerous methods are applied to analyze the Multi-Environmental trials data offers statistics on selection of components of stability and adaptability. Maximum methods of stability provide explanation for the efficiency of genotypes. Several researches are used for approaches of stability. Almost these types of studies reported approximately similar types of conclusions for the usage of stability methods which might be because of nature of statistics under research. In addition, for researchers the model of stability can be unique, as extraordinary standards of stability are described in the review. A cultivar is believed appropriate whether it possess higher average yield as well as reliable efficiency through the locations. Flores-1988 categorized the methods of stability in 3 clusters: (i) one of them is considered nearest stable results of genotypes, (ii) while The other one does not exhibit maximum effective average yield of varieties, and (iii) and The 3rd one does not show stability and average yield simultaneously.

There are two main objectives of the present study, the first objective is to assess wheat genotype through numerous statistical approaches and define genotype environment interaction (GEI) in the rain fed region through multi-locations of wheat yield in Pakistan. The frequent performances of wheat of rain fed areas depend on soil, environmental situations of the specific region and selection of genotype. The second objective is to find out the greatest dependable and stable genotype, which can similarly perform the best through the maximum environments. Furthermore the association and comparison among different stability methods are found. Twenty wheat genotypes of the rain fed zones were assessed based on the sixteen environments of Pakistan during the period of 2016-17. Numerous methods were used for the assessment purpose involved the methods of univariate ofParametric. Six univariate parametric stability approaches mean yield Y, GAI, σi^2, Wi^2, $Si^2$and CV.

Mean yield declared G11 (NR-443) as a stable genotype through sixteen environments because it had higher value than other genotypes followed by G16 (NW-1-8183-8), G14 (NR-488), G8 (AZRC-11) and G15 (NR-491) declared as unstable genotype in overall environments because it had lowest value followed by G19 (SD-1013), G6 (KT-335) and G7 (KT-325). E15 (ARFKotNaina, Shakargar) showed highest mean yield followed by E8 (SZS-Farm Sakrand) and E11 (RSS. Bahawalpur) but E35 (ARI -D.i.KHAN) showed lowest mean yield followed by E34 (Mardan) and E14 (ARF Gujranwala).

GAI declared G8 (AZRC-11) as a stable genotype through sixteen environments because the value of (GAI) G8 was greater than other genotypes followed by G4 (14C036), G3 (14C040), G11 (NR-443) and G7 (KT-325) was declared as unstable genotype because it had lowest value of GAI followed by G6 (KT-335), G19 (SD-1013). Mean Yield and GAI declared G8 as a stable genotype while G7 had been considered as not stable cultivar.

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σi^2 (Shukla's Stability Variance) declared G10 (AZRC-20) as a stable genotype through sixteen environments because the value (Shukla's Stability Variance) of G10 was lowest than other genotypes followed by G5 (QS-3), G17 (NW-520-1), G13 (NR-487) and G2 (1V-11) declared as unstable genotype because it had largest value of σi^2 followed by G16 (NW-1-8183-8), G12 (NR-448).$\sigma i2$ Had perfect positive correlation (r=1) with Wi2 therefore we cannot recommend calculating both methods for analysis of adaptability as an alternative we can use suggest any one (σi^2 or Wi^2) and a low relationship with mean Yield and GAI. Exactly Wi^2 displayed same results as σi^2. Si^2 (Environmental variance) declared G2 (1V-11) as a stable genotype through sixteen environments because the value (Environmental variance)of G16 was lowest than other genotypes followed by G1 (1V-1), G3 (14C040), G13 (NR-487) and G14 (NR-488) declared as unstable genotype because it had largest value of Si^2 followed by G11 (NR-443), G15(NR-491)and G16 (NW-1-8183-8). Si^2 had positive association with CV, mean yield Y and negative association with σi^2, Wi2and GAI. It had identical association with Wi^2andσi^2.

Coefficient of variation (CV) declared G2 (1V-11) as a stable genotype through sixteen environments because it had low CV and high mean followed by G1 (1V-1), G3 (14C040), G10 (AZRC-20) and G14 (NR-488) declared as an unstable genotype because G7 (KT-325) G15 (NR-491) it had high CV and lowest mean yield. CV had positive association with Si^2 and negative association with σi^2, Wi^2.

REFERENCES

1. Ahmed A, Ahsan HJRJSS (2014) Contribution of services sector in the economy of Pakistan. 3 (1).
2. Chaudhry IS, Malik S, Ashraf MJPE, Review S (2006) Rural poverty in Pakistan: some related concepts, issues and empirical analysis.259-276.
3. Council Par (2017-18) Wheat Program-Pakistan agricultural research council. www.parc.gov.pk.
4. Fasahat, P., Rajabi, A., Mahmoudi, S. B., Noghabi, M. A., & Rad, J. M. (2015). An overview on the use of stability parameters in plant breeding. Biometrics & Biostatistics International Journal, 2(5), 00043.
5. Francis T, Kannenberg LJCJoPS (1978) Yield stability studies in short-season maize. I. A descriptive method for grouping genotypes. 58 (4):1029-1034.
6. hukla GKJB (1972) An invariant test for the homogeneity of variances in a two-way classification.1063-1072.
7. Nazli H, Haider SH, Hausladen S, Sheikh AT, Shafiq H, Shahzad S, Mehmood A, Shahzad A, Whitney E (2012) Pakistan Rural Household Panel Survey 2012 (Round 1). Citeseer.
8. Saima A, Zakir HJPE, Review S (2011) Impact of institutional credit on production efficiency of farming sector: a case study of district Faisalabad. 49 (2):149-162.
9. ul Haq Z, Gheblawi M, Muhammad SJTPDR (2011) The role of global economic growth in Pakistani agri-food exports.245-256.
10. Usman MJJoGE (2016) Contribution of agriculture sector in the GDP growth rate of Pakistan. 4 (2):1-3.
11. Wricke GJZp (1962) Uber eine Methode zur Erfassung der okologischen Streubreite in Feldverzuchen. 47:92-96.