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INFLUENCE OF SEED HYDRO PRIMING DURATION ON GROWTH AND YIELD OF SOYBEAN (*Glycine max. L. Merr*) IN THE SUDAN SAVANNAH

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ABSTRACT

Rapid germination and emergence is an important factor of successful establishment in soybean. 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, and at Gaya fields respectively 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 result showed that priming duration has significant effect on stand count and plant height at Gaya alone, there were no significant effects on the number of pods per plant, number of seeds per pod, number seeds per plant, grain yield (t/ha). The highest value was obtained at 8 hour priming duration at both locations. The varieties tested also differed significantly, where TGX-1904 and TGX-1951 recorded superior growth and yield parameters compared to TGX-1835 and TGX-1955 at Gaya. At Bagauda TGX-1904 and TGX-1955 proved superior in terms of stand counts, plant heights at eight weeks after sowing compared to others. From the foregoing, therefore, it is recommended that, priming duration of 8 hours in both locations and varieties TGX-1904 and TGX-1951 could be cultivated by soybean farmers in Gaya while varieties TGX-1904 and TGX-1955 is recommended for farmers in Bagauda for good crop yield.

Keywords: Priming**,** Soybean varieties, Sudan Savannah, Superior, Yield

INTRODUCTION

Soybean (*Glycine max* [L.] Merr.) is a leguminous crop of global importance. In Nigeria, the land area under soybean cultivation has been on the increase in the last 20 years. This development is attributable to increase in demand for it in human nutrition and animal feed. In 2013, Nigeria produced 600,000 tonnes of soybean estimated from 600,000 ha of land (FAO, 2013). The increased production of soybean in recent years has led to the dominance of soybean oil (about 20 %) among the various vegetable oils available for food use worldwide (FAO, 2008). Soybean (*Glycine max* (L.) Merrill) is one of the most important contributors to protein and world's edible vegetable oils. Its oil is the largest component of the world's edible oils. Soybean seed contains 20 % oil and 40% protein.

It is an ingredient of more than 50% of the world's high protein meal. The United States of America has the largest area under soybean cultivation with the highest yield and production (Lewandowska, 2016). Despite numerous uses of soybean products, the yield per unit area of the crop is still low in the tropics. Poor germination and low seed viability are among the serious problems in the production of soybean. 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*., 2004).

Seed priming or osmopriming 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*., 2016). 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 such as TGX-1835, TGX-1904, TGX-1951 and TGX-195, have been developed and released for cultivation. 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. Therefore, this study determined the effect of seed priming duration on growth and yield of some improved selected soybean varieties in the Sudan savannah agro-ecological zone of Nigeria.

MATERIALS AND METHODS

Field experiments were conducted during the 2018 rainy season at two locations, namely; 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.) and the second location was at the Research Farm of the Faculty of Agriculture, Kano University of Science and Technology, Wudil, in Gaya local government (11^0. 22 and 180. 22' with an altitude of 500 m above mean sea level.). Data on rainfall, temperature, relative humidity

and solar radiation were obtained from the National Horticultural Research Institute (NIHORT) in Bagauda and Kano State Agricultural and Rural Development Authority (KNARDA) in Gaya respectively.

Treatments, Experimental Design and Plot Size

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, they were factorially combined and laid out in a randomized complete block design (RCBD) and replicated three times. Each plot consisted of 6 ridges with 0.75cm apart, the size of each of the plot were 6 by 3m. 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 (Sylwia *et al*., 2020) 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. 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 height, 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

Physical and Chemical Properties of the Soils at the Experimental Sites

Results of soil analysis of the experimental sites (Bagauda and Gaya) are presented in Table 1. Percentage organic carbon were moderate at both locations, total nitrogen was higher at Bagauda, while at Gaya available P was higher, exchangeable cations (K, Na, Mg) and cation exchange capacity (CEC) were moderate at both locations. The soil type was sandy loam at Baguda, while at Gaya was loam sandy and slightly acidic.

Table 1: Physical and Chemical Properties of Soils of the Experimental Sites at Bagauda and Gaya during 2018 wet season at depth of 0 – 30cm.

Soil Characteristics	Gaya	Bagauda
Physical Properties		
Sand (gk^{-1})	530	560
Silt (gk^{-1})	350	310
Clay (gk^{-1})	120	130
Textural Class	Sandy Loam	Sandy Loam
Chemical properties		
pH in Water	5.83	6.65
pH in $CaCl_2$	4.1	5.26
Organic Carbon (gk^{-1})	6.5	7.8
Organic Matter (gk^{-1})	11.2	24.2
Total nitrogen (gk^{-1})	2.8	7.0
Phosphorous (mg/kg)	10.26	27.88
Base saturation (%)	29.27	33.35
Exchangeable bases in ($Cmol+kg^{-1}$)		
Sodium	0.38	0.165
Potassium	0.03	0.16
Calcium	0.14	0.204
Magnesium	1.0	0.238
CEC($Cmol+kg^{-1}$)	2.486	4.866

Source: Soil Science Laboratory, Department of Soil Science, Faculty of Agriculture, Bayero University Kano (BUK). 2018

Effects of Variety and Seed Priming Duration on growth components of Soybean

The effect of Soybean varieties and priming duration on stand count at Bagauda and Gaya is shown on Table 2. At Bagauda field, there were no significant differences among the varieties evaluated. However, significant effect was found on priming duration during the study on stand count of Soybean, 0hour (control) and 8hours priming duration gave significantly ($P \leq 0.05$) highest stand count. At Gaya, there were significant differences ($P \leq 0.05$) amongst the varieties tested. Soybean variety TGX-1904 had significantly ($P \leq 0.05$) highest stand count followed by TGX-1955 and TGX-1835 with respectively whereas TGX-1951 gave the least. Also, a significant effect was recorded on priming duration on stand count of Soybean, 0hour (control) and 8hours priming duration gave significantly ($P \leq 0.05$) highest stand count while soybean primed at 4 and 6 hours did not differ statistically on stand count. There was no significant interaction between the varieties and priming duration.

Table 2: Effect of Variety and Seed Priming Duration on Stand Count of Soybean at Bagauda and Gaya during the 2018 Rainy Season.

Treatment	Bagauda	Gaya
Variety (V)		
TGX-1835	111.47	101.52c
TGX1904	117.00	267.01a
TGX1951	176.56	84.04c
TGX-1955	138.16	214.26b
SE±	25.14	12.23
Priming duration (PD)		
0 hour	191.14a	249.06a
4 hours	122.57ab	121.46c
6 hours	99.16b	117.50c
8 hours	130.49ab	178.82b
SE±	25.14	12.23
Interaction (V x PD)	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; * = Significant at 5% probability level

Among the varieties evaluated, there was no significant difference at Bagauda for all the growth stages. At 4 and 6 WAS the performance of the priming duration was the same, while the interaction between variety and priming duration was not significant (Table 3). Result of the study on plant height differed significantly ($P \leq 0.05$) in Gaya (table 3). At four WAS, TGX-1835, TGX-1904 and TGX-1955 which were at par produced significantly ($P \leq 0.05$) the tallest plants while TGX-1951 produced the shortest. At six WAS variety TGX-1904 significantly ($P \leq 0.05$) gave the tallest plants followed by TGX1955 and then TGX1835, while TGX-1951 gave the shortest. At eight WAS TGX1904 and TGX1955 which were at par produced significantly ($P \leq 0.05$) the tallest plants while TGX1835 and TGX1951 produced the least canopy heights. Among the priming duration, 8hours proved significantly ($P \leq 0.05$) the best followed by 0hour (control) while the least was 4hours.There was significant interaction between variety and priming duration at Gaya (Table 3).

Table 3: Effect of Variety and Seed Priming Duration on Canopy Heights (cm) at different growth stages of Soybean varieties at Bagauda and Gaya during the 2018 Rainy Season.

Treatment	Bagauda			Gaya		
	4was	6was	8was	4was	6was	8was
Variety (V)						
TGX-1835	26.39	39.61	42.13	17.74a	24.54ab	32.14b
TGX1904	22.59	36.50	48.35	17.44a	28.45a	70.85a
TGX1951	20.47	37.24	41.74	12.58b	18.16b	23.30b
TGX-1955	25.32	38.88	48.27	17.04a	24.62ab	67.27a
SE±	2.09	2.59	3.21	0.63	2.13	11.24
Priming duration (PD)						
0 hour	23.38	38.87	50.96a	17.81a	24.15	28.87b
4 hours	22.05	35.31	45.42ab	13.59b	20.85	33.13ab
6 hours	22.55	36.65	39.64b	16.57a	22.97	27.49b
8 hours	26.79	41.41	44.47ab	16.82a	27.81	64.07a
SE±	2.09	2.59	3.31	0.63	2.31	11.24a
Interaction (V x 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; * = Significant at 5% probability level; ** =Significant at 1% probability level

Effects of Variety and Seed Priming Duration on yield components of Soybean

The effect of Soybean varieties and priming duration on number of pods per plant at Bagauda and Gaya is shown in Table 4. At Bagauda, the result showed significant difference among the varieties evaluated; TGX-1904 gave significantly ($P < 0.05$) highest number of pods per plant followed by TGX-1955 and TGX-1951 whereas TGX-1835 had the least. Also, among the priming duration tested, 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.

At the Gaya location, the result showed no significant difference among the varieties evaluated; the performance of priming duration was also the same. There is no any interaction between variety and priming duration.

The effect of Soybean varieties and priming duration on number of seeds per pod at the two fields is shown on Table 4. At Bagauda field, the performance of the varieties did not differ from one another. Same trend follows with the performance of the priming duration. The interaction between variety and the priming duration was not significant**.** Also, at the Gaya field, there was no significant difference among the varieties evaluated; the performance of the varieties were similar, likewise that of seed priming. The interaction

between the variety and priming duration was also found not significant.

Table 4: Effect Variety and Seed Priming Duration on number of Pods per Plant and number of Seeds per Plant of Soybean varieties at Bagauda and Gaya duringthe 2018 Rainy Season.

Treatment	Bagauda		Gaya	
	Npdplnt	Nsdpd	Npdplnt	Nsdpd
Variety (V)				
TGX-1835	268.46b	3.00	37.79	3.00
TGX1904	349.90a	3.00	78.83	2.00
TGX1951	340.42a	3.00	34.68	2.00
TGX-1955	338.45a	3.00	60.55	2.00
SE±	14.789	0.04	20.577	0.18
Priming duration (PD)				
0 hour	318.92	3.00	57.59	2.00
4 hours	326.55	3.00	34.81	2.00
6 hours	330.25	3.00	59.18	2.00
8 hours	321.51	3.00	60.28	2.00
SE±	14.789	0.04	20.577	0.18
(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; * = Significant at 5% probability level; ** =Significant at 1% probability level

The effect of Soybean varieties and priming duration on number of seeds per plant (g) at Bagauda and Gaya is shown in Table 5. At Bagauda the performance of the varieties was the same likewise that of priming duration. The interaction between variety and priming duration was not significant. However, result of Gaya field showed significant difference ($P < 0.05$) among the four varieties evaluated, TGX-1955 produced significantly ($P < 0.05$) highest number of seeds per plant, this was closely followed by TGX-1904, then TGX-1835, whereas the least was gotten from TGX-1951. The performance of priming duration was found not significant. There was no significant interaction between variety and priming (Table 5).

Result obtained from soybean grain yield was significant ($P < 0.05$) among the four soybean varieties evaluated at Bagauda, TGX-1955 and TGX-1904 which were at par significantly ($P < 0.05$) produced the highest grain yield (kg/ha) followed by TGX1835, while the least was produced by TGX-1951. Among the priming duration evaluated, their performance did not differ statistically (Table 5). Also, the interaction between variety and priming duration was not significant. At Gaya, there was a significant different ($P < 0.05$) among the varieties evaluated, TGX-1904 produced the highest grain yield (kg/ha) followed by TGX-1385 and TGX-1951 and the least was produced by TGX-1955. More so, no significant difference was found in the priming duration, and the interaction between varieties and priming duration was not significant

Table 5: Effect of Variety and Seed Priming Duration on number of Seeds per Plant and Grain Yield per Plot (t/ha) of Soybean varieties at Bagauda and Gaya during the 2018 Rainy Season.

Treatment	Bagauda		Gaya	
	Nsdplnt	Grain yield (t/ha)	Nsdplnt	Grain yield (t/ha)
Variety (V)				
TGX-1835	571.5	143.18ab	35.284b	123.03ab
TGX1904	617.8	145.33a	38.958ab	123.67a
TGX1951	604.3	136.00b	33.292b	122.96ab
TGX-1955	611.3	147.50a	45.845a	122.46b
SE±	36.18	2.828	2.837	0.322
Priming duration (PD)				
0 hour	596.7	143.58	37.383	122.97
4 hours	569.7	143.08	38.158	122.68
6 hours	596.33	142.67	41.208	123.00
8 hours	642.29	142.67	36.628	123.41
SE±	36.189	2.828	2.837	0.322
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. Nsdplnt: Number of seeds per plant;

DISCUSSION

The stand counts, plant height, number of pods per plant, number of seeds per pod, number seeds per plant and grain yield (t/ha) were significantly influenced by priming duration, however, priming duration with 8 hours exhibited more stand count and plant height compared to others and the least priming duration with four hour was observed at Gaya. This result agree with the findings of Meseret (2020) which reports the speed of germination to increased 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 in the two locations 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 difference increase in stand count and plant height were observed on variety TGX-1955 and TGX-1904 compared to others in Gaya, while at Bagauda, there were no significant difference between the varieties, exception of with TGX-1955 and TGX-1951that had higher stand count and plant height. 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. 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. 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 in Bagauda. This could be due to differences in genetic makeup of the varieties.

However, the interaction between the priming duration and the variety was not significant for all the growth stages among the two locations. Also, the interaction between seed priming duration and variety for all the growth stages was not significant and no significant variation amongst the locations was found for all 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. 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 at both the locations. 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 grain 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, it is recommended that, priming duration of 8 hours in both locations and varieties TGX-1904 and TGX-1951 could be cultivated by soybean farmers in Gaya while varieties TGX-1904 and TGX-1955 is recommended for farmers in Bagauda for good crop yield.

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