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Effect of Solid Set Sprinkler Irrigation System on Lucerne (*Medicago Sativa*) Production Under River Nile State condition, Sudan

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Abstract
The study was conducted during the growing seasons 2011/12 and 2012/13 on an area of 2 hectares at the Experimental Farm of the Faculty of Agriculture, Nile valley University, Darmaly, Sudan, longitude 34 00 E0, latitude 17 48 N0, and altitude 346.5 m above m.s.l. The climate is semi-arid and the soil is sandy clay loam. The objective of the study was to investigate into the effect of main line and laterals length of solid set sprinkler system on growth and yield of alfalfa forage, as an indicator crop, the experiment was arranged in split plot procedure with two replications. Treatments were 60, 120 and 180 m main pipe lengths which allotted to main plots. In addition to 25 and 50 m laterals lengths assigned to subplots. The results revealed that the main line length showed no significant impact on plant height. However, it had a highly significant effect on number of leaves per plant with the 120 m-line recording the greatest values of plant growth throughout the two seasons. Fresh weight was highly significantly affected by the main line length in two season, Which in dry weight was effected by treatments of the trail, but not effected in second season. The highest fresh weight was recorded under the 120 m- length treatment, but, in the 180 m- length treatment they had the lowest dry weight. On the other hand, the laterals length had not significantly affected the growth and yield of alfalfa.
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INTRODUCTION

The major constraints to produce enough food to meet the increasing demand of the world population are water scarcity and energy which it considers as a new challenge will be imposed farmers. The increased competition for water among agricultural, industrial and domestic consumers creates the need for continuous improvements in techniques for judicious use of water in crop production. It is inevitable in near future because of high water savings, friendship of environment and is suitable for most crops with frequent and uniform applications of water, adaptable over a wide range of topographic and soil conditions. One possible approach to conserve these scarce resources may be through introducing efficient irrigation systems. Irrigation is an important determinant of crop yield and growth because it is associated with many factors of plant environment, which influence growth and development. Availability of adequate amount of moisture at critical stages of plant growth not only optimizes the metabolic process in plant cells but also increases the effectiveness of the mineral nutrients applies to the crop (Saif, *et al*., 2003).An efficient sprinkler system depends on a good design and factors which affect uniformity and distribution of irrigation water. A major factors affecting irrigation water uniformity of distribution are hydraulic performance which affect by pipe length, the field topography, the arrangement and spacing of nozzles on the lateral and spacing between laterals. Alfalfa (Medicago Sativa) crop is considered as important forage in the zero grazing areas in Sudan in general and in River Nile State in particular. This crop is exclusively grown under surface irrigation on many farms with different soil type, especially the newly

outlet and section 3; 300 meter from the first outlet) and each with two laterals parts (part 1 was from the inlet of lateral to 25 meter from the main line and part 2 was from 25 to 50 meter from the main line).

Water was provided by using a pump giving a head of 70 m with a flow rate of 35 m^3/min. Behind the pump there was a valve to regulate and control of the main discharge and the main pressure head in the main line. The main line was an aluminum pipe of 150 mm diameter and 300 m in length. 30 laterals were fixed to two sides of main line with valves at the head of each lateral. The lateral was an aluminum pipe 100 mm diameter and 90 m long, with 18 m sprinklers head apart. The spacing between tow laterals was 18 m. The ends of the laterals were closed.

Plant measurements:

Agronomic traits for alfalfa crop were taken on plant height, number of leaves per plant, wet and dry matter weight. From each plot, some plants were selected at random (at least 5 plants from the middle of each plot) and the average plant height (cm) was measured by a metal meter from the base of the stem to the tip of the youngest leaf, and then the mean was calculated for each treatment. In addition, the number of leaves per plant was obtained. A quadrate (1m square) was tossed randomly in each plot, and the plants enclosed inside were counted to give the number of plants per m2. These plants were cut, tied in bundles and weighed to give the fresh yield (kg). The bundles were left to dry in the air for several days, then they were re-weighed to obtained the air dry yield.

Statistical Parameters Analysis:

Analysis of variance was used to evaluate the responses of each studied character of alfalfa crop. Wherever a significant F-test was found, the mean values were separated using least significance difference (LSD). All analyses of variance were computed using the SAS microcomputer program (2004).

RESULTS AND DISCUSSION

Effect of the main line sections length on plant parameters

Effect of the main line length on plant height for the two seasons is shown in table 1. As it is clear from the table, the effect of the main line length on plant height was not significant ($P \leq 0.05$) in both seasons. However, the 180m – treatment gave the tallest plants in both seasons (44.05 and 40.25 cm) in the two seasons, respectively, followed by 120 m length as compared to the 60 m – treatment which gave the shortest plants in the second season. Taller plants are a sign of proper amount of irrigation water been applied to the plants.

cultivated areas. Iqbal et al., (2014) mentioned that the commercial production of crops is not possible without adequate water availability throughout the growing season. Internationally, the water availability is a great challenge and in the present scenario. The total area of forage production in Sudan is estimated to be about 126,000 ha, (Zaroug, *et al*., 1997). This area is expanding with the increased attention given to dairy production and also to satisfy the requirements of increasing animals for meat. The demand is continuously increasing due to normal population growth and mass immigration of rural communities. In addition to this, a remarkable activity for cattle and sheep for export has resulted in increasing the area of fodder crops grown primarily under irrigation (Idris, *et al*., 2013).

Alfalfa has a high water requirement compared to other crops. Evapotranspiration is between 800 and 1600 mm growing period depending on climate and length of growing period (FAO, 2002). So that the objectives of present work seek to investigate into the effect of main line and laterals length of solid set sprinkler system on growth and yield of alfalfa forage

MATERIALS AND METHODS

Field experiments were conducted during consecutive growing seasons 11/2012 and 12/2013 in an area of 2 ha. The study site was located in Nile State, Sudan at the Experimental Farm of the Faculty of Agriculture, Nile Valley University, Darmaly, , longitude 34^0 00' E, latitude 17^0 48' N and altitude 346.5 m above msl. The climate of the region is arid with great variation in temperature and rainfall. The weather is very hot in summer and very cold in winter. The soil of the location of the experiment is sandy clay loam with high percentage of sand. The topography of the area is mostly gently sloping towards River Nile. The field capacity by weight was 33%, the intake rate ranges between 19 and 31 mm/h, the bulk density was 1.45gm.cm^{-3} and very low organic matter of 0.04%. The irrigation water was obtained from local well. The irrigation water has a pH of 7.4 and total soluble salts of 945 ppm. Sodium adsorption ratio (SAR) value was 2.66. Treatments involved thee sections (main plots) of the mainline started from the first laterals. Each section was divided into four parts (subplots) according to the length from the mainline in two side on both its sides, two parts located at length of 25 m. While, the other two parts were allotted at a length of 50 m from the mainline.

The experiment was arranged in split plot design with three replications. The indicator plant used was alfalfa. The sections of the main line were assigned to the main plots and the laterals parts were plotted in subplots. Three sections of the main line (section 1; 100 meter from the first outlet, section 2; 200 meter from the first

Table 1. Effect of the main line sections length on plant parameters

	Plant height (cm)		No. of leaves/plant		Wet weight (kg)/m^2		Dry weight (kg)/m^2	
	main		Main		main		main	
	First Season (NS)	Second Season (NS)	First Season(**)	Second Season (*)	First Season (**)	Second Season (**)	First Season (*)	Second Season (NS)
60 m	36.05	33.6	70.75b	69.6b	5.328a	3.819b	1.4798b	1.1688
120 m	40.25	44.05	96.4a	79.75a	2.5988b	6.645a	2.9358a	2.969
180 m	35.5	38.3	76.7b	70.6b	2.14b	3.4218b	2.9235a	2.8638
C.V.	16.7	15.1	5.21	4.24	7.77	12.63	20.8	7.67
LSD	13.997	13.135	9.5341	6.9929	0.5867	1.3158	1.1449	0.5177

**Highly significantly different (P≤0.01)
* Significantly different (P≤0.05)
NS not significantly different (P≤0.05)

Effect of lateral lengths on plant parameters

Effect of first lateral lengths on plant height is illustrated in table 2. It is clear that the treatments had no significant effect (P≤0.05) on plant height in the two seasons. However, 50 m long lateral, in the second season, gave the highest plant height. This may be attributed to good water distribution obtained at this length.

Number of leaves per plant was also unaffected by lateral length. However, 50 m long lateral treatment showed the highest number of leaves per plant in the first season. The highest number of leaves per plant is a sign for vigorous vegetative growth obtained under proper amount of irrigation water.

As data presented in table 2 the length of the lateral had no significant effect on wet weight of the crop, but, the highest fresh weight was obtained under 50 m long lateral in the second season. Whereas, the lowest fresh weight was obtained under 50 m long lateral in the first season. This indicates that there was no clear trend of fresh weight during the two season trials with regard to the length of the lateral.

Dry weight of the crop was not significantly affected by the length of the lateral (table 2). However, 25 m length lateral in the second season scored the highest value of dry weight, whereas 50 m length lateral gave the lowest value of dry weight of 2.28 kg/m2. This may be understood in the light of the fact that the plants under 50 m long lateral with their vigorous vegetative growth had high moisture content in their tissues which was easily lost during open sun drying resulting in low values of dry weight.

The interaction of main plots and sub plots did not show any statistical difference under all studies plant parameters in two seasons

Table 1. depicts the effect of lateral length on number of leaves per plant. It is evident from the table that the effect of lateral length was highly significant (P≤0.01) and significant (P≤0.05) in the first and the second seasons, respectively. Throughout the two seasons, 120 m obtained the highest number of leaves per plant of (96.4) which was significantly different from 60m and 180m. The greater number of leaves per plant is an indication of suitable amount of irrigation water. The 120 m-length plants received the proper amount of water without shortage of water or water logging.

This is shown in table 4.3. It is clear that the effect of lateral length on wet weight was highly significant (P≤0.01) in both seasons. The 120 m – legth plants gave the highest wet weight per m^3 throughout the two seasons (6.645 kg/m^2) which was not significantly different from the 60 m – distant ones that gave 5.328 kg/m^2. It is clear that the 120 m – length gave the highest number of leaves per plant; hence they attained the highest fresh weight due to vigorous vegetative growth ascribed to the suitable amount of irrigation water they received.

It is evident from table 1. the length of the lateral had a significant effect on dry weight in the first second season. Among the three treatments, the 60 m had the lowest dry weight. While the highest dry weight obtained under 120 –m main line length. Followed by 60-m main line length, which they were statistically similar and differ from 120-m main line length. 120 –m main line length might have supplied water in adequate proportion throughout the growing period of crop which triggered the plant growth through accumulation of higher photosynthesis in the plant leaves resulting more vegetative growth.

Table 2. Effect of lateral lengths on plant parameters

	Plant height		no. of leaves/plant		Wet weight (kg)/m^2		Dry weight (kg)/m^2	
	sub		sub		sub		sub	
	First Season	Second Season	First Season	Second Season	First Season	Second Season	First Season	Second Season
25 m	38.233	36.733	80.867	72.467	3.4143	4.6022	2.6145	3.0743
50m	36.3	40.567	81.7	74.167	3.2968	4.655	2.2782	2.9267
C.V.	16.7	15.1	5.21	4.24	7.77	12.63	20.8	7.67
LSD	11.428	10.725	7.7845	5.7097	0.479	1.0744	0.9348	0.4227
	NS	NS	NS	NS	NS	NS	NS	NS

**Highly significantly different (P≤0.01)

* Significantly different (P≤0.05)

NS not significantly different (P≤0.05)

CONCLUSIONS AND RECOMMENDATIONS

From the results of the present study, it can reasonably be concluded that laterals lengths had not impact the plant growth and yield. Whereas the fresh weight was highly significantly influenced by main line length. Solid set sprinkler systems can efficiently be used for alfalfa production under arid and semi- arid conditions

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