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EVALUATION OF SPRING WHEAT VARIETIES FOR YIELD IN THE SEMI-ARID ENVIRONMENTS IN NIGERIA

BY
Yakubu Yahaya: Lake Chad Research Institute, Maiduguri, Borno State, Nigeria;
E-mail: dryahayayakub@gmail.com

Bashir Alhaji Baba: Lake Chad Research Institute, Maiduguri, Borno State, Nigeria;
E-mail: bashir5880@gmail.com

Kachalla Kyari Mala: Lake Chad Research Institute, Maiduguri, Borno State, Nigeria;
E-mail: kkmala507@gmail.com

Alhaji Sheriff Wali: Lake Chad Research Institute, Maiduguri, Borno State, Nigeria;
E-mail: walisheriff@gmail.com
&
Kyari Alkali: Lake Chad Research Institute, Maiduguri, Borno State, Nigeria;
E-mail: kyarialkali@gmail.com

Abstract
*This study evaluates spring wheat varieties for yield in twelve locations of the semi-arid zone, Nigeria. Treatments were laid out in a randomized complete block design with three replications. The results indicate that mean flowering dates across location were 61, 68, 62, 57 and 70 DAS for Kirenowa, Jigawa. Kano. Sokoto and Kadawa respectively. Grain yield, show that there was no significant difference among the wheat lines tested in all locations except Jigawa. The genotype Kauz*2/Bows/Kauz and Kauz/Bow/mkt are very promising heat tolerant materials across the wheat growing zone. These two varieties are therefore recommended for further testing on-farm trial.*
Keywords: Spring Wheat, Varieties, Yield, Semi-Arid and Nigeria

Introduction
Wheat (Triticum aestivum L.), although a temperate crop has been grown in Nigeria from early times. It has been restricted to River basins and Fadama in the Northern part of Nigeria and grown during the short cool season (November - March) under irrigation conditions. Wheat production level in Nigeria has been very low, in fact up to 1985; domestic wheat production was about 66,000 tons. However, in 1988/89 wheat season, about 600,000 tons of wheat was reported to have been produced from a total area of 214,000 hectares with an average yield of 2 tons per hectare (Olugbemi, 1991). This shows an increase of over ten times the 1985 production figures before the wheat ban. The Country requires about 3.7 million metric tons of wheat annually (Food and Agriculture Organization (FAO) 2006). However, since the oil shock of last quarter of 2014 up to 2016, wheat farming is attracting policy makers who see Nigeria's capacity in wheat production to be self-sufficient (Klynveld, Peat, Marwick and Goerdeler (KMPG), 2016; Sinclair and Jamieson, 2006). Abah and Ochoche (2021), lamented that, local wheat production remained inadequate. Though, the production remains low at 60,000MT in 2016 (KPMG, 2016; Dambazau *et. al.* (2021). The country produced 67,000MT of wheat in 2017 (Knoema, 2019).

This is an indication that the demand for local wheat far exceeds its supply. High temperature, especially during grain filling is considered the major environmental factor drastically reducing wheat production in the semi-arid environment. In Nigeria, wheat production is characterized by high temperature, heat stress, and water for irrigation. Therefore, pre-release trials; be carried out across the wheat growing zones of the country to select specific and broadly adapted stable wheat varieties. Consequently, most of the area suffers from late heat stress resulting in yield reductions. Therefore, developing high yielding wheat varieties tolerant to heat stress is a very important study to increase wheat productivity in Nigeria.

The purpose of this study is to evaluate wheat varieties for high yield, heat tolerance and other good agronomics characters. Lines that are heat tolerant and good agronomics characters are selected for production that will

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enhance national production, reduce total dependence on imports, conserve foreign exchange, and contribute towards poverty reduction.

Methodology

Twelve wheat lines from International Maize and Wheat improvement Center Mexico (CIMMYT) were evaluated in wheat growing zones in Nigeria; Kirenowa in Borno State. Kadawa in Kano State, Bimin Kudu in Jigawa state, Kano State Agricultural and Rural Development Authority (KNARDA) in Kano State and Usman Danfodio University in Sokoto State. Treatments were laid out in a randomized complete block design with three replications. Plot size was 5m x 3m. The seeds were dressed with apron-star and planted late November to end of December in all locations except Kano where planting was done in early January. The seeds were drilled at 30cm apart at seed rate of l00kg/ha and fertilizer rate of 100 kgN, 40kg K_2O were applied. All treatment received 50kgN, 40kg P_2O_5 and 40kg K_2O/ha as basal application. The balance of 50kgN/ha was applied four weeks after sowing.

The data collected were subjected to analysis of variance. The various treatment means were compared using least significant difference (LSD). The sowing date of the trials at each location is presented in Table 1

Table 1: ***Dates of Sowing Bread Wheat in the Respective Locations during the 2008/2009 Dry season***

Location	Kirenowa	Jigawa	Kano	Sokoto	Kadawa
Sowing	2/12/08	10/12/08	22/1/09	23/12/08	8/12/08

Results

The yield and yield components of bread wheat as affected by genotypes and environment are presented in table 2. The results indicate that mean flowering dates across location were 61, 68, 62, 57, and 70 DAS for Kirenowa, Jigawa, Kano, Sokoto and Kadawa respectively. The mean plant height varied from 37.8 to 87.1cm across location, with Kirenowa materials being tallest and entries from Kano were the shortest. On grain yield, there was no significant yield difference among the wheat lines tested in all locations except Jigawa (Table 2). At Jigawa, Embrapa-22 gave the highest yield (3016.7kg/ha) while the lowest yield was SERI-M82 (2433.3kg/ha GEXE/RABE, KAUZ*2/BOW/S/KAUZ, BRS 207 and HD2206/HORK were the highest yielding lines in Kirenowa, Kano, Sokoto and Kadawa respectively. Variation among genotypes across locations was higher which may be due to climatic conditions and soil characters.

Discussion

The combined analysis of variance indicated significant ($P<0.05$) variety, location and variety x location interaction for 50 days to flowering, plant height and number of seeds per spike. (Table 3). Genotypes show no significant difference in the grain yield (Table3). The mean flowering dates across location were 61, 68, 62, 57 and 70 DAS for Kirenowa, Jigawa, Kano, Sokoto and Kadawa respectively. Plant height ranged from 37.67cm to 87.14cm across location with Kirenowa and Kano recording the tallest and shortest plant height. The number of seeds per spike was significantly higher at Kadawa than other locations. However, there was no significance difference in plant height between Jigawa and Kano locations. Some lines from Kano flowered earlier and were shorter which may be as a result of heat stress resulting from late planting.

Table **3:** ***Combined data for days to 50% flowering, plant height, Number of seeds per spike, and grain yield of twelve varieties of bread wheat grown in five locations during 2008/2009 dry season.***

S/N	GENOTYPE	FLD	PHT	GN	GYLD
1	HD 2206/HORK	64	71.91	41.93	2166.4
2.	HD 2329/SABUF	66	65.75	40.73	2172.7
3	KAUZ/WEAVER	64	69.89	38.33	2030.8
4	KAUZ *2/BOWS/KAUZ	64	65.93	39.67	2317.6
5	STAR //TR 77173/SLM	63	75.49	42.93	2202.3
6	GENE/RABE	65	70.80	39.67	2457.4
7	SERI/BUC/WEAVER/STAR	65	70.89	39.93	2157.6
8	Mean	63.6	70.76	40.39	2075.1
9	SE+	0.3	0.87	1.08	1546.0

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10	LSD(0.05)	**	**	**	2048.3
11	EMB RAPA-22	62	71.49	41.07	2065.4
12	EMB RAPA-42	62	72.02	38.00	1921.9
	Mean	64	70.76	40.39	2096.8
	SE+	0.53	1.34	1.67	119.68
	CV (%)	3.20	7.35	16.06	22.11
	LSD(0.05)	**	**	**	NS
Location					
	Mean	63.6	70.76	40.39	2096.8
	SE+	0.3	0.87	1.08	77.26
	LSD(0.05)	**	**	**	NS
Interaction					
	V x L (Variety * Location)	**	**	**	NS

The interaction between genotypes and locations on 50 days to flowering of wheat was very significant (Table 4). Seri M82. Embrapa22 and Embrapa-42 flowered early at Kirenowa and Sokoto locations than genotypes from other locations. The lines planted at Kadawa flowered later than lines from other locations.

Table 4: ***Interaction between treatments and locations on days to flowering of Bread wheat in 2008/2009 dry season***

S/N	TREATMENT	Kirenowa	Jigawa	Kano	Sokoto
1.	HD 2206/HORK	64	67	64	53
2.	HD 2329/SABUF	66	69	63	59
3,	KAUZ/WEAVER	63	68	61	58
4.	KAUZ *2/BOWS/KAUZ	61	66	60	60
5.	STAR//TR 77173/SLM	60	68	61	54
6.	GENE/RABE	63	68	62	59
7.	SERI/BUC/WEAVER/STAR	62	69	63	60
8.	KAUZ/BOW/MKT	61	67	59	59
9.	SERI M82	55	67	64	50
10.	BRS 207	64	68	63	60
11.	EMBRAPA-22	56	69	61	56
12.	EMBRAPA-42	56	68	61	56

Interaction between treatments and locations on the plant height of wheat was significant (Table 5) Seri M82, Embrapa-42, Gene Rabe and STAR//TR 77173/Slm were tallest in all locations. However, the materials from Kano were very dwarf which may be due to the environmental stress as a result of late planting.

Table 5: ***Interaction between treatments and locations on the plant-height of wheat in 2008/2009 dry season***

S/N	TREATMENT	Kirenowa	Jigawa	Kano	Sokoto	Kadawa
1.	HD 2206/HORK	88.30	87.33	33.00	65.00	85.87
2.	HD 2329/SABUF	80.67	89.33	33.00	50.33	75.43
3.	KAUZ/WEAVER	87.33	79.67	53.00	48.67	80.77
4.	KAUZ *2/BOWS/KAUZ	77.67	80.00	37.00	55.00	80.00
5.	STAR //TR 77173/SLM	88.33	85.00	52.00	63.00	89.10
6.	GENE/RABE	88.33	85.67	34.67	52.67	92.67
7.	SERI/BUC/WEAVER/STAR	87.00	89.33	35.00	56.00	87.13
8.	KAUZ/BOW/MKT	78.00	79.67	39.67	53.67	72.90
9.	SERI M82	105.67	95.00	31.67	77.33	107.30
10.	BRS 207	85.33	78.33	30.00	59.00	81.37
11.	EMBRAPA-22	87.67	84.67	38.33	60.00	86.80
12.	EMBRAPA-42	91.33	85.00	34.67	67.67	81.43

Similarly, interaction between treatments and locations on number of seeds per spike of wheat was significant (Table 6). HD2206/horks, kauz*2/Bows/Kauz, Kauz/Bow//mkt and STAR//TR/77173/Slm gave the highest number of seeds per spike at Kirenowa and kadawa respectively, while Kauz*2/Bows/kauz and Seri M82

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recorded the least at Kano. When the two year data were pooled (Table 6) Kauz*2/bows/Kauz, Kauz/Bow/Mkt and HD 2329/Sabuf gave the highest yield of 2498.8 and 2342.5 kg/ha respectively.

Many criteria for heat tolerance or evidence were reported by Ehleringer (1980); Freitas *et al* (2006); Asthir (2015b); Cossani and Reynolds (2012) and Langridge and Reynolds (2021) that gave number of seeds per spike, grain yield, from period of emergence to flowering and leaf pubescence as major criteria for heat tolerance. In this present study, the two year data show that kauz*2Bows/Kauz, Kauz/Bow/Mkt and HD2329/Sabuf were the highest yielders, while only kauz/Bow/Mkt flowered earlier than others that are medium maturing. These results indicated that grain yield and number of grains per spike may be used for selection parameters for terminal heat stress. Kamla *et. al* (2013). Sinclair and Jamieson (2006) and Philipp *et. al.* (2018) found similar results when screening genotypes under early and terminal heat stress.

Title 6: ***Interaction between treatments and locations on the number of seeds per spike of bread wheat in 2008/2009 dry season***

SN	GENOTYPE	KIRENOWA	JIGAWA	KANO	SOKOTO	KAAWA
1	HD 2206./HORK	50.67	33.33	36.00	48.33	41.33
2	HD 2329/SABUF	41.33	38.67	36.00	46.00	41.67
3	KAUZ/WEAVER	44.33	29.33	39.00	34.33	44.67
4	KAUZ *2/BOWS/KAUZ	48.00	36.67	29.67	39.67	44.33
5	STAR //TR 77173/SLM	36.33	37.67	47.67	50.00	43.00
6	GENE/RABE	36.33	37.00	39.00	41.00	45.00 1
7	SERI/BUC/WEAVER/STAR	41.33	37.00	38.67	44.33	38.33
8	KAUZ/BOW/MKT	49.67	36.67	37.00	45.00	59.00
9	SERI M82	29.67	36.33	30.00	37.33	37.3
10	BRS 207	41.67	34.67	40.00	50.67	52.00
11	EMBRAPA-22	42.00	38.00	38.67	42.67	44.00
12	EMBRAPA-42	35.00	36.00	33.67	42.00	46.67

Conclusion

The genotype Kauz*2/Bows/Kauz and Kauz/Bow/mkt were the most promising heat tolerant materials across the wheat growing zone in Nigeria.

Recommendations

i. These two varieties are therefore recommended for on-farm trial
ii. The on farm trial of the promising varieties should be evaluated with the farmers' varieties as check.
iii. The varieties that have performed better than the farmers varieties should recommended for release

References

Abah, D, and Ochoche, O.C (2021). Trend Analysis of Wheat Production in Nigeria (1981-2018): Impact on Agricultural Output International. *Journal of Advances in Engineering and Management* (IJAEM) Volume 3, Issue 3 Mar. 2021, pp: 871-878 www.ijaem.net ISSN: 2395-5252

Asthir B. (2015b). Protective mechanisms of heat tolerance in crop plants. *Journal of Plant Interactions* 10: Pp 202-210.

Cossani CM and MP Reynolds. (2012). Physiological traits for improving heat tolerance in wheat. *Plant Physiology* 160:1710-1718.

Dambazau, S. A., Jayasree, K. M. and Tajuddeen, B. (2021). A Contemporary issues of wheat production in Nigeria: A review 1. https://www.researchgate.net/publication/357015563. *Western Balkan Journal of Agricultural Economics and Rural Development·* December 2021

Ehleringer, J. (1980). *Leaf Morphology and reflectance in relation to water and Temperature strees*. In pages 95 - 308. Ed. N. C. Turner and P. J. Kraner. Adaptation of plants to water and high temperature stress. John Willey and Sons inc.

FAO (2006). Food and Agriculture Organization, FAOSTAT, http://faostat.faoorg/site/567/default.aspx#ancor

Freitas, M. S., Misztal, J., Bohmanova, H and West, H. (2006). Utility of on-and off-farm weather records for studies in genetics of heat tolerance. *Livest. Sci*. 105:223–228. doi:10.1016/j.livsci.2006.06.011

ISSN 2705-2559
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https://doi.org/10.1016/j.fcr.2005.12.006

Kamla, D., Mohammad, W. A., Yalaga, R. R., Radhey, S. V., Alok, S., Narendra, T. (2013). Comparative physiological response of wheat genotypes under terminal heat stress. *Plant Signal Behavior*. 2013 Jun;8(6):e24564. doi: 10.4161/psb.24564.

Knoema.com (2019b). *Nigerian wheat imports quantity*, 1960-2019 [online]. Available:https://knoema.com/atlas/Nigeria/topics/Agriculture/Trade-Import-Qu. [10th September, 2022]

Klynveld, Peat, Marwick and Goerdeler. (2016). Wheat based consumer foods in Nigeria. [Online]. Available: https://home.kpmg/ng/en/home/insights/2 016/08/wheat-based-consumer-foods-innigeria.html. [12.9.2022] Nigeria%E2%80%99sDiversification-Strategy/39427. [16th September, 2022)

Langridge, P and Reynolds M. (2021). Breeding for drought and heat tolerance in wheat. *Theor Appl Genet*. (2021) Jun; 134 (6):1753-1769. doi: 10.1007/s00122-021-03795-1. Epub 2021 Mar 14. PMID: 33715017.

Olugbemi, L. B. (1991). *Wheat Cultivation in Nigeria: Problems, Progress and Prospects*, in pages 525-529 ed. Sanders, A. Wheat for the Nontraditional warm area, Mexico, D.F. CIMMYT

Philipp, N., Weichert, H., Bohra, U., Weschke, W., Schulthess, A.W., Weber, H. (2018) Grain number and grain yield distribution along the spike remain stable despite breeding for high yield in winter wheat. *PLoS ONE* 13(10): e0205452. https://doi.org/10.1371/journal.pone.0205452

Sinclair, T.R. and P.D. Jamieson (2006). Grain number, wheat yield, and bottling beer: An strategy. *Field Crops Research* Volume 98, Issue 1, 1 July 2006, Pages 60-67