YIELD AND YIELD COMPONENTS OF SOYBEAN [*GLYCINE MAX* (L.)MERRILL] VARIETIES AS AFFECTED BY OSMO-PRIMING AT BAGAUDA, SUDAN SAVANNA

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ABSTRACT
Response of soybean varieties to hydro priming duration were investigated under field condition at the Research Farm of the Faculty of Agriculture, Kano University of Science and Technology, Wudil located at Bagauda in 2018 rainy season. The treatment consisted of four improved soybean varieties (TGX-1835, TGX-1904, TGX-1951 and TGX-1955) and four priming duration (0hour (dry seed or control), 4hours, 6hours and 8hours) respectively, they were combined and laid out in a randomized complete block design (RCBD) and replicated three times. The varieties tested differed significantly, the result showed that Soybean varieties TGX-1904 and TGX-1955 proved superior in terms of stand counts, plant heights, leaf number per plant, leaf area, and number of pods, grain yield and stover yield compared to varieties. Also, priming duration has significant effect on both crop growth and yield parameters investigated. The highest value was obtained at 8 hour priming duration, where TGX-1904 and TGX-1951 recorded superior growth and yield parameters compared to TGX-1835 and TGX-1955. From the foregoing, therefore, it is recommended that, priming duration of 8 hours with varieties TGX-1904 and TGX-1955 is recommended for farmers in the area for good crop yield.
Keywords: **Agro-ecology; Osmo-priming;;** TGX-1955; **Sudan Savannah; Stover; Yield;**

INTRODUCTION
Soybean (*Glycine max* [L.] Merr.) is one of the major legume crops in sub-Saharan Africa. The plant originated in Asia, where it has two wild relatives (Carpenter and Gianessi, 2000).It later spread to Europe, America and other parts of the world in the 18th century (Ngeze, 1993). Worldwide, 155 million metric tonnes of soybeans are presently grown. The United States is the highest producer of soybean with approximately 38% of the world output, followed by Brazil (25%), Argentina (19 %), China (7 %), India (3 %), Canada (2 %), and Paraguay (2 %), while output from all other countries was about 4 % of the overall (ASA, 2007). Soybean is beneficial in cereal cropping system because it contributes substantially to soil fertility (Yusuf *et al*., 2006). It is used to supplement cereals food stuff in many instances because cereals have low protein contents and are imbalanced in essential amino acid composition. Studies have shown that cereal grains do not supply adequate protein for satisfactory growth of infants and children or for the bodily maintenance of adults (Singh *et al*., 2008). Consequently, soybean protein has been the subject of intense investigation and has played an increasing role in human nutrition over the last few decades (Riaz, 2001).

Soybean seeds are rich in alpha-linolenic acid, omega-6 fatty acid and the isoflavones, genistein and daidzein (Song *et al*., 1998). Dry soybean contains 36 % protein, 19 % oil, 35 %

carbohydrate, 5 % minerals and several other components such as vitamins (Liu, 1997), isoflavones and saponins. In addition, soybean contains a significant amount of calcium, iron, zinc, phosphorus, magnesium, thiamine, riboflavin, niacin and folic acid (Kanchana *et al.*, 2016).Nigeria is the largest producer of soybean in sub-Saharan Africa (SSA) but yield per unit area is usually low. According to FAO (2013), about six million tonnes of soybeans were produced in Nigeria in 2013, from 6 million hectares of land. Low productivity of the crop has been partly attributed to seed viability and poor germination. The use of high quality seed with appropriate seed rate is essential to establish a suitable plant population in a soybean field for better returns. Vigorous seeds germinate rapidly, uniformly and are able to withstand environmental adversity after sowing (Ajouri *et al*.,2015).

Osmopriming or seed priming is a water based process that is carried out on seeds to increase uniformity of germination and emergence, and enhance plant establishment. It entails the partial germination of seeds by soaking them in water (or in a solution of salts) for specified period of time, and then re-dry them just before radicle emerges (Rajjou *et al*., 2012). Priming stimulates many of the metabolic processes involved with the early phases of germination. Given that part of the germination processes have been initiated, seedlings from primed seed grow faster, grow more vigorously, and perform better in adverse conditions (Paparella *et al.,* 2015). The duration of the emergence period is decreased, leading to more uniform plant stand (Carciochi *et al*., 2019).

Rapid germination and emergence is an important factor of successful establishment. It is reported that seed priming is one of the most important developments to help rapid and uniform germination and emergence of seeds and to increase seed tolerance to adverse environmental conditions (Lewandowska *et al*., 2020). Seed priming has presented promising, and even surprising results, for many seeds including the legume seeds (Michalak *et al*., 2018). The few studies on soybean are not overemphasized and are encouraging, but more information is required before its use as a routine practice in seed technology (Paparella *et al*., 2015). New varieties of soybean have been developed and released for cultivation NCRI, (2018). It is of interest to determine appropriate priming duration for these varieties with the aim of obtaining maximum yield of the crop and also increased economic value for the farmers in the study area. Therefore, this study determined the yield and yield components of soybean [*Glycine max* (L.) merrill] varieties as affected by osmo-priming at Bagauda, Sudan Savanna Agro-**ecological zone of Nigeria.**

MATERIALS AND METHODS

Field experiments was conducted during the 2018 rainy season at the Research Farm of the Faculty of Agriculture, Kano University of Science and Technology, Wudil located at Bagauda, Bebeji local government (11^0. 14 and 738. 8038' with an altitude of 475 m above mean sea level). It has the tropical wet and dry type (tropical continental climate type) classified by Koppen as Aw climate. Rainfall is between May and September with a peak in August. The average annual rainfall is about 700 mm. The pattern of rainfall in the area is highly

variable. This can result in severe and widespread droughts that can impose serious socio-economic constraints (Abaje and Iguisi, 2012). The mean annual temperature ranges from 29 °C – 31 °C. The highest air temperature normally occurs in April/May and the lowest in December through February. Evapo-transpiration is generally high throughout the year. The highest amount of evaporation occurs during the dry season. The vegetation of the area is the Sudan Savanna type which combines the characteristics and species of both the Guinea and Sahel Savanna (Abaje and Iguisi, 2012; Tukur *et al*., 2013).

Treatments, Experimental Design

The treatments consists of four improved soybean varieties (TGX-1835, 1904, 1951 and TGX-1955) and 4 priming duration 0hour (dry seed or control), 4hours, 6hours and 8hours respectively, these were combined in factorial and laid out in a randomized complete block design (RCBD) and replicated three times. Samples of 5kg each of the soybean variety was placed in a container and soaked in tap water of pH 6.5 according to treatment specifications i.e (2hour intervals for 8 hours). The seeds were dried superficially afterwards.

Cultural Practices

The land was cleared and harrowed thoroughly to obtain fine tilth soil when the rain was fully established. Ridges were made at 0.75m apart using tractor mounted ridger. Each plot consisted of 6 ridges with 0.75cm apart, the size of each of the plot were 6 by 3m. Two seeds were initially sown per hole at 3cm soil depth and 5cm intra-row spacing and latter thinned to one plant per stand at two weeks after sowing. Single super phosphate (18% P_2O_5) was applied at the rate of 40kg P_2O_5 per hectare. The weeds were controlled manually using hoes at 3 and 6 weeks after sowing (WAS). Careful observation of disease was considered although, no any serious threat was observed. When pods reached physiological maturity, harvesting was conducted immediately to avoid losses through shattering using cutlass. Threshing was conducted immediately after the harvest. The inner rows were harvested as net plot. Crop data such as stand count, plant canopy height, branches per plant, leaf area, number of pods per plant harvest index and stover yield were collected from the plants within net plot (five plants were selected at random). Data collected on all measured parameters were subjected to Analysis of Variance (ANOVA) as described by Snedecor and Cohran (1967). Means were separated using Duncan Multiple Range Test [DMRT] (Duncan, 1955).

RESULTS

Effects Variety and Seed Priming Duration on growth components of Soybean

Stand count and canopy height

The effect of variety and priming duration on stand count of Soybean is shown on Table 1. At full emergence (7 days after sowing) result obtained showed significant differences ($P < 0.05$) among the varieties tested with soybean variety TGX-1904having significantly ($P < 0.05$) highest mean stand count followed by TGX-1955 and TGX 1835 whereas the least was obtained from TGX-1951. Priming duration at 0hour (control) and 8hours gave significantly ($P < 0.05$)

highest stand count. There was no significant interaction between the varieties and priming duration.

Result of the study also differed significantly ($P < 0.05$) in respect to plant canopy height at different growth stages. At 4 WAS, TGX-1835, TGX-1904 and TGX-1955 which were at par produced significantly ($P < 0.05$) the tallest plants while TGX 1951 gave the shortest. At 6 WAS variety TGX-1904 significantly ($P < 0.05$) had the tallest plants followed by TGX-1955 and then TGX-1835 and the shortest were gotten from TGX-1951. Same trend continued at 8 WAS with varieties TGX-1904 and TGX1955 which were at par which produced significantly ($P < 0.05$) highest mean plant canopy height and varieties TGX-1835 and TGX-1951 produced the least canopy heights. Among the priming duration, 8hours proved significantly ($P < 0.05$) the best followed by 0hour (control) while the least was 4hours.There was significant interaction between variety and priming duration.

Table 1: Effect of variety and seed priming duration on stand count and canopy height of soybean at Bagauda during the 2018 rainy season.

Treatment	Stand count 1 WAS	4 WAS	Canopy height 6 WAS	8 WAS
Variety (V)				
TGX-1835	101.00c	17.7417a	24.549ab	32.14b
TGX1904	267.00a	17.4417a	28.458a	70.85a
TGX1951	84.00c	12.5817b	18.165b	23.30b
TGX-1955	214.00b	17.0483a	24.625ab	67.27a
SE±	12.231	0.639	2.139	11.24
Priming duration (PD)				
0 hour	249.00a	17.8183a	24.158	28.87b
4 hours	121.00c	13.5967b	20.851	33.13ab
6 hours	117.00c	16.5783a	22.972	27.49b
8 hours	178.00b	16.8200a	27.816	64.07a
SE±	12.23	0.639	2.319	11.24a
Interaction (V x PD)	NS	NS	NS	NS

Means followed by the same letters within a treatment group are not statistically different at 5% level of probability using DMRT.
NS = Not Significant

Plant branches and leaf area (cm^3)

The effect of varieties and priming duration on number of branches and leaf area of Soybean is shown on Table 4. The result showed significant difference ($P < 0.05$) among the varieties evaluated. At four weeks after sowing (WAS) Soybean variety TGX-1835 produced significantly ($P < 0.05$) highest number of branches, this was followed by TGX 1904 and TGX1951 had the least. At six WAS, the performance of the varieties was the same. However, at 8 WAS TGX-

1835 had significantly (P < 0.05) highest number of branches, followed by TGX-1904 and TGX-1955 which were at par while the least number of branches was produced by TGX 1951. The performance of the priming duration for all the growth stages was the same. The interaction between variety and priming duration was not significant.

At 4 WAS, the performance of the varieties was the same. However, at 6 WAS TGX-1904 produced significantly (P < 0.05) highest mean leaf area, followed by TGX-1835 and TGX-1955 which were at par, while the least was produced by TGX-1951. More so, at 8 WAS TGX-1955 significantly (P < 0.05) produced the largest leaf area per plant followed by TGX-1835 and TGX-1904 which were at par and the least leaf area per plant was produced by TGX-1951. The performance of the priming duration did not differ at 4 and 6 WAS but significantly (P < 0.05) different at 8 WAS. 4 hour priming duration significantly (P < 0.05) produced the largest leaf area followed by 6 hour priming duration, while the least was produced by zero hour priming duration (Table 2).

Table 2: Effect Variety and Seed Priming Duration on Plant Branches and Leaf Area (cm^2) per Plant of soybeans at Bagauda during the 2018 Rainy Season

Treatment	Plant branches			Leaf area (cm^3)		
	4WAS	6WAS	8WAS	4WAS	6WAS	8WAS
Variety (V)						
TGX-1835	5.00a	13.00	22.00a	12.79	20.89ab	34.80ab
TGX1904	4.00ab	11.00	21.00ab	12.51	22.13a	26.04ab
TGX1951	300b	10.00	18.00b	11.93	16.13b	19.67b
TGX-1955	5.00a	10.00	17.00ab	18.48	18.82ab	41.24a
SE±	0.47	2.03	4.31	4.039	1.716	6.039
Priming Duration (PD)						
0 hour	4.00	8.00	10.00	11.80	20.46	24.66
4 hours	4.000	11.00	13.00	17.66	19.79	44.39
6 hours	3.00	8.00	23.00	13.68	17.86	27.71
8 hours	4.00	14.00	17.00	12.56	19.85	24.98
SE±	0.47	2.03	4.31	4.03	1.71	6.03
Interaction (V × PD)	NS	NS	NS	NS	NS	NS

Means followed by the same letters within a treatment group are not statistically different at 5% level of probability using DMRT.

NS = Not Significant

Yield components

Pods per plant, number of seeds per plant, grain yield (kg/ha) and Stover yield (kg/ha)

The effect of varieties and priming duration on number of pods per plant of Soybean is shown in Table 3. Soybean variety TGX 1904 gave significantly (P < 0.05) highest number of pods per plant followed by TGX-1955 and TGX-1951, whereas TGX1835 had the least. Also, among the priming duration evaluated, priming duration of 6hours gave the highest number of pods per

plants followed by 4hours compared to others. The interaction between variety and priming duration did not produce any significant effect.

The effect of Soybean varieties and priming duration on number of seeds per plant of Soybean is shown in Table 3. The performance of the varieties were similar to one another likewise that of priming duration. The interaction between variety and priming duration was not significant.

The effect of Priming duration on grain yield (kg/ha) of Soybean varieties is shown in Table 3. Soybean varieties TGX-1955 and TGX1904 which were at par significantly ($P < 0.05$) produced the highest grain yield (kg/ha) followed by variety TGX-1835, while variety TGX1951 gave the least. Among the priming duration evaluated, their performance was the same.

The effect of priming duration on Stover yield (kg/ha) of Soybean varieties at Bagauda is shown Table 3. There were no significant effects among the varieties evaluated; likewise the performance of the priming duration was the same. The interaction between variety and priming duration was not significant.

Table 3: Effect of Variety and Seed Priming Duration on Yield Components of Soybean at Bagauda during the 2018 Rainy Season

Treatment	Pod/plant	Seed/ Plant	Grain yield (kg/ha)	Stover yield (kg/ha)
Variety (V)				
TGX-1835	571.57	54.400b	143.18ab	290.67
TGX1904	617.87	72.950a	145.33a	281.92
TGX1951	604.32	63.000ab	136.00b	258.33
TGX-1955	611.34	67.350ab	147.50a	278.67
SE±	36.189	5.233	2.828	0.018
Priming Duration (PD)				
0 hour	596.73	68.500	143.58	254.50
4 hours	569.74	58.383	143.08	285.58
6 hours	596.33	69.433	142.67	290.00
8 hours	642.29	61.383	142.67	279.50
SE±	36.189	5.233	2.828	0.018
Interaction (V x PD)	NS	NS	NS	NS

Means followed by the same letters within a treatment group are not statistically different at 5% level of probability using DMRT.

NS = Not Significant

Correlation Studies

The summary of correlation coefficient between the grain yield per hectare and other growth and yield characters is presented in Table 4. From the study, there was significant positive correlation between the grain yield and stand count, canopy height, number of branches per plant, number of pods per plant and stover yield. Stand count was also observed to significantly and positively correlate with number of pods per plant, more so, canopy heights was found to correlate

significantly with number of pods per plant. Also, significant positive correlation was observed between number of branches, number of pod per plant, leaf area and Stover yield.

Table 4: Matrix of correlation coefficient among growth and yield characters of soybean as affected by seed priming duration at Bagauda during 2018 rainy season

	1	2	3	4	5	6	7	8	9	10	11	12
1	1.00000											
2	-0.13371	1.00000										
	0.0349											
3	0.03988	0.04389	1.00000									
	0.0478	0.7671										
4	0.14593	-0.10993	0.50732	1.00000								
	0.0323	0.4570	0.0002									
5	0.26378	-0.12873	0.23364	0.37238	1.00000							
	0.0701	0.3832	0.1100	0.0091								
6	-0.03642	-0.14649	0.67130	0.36856	0.18329	1.00000						
	0.8059	0.3205	<.0001	0.0099	0.2124							
7	-0.20173	-0.09535	-0.16315	-0.12271	-0.21077	-0.00375	1.00000					
	0.0291	0.0591	0.2679	0.4060	0.1504	0.9798						
8	-0.02248	0.02631	0.03444	-0.03650	0.10184	0.03106	0.21972	1.00000				
	0.8795	0.8591	0.8162	0.0541	0.4910	0.8340	0.1335					
9	-0.00871	-0.18150	0.16721	0.27833	0.00969	0.15253	0.14902	0.16451	1.00000			
	0.0532	0.2170	0.2560	0.0554	0.9479	0.3007	0.3121	0.2639				
10	0.10410	0.12176	-0.05339	0.09925	-0.03475	0.03421	0.21061	0.10563	0.07392	1.00000		
	0.0414	0.4097	0.7186	0.5021	0.8146	0.8174	0.0508	0.4749	0.6175			
11	-0.18793	-0.19999	-0.01953	0.02365	0.03408	-0.12870	0.02208	-0.06179	0.21427	0.04305	1.00000	
	0.0209	0.1729	0.8952	0.8732	0.8181	0.3833	0.8816	0.6765	0.0436	0.0214		
12	0.04928	-0.18080	0.04797	-0.04895	0.10206	0.03125	-0.01116	0.01523	-0.13178	-0.18214	0.03054	1.00000
	0.7394	0.2188	0.7461	0.7411	0.0400	0.8330	0.9400	0.9182	0.3719	0.2153	0.8367	

* = Significant at 5% ** = Significant at 1% Key 1. Yield 2. Stand Count 3.Canopy Height 4.Number of Branches 5. Number of leaf 6. Leaf area 7. Number of pods per plant 8. Number of seeds per pod 9. Number seed per plant 10. Weight per Plant11.100 Seed Weight 12.Stov

DISCUSSION

The stand counts, plant height, leaf area, number of branches, number of pods per plant, number of seeds per pod, number seeds per plant grain and stover yield (t/ha) of the soybean varieties tested were significantly influenced by priming duration, however, priming duration with 8 hours exhibited more stand count and canopy height compared to others while the least priming duration of four hour was observe. This result agrees with the findings of Meseret (2020) which reports the speed of germination to increase as the priming duration increased from 0 hour to 14 hour and afterwards decreased rapidly with increasing priming duration with the least recorded in 24 hours. The relative increase in yield at 8 hours priming duration could be attributed to higher level of precipitation and better soil condition (moisture and soil nutrient) as earlier suggested by Zlatica *et al*. (2018). Significant increase in stand count and plant height was observed on variety TGX-1955 and TGX-1904 compared to others, this may be attributed to the genetic factor which determined their growth habit. This result agreed with the findings of Shahram (2015) who reported that, higher number of stand count and plant height could be attained from the indeterminate varieties than the determinate types. Furthermore, soybean varieties TGX-1904 and TGX-1955 produced higher number of pods per plant and grain yield (t/ha) in Gaya, while TGX-1904 and TGX-1955 gave greater harvest index. This observation is in line with the findings of Girolamo and Barbanti (2012) and Sylwia *et al*. (2020) who reported that soybean yield is strongly dependent on photosynthesis, and that yield was related to the total amount of the photosynthesis carried out by the crop during the growing season especially as taller plants were able to raise and spread leaves in search for sunlight and other growth factors.

However, the interaction between the priming duration and the variety was not significant throughout the growth stages. These results confirm the findings of Basra *et al*., (2003), Michalak *et al*. (2018) who reported highest germination, improved emergence and good stand establishment in the field trials of PEG primed seed, however, without any interaction found among factors tested. Likewise Arif *et al*., (2003) and Arif *et al*., (2005) reported improved and early germination as well as enhanced emergence in hydro primed seed but without any interaction amongst factors. There was no any significant interaction between the variety and priming duration for all the yield parameters. The results are in line with Ghana and William, (2003) and Chiu *et al*. (2005) who found no significant impact of priming media on the grain yield of wheat cultivars. Similarly, Subedi and Ma, (2005) reported that none of the seed-priming treatments showed beneficial effects on stover yield of corn some positive effects of seed priming on seedling vigor and stand establishment.

CONCLUSION AND RECOMENDATIONS

The results of this study indicated significant effect of variety in some of the parameters on growth and yield measured. Based on this, it could be concluded that varietal differences exist among the soybean varieties in terms of growth and yield. These attributed to genetic variation. Also, it can be concluded that different hydro priming duration influenced the growth and yield on soybean varieties. These differences were also attributed to genetic variation among soybean varieties. From the foregoing, therefore, soybean varieties TGX-

1904 and TGX-1951 on priming duration of 8 hours could be cultivated by soybean farmers for good crop yield and food security.

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