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RESPONSE OF SOYBEAN [*Glycine max* (L.) Merr.] VARIETIES TO INOCULATION AND SOWING DATE IN GUINEA SAVANNA, NIGERIA

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Abstract
Nigeria, being the largest producer and consumer of soybean in sub-Saharan Africa, requires stable and sustained production of the crop to meet its increasing demand for human consumption, and source of feed for the poultry industry. A field trial was conducted during the 2018 rainy season at the research field of International Institute of Tropical Agriculture, University farm of Ahmadu Bello University, Zaria at Samaru,in the Northern Guinea Savanna, and International Institute of Tropical Agriculture research farm, Kubwa, Abuja in the Southern Guinea Savanna of Nigeria. The treatments consist of four varieties of soybean (TGx 1904-6F, TGx 1951-3F, TGx 1955-4F and Sambaiba), two sowing dates (late June and early July), and two levels of inoculation (inoculation and without inoculation). The treatments were laid out in a Randomized Complete Block Design (RCBD), replicated three times. The results revealed that the rhizobia inoculated treatments had significantly ($P \leq 0.05$) taller plants (89.97 cm), and higher grain yield per hectare (2145kgha^{-1}). Plant height, days to 50% flowering, and grain yield per hectare (2035.7kg kha^{-1}) responded significantly ($P \leq 0.05$) to sowing date. Late June sowing outperformed early July sowing in these parameters. The results also indicated that the varieties TGx 1951-3F (2172.18kgha^{-1}) and Sambaiba (2240.3kgha^{-1}) out yielded the other varieties at Kubwa and Samaru respectively. Based on the results obtained from this study, it can be concluded that application of rhizobia inoculant, late June sowing date, use TGx 1951-3F and Sambaiba varieties produce the highest grain yield per hectare in the Guinea Savanna of Nigeria.

Keywords: Inoculation, Sowing Date, Variety, and Soybean

Introduction
Soybean [*Glycine max* (L.) Merrill] belongs to the family Leguminosae in the subfamily Papilionideae. It is an important legume crop that grows in the tropical, subtropical and temperate climates. It has 40 chromosomes (2n = 2x = 40), and is a self-fertile specie with less than 1% out-crossing (Shurtleff and Aoyagi, 2007; IITA, 2009). Soybeans range in composition and their use is dependent on their desired function; for soymilk preparation, soybeans are chosen with high protein content, compared to those utilized for oil extraction. The crop requires less energy, water and land to provide the world with sufficient protein from plant-based sources compared to animal-based (Aiking, 2011). In Nigeria soybean is grown on 780,679 hectares of land with production output of about 750,033 metric tons (FAO, 2018), with Benue, Kwara, Kaduna, Plateau States and the Federal Capital Territory as the leading producers. Nigeria is the largest producer and consumer of soybean in sub-Saharan Africa (ACET, 2013), with an average soybean productivity of 971.0kgha^{-1} (FAO, 2018), below the yields of 3tha^{-1} achieved on research stations in Nigeria (Tefera, 2011). For so many years, the crop has been widely grown in Nigeria, but optimum yield has not been obtained. This is due partly to non-adoption of improved varieties, and research conducted elsewhere has shown possibility of maximizing soybean yield potential through deployments of practices such as use of rhizobia inoculant, improved varieties, and sowing at the right date. Legume yields in African smallholder farming systems are often far below their potential. Numerous studies have shown that legume yields can be enhanced with the use of improved legume varieties (Okogun *et al*., 2005; Buruchara *et al*., 2011), phosphate (P) based fertilizers (Weber, 1996; Kamara *et al*., 2007; Kolawole, 2012), rhizobial inoculants (Sanginga *et al*., 2000; Osunde *et al*., 2003; Thuita *et al*., 2012), or their combination (Snapp *et al*., 1998;

Ndakidemi *et al.*, 2006).Research efforts to improve the existing soybean varieties, expand and increase production in Nigeria were initiated in different research institutes from the mid 1970's (Misari and Idowu, 1995). Notably among the various research institutes was the International Institute for Tropical Agriculture (IITA) by initiating research work on Soya bean in the 70's, and has made substantial effort to improve the output of the crop (Abdullahi, 2004).

Legume yields are mostly determined by the rhizobium strain nodulating the legume, the bio-physical environment, agronomic management, and their interactions (Giller *et al.,* 2013). According to Bai *et al.* (2003), co-inoculation of Bacillus strains in soybean plants with *Bradyrhizobium japonicum* produced the largest increases in nodule number, nodule weight, shoot weight, root weight, total biomass, total nitrogen and grain yield. Rhizobial inoculation proved to be a cheap way to increase soybean yields with low financial risks. Despite the strong agronomic and economic case for the use of inoculants, the local availability of good quality inoculants in Africa is problematic at present (Ronner *et al.,* 2016). Early sowing often yields more than later sowing, which gives the crop adequate time to produce more nodes, pods and later translate to higher yield (Robinson *et al.*, 2009). However, if sown too early, soybean may have poor emergence or limited growth because of high temperature. Also, when soybeans are exposed to days shorter than critical length, they progress rapidly to the stage of maturity. If this occurs before the plant reaches an adequate size, the soybean becomes stunted and gives low yield (Boquet and Clawson, 2007). Soybean crops occasionally compensate for delayed sowing with increase in seed mass (Robinson *et al.*, 2009).The study therefore, was to determine the performance of Soybean varieties for optimum production in the Guinea Savanna, valuate the response of soybean varieties to inoculation and determine the optimum sowing date for soybean production in the Guinea Savanna.

Materials and Methods

Field trial was conducted during 2018 rainy Season at the research field of International Institute of Tropical Agriculture, University farm of Ahmadu Bello University, Zaria at Samaru ($11^0$11'N, $07^0$38'E, 686m above sea level), Northern Guinea Savanna and research farm of International Institute of Tropical Agriculture, Kubwa ($09^0$09'N, $07^0$20'E, 447m above sea level), Abuja, Southern Guinea Savanna of Nigeria. The treatments consist of four varieties of soybean (TGx 1904-6F, TGx 1951-3F, TGx 1955-4F and Sambaiba), two sowing dates (late June and early July), and two levels of inoculation (inoculation and without inoculation). The treatments were laid out in a Randomized Complete Block Design (RCBD), and replicated three times. TGx 1904-6F, is a medium maturing variety, matures in 104 to 114 days, with an attainable yield of 2.5-2.7t/ha. TGx 1951-3F is also a medium maturing variety, and matures in 105 to 110 days with an attainable yield of 1.7-2.4t/ha. TGx 1955-4F is a medium maturing variety, and matures in 105 to 110 days with an attainable yield of 1.4-2.6t/ha (Ronner *et al.,* 2016). Sambaiba variety matures in 121 days, with an attainable yield of 2.4t/ha.

Prior to land preparation, soil samples were randomly collected using auger of 10cm diameter at a depth of 0-30cm across the experimental sites; the samples were bulked and a composite soil sample was analyzed for the physical and chemical properties, using standard procedure as described by Black (1965).The trial sites were harrowed to obtain a fine tilt. Ridges were made at 75cm spacing apart, and the fields were marked into plots and replications. The gross and net plot sizes were 15 and 7.5m^2 respectively. The spacing of 1.5m between replications was maintained. Inoculation was done by measuring 10kg of the soybean seed and gum Arabic (20g) was dissolved in 200mls of warm water. The gum Arabic solution was allowed to settle down before use. The seeds were moistened with the gum Arabic solution and mixed thoroughly. The inoculant (Nodumax) was sprinkled on the moistened seeds and also mixed thoroughly, ensuring that all the seeds were effectively covered with the inoculant. The moistened inoculated seeds were spread on a dry clean tarpaulin and kept away from direct sunlight for 7 minutes before sowing. Seeds were sown at 10cm intra-row spacing on ridges, 75cm apart. Six seeds were sown per hole and later thinned to four plants per stand at 14 days after sowing. Sowing was done on the 25th of June 2018 and 2nd of July 2018 for the Samaru location and 27th of June 2018 and 4th of July 2018 for Kubwa. At planting, single super phosphate and muriate of potash fertilizers were applied to supply P_2O_5 and K_2O at the rate of 40kg each per hectare. The fertilizer was broadcast and incorporated into the soil.The plots were treated with Pendimenthalin as pre-emergence herbicide at the rate of 1.6 a.i kg ha^{-1}using a CP15 Knapsack sprayer, fitted with a green deflector nozzle, and set at pressure of 2.1kg/m^2 to deliver 280L/ha of spray liquid. Hoe weeding was done at 4 weeks after sowing (WAS). Data were taken on plant height, number of days to 50% flowering; leaf area index, intercepted photosynthetic active radiation, crop growth rate, relative growth rate, and grain yield per hectare. All data collected were subjected to analysis of variance using SAS software (SAS Institute, 2011). Treatment means were compared using Duncan Multiple Range Test (Duncan, 1955).

Results and Discussion

Plant height

The results indicated that at Kubwa, inoculation had no significant effect on plant height except at 12 WAS, where significantly taller plants were recorded in inoculated plots compared to the non-inoculated (Table 1). At Samaru, inoculation had no significant effect on plant height throughout the sampling periods. The effect of sowing date on plant height was significant only at 9 WAS at Kubwa, while at Samaru, it was significant at 9 and 12 WAS, in which taller plants were observed in late-June compared to early July sown crop. TGx 1955-4F variety produced significantly tallest plants in all the sampling periods at Kubwa, although it was statistically at par with TGx 1951-3F. At Samaru, TGx 1904-6F had significantly tallest plants compared with other varieties throughout the sampling periods, although statistically similar with TGx 1955-4F. The Sambaiba variety produced the shortest plants in both locations across all the sampling periods (Table 1). The interaction between variety, inoculation and sowing date on plant height were not significant.

Days to 50% flowering

At both locations, inoculation recorded no significant effect on days to 50% flowering. Sowing date significantly affected days to 50% flowering, where sowing in late June took longer days to flowering than that of sowing in early July. Sambaiba variety recorded the longest number of number of days to 50% flowering, while TGx 1951-3F recorded the shortest number of days to 50% flowering (Table 1). The interaction between variety, inoculation and sowing date on days to 50% flowering were not significant.

Leave Area Index (LAI)

It was observed that inoculation did not significantly affect leaf area index at all the sampling periods at Kubwa and Samaru locations. At Kubwa, sowing date had significant effect with a higher LAI in late June at 9 WAS, while early July sown crops produced LAI at 12 WAS that was higher than that of late June sowing. Sowing date at Samaru had no significant effect on LAI, except at 12 WAS, where sowing in early July produced LAI that was significantly higher than that of late-June. At Kubwa, TGx 1951-3Fand Sambaiba produced the highest LAI at 9 and 12 WAS respectively. Sambaiba recorded the lowest LAI at 9 WAS, with TGx 1955-4F also having the lowest LAI at 12 WAS. At Samaru, TGx 1955-4F and TGx 1951-3F were observed to have similar and higher LAI than the other varieties (Table 2). The interaction between variety, inoculation and sowing date on LAI were not significant.

Intercepted Photosynthetic Active Radiation (IPAR $\mu mol m^{-2} s^{-1}$)

The result showed that inoculation did not have any significant effect on IPAR in both trial locations. At Kubwa, soybean sown in late June intercepted more light than early July sowing date at 9 WAS, while at 12 WAS, early July sowing had the higher IPAR compared to late June sowing. At Samaru, sowing date did not significantly affect light interception in all the measurement periods. The four soybean varieties significantly differed in IPAR at both locations for all the measurement periods except at 12 WAS in Samaru. At Kubwa, TGx 1904-6F, TGx 1955-4F and TGx 1951-3F varieties have higher IPAR than Sambaiba at 9 WAS, though at 12 WAS Sambaiba had higher IPAR than the other varieties, but comparable with TGx 1904-6F. At Samaru, TGx 1951-3F had higher IPAR at 9 WAS that is comparable with other varieties, except Sambaiba that recorded the lowest IPAR value (Table 2). Interactions between the factors on IPAR were not significant.

Crop Growth Rate (CGR)

At Kubwa, inoculation and sowing date had no significant difference throughout the sampling stages. However, at Samaru, inoculation at 6-9 WAS showed significant differences where inoculated plots resulted in higher CGR compared to the non-inoculated. Also, sowing date at Samaru had significant effect, where early July sowing significantly increased CGR at 9-12 WAS (Table 2). Variety significantly affected CGR in both Kubwa and Samaru only at 9-12 WAS. At Kubwa, TGx 1904-6F had the significantly highest CGR, while Sambaiba had the lowest. The trend was not similar in Samaru, where Sambaiba out performed TGx 1904-6F with the highest CGR value. Although, TGx 1904-6F and TGx 1955-4F were statistically at par (Table 3). The interaction between variety and inoculation on crop growth rate at 6-9 WAS at Samaru indicated that Sambaiba variety with or without inoculation gave the highest CGR value, but was still statistically similar with the other three varieties (Table 4).

Relative Growth Rate (RGR)

The result shows that inoculation had no significant effect at both locations. At Kubwa, sowing date had no significant performance (Table 2). However, at Samaru, sowing date of early July resulted in the higher RGR of the crop at 9-12 WAS, compared to late June sowing date, which gave a significantly lower RGR. At Kubwa, TGx 1904-6F variety significantly outperformed Sambaiba variety, but statistically similar with TGx 1951-3F, and TGx 1955-4F at 9-12 WAS. Sambaiba variety at Samaru significantly performed best in all the sampling periods, while TGx 1951-3F and TGx 1955-4F had the least RGR value at 6-9 and 9-12 WAS respectively (Table 3).

Grain Yield (kg ha^{-1})

At both locations, inoculated soybean resulted in grain yield that was significantly higher than that of non-inoculated plants. Sowing date was significant at Samaru, only where sowing in late June gave higher grain yield compared to early July (Table 3). At Kubwa, the three adapted varieties (TGx 1951-3F, TGx 1955-4F and TGx 1906-6F) produced statistically similar and higher grain yield than the exotic variety (Sambaiba). However, at Samaru, highest yield was obtained from Sambaiba, followed by TGx 1951-3F, and the lowest yield obtained from TGx 1904-6F and TGx 1955-4F (Table 2). The significant interaction between variety and inoculation on grain yield at Samaru shows that with or without inoculation, Sambaiba variety gave the highest grain yield. However, TGx 1955-4F when not inoculated produced the lowest grain yield that was comparable with TGx 1904-6F (Table

The performance of soybean depends largely on the environmental factors which comprise of soil and climate. These factors influenced the crop growth and development which effectively improved the yield potentials of the plants. This is in line with the findings of Krishna and Sachdev (2014), who reported that the optimum temperature for growth and development of soybean is 30°C, whilst for proper emergence of seedling; a temperature of 25- 33° C is optimal. Application of inoculant significantly improved growth and yield of soybean. The increase in growth attributes such as; plant height, days to 50% flowering, crop growth rate and relative growth rate could be as a result of inoculation, which possibly enhanced the soil nutrients and microbial activities in the soil. The positive effect of inoculation on plant height could probably be due to the inoculated rhizobium which may complement the little or no indigenous rhizobia available in the soils, even though the native rhizobia population in the trial fields was not assessed. This agrees with the findings of Amani (2007) and Caliskan *et al*. (2007), who reported that plant height of soybean increases with application of inoculants. Increase in growth rate such as; crop growth rate, relative growth rate and days to 50% flowering may possibly be as a result of proper crop management, and good environmental condition. This is in line with the study of Woomer *et al.* (2014), who stated that the success of *Rhizobium* inoculation primarily depends on the rhizobial strain, legume genotype, environmental conditions and crop management. The good performance of the soybean in terms of grain yield in plots where inoculant was applied compared to un-inoculated plots could be as a result of the sufficient amount of N_2 fixed by the soybean, which improved the effectiveness of rhizobia and host plant relationship. This corroborates with the study of Choudhry (2012) who stated that increased quantity of fixed N_2 by grain legumes will increase the effectiveness of the rhizobia-host plant symbiosis.

Plant height, days to 50% flowering, leaf area index, intercepted photosynthetic active radiation, crop growth rate, relative growth rate and grain yield were found better across sampling periods and locations in late-June sowing date. This could be because early-July sowing does not favor good establishment as a result of lack of optimum rainfall duration, and other climatic variables as stated by Kassam *et al.* (1975). More so, the good grain yield obtained maybe as result of the suitable time of sowing which give the plants more time for growth under favorable temperature, and moisture that enabled the crop produce profitably. Zhang *et al.* (2008), observed that the yielding ability of green soybean may be affected by its sowing time due to adverse weather conditions, and the number of pods set and therefore, green soybean yield decreased with delay in the sowing time.

The response of variety was significant in growth characters such as; plant height, leaf area index, intercepted photosynthetic active radiation, crop growth rate and relative growth rate. The variations in some of these growth parameters could be because of the inherent genetic makeup of these varieties, and their large canopy formation, which enhanced their ability to intercept solar radiation for higher assimilate production. Similar finding was reported by Joshi *et al*. (2013), who observed that significant differences exists among soybean genomic compositions, which are highlighted in their phenotypic variations. These phenomena could be as a result of variation in their interaction with the environment (moisture, abundant sunshine, temperature), and contribution of the prevailing soil factors that ultimately affected the yield characters. Koti*et al.* (2005) confirmed that soybean genotypes had differences in sensitivity, and response to various environmental factors.

Conclusion

The study analyzed the response of soybean [*Glycine max* (L.) Merr.] varieties to inoculation and sowing date in Guinea Savanna,vNigeria. From the results obtained, it can be concluded that application of inoculant, late June sowing date and the use TGx 1951-3F, and Sambaiba varieties produce the highest grain yield per hectare at Kubwa and Samaru respectively.

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Table 1:Influence of Inoculation, Sowing Dateand Soybean Varieties on Plant Height and days to 50% flowering in 2018 Rainy Season at Kubwa and Samaru

	Plant Height (cm)				Days to 50% Flowering	
	Kubwa		Samaru		Kubwa	Samaru
Treatment	**9 WAS**	**12 WAS**	**9 WAS**	**12 WAS**		
Inoculation (I)						
Inoculated	66.08	80.49a	80.36	89.97	47.96	58.46
Non-inoculated	63.88	77.15b	80.07	89.25	47.58	58.83
SE±	1.220	1.008	0.911	0.894	0.501	0.325
Sowing date (S)						
Late June	66.78a	77.86	82.88a	91.21a	47.67	59.13a
Early July	63.18b	79.78	77.55b	88.01b	47.88	58.17b
SE±	1.220	1.008	0.911	0.894	0.501	0.325
Variety (V)						
Sambaiba	50.50c	68.44c	73.08c	82.73c	48.08	65.67a
TGx 1904-6F	63.82b	76.34b	84.38a	93.95a	47.50	60.17b
TGx 1951-3F	71.30a	83.38a	78.72b	89.60b	47.92	49.75c
TGx 1955-4F	74.29a	87.13a	84.68a	92.17ab	47.58	59.00b
SE±	1.725	1.426	1.288	1.265	0.709	0.460
Interaction						
S x I	NS	NS	NS	NS	NS	NS
V x I	NS	NS	NS	NS	NS	NS
V x S	NS	NS	NS	NS	NS	NS
V x S x I	NS	NS	NS	NS	NS	NS

Means followed by the same letter (s) within a treatment group in a column are statistically similar at 5% level of probability using DMRT. WAS= Week after sowing, NS= Not significant and SE± = Standard Error

Table 2: Influence of Inoculation, Sowing Date and Soybean Varieties on Leaf Area Index (LAI) and Intercepted Photosynthetic Active Radiation (IPAR $\mu molm^{-2}s^{-1}$) in 2018 Rainy Season at Kubwa and Samaru

	LAI				IPAR ($\mu molm^{-2}s^{-1}$)			
	Kubwa		Samaru		Kubwa		Samaru	
Treatment	**9 WAS**	**12 WAS**	**9 WAS**	**12 WAS**	**9 WAS**	**12 WAS**	**9 WAS**	**12 WAS**
Inoculation (I)								
Inoculated	3.15	2.40	5.43	5.49	81.85	85.06	94.78	92.86
Non-inoculated	3.16	2.32	5.02	5.01	81.35	82.31	94.96	91.30
SE±	0.160	0.094	0.187	0.168	2.051	1.282	1.061	0.924
Sowing date(S)								
Late June	3.46a	2.05b	5.33	4.61b	88.98a	80.10b	94.47	92.93
Early July	2.85b	2.67a	5.12	5.90a	74.23b	87.28a	95.27	91.22
SE±	0.160	0.094	0.187	0.168	2.051	1.282	1.061	0.924
Variety (V)								
Sambaiba	1.58b	2.57a	4.70b	5.62	58.58b	89.85a	92.03b	92.45
TGx 1904-6F	3.59a	2.53ab	5.21ab	5.36	86.75a	84.90ab	94.52ab	92.53
TGx 1951-3F	3.82a	2.19ab	5.66a	5.10	90.81a	80.72bc	97.06a	92.40
TGx 1955-4F	3.64a	2.16b	5.33ab	4.93	90.28a	79.28c	95.88ab	90.93
SE±	0.226	0.132	0.264	0.238	2.900	1.813	1.500	1.306
Interaction								
S x I	NS	NS	NS	NS	NS	NS	NS	NS
V x I	NS	NS	NS	NS	NS	NS	NS	NS
V x S	NS	NS	NS	NS	NS	NS	NS	NS
V x S x I	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter (s) within a treatment group in a column are statistically similar at 5% level of probability using DMRT. WAS= Week after sowing, NS= Not significant and SE± = Standard Error

Table 3: Influence of Inoculation, Sowing Date and Soybean Varieties on Crop Growth Rate, Relative Growth Rate and Grain Yield per hectare in 2018 Rainy Season at Kubwa and Samaru

	Crop Growth Rate(g m^{-2} wk^{-1})				Relative Growth Rate (g g^{-1} wk^{-1})				Grain Yield (Kg ha^{-1})	
	Kubwa		Samaru		Kubwa		Samaru		Kubwa	Samaru
Treatment	6-9 WAS	9-12 WAS	6-9 WAS	9-12 WAS	6-9 WAS	9-12 WAS	6-9 WAS	9-12 WAS		
Inoculation (I)										
Inoculated	1.35	8.07	2.20a	8.43	0.21	0.41	0.17	0.33	2145.51a	2063.68a
Non-inoculated	1.40	6.43	1.84b	8.29	0.22	0.37	0.19	0.30	1789.93b	1869.18b
SE±	0.168	0.782	0.099	0.937	0.024	0.037	0.010	0.020	42.502	33.583
Sowingdate(S)										
Late June	1.35	7.39	1.96	4.92b	0.21	0.39	0.18	0.22b	2022.78	2035.74a
Early July	1.40	7.11	2.08	11.80a	0.22	0.39	0.18	0.41a	1912.65	1897.11b
SE±	0.168	0.782	0.099	0.937	0.024	0.037	0.010	0.020	42.502	33.583
Variety (V)										
Sambaiba	1.20	5.09b	2.21	11.58a	0.20	0.28b	0.21a	0.39a	1607.90b	2240.34a
TGx 1904-6F	1.25	9.55a	1.93	6.41b	0.20	0.50a	0.19ab	0.30b	2005.71a	1787.73c
TGx 1951-3F	1.54	7.95ab	1.97	8.43ab	0.23	0.43ab	0.16b	0.29b	2172.18a	2034.24b
TGx 1955-4F	1.51	6.41ab	1.98	7.03b	0.23	0.35ab	0.17b	0.27b	2085.08a	1803.39c
SE±	0.238	1.106	0.140	1.325	0.033	0.052	0.014	0.028	60.107	47.493
Interaction										
S x I	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
V x I	NS	NS	*	NS	NS	NS	NS	NS	NS	*
V x S	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
V x S x I	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

Means followed by the same letter (s) within a treatment group in a column are statistically similar at 5% level of probability using DMRT.WAS= Week after sowing, NS= Not significant, SE± = Standard Error and *= Significant

Table 4: Interactions between Variety and Inoculation on Crop Growth Rate and Grain Yield per hectare at Samaru

	Crop Growth Rate 6-9 WAS (g m^{-2} wk^{1})		Grain Yield (Kg ha^{-1})	
	Inoculation			
	With	Without	With	Without
Variety				
Sambaiba	2.18ab	2.23ab	2385.63a	2095.05b
TGx 1904-6F	1.67b	2.20ab	1800.18cd	1775.28d
TGx 1951-3F	1.50b	2.43a	2089.05b	1979.43bc
TGx 1955-4F	2.02ab	1.93ab	1979.85bc	1626.93d
SE±	0.199		67.165	

Means followed by the same letter (s) within a treatment group in a column or row are statistically similar at 5% level of probability using DMRT. WAS= Week after sowing