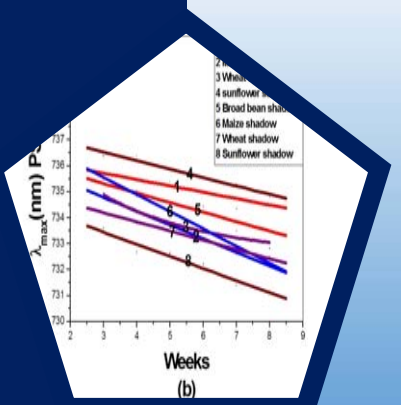
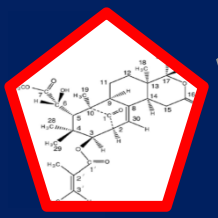
Journal of Faculty of Sciences

A Refereed Scientific Journal
Faculty of Pure and Applied Sciences
International University of Africa
Volume No. 5 , December , 2018





ISSN: 1858 – 513x

Journal of Faculty of Sciences

Refereed Scientific Journal

Faculty of Pure and Applied Sciences

International University of Africa

Volume No. 5, December, 2018

Monitoring the Development of some Winter Sudanese Cash Crops Using Emission Spectra of Chlorophyll Fluorescence

I. M. K. Medani[1], S. T. Kafi[2] and A. K. Sabir Ali[2]

[1]*Department of physics, Faculty of pure and Applied Sciences, International University of Africa, Khartoum, Sudan*
[2]*School of Applied Physics, Faculty of Science and Technology, Al Neelain University, Khartoum, Sudan*
[2]*School of Life Sciences, Faculty of Science and Technology, Al Neelain University, Khartoum, Sudan*

ABSTRACT

This work was aimed to monitor the growth and development of some winter Sudanese cash crops i.e. **broad bean** (*Vicia faba* L.), maize (*Zea mays* L.) and wheat (*Triticum vulgare* L.), and sun flower (*Helianthus annulatum*) under different environmental conditions using emission spectra of chlorophyll a fluorescence from the intact of the *in vivo* leaves. The emitted fluorescence was measured using spectrometer/graphic and data analysis software. Groups of these crops were grown in the winter season under sunlight exposure conditions, whereas other groups were grown in a shaded area. Both groups of plants were irrigated by tap water. Shaded plants exhibit environmental stress of light intensity. Monochromatic blue light of 450 nm was used as an excitation source to induce the chlorophyll fluorescence emission at 685 nm and 733 nm. The peak intensity ratio (P.I.R.), which is the ratio between maximum emitted light intensities at 685 nm and 733 nm respectively (IF685/IF733), and the area ratio (A.R.) which is the ratio between the areas under the curves of the two emission lines were used for monitoring the development of the deferent crops, from the germination until the flowering. The results revealed that the sunlight exposure conditions gave a faster seed germination rate and the best growth and development of all the

crops, while the stressing shaded conditions expressed in delayed seed germination, poor growth that led to failure of flowering and immaturity. The peak intensity ratio and area ratio for the sunlight exposure and shaded conditions were found to follow linear relationships, and approximately binomial function respectively. The ratio(IF685/IF733)is a good indicator of the plant development and can be used as a non-destructive measure of plant growth. It also appears to be a suitable fluorescence parameter in the future remote sensing of the physiological state of the vegetation by laser-equipped airborne systems.

Keywords: Winter Sudanese cash crops; Sunlight exposure and shaded conditions; Fluorescence; Chlorophyll a; IF685/IF733.

1. INTRODUCTION

Monitoring of plants growth by spectroscopic detection of electromagnetic radiation is a powerful, noncontact and nondestructive method. Plant tissue absorb the energy of the electromagnetic radiation in the visible region by the photosynthetic pigments (chlorophyll a, b, and carotenoids). This energy is used for the photosynthetic processes (Ndao et al 2005; Pandey et al 1994) . Chlorophyll molecules are arranged into two groups of pigments known as photosystem I (PSI) and photosystem II (PSII). Each photosystem has antennae chlorophyll molecules embedding a reaction center chlorophyll molecule. When an antennae chlorophyll molecule absorbs photons it transfers this energy to another nearby one until reaching the reaction center chlorophyll molecule (Schreiber 1983) . Part of absorbed energy is lost during the migration from the pigment antenna to the reaction

center and can be dissipated by a variety of non-photochemical processes. Such processes include the emission of heat and re-emission of small but diagnostically significant amount of the absorbed radiation. This re-emission which occurs in the red and far-red regions is termed as Chlorophyll Fluorescence (Buschmann and Schrey 1981; Blankenship 2002). Any exciting light (laser or light emitting diode (LED)) capable to induce chlorophyll fluorescence can be used for plant monitoring in agricultural and plant science applications.

The shape of the fluorescence emission spectrum of leaves depends on the wavelength of the excitation light (Agati 1998), and the environmental conditions of the measurements. Incident blue light is absorbed by carotenoids and by the chlorophyll of the chloroplast already at the upper part of the leaf mesophyll. The major part of the blue exited chlorophyll has to cover a short distance before it finally leaves the leaf at the epidermis and the chlorophyll fluorescence is only slightly reabsorbed by in situ chlorophyll. However, in the case of red light, which is only absorbed by chlorophyll but not by carotenoids, a substantial part of the excitation light penetrates deeper into the leaf mesophyll. This will generate more reabsorption of the red light induced chlorophyll fluorescence (Buschmann 2007). It has been observed in recent times that (ultraviolet and violet) light-induced chlorophyll fluorescence are good method for plant classifications (Anderson et al., 2004; Johnson and Thomas 2002) .

The absolute emission signal of leaves can vary from sample to sample due to small differences such as the excitation and sensing angles of the fluorescence, and the roughness and scattering properties of the leaf surface. Thus, the absolute fluorescence usually varies to a large degree than the fluorescence ratio IF(PSII)/IF(PSI) (Ndao et al 2005) .The fluorescence ratio, in turn shows much lower variation from leaf to leaf, representing more accurate tool for measuring different changes in quantities in the fluorescence characteristics of leaves.

The objective of this work, is to monitor the growth of some winter cash crops using the blue (LED) to excite intact leaves chlorophyll fluorescence during their growing process. The analysis of the fluorescence spectra using (P.I.R.) and (A.R.) of PSII and PSI from the Gaussian curves fitting were performed to distinguish between crops growing under sunlight exposure (which is normal or required conditions), and crops growing in shaded area (which is abnormal conditions for the plant). This technique has been established to discriminate between normal and stress conditions in vegetation (Chappelle et al 1984; Gitelson el al 1999). The importance of such investigations is to make early prediction of any stresses factors, so we can produce healthy productions, and save cash money.

2. MATERIALS AND METHODS

In this study some winter plants were chosen which include broad bean (V. faba), maize (Z. mays), wheat (T. vulgare), and sun flower (H.

annulatum). The used seeds in this work were improved seeds. These plants normally grown from dry seeds, which are either planted in rows or scattered way. It can grow in different soil conditions (sandy or muddy) but it prefers soils with heavy clays for optimum seed yield. These crops do not suffer much from the irregular watering but it grows better under regular watering. These crops are cold weather plants. In the Sudanese Gezira Scheme planting of these crops is done in November-December to mature in March. The seeds of these plants were brought from the Gezira state and were divided into two groups, one was grown in an open environment, directly under the sunlight exposure, while the other was grown, under a shaded place. They both were grown in the garden of the Faculty of Science, University of Al-neelain, Khartoum Sudan (altitude: 150 29' and 150 37' N and longitude: 320 33' and 320 34' E). Temperature in Khartoum has a very wide range, between 400 – 70 C in winter. The minimum temperature is reached in January. The light intensity measured as average sunshine/day varies between 9.7 – 10.3 h/day in winter. These winter crops were grown during the winter season (November). And flowered in February of the next year. They became full mature at the end of March-first of April. It must noted that some plants of the shaded group did not mature or flower.

Seeds were grown in 32 pots that were filled with heavy clay silt to about 10 cm from the top. The average diameter of the pot is about 26 cm. The soil was collected from the bank of the Blue Nile in Khartoum. 64 plants were used for the measurements, two in each of the 32 pots. Sixteen pots

were grown and measured in an open space for equally sunlight exposure. The other sixteen pots were grown and measured under a shaded place. Thus 32 plants were measured for each group. These 32 plants include the four different types of crops i.e. broad bean, maize, wheat and sun flower respectively. Four seeds were put in each pot and after growing they were thinned to the two best plants. In the open environment group, the germination began five days after sowing and by the twelfth day, germination was completed. But in the shaded group, germination began some time later.

The measurements of the induced fluorescence started at the beginning of the third week after sowing and were taken from different leaves on each plant in each pot. The measurements were taken from different points of the lower most and different points of the upper most of the fully developed leaves and then averaged.

A (LED) emitting at 450 nm wavelength and output power of 60μW was used as excitation source. A compact software controlled spectrophotometer of the type USB2000 from Ocean optics company, Dunedin, USA/Northampton, USA) was used for recording the fluorescence signal emitted from plants intact leaf. The resolution of the USB2000 spectrometer used was 1.34nm FWHM (Ocean optics 2005), and its detector covers the range from 350nm to 1100nm. The whole setup is coupled to a laptop computer for mobile use, and field measurement. Data recorded were analyzed using the software ORIGIN 6.1. The software uses (Marquardt-

Levenberg) algorithm for iterative non-linear curve fitting with a combination of Gaussian spectral functions to analyze the spectra.

3. RESULTS

The results of the measured chlorophyll a fluorescence intensity as a function of the wavelength for the open sunlight exposure group of the four selected crops during the all measuring period are shown in Fig. 1. For the shaded group, the results are shown in Fig. 2. Each spectrum is the average of seven days, and each day spectrum is the average of 10 different leaves obtained from different plants of the same type. Gaussian fitting was made on each spectrum. The evaluation of the standard errors for the wavelength at maximum peak (λmax), the full width at half maximum (FWHM), denoted as $\Delta\lambda$, the band area (A), and the fluorescence intensity peak amplitude (IF) indicated that the determination of the peaks is acceptable with minimum standard error. The parameters obtained for the two sets of plants, during the period of monitoring the development are listed in Tables (1, 2, 3, and 4) for the direct sun exposure conditions and in Tables (5, 6, 7, and 8) for the shaded conditions.

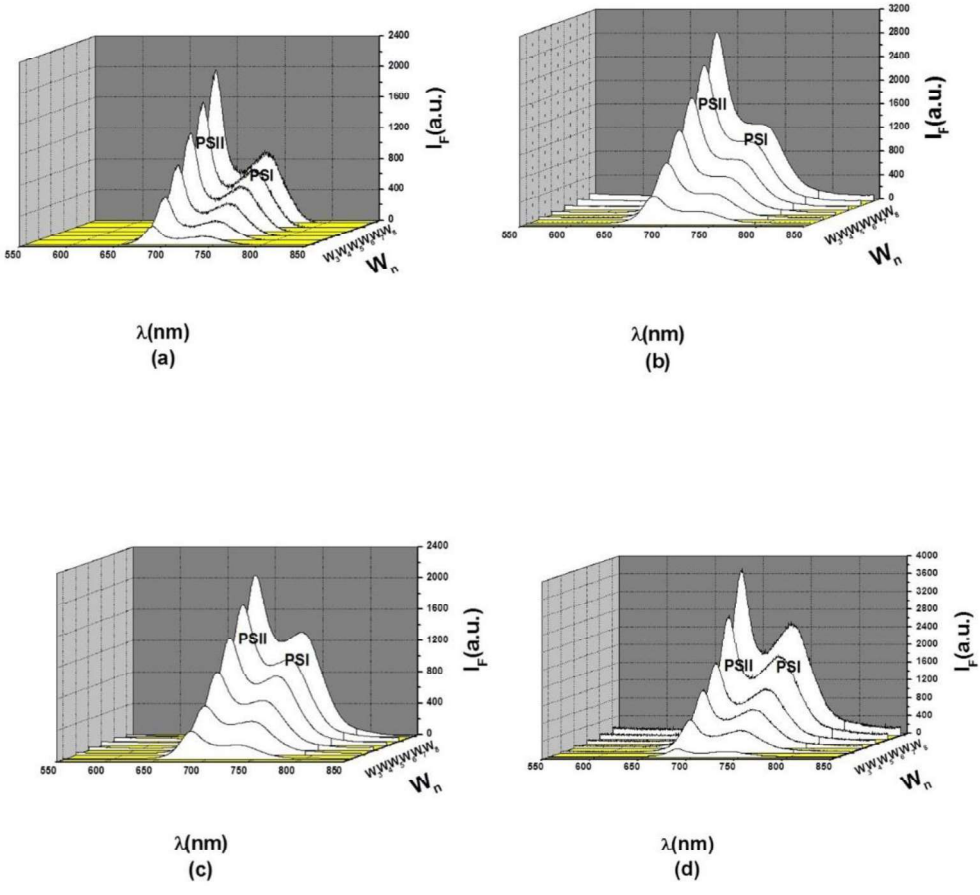


Fig. 1. Fluorescence spectra of the four selected crops under the direct sunlight conditions taken in all the measuring period, against the wavelengths of the two photosystems bands **a** broad bean **b** maize **c** wheat **d** sun flower $\mathbf{W}_n$ week number

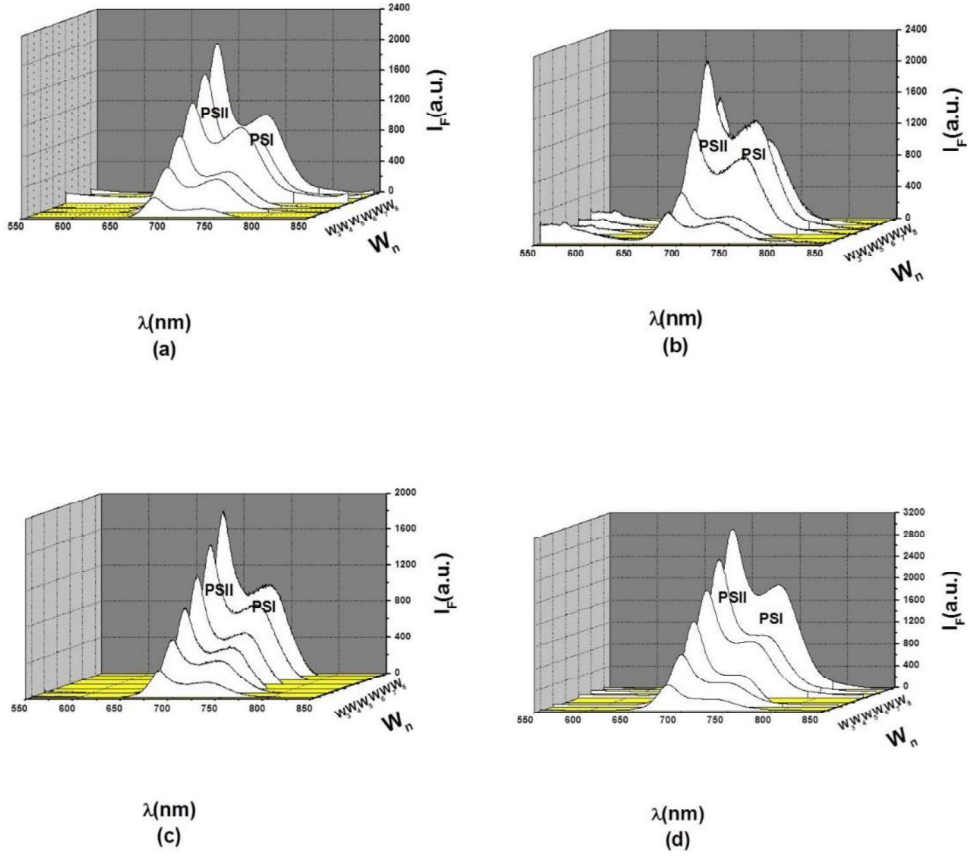


Fig .2 Fluorescence spectra of the four selected crops under the shaded conditions taken in all the measuring period, against the wavelengths of the two photosystems bands **a** broad bean **b** maize **c** wheat **d** sun flower $\mathbf{W}_n$ week number

Table1.a Sunlight conditions. Parameters for broad bean PSII

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	684.5±0.4	23.8±0.4	0.44±0.03	165.5±0.3
W_4	683.8±0.5	22.8±0.3	1.00±0.04	382.1±0.4
W_5	683.7±0.7	21.7±0.3	1.72±0.02	646.6±0.5
W_6	683.7±0.5	20.7±0.2	2.45±0.05	921.2±0.6
W_7	683.7±0.7	19.7±0.4	3.16±0.03	1182.2±0.4
W_8	683.7±0.4	19.7±0.4	3.99±0.04	1468.9±0.3

Table1.b Sunlight conditions. Parameters for broad bean PSI

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	735.5±0.3	40.1±0.5	0.56±0.02	110.2±0.4
W_4	735.4±0.3	39.9±0.5	1.25±0.03	249.4±0.5
W_5	735.4±0.5	39.9±0.8	2.08±0.04	413.7±0.3
W_6	735.2±0.6	39.7±0.4	2.90±0.02	578.3±0.5
W_7	735.2±0.6	39.7±0.3	3.65±0.05	728.4±0.2
W_8	733.9±0.2	39.5±0.4	4.50±0.06	888.1±0.5

Table2.a Sunlight conditions. Parameters for maize PSII

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	685.4±0.2	26.8±0.2	0.87±0.03	295.4±0.7
W_4	685.4±0.3	26.5±0.5	1.76±0.04	630.2±0.8
W_5	685.0±0.5	25.5±0.9	2.93±0.06	994.2±0.3
W_6	684.9±0.6	24.9±0.3	4.02±0.07	1388.7±0.7
W_7	684.7±0.7	24.5±0.7	4.82±0.08	1812.4±0.8
W_8	684.3±0.8	22.8±0.2	6.07±0.05	2295.3±0.6

Table2.b Sunlight conditions. Parameters for maize PSI

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	734.6±0.8	47.9±0.2	1.23±0.06	216.6±0.2
W_4	734.1±0.3	46.9±0.9	2.39±0.09	434.9±0.2
W_5	733.8±0.6	44.8±0.1	3.84±0.10	645.2±0.3
W_6	733.7±0.8	44.5±0.1	5.07±0.05	858.3±0.7
W_7	733.5±0.9	43.7±0.2	5.89±0.11	1065.5±0.1
W_8	731.2±0.7	43.6±0.7	7.19±0.12	1284.5±0.5

Table3.a Sunlight conditions. Parameters for wheat PSII

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	686.1±0.3	26.4±0.4	0.75±0.09	272.9±0.3
W_4	686.0±0.4	26.3±0.3	1.74±0.06	654.6±0.4
W_5	685.8±0.4	25.0±0.2	3.00±0.05	1007.9±0.2
W_6	685.5±0.7	24.9±0.3	4.10±0.04	1458.5±0.3
W_7	685.3±0.3	24.8±0.6	4.94±0.05	1772.4±0.9
W_8	685.0±0.3	24.5±0.8	6.57±0.07	2354.8±0.7

Table3.b Sunlight conditions. Parameters for wheat PSI

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	734.9±0.6	48.1±0.5	1.08±0.09	186.1±0.1
W_4	734.2±0.9	45.1±0.3	2.35±0.03	429.8±0.8
W_5	733.7±0.7	43.8±0.4	3.83±0.07	637.2±0.7
W_6	733.6±0.8	43.2±0.2	4.93±0.08	889.9±0.3
W_7	733.5±0.1	42.6±0.6	5.64±0.05	1046.9±0.6
W_8	732.8±0.3	41.8±0.5	7.13±0.06	1342.5±0.4

Table4.a Sunlight conditions. Parameters for sunflower PSII

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	684.4±0.8	24.1±0.2	0.48±0.06	151.3±0.9
W_4	684.3±0.8	24.1±0.3	1.99±0.08	651.7±0.4
W_5	684.2±0.9	23.1±0.8	3.72±0.07	1260.1±0.5
W_6	683.9±0.8	22.5±0.6	5.45±0.05	1913.9±0.3
W_7	683.9±0.7	22.1±0.5	8.82±0.09	3149.6±0.5
W_8	683.7±0.3	21.5±0.7	12.33±0.06	4496.9±0.2

Table4.b Sunlight conditions. Parameters for sunflower PSI

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	736.4±0.3	47.1±0.2	0.74±0.09	128.1±0.5
W_4	736.4±0.2	45.0±0.3	2.86±0.07	499.1±0.3
W_5	735.9±0.3	45.0±0.3	4.99±0.03	879.9±0.6
W_6	735.6±0.2	44.1±0.2	6.85±0.04	1230.1±0.8
W_7	735.3±0.2	44.1±0.5	10.45±0.08	1880.4±0.2
W_8	734.8±0.5	44.1±0.4	13.78±0.05	2495.5±0.7

Table 5.a Shaded conditions. Parameters for broad bean PSII

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	684.9±0.5	24.8±0.5	0.65±0.07	166.5±0.6
W_4	684.4±0.7	24.8±0.3	1.81±0.05	662.4±0.4
W_5	684.3±0.3	24.8±0.2	2.14±0.05	734.9±0.3
W_6	684.2±0.4	24.1±0.3	4.75±0.03	1561.4±0.2
W_7	684.1±0.4	23.9±0.1	3.95±0.06	1354.7±0.6
W_8	684.1±0.4	22.3±0.4	4.81±0.08	1673.2±0.8

Table5. b Shaded conditions. Parameters for broad bean PSI

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	735.3±0.8	46.9±0.4	0.83±0.08	109.6±0.4
W_4	734.8±0.7	45.8±0.3	2.26±0.06	428.9±0.3
W_5	734.5±0.4	44.3±0.2	2.59±0.04	469.0±0.1
W_6	734.4±0.3	43.8±0.5	5.66±0.05	984.5±0.5
W_7	734.4±0.5	42.8±0.2	4.64±0.11	845.1±0.4
W_8	733.0±0.2	41.9±0.4	5.58±0.07	1035.4±0.7

Table6. a Shaded conditions. Parameters for maize PSII

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	685.9±0.3	23.3±0.1	1.06±0.06	361.9±0.4
W_4	685.6±0.4	22.8±0.3	1.15±0.06	430.4±0.9
W_5	685.4±0.5	22.3±0.4	3.98±0.05	1497.3±0.2
W_6	684.9±0.6	21.4±0.6	5.78±0.04	2152.6±0.4
W_7	684.7±0.7	20.9±0.4	4.44±0.07	1649.3±0.1
W_8	684.5±0.8	20.8±0.6	2.25±0.08	711.5±0.1

Table6. b Shaded conditions. Parameters for maize PSI

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	735.5±0.6	45.7±0.5	1.52±0.07	273.4±0.5
W_4	735.1±0.3	44.4±0.6	1.56±0.09	296.6±0.6
W_5	734.2±0.5	42.6±0.5	5.24±0.09	981.8±0.7
W_6	733.4±0.8	42.6±0.5	7.46±0.07	1389.6±0.4
W_7	733.2±0.2	42.4±0.1	5.70±0.08	1076.6±0.3
W_8	732.1±0.4	42.3±0.2	2.93±0.06	486.3±0.4

Table7. a Shaded conditions. Parameters for wheat PSII

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	685.9±0.9	25.4±0.5	0.64±0.06	244.7±0.8
W_4	685.7±0.9	24.8±0.2	1.34±0.09	537.7±0.2
W_5	685.6±0.8	24.2±0.3	2.91±0.03	698.9±0.5
W_6	685.3±0.8	24.0±0.5	2.77±0.06	921.6±0.5
W_7	684.7±0.3	21.5±0.3	4.18±0.04	1387.2±0.4
W_8	684.5±0.4	21.1±0.4	5.47±0.08	1696.9±0.4

Table7. b Shaded conditions. Parameters for wheat PSI

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	734.2±0.3	46.1±0.6	0.94±0.09	168.2±0.9
W_4	733.8±0.9	45.0±0.3	1.84±0.07	356.5±0.4
W_5	733.7±0.5	43.4±0.9	3.77±0.05	447.2±0.9
W_6	733.1±0.7	41.7±0.7	3.40±0.03	569.2±0.3
W_7	732.6±0.4	40.9±0.9	4.89±0.11	829.7±0.7
W_8	732.5±0.9	39.4±0.4	6.14±0.08	991.2±0.2

Table8. a Shaded conditions. Parameters for **sunflower** PSII

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	685.8±0.5	24.9±0.5	0.81±0.08	246.5±0.6
W_4	685.1±0.4	24.4±0.8	1.72±0.05	555.6±0.5
W_5	684.9±0.3	24.0±0.5	3.04±0.07	713.8±0.4
W_6	684.9±0.7	23.9±0.4	4.55±0.06	1538.3±0.3
W_7	684.7±0.8	23.5±0.6	5.24±0.09	1694.5±0.4
W_8	684.7±0.3	22.4±0.5	8.93±0.04	3108.3±0.2

Table8. b Shaded conditions. Parameters for **sunflower** PSI

W_n	λ_{max}(nm)	$\Delta\lambda$ (nm)	A(m^2)	I_F (a.u.)
W_3	733.6±0.3	47.4±0.3	1.27±0.05	215.9±0.8
W_4	732.7±0.2	46.0±0.5	2.49±0.08	436.8±0.9
W_5	732.7±0.5	45.0±0.1	4.12±0.06	513.2±0.3
W_6	732.2±0.3	44.9±0.4	5.82±0.02	1033.1±0.4
W_7	731.4±0.4	44.4±0.4	6.41±0.09	1077.9±0.8
W_8	731.2±0.3	43.5±0.4	10.55±0.08	1908.1±0.3

λ_{max} : Peak center $\Delta\lambda$: FWHM (full width half maximum) A: Gaussian area I_F : Fluorescence intensity

The spectra of Figs. 1 and 2 showed that the set of plants grown under the sunlight had order stepping of growth as the weeks progressed, but that grown under the shadow had disorder stepping. From Tables 1 up to 8 the shifts of λ_{max} for all the selected plants under the two conditions of environment both for PSII and PSI peaks were less than 3 nm violet shift, this was observed clearly from Fig. 3. There was as if no shift in the peak centers either in the PSII or in the PSI peak, the shift in the peak center wavelength could happen due to deformation in the chlorophyll structure. About the full width at half maximum ($\Delta\lambda$) values of PSII and PSI there was slightly reduction during the period of growth this was also seen from Fig. 4, this means that the molecules improve their building as the growth advanced and the factors of broadening the width were gradually diminished. The observations of the Gaussian area and the fluorescence intensity of PSII and PSI showed that they were increased with weeks progressing in the direct

sunlight exposure group, this is because the number of the chlorophyll molecules were increased during the growth period. But in the shaded group the ordered increase were not found. These were also shown from Figs. 5 and 6.

The (PSII) and (PSI) fluorescence intensities are known to be due to chlorophyll (Krause and Weis 1991;Lichtenthaler and Miehe 1997). The (P.I.R.) and the (A.R.) of (PSII) and (PSI) give information about the chlorophyll pigment and are related to plant growth with regard to photosynthesis (Lichtenthaler et al 1986; Chappelle et al 1984). PSII is situated at a wavelength where the chlorophyll pigments still absorb light. This means that when the chlorophyll content in the leaf increases (PSII) can not rise at the same rate as (PSI). Thus the (P.I.R.) and the (A.R.) of (PSII) and (PSI) are related to the chlorophyll content and can be used for chlorophyll concentration (Buschmann 2007).

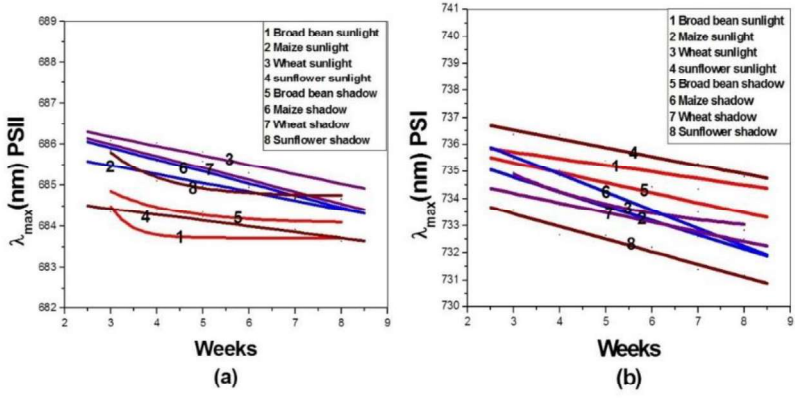


Fig .3 The peak center of the wavelength of all the selected plants versus the measuring period **a** for photosystem II and **b** for photosystem I

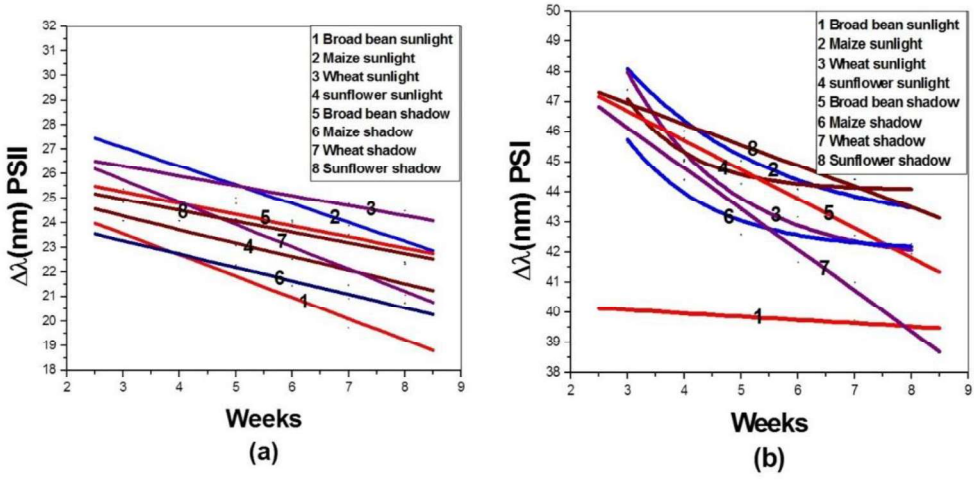


Fig. 4 The full width at half maximum of all the selected plants versus the measuring period **a** for photosystem II and **b** for photosystem I

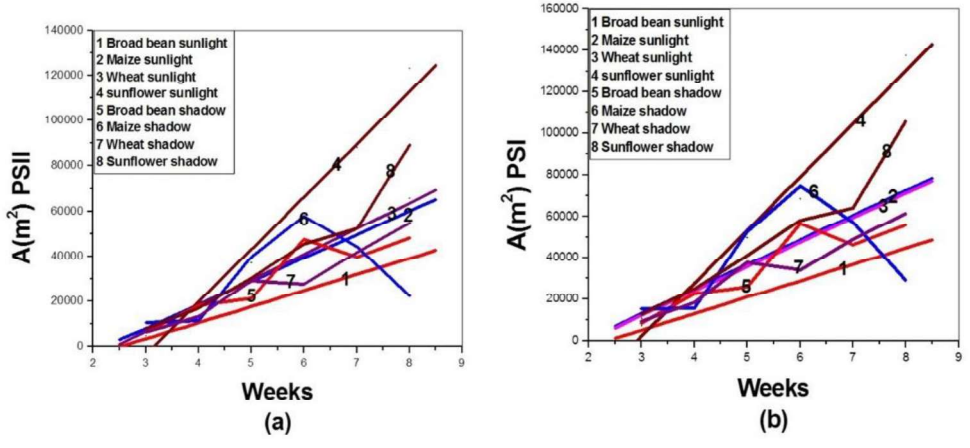


Fig. 5 The Gaussian area of all the selected plants versus the measuring period **a** for photosystem II and **b** for photosystem I

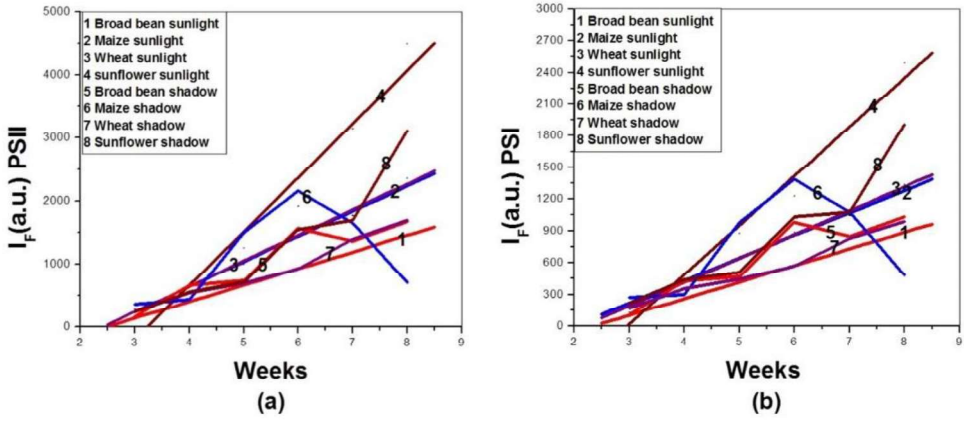


Fig. 6 The fluorescence intensity of all the selected plants versus the measuring period **a** for photosystem II and **b** for photosystem I

The (P.I.R.) changes or differences in the values during the measuring period in the two groups are due to reabsorption of fluorescence which depends on the chlorophyll concentration, thickness of the sample, light scattering properties, geometrical and other factors (Agati 1998). Or due to photochemical quenching which causes fluorescence decline by reduction-oxidation state of the first e^- acceptor molecules of PSII (Krause and Weis 1984; Agati 1998).. Also it can be due to non-photochemical quenching which include environmental stress which induces strong fluorescence quenching caused by the thylakoid damage (Rosema et al 1998; Krause and Weis 1984; Agati 1998).. The areas of integrated Gaussians are proportional to their heights such that the intensity of the chlorophyll fluorescence could be

deduced using the (A.R.) (Krause and Weis 1984; Anderson et al 2004). Thus, the (P.I.R.) data and that of the (A.R.) give additional information of the plants growth monitoring.

The (P.I.R.) and also the (A.R.) between (PSII) and (PSI) against the measuring period for each spectrum were calculated from the parameters of the Gaussian fitting curves, and the changes in the (P.I.R.) and the (A.R.) versus the measuring time were plotted in Figs. 7 up to 10.

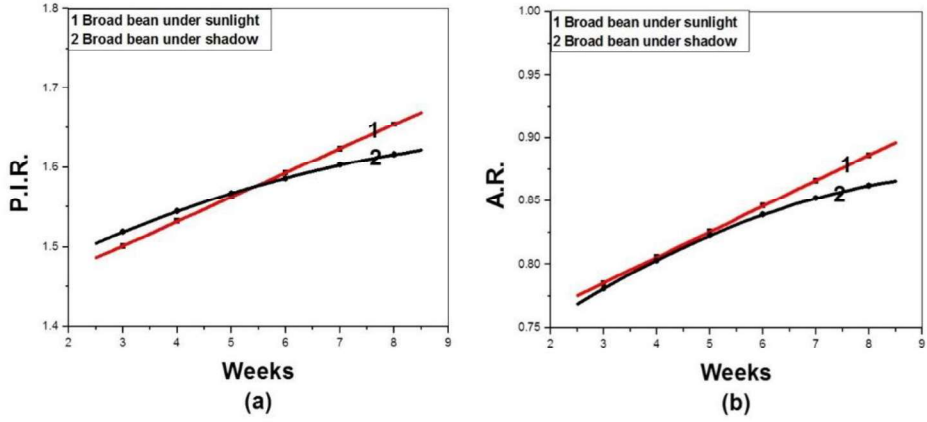


Fig. 7. the monitoring of the broad bean crop under the sunlight and shaded conditions **a** changes in the P.I.R. versus the measuring time **b** changes in the A.R. versus the measuring time. 1 represent the sunlight crop 2 represent the shaded crop.

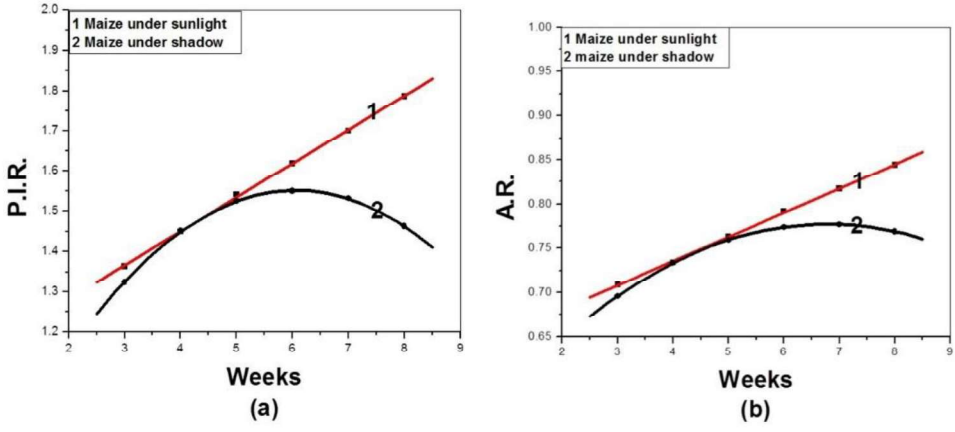


Fig 8. The monitoring of the maize crop under the sunlight and shaded conditions a changes in the P.I.R. versus the measuring time b changes in the A.R. versus the measuring time. **1** represent the sunlight crop **2** represent the shaded crop.

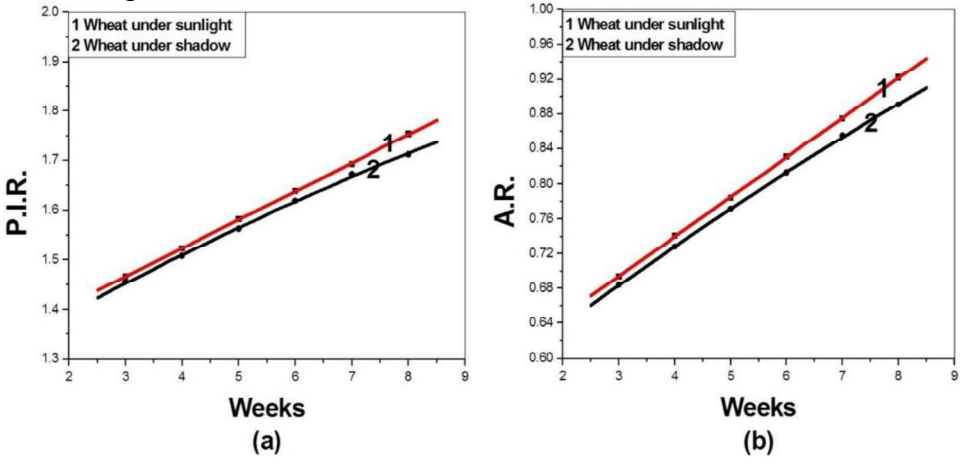


Fig 9. The monitoring of the wheat crop under the sunlight and shaded conditions **a** changes in the P.I.R. versus the measuring time **b** changes in the

A.R. versus the measuring time. 1 represent the sunlight crop 2 represent the shaded crop.

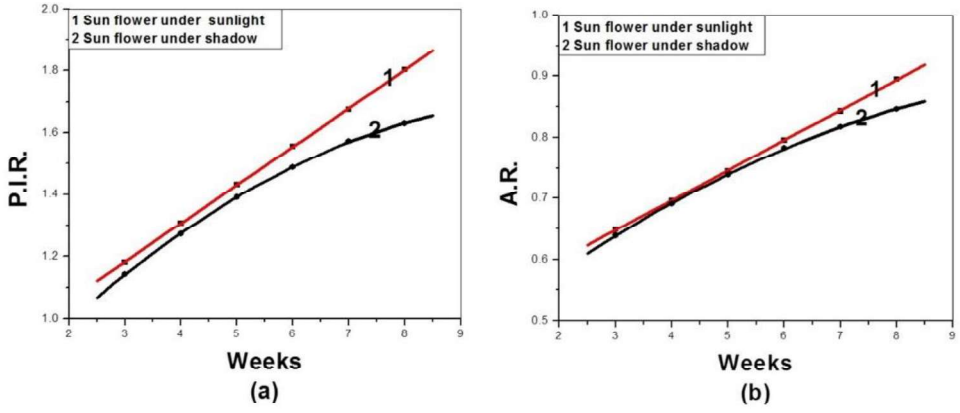


Fig.10 The monitoring of the sun flower crop under the sunlight and shaded conditions **a** changes in the P.I.R. versus the measuring time **b** changes in the A.R. versus the measuring time. 1 represent the sunlight crop 2 represent the shaded crop.

4. DISCUSSION

The results of the present study showed that all the selected crops grown under direct sunlight conditions gave higher and faster germination rates and better growth performance and development compared to those grown under shaded conditions. Signs of stress were expressed on the latter crops group by low growth rates, stunted plants, immaturity and failure of some plants to form any flowers. Superiority of direct sunlight group over shaded group is related to the suitable conditions of temperature and light intensity.

As the weeks advanced from the germination week to the flowering week for all the selected crops under direct sunlight exposure the (P.I.R.) as well as the (A.R.) followed linear increase rate as was shown in Fig. 7 up to Fig. 10. This means that the spectra were not influenced by the re-absorption. This is due to the lower concentration of the chlorophyll during the early period of the germination (Pandey and Sinha 1994). These results are in an agreement with (Buschmann 2007) observations, which showed that, at low chlorophyll concentration, the red and far-red fluorescence increased with increasing chlorophyll concentration but showed that at high chlorophyll concentration only the far-red fluorescence increased while the red fluorescence decreased due to the re-absorption. Our results are opposite to the results found by (Hak et al 1990), which showed that fluorescence ratio of PSII/PSI decreased with increasing chlorophyll content of developing leaves. According to (Gopal et al 2002; and Lichtenthaler et al 1986), the chlorophyll fluorescence intensity does not usually depend on the chlorophyll concentration, it depends on the amount of the light energy absorbed. So in our present results we can implicate that in the early stage of germination the lower ness of chlorophyll fluorescence intensity is due to the small amount of the light energy absorbed because of the small size of the molecules. Also this lower ness is attributed to the low chlorophyll concentration. In the past, photosynthetic stress in vegetation was usually assumed to be as an increase in the fluorescence signal as observed by (Chappelle et al 1984). According to (Rosema et al 1998), the results showed that the opposite may be true. So

in our present results, the low and relatively constant increase in the chlorophyll fluorescence intensity signal assumes that the crop is photosynthetically efficient.

On the other hand as was shown in Fig. 7 up to Fig 10. The results of the crops grown under shaded conditions followed different deviations from linearity**.** This declination of the (P.I.R.) and(A.R.) could be an indication for the immaturity and failure of flowering in shaded conditions caused by the small amount of the sun radiation (Blankenship 2002).

The violet shift of the λ_{max} and the decrease of the $\Delta\lambda$ value as the weeks advanced, together with the ordered increase of the (P.I.R.) and (A.R.), and the linearity attitude, confirm the fact that there was an increase in the chlorophyll concentration and also an increase in the photosynthetic efficiency due to chlorophyll concentration increase, and the growth is positively influenced.

5. CONCLUSIONS

The curve fitting of the induced fluorescence spectra using Gaussian functions gave more parameters which help in the early prediction. The monitoring of the development of all the selected crops during the winter season, related the spectra of the (P.I.R.), as well as the (A.R.) of the PSII / PSI to the weeks of the measuring period.

The (P.I.R.) and the (A.R.) of the developing crops, when measured under direct sunlight conditions, followed linear increase. But for the crops

developing under the shaded conditions, they deviated with different degrees from linearity.

The ordered increase in the chlorophyll fluorescence intensity means that the growth of the crops is positively influenced.The induced fluorescence method is an effective tool that can be used for early stage prediction in summer season.

ACKNOWLEDGMENTS

The authors extend their gratitude to the Ministry of Higher Education and Research of Sudan for financial support of this work.

REFERENCES

Agati G (1998). Response of the in vivo chlorophyll fluorescence spectrum to environmental factors and laser excitation wavelength. Pure Appl. Opt .7: 797- 807

Anderson B, Buah-Bassuah PK and Tetteh JP (2004). Using violet laser-induced chlorophyll fluorescence emission spectra for crop yield assessment of cowpea (Vigna unguiculata (L) Walp) varieties. Meas.Sci. Technol. 15: 1255-1265

Blankenship RE (2002). Molecular mechanisms of photosynthesis. Blackwell Science Arizona USA

Blankenship GH and Weis E (1984). Chlorophyll fluorescence as a tool in plant physiology II Interpretation of fluorescence signals. Photosynth. Res . 5: 139-157

Buschmann C (2007). Variability and application of the chlorophyll fluorescence emission ratio red/far red of leaves. Photosynth. Res. 92:261-271

Buschmann C and Schrey H (1981). Fluorescence induction kinetics of green and etiolated leaves by recording the complete in-vivo emission spectra. Photosynth. Res. 1: 233-241

Chappelle EW, McMurtrey III JE, Wood Jr. FM and Newcomb WW (1984). Laser-induced fluorescence of green plants 2 LIF caused by nutrient deficiencies in corn. Applied Optics 23(1): 139-142

Chappelle EW, Wood Jr. FM, McMurtrey III JE and Newcomb WW (1984). Laser-induced fluorescence of green plants 1 A technique for the remote detection of plant stress and species differentiation. Appl. Opt. 23: 134-138

Gitelson AA, Buschmann C and Lichtenthaler HK (1999). The chlorophyll fluorescence ratio F735/F700 as an accurate measure of the chlorophyll content in plants. Remote Sens. Environ. 69: 296-302

Gopal R, Mishra KB, Zeeshan M, Prasad SM and Joshi MM (2002). Laser-induced chlorophyll fluorescence spectra of mung plants growing under nickel stress. Current Science 83(7): 880-884

Hak R, Lichtenthaler HK And Rinderle U (1990). Decrease of the chlorophyll fluorescence ratio F690/F730 during greening and development of leaves. Radiat Environ Biophys. 29: 329-339

Johnson GA and Thomas AD (2002). Enhancement of photosynthesis in Sorghum bicolor ultraviolet radiation. Physiologia Plantarum. 116: 554-562

Krause GH and Weis E (1991). Chlorophyll fluorescence and photosynthesis: The basics Ann. Rev. Plant Physiol. Plant Mol. Biol. 42: 313-349

Lichtenthaler HK and Miehe JA (1997). Fluorescence imaging as a diagnostic tool for plant stress. Trends in Plant Science 2(8): 316-320

Lichtenthaler HK, Buschmann C, Rinderle U and Schmuck G (1986). Application of chlorophyll fluorescence in ecophysiology. Radiat Environ Biophys 25: 297-308

Ndao AS, Konte A, Biaye M, Faye ME, Faye NAB, and Wague A (2005) Analysis of chlorophyll fluorescence spectra in some tropical plants. J. Fluorescence 5(2): 123-129

Oceanoptics, Inc. USB2000 (2005). Fiber optic spectrometer installation and operation manual. Doc. No. 170-00000-000-02-0305

Pandey SN and Sinha BK (1994). Plant Physiology. Pashupati Printers 2nd edition Delhi-110 032

Rosema A, Zahn JFH, Buurmeijer WF and Van Hove LWA (1998). The relation between laser- induced chlorophyll fluorescence and photosynthesis. Remote Sens. Environ. 65: 143-154

Schreiber U (1983). Chlorophyll fluorescence as a tool in plant physiology I The measuring system. Photosynth. Res. 4: 361-373.

Identification of Clinical Isolates of *Candida Species* by using Chromagar in Sudanese Clinical Sources

Hassan A. Hassan[1*], Osman Khalil[1], and Hassan B. ELamin[3]

[1]Department of Microbiology, Faculty of Pure and Applied Science, I.U.A
[3]Commission for Biotechnology & Genetic Engineering, National Center for Research, Ministry of High Education and Scientific Research, Khartoum, Sudan
** Corresponding address: hassangumare@gmail.com*

ABSTRACT

The genus Candida includes about 150 different species; however, only a few are known to cause human infections.Objective of this study is to isolate and identificate *Candida species* in Khartoum, Hospitals by using Germ tube test, and CHROMagr Candida.A total of 50 clinical samples were collected, Samples collected from individuals consisted of 10 (20%) high vaginal swabs, 20 (40%) urine samples and 20 (40%) sputum samples. The samples were cultured on sabouraud dextrose agar. Identification of the *Candida species* was performed using growth characteristics, the germ tube test and the CHROMagar *Candida*.27 out of 50 samples (54%) were *Candida albicans* whereas 23 (46%) were non *C.albicans* as confirmed by CHROMagar Candida. Non albicans *Candida* included; *C. tropicalis* 12(24%), *C. krusei* 6(12%), *C. glabrata* 5(10%). This study showed *C. albicans* (54%) was the most frequently isolated species followed by (46%) non albicans Candida isolates as confirmed by CHROMagar Candida.CHROM agar is a new differential culture medium and identification of Candida to species level.

Keywords: Candida species, CHROMagar Candida