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Evaluation of Exotic Rice Varieties for Genetic Parameters in a Nigerian Agro-Ecology

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Authors' contributions

This work was carried out in collaboration between all authors. Author OSO designed the work, carried out the research and wrote the draft of the manuscript. Author BOA and ACO supervised the research. All authors read and approved the final manuscript.

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ABSTRACT

Aim: The research focused on the performance of six exotic rice genotypes from Malaysian Agricultural Research and Development Institute (MARDI) in a Nigerian agro-ecology.
Study Design: The varieties were evaluated in randomized complete block design replicated three times.
Place and Duration of Study: The study was conducted at the research fields Crop, Soil and Pest Management, The Federal University of Technology Akure and Plant Science and Biotechnology Department, Adekunle Ajasin University, Akungba-Akoko, Ondo State, Nigeria during the rainy and dry seasons of 2012/2013.
Methodology: During the period the rice varieties were planted to test for their ability to adapt to a Nigerian eco-system. The characters measured include plant height, number of tillers/hill, effective tillers with panicle, tillers without panicle, flag leaf length, panicle length, panicle weight, number of grains per panicle, number of spikelet per panicle, 1000_grain weight, number of filled grains per panicle, number of unfilled grains per panicle, grain length, grain width, number of days to heading,

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number of days to maturity and grain yield per hill.
Results: Grain yield exhibited significant correlations with number of tillers per hill (0.733), effective tillers with panicle (0.826), panicle length (0.305) and panicle weight (0.339) which is a useful guide for selection in further breeding studies.
Conclusion: This study revealed the significant contributions of number of tillers per hill, effective tillers with panicle, panicle length and panicle weight as the sole determinant of total yield.

Keywords: MARDI; characters; Exotic rice; agro-ecology; correlations; selection.

1. INTRODUCTION

Consequent upon the stoppage of rice importation and the need to increase self-sufficiency level of rice production in Nigeria, efforts are being made by the Federal Government as part of her transformation agenda to strengthen agricultural production especially in rice farming as a result of its importance in the diets of her citizens. It is on this basis that every available crop land is being prepared for rice production utilizing lowland, upland, swamp and waterlogged agro ecologies.

Before now Nigeria is the second largest importer of parboiled rice from Asia throughout the continent of Africa, therefore, breeding work had been developed in ensuring that improvement of the local low yielding varieties is raised up with the incorporation of desirable qualities of the exotic varieties. Asian rice *Oryza sativa* had its peculiar characteristics in terms of aroma, slender grains and long, intermediate to high amylose content, medium to hard gel consistency with low alkali spreading value but high gelatinization temperature.

An information on genotype x environment interaction leads to successful evaluation of stable genotype, which could be used for general cultivation Umadevi et al. [1]. Yield is a complex quantitative character and is greatly influenced by environmental fluctuations, hence, the selection for superior genotypes based on yield per se at a single location in a year may not be very effective and thus, evaluation of genotypes for stability of performance under varying environmental conditions for yield has become an essential part of any breeding programme Osekita et al. [2]; Akinyele and Osekita [3].

An understanding of the causes of genotype x environment interaction can help in identifying traits and environment for better cultivar evaluation. Akinwale et al. [4] opined that yield components breeding to increase grain yield would be most effective, if the component involved are highly heritable and genetically independent or positively correlated with grain yield. However, knowledge of heritability is essential for selection based improvement as it indicates the extent of transmissibility of character into future generations Sabesan et al. [5]. Heritability in the broad sense is the proportion of genotypic variance that is due to phenotypic variance therefore; Singh et al. [6] reported that the estimate of heritability help the plant breeder in selection of elite genotypes from diverse gene population and this was seen in yield component traits Verma [7] and Anandrao et al. [8]. The phenotypic variance was higher than the genotypic variances for all the characters thus indicating the influence of environmental factor on these traits and this was reported by various workers Singh and Chakraborty [9], Devi et al. [10] and Prajapati et al. [11]. It was reported that grain yield per plant was significantly correlated with the number of panicles per plant and 1000_grain weight Sürek and Korkut [12].

Therefore, the present investigation was carried out to evaluate the performance of rice varieties from Asia in different environment of tropical Africa in particular Nigeria and to estimate the inherent high yielding status under similar conditions of optimum soil fertility and water regimes.

2. MATERIALS AND METHODS

2.1 Source of Materials

The experimental materials for the research work consist of varieties from Malaysian Agricultural Research and Development Institute (MARDI), Pulau Pinang, Malaysia. The genotypes are MR 269, MR 263, MR 253, MR 220, MRQ 74 and MRQ76.

2.2 Experimental Site

They were evaluated in a randomized complete block design with three replications at the research fields of The Federal University of Technology Akure in the Central region and Adekunle Ajasin University, Akungba-Akoko in the Northern region of Ondo State, Nigeria during the rainy and dry seasons of 2012/2013 cropping seasons.

2.3 Nursery Practice

The seeds were raised in the nursery after subjecting them to pre-germination test by soaking in water for 24-36 hours and incubated for another 24 hours before it is sown in the nursery.

2.4 Transplanting

Three weeks after sowing, the seedlings were transplanted into the field. The plot size used was 2 m x 2 m with spacing of 20 cm x 20 cm row to row and plant to plant with two seedlings per hill. The estimated plant density per hectare was 250,000 plants/ha. Recommended fertilizer application was done according to IRRI specification and adequate crop care was maintained especially water supply, pesticide application, weed and rodent control.

2.5 Soil Analysis

Prior to transplanting, soil analysis of the field was done and the results are as follows: P^H 6.4, organic matter 1.25%, total nitrogen 0.26%, phosphorus 3.89 ppm, CEC 3.45 cmol.kg^{-1} and EC 2.54 cmol.kg^{-1} to ascertain the suitability of the experimental field.

2.6 Data Collection

Data collections were taken on the following quantitative traits: Plant height, number of tillers/hill, number of productive tillers i.e. effective tiller with panicle (ETP), tiller without panicle, flag leaf length, panicle length, panicle weight, number of filled grains/panicle, number of unfilled grains/panicle, 1000_grain weight, grain length, grain width, number of days to panicle initiation, number of days to maturity and grain yield per hill.

2.7 Statistical Analysis

The data were subjected to statistical analysis using the general lineal model (GLM) procedure for randomized complete block design in SPSS 2.0 version. Phenotypic correlation coefficients were generated from the analyzed data, genetic advance as percent of mean and heritability in broad sense was computed to estimate the performance of the varieties.

3. RESULTS AND DISCUSSION

The mean performances of six exotic rice genotypes for seventeen agronomic traits were presented in Table 1. However, plant heights of the genotypes were moderate and not too short with the values ranging from 56.43 cm to 65.23 cm. The tillering ability was excellent with the least of 17 tillers per hill and this is effectively justified with the least effective tillers with panicle of 14 tillers per hill as observed in MR 269 and the highest of 26 tillers in MRQ 74. The flag leaf length significantly correlates with panicle length, with the least flag leaf length of 19.17 cm and 23.70 cm for the highest and this trait is responsible for panicle length formation at heading/booting stage of the rice plant. The number of days to heading, number of days to maturity and grain yield per hill were repeatable characteristics of the varieties of at least 82 days, 112 days and 25.17 g respectively. These traits must be selected for in yield improvement programmes. Similar results were obtained in the findings of Akinwale et al. [4], Osekita and Ajayi [13] and Akinyele and Osekita [3].

Genetic variability parameters for quantitative traits in rice were presented in Table 2; of which the combined analysis of variance revealed highly significant differences in all the characters measured. Hence, the heritability of the traits showed low, moderate and high values, although the heritability estimate for grain yield per hill was low probably because of the differences in the that the research was conducted and the environments the genotypes were subjected, the genotypes were supposed to be evaluated under irrigated lowland condition just like its own country but here in Nigeria it was partly upland and lowland situations with irrigation provided in the case of upland everyday. Genetic advance which is the total genetic gain of the genotypes over varying conditions, the least value was observed in grain length 0.05% and highest 22,87% in number of grains per panicle which is the target of the research for farmers economic returns.

Table 1. Mean perfomance of six exotic rice genotypes for seventeen agronomic traits

Genotypes	Plant height (cm)	No of tillers/ hill	Effective tillers with panicle	Tiller without panicle	Flag leaf length	Panicle length
MRQ 76	56.43	25.33	20.33	5.00	22.43	17.57
MR 269	65.23	17.00	14.00	3.00	23.70	20.23
MRQ 74	60.13	29.33	26.33	3.00	19.80	18.40
MR 220	61.67	28.67	21.67	7.00	19.17	20.17
MR 263	56.17	22.33	19.67	2.67	20.87	18.43
MR 253	60.07	24.67	15.33	9.33	19.67	18.83
GX	59.95	24.56	19.56	5.00	20.94	18.94
S.E	1.19	1.31	1.28	0.64	0.67	0.29
CV	7.8	17.4	21.4	22.6	13.1	4.8

Table 1 (cont'd)

Genotypes	Panicle weight(g)	No of spikelet/ panicle	No of grains/ panicle	1000_grain weight(g)	No of filled grains/ panicle	No of unfilled grains/panicle
MRQ 76	1.30	8.67	80.67	16.90	60.00	20.67
MR 269	1.83	9.00	98.67	18.90	63.00	35.67
MRQ 74	1.93	10.00	118.00	16.40	89.33	28.67
MR 220	1.87	9.33	105. 33	17.80	82.00	23.33
MR 263	2.00	10.00	116.33	17.20	80.67	35.67
MR 253	1.63	10.00	114.00	17.50	89.33	24.67
GX	1.76	9.50	105.50	17.45	77.39	28.11
S.E	0.09	0.15	3.58	0.20	4.00	2.42
CV	19.6	3.5	8.2	1.6	18.4	35.3

Table 1 (cont'd)

Genotypes	Grains length(cm)	Grain width cm)	No of days to heading	No of days to maturity	Grain yield/hill (g)
MRQ 76	0.83	0.20	66.00	95.33	21.57
MR 269	0.80	0.20	71.67	102.33	17.20
MRQ 74	0.90	0.30	89.67	119.67	35.33
MR 220	0.80	0.20	84.67	115.33	30.83
MR 263	0.80	0.30	89.00	119.67	26.37
MR 253	0.83	0.20	89.67	119.67	19.73
GX	0.83	0.23	81.78	112.00	25.17
S.E	0.01	0.01	2.31	2.35	1.86
CV	3.8	0.0	1.7	1.2	20.8

The phenotypic correlations among the component traits showed the appearance of agronomic and yield components as it was observed on the field. Table 3 revealed that grain yield/hill positively and significantly correlates with number of tillers/hill (0.733). This was in line with the result of Akinwale et al. [4].

Effective tillers with panicle (0.826) was corroborated by the result of Sharma et al. [14] and Bai et al. [15] on panicle weight (0.305), number of grains per panicle (0.339) and number of spikelet per panicle (0.445). The work of Prasad et al. [16] also confirms these result, number of filled grains per panicle (0.328), grain length (0.407), grain width (0.524), number of days to heading (0.434) and number of days to maturity (0.443) but had negative and highly significant correlation with 1000_grain weight (-0.586). The flag leaf length which shows the degree of light transmission into the rice plant is a yield enhancing factor and is rightly positioned for photosynthetic process, this trait significantly correlate positively with panicle length (0.302) and number of unfilled grains per panicle (0.363), meanwhile, it negatively and significantly correlates with panicle weight (-0.413), number of filled grains per panicle (-0.498), number of days to heading (-0.484).

The graphical presentation of some of the yield component traits were presented in Fig. 1 above. The number of tillers had a mean performance ranging from 17.5 to 28.5, the flag leaf length with mean values from 19 to 23, effective tillers per panicle 15 to 27 across the varieties number of grains per panicle ranged from 80 to 120, 1000_grain weight 16.5g to 19.0 g and grain yield 16.5 g to 35 g per hill, based on the mean performance of the grain yield it was estimated that the mean yield per hectare of each of the genotypes ranged from 4.3 metric tons to 8.8 metric tons this shows the degree of similarity with the Malaysian agro-ecology with average yield of 4.5 metric tons to 8.5 metric tons.

The path diagrams in Fig. 2 below shows the direct and indirect contribution of the components of yield on grain yield. Though correlation analysis indicates the association pattern of the components traits with yield, they simply represent the overall influence of a particular trait on yield rather than providing cause and effect relationhip. It does not give an exact position of the relative importance of direct and indirect effects of various yield attributes. The path coefficient analysis, a method developed by Wright [17] and demonstrated by Dewey and Lu [18] as well as Akinyele and Osekita [3] is a potent and efficient technique in this regard. The direct and indirect effects of four characters on grain yield revealed that out of the four characters; effective tillers with panicle, panicle weight and panicle length where their correlation with grain yield were significantly high and positive except number of unfilled grains per panicle which is negative. This indicates that the characters which had positive direct path and correlations with grain yield had true relationship and direct selection for this characters is the desirable direction for improvement of rice.

Table 2. Genetic variability parameters for quantitative traits in rice

Characters squares	Mean squares	Vg	Ve	Vp	GCV	PCV	h^2B	GA	GAM
Plant height (cm)	34.55**	7.28	21.85	29.13	4.50	9.01	25.0	2.78	4.64
No of tillers/Hill	61.42**	14.38	18.28	32.66	15.48	23.33	44.0	4.38	17.87
Effective Tillers/panicle	59.82**	14.13	17.44	31.57	19.28	28.81	44.8	5.21	26.72
Tillerswithout panicle	21.73**	6.82	1.20	8.10	52.23	56.92	84.2	4.93	98.5
FlagLeaf length (cm)	9.55**	0.68	7.52	8.20	3.94	13.68	8.3	4.89	23.35
Paniclelength (cm)	3.37**	0.85	0.83	1.68	4.88	6.86	50.6	1.36	7.21
Panicle Weight (g)	0.20**	0.03	0.12	0.15	9.84	22.01	20.0	1.60	90.91
No of spikelet /panicle	1.03**	0.31	0.11	0.42	5.86	6.82	73.8	1.00	10.32
No of grains /panicle	605.57**	117.06	74.39	251.45	12.61	15.03	70.4	22.87	21.68
1000_grain weight (g)	2.22**	0.71	0.08	0.79	4.89	5.08	89.9	1.65	9.42
No of filled grains/panicle	496.06**	98.13	201.67	299.80	12.80	22.37	32.7	11.78	15.21
No of unfilled grains/panicle	122.76**	8.20	98.17	106.37	10.20	36.70	7.7	1.70	6.05
Grain length (cm)	0.01**	0.00	0.00	0.00	3.81	5.39	50.0	0.05	6.21
Grain width (cm)	0.01**	0.00	0.00	0.00	19.44	19.44	100.0	0.10	43.48
No of days to heading	321.69**	106.6	1.89	108.5	12.62	12.73	99.1	21.24	25.97
No of days to maturity	335.20**	111.18	1.67	112.85	9.42	9.49	98.5	21.67	19.34
Grain yield/Hill (g)	145.72**	39.41	27.49	66.89	24.94	32.49	58.9	9.94	39.49

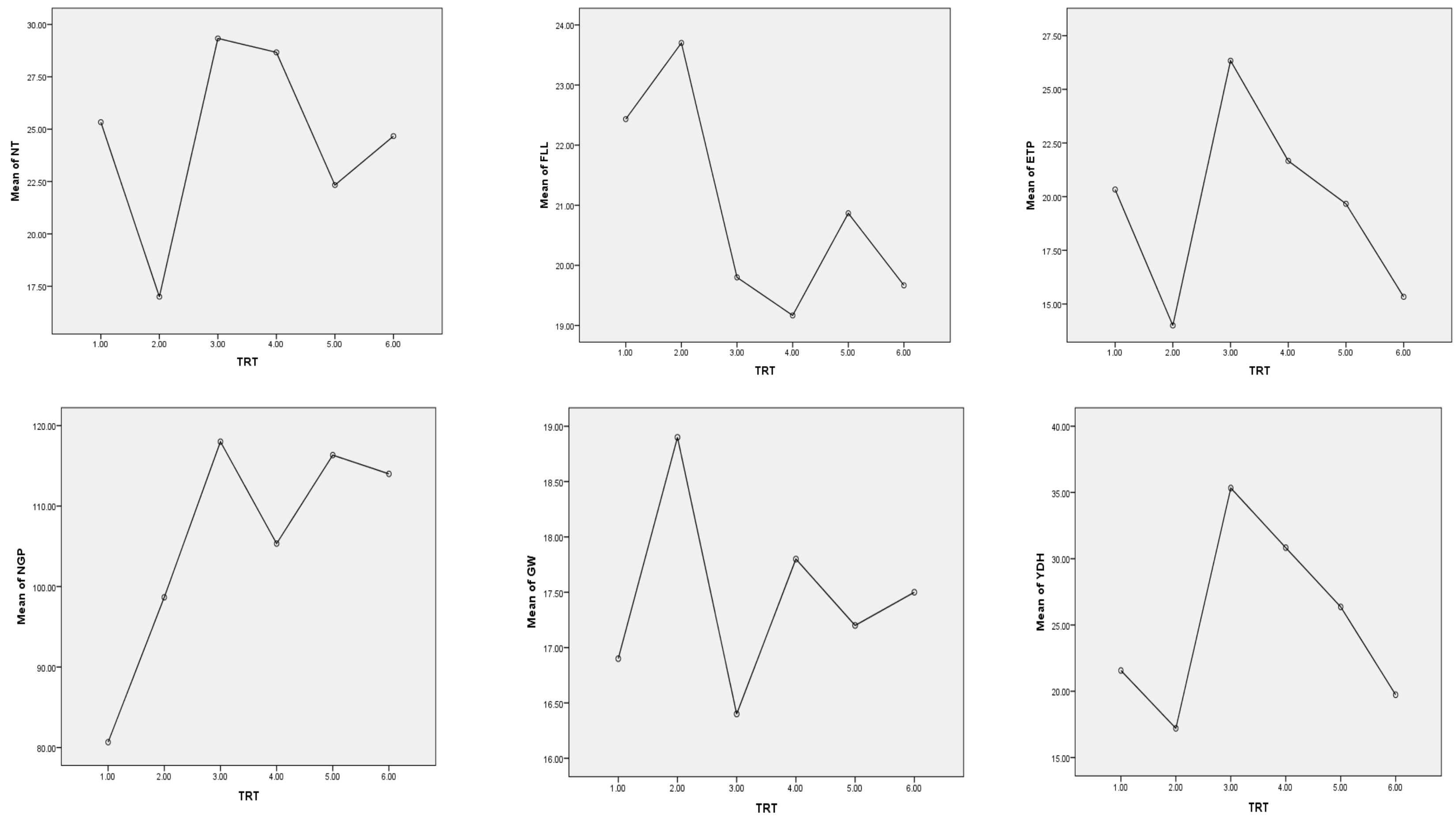

Fig. 1. Graphical presentation of some yield components

Table 3. Phenotypic correlation coefficients among agronomic and yield component traits

Characters	PLTHT	NT	ETP	TWP	FLL	PANL	PAWT	NGP	NSPP	1000_WT	NFGP	NUFGP	GLT	GWDT	NDTH	NDM	GYD/H
Plant height(cm)		0.135	0.178	-0.083	0.615**	0.793**	-0.110	0.148	-0.031	0.407**	-0.047	0.296**	-0.054	-0.259	0.061	-0.037	0.101
No of tillers/hill			0.880**	0.278**	-0.033	-0.017	-0.230	0.090	0.359**	-0.579**	0.168	-0.143	0.280	0.167**	0.296	0.293	0.733**
Effective tillers with panicle				-0.211	0.152	-0.038	-0.103	0.105	0.313**	-0.612**	0.029	0.107	0.379**	0.458**	0.211	0.215	0.826**
Tiller without panicle					-0.376**	0.043	-0.265	-0.026	0.106	0.047	0.286**	-0.511**	-0.189	-0.584**	0.182	0.168	-0.163
Flag leaf length (cm)						0.302**	-0.413**	-0.311	-0.225	0.251	-0.498**	0.363**	-0.085	-0.155	-0.484**	-0.459**	-0.137
Panicle length (cm)							-0.018	0.216	-0.034	0.593**	-0.079	0.190	-0.334**	-0.302**	0.065	0.105	0.032
Panicle weight (cm)								0.446**	0.340**	0.084	0.179	0.364**	-0.036	0.396**	0.435**	0.446**	0.305**
No of grains/panicle									0.742**	-0.152	0.802**	0.153	0.198	0.559**	0.848**	0.839**	0.339**
No of spikelet/panicle										-0.357**	0.541**	0.204	0.310**	0.588**	0.835**	0.848**	0.445**
1000_grain weight(g)											-0.320**	0.304**	-0.615**	-0.563**	-0.299	-0.270	-0.586**
No of filled grain/panicle												-0.468**	0.301**	0.326**	0.695**	0.668**	0.328**
No of unfilled grains/panicle													-0.206	0.287**	0.105	0.136	-0.040
Grain length (cm)														0.351**	0.184	0.166	0.407**
Grain width(cm)															0.561**	0.558**	0.524**
No of days to heading																0.997**	0.434**
No of days to maturity																	0.443**
Grain yield/hill																	

***Significant at P=0.01*

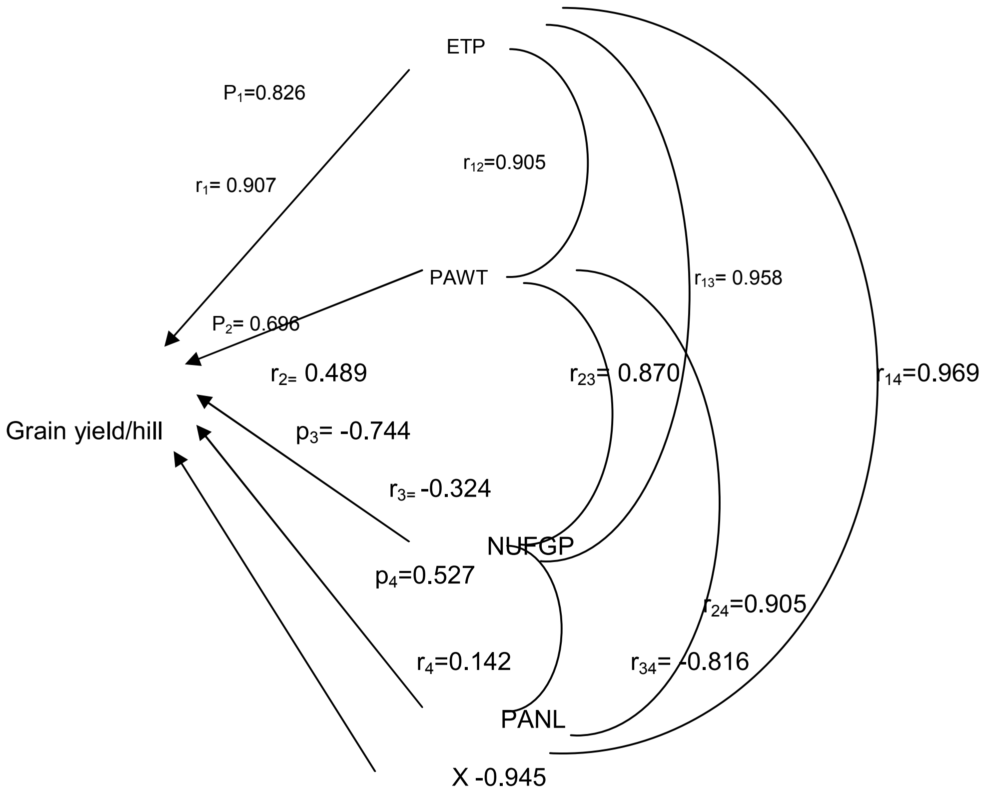

Fig. 2. Path diagram for yield and its components

4. CONCLUSION

The present findings indicated that the yield component traits contributed immensely to total yield in all the plot evaluated for the research work this is so because the mean performance of the agronomic traits out yielded the varieties in comparison to what obtains in their country of origin this is as a result of the components of the edaphic factors that supports it growth and yield.

From the results, the degree of association of grain yield per hill which significantly correlates with number of tillers per hill, effective tillers with panicle, number of grains per panicle, grain length, grain width, number of days to heading and days to maturity is an indication that this traits operates in an additive fashion that in totality contributed significantly to yield and selection for improvement breeding programmes could based on this yield component traits. The Path analysis reveals the direct and indirect contributions of yield component traits and it goes further to partition them into cause and effect mechanisms which was seen in the results,and with a very high residual factor although negative. Therefore, for subsequent breeding programme the following yield component traits should be focused on tillers per hill, effective tillers with panicle, panicle length and panicle weight.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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