Effect of Irrigation Interval on Growth and Forage Yield of Maize (Zea *Mays*) Variety Using Solar Photovoltaic Irrigation system in Sokoto, Nigeria

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ABSTRACT

Experiment was conducted at the Usmanu Danfodyio University Dryl and Teaching and Research Farm (13 01 N and 5^0 13 E), during 2022 dry seasons. The objective of the research was to study the effect of irrigation interval on the growth and forage yield of cowpeas varieties using Solar PV Irrigation system. (SAMMAZ 15, SAMMAZ 33 and Ex Dundaye) respectively, with irrigation intervals of 3, 4 and 5 days respectively were used for the experiment. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications. Results from the research shows that variety had significant effect on stand establishment count, leaf length, leaf with, number of leave per plant, days to 50% tas selling and forage yield. Also, irrigation interval had significant effect on plant height, number of leaves, leaves length, days to 50% tasseling and forage yield. Interaction effects between variety and irrigation interval was also found to be significant. From this research, it was found that production of SAMMAZ 15 with 3 days irrigation interval is encouraged in Sokoto ecological condition using Solar PV irrigation system.

INTRODUCTION

Maize also known as corn, with botanical name *Zeamays* L, belongs to the grass family Poaceae. It is one of the major cultivated cereals crops in all ecological zones (Adiaha, 2017). Maize is also a crop that has been modified to adapt to areas of cultivation which result in its subspecies which are classified based on the level of starch each contain. (Pipernoet *al*., 2001). Corn originated from Mexico and Central America and possess somatic chromosome number of 20, a genome size of 2.3 giga base and more than 32,000 genes (Schnable *et al.*,2009).

After wheat and rice, the most cultivated crop globally is maize (David and Adams, 1985). This is as a result of its moderate requirement of water and high yielding. There are different varieties of corn which includes, popcorn, flint corn, flour corn, sweetcorn e t c. Maize is said to contain protein, crude fibre, ether extract and carbohydrate. It provided the largest amount of energy in human and animal's diet. The crop supplies the body with some essential amino acid like lysine and tryptophan. IITA (2001) in their analysis said that maize gives 80% of carbohydrate, 10% protein, 3.5% fibre and addition 2% minerals. According to Dilip and Adita (2013); Lans (2006) the extracts of maize including corn silk have been used to treat urinary system disorder and kidney related problems.

About 1016.73 million metrics tons of maize is produced every year which makes it the highest producing

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staple cereals. The highest percentage word production of maize is USA with the annual average production of 310 million metric tons. United State cultivated 43% of global maize. About 30 million hectares of land is used for maize cultivation in USA. The second highest producing country of maize is China with about 162.5 million metric tons with different varieties of maize which gives about 20% of the word production. Brazil cultivates an average of 55 million metric tons of maize annually (Smriti, 2015). Argentina, gives an annual average production of 20 million tons while region like Pampa is it production belt. India is considered as the 6^{th} producing country of maize giving an average annual of 18 million metric tons. Mexico, France, South Africa and Nigeria are also leading countries in maize production (Adiaha, 2017), (Smriti, 2015).

In Nigeria, corn is produced in almost all the agro-ecological zones, and the highest producing part is the northern part of the country. The most cultivated varieties of maize cultivated in Nigeria are white and yellow maize, this is due to their adaptability. Some of the maize producing states in Nigeria are Niger, Kaduna, Katsina, Kebbi, Kogi and Kawar State, where the crop has been produced for multi-utilization. About 34- 98.3 m or 48% hectares of land are used for maize farming in Nigeria. The maize grain produced are sold as commercial crops for industries, agro-based, medical, pharmaceutical and other uses (Iken and Amusa, 2004). Maize is used as a staple human food, as feed for livestock and as raw material for many industrial products, the foliaceous bracts are used as a wrapping for cigarettes and cheroots. The cob, stem and leaves can be used to feed cattle.

Maize crop is no doubt being used as source of feed to livestock in its fresh and dry form. The growing needed for increased alternative source of animal feed necessitates irrigated maize production in northern Nigeria where maize is solely produced for animal fodder in its fresh form. Irrigation is becoming more expensive with the rising cost of petrol and diesel, hence, the need for cheaper source of power which could be provided by solar PV system of irrigation because of its cheap running cost.

The main objective of this study is to know the effect of irrigation interval on the growth and forage yield of some maize varieties using solar PV irrigation system.

MATERIALS AND METHODS

The experiment was conducted during 2021/2022 dry season at the Dryl and Teaching and Research Farm of the Usmanu Dan fodiyo University, Sokoto: Sokoto is Located in the North-Western Nigeria, latitude 13^0 :01 North and longitude 05^0:15 East. It lies in the Sudan Savanna agro ecological zone characterized by three to four months of rain-fall. The soil texture of the dry-land where the experiment was conducted is sandy, the mean annual rain-fall of Sokoto is 750 mm, mean temperature is 32°C and humidity 22 percent.

The treatments consisted of three varieties of maize (Sammaz15, Sammaz33 and Ex Dundaye) respectively, with irrigation interval of 3, 4 and 5 days respectively. The experiment was laid out in a Randomized Complete Block Design (RCBD) with three replications.

The experimental plot was made of three blocks oriented in East- west direction. There were nine plots in each block measuring 4.5mx 3m (13.5m²) with 1m path between the adjacent plots in a block and 1m between the blocks. Thus, the total plot size was 48.5mx11m (533.5m²).

The experimental area was harrowed using manually using hoe after the area had been irrigated. This is done for easy manipulation since the experiment was carried out in dry season.

Improved Variety of maize (Sammaz 15 and Sammaz 33) was obtained from Institute for Agricultural Research, Samaru, Zaria, Nigeria. And the Ex-Dundaye was got from a good source in the market. The seeds were dressed with apron star at a recommended rate. Dibbling method was used for sowing the seed at

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a depth of 5cm,with the inter-row spacing of 75 cm and intra- row spacing of 3o cm. 3 seeds were sown per hole, which was thinned to one plant per stand at two weeks after planting (2 WAP).

Large amount of organic manure was applied at the rate of 20t/ha to the soil before planting. N.P.K 20, 10, 10 was applied two weeks after planting at the rate 100kg/ha. Then urea 46%N was used as top dress 4 weeks after planting. The plots were weeded at 4 weeks and 8 weeks of planting, and the weeding was done manually using hoe. the whole plots were watered for the first two weeks, to ensure the establishment of the plants, before the irrigation interval treatment was imposed as prescribed i.e. 3, 4 and 5 days.

data were collected during the experiment from Plant establishment count, Plant height, Leaf length, Leaf width, Number of leaves, days to 50% tasseling and Forage yield**.** The data, obtained from the experiment, were subjected to analysis of variance procedure (ANOVA) and significant means were separated using Duncan multiple range test at 5% probability level.

RESULTS AND DISCUSSION

Effect of Irrigation Interval and Variety on Stand Establishment Count.

Results in Table 1 shows that, the plant establishment count was significantly affected by varieties. The highest value (95.36%) was obtained from SAMMAZ 15, followed by SAMMAZ 33 with (95.18%) and the lowest count (74.81%) was recorded from Ex-Dundaye. The significant difference among different varieties on the stand establishment count may be attributed to different genetic viability of the maize varieties. This was in line with the findings of Tesisa and Teshome (2019), who reported that the establishment count of maize varieties was as a result of the genetic differences of the varieties. However, no significant difference was observed among the irrigation regimes tested in terms of establishment count of maize varieties. This was because the irrigation treatment was imposed two weeks after establishment and therefore could not affect establishment of the crop. There was no significant difference in terms of interaction between variety and irrigation interval on the establishment count.

Plant height (cm).

Results in Table 2, shows that plant height was not significantly affected by variety at all the weeks under observation, this might due to the ability of the varieties to complete equally well. This is in agreement with the findings of Saberali (2007) who reported that, with even distribution of resources like fertilizer, light etc. uniform growth of maize is enhanced. Irrigation interval recorded a significant difference on the plant height in all the weeks under observation. The highest plant height (74.81cm,118.19cm and 130.79cm) were obtained from 3days irrigation interval at 4,6 and 8 WAS respectively, follow by 4 days interval which recorded (69.78cm, 102.39cm and 112.05cm) at 4,6 and 8 WAS respectively. The lowest value (61.99cm, 89.60cm and 101.80cm)were rescored from 5 days interval at 4,6 and 8 WAS respectively. This is as a result of the improved availability of water for those crops with shorter irrigation interval (3days) which enhances plant growth. This conformed with the findings of Wajid (1990) who reported that plant height, number of grains per cob were significantly affected by irrigation level. There was also a significant interaction effect between the variety and irrigation interval as shown in table 3,4 and 5 respectively.

Numbers of leaves

There was significant effect of variety on the leave number of maize at 4 weeks after sowing (WAS), the highest value (9.22) was recorded for SAMMAZ 15 followed by SAMMAZ 33 with (8.22) and the least value (7.22) was obtained from Ex Dundaye. No significant difference was observed at 6 and 8 WAS. It was also observed that there was increase in leave number as the week increases, this was because varieties express themselves differently toward maturity and it was found related to the work of Njodi *et al*., (2019),

who reported no significant differences in leave number of maize at week 3,5,7 and 9 except week 11 only. Also, the irrigation interval recorded no significant difference at week 4 6 and 8 WAS. The interaction between variety and irrigation interval was significant at all weeks under observation as shown in Table 7,8 and 9 respectively.

Leaf Length (cm)

According to Table 10, it was observed that variety have significant effect on the leaf length at 4 weeks after sowing. The highest means value (56.06cm) was recorded for SAMMAZ 15 followed by Ex Dundaye with (51.14cm) and the least value (48.39cm) was recorded for SAMMAZ 33. But no significant effect observed at 6 and 8 WAS. This is in agreement with the findings of Bos *et al* (2000) who reported that Increase in leave length with position was sigmoidal. Also, leaf length was significantly affected by the irrigation interval at 6WAS, the highest value (68.78cm) was recorded for 3days interval, followed by 4days interval with (65.53cm) and the lowest value (59.08cm) was recorded for 5days interval, there were no significant differences at 4 and 8 weeks after sowing. The interaction of variety and irrigation recorded significant difference at 4 and 6 WAS as shown in Table 11 and 12 respectively, and no differences at 8 weeks after sowing.

Leaf Width (cm)

Results presented in Table 13 shows that, variety had no significant influence on the leaf width at 4, 6, and 8 WAS. But irrigation interval recorded significant difference at 6 and 8 WAS. The highest value (7.15 cm) was obtained from 3 days interval followed by 4 days interval (6.63cm) and lowest value (6.26 cm) was recorded for 5 days interval at 6 WAS, also, at 8 WAS, the highest value (7.22 cm) was recorded from 3 days interval followed closely by 4 days interval with (6.55 cm) and the least value(6.16 cm) was recorded for 5 days interval. No significant difference was observed at 4 WAS. The interaction between irrigation interval and variety shows significant effect at all the weeks under observation as shown in Table 14, 15 and 16 respectfully.

Days to 50% Tasseling

Table 17. below reveal that significant difference was observed on the days to 50% tasseling due to irrigation interval, highest value (67.57 days) was recorded from 4 days interval, followed by 5days interval (65.44 days) and the lowest value (61.5661.56 days) was obtained with 3 days irrigation interval. These differences can be as a result water stress. As the irrigation interval increases, the water stress of maize also increases which brings about the increase in the means number of days to 50% tasseling. This result is in the conformity with the findings of Khan *et al* (2001). Who reported that stem height, stem diameter, leaf area and days to complete flowering, decreased significantly with increasing irrigation frequency.

Also, days to 50% tasseling was not affected by variety. The interaction between irrigation interval and variety was also not significant.

Forage Yield (t/ha)

The results in table 18shows that there was significant effect of variety on forage yield. The highest yield was recorded for SAMMAZ 15 (3.37t/ha) followed by SAMMAZ 33 (2.70t/ha) and the lowest yield (2.52t/ha) was recorded for Ex Dun daye. This differences in yield is as a result of the variety make up, this agree with the find of Udoh (2005) who reported some maize variety have high yield advantage over other maize varieties because they possess such special qualities as high yield, early maturing resistance to disease, tolerant to drought etc. Also, the irrigation interval gives significant differences on the forage yield, 3 days interval gives the highest value of (4,33t/ha), followed by 4 days interval with (2.40t/ha) and the

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lowest value (1.84t/ha) was recorded from 5 days interval. There was significant effect between the interaction. The interaction of SAMMAZ 15 and 3 days interval produces the highest value (5.58t/ha) of forage yield, followed by the interaction between SAMMAZz 33 and 3days irrigation interval with (4.22t/ha) the least valve (0.91t/ha) was obtain from the interaction between SAMMAZ 33 and 5-days irrigation interval. Based on these findings, it can be inferred that irrigation interval and varieties can significantly influence the growth and forage yield of maize in terms of plant height, number of leaves per plant and forage yield. As such, irrigation interval of 3 days coupled with SAMMAZ 15 could be recommended under Sokoto conditions during dry season using Solar PV irrigation system.

Table 1: Effect of irrigation interval and variety on some growth parameters of maize during 2022 dry season at Sokoto.

Treatment				
Variety	**Establishment count (%)**	**Plant height (cm) 4WAS**	**6WAS**	**8WAS**
SAMMAZ 15	95.36[a]	72.65[a]	111.1[a]	118.5[a]
SAMMAZ33	95.18[a]	68.93[a]	96.31[a]	106.3[a]
Ex-Dundaye	74.81[b]	64.96[a]	102.3[a]	116.7[a]
SE±	6.15	5.76	7.99	8.06
Significance	ns	ns	ns	ns
Irrigation interval				
3 days	88.52[a]	74.81[a]	118.19[a]	13.79[a]
4days	87.60[a]	69.78[ab]	102.39[ab]	112.05[ab]
5 days	89.27[a]	61.99[b]	89.60[ab]	101.80[b]
SE±	6.15	5.76	7.99	8.06
Significance	ns	*	*	*
Interaction				
I x V	ns	*	*	*

ns = non-significant

Means followed by the same letter do not differ significantly at P< 0.05 according to DMRT.

Table 2: Effect of irrigation interval and variety on number of leaves and leaf length of maize during 2022 dry season at Sokoto.

Variety	**Number of leaves**		**Leaf length**			
	4WAS	**6WAS**	**8WAS**	**4WAS**	**6WAS**	**8WAS**
SAMMAZ 15	9.22[a]	13.11[a]	15.11[a]	56.06[a]	66.17[a]	61.53[a]
SAMMAZ33	8.22[a]	11.89[a]	14.11[a]	48.30[a]	63.24[a]	62.40[a]
Ex-Dundaye	7.22[b]	12.67[a]	14.56[a]	51.14[ab]	63.98[a]	63.53[a]
SE±	0.76	0.82	0.72	3.24	3.63	3.10
Significance	*	ns	ns	*	Ns	ns
Irrigation interval						
3 days	9.00[a]	13.22[a]	15.44[a]	54.61[a]	68.78[a]	65.86[a]
4days	7.88[a]	12.89[a]	14.44[a]	52.62[a]	65.53[ab]	61.47[a]
5 days	7.77[a]	11.56[a]	13.84[a]	48.34[a]	59.08[ab]	60.57[a]

SE±	0.76	0.82	0.72	3.24	3.63	3.10
Significance	ns	ns	ns	ns	*	ns
Interaction						
I x V	*	*	*	ns	*	ns

ns = non-significant

Means followed by the same letter do not differ significantly at P< 0.05 according to DMRT.

Table 3: Effect of irrigation interval and variety on leaf width and forage yield of maize during 2022 dry season at Sokoto.

Variety	**Leaf Width 4WAS 6WAS 8WAS selling**		**Days to 50 %**	**Forage Yield Tas (t/ha)**	
SAMMAZ 15	5.83^{a}	6.80^{a}	6.84^{a}	64 ^{a}	3.37^{a}
SAMMAZ33	5.00^{a}	6.52^{a}	6.52^{a}	64.67^{a}	2.70^{a}
Ex-Dundaye	5.43^{a}	6.88^{a}	6.68^{a}	64.56^{a}	2.70^{a}
SE±	0.388	0.357	0.367	2.246	0.68
Significance	ns	ns	ns	ns	*
Irrigation interval					
3 days	5.63^{a}	7.15^{a}	7.22^{a}	67.57^{a}	4.33^{a}
4 days	5.44^{a}	6.63^{ab}	6.55^{ab}	65.44^{ab}	2.40^{b}
5 days	5.18^{a}	6.26^{b}	6.16^{b}	61.56^{b}	1.84^{b}
SE±	0.388	0.357	0.367	2.246	0.68
Significance	ns	*	*	*	*
Interaction					
I x V	*	*	*	ns	*

ns = non-significant

Means followed by the same letter do not differ significantly at P< 0.05 according to DMRT.

Table 4. Interaction of Irrigation and Variety on growth and forage yield of Maize during 2021/2022 dry season at Sokoto.

Variety	**Irrigation interval (days)**	**Plant height (cm) 4WAS**	**6WAS**	**8WAS**	**Number of leaves/plant 4WAS**	**6 WAS**	**8WAS**	**Leaf length (cm) 6WAS**	**Leaf width 4WAS**	**6WAS**	**8WAS**	**Forage yield (t/ha)**
SAMMAZ 15	**3**	84.30^{a}	134.29^{a}	140.50^{a}	10.66a	14.00^{a}	17.00^{a}	69.60^{a}	6.40^{a}	7.43^{a}	7.40^{a}	5.58^{a}
SAMMAZ 15	**4**	67.50^{a}	95.70^{bc}	99.70^{bc}	8.67^{ab}	12.67^{ab}	14.00^{ab}	63.70^{ab}	5.53^{ab}	6.36^{ab}	6.20^{ab}	1.98^{bc}
SAMMAZ 15	**5**	66.27^{ab}	103.50^{abc}	115.2^{abc}	8.33^{ab}	12.67^{ab}	14.33^{ab}	65.20^{a}	5.57^{ab}	6.73^{ab}	6.60^{ab}	2.54^{bc}

SAMMAZ 33	**3**	68.97^{ab}	106.90^{abc}	122.0^{ab}	8.33^{ab}	12.67^{ab}	6.56^{ab}	68.33^{a}	5.00^{ab}	6.76^{ab}	6.56^{ab}	4.22^{ab}
SAMMAZ 33	**4**	68.13^{ab}	105.70^{abc}	122.5^{ab}	9.00^{ab}	13.00^{a}	7.16^{ab}	68.80^{a}	5.26^{ab}	7.00^{ab}	7.16^{ab}	2.96^{abc}
SAMMAZ 33	**5**	57.70^{a}	76. 20^{c}	82.30^{c}	7.33^{ab}	10.00^{b}	5.70^{b}	52.60^{b}	4.73^{b}	5.80^{b}	5.70^{b}	0.91^{c}
Ex-Dundaye	**3**	71.17^{ab}	113.20^{ab}	129.50^{ab}	8.00^{ab}	13.00^{a}	15.33^{ab}	68.40^{a}	5.50^{ab}	7.20^{ab}	7.70^{a}	3.21^{abc}
Ex-Dundaye	**4**	57.00^{b}	104.60^{abc}	113.80^{abc}	6.00^{c}	13.00^{a}	14.00^{ab}	64.40^{ab}	5.53^{ab}	6.53^{ab}	6.30^{ab}	2.27^{bc}
Ex-Dundaye	**5**	73.70^{ab}	89.20^{bc}	107.00^{abc}	7.60^{ab}	12.00^{ab}	14.33^{ab}	59.43^{ab}	5.20^{ab}	6.26^{ab}	6.20^{ab}	2.07^{bc}
SE±		±0.64	13.82	13.95	1.32	1.42	1.27	6.82	0.64	0.62	0.64	1.18

ns = non-significant

Means followed by the same letter do not differ significantly at P< 0.05 according to DMRT.

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