NJAS

NILE JOURNAL FOR AGRICULTURAL SCIENCES



Referred Scientific Journal

Vol. 2, NO. 01, 2017
ISSN: 1585 – 5507
http://www.nilevalley.edu.sd

NILE JOURNAL FOR AGRICULTURAL SCIENCES

Published by the Faculty of Agriculture
Nile Valley University
Republic of the Sudan
In collaboration with the Unit of Scientific Research and Publication

Referred Scientific Journal

ISSN: 1585 - 5507

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

E-mail: NJAS@nilevalley.edu.sd

Preface to volume 02, NO. 01

It is by time becoming recognizable that a productive, competitive, diversified and sustainable agricultural sector will need to emerge in our country at an accelerated rate. Food security in Sudan depends on producing cereals, legumes, fruits, vegetables, milk and meat to meet the demands of the growing population with rising incomes. Raising productivity per unit of land will need to be the main engine of agricultural growth. Yet, agricultural commodities yields in Sudan are still far below expectancy. It is therefore the first and most important task of achieving developmental techniques to implement recent expertise. So considerably, more needs to be done for gabs to be bridged. However, policy makers will thus need to take measures to build a solid foundation for more productive, internationally competitive, and diversified agricultural sector with more connection between research and extension.

Here, in continuing this endeavor, we feel contented to introduce the second volume of The Nile Valley Journal for Agricultural Sciences (NJAS). Out of the brought in researches we selected seven papers to be within this volume. The sequence of topics, in rough outline, is not unusual: agricultural economics; agricultural extension; agricultural engineering; plant protection; soil fertility; crops. Thus, more achievements towards our target will go on.

We really hope that this and the forthcoming volumes of NJAS will encourage further contribution from different disciplinary agricultural scientists.

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.

Aims and Scopes

The Nile Journal for Agricultural Sciences is devoted to provide an appropriate forum for the dissemination of high-quality and high-impact original balanced credible academic writings in all aspects of Agricultural Sciences. The journal invites original papers, review articles, technical reports and short communications. The scopes of the journal include the followings:

- Agricultural economics
- Animal production
- Agricultural economics
- Animal production
- Biotechnology
- Crop protection
- Entomology and toxicology
- Extension
- Forestry
- Horticulture
- Land use
- Plant breeding
- Plant virology
- Seed science and technology
- Sustainability
- Water resources
- Zoology
- Agricultural engineering
- Aquiculture
- Agricultural engineering
- Aquiculture
- Botany
- Crop science and agronomy
- Environment and eco-system
- Food science and technology
- Genetics
- Irrigation and water management
- Microbiology
- Plant pathology
- Remote sensing
- Soil sciences
- Waste management
- Weed science
- Apiculture

Editorial Policies

Ethics

The statements and opinions expressed in the articles herein are those of the author(s) and not necessarily of NJAS editorial board. All biological experimental works (such as genetic engineering) should be ethically acceptable and be in accordance with the local and international guidelines provided for both animal and human. Authors must guarantee that the manuscript parts were not being considered for publication elsewhere.

Peer review policy and criteria of manuscript acceptance

Manuscript acceptability is based principally on the importance, objectives, originality, topicality, and appropriateness of the methodology and outcomes. All submitted manuscripts are screened by the editorial board to assure their satisfying the above criteria, and subsequently peer reviewed by two or more reviewers. Manuscripts accepted for publication are copy edited for grammar, punctuation, print style, and format.

Reviewers selection is based on reputation and experience. However, the identity of reviewers is confidential and manuscripts are considered private information. The editorial board will be certain of not to allowing authors to realize reviewers identities. Similarly, author(s) identities will not be unveiled to the referees.

Reprints

Following acceptance of a paper and prior to publication, 3 reprint copies and a pdf electronic copy will be send to the corresponding author via post and e-mail, respectively.

Instructions to authors

The work for publication will be accepted either in English (American or British flair is accepted, but not a mixture of both) with an extra abstract in Arabic language or, in Arabic with an extra abstract in English. The manuscript should be written in clear, concise and grammatically correct language. Latin scientific names at all taxonomic levels are *italicized*. All scientific manuscripts will be reviewed by at least two reviewers. While submitting a revised manuscript, authors are requested to include a point to point response to reviewer's comments. The final decision relative to acceptance will be made by the editorial board. The corresponding author is considered the guarantor for the legitimacy and correctness of the manuscript as a whole.

Manuscripts submission:

The submission of the manuscript and all correspondence, including notification of the Editor's decision and requests for revision, takes place electronically through the website: njas@nilevalley.edu.sd, or by post.

The following items should be handled in as one sided printout hard copies and in electronically readable form in either a CD (IBM formatted) or via e-mail:

1. Cover letter:

The cover letter, as a supplement file should include: article title, type of article (full research, review, etc.), scope, author(s) name(s), higher qualification/academic degree(s), affiliations, and e-mail addresses. The name of the corresponding author with contact address, phone number, e-mail and fax number (if available) must be clearly listed. Acknowledgement, if any, could also be represented. Beside any special consideration regarding your submission.

2. Manuscript:

The manuscripts submitted to the journal must conform to all style requirements stated by the Editorial Board of NJAS.

Types of articles:

Full length original scientific papers: regular scientific papers, should report the results of original research that have not being considered for publication elsewhere. A full research paper should have, in proper order, a Title, Abstract, Introduction, Materials and Methods, Results, Discussion, Conclusion and References.

Review papers**:** in which authors should review the up-to-date developments in relevant field of an active current interest. They have to be contemporary and comprehensive. Methods used for locating, selecting, extracting, and synthesizing data should be described. The abstract (250 words) should represent an accurate summary of the article.

Short communication**:** is a concise, but completely documented, description of a limited research article. The contents should be exceptionally exciting, novel or timely. The maximum length should not exceed 7 pages. These short communications will be peer-reviewed in the same way as full papers.

Regular scientific manuscript formatting: Manuscripts should be kept to a minimum length (the whole article length should not exceed 20 pages. The language of manuscript must be simple and explicit. Times New Roman font style with 12 font size should be used. The whole manuscript should be typed double spaced (except tables), with all margins fixed at 2.5cm. Do not leave lines between paragraphs, but instead, indent the first line of each paragraph with one tab space. All pages should be numbered consecutively in the bottom center. Each heading should appear on its own separate line, aligned to the left and bold. The use of footnotes should be avoided.

Title and author information: The title and author information should be centered across the top of the first page. The title should give a concise designation of the paper topic, typed in 16 font style. Capitalize the first letter of all main words (Latin names in *italics*). Abbreviations should not be used. This should be followed by the name(s) of the author(s) displayed as first name, middle and last name (with no commas in between). Numbered and listed author's affiliations will be provided immediately after the authors line flush left. The name of the corresponding author should be underlined.

Abstract: The abstract, for reviews and research articles, as one paragraph, should be rational, informative and succinctly and clearly state the basic contents of the article with special focus on the scope, objectives, methods, and major findings. The abstract must be precisely and consistently briefed, not exceeding 250 words. References and citations to other works should not be included in the abstract.

Keywords: Key words (3-7 non generic words or phrases) should be provided directly below the abstract to express the article content. They should be written left aligned, arranged alphabetically, separated with commas, capitalize only the first letters of proper nouns, and do not end the list with a full stop.

Abstract translation: An abstract translation is to be prepared and assembled below the keywords, or at the beginning of the succeeding page. It should be precise and presents word-by-word translation.

The main text: The main text should be structured into paragraphs in the following order: **Introduction** including objectives, **Materials and Methods**, **Results**, **Discussion**, **Conclusion**, **Acknowledgement** (if any) and **References**. Results and discussion could be combined in one paragraph. Each heading should be flush with the left margin and have the first letter of all main words capitalized. All major headings should be separated from the text by 1 line space above.

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 rationale for the specific experiments and other work performed. All sub-headings, if any, should be left justified, bold and title case. Objectives of the research should be clearly stated.

Materials and Methods: This section must be concise and include sufficient details of the materials, equipment and techniques used. The sources of laboratory procedures should be cited and information on the equipment model, manufacturers name and address should be provided (if recommended). Measurements should be described precisely (all in SI units) and errors of measurements (if any) should also be included. While, previously published procedures may be indicated by a reference, new procedures should be described in details. The statistical procedure used should be stated in this section.

Results – Discussion: They can be presented together (**Results and Discussion**) or in 2 different sections (**Results** followed by **Discussion**). All results obtained should be simply and concisely presented in a logical order in figures, tables, or text. Tables and figures, whether integrated into the main text, or alternatively, printed on separate pages that follow the reference section, each should be sequentially numbered and titled (above for tables and below for figures). Do not present the same information in both a table and a figure. All printed tables and figures must be referred to in the text. Tabular data, were recommended, could be accompanied by either standard deviation values or standard errors of the means. The number of replicate determinations used for making such calculations must also be included. Sufficient statistical verification should be provided to identify differences in significance.

The results at hand should be concisely discussed in relation to hypotheses advanced in the introduction section and interpreted to previously published works. It must not contain extensive reiteration of the Introduction and Results sections.

Conclusion: The main conclusions of how did the results compare with the expected outcomes and what further predictions can be gleaned from the results should be presented in a short Conclusions section, which may stand alone or form a sub-section of the Discussion section.

Acknowledgments: The source of any financial or technical assistant received for the work being published must be indicated in the Acknowledgments section.

Citations and References

In-text citation: References should be included within the body of the text as they appear. Please ensure that every reference cited in the text is also present in the reference list (and vice versa). Unpublished results and personal communications are not recommended in the reference list, but may be mentioned in the text. The NJAS in-text citation format is the familiar "author, date" format, e. g. Keunings (2003) or (Keunings, 2003). If the article has two authors, their last names are used, separated by the word "and", e. g. Gates and Dobraszczyk (2004) or (Gates and Dobraszczyk, 2004). When there are more than two authors, only the first author's last name should be mentioned, followed by "*et al*.", e.g. Liu *et al.* (2006) or (Liu *et al.,* 2006). Multiple references at a single point in the text are separated by semicolons (Kent and Evers, 1994; McLeish, 2003; Morris *et al.,* 2007 and Singh *et al*., 2011). In a case where two or more sources cited at a given place shared the last name and date use first author's last name plus initial(s) (e. g. Zhang, Y., 2001 and Zhang, W., 2001). If the author(s) has had more than one published works cited within the same year, they are then identified by letters 'a', 'b', 'c', etc. placed after the year of publication (e. g. Caballero *et al*., 2007a and Smith, 1987a, b).

References list: All articles cited in the text should be listed at the end of the manuscript, unnumbered, alphabetized by first author's last name. Author(s) name(s) are arranged as "last name, initials.",. Individual authors names should be separated by semicolons. Followed by the year of publication (in brackets), a full stop, title of article, journal name, name of publisher, volume number, a semi colon, specific page numbers (Vol: Start page–End page). If more than one publication by the same author(s) were cited in the list, arrange publications by date, early to late. If more than one publication by the same author(s) published in the same year were listed, use a, b, c, ... to distinguish the articles cited. Type references flush left as separate paragraphs. The second and successive lines of a reference are indented by 1 cm.

For books include: name of editor(s), edition and publisher. For articles from conference proceedings include: conference proceedings, publisher (if any) date (between brackets), pp. For citation from a thesis include: Thesis title. Degree level, Department, University.

For electronic citations: Websites are referenced with their URL and access date, and as much other information as is available.

Examples:

Article in a Journal:

Harris, H.; Masri, S.; Pala, M.; Raya, J. and Singh, M. (2007). Rain fed wheat based rotation under Mediterranean condition: Crop sequences, nitrogen fertilization and stubble grazing in relation to grain and straw quality. European Journal of Agronomy, 28(2):12-118.

Book:

Fitter, A.H. and Hay, R.K.M. (2002). Environmental Physiology of Plants. (2^{nd} Edition), Academic Press, London, pp. 120- 128.

Book chapter:

Jelen, P. (2003). Whey processing. In: Encyclopedia of Dairy Sciences; Roginski, H.; Fuquay, J.W. and Fox, P.F., Eds.; London Academic Press, London, UK, Vol. 4, pp. 2739-2751.

Conference proceedings:

Basu, P.S.; Brajesh, S., Minhas, J.S.; Sing, B.; Khurana, S.M.; Shekhawat, G.S; Pandey, S.K. and Sing, B.P. (2002). Nitrogen nutrition in potato: effect of photosynthesis and carbon partitioning. Proceedings of the Global Conference on Potato, Volume 2 (2002), pp. 857- 860, New Delhi, India.

Tables and Figures: Tables should be self-explanatory and the data they contain must not be duplicated in the text or figures. Tables should be submitted in “Word” format (not in excel file) and should be printed single spaced in the main text (appear where should be cited) in numerical order, or otherwise at the end of the manuscript. Place a descriptive, comprehensive, but precise caption at the top of each table begins with the word “Table” followed by a number and a colon (:). Sufficient experimental details could be added in a legend below the table, if required. If a table is taken from other publication, then the reference is to be given below it.

Figures should be properly sized and cropped so that no unnecessary white space is left bordering the figure. Figures should be cited in the main text (appear where should be cited) in numerical order, or otherwise at the end of the manuscript. Figures should have titles set below the figure begins with the word “Figure or Fig.” followed by a number and a colon(:). Legends with sufficient details could be added. Multipanel figures (figures with parts labeled a, b, c, d, etc.) should be assembled into a composite as their final form. For an illustration taken from other publication, the source is to be cited.

Abbreviations and Units: SI units (metre, kilogram, etc.) should be used. Consistency must be maintained throughout the text in the use of abbreviations and units. Use standard abbreviations, that are accepted and recognized as common scientific terminology (hr, min, sec, etc.) instead of writing complete words. Define all non-standard abbreviations the first time they are used, then subsequently use the abbreviation.

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

TABLE OF CONTENTS

Nile Valley University Publications
Nile Journal for Agricultural Sciences (NJAS)
(ISSN: 1585 – 5507)
Volume 02, NO. 01, 2017
http://www.nilevalley.edu.sd

Research paper

Relationship Between Personal Characteristics of Farmers and Adoption of the Recommended Cultural Practices of Faba bean in Siliam, Northern State of the Sudan

Awadia Ahmed Hashim[1] and Musa Hago Elfaki[2]

[1] *Faculty of Agricultural Science, University of Dongola, Dongola, Sudan*
[2] *Faculty of Agricultural Sciences, University of Gezira, Wad Medani, Sudan.*

Corresponding author: awadiahashim333@hotmail.com

ABSTRACT

The objective of this study is to determine the relationship between some personal characteristics of farmers of two blocks in Siliam Scheme in Northern state and adoption of some recommended Faba bean cultural practices. A closed ended questionnaire was developed to collect the required data from 60 farmers to establish association between variables. The collected data were statistically analyzed by using (SPSS) program. Frequencies distribution, percentage and chi-squire test were used as analyzing tools. The personal characteristics studied were the sex, age, education level, annual income, family size, kind of holding, the size of holding and the availability of the extension services. The recommended cultural practices were land preparation methods, sowing date, sowing methods, seed rate, number of irrigation, watering interval and period of harvest. Results showed that all the farmers were male the women help only during the harvest of the crop beside that 86.7% of the farmers reported that extension services were not available. It was appeared that there was no significant effect of the age and education status on the adoption of the recommended cultural practices but the net annual income, family size, kind of the holding and the size of the holding had significant effect on some recommended cultural practices. The results of the study revealed that there was a relationship between some personal characteristics of the farmers and adoption of some recommended cultural practices and there was a problem with the distribution of the extension services in the state.

Keywords: *Adoption, faba bean, personal characteristics, recommended cultural practices*

العلاقة بين بعض الخصائص الشخصية للمزارعين وتبنى بعض العمليات الفلاحية الموصى بها لمحصول الفول المصري في مشروع السليم الزراعي – الولاية الشمالية

عوضية احمد هاشم[1]، موسى هجو الفكى[2]

[1]كلية العلوم الزراعية، جامعة دنقلا، السودان.
[2]كلية العلوم الزراعية، جامعة الجزيرة، السودان.

هدفت هذه الدراسة لمعرفة العلاقة بين بعض الخصائص الشخصية لمزارعي مشروع السليم الزراعي وتبنيهم لبعض العمليات الفلاحية الموصي بها من قبل هيئه البحوث الزراعية لمحصول الفول المصري. أجريت الدراسة في مناطق القسمين الاول والثاني لمشروع السليم الزراعي. حجم العينة 60 مزارع. كان أسلوب الدراسة المستخدم هو المسح الميداني وأداة البحث المستخدمة هي الاستبيان لجمع المعلومات**.** تم اختيار عينات البحث بواسطة أسلوب العينات العشوائية. تم استخدام نظام الحزمة الإحصائية للعلوم الاجتماعية (SPSS) حيث تم تحليل المعلومات باستخدام مربع كاي، النسب المئوية وتباين التوزيع التكراري للعينات. كانت متغيرات الدراسة هي الخصائص الشخصية للمزارعين من حيث النوع والعمر ومستوى التعليم وصافي الدخل السنوي اضافة لنوع الحيازة وحجمها وتوفر الخدمات الارشادية والعمليات الفلاحية الموصي بها لمحصول الفول المصري من حيث تحضير الأرض وتاريخ الزراعة وطريقة الزراعة ومعدل التقاوي وعدد الريات والفترة بين الريات ومواعيد الحصاد. من أهم النتائج التي توصلت اليها الدراسة أن كل المزارعين من الذكور ومشاركة المرأة فقط في عملية الحصاد وخاصة في محاصيل التوابل وأيضا أكد 86.7% من المزارعين عدم توفر خدمات الارشاد الزراعي. أيضاً اتضح من النتائج أنه لا يوجد تأثير معنوي للعمر ومستوي التعليم على تبني بعض العمليات الفلاحية الموصي بها بينما يوجد تأثير معنوي لمستوى الدخل وحجم الاسرة ونوع وحجم الحيازة على تبنى بعض العمليات الموصي بها. توصلت الدراسة الي أن هناك علاقة بين بعض الخصائص الشخصية للمزارعين وتبنى بعض الحزم التقنية الموصي بها.

Introduction

Faba bean (*Vicia faba L*) is a significant crop worldwide, ranked as the fourth important grain pulses after dry bean, dry peas and chick peas. It is one of the important annually produced crops in River Nile and Northern States (Sudan Trade Point 2015). It makes up a major part of the daily diet of the population particularly in urban areas where the average per capita consumption was found to be 2.25 Kg/month. It also plays an important role in sustaining the productivity of the farming system through the atmospheric nitrogen fixation (Ahmed and Khalid, 2007). Its products are cheap source of high quality protein in the human diet (Kumari and Vanleur, 2011). Siliam, in Northern State of Sudan, is famous for the production of good quality faba bean. In Siliam, Salih and Ali (1989) reported mean yield of 3.01ton/ha (variety Sm-L).

Bohlen *et al.* (1969) stated that two interrelated processes help to bring new ideas from their sources of initial development to acceptance by farmers. These processes are called diffusion and adoption.

According to Rogers (2003) diffusion is a process in which an innovation is communicated through certain channels over time among the numbers of a social system, and it occurred between persons while adoption is a decision made by an individual to make full use of an innovation as the best course of action available. He defined innovation as an idea, practice, or object that is perceived by individuals or other units of adoption to be new. He also stated that there are four main elements in the diffusion of innovation which includes: the innovation, communication channel, time and the social system. Social system as an important element in diffusion of innovation was highlighted in early studies. For example, Linton (1952) reported that if we know what society culture is including in its particular system of values and attitudes, we can predict with a fairly high degree of probability whether that bulk of it welcome of or resist a particular innovation. This statement shows the importance of cultural values on individual innovations. A social system with modern norms is more technologically developed, cosmopolite and literate and rational than a social system with traditional norms. Oladele (2005) argued that social scientists investigating farmers' adoption behavior have accumulated considerable evidence showing that demographic variables, technology characteristics, information sources, knowledge, awareness, attitude, and group influence affect adoption behavior.

Rolling (1988) mentioned that the diffusion process leads to inequitable development unless preventive measures are undertaken. He argued that the tendency of diffusion process to enhance inequity is reinforced by government rural development agencies which follow progressive farmer's strategy.

Rogers (2003) stated that the adoption of innovation is related to innovation decision process through which an individual passes from first knowledge of an innovation, to forming an attitudes towards the innovation, deciding to adopt or reject the innovation, implementing the new ideas, and confirming the innovation decision. Accordingly, he developed a model that explains the process which consists of five stages that include: awareness, interest, evaluation, trial and adoption stage. The distribution of adopters based on innovation assumes a normal distribution which is divided into five categories that include the innovators, early adopters, late adopters, late majority and the laggards.

The objective of this study is to determine the relationship between some personal characteristics of farmers of two blocks in Siliam Scheme in Northern state and adoption of some recommended faba bean (*Ficia feba*) cultural practices. More specifically, the study aims to determine the relationship between age, education level, annual income, family size, type and size of holdings of farmers and farmers' adoption of the recommended cultural practices namely, land preparation, sowing date, method of sowing, seed rate, number of irrigation, irrigation interval, and period of harvest.

Methodology

Random sampling technique was used to select the sample of the study. Accordingly, a group of 60 of the faba bean farmers' were selected from two blocks of Siliam scheme which is one of the important schemes of the Northern State, Sudan. A structured questionnaire was administered to the 60 randomly selected farmers from the study area. Personal interviews were used during a field survey which was conducted for collection of the primary data. The survey was carried out during the season of 2014. Secondary data were collected from reports, documents, journals and books.

Statistical Package for Social Sciences (SPSS) was used for analysis. Descriptive statistic was used to determine frequency and percentages of personal characteristics of the farmers and adoption of the recommended cultural practices of faba bean. Chi-square test was used to determine the relationship between personal characteristics and the adoption of the recommended cultural practices of faba bean.

Results and Discussion

Personal characteristics of the farmers

Table (1) showed that all of the respondents were males. This is one of tradition of the people in the Northern State, farms are owned by males and women contribution is limited compared to other regions in Sudan. However, now a days, women start to share in the harvest of all the crops especially the spices crops. From the same table we noticed that most of the farmers were literate and young. Also 66.7% of the farmers have medium family size (5 -10 members) and more than half of the farmers, (55%) owned the farms. The vast majority of the farmers (86.7%) said that the extension services were not available so they depend on their own knowledge and other sources of information. In addition, 46.7% of the farmers stated that their holdings are between 5 – 10 feddans.

Table 1: Frequency and percent distribution of personal characteristics of farmers

Item	frequency	%	Item	Frequency	%
Sex			**Education**		
Male	60	100	Illiterate	3	5.0
Female	00	00	Literate	57	94.9
Total	60	100	Total	60	100
Age			**Family size**		
Less than 30	22	36.5	Less than 5	17	28.4
30 -39	16	26.7	5-10	40	66.7
40 and above	22	3.7	above 10	3	5.0
Total	60	100	Total	60	100
Income/SDG			**Type of holding**		
Less than 5000	13	21.7	Owned by farmer	33	55
5000-10000	16	26.7	Government	4	6.7
Above 10000	31	51.6	Rented	19	31.7
Total	**60**	**100.0**	Sharecropping	4	6.7
			Total	60	100.0
Extension			**Farm size/feddan**		
A viable	8	14.3	Less than 5	14	23.4
Not available	52	86.7	5-10	28	46.7
Total	**60**	**100.0**	Above 10	18	30
			Total	**60**	**100**

Association between age and adoption of recommended cultural practices:

Table (2) shows that there is no significant association between age and adoption of all of the recommended faba bean cultural practices. This seems to be in line with the research result of Abass (2006) who found that there were no significant differences between farmers of different groups of ages and their adoption of recommended cultural practices of cotton in Gezira scheme. Age seems to have limited or no effect on adoption of recommended cultural practices. In reviewing research of characteristics of adopter categories, Rogers (2003) found that early adopters are not different from later ones in age.

Table 2: Chi-square test for association between age and recommended Faba bean cultural practices

Recommended cultural practices	Percentage of holders – Age				Sig.
	Less than 20	20-29	30-39	40 and above	
Land preparation	5.6	28.3	26.4	39.6	0.682
Sowing date	8.0	27.3	31.8	40.9	0.581
Method of sowing	6.9	27.9	39.8	40.9	0.877
Seed rate	00	25.0	25.0	50.0	0.415
No. of irrigations	6.0	27.3	39.45	33.3	0.530
Irrigation interval	6.7	33.3	36.7	30.0	0.693
Period of harvest	5.0	34.2	28.9	36.8	0.395

Association between education level and adoption of recommended Faba bean cultural practices:

Table (3) shows that there is no significant association between education level and all of the recommended faba bean cultural practices under investigation. This is not in line with what Abass (2006) mentioned as what is common in diffusion- adoption research. He stated that diffusion adoption- research indicated that those who have higher education levels are more responsive to new ideas than those with lower education levels.

Table 3: Chi-square test for association between education level and adoption of recommended Faba bean cultural practices

Recommended cultural practices	Education (%)					Sig.
	Illiterate	Khalwa	Primary	Secondary	High education	
Land preparation	2.1	4.3	48.9	38.3	3.4	0.395
Sowing date	2.1	4.3	4.78	39.1	6.5	0.651
Method of sowing	4.4	4.4	48.8	36.6	6.7	0.293
Seed rate	00	00	25.0	50.0	25.0	0.691
No. of irrigations	2.9	00	50.0	38.2	8.8	0.388
Irrigation interval	6.4	00	50.0	34.4	9.4	0.729
Period of harvest	2.3	2.3	48.8	32.6	9.3	0.071

Association between annual income and adoption of recommended Faba bean cultural practices:

Table (4) shows that there is significant association between net annual income and land preparation, seed rate and irrigation interval while there is no significant association between net annual income and the other cultural practices under the study. Sarker *et al*. (2009) found that farmers with higher income are more likely to adopt risky technology compared with those with low income.

Table 4: Chi-square test for association between annual income level and adoption of recommended faba bean cultural practices

Recommended cultural practices	Percentage of holders - Annual income (SDG)			Sig.
	Less than 5000	5000 and less than 10000	10000 and above	
Land preparation	00	29.4	70.6	0.000
Sowing date	00	33.3	66.7	0.328
Method of sowing	00	24.4	75.6	0.456
Seed rate	00	50.0	50.0	0.032
No. of irrigations	00	38.2	61.7	0.375
Irrigation interval	00	13.35	86.7	0.026
Period of harvest	00	30.0	70.0	0.113

Association between family size and adoption of recommended Faba bean cultural practices:

Table (5) shows that there is significant association between family size and number of irrigation and the period of harvest while there is no significant association between family size and land preparation, sowing date, seed rate and irrigation interval. Arene (1994) reported a positive and significant relationship between family size and adoption of recommended cultural practices. However, Voh (1982) established that household size is not significantly related to adoption.

Table 5: Chi-square test for association between family size and adoption of recommended faba bean cultural practices

Recommended cultural practices	Percentage of holders - Family size			Sig.
	Less than 5	**5 – 9**	**10 and above**	
Land preparation	39.1	52.1	8.7	0.319
Sowing date	37.8	53.3	8.9	0.345
Method of sowing	34.1	56.8	9.1	0.715
Seed rate	00	100	00	0.144
No. of irrigations	37.1	57.1	5.7	0.003
Irrigation interval	40.6	56.3	3.1	0.146
Period of harvest	37.5	52.5	10.0	0.007

Association between kind of the farm and adoption of recommended Faba bean cultural practices:

Table (6) shows that there is significant association between kind of the farm and land preparation, seed rate and irrigation interval while there is no significant association between net annual income and the other cultural practices under the study.

Table 6: Chi-square test for association between kind of the farm and adoption of recommended faba bean cultural practices

Recommended cultural practices	Percentage of holders				Sig.
	Type of holding				
	Owned	Governed	Rented	Shared	
Land preparation	34.0	6.0	34.0	26	0.003
Sowing date	32.6	10.9	28.3	28.3	0.447
Method of sowing	29.5	11.4	29.5	29.5	0.251
Seed rate	50.0	25.0	00	25	0.009
No. of irrigations	36.1	8.3	25.0	30.6	0.645
Irrigation interval	50.0	00	16.7	33.3	0.010
Period of harvest	41.5	7.3	24.4	26.8	0.107

Association between farm size and adoption of recommended faba bean cultural practices:

Table (7) shows that there is significant association between the size of the farm and sowing date and no. of irrigations while there is no significant association between the size of the farm and the other cultural practices under the study. Abdul *et al.* (1993) reported a significant relationship between landholdings (farm size) and adoption.

Table 7: Chi-square test for association between farm size and adoption of recommended Faba bean cultural practices

Recommended cultural practices	Percentage of holders			Sig.
	Size of holding (fd)			
	Less than 5	5-10	More than10	
Land preparation	19.6	56.5	23.9	0.206
Sowing date	19.5	53.6	26.8	0.001
Method of sowing	16.7	57.1	26.2	0.298
Seed rate	75.0	00	25.0	0.128
No. of irrigations	25.0	34.8	31.3	0.023
Irrigation interval	20.7	55.2	24.1	0.842
Period of harvest	13.5	56.8	29.7	0.507

Conclusion:

Results showed that all the farmers were male and the women help only during the harvest of the crops. There was no significant effect of the age and education status on the adoption of the recommended cultural practices but the net annual income, family size, kind of the holding and the size of the holdings were found to have significant effect on adoption of some recommended cultural practices. Further, there was a problem with the distribution of the extension services in the state.

References

Abass, E.A. (2006). Relationship of some personal characteristics of Tenants and the adoption of some recommended cotton cultural practices in the centre Group, Gezira Scheme, Sudan. MSc Thesis, University of Gezira.

Abdul, R.Q.; Ashfaq, H.M. and Sultan, A.C. (1993). Farmers characteristics affecting adoption of agricultural innovations. Journal of Rural Dev. and Admin. Vol. xxv, (3): 111 – 113

Ahmed, E.M.; Abubaker, M. and Khalid, S. (2007). Economics of faba bean production and marketing in northern Sudan. Conference on International Agricultural Research for Development, University of Kassel-Witzenhausen and University of Göttingen, October 9-11, 2007, Tropentag, Germany.

Arene, C.J. (1994). Discriminant analysis of small holder farmer adoption potential and the prediction of extension cost in Nigeria: a comparative enterprise perspective. Journal of Extension System, 10 (1): 46–58.

Bohlen, G; Conphenous, C.; Milton, C.; Lionberger, H. and Rogers (1969). Adopters of new ideas. North Central Regional Extension publication. No.13-New Yourk, U.S.A.

Kumari, S.G. and Van Leur, J.R.G. (2011). Viral disease infecting faba bean (*Vicia faba*). The Magazine of European Association for grain legume research, Issue No. 56

Linton, R. (1952). Cultural and personality factors affecting economic growth. In: B.E Hoselitz (ed); The progress of underdeveloped areas. University of Chicago press.

Oladele, O.I. (2005). Atobit analysis of propensity to discontinue adoption of agricultural technology among farmers in Southwestern Nigeria. Journal of Central European Agriculture, Vol. 6 (2005) No. 3

Rogers E.M. (2003). Diffusion of innovation *(5th ed.)* New York: The free press

Salih, H.S. and Ali A.E. (1989). A new faba bean cultivar for the Northern Province of the Sudan. Fabis newsletter, April

Sarker, M.A.; Cithara, Y. and Hoque, M. (2009). Determinants of adoption decisions: The case of organic farming in Bangladesh. Extension Farming Systems Journal, Vol. 5 No. 2.

Sudan Trade Point (2015). Faba bean (Broad bean). In Sudan Trade point, the electronic trade facilitation centre, Ministry of Trade, Khartoum, Sudan.

Voh, J.P. (1982). A study of factors associated with the adoption of recommended farm practices in a Nigeria Village" Agricultural Administration 2: 17 – 27.

Nile Valley University Publications
Nile Journal for Agricultural Sciences (NJAS)
(ISSN: 1585 – 5507)
Volume 02, NO. 01, 2017
http://www.nilevalley.edu.sd

Research paper

Economics of Wheat (*Triticum spp.*) Production in Dongola Area, Northern State, Sudan

Abubakr I. S. Elhori, Asma A. A. Mohamed and AlaAldin S. Mohamed

Department of Agricultural Economics, Faculty of Agricultural Science, University of Dongola, Sudan

Corresponding author: abubakerelhouri@yahoo.com

ABSTRACT

The objective of this study was to analyze the economics of wheat production in the Nile and the Underground water schemes in Dongola area, Sudan, through examining the socio-economic characteristics of wheat-producers, investigating wheat costs, returns and profits and derive wheat's production function in the two mentioned schemes. A multi-stage stratified random sampling technique was used to collect data from 240 respondents by means of questionnaire during 2013/14 season. Descriptive statistics, gross margin and regression analysis techniques were used to meet the stated objectives. Results revealed that; wheat producers in the state used their resources inefficiently. Almost all inputs used were significantly differing from the recommended ones; consequently, farmers gained discouraging profits. There is a great potential for improving farmers productivity/profitability if certain measures are carefully adopted. These measures include improving the technical knowhow of the farmers (strengthening of extension services), access to microfinance and reducing farmers' costs through electrification of agricultural schemes, and removing/reducing taxes.

Keywords: *Cobb-Douglass production function, costs of production, socio-economic characteristics, wheat productivity*

اقتصاديات إنتاج محصول القمح في منطقة دنقلا – الولاية الشمالية – السودان

أبوبكر إبراهيم سعيد الحوري، أسماء عوض أحمد محمد وعلاء الدين سيد أحمد محمد

قسم الاقتصاد الزراعي – كلية العلوم الزراعية – جامعة دنقلا

هدفت هذه الدراسة إلى تحليل اقتصاديات إنتاج محصول القمح في المشاريع التي تروى من النيل ومن الآبار الجوفية في منطقة دنقلا-الولاية الشمالية–السودان وذلك من خلال تحليل الخصائص الاقتصادية والاجتماعية لمزارعي المحصول وإيجاد التكاليف والعوائد والأرباح ومن ثم إيجاد دالة إنتاج المحصول في كل من المشروعين المذكورين. استخدم أسلوب العينة الطبقية العشوائية المتعددة لجمع البيانات من 240 مستهدف بواسطة استبيان من خلال موسم 2013/14. استخدم الاحصاء الوصفي وهامش العائد وتحليل الانحدار لتحقيق الاهداف الموضوعة. أظهرت النتائج أن مزارعي القمح في الولاية يستخدمون موارد الإنتاج بطريقة غير كفئة. في الغالب كل عوامل الإنتاج استخدمت استخداماً مختلفاً بصورة معنوية عن تلك الموصى بها نتيجة لذلك يكسب المزارعون أرباح غير مشجعة. هنالك إمكانية كبيرة لتحسين الإنتاجية والربحية إذا طبقت بعض المعايير بصورة صحيحة. هذه المعايير تشمل تحسين المعرفة التقنية للمزارعين (تقوية خدمات الإرشاد)، وتسهيل الحصول على التمويل الأصغر وتقليل التكلفة من خلال كهربة المشاريع الزراعية وإزالة أو تقليل الضرائب.

Introduction

Wheat is one of the most important food crops, originating from the levant region of the Near East and Ethiopian Highlands, but the crop is now cultivated worldwide. It almost comes the third most-produced cereal after maize and rice, although sometimes come second after maize. It is grown on about 220 million hectares worldwide, covering more land area than any other crop. Major wheat producing countries include China, India, USA, Russia and France (FAO, 2016).

Domestically, the Gezira scheme produces about 50% of the country's wheat production; the rest is produced in the Northern and Nile States in addition to little areas in Rahad and New Halfa schemes. Production of wheat is insufficient to meet growing needs and imports attempt to cover the deficit because Sudan consumed 2.75 million metric tons of wheat in 2016, and only produced 456000 Tones (MASTAT, 2016). Table (1) shows the fluctuated planted areas and yields which vary significantly due to weather conditions and other factors.

Table 1: Production of wheat in Sudan during the period 2009/10 to 2015/16

Year	Cultivated area (1000 ha)	Yield (ton/ha)	Production (1000 ton)
2009/10	237	1.70	403
2010/11	196	1.50	292
2011/12	187	1.73	323
2012/13	185	1.51	279
2013/14	137	1.77	242
2014/15	237	2.00	473
2015/16	224	2.04	456

Source: Agricultural Statistics Department - Ministry of Agriculture and Forests (2016)

The Northern State occupies the distant Northern part of Sudan and lies between latitudes 16-22 Nº and longitudes 20-32 Eº. It is bordered by Khartoum State in the south, the River Nile State in the east, Republic of Egypt to the north and Libya and north Darfur in the west. The state lies in the arid and semi -arid zones, where the annual rainfall is less than 100 mm. The climate is characterized by distinct seasons where summer extends from April to the end of September. The maximum temperature in summer reaches 45°C. Winter extends from October to the end of March and it is cold season. The maximum winter temperature is about 30°C, while the minimum temperature is around 5°C. The State with an area of 35 million ha is administratively divided into seven localities; Halfa, Dongola (Al-Porgage, East Nile, Dongola, Algolid), Al-Debba and Merawe, each with a number of administrative units. Irrigated agriculture from the River Nile and/or underground water is the main economic activity. The total currently cultivated areas in the State is estimated at 199,958 ha, 75% of which is cultivated in winter. Wheat and faba bean cultivated areas are about 37% and 25% on the average of the total winter cultivated area in the State, respectively. About 3.83, 4.10 and 2.58% out of the total cultivated area in the State are grown by spices (cumin, garlic and fenugreek), vegetables and fodder crops, respectively. The total perennials crops area in the State is estimated at 20704 ha, 74% of which is occupied by date palm (NSMA, 2016).

Agricultural production in the State is believed to be constrained by many factors; mainly high inputs cost especially fuel for irrigation water, unavailability of inputs at the right time, and land fragmentation. These constraints resulted in low yields, inefficient allocation of resources and low farmer's income.

The main objectives of this study were to evaluate the economics of wheat production in the Nile irrigated schemes and the underground-water irrigated schemes in Dongola area, Northern State of Sudan, more specifically were to: study the socio-economic characteristics of the farmers; investigate wheat costs, returns and profits and derive wheat's production function in the two types of schemes.

Methodology

Data collection

This study depended mainly on primary data through direct personal interview by a structured questionnaire. The survey was carried out during June and July of the year 2014 using a multi-stage stratified random sampling technique, which is characterized by its time and cost saving. About 240 farmers were selected which represented about 25% of the total farmers in Dongola area (which consists of four localities Al-Porgage, East Nile, Dongola and Algolid), distributed equally between the two types of schemes. Within each locality number of villages were selected randomly and from each village number of farmers were randomly selected. Data on farmer's age, educational level, family size, yields, cost of production…etc. were collected. In addition, secondary data pertinent to the problem investigated were obtained from relevant sources and resource persons.

Data analysis

Descriptive statistics, gross margin analysis and Cobb-Douglass production functions were used to meet the objectives of the study (Heady and Dilon, 1961 and John and Arthur, 1991). The form of the Cobb-Douglass production function is as follows:

$$Y=aX_1^{b1}X_2^{b2}\dots Xn^{bn}e$$

Where:

Y=dependent variable, a=intercept, b_1-b_n= regression coefficients to be estimated, X_1-X_n= independent variables, e=random disturbance term.

Then the function transformed into linear form and variables specified as follows:

$$\log Y = a + b_1 \log X_1 + b_2 \log X_2 + ... + b_n \log X_n + e$$

Where:

Y= revenue (SDG/ha), a=intercept, b_1-b_n= regression coefficients to be estimated, X_1=land preparation cost (SDG/ha), X_2=Seed cost (SDG/ha), X_3=irrigation cost (SDG/ha), X_4=harvesting cost (SDG/ha), e=random disturbance term.

Results and Discussion

Socio-economic characteristics of wheat producers in Dongola area

Results revealed that, the majority of wheat producers in Dongola area, were in the active age group, highly specialized, and experienced in agricultural activities (more than 10 years), owned their land (67.00%), and had a large family size that helps in farms activities (Table 2). Wheat yield in the area was low (2.19 and 2.00 ton/ha) in the Nile and in the underground water schemes, respectively, compared to the productivity in Dongola research station (5.95 tons/ha). The low productivity might be attributed to the fact that, the majority (85.50%) of the producers had low education level or illiterate, as presented by the percentage of illiterate (2.50%), informal Islamic schools (1.50%) and basic+secondary formal educational level (81.60%), poor extension services leading to practices of traditional methods of productions, these results were confirmed by Mohamed (2000) and Ahmed (2008). Moreover, 70% of the farmers had no second job, this is important in making farmers focusing on farm activities, however, the second job helps in facing unexpected farm risks. The size of agricultural holdings is small, and that is due to the fact that the available cultivable lands are limited to the narrow area along the river bank limiting the use of machinery in farm cultivation, which may affects wheat productivity (Tawfeeq, 1999).

Costs, returns and profits of wheat production in Dongola area

In calculating production costs, the following items were considered: land preparation, agricultural practices and agricultural inputs (Table 3). It is clear from Table (3) that, the total costs of wheat production in the Nile and the underground water schemes were relatively high, 5856.52 and 5700.07 SDG/ha, respectively with land rent, taxes and Zakat representing the main cost items in both schemes contributing substantially to the total costs of 31.70 and 26.75%, respectively. These results coincide with Elhori *et al.* (2013) in their study of potato production in

Dongola area. They found that harvesting costs were the second cost items in both schemes contributing significantly to the total costs of 22.54 and 22.37%, respectively.

Table 2: Socio-economic characteristics of the farmers in Dongla Area

Items	**%**	**Items**	**%**
Age:		**Land Type:**	
Less than 20	1.30	Owned	67.00
20-40	39.90	Rented	15.80
40-60	53.80	Governed	17.20
More than 60	5.00	Total	100.00
Total	**100.0**		
Education Level:		**Family Members:**	
Illiterate	2.50	1-4	20.50
Khalwa	1.50	4-7	42.10
Basics (primary)	46.20	7-9	2.790
Secondary	35.40	10 and above	9.50
High secondary	14.40		
Total	**100.00**	**Total**	**100.00**
Marital Status:		Farmer's occupation	
Married	84.20	Farmer only	70.10
Not married	15.80	Merchant	7.90
Total	100.00	Governmental employee	15.80
Size of holding (ha)		Other occupations	6.20
2 and less	44.20	**Total**	**100.00**
2-4	41.30		
4-6	7.00		
Above 6	7.50		
Total	**100.00**		

Other main cost items in the Nile scheme in descending orders were the land preparation (12.30%), irrigation (11.10%), seeds (11.07%) and fertilizer (8.07%). In the underground water scheme, seeds cost item came third (13.8%), followed by irrigation cost (13.66%), fertilizer cost (10.83%) and land preparation cost (10.52%). The study shows that, the variation of the total costs and cost items between the Nile and the Underground water schemes can be explained by differences in soil fertility, farm distance from the river bank, availability and cost of inputs in the specific time and place, cost of lifting the water irrigation either from Nile or wells. This is true because, land rent near river bank is greater than land rent in upper terraces; moreover, lifting water from wells is more expensive than lifting from the river.

Table 3: Costs, (%) returns and profits of wheat production in Dongola area (SDG/ha)

Cost item	Nile scheme		Underground water scheme	
	Cost	%	Cost	%
Land preparation:				
Land plough	377.31	5.82	299.60	5.24
Land leveling	346.74	5.35	235.17	4.13
Ridges and canals	73.40	1.13	65.48	1.15
Total	**797.45**	**12.30**	**600.25**	**10.52**
Agricultural practices				
Sowing	53.74	0.82	32.75	0.57
Irrigation	718.33	11.10	778.50	13.66
Harvesting	1459.21	22.54	1274.93	22.37
Total	**2231.28**	**34.46**	**2086.18**	**36.60**
Agricultural inputs				
Seeds	716.83	11.07	786.67	13.80
Fertilizer	523.33	8.07	617.45	10.83
Pesticide	155.31	2.40	85.00	1.50
Total	**1395.47**	**21.54**	**1489.12**	**26.13**
Land rent, taxes and Zakat	1432.31	31.70	1524.52	26.75
Total production costs	5856.52	100	5700.07	100
Average yield (ton/ha)	2.19		2.00	
Average price (SDG/ton)	3703.00		3516.00	
Average revenue (SDG/ha)	8109.57		7032.00	
Average gross margin (SDG/ha)	2253.05		1331.93	

One US$ =18 SDG

Considering soil fertility, the average quantity of fertilizer applied in the underground water schemes is greater than the quantity applied in the Nile; these results is confirmed by Abdalla (2005) and Elhori and Babiker (2009) in their studies of Agricultural production and the optimum cropping pattern in the Northern State. On the other hand, all farmers in both studied schemes used the resources inefficiently, i.e. differ significantly from technical packages that recommended by the research stations, these can be attributed to many reasons, some of them are financial and credit constraints, unavailability of resources in the appropriate time and also lack of knowledge. The study showed some of these deviations as follows: 25% of the farmers sowing their crop earlier compared to the recommended date and 23% of them delayed planting of wheat till December (after the recommended date), most farmers used traditional seed varieties from the previous season(s) rather than using improved seeds, the seed rate applied for both schemes were over the recommended dose by 80%. Fertilizer rate was applied less than the recommended level by 55% and 40% in the Nile and the underground schemes, respectively (Dongola Agricultural Research Station, 2009). This confirms the findings of Elfiel *et al*. (2001) in their study of wheat, faba bean and sorghum production in the Northern State of Sudan; they found that farmers in the Northern state usually reduced their agricultural inputs to cope with the increasing inputs prices. Farmers in the study area applied number of irrigations over the recommended by 18%.

The returns/hectare of the Nile and the underground watering schemes were found to be 8109.57 and 7032.00 SDG, respectively. Gross margins analysis revealed that, farmers gain low and discouraging net return 2253.05 and 1331.93 SDG/ha in the Nile and the underground watering schemes, respectively. This is not surprising if we know that farmers in Dongola area sow wheat as a staple food crop.

Wheat production function in Dongola area

Table (4) shows the regression equations for wheat production in the Nile and the underground water schemes, the adjusted (R^{-2}) of the Cobb-Douglass production function for the Nile scheme was 0.82 and 0.92, for the underground water schemes, implying that 82% and 92% of the total variation in wheat revenues (SDG/ha) are explained by the explanatory variables in the models. The F-statistics which was highly significant (0.000) implying that, the independent variables were collectively important in explaining the variation in the dependent variable (wheat revenue). The results revealed that, the effect of each of the independent variables; seed costs, irrigation costs, harvesting costs were positive and highly significant (0.01% and 0.05%).

Table 4: Wheat production function in Dongola area

Cost item (SDG/ha)	Nile schemes			Underground water schemes		
	Coefficient	T-Value	Sig.	Coefficient	T-Value	Sig.
Constant		-2.52	0.019		-9.33	0.362
Land preparation	-2.34	-3.89	0.001	-0.31	-3.20	0.005
Seed	0.89	7.24	0.000	0.80	11.42	0.000
Irrigation				0.31	2.37	0.029
Harvesting	2.68	4.50	.000	0.39	2.72	0.014
R^2	82%			92%		
F-Value	20.98	0.000		54.76	0.000	

This means that a one percent increase of each of the independent variables increases wheat revenues by their corresponding elasticity. The coefficients of land preparation in both schemes were found to be highly significant (0.00%) and (0.01%), respectively, but with negative signs. The negative relationship indicates the over usage of the land preparation cost, especially in the Nile scheme and this result coincides with the results of budget analysis in Table (3).

Conclusion and recommendations:

There is a high potential for improving wheat production and farmers income if certain measures are taken. These measures are; strengthening extension services to improve farmers' technical knowhow, provision of microfinance and subsidized agricultural inputs to use an improved seeds and to encourage farmers' adoption of the technical packages, electrification of agricultural schemes, and removing/reducing taxes. Thus policies aiming at expanding wheat production in the State (National Program to Produce Wheat) need to consider the achievement of high productivity and lowering the production cost.

References

Abdalla, A.B. (2005). The determinants of agricultural production and the optimum cropping pattern in the Northern State, Sudan. Ph.D. Thesis, University of Khartoum, Sudan.

Agricultural Research Station, Dongola (2009). The annual report.

Ahmed, A.A. (2008). Economics of wheat production in Dongola Locality, Northern State-Sudan. MSc. Thesis, University of Dongola, Dongola, Sudan.

Elfeil, M.A.; Babikir, B.I. and Davis, J. (2001). An economic analysis of wheat, broad beans and sorghum production in the Northern State of the Sudan. University of Khartoum. J. Agric. Sci.: 9(1): 139-152.

Elhori, A.I.S. and Babiker, B.I. (2009). Optimum winter cropping pattern in the Northern State, Sudan. J. Sc. Tech.: 10(3): 77-86.

Elhori, A.I.S.; Shaddi, E.H.; Elrasheed, M.M.M., and FadlElmola, F.Y. (2013). Economic analysis of potato production in Dongola locality- Sudan. International Journal of AgriScience, International Academic Journals: (7):577-583.

FAO (2016). Food and Agriculture Organization. Italy, Rome. The annual statistical report.

Heady, E.O. and Dilon, J. (1961). Agricultural production function. Iowa State University Press, Ames, Iowa, U.S.A.

John, E. and Arthur, G. (1991). Understanding Business Statistics. R.D. Irwin, Inc. U.S.A.

MASTAT (2016). Agricultural Statistics Department - Ministry of Agriculture and Forests (2016). The annual report.

Mohamed, A.S. (1996). Economics of crop production in Dongola Province, Northern State, Sudan. M.Sc. Thesis, University of Khartoum, Sudan.

Mohamed, A.S. (2000). Economics of crop production in Matarat in Dongola Province, Northern State, Sudan. M.Sc. Thesis, University of Khartoum, Sudan.

NSMA (2016). Northern State Ministry of Agriculture annual report.

Tawfeeg, M.A. (1999). The economics of wheat production in the Northern State. M.Sc. Thesis, University of Khartoum, Sudan.

Nile Valley University Publications
Nile Journal for Agricultural Sciences (NJAS)
(ISSN: 1585 – 5507)
Volume 02, NO. 01, 2017
http://www.nilevalley.edu.sd

Research paper

Effect of Some Neem *(Azadirachta indica)* Organic Extracts Against Mosquitoes *Anopheles arabiensis* Patton

Fathelrahman Ibrahim Elsiddig

Plant Protection Department, Faculty of Agriculture, Sinnar, University, Sudan,
Corresponding author: elsiiddig@gmail.com

ABSTRACT

Laboratory experiments were carried out at the National Malaria Centre, Sinnar State, Sudan, to investigate the effect of organic extracts of leaves and seed kernels of neem (*Azadirachta indica A. juss.*) against larvae and adults of the main malaria vector in Sudan Anopheles arabiensis Patton. Larvicidal activity, oviposition deterrency and adult mortality after 24 hours exposure were measured according to the WHO standards, using ethanol and hexane extracts of the mentioned neem parts. Results indicated that all tested extracts exhibited larvicidal properties against Anopheles arabiensis mosquito. However the seed hexane extract was superior over other ones, depicting minimum LC50 of 1998 mgℓ-1. Oviposition deterrency to Anopheles adult was noticed from all tested extracts, with their different concentrations. Meanwhile, the extracts showed negligible insecticidal characteristics to the tested mosquito. It can be concluded from the present investigation that the tested neem extracts could be compatible to apply with other conventional biological measures used in malaria vector control program after field verifications, keeping in mind the great concern raised about vector resistance and environmental hazards of conventional pesticides.

Keywords: *Anopheles arabiensis, Azadirachta indica, larvicides, mosquito, oviposition deterrency*

تأثير مستخلصات طبيعية من النيم (*Azadirachta indica* A.juss) على بعوض الانوفليس (*Anopheles arabiensis* Patton.)

فتح الرحمن ابراهيم الصديق

قسم وقاية النباتات، كلية الزراعة، جامعة سنار- السودان

تم اجراء تجارب معملية في المركز القومي للملاريا بولاية سنار- السودان، لمعرفة تأثير مستخلصات عضوية من اوراق وجنين بذور النيم (*Azadirachta indica* A. juss) على أطوار اليرقة والحشرة الكاملة للبعوض الناقل للملاريا بالسودان (*Anopheles arabiensis* Patton.). تم قياس النشاط القاتل لليرقات، التأثير المانع لوضع البيض، والقاتل للحشرة الكاملة بعد 24 ساعة من التعرض وذلك باستعمال مستخلصات من الايثانول والهكسان للأجزاء المذكورة سابقاً من النيم، تبعاً لمقاييس منظمة الصحة العالمية. اوضحت النتائج ان جميع المستخلصات المختبرة من اجزاء النيم قد اظهرت تأثير قاتل ليرقات بعوض الانوفليس، وقد كان مستخلص الهكسان لجنين بذور النيم هو الاكثر تفوقاً على المستخلصات الاخرى معطياً اقل تركيز نصفي قاتل، بلغ 1998 ملجم/ لتر$^{-1}$. اظهرت المستخلصات تحت الاختبار وبكل التركيزات المستخدمة منها، خصائص مانعة لوضع البيض، فى حين انها لم تظهر تأثير قاتل يذكر للحشرة الكاملة للباعوض موضوع الدراسة. يمكن ان نخلص من هذا التقصي ان مستخلصات النيم تحت الدراسة يمكن ان تستخدم بتوافق مع الطرق البيولوجية التقليدية الاخرى في برامج مكافحة البعوض الناقل للملاريا وذلك بعد التقييم الحقلي، واضعين في الاعتبار الاهتمام العام بتنامي ظاهرة مقاومة النواقل للمبيدات والتأثيرات البيئية الضارة لها.

Introduction

Mosquito *Anopheles arabiensis* is one of the most important vectors of malaria in sub-saharan Africa, and it occurs in overlapping manner with other important species (Mabaso, 2004). Control of anopheline mosquito vectors of malaria by using synthetic insecticides has shown greater impact on morbidity and mortality caused by this disease. Regarding that insecticide resistance is widely spread in Africa where it has been associated with the use of insecticides in public health for mosquito control and in agriculture for pest control (Kristan, 2003). In Sudan, although more recent studies indicated that resistant level has increased only marginally (Kamau and Valule, 2006). But there is concern that continued and/or increase use of insecticides may result in increased resistance that would threaten the sustainability of the vector control strategies (Maharaj *et al.*, 2005).

Phytochemicals obtained from plants with proven mosquito control potentials can be used as an alternative to synthetic insecticides or along with them under integrated control programmes. Large number of plant extracts have been used against *Anopheles spp*. as control agents viz. *Calotropis procera* (Markouk *et al*., 2000); *Eucalyptus camaledulensis* (Yang and Ma, 2005) and *Ocimum basilicum* (Elsiddig, 2007).

In Sudan, neem *Azadirachta indica* tree is widely spread and it is found almost in every part of the country. A number of workers studied the effect of the different parts of neem tree on different arthropod pests of crops (Mansour and Salem, 2001; Sati *et al*., 2003; and Elsiddig, 2009). Nathan *et al*. (2005) explored the advantages of pure neem limonoids, and study the larvicidal, pupicidal, adulticidal and antiovipositional activity of neem limonoids. Azadirachtin, salannin and deacetylgedunin showed high bioactivity at all doses, while the rest of the neem limonoids were less active, and were only biologically active at high doses. Azadirachtin was the most potent in all experiments and produced almost 100% larval mortality at 1 ppm concentration. Batra *et al*. (1998) reported that neem oil emulsion in water was found to control breeding of *Culex quinquefasciatus*, *Anopheles stephensi*, and *Aedes egypti* in pools, basement tanks, and desert coolers. Topical application of 2% neem oil mixed with coconut oil produced varying degree of protection against different vector species (Moore *et al*., 2003).

The present study was carried to test the potentials of different neem organic extracts against *Anopheles arabiensis* larvae, and to evaluate their oviposition deterrency and mortality on adults.

Materials and Methods

Study area

Experiments were carried out at the National Malaria Centre, Sinnar- Sinnar State-Sudan.

Preparation and extraction of the plant material

Fresh leaves of neem *Azadirachta indica* were collected from Shambat campus, Sudan University of Science and Technology, dried under shade for 10 days, and then powdered to a uniform mesh. However, ripe fruits of the plant were harvested from the same area and soaked in water to remove pulps. The obtained seeds were dried under shade for 10 days. The well dried seeds were decorticated to obtain the kernel separately, which powdered to a uniform mesh. Extraction was done for the two prepared parts at the Department of Pesticides Alternatives of the Environmental and Natural Research Institute-Sudan, using soxhlet extractor, firstly with hexane and then with ethanol (98%). The solvents were removed by means of rotary evaporator.

Mosquito Rearing

Anopheles arabiensis mosquitoes were reared at the insectory of the National Malaria Centre, Sinnar State, Sudan, using the method described by Zarroug *et al*. (1988).

Bioassay

Tests on larvae

Twenty percent solutions from each of ethanol and hexane extracts were prepared using tap water. Serial dilutions were made to give the concentrations of 500, 1000, 3000, 5000, and 10000 $mg\ell^{-1}$ in a final volume of one liter each. Water and solvents controls were prepared with the same final volumes, and all treatments were replicated four times. These treatments were then evaluated for mosquito larvicidal activity according to the method of WHO (1969). A group of third stage larvae of *Anopheles arabiensis* (twenty larvae) were placed in exposure bowls. The exposure period was 24 hours, during which no food was offered to the larvae. Mortality was recorded by counting the completely dead or moribund larvae together with the larvae that failed to reach the surface of the solution. Then data recorded was subjected to probit analysis using MSTAT-C package computer program (1991), to calculate LC_{50} values.

Tests on adult

The method adopted was the excito-repellency test recommended by the WHO (1979). Solutions of 20% from each of the ethanol and hexane extracts were prepared, and dilutions were made to form concentrations of 1%, 5%, and 10% in a final volume of 50 ml. These volumes of each concentration were poured on five filter papers (24 cm diameter) until wetting, and then were embedded in the internal part of the main box. Two petri dishes lined with a piece of wetted cotton and covered with filter paper were prepared; one was placed in the main box and the other in the trap box to serve as an egg laying sites. All treatments were replicated three times with water and solvents controls for comparison.

Fifty gravid *A. arabiensis* mosquitoes were then released inside the main box. Ovipositon activity index (OAI) was determined after 24 hours using the formula of Kramer and Mulla (1979) *viz*. OAI= (Nt-Nc)/ (Nt+Nc). Where OAI= oviposition activity index, Nt= number of eggs in the treatment and Nc= number of eggs in the control. OAI values +1 indicate an attractive effect, while OAI values -1 indicate deterrency activity of the material tested. Adult mortality was recorded after 24 hours and presented in percentage.

Results and Discussion

Results given in Table (1) demonstrated the crude hexane and ethanol neem extracts (leaves and seed kernels) at different concentrations depicted larvicideal effect against *Anopheles arabiensis* mosquito. These results agreed with Aliero (2003), who suggested that seed oil and leaf extract of neem *Azadirachta indica* had properties that could be developed and used in the control of Anopheles mosquitoes in the tropics. Moreover, it was observed that better mortality results were obtained by the neem seed kernel extract compared to neem leaves extract. The advantages of seeds over leaves was also confirmed by Grunwald *et al*. (1992), who concluded that the bioactive compounds in the neem were found throughout the tree, but those in the seed kernel were the most concentrated and accessible. Likewise, Aliero (2003) concluded that seed oil appeared as the most lethal among various parts tested against *Anopheles spp*. He attributed this to deficiency of dissolved oxygen in the water. Further, it was also observed that neem seed hexane extract exerted better mortality when compared to ethanol. Regarding this manner, hexane solvent was well known to remove the oil from the seed (non-polar), and this oil was an interesting material that could be used to kill eggs, larvae and adults of certain pests.

Table (2) showed results of probit regression analysis which demonstrated the LC_{50} of different plant extracts. It depicted the same trend of the mortality results in table (1), when the neem hexane extracts of the tested parts exerted lower LC_{50}. However the seed extract was the best treatment compared to the other ones, with LC_{50} of 1998 $mg\ell^{-1}$.

The negative results of Oviposition Activity Index (OAI) presented in Table (3) Demonstrated that the different neem part organic extracts with their different concentrations, had the ability to deter *Anopheles arabiensis*adult from laying eggs. This result is agreed with Schmutterer (1990), who reported that neem based pesticides containing azadirachtin which is a predominant active ingredient, having antifeedant, ovipositional deterrence repellency, and growth disruption against insects. Goektepe *et al*. (2004) confirmed the previous conclusions and continued reporting that they are relatively safe towards non-target biota, with minimum risk of direct adverse effects and contamination of water bodies. However, “Neem Aura”, a commercial botanical product containing neem ingredients, was proved to be highly effective oviposition deterrent to *Aedes albopictus*, it reduced oviposition by 76% (Xue *et al*., 2001).

Adult mortality presented in Table (3) revealed that lower mortality percentages were induced by different tested parts when applied as paper impregnation. This result agreed with that of Sagar and Segal (1996) who stated that, though neem products show high larvicidal activity, they do not show adulticidal action. However, Khan and Ahmed (2000) revealed the toxicity of crude neem extract and commercial eucalyptus against the adult housefly Musca *domestica* when measured as topical application. From the result of oviposition deterrency, it could be assumed that while neem extract had the ability to deter adult from laying eggs, the mosquito make little or no contact with the treated surface, and consequently mosquito intoxication does not occur.

Conclusion

This study clearly demonstrated that ethanol and hexane extracts of neem leaves and seed kernels exhibited larvicidal effect on *Anopheles arabiensis* mosquito, with the superiority of the seed hexane extract. However, oviposition deterrency properties were observed from all concentrations of the tested extracts, with negligible toxicity towards adult mosquitoes. The obtained results, after further field evaluation, will encourage the inclusion of these extracts in IPM programs for mosquito control with other natural and biological measures.

References

Aliero, B.L. (2003). Larvicidal activity of aqueous extracts of *Azadirachta indica* on the larvae of Anopheles mosquito. African J. biotechnology, 2: 325-327.

Batra, C.P.; Mittal, P.K.; Adak, T. and Sharma, V.P. (1998). Efficacy of neem water emulsion against mosquito immatures. Indian Journal of Malariology, 35: 15.

Elsiddig, F.I. (2007). Effect of neem, cafure, and rehan organic extracts compared to other chemical and biological standard insecticides on *Anopheles arabiensis* Patton Mosquito. Ph.D. Thesis, Sudan University of Science and Technology, 158pp.

Elsiddig, F.I. (2009). Effect of different preparations from neem tree on *Microtermes thoracalis* Sjost. Infesting ground nuts. Journal of Agro-estimation Scientific Agency (Gagresca), Vol. (1): 84-95.

Goektepe, I.; Portier, R. and Ahmedna, M. (2004). Ecological risk assessment of neem based pesticides. J. Env. Sci. Hlth. B. 39: 311-320.

Grunwald, J.; Boschitz, C. and Claudia, E. (1992). Possibilities of vector control. Proceedings of the first workshop on the use and production of neem ingredients, Wetzlar-Germany, 91-93.

Kamau, L. and Valule, J.M. (2006). Status of insecticidal susceptibility in *Anopheles arabiensis* from Mwea rice irrigation scheme, central Kenya. Malaria Journal, 5: 46-49.

Khan, M.F., and Ahmed, S.M. (2000). Toxicity of crude neem leaf extract against housefly *Muscadomistica* L. adult as compared with DDVP, Dichlorvis. Turk. J. Zool., 4: 219-233.

Kramer, W.L. and Mulla, M.S. (1979). Oviposition attractants and repellents of mosquitoes: Oviposition response of *culex* mosquitoes to organic infusions. Environmental Entomology 8:1111-1117

Kristan, M. (2003). Pyrethroid resistance/ susceptibility and differential urban/rural distribution of *Anopheles arabiensis*and *Anopheles gambiae* malaria vectors in Nigeria and Ghana. Med. Vet. Entomology, 17: 326-332.

Mabaso, M.L.; Sharp, B. and Lengeler, C. (2004). Historical review of malaria control in southern Africa with emphasis on the use of indoor residual house spraying. Tropical Med. Int. Health, 9: 846-856.

Maharaj, A.; Mathembu, D.J. and Sharp, B.L. (2005). Impact of DDT re-introduction on malaria transmission in Kwazulu, Natal. South Africa Medical Journal, 95: 871-874.

Mansour, M.H. and Salem, H.A. (2001). Efficiency of two neem formulations in controlling pallid scale *Insulaspispalidula* Green, infesting mango trees in Egypt. Workshop on "practice oriented results on use of plant extracts and pheromones in integrated and biological pest control". Cairo-Egypt, 39-40.

Markouk, M.; Bekkouche, K.; Larhsini, M.; Bousaid, M.H.; Lazrek, B. and Jana, M.(2000). Evaluation of some Moroccan medicinal plant extracts for larvicidal activity. Journal of Ethnopharmaco l73: 293–297.

Moore, S.A.; Lenglet, A. and Hill, N. (2003). Field evaluation of three plants based insect repellents against malaria vectors in province of Bollivian Amazon. Journal of American Mosquito Control Association, 9: 202-215.

MSTAT-C (1991). A software program for the design, management and analysis of agronomic research experiments. Michigan University, USA.

Nathan, S.S; Kalaivani, K. and Murugan, K. (2005). Effect of neem limonoids on the malaria vector *Anopheles stephensi* Liston (Diptera: Culicidae). Acta Tropica, 96 (1) 47-55.

Sagar, S.K. and Segal, S.S. (1996). Effect of aqueous extracts of de-oiled neem (*Azadirachtaindica*) seed kernel and koranja (*Pongamiaglobera*) seed kernel against *Culexquinquefascaitus*. Journal of Community Dis., 28: 260-266.

Sati, A.A; Bashir, N.H.H.; Elkhidir, E. and Nasr, O.E. (2003). Effect of neem seed Kernel and "handal" extract on muskmelon pests complex. University of Khartoum Journal of Agricultural sciences, 11: 40-58.

Schmutterer, H. (1990). Properties and potentials of natural pesticides from neem tree *Azadirachtaindica.* Ann. Rev. Entomology. 35: 271-297.

WHO, (1969). Insecticidal resistance and vector control. Tenth Report of the World Health Organization Expert Committee on Insecticides, No. 191, 98 pp. Swiss Land, Geneva

WHO, (1979). Safe use of Pesticides. Third Report of the Expert Committee on Vector Biology and Control, Technical Report No. 634, pp 18-23. Swiss land, Geneva.

Xue, R.D.; Barnard, D.R. and Ali, A. (2001). Laboratory and field evaluation of insect repellents as oviposition deterrents against the mosquito *Aedesalbopictus.* Med. Vet. Entomol., 15: 126-131.

Yang, P. and Ma, Y. (2005). Repellency effect of plant essential oils against *Aedesalbopictus*. Journal of Vector Ecology 30: 231-234.

Zarroug, I.M.A.; Nogud, A.D.; Bashir, A.K. and Mageed, A.A. (1988). Malaria vectors. International Journal of Crude Drug Research 26:77-80.

Table 1: Mortality percentage caused by different neem organic extracts to *Anopheles arabiensis* larvae.

Concentration ($mg\ell^{-1}$)	500	1000	3000	5000	10000
	Neem Leaves Ethanol Extract (NLE)				
Mortality %	7.5	10	15	16.25	67.5
S.E (±)	0.22	0.0	0.35	0.22	0.50
	Neem Leaves Hexane Extract (NLH)				
Mortality %	11.25	18.75	55	61.25	92.5
S.E (±)	0.65	0.41	0.87	1.14	0.83
	Neem Seeds Ethanol Extract (NSE)				
Mortality %	5	12.5	25	81.25	100
S.E (±)	0.35	0.56	0.0	0.54	0.0
	Neem Seeds Hexane Extract (NSH)				
Mortality %	5	25	93.75	98.75	100
S.E (±)	0.35	0.0	0.41	0.22	0.0
	Water control		Solvent control		
Mortality%	0.00		0.00		
S.E (±)	0.00		0.00		

Table 2: Probit regression line parameters of response of *Anopheles arabiensis* larvae to different *neem* organic extracts.

Parameter	Leaves extract		Seeds extract	
	Ethanol	**Hexane**	**Ethanol**	**Hexane**
Intercept	0.7817	1.5278	4.7710	8.0276
Variance of slope	0.0360	0.0288	0.0533	0.1215
Slope	1.446	1.907	2.816	4.154
Chi-square	28.999	23.742	47.825	10.158
Probability	0.0483	0.1636	0.0001	0.9266
Degrees of freedom	18	18	18	18
Logarithm LC_{50}	3.9181	3.6090	3.4694	3.3005
Variance of logarithm LC_{50}	0.0059	0.0001	0.0008	0.0008
LC_{50} ($mg\ell^{-1}$)	8282	4065	3380	1998

Table 3: Oviposition deterrency and adult mortality of *Anopheles arabiensis* resulting from different neem extracts.

Treatment	Mean No. of eggs	S.D	Oviposition activity index	Attractancy or deterrency	Adult mortality (%)
NLE 1%	29.67	4.16	-0.7308	Deterrency	00.00
5%	17.33	2.08	-0.8344	"	00.00
10%	15.00	0.00	-0.8551	"	02.00
NLH 1%	55.67	0.58	-0.4339	Deterrency	00.00
5%	08.33	3.51	-0.8884	"	00.00
10%	00.00	0.00	-1.0000	"	04.67
NSE 1%	48.00	1.00	-0.6000	Deterrency	00.00
5%	23.67	1.18	-0.7790	"	03.33
10%	13.67	2.08	-0.8671	"	07.33
NSH 1%	33.33	1.15	-0.6176	Deterrency	02.67
5%	33.33	0.58	-0.6176	"	15.33
10%	00.00	0.00	-1.0000	"	26.00

NLE= Neem Leaves Ethanol Extract
NLH= Neem Leaves Hexane Extract
NSE= Neem Seed Ethanol Extract
NSH= Neem Seed Hexane Extract
OAI= Oviposition Activity Index
S.D= Standard Deviation
S.E= Standard Error
WHO= World Health Organization
IPM= Integrated Pest Management
LC= Lethal Concentration

Nile Valley University Publications
Nile Journal for Agricultural Sciences (NJAS)
(ISSN: 1585 – 5507)
Volume 02, NO. 01, 2017
http://www.nilevalley.edu.sd

Research paper

Effect of Irrigation Frequency, Furrow Length and Farm Yard Manure on Salt-Affected Soil in Dongola Area

Amal M. Izzel Din[1] and Malik Nasr Malik[2]

[1] *Faculty of Agricultural Sciences, University of Dongola, Dongola, Sudan*
[2]*Faculty of Agriculture, University of Khartoum, Shambat, Sudan*

Corresponding Author: amalizz5@hotmail.com

ABSTRACT

A field experiment was carried out at Dongola University Farm, in Northern State to investigate the effect of irrigation frequency seven days, fourteen days and twenty one days, furrow length five meters (F5) and ten meters(F10) with and without addition of farm yard manure (M1 and M0) on salt leaching under saline-sodic aridisols. The quantity of water applied was estimated according to Jensen and Haise equation where the total water quantity was the same by the end of the experiment. The experiment was designed in a split – plot design, where irrigation frequency was assigned to the main plot and the furrow length (F) and FYM (M) were assigned to the sub-plots. In general, the results indicated that the irrigation frequency of 7 days enhanced salt leaching from the soil depth. Generally, the reduction in ECe due to irrigation frequency was as follows: I7 > I14 > I21. The data obtained indicated that the addition of FYM (M1) significantly decreased ECe and leached it below the soil depth, compared with the plots without FYM (M0). Generally, the salt leaching plots showed a leached zone underlied by a salinized zone. In general, irrigating every 7 days (frequent irrigation), adding FYM at the rate of 5 tons/fed with the furrow length of 5 meters, resulted in the lowest ECe.

Key Words: *Amendments, Ece, farm yard manure, furrow length, irrigation frequency, saline-sodic soil*

تأثير فترات الري، طول السراب وسماد المزرعة على الاراضي المتأثرة بالملوحة بمنطقة دنقلا

امال عز الدين [1] ومالك نصر مالك [2]

1 قسم المحاصيل، كلية العلوم الزراعية، جامعة دنقلا
2 قسم التربة، كلية الزراعة، جامعة الخرطوم

أجريت تجربة حقلية في مزرعة جامعة دنقلا بالولاية الشمالية لدراسة أثر ثلاث مناوبات ري (7، 14 و21 يوم) مع إضافة او بدون اضافة سماد المزرعة في أحواض مسربة بطولين مختلفين للسرابة مع إضافة كميات محسوبة من المياه تم تقديرها بواسطة معادلة جنسن وهيز، حيث كانت كمية المياه ثابتة لكل المعاملات في نهاية التجربة. تمت دراسة أثر كل هذه المعاملات على غسيل محلول تربة شديدة الملوحة. اجريت التجربة وفق تصميم القطع المنشقة حيث وضع مكون الري في القطع الرئيسة وطول السرابة وسماد المزرعة في القطع الفرعية بعدد 36 قطعة (حوض)، 18 منها للسرابات الطويلة و18 اخرى للسرابات القصيرة. أسفرت نتائج التجربة أن مناوبات الري قللت التوصيل الكهربائي لمحلول التربة على النحو التالي 7 يوم < 14 يوم < 21 يوم. حيث أكدت النتائج أن ري التربة كل 7 يوم كان أفضل وتبعه الري كل 14 يوم بينما كان الري كل 21 يوم الأسوأ في غسيل الأملاح. أوضحت النتائج بأن الري بصرف النظر عن المعاملات المختلفة قام بتخفيف التوصيل الكهربائي لمستخلص التربة حتى عمق 50 سم. اما إضافة سماد المزرعة فقد كانت ذات فعالية في غسيل الأملاح حيث وجد أن هنالك فرق معنوي بين الأحواض المعاملة بسماد المزرعة والأحواض التي لم يضاف إليها. كما أفادت نتائج البحث أن طول السرابة كان ذا أثر معنوي حيث أن طول السرابة (5 متر) أظهرت نتائج معنوية مقارنة بطول السرابة (10 متر) في غسيل الأملاح. مما سبق يمكن القول بأن الأثر المتداخل لمناوبة الري كل 7 يوم مع إضافة 5 طن/الفدان سماد المزرعة في أحواض مسربة بطول 5 متر هي الطريقة المثلي لتحقيق أفضل غسيل للأملاح.

Introduction

The accumulation of the excessive salts in the root zone often results in a partial or complete loss of soil productivity. This is a widespread phenomenon in the arid and semi-arid regions of Sudan (Nachtergeale, 1976).

There are three types of salt-affected soils, namely, saline soils, sodic soils and saline – sodic soils. The traditional classification of salt-affected soils has been based on the soluble salt concentration and on the exchangeable sodium percentage (ESP) of the soil (El- Morsy, *et al*., 1991). Saline soils are characterized by a high concentration of soluble salts (more than 4 dS/m) with a soil pH less than 8.5. These soils contain excessive amounts of soluble ions such as Na^+, Mg^{++}, Ca^{++}, $K^{+,}$ Cl^-, SO_4, CO_3 and HCO_3 (Bohn *et al*., 1985). On the other hand, sodic soils contain excessive amounts of exchangeable sodium with an ESP greater than 15% and pH > 8.5 (USDA, 2009). High values of ESP always adversely affects aggregate stability and hence, resulting in a low soil permeability.

Saline- sodic soils are those of ECe > 4 dS/m and ESP > 15% with a pH > 8.5 (Richards, 1954). Salt-affected soils are found in the Northern part of Sudan, in desert, semi-desert, arid and semi-arid climates. Large areas of Sudan soils are affected to some degree by salinity and/or sodicity.

The increase in both human and animal density encouraged horizontal expansion in agriculture; therefore, the use of these soils for growing crops becomes a necessity

Dongola area is severely affected by desertification and salinization processes. The more productive first terrace soil is intensively used (Izzeldeen, 2002), thus utilization of salt-affected soils has become an important aspect of agricultural development. The upper terrace soils are constrained by salinity and sodicity which restricts crop productivity due to a high osmotic pressure and specific ion effect. In this area, Huntings (1964) and Karouri (1967), cited that considerable variations in salt content and composition exist not only between different sites but also with depth in the same site.

Water resources in Sudan are limited because of the large expansion of the cropped area, particularly, in desert, semi desert, arid and semi-arid regions. However, the scarcity of rainfall led to an increased demand for irrigation water. The situation emphasizes the need for using scientifically sound method for scheduling irrigation water. Thus, the efficient utilization may be realized by the use of salt - tolerant crops, application of soil amendments, addition of fertilizers and proper water management.

Inorganic fertilizers are imported and hence they are very expensive. Thus, there is an increasing trend for the use of agricultural and animal wastes (organic amendments as sources of nutrients). Furthermore, soil organic amendments may improve the soil physical conditions and may thus offer possibility of increasing the efficiency of salt leaching.

Crops vary widely in their tolerance to salinity; salt tolerance of a given crop may vary according to its stage of growth. In general, salts may affect plant growth directly by increasing the osmotic pressure of the soil solution, by accumulation of a certain ion to a toxic level in plant tissues, and by causing nutritional imbalance.

Local barley (*Hordeum Vulgare*) is a potential crop in Dongola area. People use the barley as food and its powder as a medicine. Besides this, the crop is very tolerant to salinity and sodicity.

This research was undertaken to study the effect of irrigation interval, furrow length, and application of farm yard manure on salt leaching in Dongola area.

Materials and Methods

The study area climate

The study was conducted in Dongola area which is true desert with extremely high temperatures and radiation in summer, low temperature in winter, scarce rainfall, and high wind speed. The diurnal range of temperature is wide all the year. The mean maximum and minimum temperatures are 36.8 and 19.5ºC, respectively. Temperatures as high as 49ºC are not uncommon in the period extending from April to June. In winter, temperatures as low as 1.0ºC have been recorded. The climate is hyper arid with a vapor pressure of only 10.8mb and a relative humidity of less than 20% with a mean bright sunshine duration of 10.5 hours (at 87% of the possible hours). Clouds are generally rare. Solar radiation is as high as 25.88 MJ/m^2/day in May. Rainfall is scarce with a mean annual of 12.3mm. Wind prevails from the North at a mean speed of 15.7km/hr (Izzel Deen, 2002).

Physiography

Dongola area, consists of a basement complex of precambrian metamorphic rocks overlain by the Nubian sandstone which is known for it's abundant ground water (Izzel Deen, 1983) observed out crops of basement complex just North of Kerma town. Alluvial deposits dominate the flood plains along the Nile banks. Away from this bank, sand dunes rest upon smooth ground sloping gently towards the Nile. The land is flat due to wind erosion and the nature of the underlying rocks (Andrew, 1947). The geomorphology of the area is characterized by sand and wind hammocks. In general, in Dongola, the soil area is divided into two main groups; soils of the recent flood plain and soils of the high terrace (Karouri, 1978).

Soil of the study area

A profile was dug in the experimental area and described according to the standard soil survey procedures. The physical and chemical properties of this profile are reported in Table (1).

Profile Description

- Parent material: Nile alluvial deposits.
- Drainage: well drained.
- Soil moisture condition: dry.
- Depth of ground water table: 8 meters.
- Presence of erosion: wind erosion.
- Presence of surface stones: (Nil.)
- Presence of salt or alkali: common $CaCO_3$ white concretions.
- Human influence: virgin land, dark with wheat fields nearby.

0-10cm: Brown to dark brown (10 YR 4/3) moist and dry, loam to sandy loam, slightly sickly and slightly plastic fine granular structure, friable moist; soft dry; few fine tubular pores; calcareous matrix; abrupt smooth boundary; pH 8.2.

10-40cm: Brown to dark brown (10 YR 4/3) moist and dry, sandy clay loam, moderate to medium and fine sub-angular blocky; sticky and plastic wet; friable moist; hard dry; few fine tubular pores; common $CaCo_3$ calcareous; smooth boundary; pH 7.7.

40-60cm: Grayish brown (10 YR 4/3) moist and dry; sandy clay loam; moderate; fine sub-angular blocky; sticky; plastic wet; firm moist; hard dry; few fine pores; sand grains; gray $CaCO_3$ nodules; gradual smooth boundary; pH 7.8.

60-75cm: Grayish brown (10 YR 5/2) moist; loam, weak, coarse, medium and fine sub-angular blocky; slightly sticky; plastic; firm moist; hard dry; few tubular pores; many $CaCO_3$ nodules; very strong calcareous with smooth boundary; pH 9.5.

75-120cm: Light yellowish brown (10 YR 6/4) dry; dark brown to brown (10 YR 4/5) moist; friable; sandy loam; massive; slightly sticky, slightly plastic; wet friable moist; hard dry; few $CaCO_3$ white concretions; slightly calcareous; pH 7.3.

140-170cm: Yellow (10 YR 7/6) dry; yellowish brown (10 YR 5/6) moist; sand; single grain; non sticky and non plastic; loose moist; loose dry; non calcareous; pH 7.4.

Layout of the experiment

A field experiment was carried out, in Dongola University Farm at Elselaim, on the eastern bank of the Nile. The experiment was undertaken to investigate the effect of irrigation frequency (I), furrow length (F) and filed yard manure, FYM (M) on ECe. The treatments consisted of three irrigation intervals; 7, 14 and 21 days, two furrow lengths, 5 m- long (F_5) and 10 m- long (F_{10}) with and without addition of FYM ($M_1$and M_0, respectively). The experiment was arranged in a spilt-plot design, where irrigation interval (frequency) was assigned to main plots (10x15m), each experiment was divided into four subplots. Thus, it was consisted of nine main plots and 36 subplots. The main plot (10×15m) was separated by 2m-wide path. The whole area was ploughed to 30 cm depth. Each main plot (10×15m) was consisted of two short furrow (F_5) plots (5×5m) and two long furrow plots (5x10m). The test crop was local barley (*Hordeum Vulgare*).

Land Preparation

Experimental area was ploughed to the depth of 30 cm, then the span leveler was used for leveling the area, then a tool bar was used for ridging to give a standard ridge spacing of 80 cm for the furrow.

Soil Sampling

Two sets of soil samples were taken from each plot, one before sowing and a second set at harvest. Soil samples of approximately 2kg were collected from depths of 0- 20, 20- 40, 40- 60, 60- 80 and 80- 100 cm soil depths. Total number of samples collected was 720 soil samples. The samples were air-dried, crushed and passed through 2-mm sieve and kept in labeled bags for physical and chemical analysis.

Table 1. The physical and chemical properties of a typical soil profile from the experimental site

Depth (cm)	ECedS/m	pH	Soluble cations (meq/l)				Soluble anions						S.P %	Particle size distribution %				ESP %	CEC Meq/100g soil	$CaCO_3$	B.D g/cm^3	SAR
							%		(meq/l)													
			Ca^{++}	Mg^{+}	Na^{+}	K^{+}	N%	P%	CO_3^{-}	HCO_3^{-}	Cl^{-}	SO_4^{-}		Clay	Silt	Sand	Fine sand					
0-10	23.9	8.5	20	5.3	212	1.15	0.08	0.0018	-	19.2	45	173.3	40.5	19.0	10.1	37.2	33.7	58.8	19.0	8.42	1.54	59.55
10-40	26.8	7.7	28	7.8	231	1.17	0.014	0.0015	-	10.9	190	66.0	39.8	21.9	13.9	22	42.2	54.1	24.0	7.20	1.51	54.61
40-60	27.3	7.8	19.2	7.9	245	1.16	0.002	0.012	-	12.5	130	129.8	52.9	29.5	21.5	16.1	32.9	66.0	30.0	8.51	1.76	66.58
60-75	30.2	9.5	16.5	6.0	269	1.01	0.002	0.028	-	11.8	80	199.8	45.9	25.2	29.9	5.0	39.9	78.5	24.0	8.32	1.77	80.30
75-120	20.8	7.5	9.4	6.1	192	0.18	0.005	0.007	-	18.4	91	98.3	48.4	23.1	25.2	4.2	47.0	67.8	26.0	6.21	1.54	69.06
120-140	21.9	7.3	7.2	5.3	205	1.06	0.009	0.019	-	16.5	110	91.2	42.3	20.5	15.5	4.0	60.0	80.1	28.0	4.29	1.54	82.0
140-170	8.2	7.4	3.4	4.8	70.9	1.09	0.002	0.007	-	10.4	35	33.7	32.0	-	-	29.1	70.9	35.6	3.4	1.90	1.50	35.10

For each soil depth, clots each of approximately 5 cm in diameter were taken from the same soil depths for bulk density determination.

Irrigation treatments

A predetermined quantity of water (Qi) was delivered to the sub plots using the 5-cm throat width Parshall flume in the experiment. The water quantity was estimated by the following relationship:

$$\mathrm{Qi(mm)} = \frac{\mathrm{K_c ET_p \times F \times 100}}{\mathrm{E_i}}$$

Where:

K_c: crop coefficient

ET_p: potential evapotranspiration (mm/day)

F: irrigation frequency

Ei: irrigation application efficiency assumed as 70%

ET_p was estimated by the following Jensen and Haise (1963) equation;

$$\mathrm{ET_p = C_T(T - T_x)R_s \text{ (ETp has the same units as } R_s)}$$

$$\mathrm{C_T} = \frac{1}{\mathrm{C_1 + 7.6 \times C_H}}$$

$$\mathrm{C_H} = \frac{\mathrm{50mb}}{\mathrm{C_2 - C_1}}$$

$$T_x = -2.5 - 0.14(e_2 - e_1) - \frac{E}{550}$$

Where:

T = mean air temperature, ºC.

R_s = short wave incoming solar radiation

e_2 is the saturation vapor pressure of water in mb at the mean monthly maximum air temperature of the warmest month in the year (long term climatic data), and e_1, is the saturation of vapor pressure of water in mb at the mean monthly minimum air temperature of the warmest month in the year.

$$\mathrm{C_1} = 38 - \frac{\mathrm{2E}}{305}$$

Where:

E= the site elevation in m.

Soil analysis

All determinations were carried out according to the standard method outlined in USDA (2009). The following determinations were made for each sample at the laboratory of Agric. Research Station of Dongola: saturation percentage, moisture content, pH, electrical conductivity (ECe), soluble cations, (Ca and Mg), Na by flame photometer, sodium adsorption ratio (SAR), exchange sodium percentage (ESP) and mechanical analysis. Soil bulk density was determined using the clod method (Black, 1962).

Results and discussion

The effect of irrigation frequency on ECe

Table (2) shows the effect of irrigation frequency (I) on the initial ECe for the experiment at depth 0 – 20cm. The irrigation frequency reduced the initial ECe by 73.2, 68.5 and 52.0% for irrigation frequency at 7 days, 14 days and 21 days, respectively. The statistical analysis of the data showed that there was no significant difference between I_7 and I_{14}, but showed a significant difference (P=0.05) between I_7 and I_{21} and I_{14} and I_{21}.

Effect of irrigation frequency on the initial ECe for at the depth 20-40cm presented in Table (3). The effect of the irrigation frequency on ECe at this depth has the same trend as top soil (0 – 20cm). The reduction in the initial ECe is as follows: $I_7 > I_{14} > I_{21}$, respectively. The reduction in the initial ECe was 61.1, 53.0 and 20.7% when irrigated every 7, 14 and 21 days, respectively. In general, salt leaching was increased with decreasing irrigation frequency. This may be attributed to the fact that the frequent irrigation reduced the soil matric suction and alleviate both osmotic and water potential (Hillel, 1982). These results are in agreement with the findings of Wagenet *et al.* (1980), Abdel Rahim (1985), Ali (1987), Ahmed (1995) and Fardad and Shirdeli (1996).

Table 2: Mean electrical conductivity (dS/m) as affected by irrigation frequency, furrow length and FYM at 0- 20 cm soil depth at the end of the experiment

Irrigation frequency (days)	Initial ECe (dS/m)	Treatment				Mean
		F_5		F_{10}		
		M_0	M_1	M_0	M_1	
I_7	51.52	13.00	11.00	15.21	16.00	13.80[b]
I_{14}	51.52	15.00	13.90	18.91	17.20	16.25[b]
I_{21}	51.52	25.00	20.87	27.00	26.00	24.72[a]
FYM (mean)	51.52	17.77	15.25	20.37	19.73	
Furrow mean	51.52	16.38[b]		20.05[a]		
CV	16.95					

I_7, I_{14} and I_{21} denote irrigation frequency at 7, 14 and 21 days, respectively.
F_5 and F_{10} represent furrow length 5 and 10 meter long, respectively.
M_0 and M_1 represent 0 and 5 tone/feddan - farm yard manure, respectively.
NS, S^*, S^{**} represent non significant, and significant at 0.05 and 0.01 level of probability, respectively.
Main irrigation frequency (I) effect $LSD_{0.05}$ = 2.66
Main furrow length (F) effect $LSD_{0.05}$ = 2.17
Main farm yard manure (M) effect $LSD_{0.05}$ = 2.17
Interaction (I × F) effect = NS
Interaction (I × M) effect = NS
Interaction (F × M) effect = NS
Interaction (I × F × M) effect = NS

Table 3: Mean electrical conductivity (dS/m) as affected by irrigation frequency, furrow length and FYM at 20-40cm soil depth at the end of the experiment

Irrigation frequency (days)	Initial ECe (dS/m)	Treatment				Mean
		F_5		F_{10}		
		M_0	M_1	M_0	M_1	
I_7	34.25	17.10	14.21	18.90	19.70	17.48[b]
I_{14}	34.25	18.20	16.40	19.70	19.70	18.50[b]
I_{21}	34.25	27.00	22.00	27.33	27.67	26.00[a]
FYM (mean)	34.25	20.76	17.53	21.97	22.35	
Furrow mean	34.25	19.15[b]		22.17[a]		
CV	9.22					

Abbreviations as explained in Table (2)
Main irrigation frequency (I) effect $LSD_{0.05}$ = 1.61
Main furrow length(F) effect $LSD_{0.05}$ = 1.32
Main farm yard manure (M) effect $LSD_{0.05}$ = 1.32
Interaction (I × F) effect = NS
Interaction (I × M) effect = NS
Interaction (F × M) effect = S^{**}
Interaction (I × F × M) effect = NS

Table (4) showed the effect of irrigation frequency (I) on ECe at (40 – 60cm) depth. It is evident that the effect of I on this layer was not as marked as that on the top layers. This may be due to the slow water movement in these layers due to increase in ESP and the bulk density with depth, hence the ECe increased by 27.8, 28 and 34.2% when irrigated every 7, 14 and 21 days, respectively. However, there was no significant difference among the three irrigation frequencies in this layer.

Table 4: Mean electrical conductivity (dS/m) as affected by irrigation frequency, furrow length and FYM at 40-60cm soil depth at the end of the experiment

Irrigation frequency (days)	Initial ECe (dS/m)	Treatment				Mean
		F_5		F_{10}		
		M_0	M_1	M_0	M_1	
I_7	21.76	20.91	20.41	39.20	30.67	27.80[a]
I_{14}	21.76	20.00	20.00	40.50	30.90	27.85[a]
I_{21}	21.76	17.33	17.89	39.70	41.90	29.21[a]
FYM (mean)	21.76	19.41	19.43	39.8	34.49	
Furrow mean	21.76	19.42[b]		37.15[a]		
CV	10.77					

Abbreviations as explained in Table (2)
Main irrigation frequency (I) effect $LSD_{0.05}$ = 2.58
Main furrow length (F) effect $LSD_{0.05}$ = 2.11
Main farm yard manure (M) effect $LSD_{0.05}$ = 2.11
Interaction (I × F) effect = S^{**}
Interaction (I × M) effect = S^{*}
Interaction (F × M) effect = NS
Interaction (I × F × M) effect = NS

Table (6) presents the effect of irrigation frequency on (80–100cm) depth for the experiment. In this layer, the initial ECe increased by 174.7, 198.3 and 148.1% for I_7, I_{14} and I_{21}, respectively.

The ECe distribution can be divided into two zones, leached zone from top to 50cm depth and accumulation zone, from 50cm up to 100cm depth and the efficiency of leaching decreased with the increasing of soil depth. This may be due to decrease in water movement with the soil depth due to increase in clay content and the bulk density with increase in soil depth (Table 1).

The effect of furrow length (F) on ECe

The effect of furrow length on ECe for 0 - 20cm and 20 - 40cm depth for the experiment, is shown in Tables (2) and (3). The effect of furrow length on ECe is statistically significant (P=0.05). The ECe values at the (0-20cm) depth were decreased by 68.2 and 61.2% at furrow length five meters (F_5) and furrow length ten meters (F_{10}), respectively.

For (20–40cm) depth, ECe values were decreased by 44 and 32.3% for F_5 and F_{10}, respectively.

Tables (4,5 and 6) show the effect of furrow length on the ECe for (40-60cm), (60–80) and (80–100) soil depth for the experiment. The effect of furrow length on ECe is statistically significant (P=0.05) for all. The ECe values were decreased by 10.9% at F_5 and increased by 70.7% at F_{10}.

For (60 – 80cm) depth, the initial ECe was increased by 259.5% at F_5 and 128.8% at F_{10}.

The initial ECe increased in the 80–100cm depth by 146.3% for F_5 and by 201% for F_{10} for the experiment. Generally, the reduction in ECe was in the following order: $F_5 > F_{10}$.

It is clear that the furrow length (F_5) was more effective in salt leaching than the furrow length (F_{10}). This is may be due to the fact that short furrow conserves more water and minimizes unnecessary deep drainage (Izzel Din, 1995). Long furrow results in deep percolation losses and erosion in the upper ends of furrows (Schwab *et al.*, 1966). These results were in agreement with the findings of Mohamed (2002).

The effect of FYM (M) on ECe

Tables (2) and (3) show the effect of FYM on the initial ECe for (0–20cm) depth and (20– 40cm) depth for the experiment. Addition of FYM, significantly (P = 0.05) affected salt leaching and reduced ECe by 63.1 and 66% for plots without FYM (M_0) and plots received 5 ton/ fed. FYM (M_1), respectively.

Tables (4, 5 and 6) show the effect of addition of FYM on ECe at the (40–60cm), (60–80cm) and (80–100cm) soil depth. The initial ECe was affected by the application of M_1 where it was increased by 36 and 24% for M_0 and M_1, respectively. Further, the data showed that the (60–80cm) and (80–100cm) soil depth followed the same trend as in depth (40–60cm) and the initial ECe increased by 51.1 and 52.1% for M_0 and M_1, respectively. The initial ECe of (80 – 100cm) depth was increased in the experiment by 26.9 and 37.5% for M_0 and M_1, respectively.

In general, as the results showed, application of FYM, significantly (P = 0.05) affected salt leaching and ECe distribution in the soil profile which showed a top leached zone and a salt accumulation zone.

It is clear that the plots received FYM (M_1) resulted in the best salt leaching than those without FYM (M_0). These results were in agreement with the findings of Poonia and Bhumbla (1974); Meek *et al.* (1979); Parsad and Singh (1980) and Izzel Deen (1995). This may be due to the fact that FYM improved the physical and chemical conditions of soil, protect soil water from evaporation and enhanced the stability of the soil aggregates (Mustafa and Abdel Magid, 1981).

The combined effect of furrow length (F) and FYM (M) on ECe

Table (2) shows the combined effect of furrow length ten meters (F_{10}) and five meters (F_5) with the addition of 5 ton/ fed of FYM to each furrow length (F_5M_1 and $F_{10}M_1$) and without the addition of FYM (F_5M_0 and $F_{10}M_0$), at 0 – 20cm depth for the experiment on the initial ECe. The combined effect of F_5M_1 and $F_{10}M_1$, reduced the initial ECe by 70.4 and 61.7%, respectively.

In general, the combined effect of FYM and furrow length reduced the initial ECe in the following order: F5M1 > F5M0 > F10M1 > F10M0.

Table (3) presents the combined effect of furrow length and addition of FYM on ECe at 20 – 40cm depth for the experiment. It is clear that in this depth, the combined effect of (F) and (M), reduced the initial ECe by 48.8 and 34.7% for F5M1 and F10M1, respectively, for the experiment.

Table (5) presents the effect of irrigation frequency on initial ECe at 60 – 80cm depth. In this depth, salt leaching followed the same trend as in 40 – 60cm depth and the ECe values increased by 191.6, 204 and 185.3% when irrigated every 7, 14 and 21 days, respectively, for the first experiment. However, there was no significant difference among the three irrigation frequencies.

Table (6) presents the effect of irrigation frequency on (80-100) soil depth for the experiment, in this layer, the initial ECe increased by 174, 7,198.3 and 148.8% for I7, I14 and I21, respectively.

Table (4) shows the effect of combined treatments, F_5M_1 and $F_{10}M_1$ at depth (40 – 60cm). The data showed that F_5M_1 reduced the initial ECe by 10.7%, whereas $F_{10}M_1$ increased ECe by 58.5% for the experiment.

Tables (5) and (6) show the combined effect of furrow length (F) and FYM (M) on ECe of (60 – 80cm) and (80 – 100cm) depth for the experiment. The combined effect of F_5M_1 and $F_{10}M_1$ both increased ECe by 223.2 and 170.1%, respectively, for (60 – 80cm) depth by the end of the experiment. At (80 – 100cm) depth for the experiment, the combined effect of furrow length and FYM increased ECe by 185.1 and 252% for F_5M_1 and $F_{10}M_1$, respectively. In general ECe increased in this depth in the following order: $F_{10}M_1 > F_5M_1 > F_{10}M_0 > F_5M_0$.

Table 5: Mean electrical conductivity (dS/m) as affected by irrigation frequency, furrow length and FYM at 60-80cm soil depth at the end of the experiment

Irrigation frequency (days)	Initial ECe (dS/m)	Treatment				Mean
		F_5		F_{10}		
		M_0	M_1	M_0	M_1	
I_7	17.56	70.83	39.50	43.90	50.60	51.21[a]
I_{14}	17.56	71.50	65.49	25.90	51.27	53.54[a]
I_{21}	17.56	66.07	65.30	28.60	40.40	50.09[a]
FYM (mean)	17.56	69.46	56.76	32.80	47.42	
Furrow mean	17.56	63.12[a]		40.17[b]		
CV	7.75					

Abbreviations as explained in Table (2)
Main irrigation frequency (I) effect $LSD_{0.05}$ = 3.38
Main furrow length (F) effect $LSD_{0.05}$ = 2.76
Main farm yard manure (M) effect $LSD_{0.05}$ = 2.76
Interaction (I × F) effect = S^{**}
Interaction (I × M) effect = S^{**}
Interaction (F × M) effect = S^{**}
Interaction (I × F × M) effect = S^{**}

Table 6: Mean electrical conductivity (dS/m) as affected by irrigation frequency, furrow length and FYM at 80-100cm soil depth (cm) at the end of the experiment

Irrigation frequency (days)	Initial ECe (dS/m)	Treatment				Mean
		F_5		F_{10}		
		M_0	M_1	M_0	M_1	
I_7	11.76	28.00	29.60	29.00	42.60	32.30[a]
I_{14}	11.76	25.00	40.50	31.90	42.90	35.08[a]
I_{21}	11.76	20.17	30.50	27.23	38.80	29.18[b]
FYM (mean)	11.76	24.39	33.53	29.37	41.43	
Furrow mean	11.76	28.96[b]		35.41[a]		
CV	10.61					

Abbreviations as explained in Table (2)
Main irrigation frequency (I) effect $LSD_{0.05}$ = 2.89
Main furrow length(F) effect $LSD_{0.05}$ = 2.36
Main farm yard manure (M) effect $LSD_{0.05}$ = 2.36
Interaction (I × F) effect = NS
Interaction (I × M) effect = NS
Interaction (F × M) effect = NS
Interaction (I × F × M) effect = S^{*}

Conclusions

In this study, the effect of irrigation frequency, furrow length and FYM was investigated. The results indicated that the short frequency irrigation (7 days), with the application of 5ton/fed FYM and the furrow length (F_5) were found to be good practices to enhance leaching of salts.

References

Abdel Rahim, H.A. (1985). The effect of irrigation regime and some soil amendments on salt redistribution and forage (*Sorghum bicolor*) grown on a saline–sodic clay soil. M.Sc. thesis. University of Khartoum.

Ahmed A.B. (1995). Impact of soil water management on salt leaching and forage Sorghum growth in Shambat soil. M.Sc. thesis. University of Khartoum.

Ahmed, S.H. (1987). Effect of two soil amendments on wheat yield grown on high terrace soil in Eddamer area. A. R. C. IFAD. Annual report. Medani Sudan.

Ali, F.M. (1987). Wheat research and production in Sudan. Agricultural research corporation, Wad Medani. Sudan Tech. Bull. No.57

Andrew, G. (1947). Memorandum on desert creep Sudan. Gov. Rep. Soil cons. Commi.

Ayers, R.S. and Westcot, D.W. (1976). Water quality for agriculture irrigation and drainage paper No. 29, FAO, Rome, Italy.

Bhatangar, V.K.; Kundus, S. and Vedprakash, S. (1992). Indian J. Agric. Sci. 62: 212.

Black, C.A. (1962). Methods of soil chemicals analysis part I and part II. Macmillan Publishing company Inc.

Bohn, H.L.; McNeal and O'connor, G.A. (1985). Soil chemistry, 2nd ed., John Wiley and Sons.

Dahab, M.H. (1984). The effect of irrigation quantity and frequency and some soil amendments on salt leaching in a saline-sodic clay soil. M.Sc. thesis, University of Khartoum. .

EL-Morsy, E.A; Malik. M, and Letey. (1991). Interactions between water quality and polymer treatment on infiltration rate and clay migration. Soil technology. 4: 221-231.

Fadul, E.M. (2003). The impact of irrigation and FYM on the productivity of wheat (*Tritichum aestivum*) on a salt – affected soil in Elseleim, M.Sc. thesis, University of Khartoum.

Fardad. H. and Shirdeli. A.C. (1996). Effect of irrigation frequency on barley growth and grain yield. Irrigation J. of Agric Sci. 26: 1, 23-31.

Hillel, D. (1982). Soil water: content and potential introduction to soil physics. Academic press: 57.

Huntings Technical Services (1964). Roseires soil survey. Report No. 5, Ministry of Agriculture, Sudan.

Izzel Deen, S.I.M. (1983). Land degradation in Kerma basin. M.Sc. thesis, University of Khartoum, Sudan.

Izzel Deen, S.I.M. (2002). Impact of irrigation method and plough depth on wheat productivity on a saline – sodic soil in Dongola, Sudan, Ph.D. Thesis, University of Khartoum.

Izzel Din, A.M. (1995). The impact of irrigation and organic amendment on salt leaching and soil water conservation of a saline-sodic clay soil and A sand. Shambat Lib. MSc. Thesis.

Jensen, M.E. and Haise, H.K. (1963). Estimating evaporanspiration from solar radiation. Proc Am .Soc. CN. Enger., J. 89: 5-41.

Karouri, M.O.H. (1967). Annual report of research division. Ministry of Agriculture, Sudan.

Karouri, M.O.H. (1978). The effect of soil salinity on the productivity of arid lands, with special reference to the Sudan. Proc. of Khartoum workshop on Arid lands management. 49 – 54

Meek, B.D.; Graham, L.E.; Donoven, J.J. and May Berry, K.S. (1979). Phosphorus availability in calcareous soil after a high adding rate of animal manure. Soil–Sci. Soc. Am. Proc. 43; 741-744.

Mohamed, M.S. (2002). Appraisal of the long furrow irrigation system in Kenana sugarcane plantation, M.Sc. Thesis, University of Khartoum.

Mustafa, M.A. and Abdelmagid, E.A. (1981). The effect of irrigation interval, urea–Na, gypsum on salt leaching redistribution in highly saline sodic montmorillonite clay soil under forage sorghum. Soil Sci. 132(4): 308.

Nachtergeale, F.O.F. (1976). Studies on saline sodic soils in Sudan. FAO/UNDP. Project for strengthening the soil survey administration. SUD/71/553. Technical Bulletin N. 24-May 1976. Wad Medani, Sudan.

Paliwal, K.V. (1977). Nutrient requirement of salt – atech soil –proceeding indo-Hungarian seminar “management of salt–affected soil S. S. R. I., Karnal, India.p. 202-218.

Parasad, B., and Singh, A.P. (1980). Changes in soil properties with long–term use of fertilizer, lime and farm yard manure. J. Indian: Soc. Soil Sci. 28: 465.

Poonia, S.R. and Bhumbla, D.R. (1974). Effect of FYM on the yield, chemical composition and calcium availability from gypsum and calcium and carbonate to barley in a saline alkali soil. J. Ind. Soc. Soil Sci. 22: 371.

Schwab, G.C.; R.K. Frevert, T.W.; Edminster, and K.K. Barnes (1966). Soil water conservation engineering. 2nd ed. John Willy and Sons. New York.

Sharma, H.L.; Singh, C.M. and Model, S.C. (1987). Use of organic fertilizers in rice wheat crop sequence. Indian J. Agric. Sci. 57 (3), 163-168.

USDA (2009). Soil survey filed and laboratory methods manual. USDA, USA, 405 pages.

Wagenet, R.J.; Eamplieu; W.F; Bamatrat, A.M.; and Turner, D.L. (1980). Salinity, irrigation frequency and fertilization effects on barley growth. Agron. J. 72: 969-974.

Nile Valley University Publications

Nile Journal for Agricultural Sciences (NJAS)

(ISSN: 1585 – 5507)

Volume 02, NO. 01, 2017

http://www.nilevalley.edu.sd

Research paper

The Correlation and Path Coefficient Analysis for Yield and Some Yield Components of Faba Bean (*Vicia faba* L.) Genotypes in Northern Sudan

Fatih E. A. Hamza[1] and Gamal E. Khalifa[2]

[1]*Merowe Research Station, Agricultural Research Corporation (ARC).*
[2]*Hudeiba Research Station, Agricultural Research Corporation (ARC), Wad Medani, Sudan.*

Corresponding author: gamalhrs@yahoo.com

ABSTRACT

The present study was carried out for two consecutive seasons; 2010/11 and 2011/12 at Merowe Research Farm to investigate the correlation coefficient and path coefficient with two released faba bean varieties; Basabeer and Hudeiba 93 as checks and ten advanced crosses. Field experiments were conducted in a randomized complete block design with three replications. Data were collected on number of days to 50% flowering, number of days to 90% maturity, plant height (cm), number of pods per plant, number of seeds per pod, hundred seed weight (g) and seed yield kg ha^{-1}. Statistical analysis was based on the combined data of the two seasons. Significant differences were observed among the tested genotypes for all traits. The genotypes: C.28\02, C.19\02, C.9\02 and C.98\02 produced significantly the highest seed yield and surpassed the first check (BB-7) by 16.5%, 15.1%, 9.6% and 8.0% and the second check (H.93) by 14.9%, 6.7%, 6.1% and 4.3%, respectively. Positive and highly significant relationships were observed for seed yield with hundred seed weight, number of seeds per pod and plant height. Direct and indirect effects of days to 50% flowering, number of days to 90% physiological maturity, plant height (cm), number of pods per plant, number of seeds per pod and hundred seed weight (g) upon seed yield were determined. Days to 90% physiological maturity, hundred seed weight, number of seeds per pod and plant height had the highest positive direct effects on seed yield (kg ha^{-1}). These traits could be used as selection criteria in faba bean breeding program.

Keywords: *Correlation, faba bean, path coefficient, seed yield, Sudan*

تحليل الارتباط ومعامل باث للإنتاجية وبعض مكوناتها لطرز من الفول المصري في شمال السودان

فتح العليم احمد حمزة[1] وجمال الخير خليفة[2]

[1] محطة ابحاث مروي [2] محطة بحوث الحديبة

اجريت هذه الدراسة لموسمين متتاليين 11/2010 و12/2011 في مزرعة محطه بحوث مروي للتحقق من معامل الارتباط ومعامل المسار لاثنين من الاصناف المجازة وهما بسابير وحديبة 93 بالإضافة الى عشرة سلالات متقدمة. التجارب رتبت في تصميم القطاعات العشوائية الكاملة بثلاثة مكررات. البيانات المأخوذة هي عدد ايام الازهار 50 %، عدد ايام النضج الفسيولوجي 90 %، طول النبات، عدد القرون في النبات، عدد الحبوب في القرن، وزن ال 100 حبه، الغلة الحبيه كجم/هكتار. التحليل الإحصائي تم بناءً على جمع البيانات للموسمين. اوضحت النتائج وجود فروق معنوية بين السلالات في كل الصفات المدروسة. متوسط الإنتاجية للموسمين اوضحت ان اربعة من التهجينات وهي C.28/02، C.19/02، C.9/02، C.98/02 اعطت اعلى انتاجية وتفوقت على الشاهد الاول بسابير بنسبة 16.5، 15.1، 9.6، 8 % على التوالي وعلى الشاهد الثاني حديبه 93 بنسبه 12.9، 6.2، 5.7، 4 % على التوالي. لوحظ ارتباط موجب ومعنوي بين الغلة الحبيه وكل من وزن المائة حبة، وعدد الحبوب في القرن، وطول النبات. تم تحديد التأثير المباشر وغير المباشر لعدد أيام الازهار، عدد ايام النضج الفسيولوجي، طول النبات، عدد القرون في النبات، عدد البذور في القرن، ووزن المائة حبة على انتاج الغلة الحبيه. تحليل معامل المسار اشار الى ان عدد ايام النضج الفسيولوجي، وزن المائة حبة، وعدد الحبوب في القرن، وطول النبات كان لها تأثير مباشر وعالي الإيجابية على الغلة الحبيه. هذه الصفات يمكن ان تستخدم كمعيار للانتخاب في برنامج تربيه الفول المصري.

Introduction

Faba bean (*Vicia faba* L.) is a diploid (2*n*= 12 chromosomes) crop which is one of the most important food legumes ranking fourth world wide after garden pea, chickpeas and lentil. It is cultivated in the temperate and subtropical regions of the world (Maxted and Bennett, 2001 and Torres *et al.,* 2006).

Faba bean is a grain legume and grown for its high protein content (25.4%) in the seed (Karadavut *et al.,* 2010). The green immature beans are boiled and eaten as vegetable. The mature seeds can be used for feeding livestock, swine, and equine and or poultry animals. The stock or haulms is used as animal feeding stuff. Faba bean also serves as a rotational crop which plays great role in controlling disease epidemics in areas where cereal mono-cropping is abundant (Yohannes, 2000).

In Sudan, faba bean is the most important pulse crop on basis of area cultivated and farm income. The boiled beans are considered as the main dish in breakfast and dinner meals for large population in the urban areas of Sudan (Ahmed, 1996). It is grown as a winter crop under irrigation mainly in the Northern and River Nile States in about 70% and 30% of the total cultivated area, respectively. Also it is grown to a limited extent in Khartoum State and Jabel Marra in Western Sudan due to the suitability of the environmental conditions (Salih and Salih, 1996). Lately, it was introduced to the larger irrigated schemes of Gezeira, Rahad and New Halfa.

Yield improvement is a major breeding objective of most crop improvement programs (Ghobary and Abdallah, 2010). Yield in faba bean, similar to the other crops, is a complex trait related to many morphological and physiological traits. Seed yield is a quantitative trait and affected by genotype and environmental factors. Using as selection criteria of characters, direct relationship with seed yield increases the success of selection in plant breeding (Karasu and Oz, 2010). Therefore, progress of breeding in such traits are primarily conditioned by the magnitude and nature of variation and interrelationships among them (Raffi and Nath, 2004).

Simple correlation analysis is not suitable to provide detailed and actual knowledge in the relation between dependent variable and predictor variables. Hence, the path analysis was also performed to determine the direct and indirect contribution of each character to seed yield (Chitra and Rajamani, 2010). For this reason Berhe *et al.* (1998); Ulukan *et al.* (2003) and Tadesse *et al.* (2011) determined the direct and indirect effects of various plant characters on yield and its components by using path analysis in faba bean. They indicated days to flowering, days to maturity, number of pod per plants, seeds per pod, thousand seed weight and plant height had high positive direct effect on seed yield. They also indicated the direct and indirect effects of plant height, pod length, first pod height, pod number per plant and grain number per pod upon biological yield. In the other study, path analyses showed that number of seeds per plant and 100-seed weight were the major direct contributors to seed yield per plant. As in previous studies, breeders can release new varieties with certain characters by using path coefficients.

The objective of the present study was to estimate the correlations and partition of the coefficient of correlation between seed yield with its primary components, into direct and indirect effects to determine the relative importance of each one in faba bean seed yield in Northern Sudan.

Materials and Methods

The data of this research experiment were collected from a study conducted over two consecutive years (2010/11and 2011/12) during the winter season, at Merowe Research Station Farm- Northern state, which is located at Latitude: 18° 27' 0" N, Longitude: 31° 49' 59" E, Elevation: 258 meter above the sea level.

Ten faba bean promising crosses were selected from advanced material (Table 2) provided from Hudeiba Research Station-River Nile State. The material was compared to the two released varieties; Basabeer (BB-7) and Hudeiba 93(H.93). The design used was a randomized complete block with three replications. Planting was done manually at a seed rate of 120 kg/ha. The plot consisted of 5 ridges, 5 m long spaced at rate of 0.6 m**.** Two seeds were placed in holes spaced at 20 cm on the two sides of the ridge. The sowing dates of the two seasons were usually within the third week of November. The experiment was irrigated every 10– 12 days throughout the growing season. The crop was harvested manually 16 weeks after sowing. Seed yield was assessed from a net area of 8.28 m^2. Data was recorded on phenological characters (days to 50% flowering [DFF] and days to 90% physiological maturity [DPM]). With regard to plant height (cm), ten plants were randomly selected from each replicate and their height was measured from the tip to the ground level. Yield components were recorded by harvesting a sample of five plants, and then numbers of pods per plant, number of seeds per pod were calculated. Total weight of the whole plant cut was used to determine the biological yield. The pods per plant harvested were then threshed and weighed to calculate the seed yield per plant. Further, 100 - seed weight was recorded from the weight of 100 - seeds of bulk seeds.

Separate analysis of variance for each season was performed for seed yield and its component before running the combined analysis. Means were separated using Duncan′s multiple range test (DMRT). The correlation and path coefficient analysis were worked out according to the methods described by Dewey and Lu (1959) and Falconer (1964). General analysis was done using a computer program of GenStat, 12th edition.

Results

Analysis of variance and genotypes mean performance

The results presented in Tables (1) and (2) show the combine analysis of variance, in which the genotypes under study were significantly different for all characters. In season 2010/11 the genotypes, C.4/02, C.8/02 and C. 28/02 were the latest as they required 97 days to mature. The rest of the tested material needed 93-95 days to reach maturity. Most of the tested genotypes gave significantly heavier seed weight than the two checks. The genotypes C.98/02 and C.28/02 gave the heaviest seed weight, 50.6 and 50.3 g, respectively.

In season 2011/12, the genotypes C.28/02 and C.9/02 produced higher seed yield than the two checks. The respective increases in seed yield of the two genotypes over the check BB-7 were 20.0% and 15.2%, respectively. Results summarized in table 2 indicated that the seed yields of the three genotypes C.98/8, C.14/02 and C.8/02, were significantly higher than those of the two checks, B B-7 and H.93.

On the average over the two seasons the four crosses: C.28\02, C.19\02, C.9\02 and C.98\02 produced better seed yield than the two checks and surpassed the first check (BB-7) by 16.5%, 15.1%, 9.6% and 8.0% and the second check (H.93) by 14.9%, 6.7%,6.1% and 4.3%, respectively.

Correlation coefficient analysis

The simple correlation coefficients determined at the end of the research between the characteristics investigated are presented in Table (3) for mean values of the two seasons. Highly significant positive correlation values were detected between seed yield and plant height (r= 0.469**), number of seeds per pod (r= 0.572**) and hundred seed weight (r= 0.573**). The strong association of these characters can be used during selection to improve the yield potential of the crop. Positive and significant correlation was observed between number of seeds per pod and plant height (r= 0.302). Positive correlation also was observed between 100- seed weight and plant height (r= 0.294) and between 100-seed weight and number of seeds per pod (r= 0.163). Similarly, positive and highly significant correlation was recorded between days to 90 % maturity and days to 50% flowering (r= 0.539**) but significantly correlated with number of pods per plant and plant height (r= 0.060). There is a negative and highly significant correlation between number of seeds per pod and number of pods per plant (r= -0.523**), 100-seed weight and days to 50 % flowering (r= -0.547**) and between seed yield and number of pods per plant (r= -0.522**). Number of pods per plant exhibited a negative correlation with days to 50 % flowering (r= -0.181) and days to 90 % maturity (r= -0.081). Also the hundred seed weight recorded a negative correlation with days to 50 % flowering (r= -0.236) and days to 90 % maturity (r= -0.182). Thus, correlation helps breeders to identify the characters that could be used as selection criteria in breeding program. These results suggested that improvement of grain yield in faba bean is linked with these traits and selection of these traits might have good impact on seed yield.

Path coefficient analysis

In order to determine the relationships between yield and the other examined traits, path correlation coefficients were calculated. The path coefficients were partitioned into direct and indirect effects by using grain yield as a dependent variable. Direct and indirect effects are given in Table (4). Days to maturity had the greatest direct effect on seed yield (p.c= 0.531). Also its indirect effect on seed yield was more positive through number of pods per plant but negative and low through days to flowering, plant height, number of seeds per pod and hundred seed weight. The second highest direct effect on seed yield was the hundred seed weight (p.c= 0.452). Number of seeds per pod was the third highest positive direct contributors to seed yield following days to maturity and hundred seed weight. The number of pods per plant had the highest negative indirect effect on seed yield via number of seeds per pod (p.c= -0.230). The indirect effects via hundred seed weight (p.c= -0.082), days to maturity (p.c= -0.010), plant height (p.c= 0.016) and days to flowering (p.c= 0.017) were negligible.

The results of correlation and path analysis indicated that number of pods per plant, hundred seed weight and plant height were the major yield contributing characters as they showed positive and significant association with seed yield and also had high positive effects. Thus these characters could be considered as the most important for selection in order to improve the seed yield in faba bean.

Discussion

The analysis of variance showed that the twelve faba bean genotypes had significant differences among genotypes, seasons and their interaction ($P \leq 0.01$) for most of the studied traits. These results confirmed the results of Hassan (2006) and Abdel-Rahman (2009), who reported considerable variation among faba bean cultivars tested.

The results of the correlation coefficients between traits and path analysis indicated that the 100-seed weight, number of seeds per pod and plant height exhibited positive and significant correlation with seed yield. Similar results were reported by Badolay *et al.,* (2009) who found that the seed yield exhibited positive and significant correlation with clusters per plant, pod length, plant height, branches per plant, pods per plant and hundred seed weight. These results were also in conformity with Alghamd (2007) who detected significant positive correlations between seed yield and each of number of seeds per pod, seed weight and biological yield.

Path coefficient analysis indicated that the traits containing, days to 90 % maturity, number of seeds per pod and hundred seed weight play major role in seed yield determination of faba bean. This result concur with Berhe *et al.* (1998) who indicated that number of seeds per plant and 100-seed weight were the major direct contributors to seed yield. These results also agree with those of Tadesse *et al.* (2011) and Ulukan *et al.* (2003) who found out number of pods per plant, seed per pod, thousand seed weight, pod length, and grain number per pod had high positive direct effect on seed yield per plot. Whereas seed yield had maximum negative direct effect on number of pods per plant (p.c= -0.233). These results are in agreement with those obtained by Peksen and Gulumser (2005) and Cokkizgin (2007).

Conclusion

Conclusively, attention should be paid to some of characters such as plant height, number of seeds per pod and hundred seed weight, for increasing of seed yield and these traits could be used as selection criteria in faba bean breeding programs. These findings indicate that selection for each or full of the above traits would be accompanied by high yielding ability under such conditions. These results suggest that the mentioned traits are the most important seed yield components in the development of high yielding varieties.

Results showed that the genotypes C.28/02, C.19/02 and C.9/02 possessed the high values of traits. It could be concluded that the high yielding genotypes, such as C.28/02, C.19/02 and C.9/02 could be used to improve faba bean and making possibilities of extending its production. Moreover, the traits that exhibited strong and positive association with yield could be used as selection criteria for improving faba bean.

Table 1: Some vegetative traits of 12 faba bean genotypes over two seasons

Genotype	Days to 50% flowering		Mean	Days to 90% maturity		Mean	Plant Height (cm)		Mean
	2010/11	2011/12		2010/11	2011/12		2010/11	2011/12	
C.98/02	38	35	37	95	94	94	85.3	94.5	89.9
C.98/8	36	35	36	93	97	95	82.1	100.5	91.3
C.1/02	38	37	37	94	94	94	75.3	96.7	86.0
C.4/02	39	37	38	97	93	95	72.7	90.1	81.4
C.8/02	39	37	38	97	95	96	76.7	92.0	84.4
C.9/02	38	34	36	93	94	94	82.8	91.4	87.1
C.14/02	38	37	38	94	96	95	80.7	97.2	88.9
C.15/02	38	37	37	94	94	94	84.9	97.8	91.3
C.19/02	39	37	38	94	96	95	84.3	102.7	93.5
C.28/02	38	37	38	96	96	96	80.5	98.4	89.5
BB7 (check)	39	37	38	94	93	94	82.6	97.1	89.8
H.93 (check)	38	34	36	94	93	94	80.6	92.0	86.3
S.E+(SXG)	0.4*			0.8**			3.9 n.s		
Mean	38	36	37	95	95	95	80.7	95.9	88.3
S.E+	1.5 **		0.3***	0.3 *		0.5*	1.4*		2.7n.s
C.V (%)	2.1			1.5			7.1		

***, ** Significant at 0.05 and 0.01 probability levels, respectively.**

Table 2: Average number of pods /plant, seed/pod, 100-seed weight (g) and seed yield (kgha-1) of 12 faba bean genotypes, over two seasons.

Genotype	pods/plant		Mean	seed/pod		Mean	100 – SW (g.)		Mean	Seed yield (kg ha-1)		Mean
	2010/11	2011/12		2010/11	2011/12		2010/11	2011/12		2010/11	2011/12	
C.98/02	9.1	21.9	15.5	2.5	1.9	2.2	50.6	50.3	50.5	3256	4357	3806
C.98/8	12.8	41.4	27.1	2.1	1.9	2.0	48.0	49.0	48.5	3331	3986	3658
C.1/02	13.7	32.9	23.3	2.1	2.2	2.1	48.2	48.0	48.1	2805	3894	3349
C.4/02	17.0	22.6	19.8	2.2	2.2	2.2	42.4	47.0	44.7	2856	4206	3531
C.8/02	11.9	27.3	19.6	2.2	1.8	2.0	42.6	43.0	42.8	2843	4068	3455
C.9/02	12.7	25.4	19.0	2.5	2.4	2.4	49.6	49.3	49.5	3241	4504	3872
C.14/02	15.1	34.1	24.6	2.1	1.8	1.9	46.6	46.7	46.6	3006	3955	3480
C.15/02	12.1	28.3	20.2	2.3	2.3	2.3	44.4	46.7	45.5	3482	3992	3737
C.19/02	12.1	24.8	18.4	2.7	2.4	2.6	43.9	49.0	46.5	3387	4402	3894
C.28/02	15.6	22.1	18.9	2.1	2.5	2.3	50.3	49.3	49.8	3616	4770	4193
BB-7 (check)	16.7	30.2	23.4	2.1	2.5	2.3	43.5	44.7	44.1	3180	3816	3498
H.93 (check)	14.9	27.7	21.3	2.3	2.5	2.4	46.6	49.3	48.0	3115	4185	3650
S.E+(SXG)												
Mean	13.6	28.2	20.9	2.3	2.2	2.2	46.4	47.7	47.0	3176	4178	3677
S.E+	9.2*			0.5*			4.8**			542**		
C.V(%)	25.2			13.7			6.3			8.9		

***, ** Significant at 0.05 and 0.01 probability level, respectively.**

Table 3: Correlation coefficient analysis among characteristics in investigated 12 faba bean genotypes, combined over two seasons.

Characters	Flowering	Maturity	Plant height	Pods/plant	Seeds/pod	100-seed wt
Maturity	0.539 **					
Plant height	-0.064	-0.117				
Pods/plant	-0.181	-0.018	0.060			
Seeds/pod	-0.092	-0.291	0.302*	-0.523**		
100-seed weight	-0.547**	-0.236	0.294	-0.182	0.163	
Seed yield	-0.071	0.218	0.469*	-0.522**	0.572**	0.573**

***, ** Significant at 0.05 and 0.01 probability levels, respectively.**

Table 4: Path coefficient analysis among characteristics in investigated 12 faba bean genotypes, combined over two seasons.

Characters	Direct Effect	Indirect effect						Correlation value with yield
		DF	DM	PH	NPP	NSP	HSW	
DF	-0.090		0.286	-0.017	0.042	-0.040	-0.247	-0.071
DM	0.531	-0.051		-0.032	0.004	-0.128	-0.107	0.218
PH	0.273	0.006	-0.062		-0.014	0.133	0.133	0.469*
NPP	-0.233	0.017	-0.010	0.016		-0.230	-0.082	-0.522
NSP	0.440	0.009	-0.155	0.082	0.122		0.074	0.572**
HSW	0.452	0.051	-0.125	0.080	0.042	0.072		0.573**

DF: Days to 50 % flowering, DM: Days to 90 % maturity, PH: Plant height (cm), NPP: Number of pods per plant, NSP: Number of seeds per pod, HSW: hundred seed weight (g).
***, ** Significant at 0.05 and 0.01 probability levels respectively.**
Residual effect = 0.11

References

Abdel-Rahman, M.S. (2009). Inheritance of some growth and yield characteristics in new breeding lines on faba bean (*Vicia faba L.*). Ph.D. Thesis, Faculty of Agriculture, Assiut University, Egypt.

Ahmed, A.M.T. (1996). Food legumes production situation. In: Production and improvement of cool season food legumes in the Sudan. Salih H. Salih, Osman A.A. Ageeb, Mohan C. Saxena and Mahmoud B. Salih (1996), Nile Valley Regional Program, ICARDA, Cairo, Egypt.

Alghamd, S.S. (2007). Genetic behavior of some selected Faba bean genotypes. African Crop Sci. Conf. Proc. 8: 709 - 714.

Badolay, A.; Hooda, J.S. and Malik, B.P.S. (2009). Correlation and path analysis in fababean (*Vicia faba* L.). J. Haryana Agron. 25: 94-95.

Berhe, A.; Bejiga, G. and Mekonnen, D. (1998). Associations of some characters with seed yield in local varieties of Faba bean. Afric. Crop Sci. J. 6: 197-204.

Chitra, R and, Rajamani, K. (2010). Character association and path analysis in glory lily (*Gloriosa superba L*.). Commun. Biom. Crop Sci. 5: 78–82.

Cokkizgin, A. (2007). Research on determination of botanical and agronomic properties of local genotypes of some lentils (*Lens culinaris Medik*.) selected from south and southeastern anatolian regions in Turkey. PhD. Thesis, Department of Field Crops Institute of Natural and Applied Sciences University of Cukurova, 127pp

Dewey, D.R and Lu, K.H. (1959). A correlation and path coefficient analysis of components of crested wheat grass seed production. Agronomy J., 51 (9): 515: 518.

Falconer, D.S. (1964). An introduction to quantitative genetics. 2nd edition. Oliver and Boyd Ltd., Edinburgh, : 312-324.

Ghobary, H.M.M and Abdallah, S.A.M. (2010). Correlation and path coefficient studies in common bean (*Phaseolus vulgaris* L.). J. Plant Prod. 9: 1233–1239.

Hassan, A. R. (2006). Performance of some faba bean (*Vicia faba* L.) genotypes under clay soil conditions in Assiut Governorate Ph.D. Thesis, Faculty of Agriculture, Assiut University, Egypt.

Karadavut, U.; Palta, C.; Kavurmaci, Z. and Bolek, Y. (2010). Some grain yield parameters of multi-environmental trials in faba bean (*Vicia faba*) genotypes. Inter. J. Agric. Biol. 12: 217–220.

Karasu. U. A. and Oz, M. (2010). A study on coefficient analysis and association between agronomical characters in dry bean (*Phaseolus vulgaris L*.). Bulgar. J. Agric. Sci. 16: 203-211.

Maxted, N., and Bennett, S. (2001). Plant genetic resources of legumes in the Mediterranean. Current plant science and biotechnology in agriculture. Kluwer Academic Press, Netherlands. p. 1-386.

Peksen, E. and Gulumser, A. (2005). Relationships between seed yield and yield components and path analysis in some common bean (*Phaseolus vulgaris L.*) Genotypes. J. of Fac. of Agric., OMU, 20(3): 82-87.

Raffi, S.A. and Nath, U.K. (2004). Variability, heritability, genetic advance and relationships of yield and yield contributing characters in dry bean (*Phaseolus vulgaris L.*). J. Biol. Sci. 4: 157-159.

Salih S.H. and Salih, F.A. (1996). Faba bean improvement. In: Production and improvement of cool season food legumes in the Sudan, Salih H.S., O.A.A. Ageeb, M.C. Saxena and M.B. Solh. Edt. Nile Valley Regional Program, ICARDA, Cairo, Egypt.

Tadesse T. M. Fikere; Legesse, T. and Parven, A. (2011). Correlation and path coefficient analysis of yield and its component in faba bean (*Vicia faba L.*) germplasm. Inter. J. Biodiv. Conserv. 3: 376-382.

Torres, A.M.; Rom, B.; Avila, C.M.; Satovic, Z.; Rubiales, D. and Sillero, J.C. (2006). Faba bean breeding for resistance against biotic stresses: Towards application of marker technology. Euphytica 147:67-80.

Ulukan, H.; Mustafa, G. and Siddik, K. (2003). A Path coefficient analysis of some yield and yield components in faba bean (*Vicia faba L.*) genotypes. Pak. J. Biol. Sci. 6: 1951-1955.

Yohannes, D. (2000). Faba bean (*Vicia faba L.*). Ethiopia Institute of Biodiversity Conservation and Research (IBCR). Addis Ababa, Ethiopia, : 23.

Nile Valley University Publications
Nile Journal for Agricultural Sciences (NJAS)
(ISSN: 1585 – 5507)
Volume 02, NO. 01, 2017
http://www.nilevalley.edu.sd

Research paper

Effect of Chicken Manure and Urea Fertilizer on Growth and Yield of Clitoria (*Clitoria ternatea*) under Two Types of Soils

Abdelnasir Awad Abdalla[1] and Awad Osman Abusuwar[2]

1 Depart of Seed Technology, Faculty of Agriculture, Nile Valley University, Dar mali, Sudan
2 Department of Arid Land Agriculture, Faculty of Meteorology, Environment and Arid Land Agriculture, King Abdal Aziz University, Saudi Arabia

Corresponding author: ***nasserawad816@gmail.com***

ABSTRACT

Two experiments were conducted for two consecutive seasons (2004/05 and (2005/06) at the Farms of Faculty of Agriculture, Nile Valley University, Dar mali, to investigate the effect of two levels of treated chicken manure, two levels of untreated chicken manure (2and 4 tons/feddan) and two levels of urea (0 and 50 kg/feddan) on growth and yield of clitoria *(Clitoria ternatea)* on the low and high terrace soils. The experiments were laid out in a split plot design with three replications. Chicken manure (treated and untreated) significantly increased plant cover, and leaf area of clitoria. The highest rate of chicken manure (4 tons/feddan) significantly increased fresh yield and dry yield. Untreated chicken manure increased fresh yield and dry yield by 76.7% and 12% respectively, compared to treated chicken manure. Nitrogen fertilizer significantly increased plant density and dry yield. With respect to locations, productivity of clitoria was higher in the low terrace soils.

Keywords: *Chicken manure, clitoria, high terrace soils, urea*

تأثير سماد مخلفات الدواجن واليوريا على النمو والإنتاجية لمحصول الكلايتوريا المزروعة في نوعين من الأراضي

عبد الناصر عوض عبد الله[1] وعوض عثمان أبو سوار[2]

[1]قسم تكنولوجيا البذور، كلية الزراعة - جامعة وادي النيل – السودان
[2]قسم الاراضي القاحلة – جامعة الملك عبد العزيز- المملكة العربية السعودية

أجريت تجربتين حقليتين خلال المواسم 5/2004 و6/2005 بمزرعة كلية الزراعة جامعة وادي النيل بدارمالي لدراسة تأثير المستويات المختلفة من سماد الدواجن المخمر وغير المخمر (2،4 طن/فدان) وسماد اليوريا (صفر،50كجم يوريا/فدان) على النمو والإنتاجية للكلايتوريا المزروعة في أراضي الجروف والتروس العليا. استخدم تصميم القطع المنشقة بثلاث مكررات. أدت إضافة سماد الدواجن المخمر وغير المخمر إلى زيادة معنوية في الغطاء النباتي والمساحة الورقية للكلايتوريا. وأعطى أعلى معدل لسماد الدواجن (4طن /فدان) زيادة معنوية للوزن الرطب والوزن الجاف. سماد الدواجن غير المخمر أدى إلى زيادة الوزن الرطب والوزن الجاف بنسبة 76.7% و12% على التوالي مقارنة بسماد الدواجن المخمر. إضافة السماد النيتروجيني أدت إلى زيادة معنوية في الكثافة النباتية والوزن الجاف. فيما يتعلق بالمواقع أظهرت الكلايتوريا المزروعة في الجروف أعلى إنتاجية مقارنة بالتروس العليا.

Introduction

In Sudan, clitoria is grown mainly under irrigation in area of about (105.000 feddans) mainly in Khartoum, Gezira, White Nile, and Blue Nile State. It is also grown under rainfed conditions in few pockets in former Southern Sudan (Abusuwar and Abdella, 2001). Burhan and Makki (1989) found that if clitoria is established by irrigation, the plant remain alive till the following rains. Expansion in the cultivated areas in Sudan and the extension to marginal lands away from fertile soil closer to the river banks has enhanced attempts to make use of these marginal lands by cultivating tolerant crops of low fertilizer and water demands or by reclamation of these soils by different available methods Eltilib *et al* (1993).

Organic agriculture is currently gaining increasing popularity as alternative strategy to chemical fertilization and receives more attention world-wide (Mahadi,1993). Manure supplies nutrients required by plants and improves the physical properties of the soil (Elhassan,1993). Chicken manure is one of the most promising sources of nitrogen and organic matter. Besides, it could be useful as soil amendment.

In the present work, response of clitoria to chicken manure and chemical nitrogen (urea) under the low and high terrace soils was studied.

Materials and methods

The study was carried out during the period 2004 to 2006 at the farms of the faculty of agriculture, Nile valley University in Darmali, River Nile state (latitude 17º 48ˉ N, longitude 34 º 00ˉ E and 346.5m above sea level). The soil of the low terraces is silt clay (clay 42.12, pH 7.6, organic carbon 26%, organic nitrogen 344 ppm and ESP 4.8. The high terrace soils are sandy clay loam, saline (sand 56.19 %, clay 26.26 %, silt 19. 37 %, pH 8.8, organic carbon 0.67 %, organic nitrogen 178 ppm and ESP 31.8).

The treatments consisted of two levels of treated and untreated chicken manure (2 and 4tons/feddan) and tow levels of urea (46 % nitrogen) 0 and 50 kg/feddan. The treatments were arranged in split plot design and replicated three times. For treated chicken manure a pit was made in the soil. Chicken manure was moistened with water, covered with plastic sheet and then a layer of soil was spread on top and left three weeks for fermentation. The treated and untreated chicken manure were applied before sowing, broadcasted manually on the bottom of the ridge, mixed with soil and distributed equally to the whole plot using a rake. Nitrogen fertilizer was drilled on one side of ridge in the form of urea after two weeks from planting. Sowing was done on the 15th of July at the rate of 10 kg/feddan, for the low and high terrace soils.

The growth parameters, which were measured during the course of the study included the plant density, leaf area, plant cover, fresh yield and dry yield. Plant density was determined by counting the number of plants in an area of $0.7m^2$ for each plot. Leaf area was determined each time at harvest. Five plants were randomly taken from each plot, leaves were punctured and oven direct at 80ºc for 48 hrs. Leaf area was calculated using the following formula (Watson and Watson, 1953):

$$\text{Leaf area} = \frac{\text{Wt. of leaf} \times \text{area of discs}}{\text{Wt. of leaf discs}}$$

Percent cover was estimated by a rectangular quadrat of $50 \times 50\ cm^2$.The quadrat was randomly thrown in each plot and plants within the area of the quadrat were estimated as a percent in relation to the area of quadrat. The cover estimation values were converted using the Arc-Sin transformation methods before analysis of the data. For fresh yield determination the whole plot was harvested and fresh weight was measured immediately in the field using a spring balance. Plants were harvested for forage determination when they obtained full canopy or at early flowering, whichever came first. Forage dry yield was determined each time at harvest by using a sample of o.7 m^2 from the middle of the plot, and oven dried at 70^2c for 48 hours until a constant weight was reached.

Results and discussion

The control treatment was significantly higher in plant density of clitoria in the first and second season of the low and high terrace soils respectively, while the effect of chicken manure resulted during the second season of the low terrace soils (Table 1). Phytotoxic substance from the manure might cause the damage of seeds in the first season of the low terrace and second season of the high terrace soils. Similar results were mentioned by Robertson and Morgan (1995). Moreover, the gradual release of nutrients from the manure in the second season of the high terrace soils might have benefited the crops.

As shown in Table (1), number of plants/m2 of clitoria were significantly higher in the low terrace soils compared to the high terrace soils. High concentration of salt in the high terrace soils might resulted in high osmotic pressure of the soil solution that lowered water imbibitions by seed coat and plant to inhibit the hydrolytic processes that yield energy necessary for emergence of the shoot and of the seedlings establishment. The result obtained is in line with that reported by Aceres *et al*. (1975).

Addition of nitrogen significantly increased plant cover of clitoria in the first season of the low terrace soils and in the second season of the high terrace soils (Table 2). Untreated chicken manure (UM1) significantly increased plant cover in the second season of the low terrace soils, while treated chicken manure (TM1) significantly increased it in the first season of the high terrace soils. Since increasing the supply of nitrogen almost always increase the shoot/root ratio and the root growth also increases, plant cover increase. This finding is in agreement with that of Abusuwar and Elzilal (2006) and Ellnhamm (1995). Plant cover was high in the low terrace soils compared to the high terrace soils. However, plant cover in the low terrace soils was higher in the first season than the second season and the opposite was true in the high terrace soils. This may be attributed to the favorable conditions such as soil fertility and higher ability of the soil for moisture retention. This result confirms the findings of Ashraf and Menilly (1987).

As shown in Table (3), the highest rate of untreated chicken manure (UM1) significantly increased leaf area of clitoria in both seasons of the low terrace soils and during the second season of the high terrace soils. This might be attributed to the improvement of the soil condition and the restoration of the soil fertility that result in vigorous growth and healthy plants. This result seems to be in agreement with the finding of Ibrahim (1996) and Abusuwar and Elzilal (2006).

Leaf area was higher in the low terrace soils compared to the high terrace soils due to the favorable growing conditions manifested by relatively good physical and chemical properties of low terrace soils. The highest rate of untreated chicken manure (UM1) significantly increased forage fresh yield of clitoria in the low and high terrace soils. Application of nitrogen fertilizer significantly increased fresh yield in the first season of the low terrace soils. Warm, moist conditions favorable for microbial decomposition of chicken manure in the second season to release nitrogen from manure might be the reason. This result is in line with that reported by Mohamed (1990) who found that nitrogen fertilizer increased the yield and growth attributes of grasses and legumes during the first season. Similar results for the effect of higher rate of chicken manure were reported by Abusuwar and Elzilal (2006), Ellnham (1995) and Hassan (2002).

Fresh yield of Clitoria was significantly higher in the low terrace soils compared to the high terrace soils. In the first season of the low terrace soils fresh yield was significantly higher than the second season, while the opposite in the high terrace soils (Table 4). This may be due to the favorable conditions such as moisture and soil fertility in the low terrace soils. This result is in line with those reported by Osman and Abu-Diek (1982).

Application of nitrogen fertilizer significantly increased dry yield of clitoria in the low terrace soils, while the higher rate of untreated chicken manure (UM1) significantly increased dry yield of clitoria in the high terrace soils (Table 5). This may be due to its higher nitrogen content, organic carbon, cation exchange improved soil structure and water relations. This result is in line with those reported by Mondini *et al.* (1993) and Hansen (1996). Dry yield of clitoria was higher in the low terrace soils compared to the high terrace soils. This may be due to the fertile soil and higher moisture content.

Table 1: Effect of chicken manure and urea fertilizer on plant density/m^2 of clitoria during 2004/2005 and 2005/2006 seasons.

Location	Low terrace soils			High terrace soils		
Season / Treatment	1st	2nd	Mean	1st	2nd	Mean
C_0	21.78^{a}	20.71^{b}	21.25^{a}	2.67^{cd}	26.62^{a}	14.65^{a}
N	19.50^{b}	21.24^{b}	20.37^{b}	5.07^{a}	22.04^{c}	13.56^{b}
UM_1	18.87^{bc}	23.76^{a}	21.32^{a}	3.53^{bc}	20.52^{d}	12.02^{cd}
UM_2	20.00^{b}	21.38^{b}	20.69ab	2.00^{d}	21.90^{c}	11.95^{d}
TM_1	19.04^{bc}	14.14^{d}	16.59^{c}	4.33^{ab}	21.09^{cd}	12.71^{c}
TM_2	17.50^{c}	15.62^{c}	16.56^{c}	4.53^{ab}	23.42^{b}	13.98^{ab}
Mean	19.45^{b}	19.48^{a}	19.49^{b}	3.69^{b}	22.60^{a}	13.15^{b}
LSD	1.61	0.82	1.04	0.84	1.02	1.67

Means followed by the same letter (s) in a given column are not significantly different. P=0.05

C_0 Control
N 40 kg of nitrogen
UM_1 2 tons untreated chicken manure
UM_2 4 tons untreated chicken manure
TM_1 2 tons treated chicken manure
TM_2 4 tons treated chicken manure

Table 2: Effect of chicken manure and urea fertilizer on plant cover of clitoria during 2004/2005 and 2005/2006 seasons

Location	Low terrace soils			High terrace soils		
Season / Treatment	1st	2nd	Mean	1st	2nd	Mean
C_0	73.73^{ab}	55.86^{d}	64.80^{d}	17.78^{cd}	31.02^{cd}	24.40^{d}
N	75.73^{a}	66.94^{ab}	71.34^{a}	21.32^{bc}	37.95^{a}	29.64^{a}
UM_1	66.71^{b}	69.94^{a}	68.33^{b}	18.48^{cd}	31.59^{d}	25.04^{cd}
UM_2	73.74^{ab}	61.01^{cd}	67.38^{bc}	17.42^{d}	36.00^{ab}	26.75^{bc}
TM_1	71.08^{ab}	66.91^{ab}	69.00^{b}	27.56^{a}	29.77^{cd}	28.67^{a}
TM_2	67.15^{b}	63.74^{bc}	65.45^{cd}	22.59^{b}	33.76^{bcd}	28.17^{ab}
Mean	71.37^{a}	64.07^{b}	67.72	20.86^{b}	33.35^{a}	27.11^{b}
LSD	7.33	5.19	2.32	3.72	4.09	

Means followed by the same letter (s) in a given column are not significantly different. P=0.05

C_0 Control
N 40 kg of nitrogen
UM_1 2 tons untreated chicken manure
UM_2 4 tons untreated chicken manure
TM_1 2 tons treated chicken manure
TM_2 4 tons treated chicken manure

Table 3: Effect of chicken manure and urea fertilizer on leaf area (cm^2) of clitoria during 2004/2005 and 2005/2006 seasons.

Location	Low terrace soils			High terrace soils		
Season / Treatment	1st	2nd	Mean	1st	2nd	Mean
C_0	29.15^{b}	23.28^{c}	26.22e	22.40^{bc}	18.57^{c}	20.49^{b}
N	30.07^{b}	24.14^{c}	27.11^{de}	28.66^{a}	19.97^{ab}	24.32^{a}
UM_1	30.24^{b}	27.25^{b}	28.75^{c}	18.84^{c}	19.96^{a}	19.40^{c}
UM_2	33.65^{a}	29.41^{a}	31.53^{a}	20.25^{c}	21.09^{a}	20.67^{b}
TM_1	32.52^{a}	27.43^{b}	29.96^{b}	26.52^{ab}	20.17^{a}	23.35^{a}
TM_2	27.87^{c}	27.14^{c}	27.51^{d}	18.49^{c}	18.43^{b}	18.46^{c}
Mean	30.58^{a}	26.44^{b}	28.51^{a}	22.53^{a}	19.70^{b}	21.12^{b}
LSD	1.16	1.62	1.69	1.91	1.08	2.28

Means followed by the same letter (s) in a given column are not significantly different. P=0.05

C_0 Control
N 40 kg of nitrogen
UM_1 2 tons untreated chicken manure
UM_2 4 tons untreated chicken manure
TM_1 2 tons treated chicken manure
TM_2 4 tons treated chicken manure

Table 4: Effect of chicken manure and urea fertilizer on fresh yield of clitoria (ton/fed) during 2004/2005 and 2005/2006 seasons

Location	Low terrace soils			High terrace soils		
Season / Treatment	1st	2nd	Mean	1st	2nd	Mean
C_0	8.58^{b}	5.13^{d}	6.86^{b}	0.07^{c}	2.02^{ab}	1.05^{c}
N	9.56^{a}	5.59^{b}	7.58^{a}	0.17^{b}	2.21^{a}	1.19^{b}
UM_1	6.96^{d}	5.91^{a}	6.44^{e}	0.18^{b}	1.53^{d}	0.86^{e}
UM_2	8.81^{ab}	5.68^{bc}	7.25^{a}	0.19^{b}	2.31^{a}	1.25^{a}
TM_1	8.30^{bc}	5.39^{cd}	6.85^{b}	0.34^{a}	1.50^{cd}	0.92^{d}
TM_2	7.40^{cd}	5.64^{ab}	6.52^{bc}	0.20^{b}	1.92^{bc}	1.06^{c}
Mean	8.27^{a}	5.56^{b}	6.92^{a}	0.19^{b}	1.92^{a}	1.06^{b}
LSD	0.31	0.14	0.37	0.01	0.10	0.04

Means followed by the same letter (s) in a given column are not significantly different. P=0.05

C_0 Control
N 40 kg of nitrogen
UM_1 2 tons untreated chicken manure
UM_2 4 tons untreated chicken manure
TM_1 2 tons treated chicken manure
TM_2 4 tons treated chicken manure

Table 5: Effect of chicken manure and urea fertilizer on dry yield of clitoria (ton/fed) during 2004/2005 and 2005/2006 seasons

Location	Low terrace soils			High terrace soils		
Season / Treatment	1st	2nd	Mean	1st	2nd	Mean
C_0	$2.^{bcd}$	1.45^{b}	$1.92b^{c}$	0.03^{c}	0.67^{ab}	0.35^{c}
N	2.70^{a}	1.59^{ab}	2.15^{a}	0.10^{a}	0.68^{ab}	0.39^{a}
UM_1	2.17^{c}	1.72^{a}	1.95^{b}	0.11^{ab}	0.49^{b}	0.30^{d}
UM_2	2.46^{b}	1.54^{ab}	2.00^{b}	0.08^{b}	0.72^{a}	0.40^{a}
TM_1	2.37^{bc}	1.54^{ab}	$1.96b^{c}$	0.12^{a}	0.48^{c}	0.30^{d}
TM_2	2.09^{d}	1.62^{c}	1.86^{c}	0.10^{a}	0.64^{ab}	0.37^{b}
Mean	2.36^{a}	1.58^{b}	1.86^{c}	0.09^{b}	0.61^{a}	0.35^{b}
LSD	0.23	0.06	1.97	0.01^{c}	0.02	0.01

Means followed by the same letter (s) in a given column are not significantly different. P=0.05

C_0 Control
N 40 kg of nitrogen
UM_1 2 tons untreated chicken manure
UM_2 4 tons untreated chicken manure
TM_1 2 tons treated chicken manure
TM_2 4 tons treated chicken manure

References

Abusuwar, A.O. and Abdalla, A.A. (2001). Effect of phosphorus fertilizer and type of seedbed on growth, dry yield and seed yield of clitoria (*Clitoria ternatea*). University of Khartoum J.of Agric.Sci.9 (1), 29 –45.

Abusuwar, A.O. and Elzilal, H.A. (2006). Effect of chicken manure on the performance of two forage sorghum cultivars in Khartoum State. University of khartoum J. of Agric. Sci. 14(2), 227 – 236.

Aceres, N.E.; Stalzy, L.H. and Mechuys, G.R. (1975). Effect of soil osmotic potential produced with two salt species on plant water potential, growth and grain yield of wheat. Plant and Soil. 42: 619 – 628.

Ashraf, M. and Menilly, T. (1987). Salinity effect on five cultivars of pearl millet (*Pennisetum americanum*). Plant and Soil. 103: 13 – 19.

Burhan, H.O. and Makki, Y.M. (1989). Agronomic and nutritional evaluation of some selected forage crops grown in Al- HASSA. Bulletin 23 – 24.

Elhassan, M.M. (1993). Effect of farmyard manure on soil fertility, mmicrobial activity and Wheat Grain yield. M.Sc. Thesis Faculty of Agriculture, University of Gezira, Wad Medani Sudan..

Ellnham, M.M. (1995). Yield and Quality of Forage Sorghum (*Sorghum bicolor*) Cultivar Abu Sabein as affected by Nitrogen, Poultry Manure and Cow Manure. M.Sc. Thesis, University of Gizera, Wad Medani, Sudan.

Eltilib, A.M.A.; Ali, A.M. and Abdalla, M.A. (1993). Effect of chicken manure and salinity on growth and leaf N, P and K contents of okra growth on two soil types. Journal of Agric. Sci. Vol.(2), 16 – 35.

Hansen, S. (1996). Effect of manure treatment and soil compaction on plant production of a dairy farm system converting to organic farming practice. Agriculture, Ecosystem and Environment (56) 173 – 186.

Hassan, H.A.E. (2002). Effect of Chicken manure and season on the performance and HCN content of two Forage Sorghum Cultivars. Ph.D. Thesis, Faculty of Agriculture, University of Khartoum Sudan.

Ibrahim, A.S. (1996). Growth and forage yield of pearl millet (*Pennisetum americanum L.*) as affected by irrigation frequency, seed rate and nitrogen in the United Arab Emirates. University of Khartoum J. of Agric. Sci. Vol. (4) No. 1.

Mahadi, A.A. (1993). Biofertilizer research in Sudan. Areview, University of Khartoum Journal of Agric. Sci. 1 (1): 137 – 153.

Mohamed, G.G. (1990). The effect of nitrogen and phosphorus fertilizers on growth and yield of some grasses and leguminous forages. Sudan Science Abstract Vol. (18).

Mondini, C.; Chiumenti, R.; Da Borso, F.; Leita, L. and De Nobili, M. (1996). Changes during processing in the organic matter of composted and air dried poultry manure, Bioresource Technology 55: 243 – 249.

Osman, A.E. and Abu-Diek, A.A. (1982). Effect of defoliation on yield and forage quality of some tropical grasses, legumes and their mixtures. J. Exp. Agric. 18: 157-166.

Robertson, F.A. and Morgan, W.C. (1995). Mineralization of C and N in organic materials as affected by duration of composting. Aust. J. Soil Res. 33: 511-514.

Watson, D.J. and Watson, M.A. (1953). Comparative physiological studies on growth of field crops. Ann. Appl. Biol. 40: 1-6.

Nile Valley University Publications
Nile Journal for Agricultural Sciences (NJAS)
(ISSN: 1585 – 5507)
Volume 02, NO. 01, 2017
http://www.nilevalley.edu.sd

Research paper

Development of Feeding Conveyor in Grain Stationery Thresher

Mohammed Ahmed Abd Elmowla[1], Mohamed Hassan Dahab[2] and Fatah El Rahman Ahmed EL Mahie[3]

[1] *Dept. of Agricultural Engineering, Faculty of Agriculture, Nile Valley University.*
[2] *Dept. of Agricultural Engineering, Faculty of Agriculture, University of Khartoum.*
[3] *Department of Mechanical Engineering, Faculty of Engineering and Technology, Nile Valley University.*

Corresponding author: elmowla@nilevalley-edu.sd

ABSTRACT

This study was conducted at the Faculty of Agriculture, Nile Valley University. It aims to develop the conventional grain thresher by the addition of a conveyor feeding belt to increase productivity and reduce operational costs. The improved thresher with conveyor feeding belt was compared with the conventional feeding. Both systems were evaluated in terms of labors requirement, costing and crops losses. For feeding, measurements were taken in all plots using three replications. Independent T- test with three replications was used for analysis of results. Results indicated that there is a significant difference between the threshing methods, for the required man-hrs./fed, labor-saving SDG/fed and crops losses between the two systems. The labour requirement was 2 man-hr./fed for the developed system compared to 6 man-hr./fed for the conventional one. The cost of labour for feeding was 32 SDG /fed compared to 75 SDG /fed with conventional system constituting 43 % of the harvesting operation cost. The total crop losses for traditional feeding was about 10% at feeding rate of 10 kg/min compared with 6% when using developed thresher with conveyor feeding at 10 kg/min feeding rate. The developed thresher with conveyor feeding is durable, easy to operate and with lower maintenance costs. All components of the machine were fabricated from local materials and total cost for the designed and developed conveyor feeding belt was only 1150 DSG.

Keywords: *Crops losses, designing, feeding conveyor*

تصميم وتطوير سير تغذية لدراسة المحاصيل الثابتة

محمد احمد عبد المولى[1]، محمد حسن دهب[2] و فتح الرحمن احمد الماحى[3]

[1] قسم الهندسة الزراعية، كلية الزراعة، جامعة وادي النيل
[2] قسم الهندسة الزراعية، كلية الزراعة، جامعة الخرطوم
[3] قسم الهندسة الميكانيكية، كلية الهندسة والتقنية، جامعة وادي النيل

أجريت هذه الدراسة في كلية الزراعة- جامعة وادي النيل. تهدف هذه الدراسة لتطوير آلة درس الحبوب الثابتة بإضافة سير تغذية لزيادة الانتاجية وتقليل تكاليف التشغيل. تم اجراء مقارنة بين اداء الدراسة باستخدام سير التغذية وبطريقة التغذية التقليدية، من حيث احتياج العمالة، التكاليف والفاقد في المحصول. أظهرت النتائج تأثيراً عالياً (P >0.01) لعملية التغذية بين آلة دراسة الحبوب المطوره (بالسير الناقل) ودراسة الحبوب التقليدية (يدوية التغذية) في احتياج العمال وتكلفتهم وزمن العملية وفاقد المحصول لعملية التغذية. ووجد اقل عدد للعمال (2 عامل) فقط بالنسبة لآلة الدرس المطورة بينما (6 عمال) في حالة آلة درس الحبوب التقليدية، وكانت اقل تكلفة لعملية تغذية الفدان/عامل للدرس المطورة (32 جنية سوداني) للفدان بينما تكلفة تغذية آلة الدرس التقليدية (75 جنية سوداني)، وكانت نسبة تكلفة العمال اقل بنحو 43 %. وجملة فاقد الحصاد لعملية التغذية لآلة الدرس التقليدية (يدوية التغذية) 10 % بمعدل تغذية 10كجم/دقيقة مقارنة بـ 6 % عند استخدام آلة الدرس المطورة (السير الناقل) لنفس معدل التغذية. معظم مكونات التعديل في آلة درس الحبوب من المواد المحلية بتكلفة حوالي 1150 جنية سوداني.

Introduction

Different models of stationary grain threshers have been imported to Sudan (G.A.S., 1996). They are simple in design, easily maintained, consume little power (35 - 40 hp) and have been designed with simple threshing, cleaning and bagging units.

However, there are claims of injuries associated with the stationary thresher. Rawal (1988) reported that the human factors associated with thresher injuries were 73 %. These included inattentiveness, wearing of loose garments, overwork and physical incapability. Mufti *et al*. (1989) reported that belt entanglement, electric shock and feeding crop without safety were main reasons attributed to thresher injuries, they also added that the mechanical failures responsible for injuries were 17%. Kumar *et al*. (2000) stated that threshing machine recorded 2 % of total agricultural injuries though they are used only for a few days in the whole year. Morad (1997) investigated threshing machine performance and concluded that threshing losses as well as threshing cost can be minimized when the feed rate of 1 ton/h, drum speed of 25 m/s, and moisture content of 20 % are considered for the used machine.

The main objectives of this study was to design and to test the performance of feeding conveyor belt for grain stationary thresher, and to compare Labouring requirement and cost of the conventional and developed systems.

Materials and Methods

Materials

The developed parts of the grain stationery thresher

This study conducted at the faculty of agriculture, Nile Valley University in Darmali, North of Atbara. Thresher developed by El-mowla *et al.* (2014) was employed in the stationary thresher Elshams with its technical specification shown in Table (1). All experiments were conducted using a stationery thresher before and after development. The elevation and plan of stationery thresher machine before and after development are shown in Figs. (1) and (2), respectively. Experiments were conducted using two crops: wheat and faba beans.

Methods

The developed feeding conveyor

A feeding device in the developed threshing machine was designed and assembled to increase machine efficiency and to reduce traumatic injuries during threshing process. The developed feeding device in the thresher machine consists of four main parts as shown in plates (1) and (2).

The frame

The frame consisted of inclined rectangular table of 245 × 197.5 cm. It was designed with these dimensions to help in handling the crops from the heap at an inclined surface of 35º to the feeding platform, which is at a height of 1.77 cm above the ground surface. This angle of elevation was determined through a micro-test by putting some faba bean and wheat crops on flat and smooth metal sheet, which was raised slowly from the horizontal position. The faba bean and wheat started to slide at an angle 37º. Therefore, a smaller angle 35º was chosen for calculation of the total length of the conveyor belt table by dividing the vertical height of the feeding platform 1.77 cm by sine 35º. Then an extra 39.88 cm were added to extend the length towards the threshing unit for a total length of 236 cm. The width of the thresher feeding plate frame was 120 cm. Therefore, the width of conveyor belt table was taken as 118 cm with 1 cm clearance at each side in order to have as great as possible conveyor belt area (Fig. 3).

Transmission system

The motion is transmitted from the threshing shaft connected to tractor P.T.O shaft, which provided with a fixed pulley of 20 cm diameter to transmit the motion through belt and pulleys to belt feeding shaft, which operate the belt for feeding the crop materials.

The belt drive and pulley

The distances between the centers of the driving shaft (threshing shaft 400 rpm) and the driven shaft (roller shaft 320 rpm) were 72.5 cm. The driven pulley was attached to the roller shaft. The driven pulley diameter was calculated by the equation applied by Hunt (1983):

$$\frac{\mathrm{PD_r}}{\mathrm{PD_n}} = \frac{\mathrm{rpm_n}}{\mathrm{rpm_r}} \dots\dots\dots\dots\dots.(1)$$

Where:

PD = pitch diameter, cm

RPM = shaft speed revolution per minute

r = drive sheave

n = driven sheave

$$\mathrm{PD_n} = \left(400 \times \frac{20}{320}\right) = 25\ cm$$

The belt length was calculated using the equation applied by Shigley and Mitchell (1983) and Helmy (1988):

$$\mathrm{L} = 2\mathrm{C} + 1.57(\mathrm{D} + \mathrm{d}) + \frac{\mathrm{D} - \mathrm{d}}{4\mathrm{C}} \dots\dots\dots\dots\dots..(2)$$

Where:

L = effective length of the belt.

C = distance between centers of pulleys.

D = effective outside diameter of the large pulley (sheave).

d = effective outside diameter of the small pulley (sheave).

$$L = 2 \times 72.5 + 1.57(10 + 12.5) + \frac{12.5 - 10}{4 \times 72.5} = 187.5\ cm$$

The nearest standard size of V-belts from Table (3); B187.5 V-belt was used for power transmission to the roller shaft when using the pulleys of 25 cm diameter.

The rollers, shafts and bearings

Two rollers 97.5 long and 10 cm diameter were installed to support the conveyor belt. The rollers were made of galvanized steel tubes welded to a steel shaft 2.5 cm diameter and 115 cm long. Each roller was supported by two pillow-block ball bearings. The front drive roller shaft was 115 × 9.7 cm, which was extended 8 cm to one side and 12.59 cm to the other side (the driven pulley side).

Selected conveyor belt dimensions

A flat belt with dimensions of 411.48 cm length, 80.01 cm width and 0.203 cm thickness was tatted between drive and driven shaft (equation 2):

$$L = 2 \times 197.5 + 1.57 \times 15 + \frac{2}{4 \times 197.5} = 405\ cm$$

Fenders

Two side fenders, made from sheet metal (197.5 × 20 cm), were attached to each side of the conveyor table to prevent the conveyed crop from falling to the sides (Fig. 4).

Supporting pipe

Supporting pipe consisted of two telescoping pipes. The inner pipe diameter was 3.4 cm and length 67.5 cm while the outer pipe diameter was 4.1 cm and length about 117 cm. The pipes were connected to the conveyor belt table through pin joints.

Operational performance

The man-hours per fed was determined using the following formula:

Man-hours/fed = (L × t) / A……... (4)

Where:

L = number of labours.

t = spent time (hours).

A = the area of collected crop (fed).

Time required during the feeding threshing operation was recorded using a stopwatch.

Crop losses

The total crop losses percentage (TCL) was calculated before and after developing the thresher using the following equation (Mishram and Desta 1990):

$$Tcl\ \% = (T_{fe} / T_{cr}) \times 100 \ldots\ldots..(5)$$

Where:

Tcl= total crop weight losses percentage (kg)

T_{cr}= total crop weight before feeding (kg)

T_{fe} = total crop weight after feeding (kg)

Machine developing cost

Cost of the developed system divided into:

1- Cost of linking the developed feeding device to thresher (iron angles, iron flanges, iron sheet, other tools).

2- Cost of power transmission parts (Table 4).

Results and discussion

Labour requirement and costing evaluation

The labour requirement was only 2 man-hr/fed for the developed thresher as compared to 6 man-hr/fed with the undeveloped machine, which was a labour saving of 43 %. The cost of harvest was 32 DSG/fed as compared to 75 SDG/fed with undeveloped machine (Figs. 5 and 6). However, statistical analysis showed significant differences between the two threshing operation methods in terms of labour requirement and harvesting cost.

Time of feeding

The obtained results indicated highly significant difference ($P< 0.01$) between the two threshing operation methods. As shown in Figure (6), conventional threshing operation resulted in higher man hrs/fed (0.08 hr) compared to the developed thresher (0.03 hr). However, the improved developed thresher with conveyor feeding resulted in highly significant savings of 2 man-hrs/fed compared to the undeveloped thresher with direct manual feeding. Therefore, the use of conveyor feeding belt reduced the required threshing time. El-Awad (2007) found that, such designed conveyor-feeding belt could be used in the thresher feeding of grains, so as to improve the threshing operation performance.

Crops losses measurement

Figure (7) illustrated that at a feeding rate of 10 kg/min, the maximum values of total crop losses percentage (10 %) was obtained when using direct manual feeding threshing, compared to the developed conveyor feeding threshing machine with 6 % crop losses. On the other hand, increasing feeding rate from 2.5 to 10 kg/min increased the total crops losses by 20 % and 30 % for the developed and undeveloped threshing machine, respectively.

Statistically the difference between the two threshers was highly significant. Results indicated that the developed machine decreased the percentage of grains losses compared to the undeveloped machine due to the uniform distribution of wheat plants along the developed feeding conveyor, which enable plants to enter the threshing chamber from the wheat spikes direction, thus uniform impact is resulting in low percentage of grains losses. Results also showed that, the unstrapped legumes loss increased by increasing feeding may be attributed to the increase in the thickness (bulking) of crops. However, these results are in agreement with Badawi (2002).

Conclusion

A feed conveyor thresher was successfully developed and evaluated for its performance. The overall performance of the developed feeding, conveyor thresher was satisfactory for threshing of faba bean and wheat crops. The development of mechanical threshers has clearly proved to be necessary in order to reduce the drudgery of threshing works to a great extent.

References:

Badawy, M.E. (2002). Modification and evaluation of paddy rice thresher to suit flax deseeding. Misr J. Ag. Eng., 19(4): 881– 900

El-Awad, Sh. A, A.E.S. and M.A.A. (2007). Improvement of the modified grain thresher for groundnut threshing. AMA, 38(3): 67-72

El-mowla, M.A.; Dahab, M.H. and Elmahie, F.A. (2014). Improvement and performance evaluation of stationary combine thresher. International Journal of Engineering and Scientific Research, Volume 2, Pp:41-51

G.A.S. (1996). General Administration of Statistics Annual report, Ministry of Agriculture and Forestry, Khartoum, Sudan.

Helmy, M.A. (1988). Threshing parameters affecting the performance of local and foreign wheat threshing machines. Misr. J. Ag. Eng., 5 (4): 329-343.

Hunt, D. (1983): Farm power and machinery management. 8th ed. Iowa State University Press, Ames, Iowa, USA, 364-368.

Kumar, A; Varghese, M. and Mohan, D. (2000). Equipment related injuries in agriculture: an international perspective. J. Injury Preview. Control, 7(3): 175-186.

Mishram, T.N. and Desta, K. (1990). Development and performance evaluation of a sorghum thresher. Agric. Mech. In ISIA, 21 (3): 33-37.

Morad, M.M. (1997): Cost analysis and energy requirements for threshing wheat. Misr. J. Ag. Eng. 14 (1): 93-105.

Mufti, I.; Ahmad, S.I. and Majid, A. (1989). Farm accidents in Pakistan. Agric. Mech. Asia Africa Latin America 20, 73-75.

Rawal, H.S. (1988). Proper selection and safe use of power wheat thresher. Prog. Farming. 24 (7): 12-14.

Shigley J.E. and Mitchell, L.D. (1983). Mechanical Engineering Design. Fourth edition. Mc Graw-Hill Book Company.

Table 1: Technical specification of stationery thresher "ElSHAMS"

Technology specification	ElSHAMS
Length (mm)	4020
Width (mm)	2200
Height (mm)	24000

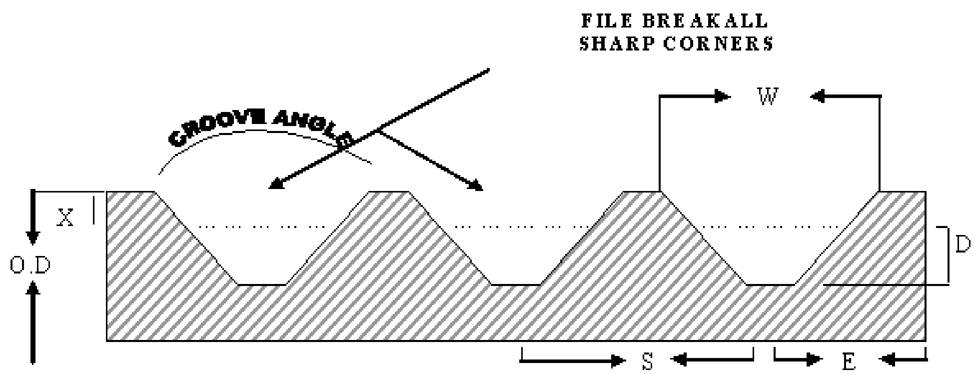
Table 2: Standard V-belts sections

Belt section	Width a (in)	Thickness b (in)	Hp range one or more belts	Minimum sheave diameter (in)
A	½	11/32	¼ - 10	3.0
B	21/32	7/16	1 –25	5.4
C	7/8	17/32	15 –100	9.0
D	11/4	¾	50 –250	13.0
E	11/12	1	100 and up	21.6

Source: Shigley and Mitchell, 1983

Table 3: Groove dimensions and tolerances for multiple V- belt Sheaves

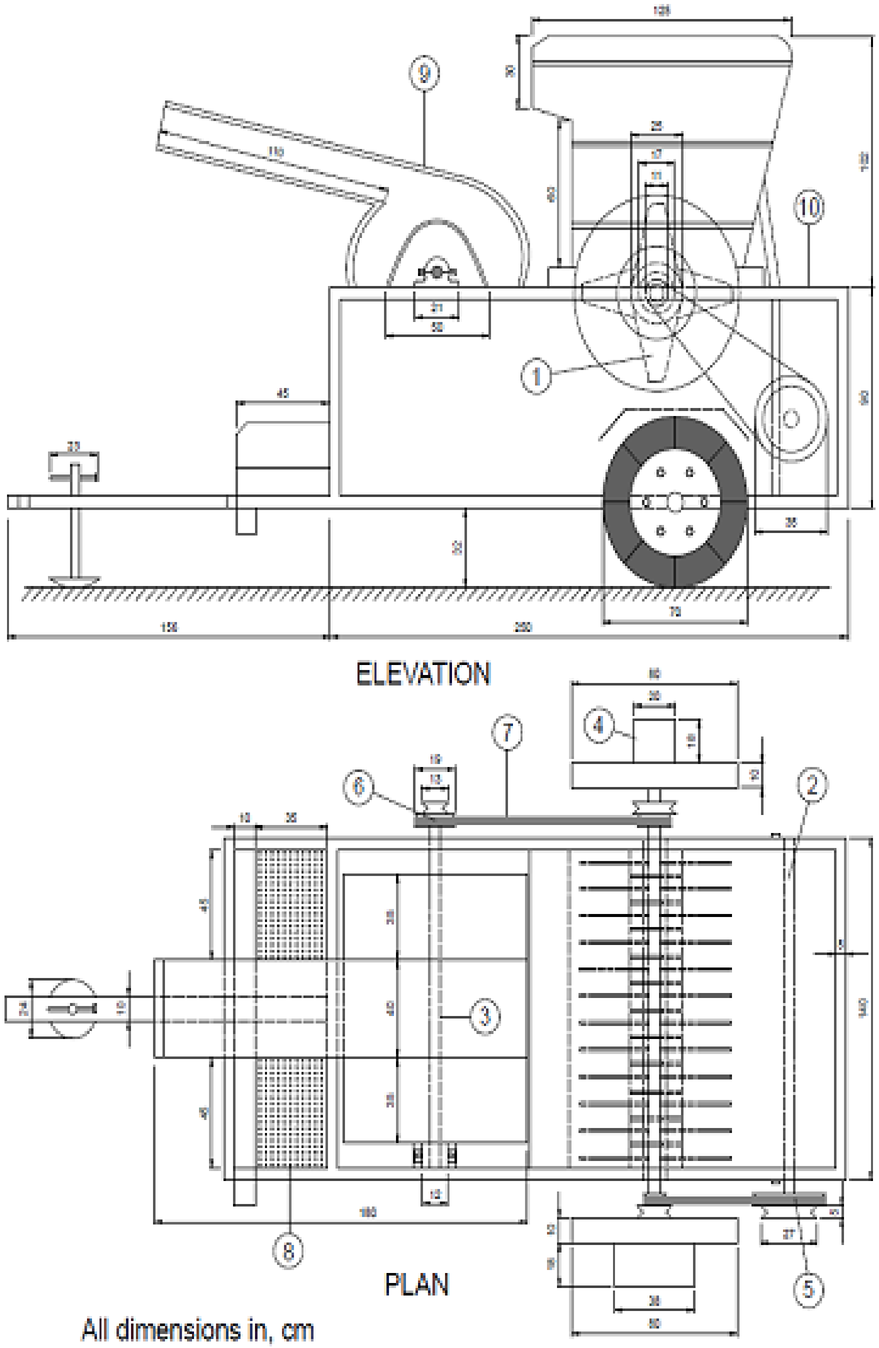
Belt	Pitch diameter		Groove angle	Standard groove Dimension (inch)					Deep groove Dimension (inch)				
	Minimum recommended	Range		W	D	X	S'	E	W	D	X	S'	E
B	3.0	2.6 to 5.4 Over 5.4	±1/2°	(2)	±.031	…	±.031	(3)	(2)	±.031	…	±.031	(3)
			34° 38°	.494 .504	.490	.125	5/8	3/8	.589 .611	.645	.28	3/4	7/16



Source: Machinery's Handbook (2000)

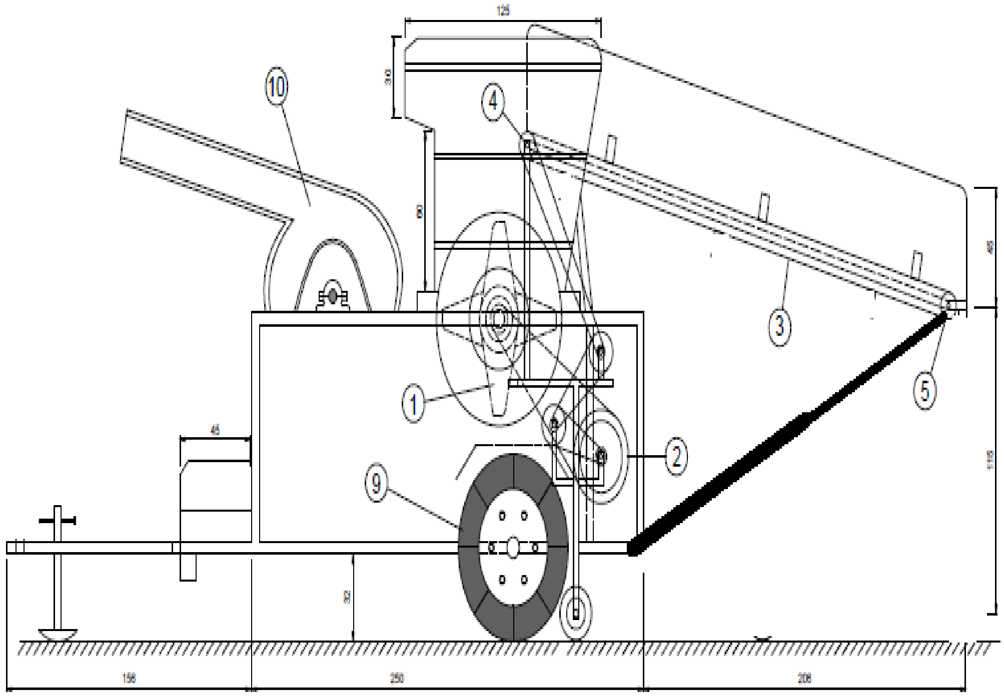
Table 4: Cost of developed parts

Items	Price in SDG
Fasteners, shim, angles etc.	250
Workshop and labour	500
Supporting pipe	100
Pulleys and rollers	0200
Conveyer belt and V-belt	0100
Total	1150

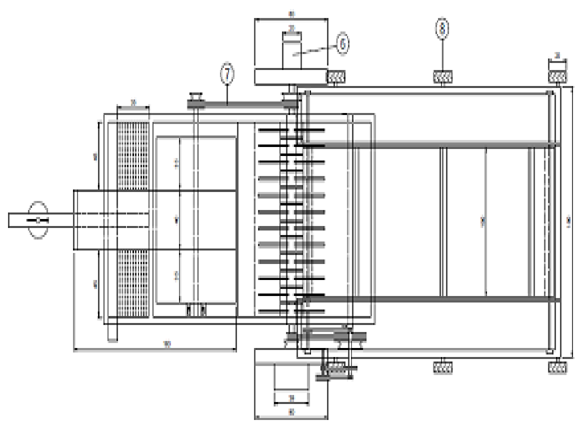


No.	Part name	No. off	No.	Part name	No. off
1	Threshing drum	1	6	Fan pulley	1
2	Sieve shaft	1	7	V-Belt	2
3	Fan shaft	1	8	Sieve	1
4	Guide pulley	1	9	Blower	1
5	Sieve pulley	1	10	Frame	1

Figure 1: Elevation and plan of stationery thresher before development



ELEVATION



PLAN

All dimensios in, cm

No.	Part name	No.off	No.	Part name	No.off
1	Threshing drum	1	6	Guide pulley	1
2	Sieve pulley	1	7	V-Belt	5
3	Flat belt	1	8	Device wheel	6
4	Edler pulley	1	9	Thresher wheel	2
5	Edle pulley	1	10	Blower	1

Figure 2: Elevation and plan of stationery thresher after development

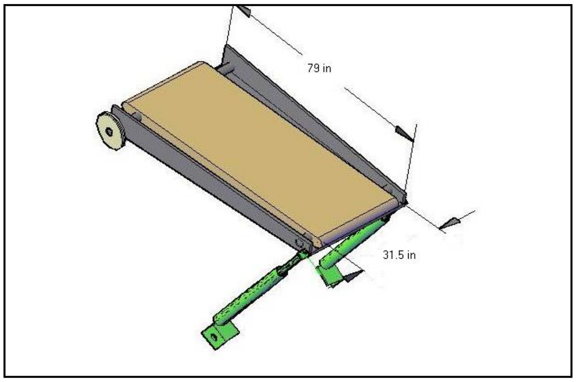


Figure 3: The frame for feeding conveyor

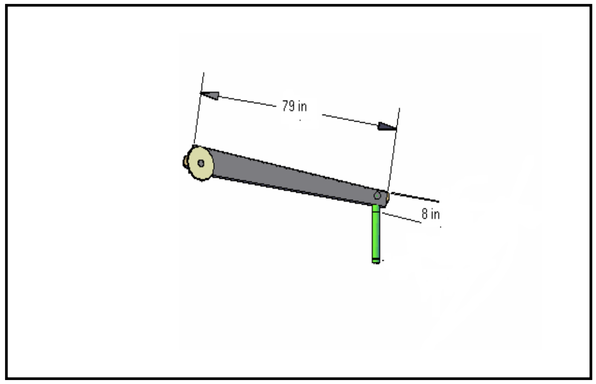


Figure 4: The Fenders

Plate 1: The developed feeding device

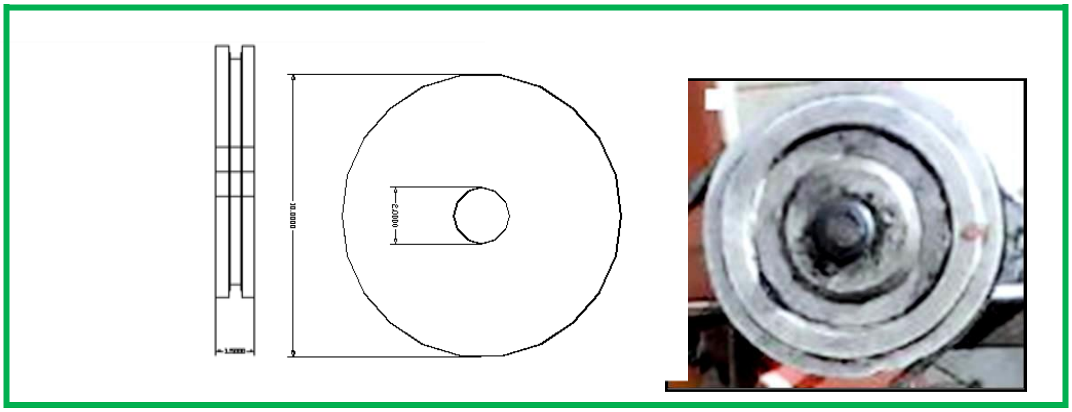


Figure 5: pulley for conveyor belt

Plate 2: Shaft and pillow-block ball bearings

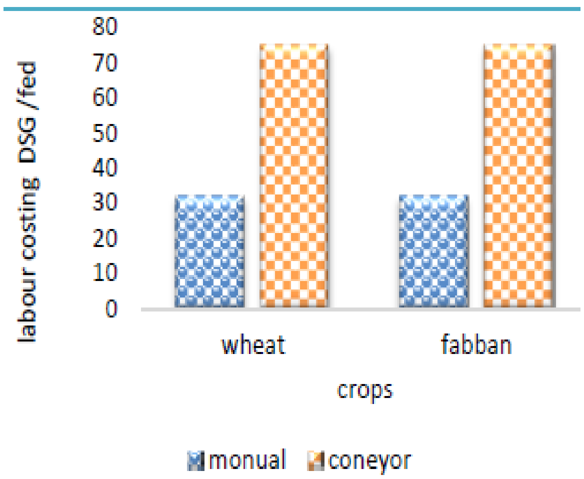


Figure 6: average of Labor requirement

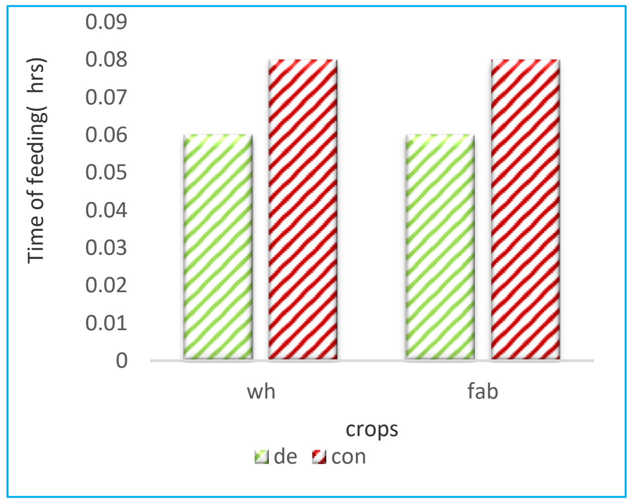


Figure 7: average of feeding time

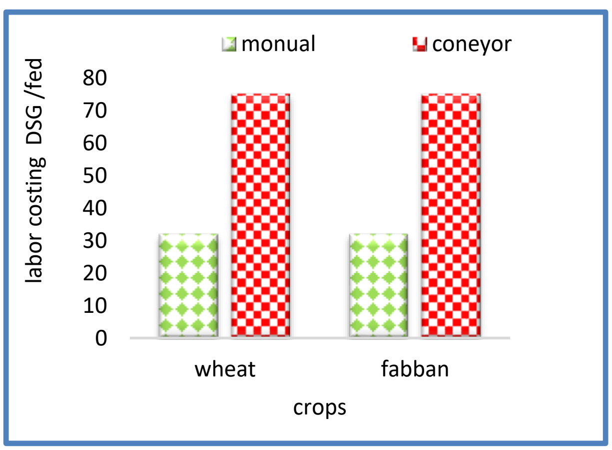


Figure 6: average of Labor costing

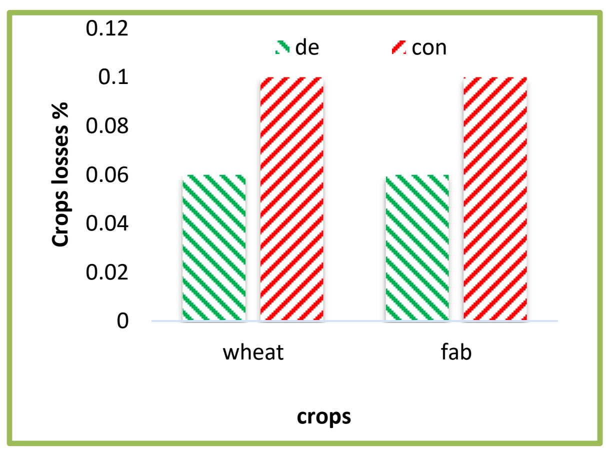


Figure 8: average of Crops losses