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Nile Valley University - Faculty of Agriculture, River Nile State, Atbara, PO Box 346, Sudan

E-mail: NJAS@nilevalley.edu.sd

Preface to volume 9, 1

Here before you is volume 9, Issue 1, in the time the country is suffering from the plague of conflict that has had a significant impact on agricultural production and productivity in many states of Sudan. This is happening in one of the countries that the world relies on to bridge the gap in the supply of agricultural products and food. There is no doubt that this conflict has also affected the prices of goods and production inputs, and the question post that has become increasingly relevant: Can the country suffer from a food gap or will it be able to overcome this bad scenario?

Rains of this year came at rates that far exceeded expectations, which had a positive impact on the rain-fed sector, but in the same time caused negative consequences on the irrigated sector. This could be described as the balance of destruction and benefit. The areas that are out of production in the conflict areas were compensated by another belt that was considered one of the marginal rain-fed production areas.

Perhaps the most expected problem with a negative impact on the season is the problem of transporting inputs to the production areas and transporting the product to the domestic and foreign markets. Conflict areas have witnessed total or partial closure of roads with high and illegal fees collection by militants, which has negatively affected the flow of goods and is expected to be reflected in the cost of production in general.

This issue includes a group of important scientific papers covering important and useful areas in the stages of agricultural production. We spare no effort to ensure that this journal reaches all those interested in publishing in agricultural fields from researchers in research stations and universities inside and outside Sudan, hoping that this will contribute to enriching agricultural sciences and serving workers in agricultural business.

Instructions to Authors

Introduction

The Nile Journal for Agricultural Sciences (NJAS) is a research journal issued twice a year and aimed to publish original high quality research articles in the field of Agricultural Sciences that are not published or not being considered for publication elsewhere. The work for publication will be accepted either in English or in Arabic.

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Introduction: The introduction is a brief review of literature which should supply sufficient background information on the importance of the topic, the research area of the study and the hypotheses tested in the study. The specific aims of the project should be identified along with

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Examples of some common abbreviations: Time: min, hr, sec; Length: km, m, cm, mm; Mass: kg, g, mg, µg; Concentration: g/cm^3, g/L, mg/L, µg/L, ppm; Volume: cm^3, L, mL, µL

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Effect of Alley Cropping Microclimate on Wheat Productivity and Leave Decomposition in a Semi-Desert Region of Northern Sudan

Dalia, A. Arabi[1], Haider E. Shapo[2] and Mohamed A. Adlan[3]

1 Hudeiba Research Station, Agricultural Research Corporation, Ed Damer, Sudan

2 Forest Research Centre, Agricultural Research Corporation, Suba, Khartoum, Sudan

3 Gezira Research Station, Agricultural Research Corporation, Wad Medani, Sudan

Email: daliaarabi22@gmail.com

Abstract

The study was conducted at Hudieba Research Station (Lat. 17.°57′N, 33.°8′E, 300 Km, on a loamy sand soil of the semi-desert region of northern Sudan during 2013 -2015 to examine the effect of alley-cropping system using three N-fixing trees (*Leucaena leucocephala, Sesbania sesban and Sesbania Formosa*) on climatic factors, soil fertility, and to examine the effects of incorporating tree leaves on soil on wheat grain yield in alley cropping system compared to control. The seedlings of the three trees were transplanted in the field in 2011 to establish alleycropping system (8-m wide alleys and 2-m inter rows), the performance of the tree species was assessed as the microclimatic factor and their effect on water use efficiency. Wheat was sown in November two months after incorporating tree leaves earlier in September in RCBD with three replicates and then evaluated for yield and yield components compared to control. Results indicated that the three trees differed in their ability to modify the microclimate with regard to solar irradiance, Formosa being the suitable one. Alleycropping system using Formosa and Sesban trees had good potential in improving water use efficiency compared to Leucaena and control. Nitrogen contents in tree alleys soil much higher in the depth from 0-60cm (309.3, 280.8 and 240.4ppm) for Formosa, Sesban and Leuceana respectively than in control (172.2ppm). Nitrogen content was increased in alley cropping system and in control after incorporating Formosa, Sesban and Leucaena leaves, respectively. Whereas Formosa and Sesban gave higher wheat grain yield (2810, 2513 kg/ha), Leucaena showed the lowest (632 kg/ha) as compared to the control (1759, 1912 and 1776 kg/ha) after incorporating Formosa, Sesban and Leucaena leaves, respectively. It could be concluded that Formosa was a suitable for alleycropping system for the purpose of modifying microclimate and improving crop productivity in semi-desert areas of Northern Sudan. Also All leaves examined in this study were good sources of N for high tress soils which are low in this element.

Keywords: *Leucaena leucocephala, Sesbania sesban, Sesbania Formosa,* microclimate, incorporating, solar irradiance.

تأثيرنظام زراعة ممرات الأشجارعلى المناخ الموضعي وتحلل اوراق الاشجارونمو إنتاجية محصول القمح بمنطقة شبه الصحراء شمال السودان

داليا عبد الحفيظ عربي [1]، حيدر الصافي شبو [2] ومحمد احمد عدلان [3]

1 محطة بحوث الحديبة، هيئة البحوث الزراعية، الدامر، السودان

2 مركز بحوث الغابات، هيئة البحوث الزراعية،سوبا- الخرطوم، السودان

3 محطة بحوث الجزيرة، هيئة البحوث الزراعية، ود مدني، السودان

المؤلف : daliaarabi22@gmail.com

المستخلص

أجريت الدراسة بمحطة بحوث الحديبة شمال السودان في الفترة ما بين 2013-2015م بهدف دراسة إمكانية استخدام ثلاثة أشجار بقولية (الفورموزا – السيسبان – الليوسينا) في نظام الاستزراع الغابي بأتباع نظام زراعة الممرات، ودراسة أثر نظام زراعة الممرات على عناصر المناخ وخصوبة التربة وأيضا دراسة أثر دمج أوراق الأشجار في التربة على إنتاجية محصول القمح في ممرات الأشجار مقارنة بالشاهد (المحصول بدون أشجار). تمت زراعة شتول الأشجار في 2011 لإنشاء حقل الاستزراع الغابي في شكل صفوف بعرض 8 متر بين الصفوف و2 متر بين الأشجار بعد ذلك تم تقييم معدل نمو الأشجار كل ثلاث أشهر ودراسة المناخ الموضعي بين صفوف الأشجار وقياس أثر ذلك على كفاءة استخدام المياه. تمت زراعة محصول القمح في نوفمبر بعد شهرين من دفن أوراق الأشجار في الممرات والشاهد وتقييم الإنتاج ومكونات الإنتاج لمحصول القمح داخل ممرات الأشجار مقارنة مع الشاهد. وجدت نتائج الدراسة أن الثلاث أشجار تختلف في قابليتها لتغيير المناخ الموضعي فيما يتعلق بنسبة الإشعاع الشمسي وأن الطاقة الشمسية هي أهم عامل يؤثر على إنتاجية المحاصيل حيث وجد أن شجرة الفورموزا اعطت الطاقة الشمسية الأنسب خلال العام. أيضا بينت النتائج أن نظام زراعة الممرات باستخدام أشجار الفورموزا والسيسبان ذو كفاءة عالية في تحسين استخدام المياه مقارنة بشجرة الليوسينا والشاهد. أظهرت النتائج ايضا أن محتوي النيتروجين في تربة ممرات أشجار الفورموزا، السيسبان والليوسينا في العمق 0-60سم أعلي كثيراً (309.3، 280.8 و240.4جزء من المليون) للثلاثة أشجار على التوالي مقارنة بالشاهد (172.2 جزء من المليون). زاد محتوي النيتروجين في التربة في ممرات الأشجار والشاهد بعد دفن أوراق أشجار الفورموزا والسيسبان والليوسنا على التوالي. ايضا أظهرت النتائج أن إنتاجية القمح المزروع في ممرات أشجار الفورموزا والسيسبان مع دفن أوراق الأشجار (2810، 2513 كجم /هكتار) أعلي إنتاجية من المزروع في ممرات الليوسينا (632 كجم /هكتار) مقارنة بالإنتاجية في معاملة دفن أوراق الثلاث أشجار على التوالي في الشاهد (1759، 1912، 1776 كجم / هكتار).خلصت الدراسة الي أن شجرة الفورموزا تناسب نظام الاستزراع الغابي لكفاءتها في تحسين المناخ الموضعين زيادة كفاءة استخدام المياه وزيادة إنتاجية المحاصيل في المناطق شبه الصحراوية في شمال السودان، أن كل أوراق الأشجار التي استخدمت في التجربة ذات مصدر جيد للنتروجين في أراضي التروس العليا ذات المستوي المنخفض لذلك العنصر.

كلمات مفتاحية: المناخ الموضعي، الاشعاع الشمسي، الفورموزا ، السيسبان ، الليوسينا

Introduction

Desertification is one of the major environmental problems in Sudan, which it considered one of the most arid territories in Africa and about 31% of the country's land is hyper-arid, and 63% is dry lands at risk of desertification (Ayoub, 1998). Desertification in the Northern Sudan is a very serious problem threatening not only the agriculture land base, but also the stay of the inhabitants of the area who depend mainly on agriculture for their livelihood. Planting woody trees could play a protective and productive role in the Northern Sudan. However, there are some obstacles hindering the development of a forestation programme in the area, such as the high cost of irrigation water and lack of short-term incentive until the trees become economically valuable. In addition, farmers believe that the integration of woody species in their farms would adversely compete with the associated crops. Thus the challenge of sustainable land-use intensification requires the integration of trees into the farming system to achieve a range of social, environmental and economic objectives at the same time. Alley cropping is one of the methods of integrating trees in agricultural land (agroforestry system). According to the recent FAO's definition in HLPE, (2017); Agroforestry is defined as a collective name for land-use systems and technologies where woody perennials (trees, shrubs, palms, bamboos, etc.) are deliberately used on the same land management units as agricultural crops and/or animals, in some form of spatial arrangement or temporal sequence. The combination of trees and crops can be done in different temporal and spatial sequences, e.g. alley cropping, intercropping, hedgerow systems and improved fallows (Sharma *et al*., 2016). Because of their ability to provide economic and environmental benefits, agroforestry interventions are considered to be the best way to minimize the impacts of climate change through improving microclimate, soil fertility and water use, as well as diversification of the agricultural systems. Alley cropping, using N-fixing trees, is sought a potential production practice that can provide several conservational and production benefits in the study area (Shapo, 2006). Trees used in agroforestry systems are mainly leguminous because of their ability to fix nitrogen especially in the arid and semi-arid regions where fertilizer use is not economically feasible (Van Noordwijk and Ong, 1999). Application of plant residues to the soil surface has widely been used in the semi-arid tropical agriculture and agroforestry. These nutrients become available to crop through decomposition of the tree pruning and litter.

The main objective of this study was to examine the potential of agroforestry system in combating desertification, improves and sustains crop productivity. The specific objectives

were to examine the effect of alley-cropping system on climatic factors, water behaviour and to examine the effects of incorporating tree leaves on soil on wheat grain yield in alley cropping system compared to control.

Materials and methods

The experiments were conducted at Hudeiba research station, (Lat. 17. °57′N, 33. °8′E, 300 Km north of Khartoum, Sudan). The study area lies within semi-desert region with mean range annual rainfall of 0 -100 mm. The summer season was characterized by low humidity and high temperature. The soil generally is alkaline (pH 8 to 8.4), non-saline, non-sodic with very low organic carbon and total N. The percentage of Ca CO_3 increases with depth.

Three month old seedlings (55-60cm in height for Leucaena and Sesban, 30-35cm for Formosa tree) were transplanted in July 2011for establishing the agroforestry farm. Trees were planted at 2m intra row spacing and 8 m inter row spacing and was arranged in an east-west direction.

Air dried leaves (156g/m^2) from each tree was incorporated in the top soil in the middle of September and it was irrigated every 10 days. Then wheat crop *(Triticum aestivum L.)* variety Neelain was sown in middle of November (2013-2014) in these different plots, land preparation of each plot was done manually. Wheat was sown at a seed rate of 120kg/ha in lines 20cm apart. Nitrogen fertilizer was added at a rate of (86kg N/ha) as urea in two split doses after second and fifth irrigation. Weeds were controlled manually.

Data collection

Tree performance

Height, diameter at breast height (dbh) (at 1.3 m above ground), diameter at 10 cm above the ground level (dbase), number of branch and dry weight of branches and leaves were done to assess the performance of the three tree species. The diameters were measured using caliper.

Tree metrological data

These data covered maximum temperatures, humidity and solar radiation at three zones of the alley. Thermometers were used to measure maximum temperatures, while wet and dry-bulb thermometers were used to determine humidity. Tube solarimeters (Delta-T TSL, 85.8 × 2.2 cm, sensitive to solar radiation of 0.35 to 2.5 um) coupled with microvolt integrators (Delta-T) were used for measuring incoming radiation. They were placed at ground level across the three zones of the alley and the control plot. Measurements were taken three times a day

(9:00, 12:00 and 16:00 Local Time) at 10-day intervals Average monthly values were accumulated to obtain seasonal values in the control plot and in each alley zone.

Crop parameters

Plant samples were taken at harvesting time from an area of one squire meter in the center, southern and northern alleys and control plots to determine wheat grain yield (kg/ha) and yield components (plant height (cm), number of spike/m^2, thousand grain weight, number of grain/spike and spike height).

Soil analysis

Soil analysis was done at the laboratory of soil and water research department of Hudieba Research Station (HRS). The samples from soil sites were taken for analysis of NPK and O.C. ,from different tree alleys and control plots from three depths (0-20, 20-40 and 40-60cm) before incorporating tree leaves and from the depth of 20cm after leaves incorporation.

Measurement of Applied water and Soil Moisture Content

The average of the applied irrigation water (m^3) was measured directly in the field by a current meter using the following equation:

$I = A \times T \times V$. Where, I = applied irrigation water (m^3), A = cross section area (m^2), T = total time (s) and V = velocity (m s^{-1}) which was derived from the equation: V = 0.008 + 0.2667n

Where, n = revolutions per second (rev s^{-1}) obtained from the formula

$$n = \frac{\text{number of pulse counts}}{\text{times in second}}$$

Soil moisture was measured gravimetrically at depths of 15, 30, 45cm, just before subsequent irrigation. Soil samples were dried at 105 ℃ for 24 hours and soil moisture calculated on dry weight basis.

Statistical Analysis:

Statistical analysis was done according to standard statistical methods using GENSTAT statistical package.

Results

Performance of the three tree species

There were highly significant differences (P = 0.001) among the different trees in terms of plant height, dbh and dbase (Table 1). Formosa and Leucaena had significantly higher air dry weight of leaves, while Sesban showed the lowest one.

Table 1. Performance of the three tree species.

Treatments	Measurement (cm)			Number	Air dry weight (kg)	
Tree species	**Height**	**Dbh**	**dbase**	**Branches**	**Branches**	**Leaves**
S.formosa	683	13.7	21.4	22.0	54.5	2.7
S.sesban	511	6.0	21.9	27.3	27.0	0.49
L.leucocephala	720	7.5	10.5	43.3	22.8	1.93
Sig	***	***	**	**	*	*
S.E	7.69	0.50	0.59	1.4	2.7	0.26
C.V%	2.09	9.59	6.8	8.0	13.5	26.6

dbh, diameter at breast height, dbase, diameter at 10 cm above the ground level.

*, **, *** Significant at $p \leq 0.05$, 0.01 and 0.001 respectively

Microclimatic Modification

Table 2a and 2b showed that during the crop season, the modification on solar irradiance in tree alleys was 53.6, 45.5 and 67.6% of control for Formosa, Sesban and Leucaena alleys respectively (this equals a reduction of 46.4, 54.5 and 32.4% in solar irradiance in the three tree alleys respectively), while the maximum temperature was reduced by 1.2, 1.1 and1.2°.

The relative humidity was increased by 11.3, 9.3 and 11.8% for Formosa, Sesban and Leucaena alleys respectively.

Table 2a Irradiance of the tree alleys as a percentage of control in 2013-2014.

	S.formosa		*S.sesban*		*L.leucocephala*		control
(Seasons)	kw m−2	S.f/cont	kwm−2	S.s/cont	kwm−2	L.l/cont	kwm−2
November	0.119	42.7	0.099	35.5	0.195	69.6	0.279
December	0.099	39.7	0.079	31.7	0.190	76.3	0.249
January	0.162	53.1	0.126	41.3	0.193	63.3	0.305
February	0.165	50.3	0.132	40.1	0.200	61.0	0.328
X(Winter)	0.136	46.4	0.108	37.2	0.195	67.6	0.290

Table 2b Average variation in maximum temperature and relative humidity in the alleys as differences from the control (2013-2014).

	Maximum temperature (°C)				**Relative humidity (%)**			
(Seasons)	*S.formosa*	*S.sesban*	*L.leucocephala*	Control	*S.formosa*	*S.sesban*	*L.leucocephala*	co
November	-0.9	-1.1	-1.0	34.3	18.5+	18.3+	20+	
December	-2.0	-2.0	-2.1	32.9	15+	17+	17+	
January	-1.4	-1.4	-1.3	30.5	10+	11+	12+	
February	-1.4	-1.4	-1.6	31.7	8+	9+	11+	
X(Winter)	-1.4	-1.5	-1.5	32.4	12.9+	13.8	15+	4

Amount of water applied and Soil moisture content

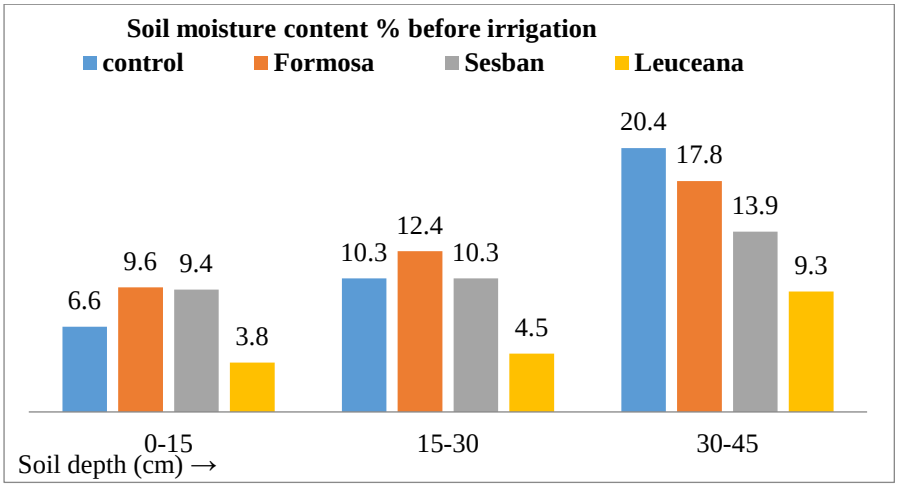
There were significant differences in water consumption by the three tree species (Table 3.). Wheat crop under Formosa and Sesban Alleys consumed less water compared to control and Leucaena. The highest amount of saved water shown under Formosa alley while the lowest value under Leucaena.

Formosa and Sesban alleys gave the highest moisture content in the 0-15 cm depth compared to Leucaena alley and control (Figures.1). Also Formosa alley gave higher soil moisture content in 15-30cm zone compared to the other two species and control. Leucaena alley gave the lowest soil moisture content.

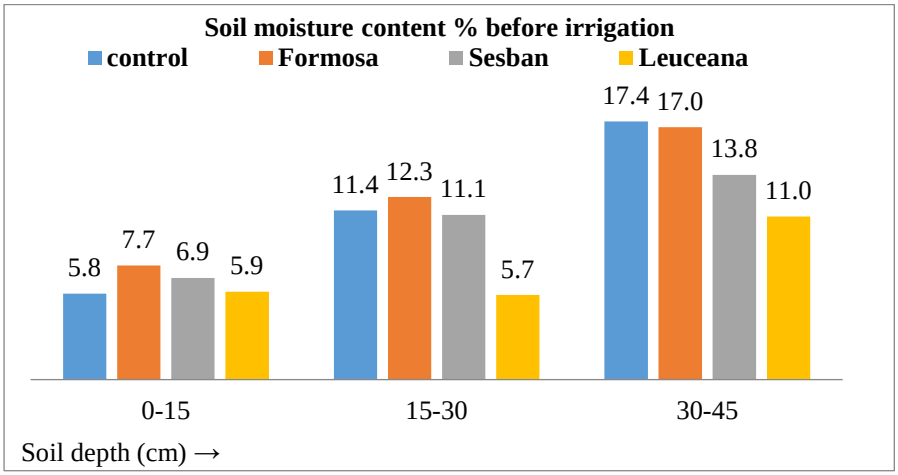
Table 3. Amount of water applied (m^3ha^{-1}) and water saved as percentage of control in alley cropping for wheat crop.

Months	November	December	January	February	Average	%water saved
Control	933.8	1153.5	1020.4	1128.8	1059.1	
S.formosa	729.0	886.9	783.5	931.3	832.7	**21.4**
S.sesban	854.1	910.2	927.8	1105.2	949.3	**10.4**
L.leucocephala	923.3	1191.5	1156.2	1210.1	1120.3	**- 5.8**
Sig	**	***	***	***		
S.E±	28.5	25.6	39.4	33.3		
C.V%	6.6	4.9	8.1	6.1		

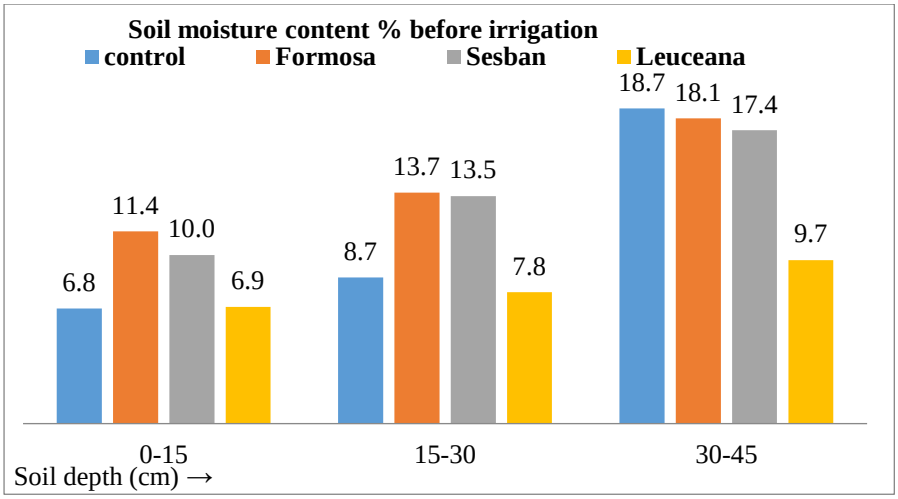
Sig.L **, *** Significant at $p \leq 0.01$ and 0.001 respectively



December



January



February

Figure 1. Residual soil moisture content at three wheat growth stages in the tree alleys compared to control

Nitrogen and organic carbon content in the Soil

There were highly significant differences (*P*=0.001) between alley cropping system and control in soil nitrogen and organic carbon contents. Higher nitrogen was found under alley cropping system (349.9) ppm compared to control (193.4 ppm).

Generally, there were significant differences (*P*=0.001) in soil nitrogen and organic carbon contents before and after incorporating tree leaves in ally cropping system and control. Before incorporating tree leaves Soil nitrogen content was 232.3 ppm and organic carbon contents was 0.154%, nitrogen increase after incorporating tree leaves (311.7ppm), and organic carbon contents was 0.188%. The results showed that incorporating Formosa, Sesban and Leucaena leaves increased Nitrogen soil content by 34.4, 62.1, and 32.8% in alley cropping treatments and by 14.4, 27.9 and 14.6% in control for Formosa, Sesban and Leucaena leaves, respectively.

Effect of ally cropping system on Wheat grain yield

Analysis of variance revealed that wheat grain yield was significantly affected by alley cropping system. Table (6) showed that there were highly significant ($P < 0.001$) differences between various treatments in terms of yield and yield components of wheat crop under tree alleys compared to control plot. In direct sun (100% light intensity) there were no significant differences between wheat grain yield after incorporating Formosa, Sesban and Leucaena leaves. In alley cropping system after incorporating leaves, Formosa and Sesban trees increased yield of wheat grain yield by 60 and 31% respectively, while it was reduced in Leuceana alley by 64% compared to control.

Table 4. Effect of tree species and soil depths (0-60cm) on soil nitrogen, organic carbon, phosphorus and potassium contents.

Treatments	Nitrogen(ppm)	O.C(%)	P(ppm)	K(ppm)
Tree species				
S.formosa	309.3	0.163	1.34	0.460
S.sesban	280.8	0.154	1.30	0.432
L.leucocephala	240.4	0.141	1.54	0.507
Control	172.2	0.129	1.12	0.434
Sig.L	***	**	***	Ns
S.E±	9.0	0.004	0.034	0.024
Soil depths(cm)				
20cm	262.7	0.161	1.5	0.518
40cm	257.5	0.141	1.34	0.422
60cm	231.9	0.138	1.29	0.436
Sig.L	***	**	**	**
S.E±	3.7	0.005	0.03	0.016
Effect of tree species and soil depths				
***S.f* x 20cm**	333.3	0.173	1.43	0.543
40cm	326.7	0.167	1.37	0.383
60cm	268.0	0.151	1.23	0.453
***S.s* x 20cm**	282.7	0.172	1.40	0.480
40cm	283.3	0.141	1.30	0.403
60cm	276.3	0.149	1.20	0.413
***L.l* x 20cm**	248.0	0.160	1.77	0.537
40cm	249.0	0.130	1.4	0.493
60cm	224.3	0.135	1.4	0.490
Co x 20cm	180.7	0.140	1.10	0.510
40cm	171.0	0.128	1.13	0.407
60cm	159.0	0.119	1.13	0.387
Sig.L	10.9	0.01	0.07	0.04
S.E±	*	Ns	Ns	Ns
C.V%	5.1	10.8	9.0	12.2

Ns: Not significant. *, **, *** Significant at p ≤ 0.05, 0.01 and 0.001 respectively. *S.f, S.formosa, S.s, S.sesban, L.l, L.leucocephala*.

Table 5. Nitrogen and organic carbon contents in alleycropping system and control before and after incorporating tree leaves in the 0-20cm soil depth.

Leaves treatments			**Soil treatment**			**Alleycropping and control**		
Leaves	**N (ppm)**	**O.C (%)**		**N (ppm)**	**O.C (%)**		**N(ppm)**	**O.C (%)**
S.f	290.6	0.178	**Bef.lea**	232.3	0.154	**Control**	193.4	0.154
S.s	286.7	0.173	**Aft.lea**	311.1	0.188	**Alley**	349.9	0.189
L.l	237.8	0.163	-	-	-	-	-	-
Sig	***	*		***	**		**	*
S.E±	5.0	0.006		3.5	0.003		5.0	0.006

Effect of different leaves on N and O.C in soil after and before incorporating tree leaves

		Bef.incor.Leaves		**Aft. incor.Leaves**	
Leaves	**Treatments**	**N (ppm)**	**O.C (%)**	**N (ppm)**	**O.C (%)**
S.f	**Control**	177.7	0.143	203.3	0.169
	Alley	333.3	0.173	448.0	0.219
S.s	**Control**	178.0	0.136	227.7	0.176
	Alley	282.7	0.172	458.3	0.217
L.l	**Control**	174.3	0.142	199.7	0.157
	Alley	248.0	0.160	329.3	0.193
Sig		*	Ns		
S.E±		8.3	0.008		
C.V%		5.4	6.2		

*P = 0.01; ** P = 0.001; *** P = 0.0001, Ns=Non significant. Bef.incor.Leaves . Before incorporating leaves. Aft.incor . After incorporating leaves. N: Nitrogen .O.C: Organic Carbon. *S.f, S.formosa*. *S.s, S.sesban*. *L.l, L.leucocephala*

Table 6. Yield and yield component of wheat grown after incorporating three tree leaves in alley cropping system compared to control.

Light intensity	Yield (kg/ha)	plant height (cm)	No.spike /m²	Wg.1000s (g)	Spike length (cm)	Seeds/spike
100%	1816	65.3	347	35.2	6.9	30.2
50%	1985	69.1	348	33.2	6.2	28.1
Sig.L	Ns	Ns	Ns	Ns	*	Ns
S.E±	42.4	1.8	9.6	1.06	0.20	0.82
Tree leaves						
S.f	2284	72.0	359	36.4	7.2	32.9
S.s	2212	71.7	353	36.0	7.0	32.6
L.l	1204	57.9	332	30.2	5.5	22.0
Sig.L	***	**	Ns	***	**	***
S.E±	50.4	2.21	11.8	1.30	0.24	0.54
Effect of light intensity and tree leaves						
100%x *S.f*	1759	65.0	352	35.8	7.2	30.1
S.s	1912	66.8	347	34.9	7.0	32.6
L.l	1776	64.0	343	34.8	6.4	27.8
50%x *S.f*	2810	79.0	365	36.9	7.1	35.6
S.s	2513	76.6	358	37.0	7.0	32.6
L.l	632	51.7	322	25.6	4.6	16.2
Sig.L	***	**	Ns	**	*	***
S.E±	72.0	3.12	16.7	1.84	0.34	1.41
CV%	6%	8%	6%	7%	9%	8.4%

Ns: Not significant. *, **, *** Significant at $p \leq 0.05$, 0.01 and 0.001 respectively. *S.f, S.formosa, S.s, S.sesban, L.l, L.leucocephala*.

Discussion

Alley cropping system with the suitable selected trees has proven to be suitable for microclimate improvement and modification, water use efficiency and soil nutrient availability; hence, they had positive impact on increasing crop productivity. According to results obtained in these experiments, the tree component in the system play the greatest role in improving microclimatic conditions, water use, soil nutrients status, and thus wheat grain yield. There is good experimental evidence that a suitable choice of agroforestry systems may enhance system productivity by increasing the use of available resources (Ong and Huxley; Ong *et al*., 1996, 2006).

The aboveground interaction regarding microclimate modification and water use had confirmed the previous findings obtained out in Hudieba Research Farm in spite of the fact that the tree species used previously differ from ours; Shapo and Adam (2008) reported that in the same area solar radiation is the most influential factor responsible for yield reduction or increase in alley cropping system. In addition, the reduction in solar radiation and wind speed reduced evapotranspiration and thereby water use of crop plants. Ivezi´c *et al.* (2021) reported that trees mitigate microclimatic extremes, creating more stable environmental conditions for understory species, and avoiding heat stress.

In this study the amount of intercepted light in the alleys of the three tree species depends mainly on tree structure (height and general growth character of the tree), that affected the performance and the yield of the crops. Formosa showed high suitability in alley-cropping system and gave the highest wheat grain yield this because of its capacity to transmit sufficient amount of light through the canopy. This agreed with Shapo and Adam (2008) who reported that in the same area of the study *A. stenophylla* alley with its relatively higher average radiation (62% of the control) remarkably increased the economic yield of both groundnut and sesame by 37.7 and 40.3%, compared to the control, respectively. Also this result agrees with Jose *et al*. (2004) who reported that the most noticeable aboveground interaction is the competition for light between the specie.

Alley cropping system has a good potential in improving water use efficiency compared to mono-cropping systems. The saved water was much higher in alley-cropped plots than in control one, because the reduction in solar radiation and wind speed resulted in lower evapotranspiration and therefore less water use by crop plants, Ellison *et al*. (2017) mention that trees improve the

microclimate by shading crops and cooling the surrounding air by increasing the transpiration rate. Formosa-alley affected the below-ground interactions positively since it had surface lateral roots, which was subjected to regular root pruning due to land preparation for seasonal crops, so it reduced root competition each growing season in the soil depth between 15-30cm resulting in the highest water saving in this zone.

Nitrogen and organic carbon content in the Soil

Higher nitrogen was found under alley cropping system due to the, nitrogen fixation and the high quantity of the different tree residues and the continues addition of leaf litter and other tree components such as roots, floors, etc . Pinho *et al.,* (2012) showed that When their leaves fall, more nutrients are reintroduced to the soil, and this process, which is often most productive in native forests, can be replicated by introducing diverse tree species into agricultural systems

Wheat grain yield in tree alleys compared to control

Alley cropping system with the suitable tree species had positive impact on crops yield. Within the alley cropping system, the result was a little bit complicated due to the complicated intermingled interactions of the above and the below ground interaction, which is so difficult to separate the effect of each climate factors or soil behaviour. However, Formosa tree optimize the microclimate and saved the water, in addition, there was contentious addition of leaves that might increase the soil nitrogen content, therefore Formosa alley effects gave the highest wheat yield. Sesban alley gave higher wheat yield compared to control and relatively similar to Formosa alley, that possibly of its high leaves nitrogen content and high rate of decomposition compared to the other two species (Dalia *et al*., 2020). Shapo (2008) found that the average yield in the alley plots increased over control by 69, 15, and 10% for wheat, faba bean, and common bean, respectively. Also in a review summary of 94 studies from Sub-Saharan Africa, Akinnifesi *et al*. (2010) concluded that using nitrogen-fixing trees increased yields up to several hundred per cent and significantly improved food security

The lowest yield of the wheat crop in Leucaena tree alleys might be due to its high aggressive competition for water (underground competition) and due to the high incoming radiation in the alley (aboveground competition). These results were similar to those of Govindarajan *et al.* (1996) who found that alley cropping involving *Leucaena leucocephala* greatly reduced crop yield because competition for water outweighed the benefits of improvements in soil fertility resulting from applications of green leaf manure, nitrogen fixation and increased root turnover.

This result also agreed with Ong *et al.* (2000) who showed that in the semi-arid tropics, the competition for water and nutrients severely reduced maize yields when grown with *Grevillea robusta*. Furthermore, Kuyah *et al*. (2016) found many studies confirming that competition between trees and crops could be minimised by selecting non-competitive species as well as pruning the roots and the canopy.

Conclusions

- Alleycropping system using N-Fixing trees is a suitable technology for increasing crop yield through improving microclimate, water use, and soil nutrient status.
- Although it is difficult to separate between above and below ground interaction of trees in agroforestry system, there were positive effects of these interactions in all the system and in overall yield.
- The application of the N-fixing tree leaves in the soils that are deficient in N will improve soil nutrient status.

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Economic Aspects of Potatoes Production in North Sudan

Elgilany A. Ahmed[1], Hamid H. Faki[2] , Abbas Elsir[2], Hanadi Elfadil[2], Abaker Ismai[2]
1Agricultural Economics and Policy research Centre,
2Agricultural research Corporation of Sudan
Email : elgilanya@yahoo.com

Abstract

Potatoes crop in River Nile State (RNS) of Sudan has received limited development efforts over the past few years. The crop is one of the most potential crops in area of the study that can attain this purpose. This study looks to assess the potatoes economic aspects in the State. It depends on both primary and secondary data. The partial budgets for potatoes were estimated separately for all actors and players to visualize the important factors affecting the yield and returns of potatoes. The respondents distributed over four major localities namely, Shendi, Elddamer, Atbara and Berber specializing in potatoes production by using structured interview questions and researcher's observations. The study findings illustrate that, potato is important strategic crop that combats malnutrition in the country and the major constraints that faced potatoes were shortage and instability of power as well as the high cost of production inputs. Finally, to tackle these hindrances, preparation of good and shared policies between public and private sector would improve the crop production and livelihood of producers.
Keywords: *potatoes, economics, production, north Sudan*

الجوانب الاقتصادية لإنتاج البطاطس في شمال السودان

الجلاني أحمد[1] ، حامد فكي[2] ، عباس السر[2] ، هنادي الفاضل[2]، أبكر إسماعيل[2]
1مركز بحوث الاقتصاد والسياسة الزراعية
2هيئة البحوث الزراعية السودانية

المستخلص

تلقى محصول البطاطس في ولاية نهر النيل في السودان جهودًا إنمائية محدودة خلال السنوات القليلة الماضية .يعتبر المحصول من أكثر المحاصيل الواعدة في منطقة الدراسة والتي يمكن أن تحقق عوائد مجزية .تهدف هذه الدراسة إلى تقييم الجوانب الاقتصادية للبطاطس في الولاية . تعتمد الدراسة على كل من البيانات الأولية والثانوية .تم تقدير الميزانيات الجزئية للبطاطس بشكل منفصل لجميع الجهات الفاعلة واللاعبين لتصور العوامل المهمة التي تؤثر على المحصول وعوائد ه . توزع المشاركون على أربع مناطق رئيسية وهي شندي والدامر وعطبرة و بربر من المتخصصين في إنتاج البطاطس باستخدام أسئلة الاستبانات المنظمة وملاحظات الباحث الشخصية. توضح نتائج الدراسة أن البطاطس محصول استراتيجي مهم يكافح سوء التغذية في الدولة، وكانت المعوقات الرئيسية التي واجهت زراعة وانتاج البطاطس هي نقص الطاقة وعدم استقرارها بالإضافة إلى ارتفاع تكلفة مدخلات الإنتاج .أخيرًا ، لمعالجة هذه العوائق ، فإن إعداد سياسات جيدة ومشتركة بين القطاعين العام والخاص من شأنه تحسين إنتاج المحصول وسبل عيش المنتجين.

كلمات مفتاحية: البطاطس، اقتصاديات، انتاج، شمال السودان

Introduction

Historically, Sudan's economy depends on agricultural sector; it employs 65% of the workforce and forms about 38% to its GDP (Abdallah, 2012). Although Sudan is extracting oil and gold but the economy of the country is still looks agro-based, where more than 70% of population directly or indirectly dependents upon agriculture. In spite its essential in the economy, agricultural sector is still lag behind than its potential level. Predomination of small holdings, inefficiency of resources use with high cost of production and inadequate agricultural finance are the main causes responsible for low crop productivity that justify why most of the farmer prefer vegetable and annual crops to gain a rapid return. In Sudan, potatoes have characterized as a high yielding crop and the area under potato has stretched from 7,000 feddan (0.42 hectare) in 2004 to 31,000 feddan in 2007. The average yield of the crop ranged between 3-12 ton/feddan according to the crop variety, climate, farm technical practices and others (Ministry of Agriculture Animal wealth and Irrigation, 2007). Potatoes crop is the fourth important crop in world after rice, wheat and sorghum as the most edible and consumed crops in the world (Singh et. al. 2004).

The River Nile State of Sudan boasts of huge agricultural resources that made the state a potent and promised for potatoes production. The River Nile State enjoying about four types of farming systems, these types were according to the type of the agricultural activities. These systems were namely, private, cooperative, public and foreign investment irrigated schemes. The selection of the River Nile State was based on the farming system pattern and the dominant crop combinations that represented by annual field crops as well as it large arable fertile areas that occupied by large number of farmers. The location of River Nile State is about 300 kilometers north Khartoum (Figure 1), the district has chosen rather than whole of the north region to save time and money. Potatoes crop in the State depends mainly on surface irrigation from River Nile. The predominant climate there is relatively cool in winter season; it always extends from October to March. The state is enjoyed with alluvial fertile soils, while the environment is rather favorable for producing relatively high-value crops compared to other states of the country. The crop is grown in the state in the winter season, it begins in November and continues to March, it prevailed along the River Nile banks as well as in the islands existed along the River Nile. Potato crop in the State is commonly produced under irrigated sector from the River Nile. The crop production and marketing in the state is faced by numerous constraints such as high cost of production, lack of certified seeds, diseases and blights, remoteness of cold storage facilities, prices fluctuation and inadequate market system. Finally, this research aims to assess the economic aspects of potatoes in the State. Specifically, it looks to illustrate the challenges and the main factors that constraining potatoes production and development and facing to achieve yield improvement and full commercialization, also to examine routes for sustainable change in potatoes farming system and that increase market opportunities in the area of the study.

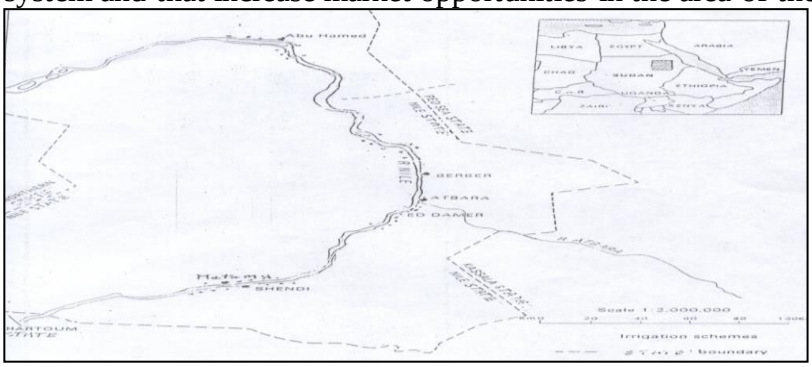


Figure (1) Map of the River Nile State of North Sudan Source: Ahmed 2004

Methodology

The study collected primary data and secondary information. The primary data collected by using structural questionnaires, it was largely qualitative, using key informant interviews and observations. The primary data covered technical, social and economic aspects of potatoes production in area of the study.

Analytical techniques

Qualitative analysis was used; it was chosen because there is little quantitative data about the potatoes marketing in the area of the study. Generally, a set of techniques were applied to achieve the goals of the study. Descriptive statistical analysis and partial budget analysis were used. This research is based on in-depth respondents conducted in River Nile State in Feb. 2018. The surveyed potatoes growers and actors took place in four localities in the State, namely Shendi, Eddamar, Atbara and Berber. The selection of potatoes actors was based on their involvement and expertise in potatoes production and business.

Partial budget analysis

Statistical tools were used to analyze the main cost items of potato production to determine the significant variables. According to Haddad (2000) there are three broad types of situation in which budgeting may be called for: (a) A comparatively minor change in practice, (b) A drastic change in farming, and (c) Starting up on a new farm.

Table 2 shows the calculation of partial budget analysis according to the following criteria:

1. The gross revenue (GR); was calculated by multiplying the farm gate price of the crop by the crop yield,
2. Total variable costs (TVC); is calculated by multiplying the quantity of input (material or practice) used by its price,
3. Gross marginal revenue (GMR); was calculated by subtracting the gross revenues minus the total variable costs. The difference in gross marginal revenues of adopters and non-adopters indicated the net monetary return that resulted from use of the technology. The general mathematic expression is:

   Gross marginal return = Gross revenue - total variable costs

GMR = GR – TVC …… (1)

Where: GMR Gross marginal return (revenue),

GR Gross revenue,

TVC Total variable cost

The study also applied partial budget analysis to assess the cost and returns of the crops under the study. The basic data used to compute gross returns per fed are output values, while gross margin per fed was calculated by subtracting the average total operation cost (variable costs) from the average total returns. The general mathematical form for the gross margin calculation per crop is as follow:

GM = GR - TVC

Where: GM = Crop gross margin per feddan in SDG,

GR: Crop gross revenue per feddan in SDG, and

TVC: Crop total variable costs per feddan in SDG.

Results and Discussion

In Sudan, the recent state policies addressed agricultural production development and became one of top priorities to meet the demand of rapid population growth, increasing agricultural products export and boost producers' returns. The River Nile State (RNS) of Sudan is characterized by a relatively unique cool winter compared to the rest of the country. This makes

the State one of the most suitable states for producing winter-season crops. The design of a seasonal crop combination for each season especially the winter season in RNS is considered as a key factor to obtain a successful production and farms sustainability. The predominant winter season crops in the State are mainly cereal, vegetables, fodders and legumes crops. Abdel Magid (1991) mentioned that, the performance of legumes and annual cereal intercropping varied by intercrop pattern.

The total area of the River Nile State is estimated at 129.744 km^2 (30 million fed) out of which about 9,500,000 feddan is a categorized as agricultural arable land, while the current invested land is about 1,200,000 feddan and 3,249,000 fed is certified land for agricultural investment and suitable for multi agro-activities and crop production (Table 1). On the other hand, the State is one of the relatively rich states in the country with water resources. The main direct resources of irrigation water in RNS are the River Nile, Atbara River, underground water and rains as shown in Table 1.

Table (1) Potential of fundamental agricultural resources (land, water) - RNS

Land resources	**Area (**feddan**)**	**Water sources**	**Water amount**
Agric. Arable land	9,500,000 feddan	River Nile along the RNS	670 km^3
Certified land	3,249,000 feddan	Atbara River	200 km^3
+Invested land	1,200,000 feddan	Underground water aquiver	3,16 milliard m^3
Forest land	209,000 feddan	Surface water & valleys from rains	1, 490 milliard m^3 and 57 valley
Natural pasture land	48,000 km^3		

Source: Annual Report of Ministry of Agriculture in RNS - 2018

However, this research revealed that the performance of resources management for agricultural production in the state is indicated existing of production potent and area gap between the targeted and cultivated areas in RNS for season 2017/2018, this might be due to resources misuse and inefficient management as shown in Figure (2).

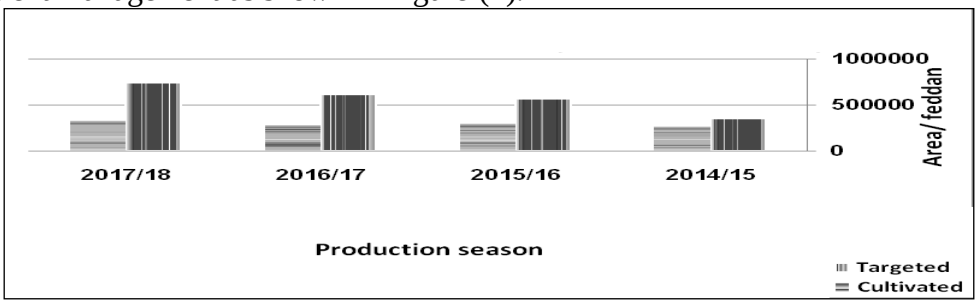


Figure (2) Potential and gap between the targeted and cultivated areas in RNS

Source: Report of Ministry of Agriculture in RNS season 2017/2018

Socio-economic characteristics of main production players in the State

The study undertook an analysis of some socioeconomic characteristics including mainly locality, occupation, age, education level and experiences for the surveyed potatoes producers. The underneath table (Table 2) represents these characteristics.

Table 2: Socio-economic characteristics of potatoes producers in the State

Variable		Producers	
Locality	Items	Frequency	Percent
	Shendi	24	54.5
	Alddamer	15	34.1
	Berber	5	11.4
	Total	44	100.0
Occupation	Yes	36	81.8
	No	8	18.2
	Total	44	100.0
Age	Less than 20	0	0
	21 – 30	3	6.8
	31- 40	11	25.0
	41 – 50	10	22.7
	51 – 60	12	27.3
	More than 60	8	18.2
	Total	44	100.0
Education Level	Khalowa	3	6.8
	Primary	16	36.4
	Basic	7	15.9
	Secondary	18	40.9
	University	-	-
	Total	44	100.0

Source: field survey, 2020

Locality: The study revealed that 54.5% of potatoes growers of the crop value chain live in Shendi locality, while Elddamr showed 34.1% and Berber just 11.4%. *Occupation*: Table 2 unveiled that 81.8% of the producers mentioned that their basic occupation is agricultural activities and 18.2% of them have additional work. *Age*: The research unveiled that the majority of producers were under the category of age groups 31 – 40 and 51 – 60 which are the most active group while the others were found as less than 20 and more than 60 represented less share. *Education level*: The results showed that 40.9% of the producers have attended secondary school and 36.4% basic school, it's noticed that only 6.8% were *"khalowa"* that indicated high awareness of the producers in cultivation potatoes in the State. *Experiences*: The study unveiled that the average experience years for producers, wholesalers and retailers were 12.2, 18.0 and 14.6 years respectively.

Potatoes growers in River Nile State

Small-, medium- and large-scale privates producers and big companies; tenants in quasi-government schemes; mostly traditional production concentrated along the River Nile banks as well as in eastern, central and western States of the country. Potatoes are grown mainly by vegetables farmers, average allocated area for potatoes is found as 17.43 fed per producer of the River Nile State. The most famous districts that produce potatoes in River Nile State were namely, Altragma, Alkityab, Almtama, Alsnahir Alnyha island, Almosiab and Alzidab, while the

most common variety grown called Zafera and Billini and the average yield of potatoes achieved by the crop growers was about 166.43 sack/fed (45-50 kg each).

Table 3: Distribution of producers according to type of land, seeds and finance

Variables		Producers	
Land tenure type	Items	Frequency	Present
	Owner	12	27.3
	Rent	31	70.5
	Share	1	2.3
	Total	44	100.0
Type of Potatoes seeds input	Local	20	45.5
	Imported	5	11.4
	Local & Imported	19	43.2
	Total	44	100.0
Sources of potatoes seeds	From market	17	38.6
	Cold store owner	9	20.5
	Seeds company	14	31.8
	Wholesalers	1	2.3
	Agricultural Bank	3	6.8
	Total	44	100.0
Sources of finance	Self-funding	26	59.1
	Share	10	22.7
	Agricultural company	2	4.5
	Agricultural Bank	4	9.1
	Friends and relative	1	2.3
	Other	1	2.3
	Total	44	100.0

Sources: field survey, 2020

Table 3 shows some of essential inputs of potatoes including land tenure type, potatoes seeds input, sources of finance, sources of potatoes seeds.

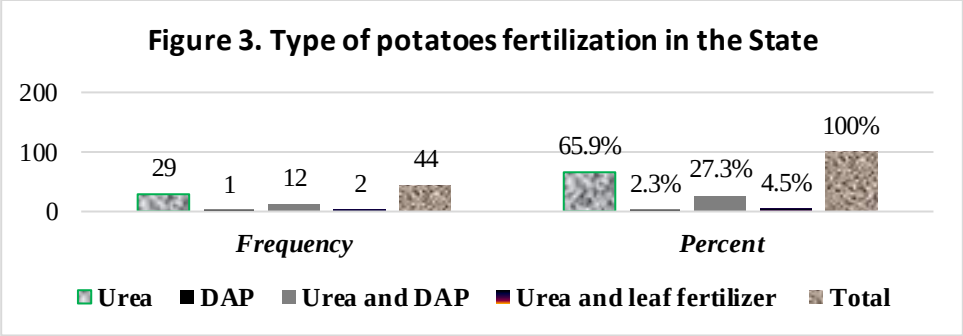
Land tenure type: according to Table 3 that 70.5% of land was rented and 27.3% was owned, while only 2.3% of the land was shared.

Type of potatoes seeds input: The research revealed that the greatest portion of producer's (45.5%) preferred locally produced seed tubers varieties from market, while about 43.2% of them planted locally produced seeds mixed with imported seeds, and the minority of the producers (11.4%) planted imported seed tubers, due to its high prices (see Table 3).

Sources of potatoes seeds: From Table 3, about 38.6% of the potatoes producers obtained their seeds from the local and central markets, while 31.8% of them have obtained it from Seeds Companies and a few of them obtained it either from cold storage owners or Agricultural Bank of Sudan (ABS) for 20.5% and 6.8% respectively (Table 3).

Sources of finance: The study unveiled that 59.1% of the producers under the study were reported as self-finance while 9.1% of them have received finance from the Agricultural Bank of Sudan (ABS) due to complicated procedures at financial institutions in the country.

Type of potatoes fertilization in the State: Figure 3 illustrates some types of fertilizer that applied by potatoes growers in the State.



The figure shows that the majority of producers (65.9%) used Urea while 27.3% of them used Urea mixed with DAP and 4.5% of them used Urea with leaf sprayed fertilizer and only 2.3% of them used DAP only.

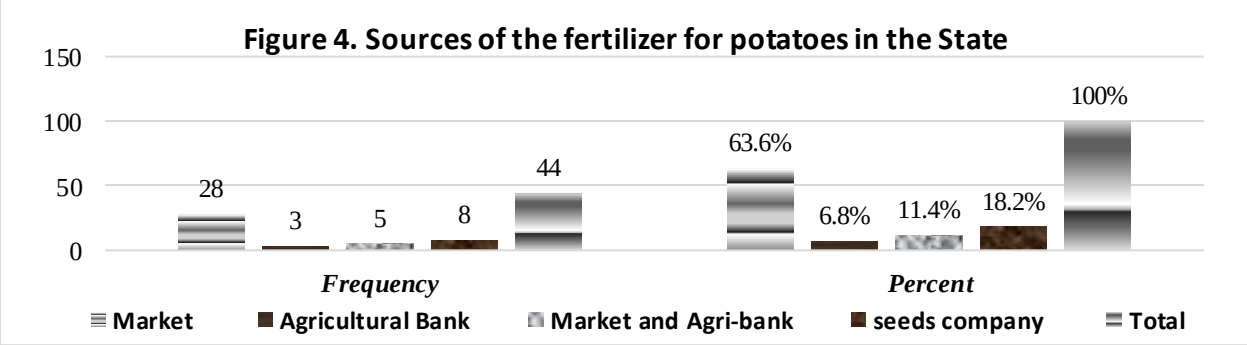
Sources of the fertilizer for potatoes: From the Figure 4 that 63.6% of the potatoes producers obtained fertilizer for potatoes from local and central cities markets, while 18.2% them brought it from seeds companies, and 11.4% from the market with agricultural bank and only 6.8% of them obtained it Agricultural Bank.

Table 4: Distribution of the fertilization of potato according to quantity & prices (sack/fed)

Variable	Fertilization	
	Mean	SD
Quantity (sack)	4.06	1.917
Prices (SDG)	1566.27	289.000

Sources: field survey, 2020

On the other side Table 4 depicts the distribution of fertilization for potatoes crop according to quantity and prices (sack/fed) in River Nile State.



Sources: field survey, 2020

From Table 5 that the highest cost component recorded was for seeds which accounted for 59.79% of the total costs, while 10.01% for the fertilizer and 9.22% for land rent.

Table 5: A Partial budget for potatoes crop (SDG/fed) in the State

Revenues and costs	Mean (sack/fed)	(%)	Mean (for one ton)
Revenues:			
Productivity (sack/fed)	166.43		1.00
Prices of potato (SDG/ sack)	600.11		12,000
Return of potato (SDG/fed)	**99,876.30**		12,000
Total of revenues (SDG/fed)	**99,876.30**		**12,000**
Costs:			
Rent	5854.54	9.22	p.
Seeds	37982.81	59.79	p.
Fertilizer	6359.05	10.01	p.
Tilling	1271.48	2.00	p.
Total production cost	**51467.88**		**6185**
Prepare	1131.73	1.78	o.
Cultivation	1757.73	2.77	o.
Weeding	1619.68	2.55	o.
Irrigation	757.73	1.19	o.
Harvesting	3008.95	4.74	o.
Transport	3072.27	4.84	o.
Load	684.20	1.08	o.
Taxes	30.57	0.05	o.
Total operation cost	**12062**		**1450**
Total costs (as a proxy for purchase price)	**63,530.74**		**7,634.529** **(**Total costs for one ton)
Net Returns	**36,345.56**		**4,365.471**

Sources: field survey, 2020

Potatoes storage in River Nile State

The research has considered some factors that affects cold storage management such as type of the storage and area of the crop production, in addition to the location of the suitable markets that intake the surplus of potatoes as well as sources of crop purchase and showed who sell the crop and who provide finance to potatoes growers to obtain their crops after harvest.

Type of cold storage ownership: For the cold storage ownership in the area of the study, the results showed that 100% of the cold storage owned by wholesalers of potatoes in the State. The research revealed *locations for production potato crop*: it shows that 50% of the cold storage owners from Almhmia and Berber locality, and 50% of them same percentage from Shendi and Elddamr, while the *markets of potatoes in the State* were included cold storage that receive potatoes directly from potatoes producers as well as from central markets of the State such as Almhmia, Berber, Shendi and Elddamr of the State. The study unveiled that the main *sources of potatoes crop to be purchased by cold storage owners in the River Nile State were* found that 50% of the cold storage owners purchase the crop from trade in the markets, while 50% of them purchase it from other producers. It's clear that there are different sources to purchase the crop in the area of the study. In addition, the research found that the *main buyers of potatoes* were

wholesalers. This means that the cold storage owners deal with the high quantity and big sizes of potatoes marketable surplus. The research also evaluated the impacts of actors finance on potatoes marketing, it showed that 50% of the cold storage owners finance potatoes producers under the condition including future contract to obtain the crop after harvest, while 50% of the cold storage owners did not use future contract with potatoes growers in the State.

Table 6: Distribution cold storages capacity and withdrawn quantity per month (sack**)**

Variable	**cold storage owners**	
	Mean	SD
Capacity of cold storages (sack)	1250.00	353.553
Withdrawn quantity during a month (sack)	300.00	282.843

Sources: field survey, 2020

Table 6 depicts the distribution of cold storage owners for capacity of their cold storages (sack), and also it shows the withdrawn quantity during a month per sack in River Nile State.

Marketing channels and marketable surplus of potatoes in the State

The markets in River Nile State include different types of actors, one of them is wholesaler who works as intermediary between producers/traders and retailers. Wholesalers usually assemble the crop and sell it in central or town markets, sometimes he sells on an auction basis and the supplier (farmer or trader) and buyer (retailers) pay a particular fee to the wholesaler. The wholesaler is an intermediary who does not sell to the public. In the State the wholesalers buy potatoes crop from the potatoes growers and central markets of the State then sell it to potatoes retailers and cold storage owners and pass up the crop to potatoes processors and sometime to exporters. Most of potatoes wholesalers attend in the crop markets at production areas at post-harvesting periods aiming to know prices of the crop.

The study revealed a set of activities concerning potatoes wholesalers' activities in River Nile State. It depicts *the main locations of potatoes production in the State* were found as 63.2% of the production potatoes in Shendi locality, while the other locations namely, Almhmia and Elddamr recorded 21.1% and 15.8% respectively. The study evaluated *the main markets of potatoes for wholesalers in the River Nile State were* Shendi and Elddamr for 36.8% and 26.3% respectively, while the other markets such as Atbra and Almhmia formed only 10.5%. In addition, the research depicted the *main buyers of potatoes* were cold storages owners, wholesalers and producers buy potatoes by 42.1%, 31.6% and 26.3% respectively. The mentioned actors contribute in *determination of potatoes prices in the state specially* the cold storages owners who control the prices by 47.4%, while the rest percentages 26.3% and 15.8% were allocated for producers and brokers respectively. Generally, the *mechanism of determination of potatoes prices in the state* is based on the marketing prices forces by 52.6% and 47.4% formed by quantity and quality of potatoes crop. The study revealed that the main *Sources of information about market prices* were distributed as 52.6% for wholesalers and 36.8% for cold storages owners and the *wholesalers intend to sell potatoes in markets* for retailers by 89.5% that means the majority of the sold potatoes go to the retailers, while only 10.5% of them goes to the other wholesalers. Finally, the *determination of potatoes selling prices* were found 57.9% determined by marketing prices forces and 42.1% according to quantity and quality of potatoes.

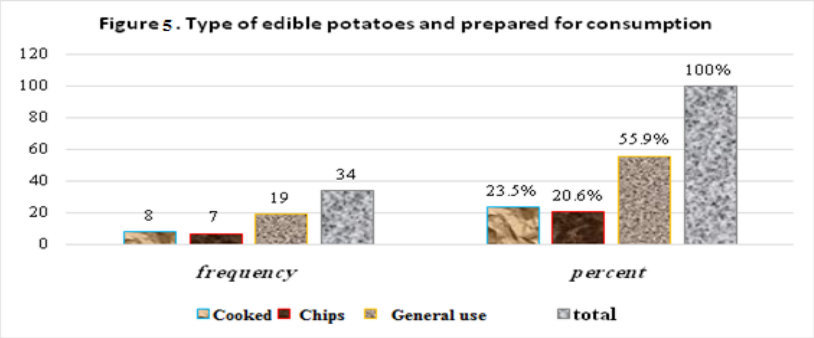
The research also emphasized on other marketing activities that undertake be retailer. In River Nile State, various, ranged from simple small shop and street retailers in village and town

markets to modern shops in big towns. Source supplies from wholesalers or directly from production areas in case of some modern retailers. Potatoes retailers are considered as essential actors in potatoes markets of the State. They mainly receive the crops from the crop wholesalers in the central markets of the State namely, Shendi, Atbra, Elddamr and Almhmia, and the next chain for retailer is always the consumers who usually by the crop in a Kilogram unit. The study unveiled numerous results with concern to retailers' activities similar to that of potatoes wholesalers' activities in River Nile State consisting locations of potatoes production, main markets of potatoes in the State, main buyers of potatoes, determination of potatoes prices in the state, mechanism of determination of potatoes prices in the state, Sources of information about market prices, main actors who willing to buy potatoes in the State markets and Determination of potatoes selling prices. The study found that *the main locations of potatoes production in the State* were found as 62.9% of the production potatoes in Shendi locality, while 22.9%, 8.6% and 5.7% formed by Atbra, Elddamr and Almhmia respectively. The study evaluated *the main markets for retailers where they buy the crop in the River Nile State* were Atbara central market by 63% and 18.5% recorded for Shendi and Elddamr for each one. In addition, the research depicted the *main buyers of potatoes* were wholesalers and cold storages owners buy potatoes by 91.4% and 8.6% respectively. The mentioned actors contribute in *determination of potatoes prices in the state specially* the wholesalers who control the prices for retailers by 97.1%, while only 2.9% percentages were allocated for retailers. This indicates that the retailers depend on wholesalers to determine potatoes prices in the State markets. Generally, the *mechanism of determination of potatoes prices in the state* according to retailers' response is based on the marketing prices forces by 62.9% and 37.1% formed by quantity and quality of potatoes crop. The study revealed that the main *sources of information about market prices* were distributed as 74.3% for wholesalers, while 17.1% and 8.6%% allocated for retailers and brokers respectively. The study found that the *retailers intend to sell potatoes in markets* mainly for consumers by about 88.6%, while 11.4% of them go to the other wholesalers. Finally, the *determination of potatoes selling prices* according to the retailers reports were found as 51.4% determined by marketing prices forces and 48.6% according to quantity and quality of potatoes. This confirms that the marketing preference of actors in potatoes markets in the State is predominant.

Potatoes consumption in the State

Despite this humble tuber's popularity, shoppers have generally been offered very little choice about what types of potato to choose from. Supermarkets and some farmers' markets are increasing their range of old and new potato varieties, with myriad tastes and textures. Whichever you buy, they should be firm and well-shaped with no eyes or green patches. The British tend to prefer white-fleshed tattles, whereas the Dutch and Spanish like yellow-fleshed potatoes, but color makes little difference to the taste. Once cooked the texture of potatoes can range from smooth, waxy-textured flesh perfect for salads to floury-textured flesh ideal for fluffy mashed potato, so it's important to know what type of potato you've bought before you decide how to cook them. Consumers of potatoes mainly use potatoes for fast food or to be prepared as the chips and boiled for the kids. The study results appear that the majority of the consumers purchase potatoes from retailers in local markets. The research also considered *the important of the potatoes for you as the house keeper*, it shows that 73.5% of the consumers prefer prepared potatoes as fast food, while 26.5% of them reported potatoes crop important for starch benefits for the children. In other words, and based on consumers responds, the most preferred type of cooked potatoes, the study revealed that 55.9% of the consumers preferred to use the crop for different kind of food, while 23.5% as boiled potatoes and 20.6% preferred potatoes chips as

shown in figure 5. The research has considered *the frequencies of potatoes consumption*, it unveiled that 88.2% of the consumers purchase potatoes every week, while only, 5.9% of the consumers purchase potatoes every day and the percentage (5.9%) every two week indicating that the demand for potatoes high and increasing.



Sources: field survey, 2020

The study also aimed to *identify the relevant markets for consumers*, it revealed that 67.5% of consumers purchase potato usually from retailers in the local markets, and17.6% of them purchase potato from retailers in the central markets of the State, this mean consumers usually require small amount of the crop just mainly for household consumptions, while *consumers look to buy potatoes from a particular actors* where 70.6% of the consumers prefer to purchase potatoes from retailers in the local markets, while 20.6% of them prefer to purchase from retailers in central markets, and only 8.8% of the consumes prefer to purchase potato from shops cross the road. The *potatoes consumers justify their selection of the mentioned markets* due to some reasons, that 50.0% of the consumers prefer to purchase potatoes for its good quality, while 41.2% of the consumers prefer to purchase potatoes for its cheap price, and only 8.8% of the consumers prefer to purchase potatoes for its near place. The study also found that *the consumers look for good quality of potatoes with a certain criterion*. It reported that 67.6% of the consumers preferred potatoes based on the form and volume; while 26.5% of the consumers purchase potato according to the variety or type, and there are only 5.9% choose potato for purchase according to the price. *The consumers usually prefer fresh potatoes for consumption*. The results shows that 73.5% of the consumers don't used cold storages or freezer for saving their potatoes, while 26.5% of the consumers like to use cold storage or freezer for saving potatoes for a long time.

From Table 7 the distribution of consumers according to purchased quantities (kg) and prices (SDG), and also it shows the withdrawn quantity during a month per sack in River Nile State.

Table 7: Distribution of potatoes consumers according to purchased quantities and prices

Variable	Consumers	
	Mean	SD
Quantity (kg)	1.47	.873
Prices (SDG)	32.64	8.637

Sources: field survey, 2020

Table 8 summarizes and represents the average purchase prices, selling prices, costs, revenues, and profits for each stage of potatoes production as well as marketing stages among potatoes value chain in the River Nile State.

Table 8: Profits and marketing margins of one ton of potatoes for different actors

Items	**Value (SDG/ton)**
Producers:	
Purchase price of potatoes	7634.53
Production expenses	1450
Selling price of potatoes	12000
Gross marketing margin (GMM)	4365.47
Gross profit margin (GPM)	4365.471
Cold storage owner:	
Purchase price of potatoes	12000
Operation expenses	260.9
Selling price of potatoes	19000
Gross marketing margin (GMM)	7000
Gross profit margin (GPM)	6375
Wholesalers:	
Purchase price of potatoes	19000
Marketing expenses	398.06
Selling price of potatoes	22894.6
Gross marketing margin (GMM)	3894.6
Gross profit margin (GPM)	3496.54
Retailers:	
Purchase price of potatoes	23028.4
Marketing expenses	791.5
Selling price of potatoes	30570
Gross marketing margin (GMM)	7541.6
Gross profit margin (GPM)	6750.09

Source: Field survey, 2020

From the table it was noticed that the retailers achieved the highest gross marketing margin (GMM) and gross profit margin (GPM) as SDG 7541.6 and SDG 6750.09 respectively, ranked by cold storage owner for one ton potatoes marketing, while the wholesalers were formed the lowest percentages. On the other hand, the producers recorded the highest cost of production for the crop appeared as SDG 1450 compared to potatoes actors of the crop value chain.

Conclusion and policy implication

The main outcomes of this research comprise increased potatoes production, improved potatoes quality, institutional and human capacity building, higher standard of living of potatoes growers, and advanced role of potatoes in contributing to increase the national revenue from sales of potatoes locally and abroad. Several points represented at the conclusion and policy implication part as follow:

1. Potatoes producers should develop awareness:

a. Cultural practices suitable to different agro-ecological zones, irrigation supply, pesticides and fertilizers use, and frequent water and soil analysis and the importance of crop rotation.

b. Appropriate management practices for the control of major pest and diseases in the existing groves and for the protection of new ones.

c. Provision of facilities for training technician, extension agents and growers' proper pre-and harvest technologies for potatoes production and marketing. Interventions concerning the crop growers should aim to raise their awareness how to think as if as small entrepreneur

d. Promotion of techniques for the post-harvest handling, processing and making of potatoes and for utilization of by-products.

e. Identification of superior varieties with emphasis on adoption to non-conventional growing areas and high quality varieties for local consumption as well as exportation.

f. Encouragement of expansion of potatoes growing at potential areas in the State and by supplying the private sector with suitable planting material and recommendations on appropriate cultural practices.

g. Importance of working to gather in small groups or cooperative associations in order to reduce share and minimize costs of production (using proper methods of calculating production costs and keeping records and other basic business management), distribution and marketing, protect each other from marketing instability through share of experiences and strengthen the bargaining power within the chain.

h. Different available options regarding access and process to agricultural finance.

2. Potatoes retailers, wholesalers, and cold storage owners should develop awareness:

a. Distribution and transportation of the crop, marketing and exhibiting at trade fairs.

b. The potential of investing in storage facilities of potatoes (cold storages and cold trucks)

c. Correct and feasible selection for new markets.

d. Global standards of international trade and methods of adopting them, and fair trade and ethical trading principles.

3. Governmental institutions should:

a. Play a role in providing financial support to the crop growers to gradually break the tight grip of traders and wholesalers over the whole value chain.

b. Encourage greater facilitation by financial institutions for businesses to access finance

c. Enforce implementation of an agriculture calendar maximize production, reduce risk, and competitiveness is increased through forming a steering committee with core members who are active key players from the whole value chain.

d. Establishment of a training center for specialized institutional and human capacity building. To learn them step by step about the way of how to increase the crop yield per unit area.

f. Improvement of techniques for genetics, breeding and propagation (i.e. Potatoes breeding research is required for evolving new varieties which give high yield and should have resistant against disease and pest attacks). The main service provider for this part in Sudan is Agricultural Research Corporation (ARC), the flowing part is concerning with this important institution in the country.

Potatoes research in Sudan is managed mainly by Agricultural Research Corporation; it addresses a number of issues anticipated to develop the crop sub-sector, such as follow:

1) Sustainable potatoes production techniques, potential cropping systems and appropriate plant genetic resources explored, identified and conserved in various regions of Sudan in accordance with the comparative advantage and food security requirements.

2) Strengthened national capacity in protection and prevention of potatoes pests and diseases; and
3) Developed potatoes' agricultural research processes, systems and programs.

The key expected results will be achieved through several interventions as follows:

a) Assess and evaluate the present situation of potatoes diversity and production.
b) Review the agro-climatic data of the areas and agricultural resources availability for sustainability of potatoes cultivation.
c) Review and assess the current potatoes research strategies and propose key interventions to enhance development of efficient agricultural practices techniques.
d) Explore the potential areas for cultivation of potatoes in River Nile State and hence at the macro levels.
e) Assess the local potatoes selections and develop standard protocol for identification and regional comparative advantage.
f) Identify key technical production constraints to be overcome.
g) Identify harvest, post-harvest and marketing constraints and develop improved techniques and channels.
h) Identify needs of international technical assistance to support the development of potatoes industry.
i) Assess the local technical support capacity for potatoes development and identify the necessary components of a comprehensive training program aims at providing the technical staff and the stakeholders with the required knowledge.
j) Identify the investments in terms of manpower, equipment, internal and external training that would be required to overcome the technical constraints faced by the relevant regions as related to development of the potatoes industry.

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Effect of Plant Density on Growth, Yield and Quality of Banana (*Musa AAA*) Cavendish cv. Grand Nain under Kassala conditions

Ahmed B. A. Khalifa1[1]., Ebtihal H. M. Hamid[1] and Abdelhamed M. Magboul[2]

1 Kassala and Gash Research Station, Kassala, Kassala State, Sudan.

2 Agricultural Research Corporation, Wad Medani, Gizera State, Sudan.

Correspondent author:

Email: ahmedbab7@yahoo.com

Abstract

The experiment was established in a private farm at Alqurashi village near Atbara River, Aroma locality, Kassala State, Sudan. Three months old plants of banana cv. "Grand Nain", propagated by tissue culture, were transplanted in the field on first of January 2022 at nine spacing of 2×2m, 2×2.5m, 2×3m, 2×3.5m, 2×4m, 3×2.5m, 3×3m, 3×3.5m and 3×4m. The treatments were replicated 3 times in randomized complete block design (RCBD) and each plot encompassed 12 plants. Results showed that, higher growth parameters were recorded under spacing of 3×2.5m. Least time from planting to flowering and from flowering to harvesting were observed on plants under spacing of 3×2.5m for the mother plant and first ratoon crops. The highest bunch weight and total yield were obtained on plants spaced at 3×2.5m. The highest marginal rate of return (26.18) was recorded at this treatment.

Key words: Plant density, pseudo stem, banana, grand Nain, bunch.

اثر الكثافة النباتية علي النمو والانتاجية و جودة الموز صنف قراندنين تحت ظروف ولاية كسلا

احمد بابكر احمد[1] و ابتهال حامد محمد حامد[1] وعبد الحميد محمد مقبول[2]

[1]محطة بحوث كسلا والقاش, ولاية كسلا, كسلا, السودان.

[2]هيئة البحوث الزراعية, ولاية الجزيرة, ود مدني, السودان.

ممثل الباحثين: email: ahmedbab7@yahoo.com;

المستخلص:

أجريت التجربة في مزرعة خاصة بقرية القرشي بالقرب من نهر عطبرة، محلية أروما، ولاية كسلا، السودان. نبتات موز نسيجية عمرها ثلاثة أشهر من صنف قراندنين تمت زراعتها في الحقل في الأول من يناير 2022 على تسع مسافات 2×2م، 2×2.5م، 2×3م، 2×3.5م، 2×4م، 3×2.5 م، 3 × 3 م، 3 × 3.5 م و 3 × 4 م. تم تكرار المعاملات 3 مرات في تصميم القطاعات العشوائية الكاملة وتضمنت كل قطعة 12 نباتًا. أظهرت النتائج أنه تم تسجيل أعلى معاملات نمو تحت مسافات 3×2.5م. ولوحظ أقل وقت من الزراعة إلى الازهار ومن الازهار إلى الحصاد عند مسافة 3×2.5م للنبات الأم المحصول الاول. تم الحصول على أعلى وزن للسبيطة وأعلى إنتاجية على مسافة 3×2.5م بين النباتات. وقد تم تسجيل أعلى معدل عائد هامشي (26.18) في هذه المعاملة.

الكلمات مفتاحية: كثافة نباتية, الساق الكاذبة, الموز, قراند نين, سبيطة.

Introduction

Bananas and plantains are the fourth most important food crop in the world after rice, wheat and maize (Salvador *et al*., 2007).

In Sudan banana is the most important fruit crop. It is very delicious and popular fruit and also grown successfully in many part of Sudan (Khiry, 2006). The harvested banana area in Sudan in 2020 was about 47000 ha, and the production was estimated to be 923938 tones (FAO, 2021).

Banana plant density is an important cultural practice because it determines production, net returns and also quantity of nutrients and water per unit area (Behera *et al*., 2014). Plant density is depending on cultivar, soil type and management (Elsiddig *et al*., 2009). Litzenberger (1974) reported that wide plant spacing results in vigorous vegetative growth, large bunches and fingers, high exportable yield but low total yield. Moreover, Robinson, (1996) found that banana plant spacing also affects the time from planting to harvesting and hence crop duration.

Banana cultivar Grand Nain was released to farmers and became a popular variety grown mostly for local consumption and export. The plant of this cultivar is taller than the traditionally grown dwarf Cavendish variety and that necessitates determining the optimum plant density to obtain high yield and its components. Therefore, the objective of this study is to examine the effect of plant density on growth, yield and quality of banana cultivar Grand Nain under Kassala conditions.

Materials and Methods

The experiment was conducted in a private farm at Alqurashi village near Atbara river Aroma locality, Kassala State, Sudan (latitude 15° 13´ N, longitude 35° 93´ E, altitude 421 m above sea level) during the period of January 2022 to June 2023. The climate of the study area is characterized by being dry and hot in summer.

Three months old plants of banana cv. “Grand Nain”, propagated by tissue culture, were transplanted in the field on the first of January 2022, at nine spacing of 2×2m, 2×2.5m, 2×3m, 2×3.5m, 2×4m, 3×2.5m, 3×3m, 3×3.5m and 3×4m. This population give 2500, 2000, 1666, 1429, 1250, 1333, 1111, 952 and 833 mother plant/ha, respectively. Three months after planting, two suckers were left and this plant population was maintained thereafter. Irrigation was applied immediately after planting.

The special horticultural practices, *viz*; fertilization, weed control, leaf removal, mulching, desuckering, bunch propping, removal of male bud, wind breaks, etc. were carried out as recommended. Irrigation was applied every 5-7 days according to farmers practice by surface irrigation from Atbara River.

The nine treatments were replicated 3 times in randomized complete block design (RCBD) and each plot encompassed 12 plants. Growth parameters measured included seasonal increases in pseudostem height 5 cm above soil surface to the point of intersection of the petioles of the two youngest leaves. Pseudostem diameter was measured 5 cm above the ground level. The number of green leaves was counted and recorded at shooting. The numbers of days from planting to flowering and from flowering to harvest were also determined.

Mature bunches were harvested when they reached the full three-quarter shape. Yield and yield components were taken, with 10cm of the stalk left with the bunch to facilitate handling. The second hand of freshly harvested bunch was used to measure the fruit characteristics according to Dadzie and Orchard (1997).

Marginal rate of return analyses, as described by CIMMYT (1988), were used to evaluate the profitability of the different plant density based on the field information and data collected.

CropStat statistical program was used for data analysis and the least significant difference test was used for mean separation at the probability level of 0.05.

Results and Discussion

Effect of plant density on growth parameters:

The differences observed on pseudostem height, pseudostem diameter and number of green leaves for both mother plant and first ratoon of banana cv. Grand Nain were highly significant (Table 1). Taller plant for mother plant and first ratoon of banana were observed under close pant spacing compared to wide spacing. The highest pseudostem diameter and number of green leaves were recorded under wide plant spacing compared to close spacing of mother plant and first ratoon (Table 1). This might be due to the effect of high density on banana pseudostem through high completion for sun light. These results are in agreement with those of Kesavan *et al* (2001) who reported that banana plants grown on close spacing were taller with thinner pseudostem than those grown under wide spacing. Moreover, Elsiddig (2003) stated that banana plants grown at a close spacing were taller with thinner pseudostems than those grown under wide spacing.

Table 1. Effect of plant density on pseudostem height (cm), pseudostem diameter (cm) and number of leaves of banana.

Plant density	Pseudostem height (cm)		Pseudostem diameter (cm)		Number of green leaves	
	MP	FR	MP	FR	MP	FR
2m×2m	192b	205a	53c	58c	11e	16b
2m×2.5m	194b	205a	58b	62b	13c	17b
2m×3m	200ab	204ab	60b	64ab	13c	15c
2m×3.5m	201ab	202ab	60b	64ab	14bc	19a
2m×4m	202a	201b	61ab	65ab	15ab	20a
3m×2.5m	197ab	197bc	63a	67a	16a	20a
3m×3m	197ab	196c	64a	67a	16a	20a
3m×3.5m	196b	195c	64a	68a	15ab	20a
3m×4m	193b	192c	63a	67a	15ab	20a
Sig. level	**	***	**	**	***	***
$SE^{\pm}$	1.83	1.63	1.51	1.40	0.46	0.14
CV%	1.60	1.40	4.30	3.70	5.60	3.80
LSD	5.4	4.90	4.52	4.19	1.39	1.23

MP= Mother plant. FR= First ratoon crops

****and **: indicated significance at P≤0.001and P≤0.05, respectively.*

Effect of plant density on crop duration:

Highly significant differences were observed in the number of days from planting to flowering and number of days from flowering to harvest on mother plant and first ratoon (Table 2). Fewer days from planting to flowering and from flowering to harvesting were observed under treatment of 3m×2.5m followed by 3m×3m (Table 2). This may be due the large plant population encountered at the closer spacing resulted in a significant competition between plants which suppressed growth, delayed shooting and hence resulted in longer crop cycles as compared to the wider spacing. These results are in conformity with the findings of Ahmed (2003) who reported that the narrow spacing significantly increased the number of days from shooting to harvest.

Table 2. Effect of plant density on number of days from planting to flowering and number of days from flowering to harvest of banana.

Plant density	Number of days from planting to flowering		Number of days from flowering to harvest	
	MP	FR	MP	FR
2m×2m	301ab	410ab	112a	127a
2m×2.5m	302a	411a	111a	123b
2m×3m	300ab	409b	107b	122b
2m×3.5m	304a	408b	104b	119c
2m×4m	299a	406b	102c	117d
3m×2.5m	291c	398cd	98d	109f
3m×3m	297b	401c	102c	111f
3m×3.5m	300ab	400c	103c	112e
3m×4m	301ab	396d	105b	109e
Sig. level	**	***	**	***
$SE^{\pm}$	1.64	1.41	1.27	0.89
CV%	1.00	0.60	2.30	1.30
LSD	4.93	2.23	3.80	2.68

MP= Mother plant. FR= First ratoon crops

****and **: indicated significance at P≤0.001and P≤0.05, respectively.*

Effect of plant density on bunch weight and total yield:

Bunch weight and total yield were affected by plant density. Results showed highly significant differences in bunch weight and total yield of mother plant and first ratoon of banana (Table 3). The maximum bunch weight and total yield were recorded under plant density of 3m×2.5m compared to plant density of 2m×2m for mother plant and first ratoon of banana (Table 3). This might be due to good vigor of pseudostem diameter at wider spacing resulted in bigger bunches and high yield. These results are in conformity with the findings of Robinson and Nel (1988) who found that high density of banana induced small bunch. On the other hands, AbdElgadir (2022) found that the highest bunch weight was produced at the spacing of 3x3 m compared to 2×2 m in the three ratoons of banana.

Table 3. Effect of plant density on bunch weight (kg) and total yield (t/ha) of banana

Plant density	Bunch weight (kg)		Total yield (t/ha)
	MP	FR	
2m×2m	7.4g	8.6f	61.5d
2m×2.5m	9.1f	10.3e	59.4de
2m×3m	11.1e	12.5d	60.1d
2m×3.5m	13.4d	14.1c	59.4de
2m×4m	19.4c	21.1b	77.1b
3m×2.5m	21.2a	22.2a	87.4a
3m×3m	20.0b	21.0b	68.9c
3m×3.5m	19.5bc	20.3b	57.3e
3m×4m	19.3bc	20.4b	50.3f
Sig. level	**	***	***
$SE^{\pm}$	0.36	0.35	0.19
CV%	4.0	3.70	2.40
LSD	1.09	1.06	2.73

MP= Mother plant. FR= First ratoon crops
****and **: indicated significance at P≤0.001 and P≤0.01, respectively.*

Effect of plant density on number of hands per bunch and number of fingers per hands

There were highly significant differences in the number of hands per bunch and number of fingers per bunch of mother plant and first ratoon crops of banana (Table 4). The highest values of number of hands per bunch and number of fingers per hands were observed under plant density of 3m×2.5m followed by 3m×3m for mother plant and first ratoon of banana (Table 4). This may be due to less competition between plants grown at the wider spacing gives large fingers. These results are in conformity with the findings of Khiry (2006) who found that plant density of banana significantly affected number of hands per bunch and number of fingers per bunch of mother plant. AbdElgadir (2022) found that the largest number of hands per bunch was recorded by the spacing of 3×3 m compared to 2×2 m of banana.

Table 4. Effect of plant density on of number of hands per bunch and number of finger per hands of banana.

Plant density	Number of hands per bunch		Number of fingers per hands	
	MP	FR	MP	FR
2m×2m	5.0d	6.0d	11e	14d
2m×2.5m	5.2d	6.3d	12de	15.0cd
2m×3m	6.3c	7.0c	13cd	15.0cd
2m×3.5m	7.0c	8.3b	14bc	16.2bc
2m×4m	8.0b	9.2ab	15ab	17.0b
3m×2.5m	9.3a	10.2a	16a	19.3a
3m×3m	8.0b	9.3a	16a	18.5a
3m×3.5m	7.3c	8.2b	15ab	17.3b
3m×4m	7.0c	8.4b	14bc	17.7b
Sig. level	***	***	***	***
$SE^{\pm}$	0.31	6.34	0.69	0.59
CV%	7.8	2.40	8.60	6.10
LSD	0.94	1.03	2.06	1.76

MP= Mother plant. FR= First ratoon crops
****: indicated significance at P≤0.001.*

Effect of plant density on finger weight and finger length

Highly significant differences due to various plant densities were observed in finger weights and finger length of mother plant and first ratoon crops of banana (Table 4). The highest values of finger weight and finger length were recorded by plant of density of 3m×2.5m followed by 3m×3m for mother plant and first ratoon of banana (Table 4). These results are in conformity with the findings of Khiry (2006) who found that plant density of banana had significant affect on finger weight and finger length.

Table 5. Effect of plant density on finger weight (g) and finger length (cm) of banana.

Plant density	Finger weight (g)		Finger length (cm)	
	MP	FR	MP	FR
2m×2m	142d	154f	16c	17.0d
2m×2.5m	144d	156ef	16c	17.5d
2m×3m	146d	157e	16c	17.8d
2m×3.5m	150c	163d	17b	18.3cd
2m×4m	155bc	166c	17b	18.4cd
3m×2.5m	163a	174a	19a	22.1a
3m×3m	161ab	173ab	18ab	20.9ab
3m×3.5m	159ab	172b	18ab	19.6bc
3m×4m	156b	172b	18ab	19.3bc
Sig. level	***	***	***	***
$SE^{\pm}$	1.89	0.75	0.49	0.56
CV%	2.10	0.80	4.90	5.10
LSD	5.68	2.25	1.48	1.69

MP= Mother plant. FR= First ratoon crops
****: indicated significance at P≤0.001.*

Economic evaluation

Results of the economic analysis showed that treatment of spacing of 3×2.5m resulted in the highest return of investment. Return to investment in this treatment was estimated in the form of marginal rate of return (MRR), which came out to be 26.18 (Tables 6, 7 and 8). Therefore, the economic evaluation based on partial budget and marginal analysis indicated that the plant of banana transplanted under spacing of 3×2.5m was the most stable and economically feasible treatment under Kassala State conditions.

Table 6. Effect of plant density on partial and dominance of banana

Plant density	(Plants/ha)	Cost of plants (SDG/ha)	Cost of practices (SDG/ha)	Cost of fertilizers (SDG/ha)	Total cost (SDG/ha)
3m×4m	833	83333	83333	250000	416667
3m×3.5m	952	95238	95238	285714	476190
3m×3m	1111	111111	111111	333333	555556
2m×4m	1250	125000	125000	375000	625000
3m×2.5m	1333	133333	133333	400000	666667
2m×3.5m	1429	142857	142857	428571	714286
2m×3m	1667	166667	166667	500000	833333
2m×2.5m	2000	200000	200000	600000	1000000
2m×2m	2500	250000	250000	750000	1250000

Table 7. Partial and dominance for banana yield data (t/ha) in Kassala state

Plant density	Yield (t/ha)	Gross return SDG/ha	Total variable cost (SDG/ha)	Net returns (SDG/ha)	Dominance
3m×4m	50.3	5533611	416667	5116944	
3m×3.5m	57.3	6306667	476190	5830477	
3m×3m	68.9	7581852	555556	7026296	
2m×4m	77.1	8483750	625000	7858750	
3m×2.5m	87.4	9616444	666667	8949777	
2m×3.5m	59.4	6537143	714286	5822857	D
2m×3m	60.1	6612222	833333	5778889	D
2m×2.5m	59.4	6534000	1000000	5534000	D
2m×2m	61.5	6765000	1250000	5515000	D

Table 8. Marginal analysis or banana yield data (t/ha) in Kassala state

Plant density	Yield (t/ha)	Gross return SDG/ha	Total variable cost (SDG/ha)	Net returns (SDG/ha)	MR	MC	MRR
3m×4m	50.3	5533611	416667	5116944			
3m×3.5m	57.3	6306667	476190	5830477	713533	59523	11.99
3m×3m	68.9	7581852	555556	7026296	1195819	79366	15.07
2m×4m	77.1	8483750	625000	7858750	832454	69444	11.99
3m×2.5m	87.4	9616444	666667	8949777	1091027	41667	26.18

The price of one ton of banana=110000 SDG and one US=850SDG.

Recommendation

Based on the findings growing banana cv. Grand Nain at spacing of 3×2.5m is recommended under Kassala conditions.

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Effect of Packaging and Waxing on Quality and Shelf-life of Grapefruit (*Citrus paradisi* Macf.)

Ebtihal H. M. Hamid[1]., Ahmed B. A. Khalifa[1] and Abdelhamed M. Magboul[2]

1Kassala and Gash Research Station, Kassala, Kassala State, Sudan.

2Agricultural Research Corporation, Wad Medani, Gizera State, Sudan.

Correspondent author: email: ebtihalhamid194@gmail.com

Abstract

Experiments were conducted in the laboratory of Kassala and Gash Research Station, Kassala, Sudan, to evaluate the effect of packaging and waxing on quality and storability of grapefruit during May and August of 2022 and 2023. The experiments were carried out at two level of temperature viz; 35°C and 20°C. Fruits were packaged in intact or perforated polyethylene bag, waxed, waxed with packaged in intact or waxed with perforated polyethylene bag or left unpackaged and unwaxed as control. Treatments were arranged in a completely randomized design with three replicates. The results of the two experiments showed that packaging grapefruit in wax with intact polyethylene bag resulted in lowest weight loss and titratable acidity and higher value of TSS compared to control in both seasons under 35°C and 20°C conditions. Moreover, longest shelf life was observed in case of waxed intact polyethylene bag treatment and the lowest shelf life was recorded for the control in both seasons under 35°C and 20°C conditions.

Key words: grapefruit, packaging, polyethylene bag, wax, shelf-life.

اثر التغليف والتشميع على جودة وتخزين ثمار القريب فروت

ابتهال حامد محمد حامد[1] واحمد بابكر احمد[1] وعبد الحميد محمد مقبول[2]

[1]محطة بحوث كسلا والقاش, ولاية كسلا, كسلا, السودان.

[2]هيئة البحوث الزراعية, ولاية الجزيرة, ود مدني, السودان.

ممثل المؤلفين: email: ebtihalhamid194@gmail.com

المستخلص

اجريت تجارب في معمل محطة بحوث كسلا والقاش، كسلا، السودان، لتقييم اثر التغليف والتشميع على جودة وتخزين ثمارالقريب فروت صنف رد بلش خلال شهري مايو واغسطس لعامي 2022 و 2023. تم تعبئة ثمار القريب فروت في كيس بولي إيثيلين سليم أو مثقوب ، مشمع ، مشمع مع تعبئتها كيس بولي إيثيلين سليم أو مثقوب أو تركت غير معبأة وغير مغلفة بالشمع . تم ترتيب المعاملات في التصميم العشوائي الكامل بثلاث مكررات .أظهرت النتائج أن معاملة ثمار القريب فروت بالشمع وتعبئتها في كيس بولي إيثيلين سليم أدى إلى أقل خسارة في الوزن وحموضة اقل، وقيمة أعلى من المواد الصلبة الذائبة والفيتامينات مقارنةً بالشاهد في الموسمين .علاوة على ذلك، تم تسجيل أطول عمر للتخزين عند الشمع مع كيس بولي إيثيلين سليم وتم تسجيل أقل عمر تخزين مع الشاهد.

كلمات مفتاحية: القريب فروت، التغليف، كيس البولي إيثيلين، التشميع، عمر التخزين

Introduction

Citrus (*Citrus paradisi* Macf.) is an important cash crop and an essential source of vitamin C (Mohamed, 2014). In Sudan the total production of grapefruit was 65000 tons and ranked second after South Africa in Africa. Estimated total area of grapefruit in Sudan was 42,000 ha (SNHA, 2001) and (FAOSTAT, 2013).

Fruits and vegetables have a high-water content ranging from 70-95% Bajwa and Anjum (2007). To reduce the postharvest losses, there is need to enhance shelf-life of fruits under ordinary marketing conditions because 25-30% of the horticultural produce goes waste due the absence of an efficient marketing and poor post-harvest handling (Mahajan *et al*, 2002).

Plastic packaging by polyethylene film is very important method for maintaining fruit quality during storage. It allows control of gas and in turn can affect physiological processes in fruit (Lange, 2000). Sonkar and Ladaniya (1999) reported that wrapping reduced the rate of water loss, respiration, fruit softening, and total acidity of mandarin.

Treating fruits with wax increased the shelf-life and at the same time improve quality of fruits. Application of wax slows down the permeability of water vapour and other gases (Mahajan *et al*, 2002). Moreover, Bajwa and Anjum (2007) reported that waxing reduced the chilling injury, rind staining and weight loss in mandarins. However, there is need to conduct trails to study the effect of waxes alone or in combination with packaging in horticultural fruits. Farmers in Kassala need simple technology to preserve their product for weeks and at the same time such treatment may enable the farmers to sell their products directly to the consumer avoiding whiteout any need to the brokers. Therefore, the objective of this study was to determine the effect of packaging and waxing on quality and shelf-life of grapefruit, at two levels of temperature.

Materials and Methods

Two experiments were conducted in the laboratory of Kassala and Gash Research Station, Kassala, latitude 15° 27´ N, longitude 36° 21´ E and altitude 505 masl during May and July of 2022 and 2023 at two levels of temperature *viz*; 35°C and 20°C.

Grapefruit fruits of the Red Blush cultivar were harvested from orchard at uniform size and colour and free from blemishes and other defects. The waxes were applied by brushing over the surface of the fruits in a thin layer. Cartons and polyethylene bags were used; some of the polyethylene bags were perforated while others were left intact.

Packaging treatments were arranged in the as following:

1. Unwrapped and unwaxed fruits placed in cartons (control).
2. Fruits were wrapped in intact polyethylene bags, and then placed in cartons.
3. Fruits were wrapped in perforated polyethylene bags, and then placed in cartons.
4. Fruits were waxed, and then placed in cartons.
5. Fruits were waxed and wrapped in intact polyethylene bags, and then placed in cartons.
6. Fruits were waxed and wrapped in perforated polyethylene bags, and then placed in cartons.

The six treatments of each experiment were arranged in a completely randomized design (CRD) with three replicates. Each experimental unit contained 10 grapefruit fruits.

Initial weights of fruits were determined then their weight was recorded weekly till they were out of quality. Weight loss was determined using the following formula:

$$\text{Weight loss (\%)} = \{(w_o - w_t) / w_o\} \times 100$$

Where:

w_o = initial weight and w_t = weight at designated time.

Total soluble solids (TSS) were determined weekly using a hand refractometer (Model HRN-32).

Total titratable acidity was determined weekly on a sample of 2ml juice diluted to 200 ml with distilled water and titrated against 0.1 N NaOH to a phenolphthalein end point (light pink colour) and calculated as percentage of citric acid. Total titratable acidity was determined using the following formula:

$$\text{Titratable acidity} = \frac{\text{ml of NaOH used} \times 0.1\text{N of NaOH} \times 0.064 \times 100}{\text{ml of Juice}}$$

Marginal rate of return was analyzed according to CIMMYT (1988) and used the field information and data collected for evaluation.

Data were subjected to analysis of variance procedures. Treatment means were separated using Duncans Multiple Range Test at 5% level of significance.

Results and Discussion

Effects of packaging and waxing on weight loss and shelf-life of grapefruit

Weight loss and shelf-life of the two experiments showed very highly significant differences in both seasons at 35°C and 20°C (Table 1, 2, 3 and 4). The lowest weight loss of grapefruits was recorded in fruits treated by wax and packaging in intact

polyethylene bag, while the highest weight loss was recorded for the control at 35°C and 20°C in both seasons (Table 1and 2). The longest shelf-life was recorded in wax with intact polyethylene bags and intact polyethylene bags, followed by waxed with perforated poly ethylene bags compared to control in both seasons at 35°C and 20°C (Table 3 and 4). This might be due to reduction of water loss when using wax or wrapping, subsequently increasing the shelf-life of the fruits. Similar results were reported by Elhadi *et al*. (2011) who reported that waxing fruit reduced weight loss and improved shelf-life of grapefruits. Moreover, Ibtihal *et al*. (2016) reported that packaged lime in intact film had longer shelf-life and lower weight loss compared to control in two seasons.

Table 1. Effect of packaging and waxing on weight loss of grapefruit under 35°C during two seasons.

Packaging treatments	Weight loss (%)	
	Season one	Season two
Control	24.4a	23.5a
Perforated poly ethylene bag	16.9b	23.2a
Intact poly ethylene bag	8.4c	7.9c
Wax	8.6c	8.7b
Wax with perforated poly ethylene bag	7.7c	6.5d
Wax with intact poly ethylene bag	4.6d	4.7e
Significance level	***	***
$SE^{\pm}$	0.79	0.21
CV%	11.59	2.95

****: indicated significant at P≤0.001.*

Table 2. Effect of packaging and waxing on weight loss of grapefruit under 20°C during two seasons.

Packaging treatments	Weight loss (%)	
	Season one	Season two
Control	31.0a	27.5a
Perforated poly ethylene bag	19.1b	24.7b
Intact poly ethylene bag	6.6cd	12.5d
Wax	7.4c	18.7c
Wax with perforated poly ethylene bag	6.1d	5.5e
Wax with intact poly ethylene bag	3.2e	4.2f
Significance level	***	***
$SE^{\pm}$	0.28	0.30
CV%	4.02	3.39

****: indicated significant at P≤0.001.*

Table 3. Effect of packaging and waxing on shelf-life of grapefruit under 35°C during two seasons.

Packaging treatments	Shelf-life (Days)	
	Season one	Season two
Control	7.0f	5.5f
Perforated poly ethylene bag	11.0e	12.4e
Intact poly ethylene bag	20.0b	23.0b
Wax	13.4d	18.0d
Wax with perforated poly ethylene bag	16.3c	20.0c
Wax with intact poly ethylene bag	26.8a	28.0a
Significance level	***	***
$SE^{\pm}$	0.43	0.50
CV%	4.71	4.81

****: indicated significant at P≤0.001.*

Table 4. Effect of packaging and waxing on shelf-life of grapefruit under 20°C during two seasons.

Packaging treatments	Shelf-life (Days)	
	Season one	Season two
Control	17.5f	18.4f
Perforated poly ethylene bag	22.0e	21.3e
Intact poly ethylene bag	71.0b	65.0b
Wax	28.0d	25.0d
Wax with perforated poly ethylene bag	65.5c	58.0c
Wax with intact poly ethylene bag	76.0a	73.0a
Significance level	***	***
$SE^{\pm}$	0.50	0.51
CV%	1.86	2.01

****: indicated significant at P≤0.001.*

Effects of packaging and waxing on total soluble solids and titratable acidity of grapefruit

Total soluble solids of grapefruit under 35°C and 20°C during both seasons are shown in Fig. 1, 2, 3 and 4. Total soluble solid increased during the storage period and the highest values of total soluble solids were observed in control while, the lowest values were recorded under wax with intact polyethylene bag followed by intact polyethylene bag in both seasons at 35°C and 20°C (Fig 1, 2, 3 and 4). The results recorded that the increase during storage in the control was higher compared to other treatments and this might be due to the high water losses in unpacked and unwaxed treatments. This result is in an agreement with Elhadi *et al*. (2011) who reported that packing and waxing affected total soluble solids levels during the storage period of grapefruit and the highest value of total soluble solids was observed in control treatment.

The effect of packing and waxing on titratable acidity of grapefruit under 35°C and 20°C during the both seasons were shown in Fig. 5, 6, 7 and 8. There is a clear decrease in titratable acidity during the storage period, but waxing with the packaging was less than those of the packaging alone and the control under 35°C. Wax with

intact poly ethylene bag recorded the lowest value of titratable acidity compared to control in both seasons (Figure 5and 6). Under 20°C there were an increase in titratable acidity in all treatments, until the week 6 and then it began to decrease, but it was noted that the lowest acidity was recorded with wax within intact poly ethylene bag treatment in both seasons (Figure 7 and 8). This may be due to the fact that reduction of water loss in wax and polyethylene bags being less compared to the control which in turn led to higher titratable acidity. These results are in arrangement with the findings of Abu-Goukh and Elsheikh, (2008) who found that waxing, decreased acidity during storage of grapefruit. However, Ahmed *et al*. (2007) reported that waxing decreased titratable acidity during storage of orange.

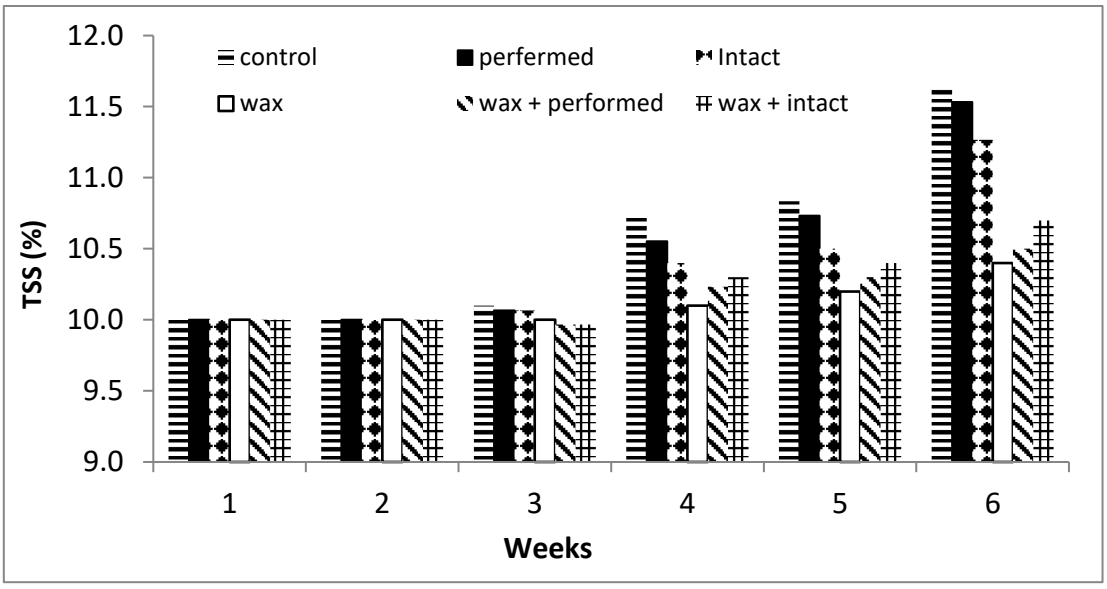

Figure 1. Effect of packaging and waxing on total soluble solids of grapefruit under 35°C during season one.

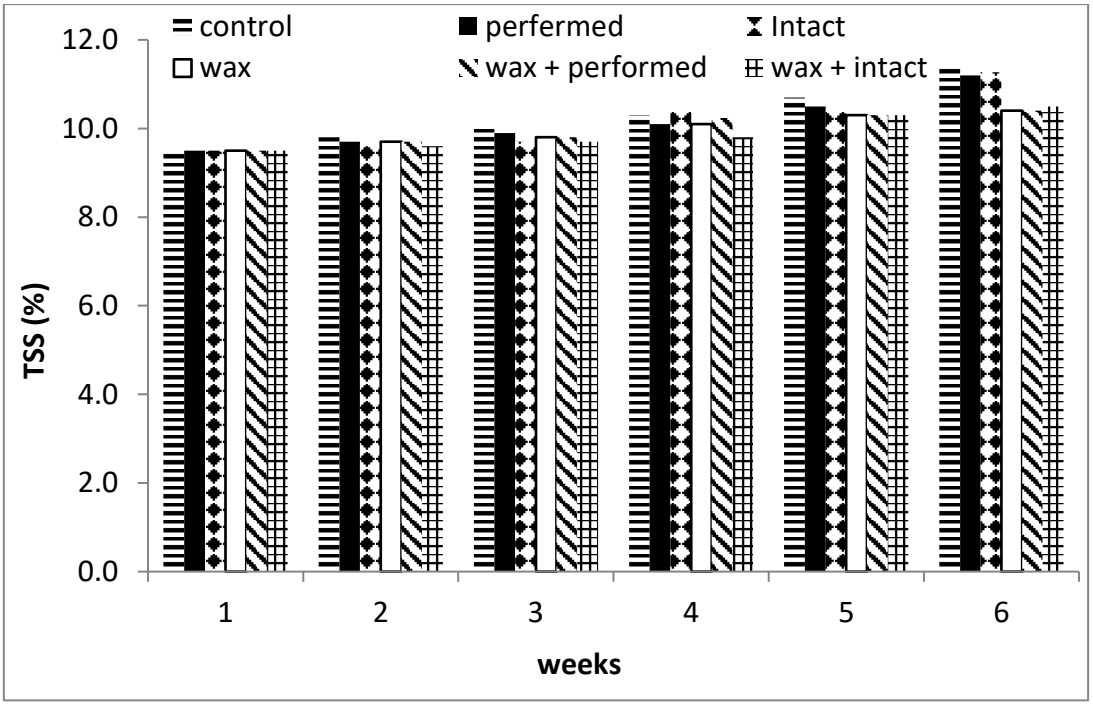

Figure 2. Effect of packaging and waxing on total soluble solids of grapefruit under 35°C during season two.

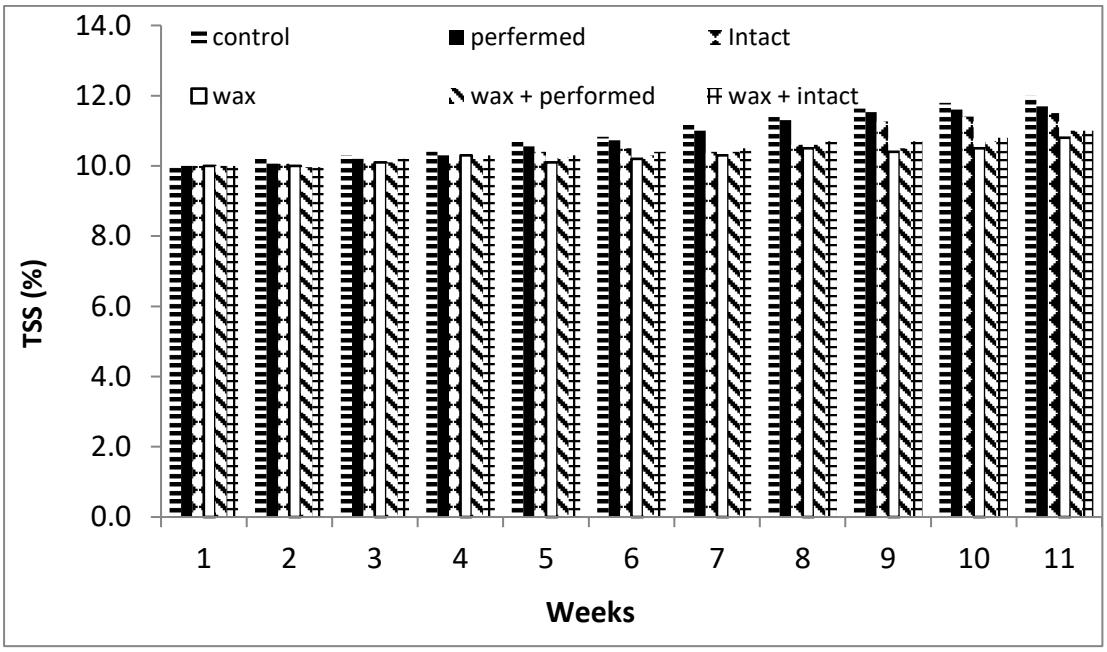

Figure 3. Effect of packaging and waxing on total soluble solids of grapefruit under 20°C during season one.

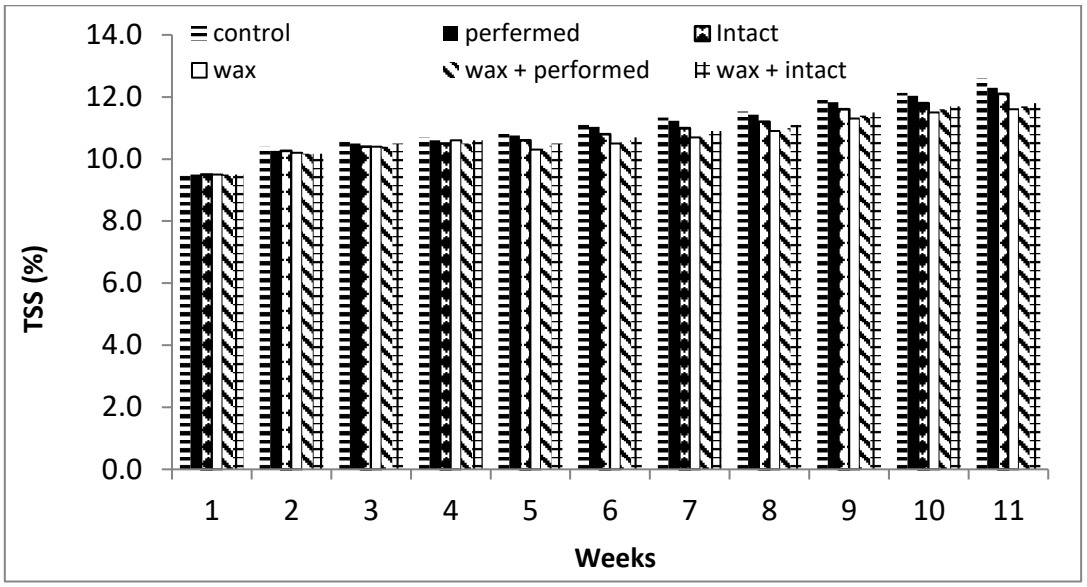

Figure 4. Effect of packaging and waxing on total soluble solids of grapefruit under 20°C during season two.

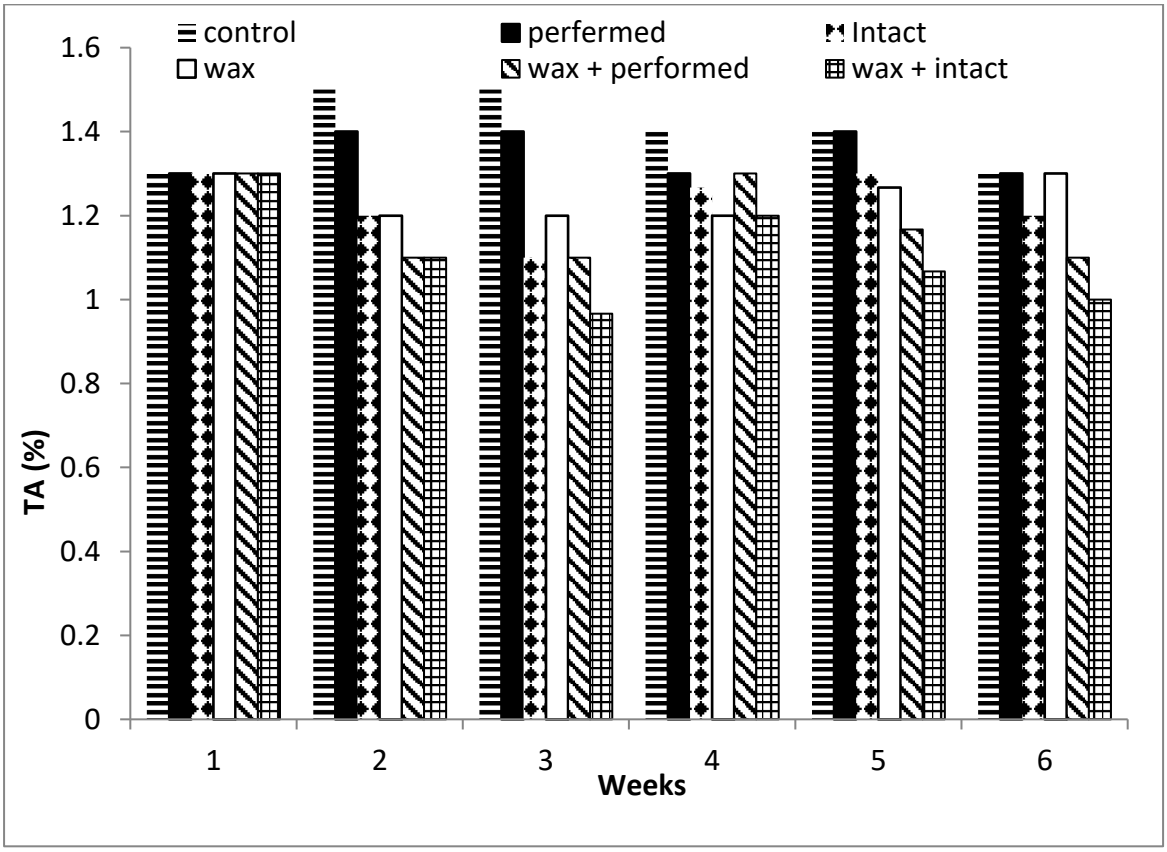

Figure 5. Effect of packaging and waxing on titratable acidity of grapefruit under 35°C during season one.

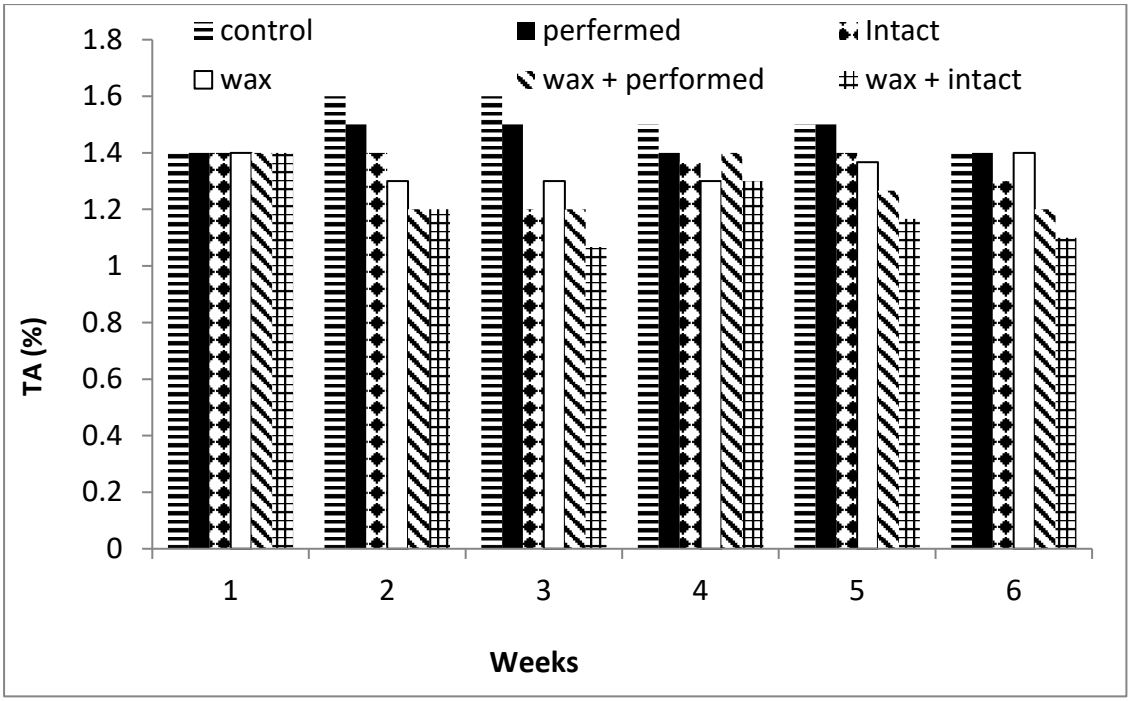

Figure 6. Effect of packaging and waxing on titratable acidity of grapefruit under 35°C during season two.

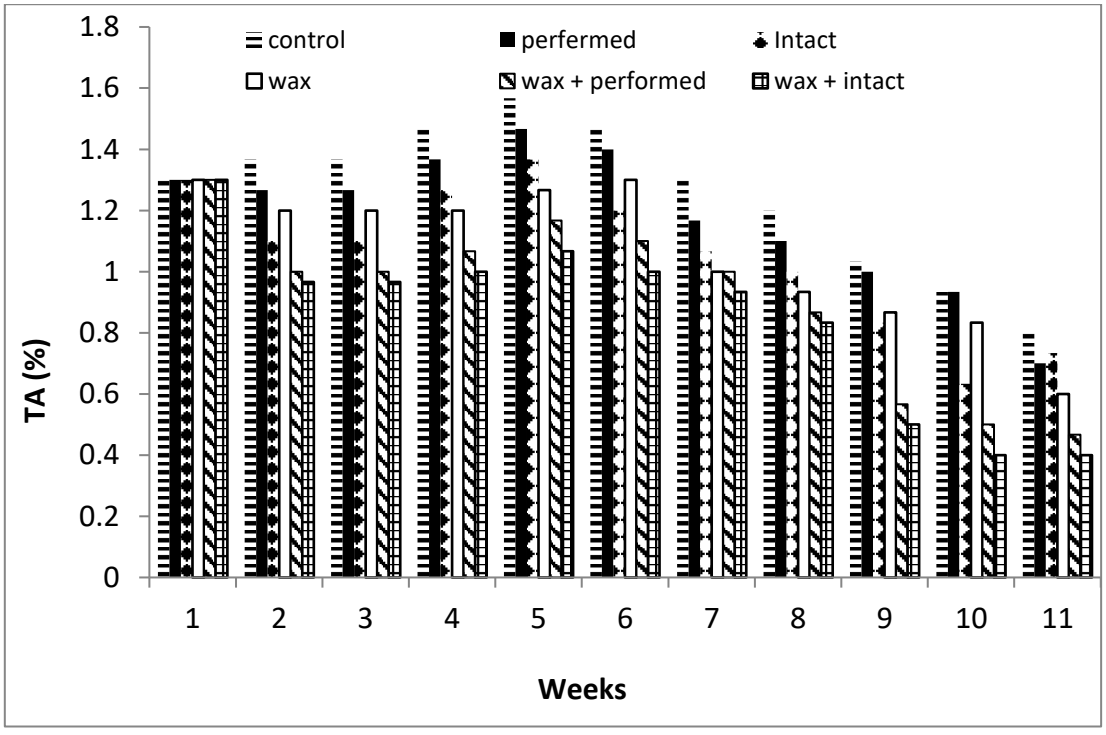

Figure 7. Effect of packaging and waxing on titratable acidity of grapefruit under 20°C during season one.

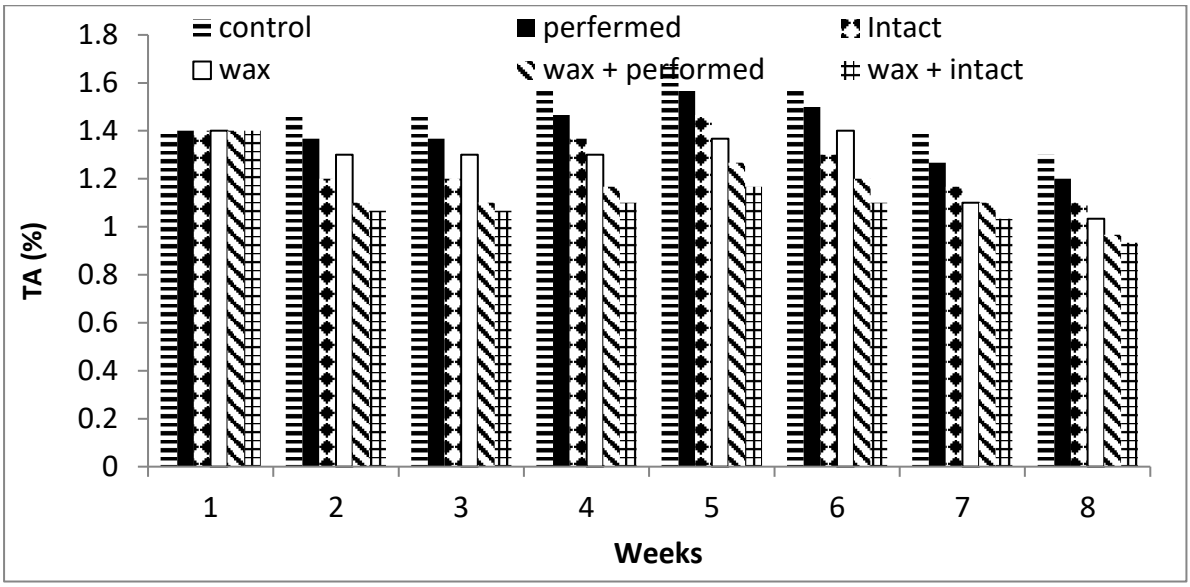

Figure 8. Effect of packaging and waxing on titratable acidity of grapefruit under 20°C during season two.

Effects of packaging and waxing on economic evaluation of grapefruit

In determining the most economically acceptable treatment, partial, dominance and marginal analysis were conducted for data of 10 grapefruits conducted in the laboratory of the Kassala and Gash Research Station, Kassala, Sudan under two types of temperature *viz*; 35°C and 20°C. All costs and returns were calculated on per-ton weight basis in SDG. Results showed treatment of waxing with packaging in intact polyethylene bag followed by intact polyethylene bag improved the quality and storability of grapefruit fruits under 35 and 20°C conditions and realized the highest returns of investment. Return to investment in this treatment was estimated in the form of marginal rate of return (MRR), which came out to be 9.15 and 4.87 for improved quality and storability of grapefruit fruits under 35 and 20°C conditions, respectively (Tables 5 to 8).

Therefore, the economic evaluation based on partial budget and marginal analysis indicated that to improve the quality and storability of grapefruit fruits under 35 and 20°C conditions, respectively using of waxing with packaging in intact polyethylene bag followed by intact polyethylene bag improved the quality and storability of grapefruit fruits under 35 and 20°C conditions and realized the most stable and economically feasible treatment.

Table 5. Partial and dominance analyses for grapefruit in per ton basis in Kassala area under 35°C.

Packaging treatments	Weight loss (%)	Shelf life (days)	Net weight (ton)	Price of (1 ton)	Loss in price	Variable cost (SDG/ton)	Gross return (SDG/ton)	Net return (SDG/ton)	Dominated
Normal	0	0	1.00	100000	0	0	100000	100000	
Control	24	6	0.80	130000	31135	1000	97865	96865	D
Perforated poly ethylene bag	20	12	0.80	160000	32080	11000	116920	105920	
Intact poly ethylene bag	8	22	0.92	240000	19560	19300	201140	181840	
Wax	9	16	0.91	200000	17300	21300	161400	140100	D
Wax with perforated poly ethylene bag	7	18	0.93	200000	14200	29300	156500	127200	D
Wax with intact poly ethylene bag	5	27	0.95	280000	13020	31300	235680	204380	

Table 6. Marginal analysis for grapefruit in per ton basis in Kassala area under 35°C.

Packaging treatments	Gross return (SDG/ton)		Net return (SDG/ton)	MC	MR	MRR
Normal	100000	0	100000			
Perforated poly ethylene bag	116920	11000	105920	11000	5920	0.54
Intact poly ethylene bag	201140	19300	181840	8300	75920	9.15
Wax with intact poly ethylene bag	235000	31300	204380	12000	22540	1.88

Table 7. Partial and dominance analyses for grapefruit in per ton basis in Kassala area under 20°C.

Packaging treatments	Weight loss (%)	Shelf life (days)	Net weight (ton)	Price of (1 ton)	Loss in price	Variable cost (SDG/ton)	Gross return (SDG/ton)	Net return (SDG/ton)	Dominated
Normal	0	0	1.00	100000	0	0	100000	100000	
Control	29	18	0.71	240000	69600	10000	170400	160400	
Perforated poly ethylene bag	22	22	0.78	260000	56940	22000	203060	181060	
Wax	13	27	0.87	320000	41760	34800	278240	243440	
Intact poly ethylene bag	10	68	0.90	380000	36290	53300	343710	290410	
Wax with perforated poly ethylene bag	6	62	0.94	340000	19720	60300	320280	259980	D
Wax with intact poly ethylene bag	4	75	0.94	380000	14060	68800	365940	297140	

Table 8. Marginal analysis for grapefruit in per ton basis in Kassala area under 20°C.

Packaging treatments	Gross return (SDG/ton)		Net return (SDG/ton)	MC	MR	MRR
Normal	100000	0	100000			
Control	170400	10000	160400	10000	60400	6.04
Perforated poly ethylene bag	203060	22000	181060	12000	20660	1.72
Wax	278240	34800	243440	12800	62380	4.87
Intact poly ethylene bag	343710	53300	290410	18500	46970	2.54
Wax with intact poly ethylene bag	365940	68800	297140	15500	6730	0.43

Conclusion

Waxing with packaging in intact polyethylene bag followed by intact polyethylene bag improved the quality and storability of grapefruit fruits under 35 and 20°C conditions.

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In Vitro Efficacy of *Acacia seyal* Delile *(*Altalh*)* Wood Extract against Four Bacteria Isolates

Mwada M.M. Salih[1] , Almahi M.A. Ali[2] and Khalid E.M.Idris[2]

1University of The Holy Qura,n and Taseel Of Science, Faculty of Education P. O. Box 222 Wad Medani, Sudan

2 University of Gezira, Faculty of Education El-Hassahesa, P. O. Box 20 Wad Medani, Sudan

Email: Mawdataha5@gmail.com

Abstract

Acacia seyal known also as the tree (*Altalh*). the bark is used to treat dysentery and bacterial infections of the skin, such as leprosy , the wood is used to treat pain from rheumatism. *Acacia seyal* wood extracted using Bilola instrument which showed effective antibacterial activity against *Xanthomonas citri*, *Xanthomonas pmalvacearum*, *Escherichia coli*, and *Staphylococcus aureus*, the maximum inhibition zone observed 11.8mm, 12.6, 14.6mm, and 17.2mm, respectively.

Keywords: Bilola instrument, *Xanthomonas citri*, *Escherichia coli Staphylococcus aureus*, *Xanthomonas pmalvacearum*

الفعالية المختبرية لمستخلص خشب السنط السيال (الطلح) ضد أربع عزلات من البكتيريا

مودة محمد طه محمد صالح [1] الماحي محمد احمد علي [2] خالد الحسين محمد ادريس[3]

1محاضر قسم الكيمياء- جامعة القران الكريم وتأصيل العلوم - كلية التربية ود مدني

2استاذ مشارك قسم الكيمياء – جامعة الجزيرة- كليه التربية الحصاحيصا

2استاذ مشارك قسم الاحياء – جامعة الجزيرة - كليه التربية الحصاحيصا

المستخلص

السنط السيال المعروف ايضا بشجرة (الطلح) , يستخدم لحاءه في علاج الدسنتاربا والالتهابات الجلديه البكتريه مثل الجزام ,كما يستخدم خشبة في علاج الام الروماتيزم .تم استخلاص خشب السنط السيال بأستخدام جهاز بلولا الذي أظهرفعاليه مضادة للجراثيم ضد الزانثوموناس سيتري و الزانثوموناس بمالفاسيروم والاشريكيه القولونيه والمكورات العنقوديه الذهبيه وبلغت منطقة التثبيط القصوي 11.8مم , 12.6 مم, 14.6 مم, 17.2 مم علي التوالي .

الكلمات المفتاحية: جهاز بلولا , زانثوموناس سيتري , الاشريكيه القولونيه , المكورات العنقوديه الذهبيه, زانثوموناس بمالفاسيروم

Introduction:

Acacia seyal known also as the tree (*Altalh*). It is a woody thorny tree with a pale greenish or reddish bark. The bark is used to treat dysentery and bacterial infections of the skin, such as leprosy. It is also used as a stimulant. Incense from the wood is used to treat pain from rheumatism and to keep expectant mothers from contracting rhinitis and fevers. (Young *et al.,* 1996). The extracts of the wood of *Acacia seyal* showed in vitro anti-malarial (Muthaura *et al.,* 2015), anti-micro bacterial and cyclooxygenase inhibition (Eldeen and Van.2008), antibacterial (Eldeen and Van, 2007), and anticancer activities (Saeed *et al.,* 2015). It was revealed that the metabolites of leaves, seeds and flowers of *Acacia seyal* rich with of flavonoids and saponononins (Abdel-Farid *et al.,* 2014).

Martials and Method

Martials

Equipment's

Incubator, Oven, Autoclave, Microscope, Benzene burner, Petri Dishes, Slides, Flasks, Wire Loops, Needle, Forceps , beaker dropper, Sensitive balance and Bilola instrument for chemical extraction.

Chemicals and reagents

Nutrient Agar (NA), Peptone, Yeast Extract, Beef Extract, Agar, Distilled Water,

Acacia seyal woods

Samples collection

Acacia seyal woods were collected from the local market EL-Hasahesa, Gezira state, Sudan

Preparation of *Acacia seyal* Extracts

Five gram of *Acacia seyal* woods was weighted by Sensitive balance put in Bilola instrument extraction for chemical extraction and collected directly from the condenser.

Bilola instrument for chemical extraction

Bilola instrument for chemical extraction is a new instrument invent by Dr. Almahi(2021-4414).

The instrument consists of burner, burner unit and condenser. The instrument technique depends on burning or boiling the sample on the unit and condensed in a condenser directly as liquid or collected by solvents after condensed on the wall of the condenser due to the solubility.

Sources of the bacterial isolates

The human bacteria (*Staphylococcus aureus* and *Escherichia coli*) was brought supplied from Faculty of Medical Laboratories at University of Al-butana, Rufa`a, Gezira state, Sudan in December 2021.

The plant bacteria (*Xanthomonas citri* and *Xanthomonas pmalvacearum*) were brought supplied from Laboratories of Faculty of Agriculture, University of Gezira, Wad Medani, Gezira state - Sudan in November2022.

Human Bacteria Isolate

Soluble of bacteria in distilled water take one ml of each bacterial suspension was spread on nutrient agar medium. Filter disks (2cm in diameter) each saturated by extract were placed in the middle of each plate and incubated for 24hrs hours at 30^{o}C and followed for inhibition zones (Onions *et al.,* 1981)

Plant Bacteria Isolate

Several small pieces were taken from the sides of the affected tissue in the form of squares or sections measuring 1-2 cm so that they contain infected and healthy tissues. These sections were placed in a container containing ethanol provided that the papers are immersed. The sections are transferred used sterile forceps from the sterile solution paper until the excess disinfectant solution is removed on the surface, or they are washed in sterile water three times in row. The sterile sections are placed on a nutritious environment by 3-5 sections in each glass dishes, then the dishes are left for a period ranging from 24-48 hours until the bacteria colonies grow on the food environment and then these colonies are transferred to other environments to further study the characteristics of the pathogenic organism **(**Hari *et al*.,1998)

Results and Discussion

Results

The *Acacia Seyal* wood extract effect against the growth of four different bacterial isolates:

The *Acacia Seyal* wood extract possessed antimicrobial activities against *Staphylococcus aureus*, *Escherichia coli*, *Xanthomonas pmalvacearum* and *Xanthomonas citri* inhibition zone observed were 17.2, 14.6, 12.6 and 11.8 respectively (Table 1).

The inhibition zone of the bacteria by *Acacia seyal* wood extract is shown in figure (1 to 5):

The inhibition zone test of *Acacia seyal* wood extract showed *Escherichia coli* bacteria in figure (1), *Staphylococcus aureus* bacteria in figure (2), *Xanthomonas citri* bacteria in figure (3) and *Xanthomonas pmalvacearum* bacteria in figure (4). While in figure (5) shows the relationship between bacteria and inhibition zone.

Table (1): Effect of *Acacia Seyal* Wood Extract on the Growth of Four Different Bacterial Isolates

Test Organisms	Zone of Inhibition (mean diameter (mm)
Staphylococcus aureus	17.2
Escherichia coli	14.6
Xanthomonas citri	11.8
Xanthomonas pmalvacearum	12.6

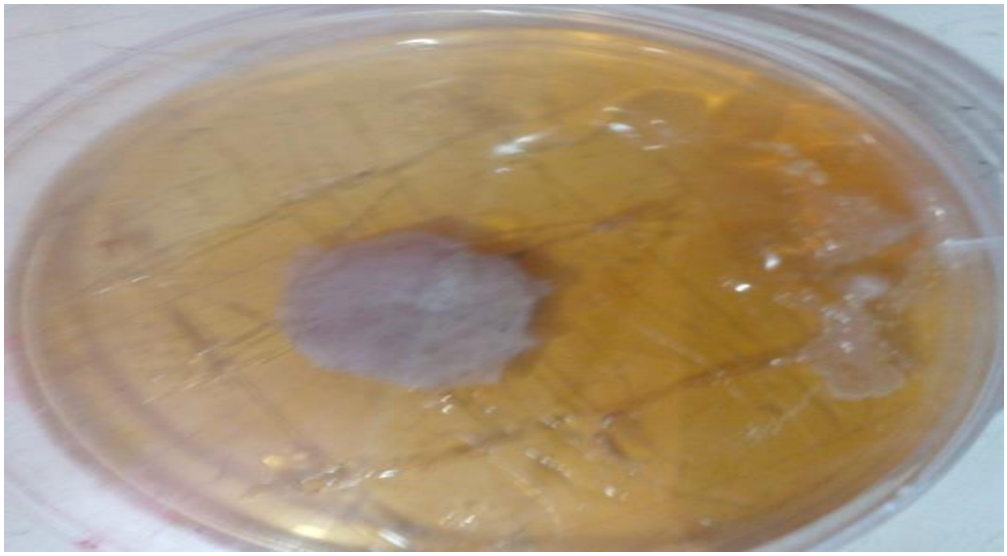

Fig (1) Showing Inhibition Zone diameters of *Acacia seyal* against Bacteria *Escherichia coli*

Fig (2) Showing Inhibition Zone diameters of *Acacia seyal* against Bacteria *Staphylococcus aureus*

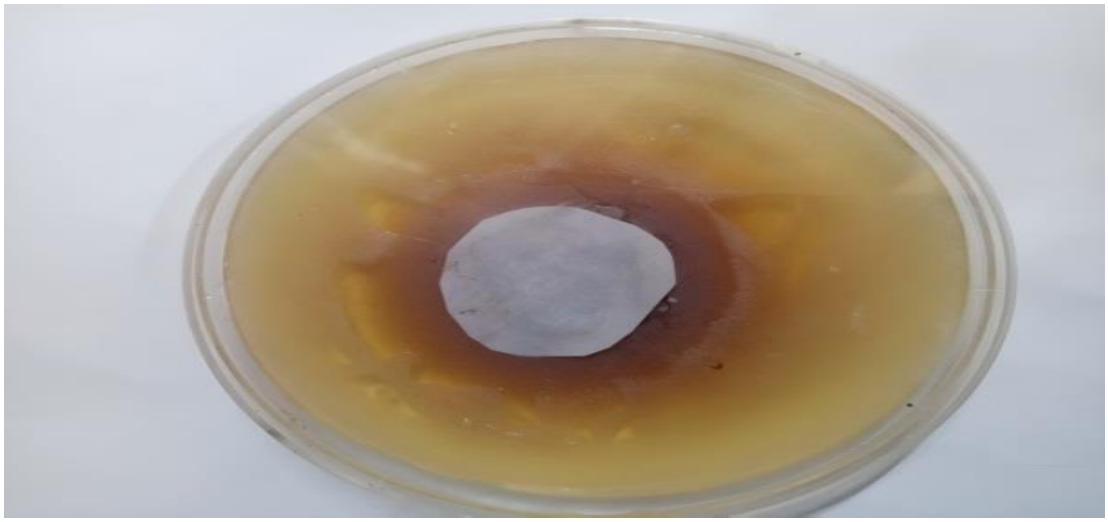

Fig (3) Showing Inhibition Zone diameters of *Acacia seyal* against Bacteria *Xanthomonas citri*

Fig (4) Showing Inhibition Zone diameters of *Acacia seyal against Bacteria Xanthomonas pmalvacearum*

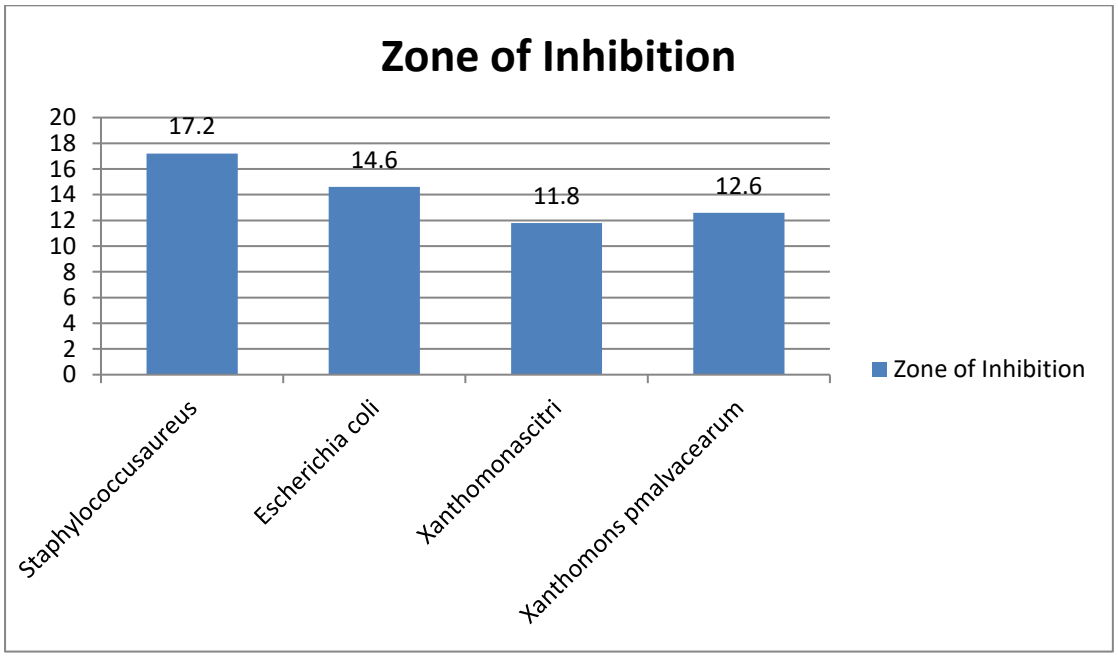

Fig (5) Effect of *Acacia seyal* wood Extract on the Growth of Four Different Bacterial Isolates

DISCUSSION:

This study was conducted four bacterial isolates to find out the effect of *Acacia seyal* wood extract extracted using the Bilola instrument aganist four bacterial isolates which are *Staphylococcus aureus, Escherichia coli, Xanthomonas citri* and *Xanthomonas pmalvacearum.* The maximum inhibition zone observed were *Xanthomonas citri* 11.8mm, *Xanthomonas pmalvacearum*12.6mm, *Escherichia coli* 14.6mm and *Staphylococcus aureus* 17.2mm see (Table 1). In contrast, these findings were semi compared to a study by Hatil and Moneer (2006) the maximum zone of inhibition was observed against *Escherichia coli* 30mm and minimum was against *Staphylococcus aureus* 23mm. This result was in accordance with that obtained by Hatil and Banga (2014) who found that *Acacia seyal* sensitivity of five clinical bacterial isolates (*Staphylococcus aureus, Escherichia coli, Klebsilla sp., Pseudomonas aeruginosa and Proteus sp*) the Minimum Inhibitory Concentration of ranged from <5 to >20 mg/ml. While Abdirahman *et al.,* (2020) found that *Acacia seyal* extract has anti-bacterial, antioxidant activities and Cyto-toxicity. René *et al.,* (2020) reported *Acacia seyal* extracts (leaves, root bark and trunk) was to have antimicrobial properties. Elamin *et al.,* (2022) reported that *Acacia seyal* of stem extract has efficacy in medicinal field as anti-diabetic, antimicrobial, and anti-inflammatory.

Conclusions and Recommendations:

Conclusions:

The *Acacia seyal* extract in this study has anti-bacterial properties was inhibition growth of four different bacterial isolates like *Staphylococcus aureus, Escherichia coli, Xanthomonas citri* and *Xanthomonas pmalvacearum*.

Recommendations:

The study recommended studying the effect of *Acacia seyal* extract on fungi.

Recommended to study the effect of *Acacia seyal* seeds on bacteria .

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المكافحة الكيميائية لهالوك الفول المصري *Orobanche crenata* Forsk

تحت ظروف الولاية الشمالية – السودان

رؤي عادل ادريس عبده [1] ومختار عبد العزيز محمد عثمان [2]

1 الولاية الشمالية -السودان وزارة الزراعة – دنقلا

2 كلية العلوم الزراعية – جامعة دنقلا –السودان

المؤلف:mukhtarazizm@gmail.com

المستخلص

أجريت التجربة خلال موسمين شتويين متعاقبين للعامين 2021/ 22 و 2022/ 23 بمشتل الإدارة العامة لوقاية النباتات . دنقلا ومشتل كلية العلوم الزراعية بالسليم ، جامعة دنقلا، الولاية الشمالية ، السودان على التوالى . تقع الولاية الشمالية بين خطى عرض 16 و22 درجة شمالاً وخطى طول 20 و 32 درجة شرقاً لتحديد تأثير مبيدى الجليفوسيت والبيرسوت على انبثاق ونمو الهالوك ، تقدير النسبة المئوية للفقد فى إنتاجية بذور الفول المصرى بسبب إصابته بطفيل الهالوك وتقييم ومقارنة تأثير المبيدين المذكورين على الهالوك بالإضافة إلى تحديد أحسن معاملة للمبيدين يحقق أعلى إنتاجية (طن /هكتار) للفول المصرى. منافسة طفيل الهالوك لمحصول الفول المصرى طول الموسم قللت معنوياً إنتاجية البذور بنسبة 77.04 % و 78.33% فى الموسمين الشتويين الأول والثاني علي التوالي. جليفوسيت (52.5 كجم .م .ف /هكتار) المستخدم رشاً بعد 4، 6، 8 أسابيع بعد الزراعة على التوالي والمعاملة الخالية من بذور الهالوك طول الموسم زادت معنوياً إنتاجية بذور الفول المصري (طن/هكتار) بنسبة 177.91% و 140.77% فى الموسمين الشتويين الأول والثاني علي التوالي. كل معاملات مبيدى الحشائش المستخدمان رشاً قبل وبعد الانبثاق والمعاملة الخالية من بذور الهالوك طول الموسم قللت معنوياً عدد نباتات الهالوك في المتر المربع فى الموسم الشتوي الأول. كل معاملات مبيدى الحشائش المستخدمان رشاً قبل وبعد الانبثاق والمعاملة الخالية من بذور الهالوك طول الموسم قللت معنوياً الوزن الجاف للمجموع الخضرى لنبات الهالوك بالجم فى الموسمين الشتويين. إنتاجية الفول المصرى (طن/هكتار) في الموسم الشتوي الأول أكثر من تلك التي تم الحصول عليها في الموسم الشتوي الثاني.

كلمات مفتاحية: النمو الخضري، الطفيل، المنافسة، طول الموسم، جليفوسيت وبيرسوت.

Chemical Control of Broomrape Infesting Faba bean Feilds in Northern State, Sudan

Roy Adel Idris Abdo [1] and Mukhtar Abdel Aziz Muhammad Othman [2]

1 North - Sudanese Ministry of Agriculture - Dongola

2Faculty of Agricultural Sciences - Dongola University - Sudan

Email: mukhtarazizm@gmail.com

Abstract

Northern State Located within latitude 16° and 22° N ., and longitude 20° and 32° E . , to de

The experiment was conducted during two consecutive winter seasons of the years2021 /22 and 2022 /23 at nursery of General Administration of Plant Protection, Dongola and nursery of Faculty of Agricultural Sciences at Selaim , University of Dongola, Northern State, Sudan respectively termine the effect of glyphosate and Pursuit herbicides on emergence and growth of broomrape, estimation of faba bean seed yield loss percentage due to broomrape Parasite infection and evaluate and compare the effect of the two mentioned herbicides on the broomrape, besides determination the best treatment of the two herbicides which achieve highest faba bean yield (ton/ha). Broomrape Parasite full season competition to faba bean crop significantly reduced seed yield by 77.04 and 78.33% in both winter seasons, the first and the second, respectively. Glyphosate (52.5 kg a .i/ha) applied at 4, 6 and 8 weeks after sowing, respectively and broomrape seeds free full season treatment significantly increased faba bean seed yield (ton /ha) by 177.91% and 140.77% in both winter seasons, the first and the second, respectively. All treatments of the two herbicides applied pre and post – emergence and broomrape seeds free full season treatment significantly reduced number of broomrape plants/m² in the first winter season. All treatments of the two herbicides applied pre and post – emergence and broomrape Seeds free full season treatment significantly reduced shoot dry weight (g) of broomrape plant in the both winter seasons. Faba bean yield (ton /ha) in the first winter season is more than which obtained in the second winter season.

Keywords: Vegetative growth, the parasite, the competition, the full season, glyphosate and pursuit

المقدمة

الفول المصري ***Vicia faba L.*** ينتمي إلي عائلة Fabaceae، يعتبر من أهم المحاصيل الغذائية الشتوية في العالم وخاصة مصر والسودان فهو من المصادر الرئيسية للبروتين النباتي ويعتبر خير بديل للحوم خاصة بالنسبة للطبقات ضعيفة ومتوسطة الدخل وهنالك حوجة لتحسين الإنتاجية وزيادة الإنتاج الكلي لمقابلة زيادة الطلب عليه (Marwa and Azza, 2018 ؛ Ekhlas,2021 ؛ عبد الحليم 2011). يزرع الفول بتوسع في العالم وتتركز زراعته في المناخ المداري وتحت المداري في آسيا، إفريقيا، أمريكا ، أوروبا، استراليا وأمريكا الشمالية والوسطي (Rabiaa, 2021 ؛عبد الحليم ،2011).

تتركز زراعة الفول في السودان في الولاية الشمالية التي تنتج أكثر من 70% من الإنتاج الكلي، ولاية نهر النيل وتنتج 20%من الإنتاج الكلي، تنتج كميات قليلة منه في ولاية الخرطوم، منطقة جبل مرة في غرب السودان، مشروع الجزيرة، الرهد، القاش وحلفا الجديدة (عاطف ،2013 ؛ عبد الحليم ،2011 ؛ kamal and Abbas, 2011). تتذبذب المساحة المزروعة من عام لعام نتيجة لتذبذب تكلفة الإنتاج والأسعار وتتأرجح الإنتاجية نتيجة للأحوال المناخية خاصة درجات الحرارة (عبد الحليم، 2011).

بالإضافة إلى الآفات الحشرية والأمراض تشكل الحشائش أخطر عائق لإنتاج الفول وخاصة الحشائش الزهرية الطفيلية مثل الهالوك (عاطف،2013). أهم عائق رئيسي لزراعة الفول المصري في السودان، منطقة البحر المتوسط وغرب آسيا هو هالوك الفول أو البقوليات وهو عبارة عن نبات طفيلي جذري يعتمد اعتماداً كلياً علي العائل لخلوه من الكلوروفيل ودائماً يقود إلي أكثر الفقد في المحصول، ولمكافحته لا توجد طريقة واحدة فعالة وعملية ولكن تستخدم طرق مختلفة لتقليل أضراره علي المحصول مثل الممارسات الزراعية الممثلة في تاريخ الزراعة ، القلع اليدوي، الدورة الزراعية، زراعة الأصناف المقاومة والمكافحة الحيوية (Nafisa *et al,* 2014 ؛ Marwa and Azza, 2018)

الهالوك نبات عشبي حولي كامل التطفل عصاري غض خالي من الكلوروفيل يتطفل علي جذور العائل ويلحق أضراراً بالغة به ويسبب فقد كبير في إنتاجيته وجودته (محمد ،2014 ؛عبد الجواد وآخرون, 2007).

مكافحة الهالوك تعني تقليل انتشاره والحد من أضراره عن طريق إيقاف وتثبيط نموه وهذا يقلل من المنافسة التي تتعرض لها العوائل المختلفة من المحاصيل مما ينعكس إيجاباً علي زيادة الإنتاج والحصول علي محصول اقتصادي (تاج الدين، 1987).

الهدف من إجراء هذا البحث هو معرفة تأثير مبيدي الجليفوسيت والبيرسوت علي انبثاق ونمو الهالوك، تقدير النسبة المئوية للفقد في إنتاجية الفول المصري بسبب إصابته بالهالوك وتقييم ومقارنة تأثيرات المبيدين علي مكافحة الهالوك وتحديد أحسن معاملة للمبيدين تحقق أعلى إنتاجية للفول المصرى.

مواد وطرق البحث

أجريت التجربة خلال موسمين شتويين متعاقبين للعامين 2021/ 22 و2022 /23م بمشتل الإدارة العامة لوقاية النباتات . دنقلا ومشتل كلية العلوم الزراعية بالسليم . جامعة دنقلا بوحدة شرق النيل الإدارية . محلية دنقلا. الولاية الشمالية . السودان علي التوالي .تقع الولاية الشمالية بين خطي عرض 16 و 22 درجة شمالاً وخطي طول 20 و 32 درجة شرقاً وحدودها الشمالية هي الحدود المشتركة بين السودان ومصر وتمتد غربًا حتي حدود الجماهيرية الليبية (قمر ،2012).

صممت التجربة عن طريق التصميم العشوائي الكامل بثلاث مكررات، تم جلب تربة من منطقة غير موبوءة ببذور الحشائش وخاصة الهالوك وتم تنعيمها وغربلتها، ثم تمت تعبئة 36 وعاء بالتربة إلي الحد المناسب وهي عبارة عن وحدات التجربة (12 معاملة×3 مكررات)، مساحة سطح الوعاء

676 سم². لعمل عدوي للتربة ببذور الهالوك تم خلط 1كجم من التربة مع 5 جم من بذور الهالوك، بعد تجهيز خليط التربة مع بذور الهالوك أخذ منه 10جم وتم وضعه وإثارته في الطبقة السطحية لكل معاملة عدا الخالية من بذور الهالوك. تمت زراعة بذور الفول المصري صنف تركي في كل المعاملات بواقع 9حفر في الجردل وبمعدل 3 بذور في الحفرة وذلك في الثالث من أكتوبر في كل موسم. تم خف البادرات إلي بادرة في الحفرة بعد أسبوعين من الزراعة. تم تطبيق المبيدات كالأتي:-

1/ مبيد البيرسوت 10% إي سي رشاً قبل الانبثاق بمعدل 0.04 ،0.05 و 0.06كجم م .ف للهكتار.

2/ مبيد البيرسوت 10% إي سي بمعدل 0.04 ،0.05 و0.06كجم م .ف للهكتار بعد أربعة أسابيع من الزراعة .

3/ مبيد جليفوسيت 64.5% أس جي بمعدل 26.25جم م .ف للهكتار بعد 4،6و 8 أسابع من الزراعة.

4/ مبيد جليفوسيت 64.5% أس جي بمعدل 26.25،26.25، 39.4جم م.ف للهكتار بعد 4،6 و8 أسابيع من الزراعة على التوالي.

5/ مبيد جليفوسيت 64.5% أس جي بمعدل 35،35، 52.5جم م .ف للهكتار بعد 4،6و 8 أسابيع من الزراعة علي التوالي.

6/ مبيد جليفوسيت 64.5% أس جي بمعدل 52.5، جم م .ف للهكتار بعد 4،6 و8 أسابيع من الزراعة. تم تطبيق المبيدات المستخدمة باستخدام رشاشة ظهرية عويرت بمعدل 96 لتر للفدان.

بالإضافة للمعاملات أعلاه شملت التجربة معاملة خالية من بذور الهالوك طول الموسم وأخري موبوءة بها طول الموسم (الشاهد) للمقارنة.

كان يتم الري بعد فترة تتراوح من 10-15يوم حسب الظروف الجوية حني الحصاد. ظهرت آفات الطيور والفئران في موقع التجربة وتم مكافحتها بالكليرات والطعم السام بفوسفيد الزنك المخلوط مع غذاء الفئران بالإضافة إلي تغطية الأصص بالشباك.

تم اختيار 5 نباتات عشوائياً بعد 8 أسابيع من الزراعة من كل معاملة لقياس صفات النمو التي شملت كثافة النباتات (000/للهكتار)، ارتفاع النبات بالسم، عدد الأوراق في النبات، الوزن الجاف للمجموع الخضري بالجم وعدد الفروع في النبات.

بعد وصول النباتات إلي مرحلة النضج تم اختيار خمسة نباتات عشوائياً في كل معاملة، ثم تم قطع وتجفيف قرون هذه النباتات الخمسة وفصل البذور منها لتحديد مكونات الإنتاجية المتمثلة في عدد القرون في النبات، إنتاجية النبات بالجم، وزن 100 بذرة بالجم بالإضافة إلي إنتاجية البذور (طن /هكتار).

لمعرفة تأثير معاملات المبيدين علي طقيل الهالوك تم حساب عدد نباتات الهالوك في المتر المربع، الوزن الجاف للمجموع الخضري لنبات الهالوك (جم/م²) وارتفاع نبات الهالوك بالسم.

البيانات المتحصل عليها تم تحليلها إحصائياً كما جاء في كتاب Gomez and Gomez ,(1984) عن طريق تحليل التباين (ANOVA) باستخدام برنامج (M-STAT-C) لمعرفة التأثيرات المعنوية بين المعاملات والوحدات التجريبية.

النتائج والمناقشة

كل معاملات مبيدات الحشائش المستخدمة رشاً قبل وبعد الانبثاق والمعاملة الخالية من بذور الهالوك طول الموسم لم تظهر أي فروقات معنوية في الكثافة النباتية، الوزن الجاف للمجموع الخضري للنبات بالجم وعدد الفروع في النبات في الموسمين الشتويين مقارنة بالمعاملة الموبوءة ببذور الهالوك طول الموسم (جدول 1، 2 و3). عدم وجود فروقات معنوية في الكثافة النباتية، الوزن الجاف للمجموع الخضري للنبات بالجم وعدد الفروع فى النبات ربما يعزى إلى نشاط الكائنات الحية الدقيقة الموجودة فى التربة التي تقوم بتحطيم المبيدات عن طريق تحليلها الى مكونات غير سامة وبالتالي لم تؤثر هذه المبيدات على الطفيل مما انعكس سلباً على نمو المحصول وبالتالي نما المحصول نمواً ضعيفاً. هذه النتائج تطابق النتائج التي أشارت إلها (وزارة الزراعة واستصلاح الأراضي (2013)، (2006) Ibrahim Babiker; يحي ومكي (2002).

بيرسوت 0.04 و 0.05 كجم .م.ف للهكتار المستخدم رشاً قبل الانبثاق وبيرسوت 0.05 و 0.06 كجم م.ف/هكتار المستخدم رشاً بعد الانبثاق زادت زيادة معنوية في ارتفاع النبات بالسم في الموسم الشتوي الأول مقارنة بالمعاملة الموبوءة ببذور الهالوك طول الموسم (جدول 1). بيرسوت0.05 كجم .م.ف للهكتار المستخدم رشاً قبل الانبثاق وبيرسوت 0.05 و 0.06 كجم م.ف/هكتار المستخدم رشاً بعد الانبثاق والمعاملة الخالية من بذور الهالوك زادت معنوياً عدد الأوراق في النبات في الموسم الشتوي الأول مقارنة بالمعاملة الموبوءة ببذور الهالوك طول الموسم (جدول 2). الزيادة المعنوية فى ارتفاع النبات بالسم وعدد الأوراق فى النبات بسبب استخدام مبيد البيرسوت تطابق النتائج التى اشارالها Ibrahim and Babiker (2006)

الزيادة المعنوية في ارتفاع النبات بالسم وعدد الأوراق في النبات بسبب استخدام مبيد البيرسوت ربما تعزى إلى تأثير المبيد سلباً على نمو الهالوك وذلك بتقليل منافسته مع المحصول وهذا انعكس إيجاباً على هذين المؤشرين.

جدول 1: تأثير معاملات مبيدات الحشائش علي كثافة وارتفاع النبات بالسم خلال الموسمين الشتويين للعامين2021/ 22 و2022 /23

لمتوسطات التي لها حروف متشابهة داخل العمود الواحد لا تختلف عن بعضها معنوياً تحت مستوي الاحتمالية 5% وفقاً لـ(Duncan,s (DMRT

المعاملات (معدل المبيد كجم.م.ف./هكتار)	وقت التطبيق	كثافة نباتات الفول (000/هكتار)		ارتفاع النبات بالسم	
		2022/2021	2023/2022	2022/2021	2023/2022
0.04 بيرسوت	قبل الانبثاق	723.06a	755.93 a	5.18 abc	4.92 a
0.05 بيرسوت	قبل الانبثاق	854.53 a	755.93 a	5.38 ab	5.80 a
0.06 بيرسوت	قبل الانبثاق	920.26 a	987.00 a	4.98 abcd	5.00 a
0.04 بيرسوت	بعد الانبثاق	690.20 a	657.33 a	4.54 abcd	4.62 a
0.05 بيرسوت	بعد الانبثاق	953.13 a	755.93 a	5.80 a	4.06 a
0.06 بيرسوت	بعد الانبثاق	1248.93 a	657.33 a	5.29 abc	4.66 a
26.25 جليفوسيت	أسابيع من الزراعة 8و 6، 4	920.26 a	591.60 a	3.99abcd	4.52 a
جليفوسيت 26.25 +26.25 +39.40	أسابيع من الزراعة 8و 6، 4	1248.93 a	1084.60 a	4.05abcd	4.64 a
جليفوسيت 35.00+35.00 +52.50	أسابيع من الزراعة 8 و 6، 4	920.26 a	854.54 a	3.81bcd	5.24 a
52.50 جليفوسيت	أسابيع من الزراعة 8 و 6، 4	953.13 a	591.60 a	3.50 cd	5.48 a
معاملة خالية من بذور الهالوك	-	854.53 a	953.13 a	4.46 abcd	7.28 a
معاملة موبوءة ببذور الهالوك	-	1051.73 a	782.40a	3.27 d	1.88 a
معامل الاختلاف %	-	32.95%	39.74 %	20.55%	31.63%
الخطأ القياسي	-	23.77	22.95	11.54	10.88

Multiple Range Test

جدول 2:. تأثير معاملات مبيدات الحشائش علي عدد الأوراق والوزن الجاف للمجموع الخضري للنبات بالجم خلال الموسمين الشتويين للعامين 22/2021 و 2022/23

المعاملات (معدل المبيد كجم.م.ف./هكتار)	وقت التطبيق	عدد الأوراق في النبات		الوزن الجاف للمجموع الخضري للنبات بالجم	
		2022/2021	2023/2022	2022/2021	2023/2022
0.04 بيرسوت	قبل الانبثاق	2.69c	3.32 a	3.20 a	7.00 a
0.05 بيرسوت	قبل الانبثاق	3.97 ab	4.37 a	2.73 a	7.80 a
0.06 بيرسوت	قبل الانبثاق	3.34 abc	2.78 a	2.93 a	6.20 a
0.04 بيرسوت	بعد الانبثاق	3.48 abc	3.46 a	2.60 a	6.26 a
0.05 بيرسوت	بعد الانبثاق	4.30 a	2.94 a	3.13 a	7.26 a
0.06 بيرسوت	بعد الانبثاق	3.88 ab	3.38 a	4.20 a	5.33 a
26.25جليفوسيت	أسابيع من الزراعة 8 و 4.6	3.67 abc	3.30 a	2.26 a	8.26 a
جليفوسيت 26.25 + 26.25+39.4	أسابيع من الزراعة 8 و 4.6	3.02 bc	3.69 a	1.26 a	5.13 a
جليفوسيت 35.0+ 35.0 +52.5	أسابيع من الزراعة 8 و 4.6	3.39 abc	4.06 a	2.53 a	6.73 a
52.5جليفوسيت	أسابيع من الزراعة 8 و 4.6	3.37 abc	3.81 a	2.60 a	4.46 a
معاملة خالية من بذوز الهالوك	-	4.22 a	3.77 a	3.06 a	7.20 a
معاملة موبوءة ببذور الهالوك	-	2.74 c	2.71a	1.00 a	2.90 a
معامل الاختلاف %	-	15.12%	23.75%	27.43%	20.56%
الخطأ القياسي	-	0.31	0.48	0.87	1.71

المتوسطات التي لها حروف متشابهة داخل العمود الواحد لا تختلف عن بعضها معنوياً تحت مستوي الاحتمالية 5% وفقاً لـ (DMRT) Duncan,s Multiple Range Test

يرسوت 0.06 كجم .م.ف /هكتار المستخدم رشاً بعد الانبثاق والمعاملة الخالية من بذور الهالوك طول الموسم زادت معنوياً عدد القرون في النبات في الموسم الشتوي الأول مقارنة بالمعاملة الموبوءة ببذور الهالوك طول الموسم . كل معاملات مبيدات الحشائش المستخدمة قبل وبعد الانبثاق والمعاملة الخالية من بذور الهالوك لم تظهر أي فروقات معنوية في إنتاجية النبات بالجم في الموسمين الشتويين (جدول 3).

جدول 3:- تأثير معاملات مبيدات الحشائش علي عدد القرون في النبات و إنتاجية النبات بالجم خلال الموسمين الشتويين

22/2021 و 23/2022

المعاملات (معدل المبيد كجم.م.ف./هكتار)	وقت التطبيق	عدد القرون في النبات		إنتاجية النبات بالجم	
		2022/2021	2023/2022	2022/2021	2023/2022
0.04 بيرسوت	قبل الانبثاق	1.33abc	3.20 a	1.00 a	0.46 a
0.05 بيرسوت	قبل الانبثاق	1.13 abcd	3.26 a	1.00 a	0.40 a
0.06 بيرسوت	قبل الانبثاق	0.53 cd	3.63 a	0.33 a	0.40 a
0.04 بيرسوت	بعد الانبثاق	0.96 abcd	2.93 a	1.26a	0.60 a
0.05 بيرسوت	بعد الانبثاق	1.53 ab	3.06 a	0.63 a	0.70 a
0.06 بيرسوت	بعد الانبثاق	1.73 a	2.00 a	1.33 a	0.66 a
26.25جليفوسيت	أسابيع من الزراعة 8و 6 ،4	0.40 cd	2.46 a	0.86 a	0.46 a
جليفوسيت 26.25 +26.25+39.4	أسابيع من الزراعة 8و 6 ،4	0.36 d	3.60 a	0.40a	0.667a
جليفوسيت 35.0+35.0 +52.5	أسابيع من الزراعة 8 و 6 ،4	0.80 abcd	4.13 a	1.00 a	0.60 a
52.5جليفوسيت	أسابيع من الزراعة 8و 6 ،4	0.80 abcd	0.73 a	1.10a	0.73 a
معاملة خالية من بذور الهالوك	-	1.70 a	4.86 a	1.50 a	0.63 a
معاملة موبوءة ببذور الهالوك	-	0.66 bcd	0.53 a	0.73 a	0.30 a
معامل الاختلاف %	-	19.93%	27.65%	20.52%	19.54%
الخطأ القياسي	-	1.28	1.20	1.27	1.25

المتوسطات التي لها حروف متشابهة داخل العمود الواحد لا تختلف عن بعضها معنوياً تحت مستوي الاحتمالية 5% وفقاً لـ(DMRT) Duncan,s Multiple Range Test

كل معاملات مبيدات الحشائش المستخدمة قبل وبعد الانبثاق والمعاملة الخالية من بذور الهالوك طول الموسم زادت معنوياً وزن 100 بذرة بالجم في الموسم الشتوي الأول مقارنة بالمعاملة الموبوءة ببذور الهالوك طول الموسم (جدول 4). الزيادة المعنوية فى عدد القرون فى النبات ووزن

100 بذرة بالجم ربما تعزى إلى فعالية هذه المبيدات المستخدمة فى مكافحة الهالوك ومنعها من منافسة المحصول وهذا انعكس إيجاباً على نمو المحصول مما أدى إلى زيادة معنوية فى مكونات الإنتاجية وخاصة عدد القرون فى النبات ووزن 100 بذرة بالجم. الزيادة المعنوية فى عدد القرون فى النبات ووزن 100 بذرة بالجم نتيجة تطبيق مبيدى البيرسوت والجليفوسيت تطابق النتائج التي توصل الها عاطف (2013) و Ibrahim and Babiker (2006).

جليفوسيت (52.5 كجم.م.ف./هكتار) المستخدم رشاً بعد الانبثاق بعد 4، 6 و 8 أسابيع من الزراعة علي التوالي والمعاملة الخالية من بذور الهالوك طول الموسم زادت معنوياً إنتاجية بذور الفول المصري (طن للهكتار) في الموسمين الشتويين مقارنة بالمعاملة الموبوءة ببذور الهالوك طول الموسم (جدول 4).

جليفوسيت (52.5 كجم.م.ف./هكتار) المستخدم رشاً بعد الانبثاق بعد 4،6 و 8 أسابيع من الزراعة علي التوالي زادت معنويا إنتاجية بذور الفول المصري بنسبة 177.91% و 140.77% مقارنة بالمعاملة الموبوءة ببذور الهالوك طول الموسم فى الموسمين الشتويين الأول والثاني على التوالي (جدول 4). الزيادة المعنوية فى إنتاجية بذور الفول المصري (طن/هكتار) بسبب تطبيق مبيد الجليفوسيت رشاً بعد الانبثاق لمكافحة طفيل الهالوك ربما تعزى الى تأثير هذا المبيد بصورة فعالة على الطفيل مما قلل من منافسته للمحصول على العناصر الرئيسية المتاحة التي يحتاج إلها نبات المحصول من ماء، غذاء، ضوء ومكان وهذا مكن المحصول من الاستفادة القصوى من هذه العناصر مما انعكس إيجاباً عليه، ونما نمواً قوياً وهذا أدي إلى زيادة مؤشرات النمو ومكونات الإنتاجية وبالتالي زادت الإنتاجية (طن /هكتار). الزيادة المعنوية فى إنتاجية بذور الفول المصرى (طن /هكتار) بسبب تطبيق مبيد الجليفوسيت فى الفول المصري لمكافحة طفيل الهالوك تطابق النتائج التي أوضحها (شومد وآخرون (2015)، Babiker *et al*. (2007) و Ibrahim and Babiker ,(2006) .

منافسة الهالوك لمحصول الفول المصري طول الموسم قللت معنوياً إنتاجية البذور بنسبة 77.04 % و78.33% مقارنة بالمعاملة الخالية من بذور الهالوك طول الموسم وذلك في الموسمين الشتويين الأول والثاني على التوالي (جدول 4). النقص المعنوي في إنتاجية بذور الفول المصري بسبب منافسة الهالوك له علي العناصر الضرورية المتاحة التي يحتاج إلها النبات يطابق النتائج التي وجد

Mehmoud and Mona (2019) , Mohamed (2010), Ibrahim and Babiker ,(2006) ,and Garcia ana Lopez (1991)

النقص المعنوي في إنتاجية بذور الفول المصري (طن /هكتار) ربما يرجع إلى منافسة طفيل الهالوك لمحصول الفول المصري على العناصر الضرورية المتاحة من ماء، غذاء، ضوء ومكان وهذا منع المحصول من الحصول على كميات كافية له من هذه العناصر وبالتالي نما نمواً ضعيفاً وهذا انعكس سلباً على مكونات الإنتاجية والمحصلة النهائية هي تدنى الإنتاجية.

معظم معاملات مبيدات الحشائش المستخدمة رشاً قبل وبعد الانبثاق والمعاملة الخالية من بذور الهالوك طول الموسم لم تظهر أي فروقات معنوية في إنتاجية بذور الفول المصري (طن للهكتار) مقارنة بالمعاملة الموبوءة ببذور الهالوك طول الموسم وذلك في الموسمين الشتويين (جدول 4). ربما تعزى هذه النتيجة إلى نشاط الكائنات الحية الدقيقة الموجودة في التربة التي أثرت سلباً على هذه المبيدات المستخدمة وذلك عن طريق تحليلها إلى مكونات غير سامة وبالتالي لم تؤثر على طفيل الهالوك وبالتالي نافس هذا الطفيل المحصول على العناصر الضرورية للنمو. أيضاً ربما ترجع هذه النتيجة إلى تفاعل المبيدات مع مكونات التربة وتحولها إلى مركبات غير سامة وغير فعالة لمكافحة الهالوك وبالتالي شدة منافسة الهالوك للمحصول أثرت سلباً على مؤثرات النمو ومكونات الإنتاجية وبالتالي أدى هذا إلى نقص الإنتاجية. من خلال النتائج التي تم الحصول علها نستنتج أن إنتاجية بذور الفول المصري في الموسم الشتوي الأول أكثر من تلك التي تم الحصول علها في الموسم الشتوي الثاني وهذه ربما تعزى إلى الاختلاف في الظروف الجوية وعوامل التربة بالإضافة إلى الاختلاف في عدد الكائنات الحية الدقيقة التي تؤثر سلباً على فعالية المبيدات

المستخدمة وبالتالي لم تؤثر بفعالية على طفيل الهالوك وهذا مكن الطفيل من منافسة المحصول والاستفادة القصوى من العناصر الرئيسية من ماء، غذاء وضوء.

جليفوسيت (52.5 كجم .م.ف /هكتار) المستخدم رشاً بعد الانبثاق بعد 4،6،8 أسابيع من الزراعة على التوالي حقق أعلى إنتاجية بذور (طن /هكتار) مقارنة بالمعاملات الأخرى ولذلك نوصى بالعمل به.

جدول 4:- تأثير معاملات مبيدات الحشائش علي وزن 100 بذرة و الإنتاجية (طن للهكتار) خلال الموسمين الشتوي 22/2021 و 23/2022

المعاملات (معدل المبيد كجم.م.ف./هكتار)	وقت التطبيق	وزن 100 بذرة		الإنتاجية (طن للهكتار)	
		2022/2021	2023/2022	2022/2021	2023/2022
0.04 بيرسوت	قبل الانبثاق	71.10 d	70.20 a	4.10 bc	1.76 c
0.05 بيرسوت	قبل الانبثاق	73.30 cd	70.90 a	3.53 bc	1.43c
0.06 بيرسوت	قبل الانبثاق	72.20 cd	71.10 a	1.43 c	1.53 c
0.04 بيرسوت	بعد الانبثاق	70.40 d	69.90 a	4.00 bc	2.43 bc
0.05 بيرسوت	بعد الانبثاق	73.30 cd	70.10 a	2.53bc	2.46 bc
0.06 بيرسوت	بعد الانبثاق	76.20 c	73.20 a	3.10 bc	2.43 bc
26.25 جليفوسيت	أسابيع من الزراعة 8و 6 ،4	69.30 d	67.90 a	2.43 bc	1.33 c
جليفوسيت 39.4+26.25 + 26.25	أسابيع من الزراعة 8و 6 ،4	72.20 cd	70.10 a	1.53 c	2.43 bc
جليفوسيت 52.5+ 35.0 +35.0	أسابيع من الزراعة 8و 6 ،4	72.10 cd	70.40 a	2.10 bc	2.10 bc
52.5 جليفوسيت	أسابيع من الزراعة 8و 6 ،4	80.30 b	74.90 a	4.53 b	3.13 b
معاملة خالية من بذور الهالوك	-	88.10 a	60.86 a	7.10 a	6.00 a
معاملة موبوءة ببذور الهالوك(شاهد)	-	59.20 e	59.80 a	c1.63	1.30 c
معامل الاختلاف %	-	3.09%	19.50%	24.97%	23.05%
الخطأ القياسي	-	1.31	2.78	3.84	2.70

المتوسطات التي لها حروف متشابهة داخل العمود الواحد لا تختلف عن بعضها معنوياً تحت مستوي الاحتمالية 5% وفقاً لـ (DMRT) Duncan,s Multiple Range Test

كل معاملات مبيدات الحشائش المستخدمة رشاً قبل وبعد الانبثاق و المعاملة الخالية من بذور الهالوك طول الموسم قللت معنوياً عدد نباتات الهالوك في المتر المربع في الموسم الشتوي الأول مقارنة بالمعاملة الموبوءة ببذور الهالوك طول الموسم. المعاملة الخالية من بذور الهالوك هي أحسن معاملة حققت اقل عدد لنباتات الهالوك في المتر المربع في الموسم الشتوي الأول (جدول 5).

كل معاملات مبيدات الحشائش عدا جليفوسيت (26.25 كجم.م.ف./هكتار) المستخدمة رشاً بعد 4،6،8 أسابيع من الزراعة علي التوالي والمعاملة الخالية من بذور الهالوك طول الموسم قللت معنوياعدد نباتات الهالوك في المتر المربع مقارنة بالمعاملة الموبوءة ببذور الهالوك طول الموسم وذلك في الموسم الشتوي الثاني (جدول 5). كل معاملات مبيدات الحشائش عدا جليفوسيت (26.25 كجم.م.ف./هكتار) المستخدمة رشاً بعد 4،6،8 أسابيع من الزراعة علي التوالي أعطت عدد نباتات هالوك مشابه لما تم الحصول عليه في المعاملة الخالية من بذور الهالوك في الموسم الشتوي الثاني (جدول 5).

كل معاملات مبيدات الحشائش المستخدمة رشاً قبل وبعد الانبثاق والمعاملة الخالية من بذور الهالوك طول الموسم قللت معنوياً الوزن الجاف للمجموع الخضري لنبات الهالوك بالجم في الموسمين الشتويين مقارنة بالمعاملة الموبوءة ببذور الهالوك طول الموسم (جدول 5). هذه المعاملات أعطت عدد نباتات مشابهة لما تم الحصول عليه في المعاملة الخالية من بذور الهالوك طول الموسم وذلك في الموسم الشتوي الثاني. النقص المعنوي في عدد نباتات الهالوك في المتر المربع يؤيد النتائج التي أشار إليها

Mehmoud and Mona (2019), شومد واخرون (2015) , and Garcia and Lopez, Ibrahim and Babiker (2006), Babiker et al . (2007), (1991) .

كل معاملات مبيدات الحشائش والمعاملة الخالية من بذور الهالوك طول الموسم قللت معنوياً الوزن الجاف للمجموع الخضري للهالوك بالجم في الموسمين الشتويين مقارنة بالمعاملة الموبوءة ببذور الهالوك طول الموسم .هذه النتائج مطابقة لتلك التي توصل إليها

Nafisa et al , (2014) , Awadalla et al, (2012) , Mehmoud and Mona (2019)

, and Garcia and Lopez,(1991) . (2002) يحي ومكي Ibrahim and Babiker.(2006) ,

النقص المعنوى فى عدد نباتات الهالوك في المتر المربع والوزن الجاف للمجموع الخضرى للهالوك بالجم ربما يعزى إلى تأثير هذه المبيدات على إنبات بذور الهالوك مما أدى إلى نقص عدد النباتات التي نمت في المتر المربع وأيضاً ربما يرجع إلى فعالية هذه المبيدات في مكافحة الهالوك وبالتالي منعها من الاستفادة القصوى من العناصر الضرورية المهمة للنبات من ماء ،غذاء ، ضوء ومكان وبالتالي نما نمواً ضعيفاً وهذا انعكس سلباً على عدد النباتات في المتر المربع و الوزن الجاف لمجموعه الخضري بالجم.

جدول 5:- تأثير معاملات مبيدات الحشائش علي عدد نباتات الهالوك في المتر المربع والوزن الجاف للمجموع الخضري لنبات الهالوك بالجم خلال الموسمين الشتويين 22/2021 و 23/2022

المعاملات (معدل المبيد كجم.م.ف./هكتار)	وقت التطبيق	عدد نباتات الهالوك في المتر المربع		الوزن الجاف للمجموع الخضري للهالوك بالجم	
		2022/2021	2023/2022	2022/2021	2023/2022
0.04 يرسوت	قبل الانبثاق	7.00 b	5.33c	46.03 b	47.33 b
0.05 يرسوت	قبل الانبثاق	6.66 b	8.90c	44.700b	47.33b
0.06 يرسوت	قبل الانبثاق	6.66 b	8.56 c	45.03 b	14.80 b
0.04 يرسوت	بعد الانبثاق	5.66 b	8.56 c	45.03 b	33.90 b
0.05 يرسوت	بعد الانبثاق	5.33 b	7.33 c	45.03b	41.36 b
0.06 يرسوت	بعد الانبثاق	5.66 b	5.00 c	44.70 b	14.10 b
26.25جليفوسيت	أسابيع من الزراعة 8و 6 ،4	6.00 b	51.66 ab	45.03 b	43.06 b
جليفوسيت 26.25 +26.25+39.4	أسابيع من الزراعة 8و 6 ،4	5.33 b	22.93bc	44.03 b	39.06 b
جليفوسيت 52.5+ 35.0+35.0	أسابيع من الزراعة 8و 6 ،4	5.66 b	11.46 c	43.36 b	54.36 b
52.5جليفوسيت	أسابيع من الزراعة 8و 6 ،4	5.33 b	18.03 bc	42.04 b	51.53 b
معاملة خالية من بذور الهالوك	-	0.00 c	0.00c	0.00 b	0.00 b
معاملة موبوءة ببذور الهالوك	-	39.33 a	85.60a	120.00 a	132.033a
معامل الاختلاف %	-	13.60%	18.25%	2.09%	15.47%
الخطأ القياسي	-	2.65	6.28	5.10	11.50

المتوسطات التي لها حروف متشابهة داخل العمود الواحد لاتختلف عن بعضها معنوياً تحت مستوي الاحتمالية 5% وفقا لـ Duncan,sMultiple Range Test(DMRT)

كل معاملات مبيدات الحشائش المستخدمة رشاً قبل وبعد الانبثاق والمعاملة الخالية من بذور الهالوك طول الموسم لم تظهر أي فروقات معنوية في ارتفاع نبات الهالوك بالسم في الموسمين الشتويين مقارنة بالمعاملة الموبوءة ببذور الهالوك طول الموسم (جدول 6). ربما تعزي هذه النتيجة إلي دخول بعض بذور الهالوك في طور سكون وخاصة في المعاملة الموبوءة ببذور الهالوك.

جدول 6:- تأثير معاملات مبيدات الحشائش علي ارتفاع نبات الهالوك بالسم خلال الموسمين الشتويين 22/2021 و

23/2022

المعاملات (معدل المبيد كجم.م.ف./هكتار)	وقت التطبيق	**ارتفاع نبات الهالوك بالسم**	
		2022/2021	**2023/2022**
0.04 بيرسوت	قبل الانبثاق	5.00 a	5.00 a
0.05 بيرسوت	قبل الانبثاق	5.00 a	5.06 a
0.06 بيرسوت	قبل الانبثاق	5.00 a	5.26 a
0.04 بيرسوت	بعد الانبثاق	5.00a	5.13a
0.05 بيرسوت	بعد الانبثاق	5.00 a	5.13 a
0.06 بيرسوت	بعد الانبثاق	5.00 a	5.00 a
26.25 جليفوسيت	أسابيع من الزراعة 8 و 6 ،4	5.00 a	5.00 a
جليفوسيت 26.25 + 26.25+39.4	أسابيع من الزراعة 8 و 6 ،4	5.00 a	5.03 a
جليفوسيت 35.0+ 35.0 +52.5	أسابيع من الزراعة 8 و 6 ،4	5.00 a	5.66 a
52.5 جليفوسيت	أسابيع من الزراعة 8 و 6 ،4	5.00 a	5.26 a
معاملة خالية من بذور الهالوك	-	0.00 a	0.00 a
معاملة موبوءة ببذور الهالوك	-	a 6.70	6.70 a
معامل الاختلاف %	-	20.93%	7.19%
الخطأ القياسي	-	3.94	3.21

المتوسطات التي لها حروف متشابهة داخل العمود الواحد لاتختلف عن بعضها معنوياً تحت مستوي الاحتمالية 5% وفقا لـ Duncan,sMultiple Range Test(DMRT)

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