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Effects of Deficit Irrigation and Mulch on Yield and Quality of Potato Crop

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Abstract

Field trials were carried out at Uswo location, located in North Rift part of Kenya during March 2016-July 2016 growing seasons. The main objective was to determine the yield and quality responses of potato crop to deficit irrigation (DI) and mulch. Experimental set up was a randomized complete block design (RCBD) with three replicates. In the study, five water levels of drip irrigation (100 % ETc, 90 % ETc, 80 % ETc, 60 % ETc and 50 % ETc) with and without mulch were considered. The 100 % ETc was used as an experimental control. Deficit irrigation was carried out at different growth stages of the plant for the remaining plots. The plots were covered during a rain event with a polythene sheet as a shelter and unrolled when there was no rain. Results revealed that plots with mulches at 100 % ETc attained 50 % plant emergence earlier than those without mulches. Also highest plant heights, stems per plant and better tuber qualities were achieved in the mulched plots under 100 % ETc. Water use efficiency (WUE) increased as the irrigation water was reduced. Tuber yields ranged from 16.2±0.6 t ha^{-1} to 29.5±0.9 t ha^{-1} and 14.3±0.5 t ha^{-1} to 27.3±0.5 t ha^{-1} for mulch and non-mulch treatments respectively. WUE ranged from 33.6 to 59.8 kg/ha/mm and 30.8 kg/ha/mm to 53.4 kg/ha/mm for mulch (M) and non-mulch (NM) respectively. Optimal crop production was obtained at 80 % ETc with WUE of 40.1 kg/ha/mm and 36.9 kg/ha/mm for mulch and non-mulch respectively. Therefore optimal crop production with minimum water use is recommended for practice in farms with scarce water resources.

Keywords: Yield, Water Use Efficiency, Deficit Irrigation, Rain Shelter

INTRODUCTION

Potato (*Solanum tuberosum* L.) is the fourth most important food crop after rice, wheat and maize in the world and over a million people on earth eat potatoes (Devaux *et al.*, 2014). According to report of Ministry of Agriculture in 2008, potato is the second most grown crop after maize in Kenya (Muthoni *et al.*, 2011). Potato production has been experiencing problems like the erratic rainfall patterns leading to annual droughts that occur in semi-arid Sub-Saharan Africa (SSA). Regular water supply is essential for growth and development of potato and with interruption it leads to low yields and poor quality. Various limiting factors have led to decline in potato production at a rate of 11 % per year (Kaguongo *et al.*, 2013). High cost of inputs, low yielding varieties, occurrence of diseases as well as poor quality seeds affects the production of potatoes in Kenya (Kaguongo *et al.*, 2008). In order to meet the market demands and standards, tuber yield and quality are very important factors to be considered.

It is important to identify the potato sensitive growth stages in order to avoid soil water deficits. Water stress during the sensitive growth stages will affect tuber yield and quality if poor timing of irrigation water is done. Deficit irrigation (DI) has a significant effect on yield and quality of potato crop (Hassan *et al*., 2002). Many researchers have found that deficit irrigation is a dependable way of increasing water use efficiency (WUE) and crop yields (Blum *et al*., 2009). Blum, Geerts and Raes in their studies pointed out that practically less water than required is used during the growing period. Also a research conducted by (Starr *et al*., 2008; Kang *et al*., 2004) revealed that DI increased tuber yield. With DI saved water can be used to irrigate more land and increase crop production per unit water used (Kipkorir *et al*., 2001).

Mulching is one of the important water management strategies used to improve water use efficiency. Mulch improves soil moisture conditions especially in arid and semi-arid regions. Further, it increases crop yield, reduce soil erosion, conserve soil moisture, modify soil temperature and structure and suppress weeds. It is important to understand the effects of irrigation levels and mulch in order to improve water management resources (Bozkurt, 2011). Chakraborty *et al*., (2008) were of the opinion that mulching is a better way of influencing the crop-growing environment to increase crop yield and improve product quality by reducing soil evaporation, controlling soil temperature, and retaining soil moisture.

Through combination of deficit irrigation and mulch by using drip irrigation, more water can be saved with improved potato yields. Therefore, efficient use of available water is encouraged in order to achieve high water use efficiency. This study aimed to: i) determine the potato yields under mulch and no mulch at different water regimes, and ii) determine the effect of deficit irrigation and mulch on yield and quality response of potato crop.

MATERIALS AND METHODS

Study Area Location

The research was carried out in Uswo location of Keiyo highlands climatic conditions at latitude 00^0 $46^{'}$ $30^{''}$ N, longitude 35^0 29’10’’E and altitude 2700m above sea level (Fig. 1) located in the North Rift part of Kenya.

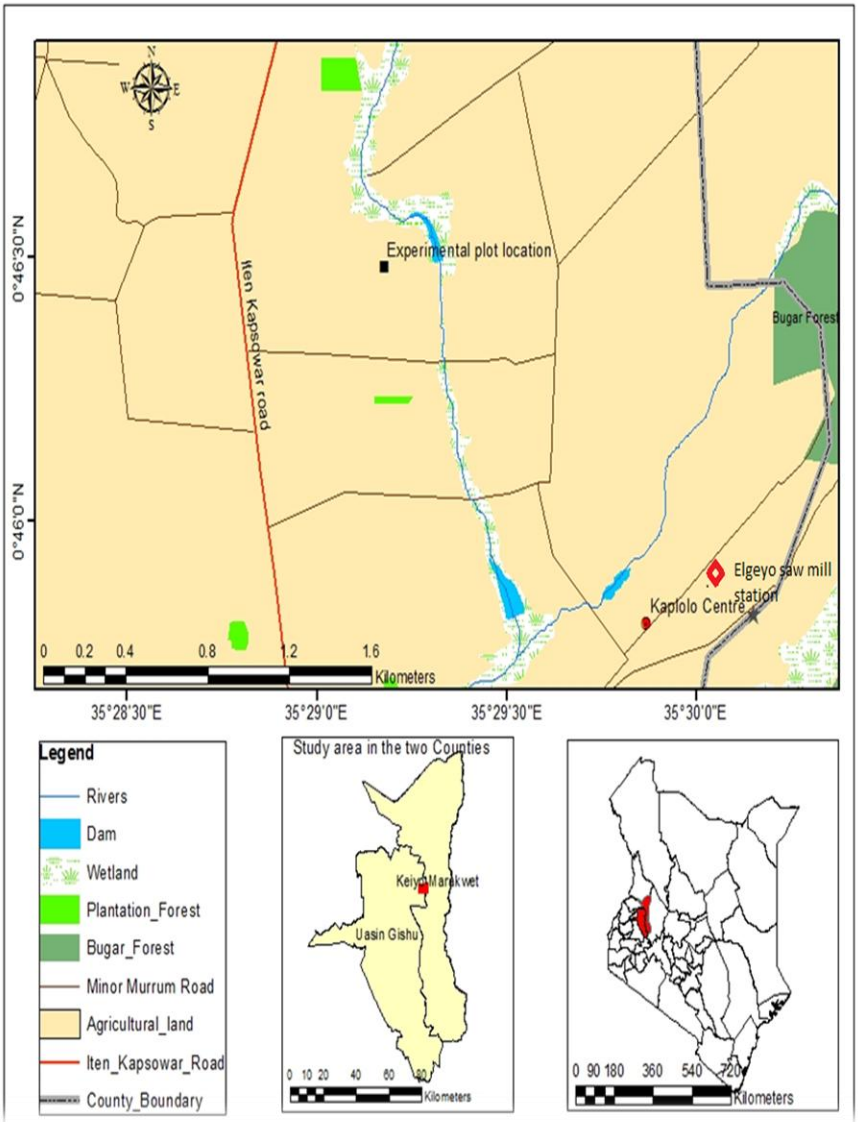
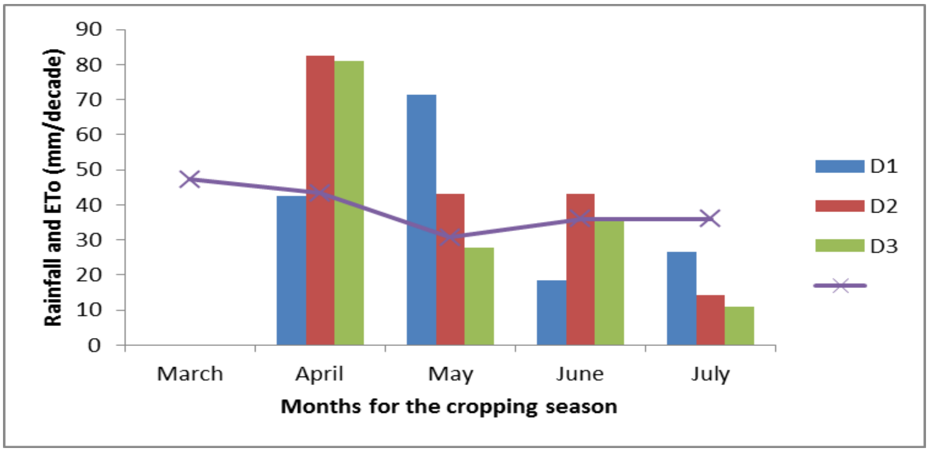


Figure 3: Study area location

Meteorological Data

The meteorological data for the period of the study was obtained from Elgeyo Saw Mills station located 2 km from the field trial site (Fig. 1). Monthly maximum temperature ranged from 19.1-28.7^{0}C while minimum temperature ranged from 8.2-14.2°C. A total rainfall of 497.7 mm was received during the period of April 2016-July 2016 (Fig. 2) The area experiences long rains between April-June and short rains between October-December.



D-denotes decade

Figure 4: Amount of rainfall received and reference evapotranspiration, ETo (line) per decade in 2016 during the growing period of field trials

Soil Sampling and Characteristics

Field experiments were conducted to determine the type of soil and their moisture contents. The samples were collected from soil depths of 0-15, 15-30 and 30-45 cm before sowing and sieving was done using hydrometer method to determine soil particle size distribution (Table 1). Results indicate that the soil type was sandy loam. Other subsequent samples were collected at an interval of 10 days up to maturity of the crop for root zone soil moisture determination. Field capacity and permanent wilting points was determined using soil calculator (Saxton & Rawls, 2006). Soil bulk density was determined using the core sampling method. This was done by driving a metal core into the soil up to the soil depths under study and then the samples were taken to the laboratory for oven drying and weighed.

Table 2: Physical characteristics of the soil from the experimental field

Depth (cm)	Sand (%)	Clay (%)	Silt (%)	Textural Class (USDA)	Bulk Density (g/cm^3)	FC (Vol. %)	PWP (Vol. %)	AWC (%)
0-15	70.5	9.5	20.0	SL	1.40	18.5	8.6	9.9
16-30	68.0	8.5	23.5	SL	1.35	18.6	8.3	10.3
31-45	64.0	10.0	26.0	SL	1.50	19.8	8.9	10.9
Mean	67.5	9.3	23.2		1.42	19.0	8.6	10.4

NB: SL= sandy loam, FC=field capacity, PWP=permanent wilting point, AWC= Available water content.

Irrigation Scheduling

Long term historical data was used to develop the irrigation schedules during the study. Irrigation schedule was based on avoiding water deficit during the sensitive growth stages like stolonization and tuber initiation. Moisture stress was avoided during these stages since they are the critical growth stages of potato crop. Severe water stress at these periods leads to great yield and quality reduction. Irrigation schedules were formulated basing on the daily reference ET_o estimated using modified Penman–Monteith equation. Ten schedules were formulated considering various levels of water application and mulch (Table 2). Crop evapotranspiration was computed on daily basis using values of crop coefficients for potato. Irrigation calendars were developed to give simple guidelines on how to adjust irrigation timing and depth during the growing season to the actual weather condition and also when shortage in the supply of irrigation water occurs.

Table 3: Formulation of irrigation schedules

Mulch Treatment	
T100	Irrigation at 100 % of crop evapotranspiration (ET_c) under wheat straw mulch with drip irrigation
T90	Irrigation at 90 % of crop evapotranspiration (ET_c) under wheat straw mulch with drip irrigation
T80	Irrigation at 80 % of crop evapotranspiration (ET_c) under wheat straw mulch with drip irrigation
T60	Irrigation at 60 % of crop evapotranspiration (ET_c) under wheat straw mulch with drip irrigation
T50	Irrigation at 50 % of crop evapotranspiration (ET_c) under wheat straw mulch with drip irrigation
Non-Mulch Treatment	
T100	Irrigation scheduling at 100 % of crop evapotranspiration (ET_c) with drip irrigation
T90	Irrigation scheduling at 90 % of crop evapotranspiration (ET_c) with drip irrigation
T80	Irrigation scheduling at 80 % of crop evapotranspiration (ET_c) with drip irrigation
T60	Irrigation scheduling at 60 % of crop evapotranspiration (ET_c) with drip irrigation
T50	Irrigation scheduling at 50 % of crop evapotranspiration (ET_c) with drip irrigation

Experimental design, Treatments and Crop Management

The experimental plots were laid out using factorial arrangement with randomized complete block design (RCBD) with irrigation treatments as the subplots. There were two sets of plots, mulch (M) and no mulch (NM). In total there were 30 plots; five (5) water regimes, two (2) mulching treatments each with three (3) replications. Five irrigation treatments, T100, T90, T80, T60 and T50 (100 % ETc, 90 % ETc, 80 % ETc, 60 % ETc and 50 % ETc) respectively were carried out under drip irrigation system installed after planting the potato seeds. Drip lines were laid with emitter spacing of 30 cm apart and flow rate of 1.2 L h^{-1}. Full irrigation (FS representing 100 % ETc) was used as a control for the other plots. Deficit irrigation was carried out at development and late stages for the remaining plots. During these stages, water deficits have less impact on tuber yield and quality. Before potato emergence, all plots received same irrigation water to avoid water deficits and later irrigation done as per the treatment. In each of the plots, same cultural practices like fertilizer application, pesticide and herbicide application, earthing up/heap and weeding were done.

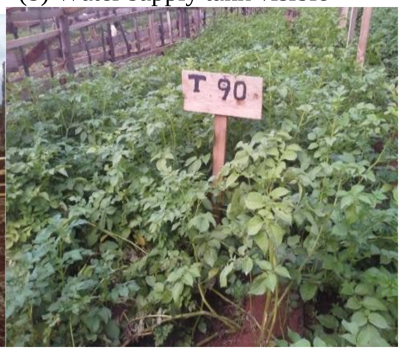
One week after planting, dry wheat straw mulch 3 inches thick was laid down on the potato plots under mulch treatment. Straw mulch was placed onto the plot and spread on the 2.25 m by 6 m plot. An average of 8.15 t ha^{-1} wheat straw mulch was applied uniformly on each plot according to treatment description. The weight of 8.15 t ha^{-1} was adopted based on trial for good coverage of the plot with the mulching material at a depth of 3 inches. In the mulched treatments, potato plants emerged two weeks after planting and three weeks in non-mulched plots. Potatoes were harvested at 120 days after transplanting after attaining maturity. The tubers were left for two weeks under ambient temperature of 18-21 ^{o}C to attain good quality. The relative humidity was 80-90 % before they were analysed.

The experimental plots were covered during a rain event with a polythene sheet as a rain shelter (plate 1). The shelter was designed in such a way that they can easily be rolled-up when there is no rainfall and unrolled when rainfall occurs and during night to avoid interference with the experiment. Wheat straw mulch (8.15 t ha^{-1}) was spread over the soil surface in the plots with mulch treatment after germination of potato tubers.


(a) Shelter during flowering


(b) Water supply tank visible


(c) Mulch treatment



(d) T90 NM treatment

Plate 1 Rain shelter structure used in the field trials

Yield and Tuber Properties

At the end of the season, plants were harvested manually. Fresh tuber weight was calculated by weighing 30 tubers from each treatment at a quadrant area of 1 m^2 of four randomly selected points within each plot and average taken. The tubers were weighed and the weight converted into t ha^{-1}. Tuber parameters were determined according to the methods described by (Kabira *et al.*, 2009).

The tuber diameter and length were measured using a vernier calliper. Tuber grading was done by using three categories namely; small size: < 40 mm, medium size: 40-60mm, large size: > 60 mm diameter. Tuber diameters above 40 mm were considered for marketing and processing. Number of tubers per plant was done by counting tubers from every plant and taking the average. Ten potato plants in each plot were selected randomly and marked to measure plant height during the growing season on a decade time step basis and average taken. To measure stems/plant, physical counting of the number of stems was done for randomly selected plants in each plot and also taking measurements of the plant sizes. Tuber dry matter (Equation 1) was determined by oven drying small chopped pieces of tubers at 65^0C for 48 hours.

$$\text{Tuber dry weight \%} = \frac{\text{tuber dry weight at } 65^0\text{C}}{\text{tuber fresh weight}} * 100$$

(Eqn. 1)

Data Analysis

The data was analysed using analysis of variance (ANOVA) due to the experimental set up of randomized complete block design (RCBD) from the multivariate system of analysis. Separation of means was carried out using Tukey's test at $p<0.05$ significance level.

RESULTS

Below-Ground Biomass

Results in Table 3 showed that mulched plots recorded significant higher ($p<0.05$) below-ground fresh yields than NM plots under all considered water levels. Results further indicated that potatoes grown in mulched plots at T100 showed a significant higher below-ground fresh yield (31.5±0.9 t ha^{-1}) than those in NM plots (28.3±0.5 t ha^{-1}) under the same water regime. At T50, lowest below-ground fresh yield of 20.3±0.5 t ha^{-1} was reported in NM plots, this was significantly lower than in M plots (23.2±0.6 t ha^{-1}).

Table 4: Influence of water regimes on below-ground fresh yield for mulched (M) and non-mulched (NM) plots

Tuber Yield (t ha^{-1})					
Below-ground fresh yield					
Water level	T100	T90	T80	T60	T50
M	31.5±0.9b	29.6±0.2b	28.9±0.4b	26.9±0.3b	23.2±0.6b
NM	28.3±0.5a	25.8±0.1a	24.9±0.2a	21.9±0.4a	20.3±0.5a

Means with different letters within a column are significantly different at p<0.05

From Table 4, significant highest dry tuber yield of 6.8±0.0 t ha^{-1} was obtained in treatment T100M as compared to T100NM which was 5.2±0.1 t ha^{-1}. Lowest yield was 5.3±0.0 t ha^{-1} for T 50 M while T 50 NM was 4.2±0.1 t ha^{-1}. From the results it can be seen that both mulch and water level had a significant effect on tuber yield. Further, tuber dry matter ranged from 18.3 % to 22.8 % (Table 5). For Tigoni variety, tuber dry matter is 18% to 22 % which is a quality parameter for processing of French fries. Other researchers have recorded dry matter content up to 28 %.

Table 5: Influence of water levels on below-ground dry tuber yield for mulched (M) and non-mulched (NM) plot

Tuber Yield (t ha^{-1})					
Below-ground dry yield					
Water level	T100	T90	T80	T60	T50
M	6.8±0.0b	6.3±0.1b	6.1±0.1b	5.6±0.0b	5.3±0.0b
NM	5.2±0.1a	5.0±0.0a	4.8±0.0a	4.4±0.1a	4.2±0.1a

Means with different letters within a column are significantly different at p<0.05

Table 6: Average tuber dry matter for mulched (M) and non-mulched (NM) plots under different water regimes

Water level	T100	T90	T80	T60	T50
M	21.6	21.3	21.1	20.8	22.8
NM	18.3	19.4	19.3	20.1	20.7

Plant Height

From the field measurements, the plant height was higher in the treatments with mulch than in the non-mulched plots. Soil temperatures in the mulched plot could have enhanced better potato growth while late emergence in the non-mulched plots could have contributed to the shorter plant heights. Moreover, full supply plots (T100M and T100NM) had greater heights than the water deficit plots displaying that water level played a significant role in boosting the plant height though the T100M had larger height than the T100NM plot. In both M and NM plots T50 plots had the least crop height. The highest average crop height for mulched plot was 1.2±0.03 m for T100M while the lowest was 0.7±0.01 m for T50M. However for non-mulched plot, the average highest was 1.0±0.06 m for T100NM and the lowest was 0.6±0.00 m for T50NM (Table 6).

Table 7: Effect of mulch and water level on plant height

Plant height (m)					
Water level	T100	T90	T80	T60	T50
Mulch	1.2±0.03b	1.1±0.03b	1.0±0.02b	0.8±0.02b	0.7±0.01b
No-Mulch	1.0±0.06a	0.8±0.01a	0.8±0.05a	0.7±0.01a	0.6±0.00a

Means with different letters within a column are significantly different at p<0.05

Stems per Plant

Mulched plots had higher number of stems/plant compared to no mulch (Table 7). The highest record was in T 100 M (7.0±0.6) and T100 NM (6.3±0.3). T 50 M and T50 NM registered the lowest number of stems per plant, 5.0±0.6 and 4.0±0.0 respectively.

Table 8: Effect of mulch and water level on stems/plant

Stems/plant					
Water level	T100	T90	T80	T60	T50
M	7.0±0.6b	6.7±0.3b	6.0±0.0b	5.3±0.3b	5.0±0.6b
NM	6.3±0.3a	6.0±0.0a	5.3±0.3a	4.3±0.3a	4.0±0.0a

Means with different letters within a column are significantly different at p<0.05

Tuber Growth Characteristics

The effect of mulch and water level on tuber growth characteristics are shown in Table 8. From the results, it is indicated that mulched treatments yielded more than the non-mulched treatments in all the plots. Application of mulch had a significant effect on all the parameters of tuber yield. Also irrigation frequency played a significant role in the tuber growth characteristics. Water deficits affected all the tuber parameters significantly (p<0.05). T100M registered the highest number of tubers per plant of 23.00, followed by T90M (19.67), T100NM was third with 18.67 tubers per plant hence showed better yield component parameters. Also T100M produced 4.33 more tubers per plant compared to bare plot of T100NM. Differences in tubers/plant was not significantly different ($p<0.05$) in T60M and T50M. The lowest number of tubers per plant was 11.67 and 10.00 for T50M and T50NM respectively.

Mulch and water level significantly ($p<0.05$) affected tuber diameter in all the mulched treatments. Tuber diameter responded well to increased irrigation frequencies and mulch. The largest tuber diameter was recorded in T100M with 8.37 cm followed by T90M with 8.00 cm. T80M, T60M and T50M indicated 6.44 cm, 5.60 cm and 4.76 cm respectively. T100NM recorded 7.33 cm while T90NM was 7.00 cm and statistically, no significant difference between the two treatments. T80NM, T60NM and T50NM showed significant difference in tuber diameter.

Significant difference among the irrigation treatments was found in mulched plots. T100 had the largest tuber length in both treatments (M and NM). However, T100M recorded 2.50 cm greater than T100NM. In non-mulched plots, tuber length between T60NM and T50NM treatments did not significantly differ.

Table 9: Effect of mulch and water level on tuber growth characteristics

	No. of Tubers/plant		Tuber Diameter (cm)		Tuber Length (cm)	
Water level	Mulch	No-mulch	Mulch	No-mulch	Mulch	No-mulch
T100	$23.00^{d}\pm1.21$	$18.67^{e}\pm0.74$	$8.37^{e}\pm0.11$	$7.33^{d}\pm0.37$	$12.31^{e}\pm0.41$	$9.81^{d}\pm0.42$
T90	$19.67^{c}\pm0.92$	$15.33^{d}\pm0.37$	$8.00^{d}\pm0.35$	$7.00^{d}\pm0.22$	$11.25^{d}\pm0.12$	$8.76^{c}\pm0.44$
T80	$16.33^{b}\pm0.71$	$13.33^{c}\pm0.31$	$6.44^{c}\pm0.30$	$6.25^{c}\pm0.24$	$9.00^{c}\pm0.67$	$7.23^{b}\pm0.43$
T60	$13.00^{a}\pm0.66$	$12.00^{b}\pm0.63$	$5.60^{b}\pm0.26$	$5.21^{b}\pm0.17$	$6.73^{b}\pm0.10$	$5.90^{a}\pm0.11$
T50	$11.67^{a}\pm0.37$	$10.00^{a}\pm0.63$	$4.76^{a}\pm0.11$	$4.63^{a}\pm0.11$	$6.41^{a}\pm0.22$	$5.54^{a}\pm0.12$

Means with different superscripts within a column are significantly different at $p<0.05$

Tuber Size Distribution

Tuber grading was done by grouping the tubers into three different grades namely, <40 mm, 40-60 mm and >60 mm and their percentage distributions were calculated. Size distribution of 93%, 83% and 73% was seen in large size tubers of >60 mm diameter from T100M, T90M and T80M respectively. Least irrigated plots with mulch, T60M and T50M had less tuber sizes in this category (20% and 10%) respectively (Table 9). These results indicated that mulch and water level had a significant effect on tuber sizes. However, in plots without mulch, irrigation frequency had a significant effect on percentage of tuber sizes > 60 mm. Tubers from T100NM, T90NM and T80NM registered 86.7%, 76.7% and 60% respectively. Both T60NM and T50NM recorded 0% percentage distribution of > 60 mm tubers.

Majority of the tubers were found between 40-60 mm size for mulched and non-mulched plots in less irrigated plots. For non-mulch plots, highest numbers of tubers were found, T60 NM (93%), T50 NM (76.7%) and T80NM (40%) while T50 M, T60 M and T80 M were 76.7%, 73% and 26.7% respectively. Few tubers were found in frequent irrigated treatments with mulch, T100 M (6.7%) and T90 M (13.3%) while for non-mulched plots were 3.3% and 16.7% for T100 NM and T90 NM in that order. Further, for <40 mm size categories, grade proportions ranged from 3.3% to 13.3% and 6.7% to 23.3% for mulched and non-mulched plots respectively. However, T100 M, T80 M and T80 NM recorded 0% proportions in this group. From this result, irrigating potato at critical stages and conservation of moisture enhances potato yield and quality of tubers. Also higher percentage of larger tuber sizes contributes to higher yields.

Table 10: Effects of mulch and irrigation level on tuber size distribution

Treatment	Small (<40mm)	Medium (40-60mm)	Large (>60mm)	Total (%)
T100 M	0.0	6.7	93.3	100.0
T90 M	3.3	13.3	83.3	100.0
T80M	0.0	26.7	73.3	100.0
T60 M	7.0	73.0	20.0	100.0
T50 M	13.3	76.7	10.0	100.0
Mean	4.7	39.3	56.0	100.0

Treatment	Small (<40mm)	Medium (40-60mm)	Large (>60mm)	Total (%)
T100 NM	10.0	3.3	86.7	100.0
T90NM	6.7	16.7	76.7	100.0
T80NM	0.0	40.0	60.0	100.0
T60NM	7.0	93.0	0.0	100.0
T50NM	23.3	76.7	0.0	100.0
Mean	9.4	45.9	44.7	100.0

Tuber Length Distribution

The results in Table 10 showed that there was a significant effect of mulch and water level on length of potato tuber. For mulched plots medium tuber lengths (50-100 mm) ranged from 67 % to 93 % with full irrigated treatment (T100M) at 67 % while T80M at 93 %. Significantly small proportion of total tuber lengths was registered in long tuber grades, ranged from 0-33 % with least at T50M and highest at T100 M while T90 M was 10 %. This could be attributed to the presence of moisture and frequent irrigation in these plots. Considerably smaller percentage of tuber lengths was recorded by short grade tubers, ranged from 0-13 %.

In the non-mulched plots, similar trend was seen in the 50-100 mm tubers. The range was from 57 % at T50NM to 93 % at T80NM. Only T100 NM registered 10 % of the total tuber proportion in the long tuber category (>100 mm) while the rest, T90NM, T80NM, T60NM and T50NM recorded 0 % yield. There was no significant difference in the short tuber (< 50 mm) group in percentage of tuber length, ranged from 7-43 %. T80NM recorded the lowest percentage of tuber length while T50NM had the highest number of tubers in this category. From the results, tuber lengths were concentrated within the medium category for all the treatments in all the plots. Also 80 % water level recorded the optimum yield from medium length grades in mulch and non-mulch plots.

Table 11: Effects of mulch and irrigation level on tuber length distribution

Treatment	Short (< 50 mm)	Medium (50-100 mm)	Long (> 100 mm)	Total (%)
T100M	0	67	33	100
T90M	7	83	10	100
T80M	6	93	1	100
T60M	13	87	0	100
T50M	10	90	0	100
Mean	7	84	9	100
T100NM	10	80	10	100
T90NM	10	90	0	100
T80NM	7	93	0	100
T60NM	20	80	0	100
T50NM	43	57	0	100
Mean	18	80	2	100

DISCUSSIONS

Potato yields were better in fully irrigated treatments as opposed to deficit irrigated plots. This could be due to availability of moisture in these treatments plots. Plant heights and stems/plant responded well to better irrigation frequencies and reduction in water level generally affected the potato growth. Similar results were registered by (Wang *et al*., 2011).

Further, (Yuan *et al*., 2003), in their study pointed out that potato height increased with increase in water level. Tuber yields were 3.2 ton/ha higher in mulched plots compared to plain field due to straw mulch for full supply treatments. These results conform to (Doring *et al*., 2005) who reported that planting potatoes using straw mulch improves tuber yields than in bare soils. Further, application of straw mulch could have contributed to better potato growth yields due to moisture retention, improved soil temperatures and addition of organic matter. These results are in agreement with various researchers (Kar & Kumar, 2007; Samad *et al*., 2015; Chandra *et al*., 2002) with use of straw mulch in arid and semi-arid environments.

Application of water and mulch had a significant effect ($p<0.05$) on all yield parameters (tuber diameter, number and length) as opposed to no mulch plots. Statistically, there was no significant difference between T100NM and T90NM in tuber diameter and also T60NM and T50NM did not significantly differ in length. Tuber initiation and bulking stages were sensitive to water stress for water deficit fields, T50NM and T60NM as compared to the mulched plots. This could have led to reduced tuber yield and quality in these plots. These results were in agreement with (Yuan *et al*., 2003).

CONCLUSION

From the study, it can be deduced that deficit irrigation significantly influenced the potato yields and tuber quality. Tuber yields, plant heights and stems/plant responded well to better irrigation frequencies and reduction in water level affected the potato growth. Application of water and mulch had a significant effect ($p<0.05$) on all yield parameters (tuber diameter, number of tubers and tuber length). Statistically, there was no significant difference between T100NM and T90NM in tuber diameter and also T60NM and T50NM did not significantly differ in length. Also from the results, it is evident that mulch has a positive influence on potato emergence and also retains moisture. In summary, more water savings can be attained with deficit irrigation and mulch with less effect on yield and quality of tuber yields. Further, net returns are better if DI and mulch are well managed in this region.

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REFERENCES

Abong, G. O., Okoth, M. W., Karuri, E. G., Kabira, J. N., & Mathooko, F. M. (2009). Influence of potato cultivar and stage of maturity on oil content of French fries (chips) made from eight Kenyan potato cultivars. *African Journal of Food, Agriculture, Nutrition and Development*, *9*(8)

Blum, A. (2009). Effective use of water (EUW) and not water-use efficiency (WUE) is the target of crop yield improvement under drought stress. *Field Crops Research*, *112*(2-3), 119-123

Bozkurt, S., & Bozkurt, G. S. (2011). The effects of drip line depths and irrigation levels on yield, quality and water use characteristics of lettuce under greenhouse condition. *African Journal of Biotechnology*, *10*(17), 3370-3379

Chakraborty, D., Nagarajan, S., Aggarwal, P., Gupta, V. K., Tomar, R. K., Garg, R. N., & Kalra, N. (2008). Effect of mulching on soil and plant water status, and the growth and yield of wheat (Triticum aestivum L.) in a semi-arid environment. *Agricultural water management*, *95*(12), 1323-1334

Chandra, S., Singh, R. D., Bhatnagar, V. K., & Bisht, J. K. (2002). Effect of mulch and irrigation on tuber size, canopy temperature, water use and yield of potato (Solonum tuberosum). *Indian Journal of Agronomy*, *47*(3), 443-448

Devaux, A., Kromann, P., & Ortiz, O. (2014). Potatoes for sustainable global food security. *Potato Research*, *57*(3-4), 185-199

Döring, T. F., Brandt, M., Heß, J., Finckh, M. R., & Saucke, H. (2005). Effects of straw mulch on soil nitrate dynamics, weeds, yield and soil erosion in organically grown potatoes. *Field crops research*, *94*(2-3), 238-249

Geerts, S., & Raes, D. (2009). Deficit irrigation as an on-farm strategy to maximize crop water productivity in dry areas. *Agricultural water management*, *96*(9), 1275-1284

Hassan, A. A., Sarkar, A. A., Ali, M. H., & Karim, N. N. (2002). Effect of deficit irrigation at different growth stages on the yield of potato. *Pakistan Journal of Biological Sciences*, *5*(2), 128-134

Kabira, J. N., & Lemaga, B. (2006). Potato Processing: Quality Evaluation procedures for research and food industries applications in East and Central Africa. *Kenya Agricultural Research Institute, Nairobi, Kenya*, 12

Kaguongo, W. P., Gildemacher, P., Demo, P., Wagoire, W., Kinyae, P., Andrade, J. & Thiele, G. (2008). Farmer practices and adoption of improved potato varieties in Kenya and Uganda. *Social Sciences working paper*, *5*, 78-85

Kaguongo, W., Nyangweso, A., Mutunga, J., Nderitu, J., Lunga'ho, C., Nganga, N. & Irungu, J. (2013). *A policymakers' guide to crop diversification*. FAO

Kang, Y., Wang, F. X., Liu, H. J., & Yuan, B. Z. (2004). Potato Evapotranspiration and Yields under Different Drip Irrigation Regimes. In *2004 ASAE Annual Meeting* (p. 1). American Society of Agricultural and Biological Engineers

Kar, G., & Kumar, A. (2007). Effects of irrigation and straw mulch on water use and tuber yield of potato in eastern India. *Agricultural Water Management*, *94*(1-3), 109-116

Kipkorir, E. C., Raes, D., & Labadie, J. (2001). Optimal allocation of short-term irrigation supply. *Irrigation and drainage systems*, *15*(3), 247-267

Muthoni, J., Mbiyu, M., & Kabira, J. N. (2011). Up-scaling production of certified potato seed tubers in Kenya: Potential of aeroponics technology. *Journal of Horticulture and Forestry*, *3*(8), 238-243

Samad, S., Mustafa, M., Baharuddin, B., & Rampisela, D. A. (2015). The Effect of Mulch and Fertilizer on Soil Temperature of a Potato Growth. *International Journal of Agriculture System*, *1*(1), 91-102.

Saxton, K. E., & Rawls, W. J. (2006). Soil water characteristic estimates by texture and organic matter for hydrologic solutions. *Soil science society of America Journal*, *70*(5), 1569-1578

Starr, G. C., Rowland, D., Griffin, T. S., & Olanya, O. M. (2008). Soil water in relation to irrigation, water uptake and potato yield in a humid climate. *Agricultural water management*, *95*(3), 292-300

Wang, F. X., Wu, X. X., Shock, C. C., Chu, L. Y., Gu, X. X., & Xue, X. (2011). Effects of drip irrigation regimes on potato tuber yield and quality under plastic mulch in arid Northwestern China. *Field Crops Research*, *122*(1), 78-84

Yuan, B. Z., Nishiyama, S., & Kang, Y. (2003). Effects of different irrigation regimes on the growth and yield of drip-irrigated potato. *Agricultural water management*, *63*(3), 153-167

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