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The Performance of Okra as Influenced by Location, Variety and Irrigation Water Regimes in Two Uplands Soils of Benue State, Nigeria

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Abstract
The performances of three okra cultivars were evaluated under surface irrigation on the upland Soils of University of Agriculture Makurdi Research Farms (UAM Research Farm) and Northbank of River K/Ala, Dogo in Makurdi and Buruku LGAs of Benue State, Nigeria. A factorial experiment with treatments consisting two Locations (UAMRF and Dogo), three Varieties (MKD-V_1, NH47-4- V_2 and LOGO-V_3) and three Irrigation Frequencies (3day, 7day and 10day) was laid out in RCBD with three replications. The land was cleared, ploughed, harrowed, leveled and 2mx2m beds manually prepared. Four (4) seeds were planted on the 8th and 12th February, 2011 and 2012 respectively at 45cm x 50cm spacing and thinned to two (2) plants/hole two weeks later. Crop parameters: plant height, canopy, fresh weight, dry weight, pod length and fresh fruit weight were noted. Combined data for the two years were subjected to ANOVA and means separated using LSD (0.05 level). The results showed that: UAM Research Farm was the best soil compared to Dogo soil for the cultivation of all the three varieties of okra studied. Variety V_1 was better in plant height; V_2 in plant canopy and fresh fruit yield while V_3 produced the largest biomass. Irrigation frequency at 3day resulted into larger plant canopy and higher fresh fruit yield, 7day produced longer pods while irrigation at 10day give higher fresh and dry biomass compared to other irrigation intervals. Irrigation interval at 7day however, has a comparable economic advantage over the other irrigation intervals, 3 and 10day in respect to the most vital trait, fresh fruit yield turn over in all the three okra varieties.

INTRODUCTION

According to Hassan *et al*., (2011), crop production especially in less rainfall areas subjected to a wide variation and changes in climates is limited by drought. In such condition lower crop yield and water use efficiency take place under water instability year in year out. The changing climatic conditions along with decrease in water resources attracted the attention for the improvement of better return of water per unit of land to gain higher yield with minimal water consumption. Not ignoring the changes due to differences in locations, water accessibility variation but also saturation in the soils. it is obvious that accessibility to water and water saturation properties of soils may show variability from one location to another. Traditionally irrigation methods which seem to be predominant are characterized by reduced efficiency of water use occasioned by evaporation and leaching. This often results in nutrient loss and lodging of some plants. To mitigate the attendant effect of this traditional approach, it is therefore necessary to apply enough water to sustain plant growth and achieve more yields without unnecessary wastage by choosing a more economic irrigation interval that will fit in each location and more importantly save costs. There is therefore the need to put in place a water saving irrigation strategy by reducing water application during those phenological periods in which controlled water deficit does not significantly affect the production and quality of the crops involved without compromising crop water requirement during the remainder of the crop cycle, hence the choice of more appropriate irrigation interval. Okra, one of the most important vegetable fruits in West Africa is an annual crop, requiring warm growing conditions is found in every market all over Africa (Schipper, 2000). Okra contains carbohydrates, proteins and vitamin C in large quantities as well as essential and non-essential acids. Its consumption therefore plays a vital role in human nutrition. Great diversifications of okra were observed with the most production regions localized in Co D'Voire, Ghana, Burkina Faso and Nigeria (Schipper, 2000). Elsewhere in Asian and African countries, Okra seeds are used as protein source and alternative for coffee.

Studies on the optimum weather requirement for high okra yield in the tropics showed that okra does best when minimum and maximum temperatures are 18-40^{0}C, rainfall of about 1000mm and relative humidity is 90%. Adeniyi (2003) studied three (3) varieties of okra in W/Afica and found that improved varieties and serial give higher yields. He concluded that plants subjected to low level of water stress performed better than those moderately stress. Khalih (2004) observed significant differences among okra genotypes regarding plant height, number of branches per plant, early/total yield as well as fruit length/weight. While Saeed *et al.*, (2003) observed no drastic effect in okra fresh fruit yield and number of branches per okra plant of Parbhani Karanti and DLPG cultivars; Onwugbuta-Enyi (1996) observed significant reduction in the plant height of okra due to water stress.
The floodplain soils irrigation potentials are high in the Mid-Benue Trough and free of forest covers and require no drainage (Abagyeh, 2015). The area has potentials for irrigation using surface and under water but has remain

under-developed limiting commercial activities.

The aim of this experiment was therefore to examine the effect of location, okra genotypes and irrigation intervals on the growth and yield of okra.

MATERIAL AND METHOS

Experiment was conducted between February and March during the dry seasons in 2011 and 2012 on the Dogo in Buruku LGA Lat. 07^0 22.986'N and Long. 009^0 12.158'E and UAM Research Farm Makurdi LGA, Lat. 07^0 45.693'N and Long. 008^0 37.483'E, both of Benue State. The aim was to assess the influence of Location, Genotype and Irrigation Frequency on the performance of Okra. On each site, A factorial experiment with treatments consisting three Varieties (MAKURDI-V_1,NH47-4- V_2 and LOGO-V_3) and three Irrigation Frequencies (3day, 7day and 10day) was laid out in Randomized Complete Block Design with three replications. A 9m x 9m plot was curved out, the land was cleared, ploughed, harrowed, leveled and 2mx2m beds manually prepared. Four (4) seeds were planted on the 8^{th} and 12^{th} February, 2011 and 2012 respectively at 45cm x 50cm spacing and thinned to two (2) plants/hole two weeks later. Water Pump was used to channel water into irrigation channels constructed between the beds and directed into appropriate bed at $0.2m^2$ (5cm depth) per irrigation interval. NPK 15:15:15 was band applied at 20g per stand (50kg/ha) at week two after first weeding while second weeding was done at week four. Delthrin 10EC (Img/l) was used to treat insect infestation. Two stands (4 plants) were chosen in each bed for the following: plant height was taken weekly by metre ruler; plant canopy was taken at weeks 5, 7 and 9 as width of the broadest section of the plant multiplied by its vertical height to peak using a metre ruler; fresh pod weight at harvest using weighing balance. Two plant stands were uprooted, weighed fresh then dried to constant weight using weighing balance.

Due to existence of homogeneity of error mean square, data for the two years (2011 and 2012) were combined and analysis of variance was carried out using GENSTAT Release 4.24 DE (Genstat, 2012) software while means were separated using Fisher's Least Significant Difference (F-LSD) at 5 % level of probability.

RESULTS AND DISCUSSION

Results of analysis of variance for the 2011 and 2012 combined data are contained in Tables 1-2. Results (Table 1) showed that okra varieties planted on UAM soils performed better in plant height and fresh fruit yield while Dogo soils was a better site for the performance of plant canopy, dry biomass and pod length. Variety V_1 was better in plant height; V_2 in plant canopy and fresh fruit yield while V_3 produced the largest biomass. Irrigation frequency at 3day resulted into larger plant canopy and higher fresh fruit yield, 7day produced longer pods while irrigation at 10day gave higher fresh and dry biomass compared to other irrigation intervals. Khalih (2004) found that all okra genotypes showed significant differences for most traits under irrigation regimes (10, 3o, 45 days).
Interaction between location, variety and irrigation frequency presented in Table 2 showed that:

Average Plant Height: Taller plants were obtained at UAM compared to Dogo. This may be due to the fertility status of the soil. The 3day irrigation interval gave the highest plants (23.03, 22.98cm) in NH47-4; the 7day (27.67, 24.13cm) in Logo while the 10day plant heights (37.34/39.69cm) in Makurdi were significantly higher than those of other varieties. The development of height in all the okra varieties may be attributed to their genotypes and location of cultivation.

Average Plant Canopy: Larger plant canopies were produced at Dogo (1101, 854 and $1198cm^2$ by NH47-4) compared to UAM (804, 915 and 808 cm^2 by Logo) with the 7day and 10day irrigation intervals giving the largest canopies respectively. The largest canopies were however produced by V_3 in the two sites. This implies that Dogo was a better site and moderate to high water stress is more favorable at Dogo and UAM respectively while V_3 is the best variety for canopy production.

Average Plant Fresh and Dry Weights: Better fresh weights (333.3, 299.0 and 390.9) were recorded at UAM and the dry weights (67, 68.83 and 88.83g) at Dogo by the 3day and 7day irrigation intervals respectively by all okra varieties. This implies that plants in the UAM suffered more weight loss than those of Dogo soils during the drying process. This may be a true reflection of the water contents acquired during the plants physiological developments per irrigation intervals.

Average Plant Pod Length: The longest pods were produced at Dogo by the 10day irrigation interval and the shortest by 7day irrigation interval in all cultivars while at UAM, there was no defined development pattern, however, the 7day irrigation interval gave longer pod in V_1 and V_3 compared to V_2. The significant ($p \leq 0.01\%$) response of pod length with V_3 and V_1 recording the highest (8.73/8.27cm) and V_2 the lowest (5.79cm) at Dogo and 6.37/7.18cm and the 6.87cm at UAMRF respectively may be due to varietal as well as location effects. Jamala *el tal.*,(2011) reported similar findings in different varieties of okra at Mubi Floodplains, North Eastern, Nigeria.

Average Fresh Fruit Yield: The optimal fresh fruit yields (7.40, 4.01 and 3.40t/ha) were recorded at UAM as against the values (4.21, 2.88 and 3.40t/ha) recorded at Dogo in NH47-4-V_2, Logo-$V_1$and Makurdi-V_3 through the 7day irrigation interval. The yields were however, not significantly different from those of other irrigation

intervals within the same variety except in NH47-4. Thus, all okra genotypes require low to moderate water stress for optimum fruit yield. Adeniyi (2003) observed no drastic effect in okra fresh fruit yield and number of branches per okra plant of Parbhani Karanti and DLPG cultivars with respect to water regimes. These results indicate that: UAM is a better site compared to Dogo for yields of okra fruits. Genotypically, V_2 was the best variety followed by V_2 than V_3. Adeniyi (2003) studied three (3) varieties of okra in West Africa and found that improved varieties and serial gave higher yields.

In general terms therefore:

-all okra genotypes performed better at UAMRF than at Dogo soils; NH47-4 variety is best due to its improved status while all varieties of okra examined showed no drastic effect among the irrigation intervals.

-Variety two (NH47-4-V_2) is the best variety followed by Variety one (Logo-V_1) in both locations and that irrigating at 7day interval is most adequate for optimal okra fruit yield production while the vegetative components showed some degree of variations across the three water regimes in respect to okra production and UAM Research Farm the best site for okra production.

-Okra variety NH47-4 gained the highest fruit yield (7.40tha^{-1}) at Makurdi (UAMRF) when irrigated at 7day interval. Consequently, irrigating once a week seems preferable when compared to irrigating at every 3 days owing to the reduced amount of water and labour involved in the weekly schedule and to irrigating at every 10 days owing to a comparable fresh fruit yield turn over in economic terms.

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TABLE 1: MAIN EFFECT OF LOCATION, VARIETY AND IRRIGATION REGIME ON THE PERFORMANCE OF OKRA () ON THE UPLANDS OF DOGO AND UAM RTF OF BENUE TROUGH.

Treatment	Symbol	PLTHT(cm)	PLTCPY(cm^2)	PLTFW(g)	PLTDW((g)	PLTPDLT(cm)	FTYD(tha^{-1})
Location	**L**						
DOGO	**1**	26.23	755	256.80	63.23	7.85	3.08
UAMRF	**2**	28.09	622	264.10	47.80	6.33	4.64
LSD	**(0.05)**	0.89	46.00	24.80	2.30	0.20	0.17
VARIETY	**V**						
	1	35.60	518	264.10	54.25	7.20	3.05
	11	21.02	792	258.80	54.65	6.82	5.31
	111	24.85	756	258.50	57.64	7.23	3.21
LSD	**(0.05)**	1.09	56.4	30.38	2.81	0.24	0.21
IRRIG. FREQ.	**F**						
	1	27.65	707	259.20	55.49	7.07	4.10
	11	26.83	696	239.50	54.05	7.49	3.95
	111	26.99	644	283.80	57.01	6.71	3.52
LSD	**(0.05)**	1.09	56.4	30.38	2.81	0.24	0.21

Key: UAMRF = UAM Research Farm; IRRIG. FREQ. = Irrigation Frequency; PLTHT = Plant Height, PLTCPY = Plant Canopy, PLTFW = Plant Fresh Weight, PLTDW = Plant Dry Weight, PLTPDLT = Plant Pod Length and FFTYD = Fresh Fruit Yield.

TABLE 2: INTERACTION EFFECT OF LOCATION, VARIETY AND IRRIGATION FREQUENCY ON THE PERFORMANCE OF OKRA AT DOGO AND UAM

VARIETY	LOCT	FREQ	PLTHT(cm)	PLTCPY(cm^2)	PLTFW(g)	PLTDW((g)	PLTPDLT(cm)	FFTYD(tha^{-1})
V	**L**	**F**						
1	**M**		**A**	**K**	**U**	**R**	**D**	**I**
		1	33.22	628	206.0	59.18	8.27	2.79
	DOGO	**2**	32.36	496	157.8	46.33	8.21	2.85
		3	37.34	509	197.7	58.34	7.97	2.69
		1	35.67	432	333.3	55.00	6.21	3.40
	UAM	**2**	35.33	461	299.0	51.33	6.37	3.38
		3	39.69	579	390.9	55.33	6.29	3.19
		1	22.98	1101	309.8	67.00	6.92	4.21
	DOGO	**2**	19.47	854	253.0	68.83	8.05	3.63
		3	18.73	1198	504.7	88.83	5.79	3.33
		1	23.03	546	207.0	40.41	6.87	7.32
	UAM	**2**	22.00	670	149.8	34.85	6.38	7.40
		3	19.90	385	128.5	28.00	6.89	5.98
3	**L**		O		G		O	
		1	24.00	731	216.2	54.33	8.53	2.88
	DOGO	**2**	24.13	777	206.4	56.67	8.73	2.74
		3	23.80	503	259.8	69.53	8.20	2.56
		1	27.00	804	282.7	57.00	5.61	4.01
	UAM	**2**	27.67	915	364.8	66.30	7.18	3.70
		3	22.50	808	221.3	42.00	5.13	3.39
LSD	**0.05%**		2.66	138.1	74.4	6.89	0.598	0.516

Key: Irrig. Freq. = Irrigation Frequency, PLTHT = Plant Height, PLTCPY = Plant Canopy, PLTFW = Plant Fresh Weight, PLTDW = Plant Dry Weight, PLTPDLT = Plant Pod Length and FFTYD = Fresh Fruit Yield.