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Effect of Solar Ultraviolet-B plus End of Day Light and Its Exclusion on Growth Performance and Dry Weight Accumulation of Two Sweet Potato Cultivars (*Ipomoea batatas* L.) on Different Altitudes

Simeneh Tamrat Alemu[1*] and Amsalu Gobena Roro[2]

1. Department of Dryland crop and horticultural science, college of dryland agriculture and natural resources, Mekelle University, Mekelle, Ethiopia

2. Department of plant and horticultural science, college of agriculture, Hawassa University, Hawassa, Ethiopia

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Abstract

UV-B radiation and EOD light (EOD) quality has both signaling and damaging effects based on the dosage and time of exposure. At highland areas UV-B decreases crop productivity and also light quality increase at high elevation area but EOD light quality effect was not researched based on altitude. Therefore, in the present study a field experiment was conducted to investigate the effects of UV-B radiation, EOD light and its exclusion on growth performance and biomass accumulation of sweet potato cultivars on different altitude. The treatments consisting of UV-B exclusion, UV-B+ EOD light exclusion, + UV-B and (control) were studied on two sweet potato cultivars, Kulfo and Hawassa-83. The experimental design was laid out in split plot design with factorial combinations. According to the result, the highest UV-B radiation (1693.0 mw m^{-2} s^{-2}) was recorded at highlands and the lowest (1107.1 mw m^{-2} s^{-2}) was recorded at lowland areas. Also EOD light quality was low at lowland. Cultivar and altitude significantly affected growth and net assimilation rate but exclusion only affected growth rate. On dry weight accumulation, cultivar and altitude had high impact but exclusion affected tuber and specific leaf dry weight. Exclusion by cultivar interaction affected net-assimilation rate and specific leaf dry weight but exclusion by altitude interactions affected growth rate, net-assimilation rate and tuber dry weight. Altitude by cultivar doesn't have any significant effect on growth performance but it has considerable effect on dry biomass accumulation. In conclusion, high UV-B at highland and low EOD time light quality at lowland negatively influenced growth performance and biomass of sweet potato cultivars

Keywords: UV-B, UV-B + EOD, + UV-B, Altitude, Potato Cultivar.

Introduction

During the past eight decades the ozone layer has been depleted by the release of ozone depleting substances such as chlorofluorocarbons and other industrial compounds containing halogens reaction that lead to ozone layer destruction and resulted in incident of high Ultraviolet radiation on the earth (Sharma, 2001). UV is a part of non-ionizing region of the electromagnetic spectrum which comprises approximately 5-9 percent of the total solar

* Corresponding Author, Email: Simattamrat@gmail.com

radiation (Kovacs and Keresztes, 2002). UV is divided into three wavelength ranges, including: UV-C (200-280 nm) that is extremely harmful to organisms, but not relevant under natural conditions of solar radiation; UV-B (280-320 nm) is of particular interest because this wavelength represent only approximately 1.5 percent of the total spectrum, but can induce a variety of damaging and signaling effects in plants; UV-A (320-400 nm) represents approximately 6.3 percent of the incoming solar radiation and is the less hazardous part of UV radiation (Hollosy, 2002).

UV-level depends on the sun angle, altitude and latitude of the location, it is found that in high altitude area UV-B radiation is expected to reach ground surface at high intensity as compared to most other lowland areas of the world (Sullivan et al., 1992).

Sweet potato (*Ipomoea batatas* L.) belongs to the Convolvulaceae family, is among the world's most important, versatile and underexploited food stuffs. It is ranked seventh in the world among the staple food products such as wheat, maize, rice, potato, barley and cassava (Teshome et al., 2012). In Ethiopia, it grows in most parts of the country i.e. from 1000 meters above mean sea level (MASL) to high altitude 2000 MASL areas (between 3-15 ^{o}N and 33-48 ^{o}E). Due to variation in agro-ecological condition productivity varies from region to region. In Ethiopia, the wide range of variation in productivity can be related to difference in climatic factors including light, temperature, relative humidity, UV-radiation and altitude as well as crop genotype variation (Zeleke, 2010).

Different report indicated that, UV-B radiation has direct and indirect effects on total biomass and overall growth by influencing developmental stage and physiology of plants (Agrawal, 1992; Kakani et al., 2003; Zhao et al., 2003; Coleman and Day, 2004; Geo et al., 2004; Robson et al., 2014).

Light quality indicates the light spectrum in the range of 400-700 nm, called photosynthetic active radiation, at the EOD time especially between 4-6 pm, the light quality exists in long wavelength radiation low red to far red light ratio affects biomass accumulation and overall growth of sweet potato. On the other hand, light quality increase at high altitude area compared with lowland but EOD time light quality effect was not well known but it may affect sweet potato productivity by affecting photosynthesis or photomorphogenic responses, since spectral change of light intensity and quality cause change in photosynthetic and morphogenic response of crop plants (Blom et al., 1983).

UV-B and EOD light exclusion from the solar radiation increase the growth performance and biomass of many crop species (Albert et al., 2008; Kataria and Guruprsad, 2012; Pal et al., 2016). Increase in biomass is in relation with increase in rate of photosynthesis and CO_2 fixation after ambient UV-B exclusion (Agrawal,1992; Kataria et al., 2013). Therefore, this study aimed to assess and depict the impact of ambient UV-B, EOD and its combined exclusion on growth performance and dry biomass accumulation of two sweet potato cultivars on different altitudes.

Material and Methods

Description of the study area

The experiment was conducted in two agro-ecological zones of Southern Tigray, Ethiopia. The sites were Gerjele and Simert. ″Gerjeile″ is located in Alamata District at 12˚ 23′ 20 ″ N latitude and 39˚ 36′ 07″ East longitude with an altitude ranging from 1450-1750 MASL in the lowland area and the second site ″Simert″ located in Mayichew district of southern Tigray, Ethiopia at 12˚47̀ 64̎ N latitude and 39˚ 32̀ 18̎ E longitude at the highland and for the climatic and soil condition of study area Gergile has average daily maximum temperature 31.29 °C and minimum temperature 15.91 °C, annual total rainfall 792.4 mm, elevation 1400 and the soil type sandy loam and the second site Simert has average daily maximum temperature 22.4 °C and minimum temperature 9.05 °C, annual total rainfall 737.5 mm, elevation 2230 and the soil type clay loam (Source: Ethiopian Metrological agency and Bureau of agriculture and rural development (BoARD)).

Experimental design and treatments

The experiment consists of three treatments such as (–UV-B), means UV-B exclusion, (-UV-B+EOD) UV-B + EOD time light quality exclusion and (+UV-B) or control, the two sweet potato cultivars were Kulfo and Hawassa-83. The experiment conducted in a split plot design with factorial arrangements. The main plot factors were UV-B exclusion, UV-B + EOD time light quality exclusion and +UV-B or open as a control, the two sweet potato cultivars as sub plot factors with three replications. There are 6 factor combinations in each altitude and the experiment totally has 12 factor combinations.

Pre-cultivation and growth conditions

Two cultivars namely Kulfo and Hawassa-83 were *in vitro* propagated at Hawassa University and acclimatized under insect proof net house until appropriate size and number of vine is obtained for experimental unit. The two varieties were planted on experimental field under different covering structures.

The structure was made of UV-blocking plastic covers and black covering plastic sheet to exclude UV-B and EOD light, respectively. The UV-B blocking sheet (solar eva-5 high diffuse opaque polyethylene film with 0.20 mm thick and 2 m wide, revora plastic, the Netherlands), selectively cut-off UV-B below 350 nm radiation. The plastic cover completely blocks the transmission of EOD light. The UV-B covering structure we reconstructed from 1 m height, 2 m wide and 4 m length wooden frame with the top sides were covered with UV-B blocking sheet or UV-B blocking and black plastic sheet. The black plastic sheet was covered for two h from 16:00 to 18:00 pm to avoid the EOD. The sides of each structure were left open (50 cm) to allow air ventilation. It was constructed in the north–south direction over the treatment plot to ensure the solar radiation reaching the plants only after passing through the filter as the sun moves from east to west. The main climatic factors recorded inside the structure during growth were temperature, relative air humidity (RH%), UV-A intensity, UV-B intensity, PAR, red, far red and red to far red light ratio at each site. Photosynthetically active radiation (PAR) under the UV-blocking, black plastic sheet and control was measured during 6:00 to 18:00 pm each day. EOD light was measured from 16:00 to 18:00 PM during the experimental period.

Climate and radiation at the field site and its measurements

An instrument called Mini data loggers (TESTO 174, version 5.0.2564.18771, Micro daq com, LTD., and South Burlington, USA) was used to record temperature and RH of the tested treatments. Moreover, UV-B (W M^{-2}), UV-A (W M^{-2}), red μmol m^{-2} s^{-1} and far-red μmol m^{-2} s^{-1} and photosynthetic active radiation (PAR) (μmol m^{-2} s^{-1}) were also measured from 6:00am–18:00 pm on randomly selected four clear sky days using Skye Spectrosense 2 (SKYE instrument LTD, Llandrindod Wells, UK). As shown in Fig. 1, the transmittance of the plastic was presented and the average light quality of two sites respective to the treatment is presented in Table 1.

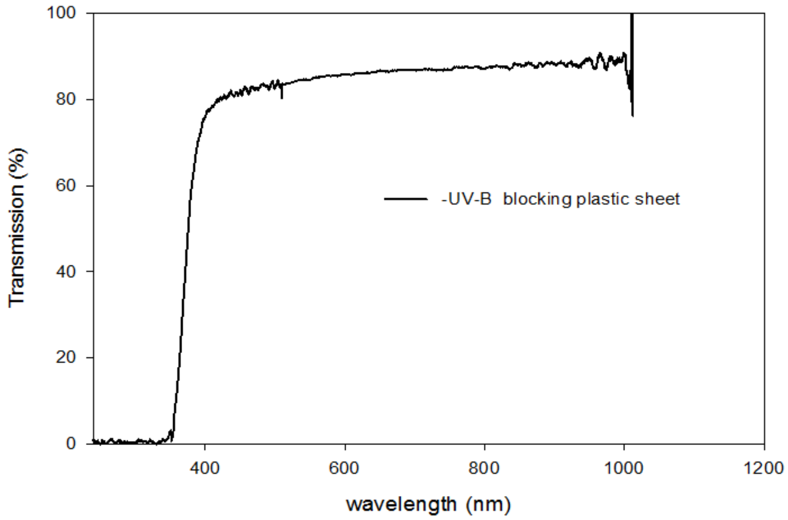

Fig. 1. UV-blocking polyethylene film (-UV) (solid line) blocks UV-B light spectrum (280-315) and the short wavelengths of UV-A spectrum 315 nm (Solar EVA-5 0.20 mm thick high diffuse opaque polyethylene film, Revora plastic, The Netherlands)

Table 1. Average Ultraviolet-B and light quality at two experimental sites in mw m^{-2} s^{-1}

	Lowland						Highland					
Treatments	**UV-B**	**UV-A**	**PAR**	**RED**	**FAR-RED**	**R:FR Ratio**	**UV-B**	**UV-A**	**PAR**	**RED**	**FAR-RED**	**R:FR Ratio**
-UV-B	156.5a	2636a	542.5b	64.18b	62.95b	1.01b	131.6a	2310b	875.8b	94.91b	92.61b	1.02b
+UV-B and EOD	1107.1b	18717b	1201.0c	136.22c	122.52c	1.12c	1693.0b	24143c	1841.5c	162.07c	144.55c	1.08c
-UV-B + EOD	48.6c	973c	40.5a	1.82a	2.27a	1.75a	6.3c	107a	8.6a	1.08a	1.59a	0.62a

N.B. (–UV-B), Ultraviolet –B exclusion treatment, (+ UV-B) control or with Ultraviolet-B, (-UV-B + EOD), Ultraviolet-B + EOD time light quality exclusion. different letters indicate the significant difference

Data collection

Net assimilation rate and growth performance

Net assimilation rate (NAR): was calculated by using the following formula

Net Assimilation Rate (NAR (g cm^{-2} d^{-1}):

$$\frac{W\,2-W\,1\,InA2-ln\ A1}{T\,2-T\,1\qquad A2-A1}$$

Where,

W1 and W2 are dry weight at (30 and 90 days), A1 and A2 are leaf area at 30 and 90 days, T2 and T1 are time intervals and LN is natural

Growth rate (GR (g g^{-1} d^{-1})): Dry weights of 10 plants in each treatment were recorded at 30 and 90 days and then growth rate was calculated by using the following formula:

$$\frac{W2-W1}{T2-T1}$$

W1 and W2 are Dry weight at (30 and 90 days), A1 and A2 are leaf area at 30 and 90 days, T2 and T1 are time intervals.

Relative growth rate (RGR (g g^{-1} d^{-1})): was calculated by using the following formula:

$$\frac{LN(W2)-LN(W1)}{T2-T1}$$

W1 and W2 are dry weight at (30 and 90 days), A1 and A2 are leaf area at 30 and 90 days, T2 and T1 are time intervals. Where, LN is the natural log

Shoot Dry Weight (SDW): This include dry mass of vine, leaves and stem separately recorded from ten representative plants by cutting the plant at the soil surface at the final harvest and dried in oven at 65 ^{o}C until constant weight was attained.

Tuberous Root Dry Weight (TRDW): Dry weight of tuberous roots, pencil size roots, fibrous root from10 randomly selected plants and sliced into small pieces and further dried in a ventilated oven at 65 ^{o}C until constant weight is obtained.

Data analysis

All the collected data were subjected to statistical analysis by using Gen State 18th edition software package. The significant difference was determined by LSD tests at ($p<0.05$).

Results

UV-B, EOD light and its exclusion main and interaction effects on growth performance, net-assimilation rate and biomass accumulation

According to the results, main effect of cultivars had a highly significant effect on relative growth and net-assimilation rate but it had no significant effect on growth rate as shown in Table 2. The highest relative growth (0.046) and net-assimilation rate (0.048) was recorded in Hawassa-83 cultivar. Altitude has a significant effect on growth and net-assimilation rate and relative growth rate. The highest growth (0.75) and relative growth rate (0.043) were recorded at lowland but the lowest (0.55 and 0.036, respectively) were at highland. Exclusion significantly affect growth rate and the highest growth rate was recorded at UV-B + EOD light exclusion but it did not affect relative growth and net assimilation rate. Exclusion by cultivar interaction did not affect growth and relative growth rate but it affected net assimilation rate significantly. The highest net-assimilation rate (0.051) was recorded at +UV-B and EOD treatment, and Hawassa-83 cultivar interaction. Exclusion by altitude interaction significantly affected growth and net assimilation rate but it had no effect on relative growth rate as shown in Table 2. The highest growth rate (1.24) was recorded at lowland and UV-B + EOD light exclusion. Altitude by cultivar did not affect growth, relative growth and net assimilation rate and also altitude by exclusion by cultivar interaction did not significantly affect growth, relative growth and net-assimilation rate.

According to the obtained result, main effect of cultivar had a highly significant effect on total leaf, stem and tuber dry weight but it significantly affected specific leaf dry weight as shown in Table 3. It increased total leaf, stem, tuber and specific leaf dry weight by 6.25%, 11.25%, 9.3% and 1.89% but high total leaf, stem and specific leaf dry weight was obtained from Hwassa-83 cultivar. However, highest tuber dry weight was obtained from Kulfo cultivar. Altitude has a highly significant effect on total leaf; stem and tuber dry weight but it significantly affected specific leaf dry weight. Total leaf, stem, tuber and specific leaf dry weights were increased by 7.48%, 15.28%, 8.93% and 5.08%, respectively at lowland but the high UV-B radiation at highland reduced the all dry biomasses. However, exclusion did not affect total leaf and stem dry weight but it had a highly significant effect on tuber dry weight and significant effect on specific leaf dry weight. UV-B exclusion increased tuber and specific leaf dry weight by 8.62% and 1.9%. Exclusion by cultivar interaction increased specific leaf dry weight by 1.1% at UV-B exclusion and Hawassa-83 cultivar but not affected total leaf, tuber and stem dry weight. Altitude by cultivar had a highly significant effect on total leaf and stem dry weights but it affected specific leaf and tuber dry weight significantly. At lowland and Hawassa-83 cultivar interaction there was an increase of total leaf dry weight by 10.62%, and stem dry weight by 19.58% and specific leaf dry weight by 2.1% but tuber dry weight increased by 11.84% at lowland and Kulfo cultivar interaction. Exclusion by altitude significantly affected only tuber dry weight but it had no effect on total leaf, stem and specific leaf dry weight accumulation. However, altitude by exclusion by cultivar had no effect on all dry weight parameters.

Table 2. UV-B, EOD light and its exclusion main and interaction effects on growth performance and net-assimilation rate

Treatments			GR (g $g^{-1}d^{-1}$)	RGR (g $g^{-1}d^{-1}$)	NAR (g $cm^{-1}d^{-1}$)
Lowland	-UV-B	Kulfo	0.71	0.033	0.032
		H83	0.65	0.051	0.042
	+ UV-B and EOD	Kulfo	0.53	0.038	0.026
		H83	0.69	0.054	0.042
	- UV-B + EOD	Kulfo	1.27	0.033	0.026
		H83	1.21	0.047	0.042
Highland	-UV-B	Kulfo	0.51	0.028	0.029
		H83	0.75	0.043	0.041
	+ UV-B and EOD	Kulfo	0.42	0.021	0.044
		H83	0.56	0.042	0.062
	- UV-B + EOD	Kulfo	0.49	0.035	0.035
		H83	0.58	0.037	0.057
P-Value					
Exclusion			0.054	0.962	0.123
Cultivar			0.414	0.002	0.001
Altitude			0.003	0.012	0.009
Exclusion × cultivar			0.856	0.345	0.019
Exclusion × Altitude			0.010	0.318	0.048
Cultivar × Altitude			0.382	0.640	0.584
Exclusion × cultivar × altitude			0.697	0.442	0.977

Abbreviations: -UV: Ultraviolet-B exclusion, + UV-B and EOD: without Ultraviolet-B and end of day light exclusion, -UV-B + EOD: Ultraviolet-B and end of day light exclusion, GR: growth rate, RGR: relative growth rate, NAR: net-assimilation rate

Table 3. UV-B, EOD light and its exclusion main and interaction effect on dry weight accumulation

Treatments			TLDW (t ha^{-1})	SDW (t ha^{-1})	TDW (t ha^{-1})	SLDW (g)
Lowland	-UV-B	Kulfo	4.22	10.43	6.61	1.7
		H83	10.28	19.71	6.19	2.3
	+ UV-B and EOD	Kulfo	4.50	10.24	6.06	1.6
		H83	12.11	22.19	4.26	1.9
	- UV-B + EOD	Kulfo	4.30	12.26	3.48	1.8
		H83	9.47	16.83	3.89	2.0
Highland	-UV-B	Kulfo	2.30	1.48	2.58	1.7
		H83	1.38	1.08	5.49	1.8
	+ UV-B and EOD	Kulfo	2.23	4.16	3.87	1.6
		H83	1.28	2.85	4.68	1.6
	- UV-B + EOD	Kulfo	2.05	4.79	2.36	1.7
		H83	3.00	4.85	2.59	1.5
P-Value						
Exclusion			0.732	0.634	0.003	0.067
Cultivar			0.001	0.009	0.006	0.026
Altitude			0.001	0.001	0.001	0.020
Exclusion × cultivar			0.790	0.528	0.654	0.115
Exclusion × Altitude			0.301	0.395	0.040	0.880
Cultivar × Altitude			0.001	0.003	0.027	0.062
Exclusion × cultivar × altitude			0.298	0.363	0.174	0.828

Abbreviations: -UV: Ultraviolet-B exclusion, + UV-B and EOD: without Ultraviolet-B and end of day light exclusion, -UV-B + EOD: Ultraviolet-B and end of day light exclusion, TLDW: total leaf dry weight, STM: stem dry weight, TDW: tuber dry weight, SLDW: specific leaf dry weigh

Discussion

UV-B radiation, EOD light and its exclusion affected growth performance, net-assimilation rate and biomass accumulations

According to the obtained result, cultivar had highly significant effects on relative growth and net-assimilation rate but it had no significant effect on growth rate as shown in Table 2. The high relative growth and net-assimilation rate of Hawassa-83 cultivar could be mainly due to its green nature and broad leaf area relative to Kulfo, which helped this cultivar in absorption of light, water and other important growth materials. Meantime, altitude had highly significant effects on growth and net-assimilation rate but it significantly affected relative growth rate. The highest growth and relative growth rate was recorded at lowland but the high UV-B radiation at highland as shown in Table 1, affected growth and relative growth rate, which may be due to reduction of total leaf area, photosynthesis rate, stomatal conductance and CO_2 fixation, however, the highest net-assimilation rate was recorded at highland. This finding was in line with Kakani et al. (2003) who reported that exposure to UV-B radiation decreases growth of leaves and stems in many plant species at both controlled environment and field condition. Zuk-Golaszewska et al. (2004) reported that high levels of UV-B decrease the relative growth rate by affecting nitrogen productivity, leaf area ratio, leaf area productivity and leaf nitrogen productivity. However, the effects of UV-B radiation on plant growth and dry matter accumulation are generally smaller under field conditions than under controlled environmental conditions (Caldwell et al., 1994; Olszyk et al., 1996). Exclusion significantly affected growth rate and the highest growth rate was recorded at UV-B + EOD light exclusion but it did not affect relative growth and net assimilation rate. This significant result on growth rate was mainly due to UV-B and UV-A light quality and intensity difference on the treatment rather than the effect of UV-B exclusion only as shown in Table 1. The effect of UV-A was more than UV-B; UV-A helped plants to synthesize important pigment like chlorophyll that may increase biomass assimilation by increasing photosynthesis rate and compensate the bad effects of UV-B. Similar findings were reported by Schumaker et al. , (1997) in maize, mung bean (Pal et al.,1997), wheat and pea (Pal et al., 2016), sorghum (Kataria and Guruprasad, 2013), *Amaranthus tricolor* (Kataria and Guruprasad, 2014) and *Vaccinium uliginosum* (Albert et al., 2008), exclusion of UV-B and UV-A from solar radiation caused a significant increase in growth and relative growth rate of many plant species. However, according to the result of this study contrasting results were found on relative growth and net-assimilation rate. Exclusion by cultivar interaction did not affect growth and relative growth rate but it affected net assimilation rate. The highest net-assimilation rate was recorded at +UV-B and EOD from Hawassa-83 cultivar as shown in Table 2. The finding of this study reviled that the cultivar is not responded to exclusion because the exclusion did not cause change in the metabolic capacity of the plant. Change in growth and relative growth rate but net-assimilation rate was not affected by UV-B at highland; this may be due to high light quality that alleviated the UV-B effect. Altitude by cultivar also did not affect growth, relative growth and net assimilation rate. The finding of this study reviled that the cultivar is not responded to the experimental altitude area to cause change in growth, relative growth and net- assimilation rate this means there is a difference in UV-B and light quality at the experimental altitude area but this different amounts of UV-B and light quality at different altitudes were unable to cause change in growth rate or faster dry matter accumulation, relative growth and net assimilation rate of the experimental cultivars. However, exclusion by altitude interaction significantly affected growth and net assimilation rate but it had no effect on relative growth rate as shown in Table 2. The highest growth rate was recorded at lowland and UV-B + EOD light exclusion, mainly due to high UV-A relative to UV-B at UV-B + EOD light exclusion. These indicate UV-B and low EOD light mainly affect growth rate. These findings were in line with the finding of Avery et al. (2004), who reported that UV-B radiation often has an inhibitory effect on plant growth (up to 20%) in herbaceous species (sweet potato) and to a lesser extent in woody perennials. At the same time, Zhao et al. (2003) and Geo et al. (2004) reported that partition of assimilate (net assimilation rate) and growth rate was reduced when plants exposed to enhanced UV-B radiation by its effect on photosynthesis and stomatal conductance. However, contrasting study on relative growth rate was reported by Zuk-Golaszewska et al. (2004), who stated that high levels of UV-B decrease relative growth rate by affecting leaf area and its nitrogen absorption and consumption ability. Highest net-assimilation rate was recorded at +UV-B and EOD at highland, this high net assimilation rate at highland was due to high light quality at the highland and at +UV-B and EOD treatment there is high PAR and other light quality that have more effect than UV-B and that are highly absorbed by Hawassa-83 sweet potato cultivar because of its green nature, large leaf area and leaf size on non-synchronizing season of high UV-B but contrasting result has been reported by Dai et al. (1997), who found that prolonged exposure to UV-B light affects net assimilation and relative growth rate in some rice cultivars but according to the finding of this study the light quality difference on different altitude and the difference in cultivar and variety alleviate the UV-B effect. The highest dry biomass from Hawassa-83 cultivar was due to its bulky, green nature and broad leaf area but the lowest dry biomass record at highland was due to high UV-B radiation. These finding was in line with Kataria et al. (2013), who reported that reduction in biomass has been linked to reduced rate of photosynthesis in many crop species by supplemental and ambient UV-B. However, UV-B exclusion did not affect total leaf and stem dry weight but it significantly affected tuber and specific leaf dry weight. Highest tuber and specific leaf dry weight at UV-B exclusion were due to partitioning of dry biomass into tubers root and also UV-B exclusion increased dry weight of specific leaf by increasing the photosynthetic capacity of the specific leaf. Similar findings with the present study have been reported (Mazza et al., 1999; Xiong and Day, 2001; Kataria et al., 2013), which stated that exclusion of UV-B from ambient level may increase biomass production of various land plants. UV-B exclusion increased specific leaf dry weight of Hawassa-83 cultivar and tuber dry weight of Kulfo cultivar. The highest specific leaf and tuber dry weights at UV-B exclusion and their lowest weights at +UV-B and EOD or control were due to the effect of UV-B on the photosynthetic capacity of the sweet potato cultivars. When UV-B is excluded the photosynthetic enzyme activity may increase and the photosynthesis improves. Same findings were previously reported (Kataria et al., 2013; Kataria and Guruprasad, 2013), which showed that exclusion of UV-B and UV-A+B from solar spectrum resulted in an elevated overall activity of carbonic anhydrase, RuBisco and PEPcase and increase in its concentration but by exclusion of UV-B radiation increase in carbonic anhydrase activity may enhance the fixation of CO_2 via PEP carboxylase as well as via Rubisco. Baker et al. (1997) reported that UV-B exposure causes a reduction in the expression and level of key photosynthetic proteins including Rubisco.

Altitude by cultivar interaction significantly affect total leaf, stem, tuber and specific leaf dry weight but all the total leaf, stem, tuber and specific leaf dry weights were low at highland and Hawassa-83 cultivar was the most sensitive cultivar to this high UV-B radiation at highland. High UV-B radiation at highland in present study was similar with the finding of Pfeifer et al. (2006), who reported that UV-B irradiance increased more than 40% at highland area and this difference was due to change in levels of ozone depletion with elevation change.

Conclusion

In the present study, Hawassa-83 cultivar had good growth performance and dry biomass accumulation except tuber dry biomass but tuber dry biomass increased at Kulfo cultivar. This is indicative of difference in sensitivity of the cultivars to UV-B and EOD light. However, Hawassa-83 cultivar had low tuber dry biomass, indicative of its more sensitiveness to UV-B and EOD light, which may be due to partitioning of majority of the dry biomass towards the leaf and stem as the sites for secondary metabolism but in Kulfo due to high photo-assimilate translocation into the tubers or partitioning of the dry biomass towards the tuber had less sensitiveness to UV-B and EOD light. High solar UV-B radiation at highland was affecting growth performance and biomass accumulation of sweet potato cultivars. However, low EOD light and UV-B at lowland reduced growth rate or fast biomass accumulation rate and its exclusion at lowland increased growth rate. High net-assimilation rate was recorded at +UV-B and EOD treatment at highland, this indicates that net-assimilation rate was not affected by UV-B at highland mainly due to high light quality at highland that alleviates the UV-B effect on biomass assimilation rate. UV-B exclusion increased tuber dry weight of Kulfo cultivar and specific leaf dry weight of Hawassa-83 cultivar mainly due to avoidance of negative effect of UV-B on photosynthetic enzymes and their activity. Kulfo cultivar was less sensitive to UV-B and low light quality due to its yellowish color relative to Hawassa-83 cultivar.

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Conflict of interest

There is no conflict of interest on this research manuscript.

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