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Effects of Irrigation Intervals on Dry Season Production of Cowpea (*Vigna unguiculata*) in Forest-Savannah Agro-Ecological Zone of Nigeria

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Abstract

A field experiment was carried out at the farm of the Federal University of Technology Akure (FUTA) to investigate the effects of irrigation intervals on dry season production of cowpea during the 2018 and 2019 dry seasons. Randomized complete block (RBCD) was used during the field experimentation with three replicates. Four treatments were considered, which include twice daily irrigation, once daily irrigation, every other day irrigation and two days interval irrigation. The two cowpea varieties used for the experiment were IT89KD-288 and IT89KD-391. The phenological data collected includes plant height (cm), number of leaves, number of branches per plant, while the yield data are number of pods per plant, pod length, seeds per plot, 100 seed weight and yield per hectare. Significant differences were observed in the different characters studied in the various treatments. Twice daily irrigation treatment exhibited highest growth and yield characteristics while two days intervals of irrigation treatment showed the lowest growth and yield characteristics probably due to low water potential. Therefore, in other to achieve a better yield of cowpea, twice daily irrigation is advisable.

Keywords

Irrigation intervals; Dry season farming; Crop water requirements; Phonological characteristics

Introduction

Cowpea (*Vigna unguiculata L Walp*) which comes from the family fabaceae is a native to Africa. Cowpea, a grain legume crop is an important source of food, income and livestock feed and forms a major component of tropical farming systems. It is a valuable and reliable asset that brings income for many smallholder farmers and traders in sub-Saharan Africa. The grain is also a good source of human protein, while the haulm is an important source of livestock protein. Growing cowpea is beneficial due to its ability to fix atmospheric nitrogen into the soil through a process called biological nitrogen fixation (BNF). Through biological nitrogen fixation nitrogen gas (N2) present in the atmosphere is fixed and turned into readily available nitrogen for the preceding plant's uptake with the aid of soil micro-organism like rhizobia.

About 80% of the cowpea produced in Nigeria is from the savannah zone of the country. Cowpea is better adapted to drought, high temperatures and other biotic stresses compare with other crops. Cowpea production is done mainly during the dry season in South-western Nigeria. The potential yield of cowpea is reduced in South-western Nigeria possibly by higher rainfall received during rainy, relatively low amount of rainfall is required for podding, while occasional showers with high temperature are required for ripening and drying for good quality seeds [1]. During this season, cowpea is easy to grow as water is availability is controlled farmers through irrigation.

Dry season is a regular period of prolonged dry weather. Dry season farming improves food availability and ensures better pricing all the yearlong. It helps reduce the country's reliance on importation and ensures food security. Dry season farming can significantly contribute to the country's GDP through food exportation. In recent times, Nigerian government has significantly increase is participation agricultural production by increasing in its investment in irrigation.

Irrigation is the process of applying controlled amounts of water to plants at needed intervals. Irrigation scheduling can be regarded as a research field, which has moved from innovative science to reading of water use, or at most the refinement of existing practical application. Regardless of irrigation scheduling, plant still regulates their diurnal water status at a favourable level by the control of stomata aperture. Stomata closure helps to maintain a high level of water potential, which leads to a reduction in photosynthetic activity [2]. Irrigation schemes in developing countries especially in sub-Sahara Africa (SSA) suffer from very low water use efficiency, resulting in water logging. Therefore, optimal use of these limited resources is essential. Sprinkler irrigation is a system in which water is applied by means of perforated pipes or nozzles operated under pressure so as to form a spray pattern. The sustained use of water is an important objective for agricultural development. The long-term sustainability of water uses was an important consideration in the development of the guidelines. Therefore, this study was designed to evaluate the growth and yield responses of cowpea to irrigation intervals during the dry season farming [3].

Materials and Methods

The experiments were conducted during the 2018 and 2019 dry seasons at the research farm section of Federal University of Technology Akure. Akure, Ondo State is within the forest-savannah agro-ecology of Nigeria. It has an average annual rainfall of about 1225 mm, average annual maximum and minimum temperature of 34.8° C and 24.3° C respectively. The rainfall pattern of the region has distinct dry and wet seasons. The dry season runs from early November to the end of early April, while the wet season is from early April to early November. There are two rainfall peaks in June and in September with dry spell in August. Relative humidity is high throughout the year and it ranges between 60 and 90%.

The two cowpea varieties used for the experiment were IT89KD-288 and IT89KD-391. IT89KD-288 is a dual-purpose cowpea variety with large white seeds and a rough seed coat. IT89KD-391is also a dual-purpose cowpea variety but it has medium-to-large brown seeds with a rough seed coat. The varieties also have yield advantages of at least 80% over the local varieties. They are early maturing variety, heat tolerant and photo-insensitive with upright growth habit. In addition to being resistant to Alectra and striga tolerant, the varieties have resistance to major diseases and insect pests [4].

The treatments consisted of four irrigation intervals (twice daily, once daily, every other day and two days interval), were laid out in Randomized Complete Block Design (RCBD) and replicated three times. The land was ploughed twice and harrowed once. The soil was loamy sand. The soil pH was slightly acidic. The organic carbon (2.72 g kg^{-l}) and total nitrogen (0.003 g kg^{-l}) were low. The calcium (3.34 cmol kg) and potassium (0.33 cmol kg^{-l}) contents were low. The available phosphorus (12 mg kg^{-l}) and magnesium (2.33 cmol kg^{-l}) contents were moderately available. The sowing depth was about 2 cm to 3 cm with one seed sown per hole. Plot size was 5.3 cm by 7.5, inter row spacing was 25 cm, Intra-row spacing was 1.1 cm, between plant spacing as 25 cm. First weeding was done manually by hand picking about 2-3 weeks after planting and weeding was done 4-6 weeks after planting and subsequent weeding was done as necessary. Phenological and yield data were collected from each treatment weekly. The phenological data collected includes plant height (cm), number of leaves, number of branches per plant, while the yield data are number of pods per plant, pod length, seeds per plot, 100 seed weight and yield per hectare.

Data collected from the experiment were subjected to Analysis of Variance (ANOVA) and least difference (LSD) using Statistical package for social science (SPSS), while mean differences were separated at 5% level of significance.

Results

Table 1 shows the effects of irrigation interval on plant height of the selected varieties of cowpea. It was discovered that plant height of cowpea decreases with reduced irrigation water application irrespective of the varieties of cowpea. The tallest plants at 8 weeks after planting during the 2018 and 2019 dry season (27.2 cm and 28.62 cm) was obtained from the variety IT89KD-288(V1) subjected to twice daily irrigation, while IT89KD-3911(V2) responded equally to the first treatment (twice daily irrigation) with plant height of 27.68 cm and 31-9 cm during the 2018 and 2019 dry season farming respectively. The shortest plant (24.17 cm and 23.48 cm) during 2018 and 2019 dry season planting for V1 subjected to irrigation at two days interval.

Similar trend with was found from the V2 subjected to two days interval irrigation. Effects of irrigation interval on number of leaves of selected varieties of cowpea are shown in **Table 2**. Effect of irrigation interval to cowpea number of leaves showed significant differences on leaves. The maximum number of leaves (14 and 15) was found on V1 irrigated at twice per day. V2 planted and irrigated with twice daily irrigation also has the highest number of leaves (14). Although number of leaves was found to reduce with reduced irrigation, there was no significant difference in the number of leaves of cowpea subjected to other two treatments (every other day and two days interval) irrespective of the varieties of cowpea.

The number of branches per plant of cowpea as affected by irrigation interval is presented. Statistical analysis of the data showed that the number of braches per plant was significantly affected by the variations in irrigation intervals. The highest number of branches were highest (18 and 17 branches per plant) were found on IT IT89KD-288 subjected to twice daily irrigation during the years of planting. This is also the case with V2 irrigated twice daily. Performance of number of nodules per plant of cowpea varieties to irrigation intervals showed significant variation .The highest number of nodules per plant pod (25.7) was found in IT89KD-288 treated twice irrigation during the 2018 dry season planting. The lowest was found the lowest (12.8) was found in IT89KD-288 planted and irrigated at two days interval during the 2019 dry season planting. The number of pods per plant and number of seeds per pod are presented.

For number of pods per plant, the two days interval of irrigation treatment produced significantly the lowest number of pods of all the other treatments. The number of pod per plant of twice daily treatment was significantly the highest in all the treatments irrespective of the variety and the year of planting. Seeds per pod was not significantly different ($P>0.05$) to differences in irrigation intervals. IT IT89KD-288 has higher average number of seeds per pod (15) than IT89KD-391 with average number of seeds per pod of 12. The 100 seed weight and grain yield as influenced by the different irrigation intervals are indicated. Hundred seed weight was not significantly ($P<0.05$) different among the treatment levels irrespective of the varieties and year of planting. The average 100 seed weight of variety 1 was 14 g while that of variety 2 was 12 g. Additionally, the two days irrigation interval treatment effect was the lowest in their responses to irrigation intervals. Grain yield differed significantly ($P<0.05$) among the treatments. The twice daily treatment recorded the highest yield of 3130.8 kg/ha and 2833.5 for variety 1 planted during the dry season of 2018 and 2019 respectively. The same pattern of yield was also recorded with variety 2 as the highest yield was recorded in twice

irrigation treatment. The two days irrigation interval treatment effect was also significantly the lowest among treatments.

Variety	Treatment	2018			2019		
		4 WAP	6 WAP	8 WAP	4 WAP	6 WAP	8 WAP
IT89KD-288	Once daily	23.17 ab	24.96 a	27.20 ab	23.26 ab	24.84 ab	28.62 ab
	Every other day interval	21.87 b	22.34 b	25.81 b	22.46 b	23.46 ab	25.64 b
	Two days interval	20.29 b	22.30 b	24.17 bc	21.42 bc	22.96 ab	23.48 bc
	SE ±	0.73	0.77	1.52	0.75	0.81	1.48
IT89KD-391	Twice daily	22.52 a	24.82 a	27.68 a	23.82 a	26.68 a	31.98 a
	Once daily	20.12 b	22.62 ab	24.96 b	23.10 a	24.96 a	29.34 ab
	Every other day interval	19.40 bc	20.86 b	22.42 bc	22.86 a	24.23 b	26.62 b
	Two days interval	18.64 b	19.48 b	20.86 c	22.48 a	24.21 b	25.42 bc
	SE ±	0.68	0.72	1.02	0.82	0.86	0.86

Table 1: Effects of Irrigation Interval on Plant Height (cm) of Selected Varieties of Cowpea at 4, 6 and 8 Weeks after Planting (WAP).

Variety	Treatment	2018			2019		
		4 WAP	6 WAP	8 WAP	4 WAP	6 WAP	8 WAP
IT IT89KD-288	Twice daily	10a	13a	14a	10a	13a	15a
	Once daily	7bc	11b	13a	9b	11b	12b
	Every other day interval	7bc	8c	9b	8c	9c	10c
	Two days interval	7bc	8c	9b	8c	9c	10c
	SE ±	0.5	1	1	0.5	1	1
IT IT89KD-391	Twice daily	9a	13a	14a	10a	13a	14a
	Once daily	9a	11b	13a	8b	11b	13a
	Every other day interval	9a	10b	12ab	7c	8c	9b
	Two days interval	7b	9bc	10b	7c	8c	9b
	SE ±	0.5	1	1	0.5	1	1
		s	s	s	s	s	s

Table 2: Effects of Irrigation Interval on Number of leaves of Selected Varieties of Cowpea at 4, 6 and 8 weeks after planting (WAP).

Discussion

Cowpea growth parameters measured were plant height, number of leaves and number of branches per plant. It was discovered that the growth parameters of cowpea decreases with reduced irrigation water application irrespective of the varieties year of planting of cowpea. Results of this study revealed that the excess watering treatment had the highest significant positive effects on plant heights, number of leaves and number of branches per plant, which implies that the cowpea plants that received excess water showed vigorous growth statistically compared to other treatment considered. This observation is in agreement with the evidences [5-7] who showed that under field conditions cowpea exhibits rapid growth and extreme drought avoidance at the vegetative stage to the extent that water conservation by the remaining tissue ensures plant survival. Cowpea plants that received fewer water treatment significantly decreased in the growth parameters investigated probably as a result of water stress. This is in conformity with the observation, who reported that under water deficit conditions, growth parameters were sharply reduced as a result abscission. It was also reported by Gomesda et al. 2001, that water stress has a significant effect on the growth and biological nitrogen fixation of cowpea [7,8].

The study showed that grain yield did differ significantly among the treatments. Twice daily treatment recorded the highest grain yield which was followed by once daily treatment while irrigation at two days intervals treatment recorded the least. An important observation was that treatments that had highest growth characteristics also had highest yield attributes (nodules/plant, pods/plant, seeds/pod, 100 seed weight and yield/ha). Meaning there is a positive correlation between the growth and yield parameters of cowpea [9-13].

Conclusion

From the result of the analysis obtained, it can be concluded that the excess watering is required for optimum growth of cowpea. Dry season cowpea production need adequate soil moisture conditions while reduced supply of water significantly decreased growth as a result of water stress as cowpea plant showed stunted growth due to lowered water potential level. There is a strong positive correlation between the growth and

yield of cowpea. Therefore, in other to achieve a better yield of cowpea, twice daily irrigation is advisable as evident from the result obtained in agronomical parameters analyzed.

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