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

E-mail: NJAS@nilevalley.edu.sd

Preface

At present, the main concerns of agricultural development in our country are being shifted increasingly from old traditional practices towards sophisticated and more goal-oriented systems. The scientific community is not lagging behind these concerns and always striving to present and employ the latest innovative scientific approaches in the field of agriculture to achieve higher levels of quality, safety and profitability in food and feed production.

It gives me a lot of pleasure to place before you issue 1 of volume 4 of the Nile Journal for Agricultural Sciences. We promise to remain ambitious with regard to further developments and we will continue to build on the work we have already carried out in achieving high standards of scientific excellence and timeliness. However, to achieve our goals, we appreciate the fruitful collaboration of authors by indorsing supplements which conform exactly to the journal's instructions and format printed in each issue of the NJAS.

Editorials

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

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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.

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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.

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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.

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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 printout hard copies and in electronically readable form in either a CD (IBM formatted) or via e-mail:

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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.

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.

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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.

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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 before 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.

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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

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Nile Valley University Publications

Nile Journal for Agricultural Sciences (NJAS)

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Research paper

Effect of Alley Cropping Microclimate and Water Use on Growth and Yield of Groundnut and Maize on Clay Soils

Medani Ibrahim Adlan[1], Hayder Elsafi Shapo[2], Hussain Sulaiman Adam[3]

1 Agricultural Research Corporation, Hudieba research station, Ed Damer, Sudan
2 Agricultural Research Corporation, Forest Research Centre, Souba, Khartoum, Sudan
3 Faculty of agricultural Sciences, Gezira University, Wadmedani, Sudan

Corresponding Author: tabagga@yahoo.com

ABSTRACT

The objective of this study was to investigate the influence of modified microclimate in eight-meter wide alleys on growth and yield of groundnut and maize under the shade of *Acacia ampliceps* and *Acacia stenophylla* trees in the Gezira Research Station which is characterized by cracking heavy clay soils of low organic and N content. Groundnut and maize crops were evaluated for growth and yield performance by laying out sample plots at southern, central and northern parts of the alleys and at control plots. Due to microclimatic modifications in the alleys, the yield of both crops in the alleys significantly (p=0.01) exceeded the control. It was observed that the alley crop yield performs better under *A.ampliceps* having transmitted radiation of about 64%, which is relatively higher than *A.stenophylla* (56%). Groundnut increased by 14 and 6 % in the *A.ampliceps*-alley and *A.stenophylla*-ally, respectively. On the other hand, maize yield increased by 27 and 15 % in the *A.ampliceps*-alley and *A.stenphylla*-ally, respectively. The results indicated that the competition for light was the major contributing factor toward the reduction of growth and yield of maize crop. Alley cropping plots consumed less water (571m^3) than the control (805m^3). Water was saved in the ampliceps-alley by 34 and 33 % and in stenophylla-alley by 24 and 24% for groundnut and maize, respectively.

Keywords: Irradiance, semi –arid, acacia stenophylla, eevapotranspiration, water use

تأثير المناخ الموضعي في زراعة الممرات وكفاءة استخدام مياه الري علي نمو وانتاجية محصولي الفول السوداني والذرة الشامية في الاراضي الطينية

مدني إبراهيم عدلان[1]، حيدر الصافي شبو[2] وحسين سليمان ادم[3]

1 محطة ابحاث الحديبة، هيئة البحوث الزراعية، الدامر
2 مركز ابحاث الغابات، هيئة البحوث الزراعية، سوبا، الخرطوم
3 كلية العلوم الزراعية، جامعة الجزيرة، مدني، السودان

أجريت هذه الدراسة لمعرفة تأثير العناصر المناخية المختلفة على نمو وإنتاجية الفول السوداني والذرة الشامية في نظام زراعة الممرات. اجريت التجربة في محطة بحوث الجزيرة والتي تتميز بتربه طينيه ثقيلة متشققه، منخفضة النتروجين والمادة العضوية. هدفت هذه الدراسة إلى معرفة تأثير المناخ المحسن في الممرات على نمو وإنتاجية الفول السوداني والذرة الشامية. الاختلافات في درجة الحرارة العليا، الرطوبة النسبية، سرعة الرياح والإشعاع تحت ظل شجرتي الامبليسبس والإستنوفيلا. تمّ تقييم نمو وإنتاجية الفول السوداني والذرة الشامية بأخذ عينات من جنوب، وسط، وشمال الممر وكذلك الشاهد. هنالك انخفاض ملحوظ في سرعة الرياح، درجة الحرارة، والإشعاع بينما شهدت الرطوبة النسبية إرتفاعاً داخل الممرات. تبعاً لتحسين المناخ داخل الممرات ازدادت إنتاجية المحصولين معنوياً مقارنةً بالشاهد. انخفاض الإنتاجية في الذرة الشامية في الجزء الشمالي عوضت كلياً بزيادة الإنتاجية في الجزئين الجنوبي والأوسط من الممر. أوضحت النتائج أنّ المنافسة على الضوء هي العامل المؤثر في ذلك. كما لوحظ أداء أفضل للمحصولين داخل ممر الامبليسبس الذي حصل على إشعاع بحوالي 64 % وهو إشعاع أعلى نسبياً من الإشعاع داخل ممر الإستنوفيلا الذي يقدر بحوالي 56 %. زادت إنتاجية الفول السوداني بنسبة 14 و6 % في ممر الامبليسبس والإستنوفيلا على التوالي. من جهةٍ أخرى زادت إنتاجية الذرة الشامية بنسبة 27 و15% في ممر الامبليسبس والإستنوفيلا على التوالي ايضاً. إضافةً إلى ذلك تمَ قياس مياه الري المستخدمة في ممرات الشجرتين لمحصولي الفول السوداني والذرة الشامية. كان هنالك فرق معنوي في استهلاك المياه بين نظام زراعة الممرات والشاهد. استهلك 517 متر مكعب من المياه في الزراعة بين الممرات الشجرية مقارنةً بحوالي 805 متر مكعب استخدمت لري الشاهد. وفر ما مقداره 34-33 % في ممر الامبليسبس 24-24 % في ممر الإستنوفيلا عن محصولي الفول السوداني والذرة الشامية على التوالي.

***كلمات مفتاحية*: الاشعاع، شبه جاف، الاكيشيا ستينوفيلا، البخر نتح، استخدام المياه**

Introduction

Historically, in Sudan as in most of the third world countries, trees grow naturally as a gift from the All Mighty God without or with limited intervention from people. Not only that, but human-beings intentionally or without awareness constitute a major threat to the well being of the trees and consequently to environment. Agroforestry as a modern science is a new theme in Sudan. However, in practice it is an old fashion of traditional agriculture. The shouting example for that is the integrated system of production in the gum belt in western Sudan where traditional crops are grown with the indigenous tree gum Arabic – producing tree *Acacia senegal* which naturally grows in that habitat. Moreover, exotic trees were introduced to Sudan and were successfully grown with field crops like wheat and faba been and they gave very encouraging results (Shapo and Adam, 2008). Crops production in Sudan focuses mainly on pure-stand crop production neglecting the participation of other resources like trees in that process. During the period from 1987 to 2002, of the total production in this country, the Gezira scheme contributed 58 % of cotton, 46 % of wheat, 23 % of groundnut and 12 % of sorghum (SCC, 1993). Sand movement towards the north western part of the Gezira irrigation scheme threatens that part. An irrigated sand blocking shelter belt *Eucalyptus microtheca* is used to protect canals and crop. Wind speed over eroded land was increasingly higher than that over irrigated cotton land. Both these values were considerably higher than those reported from the nearest meteorological stations. Of the two prevailing winds, of which the summer (SW) wind is perpendicular to the belt. Efforts to control the moving sand in the source area should be joined with those made at the borders of agricultural land (Mohammed *et al.,* 1999).

Groundnut (*Arachis hypogaea*) is one of the major rotational crop in the Gezira scheme. It was introduced to the Gezira scheme in the sixties of the last century. Besides its many industrial and other uses, it is a leguminous crop which can replenish the Gezira soil through nitrogen fixation. In addition it is a rich and palatable animal feed. Maize (*Zea mays* L) used to be a minor crop in the past and the area under it seldom exceeds 500 feddan. The crop has a wide range of usage both as food and feed.

Materials and methods

Experimental site:

An alley-cropping study area was established in 2006 at Gezira Research Station (GRS), 189 km south of Khartoum, Sudan (latitude 14˚ 23' N, longitude 29˚ 33' E and 405 meter above sea level). The soil type was typically clay soil characterized by its high clay content (58-66%). It is also high calcareous alkaline soil, with pH of 8.5, deficient in nitrogen (300-400 ppm), and low in available phosphorus (2-4 ppm) and low in organic matter 0.05% (Ageeb *et al.*, 1995). The Gezira Scheme lies within the semi dry zone. The annual rainfall is 150 – 300mm. The rainy season is very short. The summer season is characterized by low humidity and high temperatures. April and May are the hottest months. The maximum temperature during summer exceeds 40^0 C. Relative humidity varies markedly during the year from over 65 % in August to around 21 % in March and April. Sun shine in the study area is abundant and more than sufficient for plant growth. The coldest month is January, with mean daily minimum temperature of 21 ^{0}C. There is abundant sunshine and solar energy ranging from 20-26 MJ m^{-2} day^{-1}. The temperature is high and relative humidity is low. The combination of low rainfall, high solar energy and low humidity leads to a high rate of evaporation estimated as 2500 mm annually.

Experimental design and layout:

Acacia ampliceps and *Acacia stenophylla* seedlings were transplanted in June 2002, at 3m in-row spacing and 8.0 m between rows and arranged in an east-west direction. The alley cropping study started in 2006 cropping season. The alleys were divided into three zones: northern, central and southern alley. Weather stations were mounted in each of the three zones of the alleys and in the control plots for monitoring the temperatures and relative humidity. Cup anemometers were positioned in the central part of each alley zone and in the control for measuring wind speed. Portable Light meter as Radiometer was used to measure incoming solar energy in alley cropping and control plots. During seasons 2006, groundnut and maize were grown in the alleys. Each crop was grown separately in randomized complete block design replicated three times.

Sowing method:

Groundnut (variety Medani) was sown on 17th of June 2006 in ridges 80 cm apart and in row spacing of 15 cm. Two seeds per hole were sown at a seed rate of 70.2 kg\ha. Watering was applied at 10- 14 days intervals. Harvesting was at 131 days after sowing. Maize (variety

Mougtama-45) was sown on the 3rd of July 2006. The seeds were sown on ridges 80 cm apart and in row spacing of 25 cm, at rate of 2-3 seeds per hole at a seed rate of 14.8 kg\ ha. The plants were thinned to one plant per hill three weeks after sowing to give standard plant population. Nitrogen fertilization was applied after thinning and before flowering. Harvesting was at 105 days from sowing.

Data collection:

For the woody trees, measurements were done for tree height, diameter at breast height (DBH) and diameter at the base of the trees. Diameters were measured using a caliper. In addition air dry weight for stem wood, branches and twigs and leaves were done. Plant samples were taken at harvest from an area of one square meter in the center of the northern, southern and central alleys and in the control plots to determine plant height (cm), yield and some yield components.

Meteorological data:

Air temperatures: Small weather stations were mounted on iron stands about 2.0 m above ground level. One weather station was placed in each zone of the alley. Maximum temperatures were recorded in a regular systematic way at 08:00 local time every morning.

Air humidity: Wet and dry-bulb thermometers were used for measuring humidity.

Solar radiation: Solar radiation was measured using portable light meter (Radiometer) placed at ground level across the three zones of the alley and the control plot.

Wind speed: Anemometers were located in the central part of the trees' alleys and control plots at 2.0 m above ground.

Measurement of applied irrigation water and soil moisture: Irrigation water was applied to the control and the alleys of *Acacia ampliceps* and *Acacia stenophylla* trees using water meter. Soil moisture was measured using gravimetric sampling method for the depths 0-15, 15-30, 30-45 and 45-60 cm after irrigation and immediately before subsequent irrigation. Three soil samples per plot were taken from each zone of the alley and the control, using auger. Soil samples were dried at 105˚C for 24 hours and soil moisture was calculated on a dry weight bases. The gravimetric percentage (Grav.%) was given by the following equation:

$$\text{Grav.\%} = (\text{Wet soil} - \text{Dry soil}) / \text{Dry soil} \times 100$$

The bulk density (BD) was calculated according to the equations as follow:

$$BD = 0.00003(MC)^2 - 0.0019(MC) + 1.274 \text{ .For BD (0-40) \{Eq. 1\}.}$$

$$BD\ (40\text{-}60) = 0.00005(MC)^2 - 0.0019(MC) + 1.386 \quad \text{\{Eq. 2\}.}$$

According to these equations the volumetric soil moisture content (VW) was calculated as:

Volumetric soil moisture = Gravimetric × BD

The soil water in the profile in (mm) depth = VW × soil depth considered in (mm).

$$\text{Evaportranspiration (ET) per day (mm/d) for the each irrigation interval} = \frac{VW_1 \text{ after irrigation} - VW_2 \text{ before irrigation}}{\text{Number of days between } VW_1 \textit{ and } VW_{21}}$$

Results

Tree performance: Analysis of variance showed that there were highly significant differences (P= 0.001) between tree species in growth and biomass production. Plant height, diameter at breast height DBH, D. base, wood/m^3 and weight of wood and air dry leaves (kg) of *A. ampliceps* and *A. stenophylla* were 8.1 m and 8.9 m, (DBH) of 11.8 and 11.7 cm and diameter at the base (10 cm above the ground) of 15.2 and 16.3 cm, respectively (Table 1).

Microclimatic modification: During 2006 growing season, which extended from June to October, the average values of solar irradiance, maximum temperatures, relative humidity and wind speed were 0. 406 kw/m^{-2}, 37.3 ^{0}C, 66.6 %, and 1.4 m s^{-1}, respectively, and the wind speed was 54 % compared to control. Due to the modifications of microclimate during the growing season, solar irradiance in alley cropping was 60% compared to control (this equals a reduction of 40% in solar irradiance in alley cropping). While the maximum temperatures were reduced by 1.6^0 C, the relative humidity was increased by 19.4% radiation values decreased progressively from June to October. The *A. ampliceps* alley had received higher transmitted radiation (64 % of the control) compared to *A. stenophylla* alley (56 % of the control). On zonal basis, the central alley had the highest transmitted irradiance, while the southern alley had higher transmitted radiation than the northern alley). In general, alley cropping reduced maximum temperatures in different zones of the alleys. The maximum reduction occurred in the southern (-1.96 ^{0}C), while the least reduction occurred in the central alley (-1.2 ^{0}C). On monthly basis, the highest reduction in the maximum temperatures occurred during August and September. Relative humidity was maximum during June and October. The maximum increase occurred in the southern alley (+25.8 %), while the least reduction occurred in the central alley (+16.7%) (Table 2 and 3). In terms of wind speed, the tree hedgerow in the alley experiment reduced wind speed to 54% compared to the control during the growing season of 2006. The highest wind speed (4.06 ms^{-1}) was recorded during July. The maximum wind speed reduction (61%) in the alley cropping experiment occurred during July (Table 4).

Water use consumption differed significantly (P=0.001) between alley cropping and mono-cropping systems and between the different tree species. Alley cropping plots consumed less water (571 m^3) than the control (805 m^3). Saving in irrigation water varied within different tree species and different crops. Water was saved in the *A. stenophyllan* alley by 24 and 24% and in *A. ampliceps*-alley by 34 and 33 % for groundnut and maize, respectively. The maximum saving in irrigation water occurred with *A. ampliceps* (Table 5).

Crops response to microclimatic modifications: Table (6) demonstrate that groundnut pod yield, plant height and weight of 100 seeds in gram were significant differences in alley cropping than in control (P=0.001). The *A. ampliceps* alley produced more yields (14%) than *A. stenophylla* alley (6%). Regarding the zones of the alley, the southern zone gave the highest yields, while the northern zone gave the lowest. Maize yield, plant height, weight of 100 seed/ were significantly (P=0.01) higher in alley cropping than in the control. Correspondingly, *A. ampliceps* alley produced more yields (27%) compared to *A. stenophylla* alley (15 %). In the different zones of *A. ampliceps alley*, the yields increased by 0.1, 48 and 32% for northern, central and southern zones, respectively. While the yield was decreased by (-25%) in the northern zone of *A. stenophylla* alley, it was increased by 51 and 20 % in the central and southern zones, respectively (Table 7).

Discussion

Agroforestry systems have the potential to increase yields by effectively growing two crops at the same time on a single piece of land (Nair, 1991). There are many reasons for combining trees and crops on the same piece of land, such as reducing soil erosion, limited availability of land, modifying the microclimate and improving water use. Huda and Ong (1987) reported that water could be lost through both soil evaporation and percolation to beyond the tree or crop rooting zones it is conceivable that trees could utilize part of the rainfall that would otherwise be lost. When more irrigation water was applied in a drier year, an amount equals to 30-50% of these water requirements was lost through evaporation from standing water/wet surface, which is the main unproductive water (Ibrahim *et al*., 2002). Agroforestry can provide a reliable tool for soil and water conservation at much lower cost than with traditional techniques such as banks, ditches or terrace (ICRAF, 1993). In this study, the two Australian tree species being used in this trial differed in their ability to extract the water from the different soil horizons as trees differ according to their growth habit and competitive reaction. It has been stated that water could be lost through both soil evaporation and deep percolation beyond the tree or crop rooting zone, it is conceivable that trees could utilize part of the rainfall that would otherwise be lost (Huda and Ong, 1987). In the semi-desert region of the Sudan the main factor determining the success of alley cropping systems is modification of microclimate, which resulted in improving water availability (Shapo and Adam, 2003). The tree canopy reduces and modifies light availability to plants in the understory, with possible beneficial consequences for photosynthesis, water relations and morphogenesis (Bergez *et al*., 1997). Shapo and Adam (2008) indicated that mostly, the shade length in the alley increased as the solar energy decreased. Besides, the southern shade had always higher length and reached its maximum length at 1600 LT, while the northern shade reached its maximum at 0800 LT. The southern shade, increased gradually from June up to December, and then decreased progressively from January until May. On the other hand, the northern shade increased from January up to June and then decreased from July up to December.

In this study, the trees suffer from water shortage during all seasons except during the rainy season, particularly during summer seasons (March– June) where the irrigation canals were dried for clearance. Analysis of variance showed that A. ampliceps has inferior growth compared to A. stenophylla in terms of plant height, DBH, D.base, etc. The inferiority of growth and shedding of leaves during summer season gave the A. ampliceps the advantage of optimizing radiation for associated crops. The microclimatic elements showed that the micro-environmental variables had a collective effect on growth and yield of groundnut and maize. In the alley cropping plots solar radiation, air temperature and wind speed were reduced, while relative humidity was increased. The ampliceps-alley had received relatively higher incoming radiation (64% of the control) than A. stenophylla (56% of the control). Therefore, the ampliceps-alley had increased groundnut (14%) and maize (27%) yield more than the A. stenophylla alley, which increased the yield of groundnut and maize by 6 and 15%, respectively. These results are supported by Yu *et al.* (1997) who reported that the modification of microclimate favors tea (*Camellia sinensis*) plants growth, improves quality of tea leaves, and increases economic returns per unit land use system.

Furthermore, Vaast *et al.* (2004) reported that tree shade creates more favorable microclimatic conditions for coffee by improving coffee photosynthesis and lowering coffee transpiration in Central America. Although there was difficulty in separating the influence of each climatic factor, nevertheless, the results obtained indicated that the competition for light was the major factor contributing to yield reduction or increase in the alley cropped groundnut and maize. This result was in line with that of Shapo and Adam (2008), who indicated that in northern Sudan, the dense shade in the southern alley caused a relative decrease in winter crop yields; however, the substantial part of increase in yield in the central alley, as a result of optimum solar energy, compensated for this reduction. Consequently, the average yield of wheat, faba bean and common bean was increased in the alleys by 69, 15 and 10%, over control plots, respectively. Through altering micro-environmental elements in alley cropping system in semi-deserts of the Sudan water use is improved by modification in micro-climate of the alley cropping. The highest saving in irrigation water is mainly due to the reduction in solar radiation and wind speed, which are very important factors affecting evapotranspiration and hence water use. (Shapo and Adam, 2008).With respect to water use among the two tree species, the highest saving in irrigation water occurred with A. ampliceps tree. With regard to alley cropping systems, maize gave the highest saving in irrigation water (Table 5). Control plots had consumed much water with maize. Results obtained support the assumption that agroforestry can increase conservation of soil moisture. With respect to zonal alleys; the highest yield of the maize was obtained in the central alley, while the highest yield of groundnut was obtained in the southern alley. The northern alley in all cases had the lowest yield. The yield of groundnut in the southern, central and northern zones of A. ampliceps alley was increased by 25, 15, and 3%, respectively. While the yields decreased by 7% in the northern part of A. stenophylla alley, it increased by 15 and 12% in the southern and central alleys, respectively. This indicates that the groundnut yield did not increase as light supply increased, as other environmental factors, seemed to be influential (e.g. temperatures, humidity and wind speed). In addition, the relatively low increase in yield in the central may be attributed to the fact that the highest radiation in this zone coincided with the least improvement in temperature and humidity. On the other hand, the yield reduction in the northern alley is possibly due to the fact that the lowest radiation in northern alley was concurrent with the complicity of the co-existence of tree-crop roots competition. The yield of maize in the A. ampliceps alley was increased by 0.1, 48 and 32 % in the northern, central and southern zones in the alley. Regarding maize its yields in the southern and central zones of the A. stenophylla alley increased by 20 and 51 %, respectively, while it decreased by 25 % in northern alley.

Conclusions

Agroforestry, which integrates crops and/or livestock with trees and shrubs - has a great potential in the area as it could provide farmers with multiple benefits, including diversified income sources, increased biological production and better water use. The study revealed that the micro-environmental variables were responsible for yield increase or decrease, but in reality, it seemed difficult to separate the complex interacting climatic factors involved in the system. Nevertheless, the obtained results indicated that the most limiting factors that affect the yields of both crops are the water use and irradiance since the differences in maximum temperature, relative humidity and wind speed were negligible within the different zones of the alley. Yield of groundnut and maize in the alley cropping experiment were significantly increased over the control plots. Maize had largely benefited from the microclimatic modification in the alley and in effect gave the highest yields compared to groundnut crops. The higher yields obtained with *A. ampliceps* seemed to be due to its capacity in transmitting sufficient amount of light through its canopy.

Table (1): Biomass production (kg/tree) of Acacia stenophylla and Acacia ampliceps (4 year-old tree)

Tree species	Height (m)	DBH (cm)	D.base (cm)	Wood of stem (kg)/tree	Dry wood of branches and twigs (kg)/tree	Dry leaves (kg)/tree
Acacia stenophylla	8.9	11.7	16.3	20.1	28.3	6.2
Acacia ampliceps	8.1	11.8	15.2	16.4	24.3	7.3
Sig. L	*	-	-	*	* *	*
S.E±	0.08	0.19	0.24	0.5	0.19	0.17
C.V%	1.66	2.48	2.63	4.75	1.23	4.34

Table (2): Average deviation in maximum temperature and relative humidity in the different zones of the alleys of Acacia stenophylla and Acacia ampliceps as related to the control plot (2006)

Direction Months	Southern zone		Northern zone		Central zone		Average in the alley		Control	
	Max	R.H (%)	Max	R.H (%)	Max	R.H (%)	Max	R.H (%)	Max	R.H (%)
June	-1.88	30.0 +	-1.1	32.6+	-1	25 +	-1.32	29 +	40.7	47.0
July	-1.95	29.8 +	-1.56	26.1 +	-1.1	16.2+	-1.54	21.2+	35.9	72.5
August	-2	17.0 +	-1.97	11 +	-1.3	6.8 +	-1.76	8.9 +	34.9	79.6
September	-2	19.4 +	-1.99	12.8 +	-1.5	8 +	-1.84	10.4+	36.2	78.0
October	-1.96	33.0 +	-1.5	28.4 +	-1	27 +	-1.49	27.7+	39	56.0
Mean	**-1.96**	**25.8 +**	**-1.6**	**22.2 +**	**-1.2**	**16.7+**	**-1.6**	**19.4+**	**37.3**	**66.6**

Table (3): Percent irradiance in various zones of the alley of Acacia stenophylla and Acacia ampliceps (as percentage of the control)

Species	*Acacia stenophylla*				*Acacia ampliceps*					
Months	S. Alley	N. Alley	C. Alley	Average	S. Alley	N. Alley	C. Alley	Average	Alley cropping (average)	Control
June	49	44	82	58.3	60	55	89	68	63.2	0.438
July	47	42	80	56.3	57	53	86	65	61	0.417
August	43	41	78	54	53	51	79	61	57.6	0.387
Sep	45	41	78	54.7	55	51	81	62	58.4	0.397
October	44	43	76	53.3	53	51	80	61	58.9	0.390
Mean	**46**	**42**	**79**	**56**	**56**	**52**	**83**	**64**	**60**	**0.406**

S: Southern, N: Northern, C: Central

Table (4): The 24 hours means wind speed in alleys of Acacia stenophylla and Acacia ampliceps and control plots (m/s) season 2006

Month	Alley cropping	Control	Alley cropping/Control
June	2.00	3.96	0.51
July	2.48	4.06	0.61
August	2.05	3.81	0.54
September	1.15	2.12	0.54
October	0.77	1.50	0.51
Average	**1.69**	**3.09**	**0.54**

Table (5): Amount of water applied (m3/ha) in the alley cropping and control (2006)

Species	**Mean water applied (m^3)**	**Water saved as% of control**
Acacia ampliceps	532	34
Acacia.stenophylla	610	24
Control	805	
Sig. L	* * *	
S.E±	5.7	
A.ampliceps× Groundnut	528	34
A.ampliceps × Maize	535	33
A.stenophylla× Groundnut	615	24
A.stenophylla × Maize	604	24
Control× Groundnut	806	
Control× Maize	803	
Sig. L	N.s	
S.E±	17.1	
C.V%	**4.6**	

Table (6): Yield and yield components of groundnut in different zones of the alley and control plots

Treatments	**Weight of pods (kg/ha)**	**Yield change as % of control**	**Plant height (cm)**	**100-seed weight (g)**
A.ampliceps	1773	14	27.5	44.9
A.stenophylla	1651	6	25.2	43.4
Control	1551		22.5	41.9
Sig. L	*		*	N.s
S.E±	43.7		0.68	1.15
North	1514	- 2	25.7	41
Center	1691	9	25.8	45.2
South	1770	14	24	44
Sig. L	* *		*	* *
S.E±	16.1		0.45	0.56
North	1440	- 7	23.9	39.9
Center	1737	12	26.7	43.9
South	1776	15	25	46.2
A. stenophylla	**1651**	**6**	**25.2**	**43.3**
North	1593	3	24.8	42.4
Center	1785	15	28.2	48.8
South	1941	25	29.6	43.6
A. ampliceps	**1773**	**14**	**27.5**	**44.9**
Sig.L	* *		*	*
S.E±	47		0.79	0.98
C.V	**2.9**		**5.4**	**3.9**

Table (7): Yield and yield components of maize in different zones of the alley and control plots

Direction	Seed yield (kg/ha)	Yield as % of control	W/100 seeds (g)	No/of Cobs (m^2)	Plant height(cm)			
					1St	2sd	3rd	4th
A.ampliceps	3662	27	19.3	8	99	131	150	173
A.stenophylla	3326	15	17.1	8	95	118	141	162
Control	2887		14.7	8	88	115	138	158
Sig.L	* *		* *	-	-	*	-	*
S.E±	30.2		0.26	0.17	5.7	2.2	2.9	2.2
North	2633	-9	15.6	8	90	116	138	157
Center	3838	33	18.1	8	101	127	148	173
South	3403	18	17.3	8	91	121	143	164
Sig.L	* *		* *	-	-	* *	* *	* *
S.E±	71.1		0.24	0.16	3.2	1.5	1.4	1.2
Interaction								
North	2890	0.1	17.8	8	85	125	142	158
Center	4273	48	20.2	8	116	139	162	191
South	3823	32	19.8	8	96	128	148	169
A.ampliceps	**3662**	**27**	**19.3**	**8**	**99**	**131**	**150**	**173**
North	2153	-25	15.3	8	93	109	137	156
Center	4353	51	18.5	8	101	127	145	169
South	3470	20	17.4	8	91	118	142	162
A.stenophylla	**3325**	**15**	**17.1**	**8**	**95**	**118**	**141**	**162**
Sig.L	* *		-	-	-	*	*	* *
S.E±	123		0.42	0.28	5.5	2.7	2.1	2
C.V%	**6.48**		**4.25**	**6.25**	**10.1**	**3.8**	**2.88**	**2.1**

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Research paper

Critical Period for Weed Control in Okra (*Abelmeschus esculentus* L. *Moench*) in Dongola, Northern State, Sudan

Suhair Mohamed Elamin[1]; Mukhtar Abdelaziz Mohamed Osman[2]; Salah Eltoum Elamin[3] and Babiker Mohamed Mahgoub[4]

1 Ministry of Agriculture and Animal Resources, Northern State, Sudan

2 Faculty of Agricultural Studies, Khartoum, Sudan University of Science & Technology-Sudan

3 Faculty of Agriculture, University of Khartoum, Sudan

4 Faculty of Agriculture, Bahri University, Sudan

Corresponding Author: suhairmohamedelaminahmed@gmail.com, Tel: 0112520742

ABSTRACT

An experiment was conducted at Altoraa, Dongola Locality, Northern State – Sudan, for two consecutive summer seasons (2014, 2015) to determine okra yield losses due to weed infestation and the critical period of weed/crop competition. Combined analysis showed that, crop growth components were adversely affected by weed competition. Plant height, number of branches/plant, number of leaves/plant and shoot dry weight were significantly reduced by 15, 39, 41 and 50%, respectively, compared to the weed-free plots. Results of combined analysis of the two seasons indicated that, unrestricted weed growth significantly reduced okra dry pod and seed yield by 72.81 and 40.58%, respectively, compared to the weed free plots. The study also showed that, the critical period of weed/okra competition was between 6 and 8 weeks after sowing.

Key words: Yield loss, weed-free, infestation and weed competition

الفترة الحرجة لمكافحة الحشائش في محصول البامية (*Abelmeschus esculentus* L. Moench) بمحلية دنقلا-الولاية الشمالية-السودان

سهير محمد الامين[1]، مختار عبد العزيز محمد عثمان[2]، صلاح التوم الامين[3]، بابكر محمد محجوب[4]

1 وزارة الزراعة، الولاية الشمالية، السودان
2 كلية الدراسات الزراعية، جامعة السودان للعلوم والتكنولوجيا، السودان
3 كلية الزراعة، جامعة الخرطوم، السودان
4 كلية الزراعة، جامعة بحري، السودان

أجريت تجربة بقرية الترعة–محلية دنقلا – الولاية الشمالية – السودان، لموسمين صيفيين متعاقبين 2014 و2015 لتحديد الضرر الذي تحدثه الحشائش في محصول البامية والفترة الحرجة لمكافحة الحشائش للمحصول. أوضحت الدراسة بالتحليل المشترك للموسمين أن مكونات نمو النبات قد تأثرت سلبا بمنافسة الحشائش. الارتفاع وعدد الفروع وعدد الاوراق والوزن الجاف للنبات انخفضت معنويا بنسب 15، 39، 41 و50% على التوالي مقارنة بالشاهد النظيف من الحشائش. التحليل المشترك للموسمين اوضح ان وجود الحشائش ادي الي خفض معنوي للقرون الجافه والبذرة للبامية بنسب 73 و41% على التوالي مقارنة بالشاهد النظيف. كما اوضحت الدراسة ان الفترة الحرجة لمكافحة الحشائش للمحصول ما بين سته وثمانية اسابيع بعد الزراعة.

كلمات مفتاحية: الفقد فى الانتاجية، خالية من الحشائش، الانتشار والمنافسة بين الحشائش

Introduction

Okra (*Abelmeschus esculentus* (L) Moench, family is Malvaceae) is one of the most important and popular vegetable grown in Sudan and the world. The world production of okra as fresh fruit vegetable is estimated at 6 million tonnes per hectare (Lyagba *et al.*, 2012). It's main producing countries are India, Nigeria, Pakistan and Ghiana, where India at the top with a total production of 3,550,000 metric tons (FAO, 2004).

In Sudan, it is ranking third after onion and tomato with annual average area and yield of 58014 feddans and 291376 tons, respectively. It grows well in most parts of the country, in the tropical and subtropical areas under irrigation and rain-fed area (Ahmed, 2007 and Nagwa, 2012). It is grown mainly for its green pods which are used as vegetable, principally in soups and stews. Locally, the pods either fresh (Bamia) or dried (Weika), are cooked with meat making a favorable and popular dishes by most Sudanese (Umrogaiga and Tagalia). It is a typical food in combination with sorghum bread (Kisra). The leaves are also cooked in many areas. The seeds, roasted and ground to powder are used as a substitute of coffee.

One of the main problems that affect yield and quality of okra crop is weed interference and its competition with the crop (Imoloame, 2013). A critical period for weed competition (CPWC) is defined as the period in the crop growth cycle during which weeds must be controlled to prevent unacceptable yield losses (Vanacker *et al*., 1993).

In Sudan okra crop received little attention and the available information is inadequate especially in area of weed competition. Thus, this study was conducted to assess the magnitude of dry pod and seed yield losses in okra due to weed infestation and to determine the critical period of weed/crop competition.

Materials and Methods

A field experiment was conducted during two consecutive summer seasons (2014 and 2015) at Alotraa, Dongola locality, Northern State-Sudan. The area is located within latitudes 16° and 22° N, and longitude 20° and 32° E. Dongola locality is a true desert, is characterized by extremely high temperatures and radiation in summer, low temperature in winter, scarce rainfall and high wind speed. The mean maximum and minimum temperatures are 36.8 and 19.5°C, respectively. The climate is hyper arid with a vapor pressure of only 10.8 mb and a relative humidity of less than 20 % (Osman, 2004). The soil in the experimental site is a sandy clay loam, with 57.3% sand, 19.8% silt and 22.5% clay (Damirgi and Al-agidi, 1982).

Two sets of treatments were undertaken. In the first set, the plots were initially kept weedy for 0, 2, 4, 6, 8 and 10 weeks after sowing and then weed-free till harvest. In the second set, the plots were initially kept weed-free for 0, 2, 4, 6, 8 and 10 weeks after sowing by repeated hand-weeding and then left weedy till harvest.

The land was ploughed, harrowed and leveled. The sub-plots (3x3.5 m) were arranged in a randomized block design with 4 replicates. Okra (cultivar Khartuomia) was planted (3 seeds/hole) on flat at an intra row spacing of 25 cm and in rows of 70 cm a part during February. Irrigation interval was 10 days. Two weeks after sowing the seedlings were thinned to two plants per hole. One spray of Folimat was made to control aphids. Urea fertilizer was applied at a rate of 80 lb nitrogen/fed. At ten weeks after sowing 10 plants were randomly selected in each plot to determine plant height (cm), number of branches/plant, number of leaves/plant and shoot dry weight (g)/plant. At each picking, ten plants were randomly selected in each plot to determine mean number of pods/plant and mean dry pod yield (kg/fed). Two rows in each plot were kept unpicked until harvest, ten plants were randomly selected in each plot from those kept unpicked, their pods were cut and threshed in bulk to determine number of seeds/pod, 100 seed weight (g) and seed yield (kg/fed) (Baada, 1995).

Yield data were analyzed by the analysis of variance and means were separated by the Duncan's Multiple Rang Test. Combined analysis was done for the data of the two seasons.

Results and Discussion

The total number of predominant weed species/m^2 in the experimental site explained into the brackets and they were: *Chenopodium album (L.)* (69.2), *Malva parviflora (L)* (67.4), *Convolvulus arvensis* (L.) (65.6), *Amaranthus graecizans* (60.8), *Sorghum arundinaceum* (57.2), *Gynandropsis gynandra* (L.) Briq (54.8), *Sinapis arvensis* (L.) (49.4), *Tribulus terrestris* (L.) (48.0), *Datura stramonium* (L.) (46.8), *Cynodon dactylon* (L.) Pers (46.8), *Cyperus rotundus* (L.) (42.2), *Eruca sativa* (39.4), *Portulaca oleracea* (L.) (35.8), *Dactyloctenium aegyptium* (L.) Beauv. (25.2), *Sporobolus pyramidatus* (Lam.) Hitchc (20.4), *Sonchus oleraceus* (L.) (18.8) *Hyoscyamus reticulates* (15.4), *Echinochloa colona* (L.) Link (13.2), *Tephrosia apollinea* (Del.) (13.2), *Cassia italica* (Mill.) Lam. Ex Steud (11.8), *Calotropis procera* (Ait.) Ait. f. (11.8), *Aerva javanica* (Burm. f.) (10.0), *Rhynchosia memnonia* (Del.) cooke (9.4) and *Lotus arabicus* L. (9.0).

The most three predominant weeds were *Chenopodium album (L.)*, *Malva parviflora (L)* and *Convolvulus arvensis* (L.).

Combined analysis showed that, crop growth components were adversely affected by weed competition. Plant height, number of branches/plant, number of leaves/plant and shoot dry weight were significantly reduced by 15, 39, 41 and 50%, respectively, compared to weed-free check. Similar results were reported by Mohammed *et al.* (2013) and Adeyemi *et al*. (2014).

Table (1): Influence of duration of weed interference on growth components during summer seasons 2014 and 2015 combined

Treatments	plant height (cm)	Number of branches/ plant	Number of leaves/ plant	Shoot dry weight (g)
Weed free for 2 weeks	86.6 abcd	2.1 de	24.6 c	32.1 bcde
Weed free for 4 weeks	88.6 abc	2.3 cde	28.4 c	32.6 bcde
Weed free for 6 weeks	84.6 abcd	1.9 e	30.1 bc	32.1 bcde
Weed free for 8 weeks	92.6 ab	2.8 bcd	36.0 ab	33.9 bcd
Weed free for10 weeks	91.8 abc	3.3 ab	42.9 a	46.0 a
Weedy for 2 weeks	93.9 a	2.9 b	37.0 ab	38.5 abc
Weedy for 4 weeks	97.5 a	2.8 bc	36.3 ab	40.1 ab
Weedy for 6 weeks	79.1 cde	2.9 b	36.4 ab	37.4 abc
Weedy for 8 weeks	75.4 de	3.0 ab	37.0 ab	27.5 cde
Weedy for 10 weeks	67.9 e	3.6 a	38.0 a	23.8 de
Weed free full season	94.4 a	3.3 ab	41.4 a	43.4 ab
Weedy full season	80.0 bcde	2.0 de	24.5 c	21.5 e
SE±	13.3%	23.2%	18.3%	30.9%
CV%	5.7	0.3	3.1	5.3

Treatment means with the same letters are not significantly different at p (0.05) according to Duncan's Multiple Range Test.

Combined analysis of the two seasons indicated that, unrestricted weed growth, significantly, reduced okra dry pod and seed yields by 72.81 and 40.58%, respectively, compared to the weed free check (Table 2 and figure 1). This could be attributed to the presence of weeds which compete with the crop for essential mineral nutrients, water and light which resulted in reduction of plant growth parameters and henceforth decreased okra dry pod and seed yields. Similar results for reduction in dry pod yield was found by Mani (1977), while reduction in seed yield is similar to the findings of Mohammed *et al.* (2013); Rasheed and Oluseun (2009);

Bhalla and Parmar (1982) and singh *et al.* (1981).

A critical period for weed control (CPWC) is defined as the period in the crop growth cycle during which weeds must be controlled to prevent unacceptable yield losses (Oroka and Omovbude 2016).

Results showed that, okra dry pods and seed yield increased when the duration of weed infested period decreased. Similar results were found by Covindra *et al.* (1982), Iremiren (1988) and Oroka and Omovbude (2016). These results indicated that, the critical period of weed/okra competition was between 6 and 8 weeks after sowing (Figure 1). Further, these results were also in line with that obtained by Adeyemi *et al.* (2014) who reported that, the critical period of weed interference in okra was between 3 and 16 WAS; Imoloame (2013) who showed that, the critical period of weed/ okra competition was between 2 weeks after planting until harvest; Rasheed and Oluseun (2009) who said that, the critical weed-free period was between 2- 8 WAS in okra; Kumar and Charanjit (1986) who reported that, critical level in okra was 40 days after sowing and Sigh *et al.* (1981) who mentioned that, the critical period of weed competition in okra was between 2 to 6 WAS. However, the results obtained in this study did not agree with those found by Temnotfo and Henry (2017) who reported that, the critical period of weed interference in okra was 36 days after sowing; Imoloame (2013) who depicted that, the critical period of weed competition in okra was between 2 and 4 weeks after sowing and Mohammed *et al.* (2013) who reported that, the critical period for weed competition in okra was between 20 to 30 days after planting. The differences in the critical period of weed/okra competition is mainly due to many factors such as differences in weed species, weed infestation, environment, plant density, time of competition, soil fertility and crop cultivar.

Conclusions

1. The critical period for weed control in okra is between 6 and 8 WAS.
2. Weed control in okra should be carried out using post-emergence herbicides before 6 WAS.
3. Removing weeds in okra by hand or mechanical should be carried out before 6 WAS.
4. Removing weeds in okra during the critical period will negatively affect crop yield.

Table (2): Influence of duration of weed interference on yield and its components during summer seasons 2014 and 2015 combined

Treatments	Number of pods/plant	Number of seeds/pod	100 seed weight (g)	Seed yield (kg/fed.)
Weed free for 2 weeks	15.59bcd	56.53b	5.750a	726.6cd
Weed free for 4 weeks	17.81abc	66.25a	6.000a	955.5bc
Weed free for 6 weeks	17.17abc	65.80a	5.500a	963.9bc
Weed free for 8 weeks	16.99abc	62.78ab	5.500a	1012.1b
Weed free for 10 weeks	19.76a	61.53ab	5.875a	1201.13ab
Weedy for 2 weeks	17.79bc	66.28a	5.50a	1291.4a
Weedy for 4 weeks	19.09a	64.22ab	6.000a	1138.1ab
Weedy for 6 weeks	16.99abc	63.83ab	6.000a	1020.5 b
Weedy for 8 weeks	16.02bc	62.85ab	5.500a	751.8cd
Weedy for 10 weeks	13.07d	59.83ab	5.750a	665.6d
Weed free full season	18.39ab	66.40a	5.75a	1138.1ab
Weedy season	15.52cd	61.13ab	5.750a	676.3d
SE±	14.20%	11.90%	14.80%	23.24%
CV%	**1.2117**	**3.7509**	**0.4171**	**111.7663**

Treatment means in the same column with the same letters are not significantly different at p (0.05) according to Duncan's Multiple Range Test.

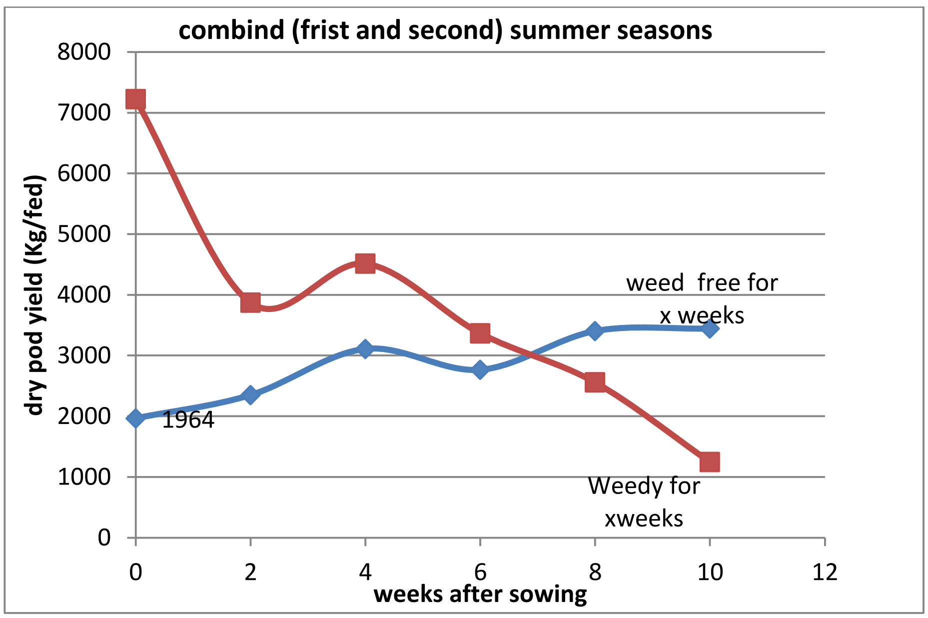

Fig. 1: Effect of weed competition on dry pod yield (kg/fed) during summer seasons 2014 and 2015, combined

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Research paper

Evaluation of Two Types of Mowers for Windrowing of Faba Bean (*Vicia faba*) in River Nile State, Sudan

Alaeldin M. E. Awad Alla

Hudeiba Research Station, Ed-Damer, River Nile State, Sudan

Corresponding author: alaeldinelhassan@yahoo.com

ABSTRACT

In northern Sudan, where farm holdings range between 0.5-2 ha, the small size of farms makes the manual traditional practices still prevailing for crops production. The faba bean is one of the major food legumes crops grown in the region. This evaluation carried out at Hudaiba Research Station, to test two types of fodder mower to cut faba bean to face the problem of unavailability of labor at harvest time and high cost of wage during the last three years. The two mowers reduce the cost of cutting by 69% compared to manual cutting. The evaluation presented some technical specifications and recommendation when using the mowers for cutting faba bean to reduce losses.

Keywords: faba bean, sickle mower, disc, mechanical cutting, losses

تقييم استخدام نوعين من قاطعات الاعلاف في القطع المنتظم لمحصول الفول المصري بولاية نهر النيل، السودان

علاء الدين محمد الحسن عوض الله

محطة بحوث الحديبة، الدامر، السودان

الحيازات الصغيرة تجعل من خدمة المحاصيل يدويا تظل هي الممارسة السائدة في شمال السودان حيث المساحات لا تتجاوز نصف الي 2 هكتار. يمثل محصول الفول المصري واحد من المحاصيل المهمة المزروعة في هذا الاقليم. اجريت هذه الدراسة في محطة بحوث الحديبة لتقييم اداء اثنين من انواع قاطعات الاعلاف لحصاد محصول الفول المصري، لحل مشكلة ندرة العمالة في وقت الحصاد وارتفاع التكاليف الملموس خلال الثلاث سنوات الاخيرة. تكلفة الحصاد بقاطعات الاعلاف كانت ادني بنسبة 69 % مقارن بتكلفة الحصاد اليدوي. اجمل تقييم هذه الحاصدات عدد من الملاحظات الفنية والتوصيات التي يجب مراعاتها عند استخدام هذا النوع منها لحصاد الفول المصري.

كلمات مفتاحية : الفول المصرى، قاطعة اعلاف منجلية، قرص، القطع الميكانيكى، الفقد

Introduction

Faba bean (*Vicia faba*) is one of the major food legume crops, it is used as human food in developing countries and as a common breakfast food in the Middle East, Mediterranean region, China and Ethiopia, it can be used as a vegetable, green or dried, fresh or canned (Gasim and Link, 2007), and used as animal feed in industrialized countries (Singh *et al*., 2012). The annual production in sub-Sahara Africa in 1999 to 2003 was estimated at 510,000 tones, almost entirely about 405,000 tons produced in Ethiopia and about 100,000 in Sudan (Anil, 2013).

Faba bean crop is one of the most important cool-season food legumes produced in the Sudan, the faba bean provide a major part of the daily diet, particularly among the poorest sections of the population and it is also cash crop for farmers. The Northern region of the country (Northern and River Nile states) is the main production area for the crop, where about 27% of the North Africa area planted in the Northern region of Sudan (MOA, 2014), because of its favorable climatic conditions, particularly the relatively cooler winter. The crop grown under surface irrigation system, and irrigated agriculture extends along the River Nile banks which stretch over 678 km of the narrow strip of cultivable land along the Nile with the farm holding ranges between 0.5-2 hectares. There is a decline in the area cultivated and average yield per hectare from season 2007 to 2013 (MOA, 2014) (Fig.1) due to traditional manual cultural practices still prevailing in the northern region including manual harvesting of the crop, which is expensive and time consuming. Several surveys conducted by Nile Valley Project in the Sudan, recorded that harvesting faba bean (including cutting; transport; threshing and cleaning) accounted for between 32-47% of the total production cost of the crop (Salkini *et al*., 1983a,b), where concerning work rate a four-labor required about 23.8 working hour to cut, bind and to collect on heaps one hectare (Awad Alla *et al*., 2014), given that food legume production is often held back by a lack of technology and the limited application of new innovations (Haddad *et al*.,1988).

Legume crops in some developed and European countries are successfully harvested mechanically, fully mechanized by direct harvest or by mowing and bandaging followed by combining. However, the systems used might not be suitable for farmers in the Sudan, as farmers in the northern region have small-holdings, they plant legume crops using traditional methods to grow the faba bean crop under surface irrigation, in addition, socioeconomic factor in the region consider the crop residue as an important animal feed. Therefore, harvest mechanization may well demand different approaches.

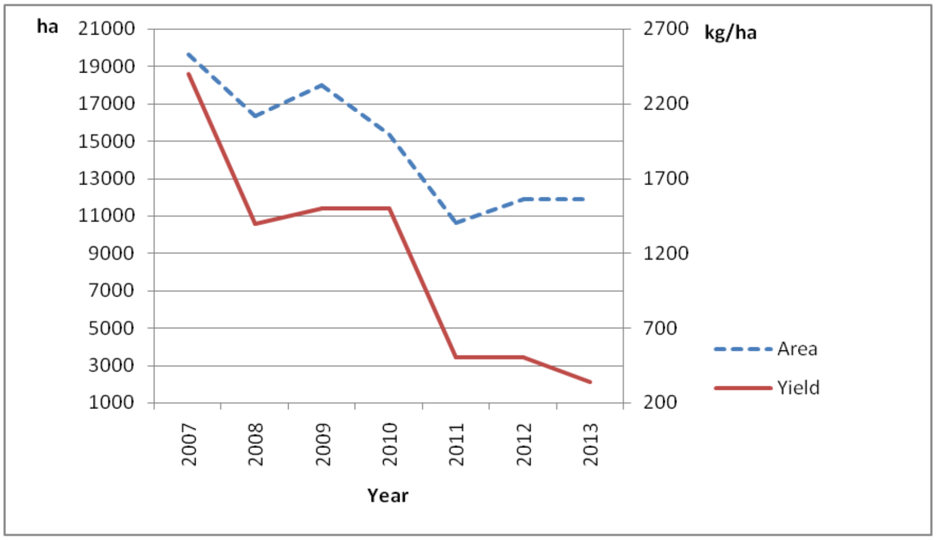

Fig. 1: Area of faba bean and yield during 2007-2013 in River Nile State

In the northern region of Sudan, two stages of harvesting is still practiced for the crop, which is manual cutting at physiological maturity for drying, and binding and collecting the crop on heaps then feeding to stationary threshers. In recent years the high cost of labor wage and unavailability at proper time, has challenge the continuity of the crop production in the region. For sustainability of crops produced with traditional practices, the application of mechanical technology in agriculture enhance the productivity of human labour up to 500 times in comparison to traditional agriculture (Mazoyer, 2001), also for analysis of data in India from 1950-1997, shows that the yield is positively related to power available in both time and space (Singh, 2001). In northern region of Sudan, introduction of direct harvesting is very difficult, because of small holdings; different crops grown; ridges and inter canals for surface irrigation and the needs of crop residue as animal fodder.

Solving faba bean harvesting problem is crucial to encourage farmers to grow more area of faba bean. Intensive efforts by national agricultural engineering research program are now being made to overcome this important constraint, as introduce of simple available technology to substitute labor at harvest cutting operation, that a simple and inexpensive tractor mounted mower or windrower equipment could be a potential solution, as windrowing is becoming more popular in faba bean. Therefore, the objective of this demonstration is to evaluate the available prevailing fodder mower in the the northern region for mechanical windrowing of faba bean in terms of pods and seeds losses, uncut stems, work rate and harvest cost.

Materials and Methods

The mechanical cutting of faba bean executed using two types of tractor rear mounted mower, single effect sickle bar mower model Gaspardo (Fig. 1, Photo1) and disc mower model Agromaster TOB 1350 (Fig.1, Photo2). Some technical specifications for the two mowers are presented in Table 1, the main difference is that the drum speed is unadjustable in the Agromaster type. The demonstration executed during seasons 2012/13 to 2015/16. According to indeterminate growth habit of faba bean, the pods ripen sequentially; therefore, windrowing needs to be done at the appropriate stage, to minimize losses due to shattering. The mechanical cutting carried out at two different intervals in the first season only and at maturity stage in the second two seasons.

The two mowers compared with manual cutting using hand held sickle, normally the work team contain three workers with seven work hours per day. Area of 1.2 hectare in Hudeiba Research Station farm sown by faba bean variety Hudeiba 93, divided to three sections equally, a twenty-one stems at W track were tagged by sticker to determine stem height and count number of pods and seeds before and after cutting. This replicated three times along each section, to determine loss as a percentage of pods and seeds; uncut stem and length of cut stems, also data on work rate were collected for each section. In a preliminary test the cut crops did not arrange in line to ease the operation of crop collection which appear with the two mowers. To overcome the problem, wings were fixed at rear of each mower. Each section was cut by one of the three methods mentioned, the time of cutting at daylight to able collecting tagged stems.

Results and Discussion

From the results shown in Table 2, generally, the losses increased when delay cutting by the two types of the mower tested, it was more in case of the disc mower, from shattering action to dry pods, which attributed to high peripheral disc speed, than with sickle mower. The more uncut stem percent with sickle mower refer to that, single effect mower bar making one cut by stroke. The distance of cut from the soil surface appears under the height of pods setting in three methods. For the work rate, one team require at least two days for one hectare working most hours at daylight. Harvest of legumes is critical, because delays can result in significant yield losses due to lodging, shattering and pod loss, as faba beans are very prone to pod splitting and pod drop after once the plant has dried down, yield losses of up to 30% have been recorded (GRDC, 2017). Therefore, considering the unavailability of labor to cut the crop at the optimum time, which will result in increased pre-harvest loss, using the mower with the reduction of cost by 69%, can become the farmer decision.

Conclusion

The results from the demonstration, explain some technical specifications to be in the mower for mechanical cut of faba bean in River Nile State, that double action sickle bar mower to reduce uncut stem, and variable pulley speed system for disc type to reduce losses, and adjustable rear wings for swathe purpose. In the mean time the available mower can be used with seeds moisture content of 45% (NSWA, 1999) in the morning or night to reduce losses.

Table (1): Some technical specifications for Sickle bar and drum mowers.

Item	Sickle bar mower	Drum mower
Working width (cm)	130	135
No. of blades	18 teeth	2 drum each has 6 blades
Rpm	Tractor rpm 540	Tractor rpm 540, Drum rpm 1920
Motion drive	V belt	V belt

Table (2): Parameters to evaluate mechanical cutting of faba bean at HRS

Method	PH (cm)	PSSS (cm)	SLAC (cm)	Losses on pods on grain (%)		Uncut stem (%)	Work rate (hr/ha)	Cost SDG/ha
Cutting date 13/2/2013								
Sickle bar mower	67	30	12	5	11	7.7	2.7	
Disc mower	72	28	11	6.3	16.5	4.8	2.9	
Manual cut	81	24	4	1.8	5.2	3.2	34	
Cutting date 17/2/2013								
Sickle bar mower	71	23	11	8.3	20	7.7		
Disc mower	84	37	19	39	60	0		
Season 2014/2015								
Sickle bar mower	97	33	20	5.3	13.7	9	3.7	
Disc mower	93	26	13	2.5	5.3	5	2.4	
Manual cut	94	24	5	1.6	2.4	3.2	57	
Season 2015/2016								
Sickle bar mower	83	32	22	5.4	12	8.1	3.4	400
Disc mower	97	40	15	8	12	5	4	400
Manual cut	101	39	12	2.1	3.1	3	32	1300
Mean								
Sickle bar mower	82	32	18	5.2	12.2	8.3	3.3	
Disc mower	87	31	13	5.6	11.3	4.9	3.1	
Manual cut	92	42	7	1.8	3.6	3.1	41	

PH: plant height, PSSS: pods setting height from soil surface, SLAC: remain stem length on soil after cutting.

SDG= Sudanese pound (1 US$= 16 SDG)

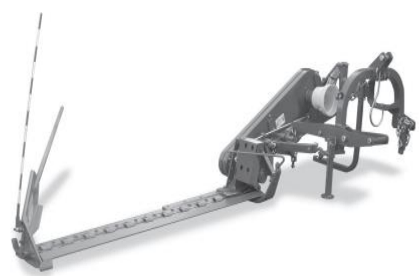

Photo 1.

Photo 2.

Fig. 1: Single effect sickle bar mower model Gaspardo (Photo1) and disc mower model Agromaster TOB 1350 (Photo2).

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Research paper

Caprine Subclinical Mastitis in Atbara Area, River Nile State

Azhari F. M. Kambal[1] and Samia A. M. Hassabo[2]

1 Department of Animal Production, Faculty of Agriculture, Nile Valley University,

2 Atbara Veterinary Hospital, Atbara, River Nile State, Sudan.

Corresponding author: fathikambal641@yahoo.com

ABSTRACT

The study investigates Caprine Subclinical Mastitis (CSM) using local breed (Nubian), Saanen and Cross breed (Nubian+Saanen) goats in Atbara Area, Sudan. The study was carried out by using two field tests; California mastitis test (CMT) and White side test (WST). Results revealed that the prevalence of CSM out of 100 half/udder milk samples was 56% and 44% according to CMT and WST, respectively. Bacterial isolation and identification was done according to Cowan and Steel. The predominant isolated bacteria were: Staphylococcus, Pasteurella, Aeromonas, Micrococcus, Escherichia and Klebsiella. Streptococcus, Corynebacterim and Enterobacteria were isolated with lesser frequencies. Results revealed that Nubian breed was more resistant to causative bacteria (33.3% susceptibility), followed by Saanen (66.6%) and Cross breed (88.8%). Antimicrobial susceptibility tests were carried out by disc diffusion method on the Mueller Hinton agar. Out of six studied antibiotics Ciprofloxacin and Gentamicin showed 100% activity against both G+ve and G-ve isolates, while Chloramphenicol showed 100 and 60% activity against G+ve and G-ve, respectively. However 77.7% of isolates were resistant to Amoxicillin. CMT is more precise than WST in screening for CSM.

Key words: goats, subclinical mastitis, CMT, WST, antibiotics

التهاب الضرع تحت السريري في الماعز بمنطقة عطبرة- ولاية نهر النيل

أزهري فتح العليم محمد كمبال[1] و سامية أحمد محمد حسبو[2]

1 قسم الإنتاج الحيواني، كلية الزراعة، جامعة وادي النيل، السودان

2 مستشفى عطبرة البيطري، عطبرة، ولاية نهر النيل، السودان

هذه الدراسة تستكشف التهاب الضرع تحت السريرى مستخدمة الماعز المحلى النوبى والسعانين وهجين من النوبى والسعانين بمنطقة عطبرة- السودان. اجريت الدراسة باستخدام اثنين من الاختبارات الحقلية، اختبار كاليفورنيا لالتهاب الضرع (CMT) واختبار الوايت سايد (WST). اظهرت الدراسة ان انتشار المرض المذكور فى 100 عينة (عينات نصف الضرع) حليب هو 56 و44% لنوعى الاختبارين المذكورين CMT و WST على التوالى. عزل ومعرفة البكتريا تم حسب طريقة كاون وستيل. النوع السائد من البكتريا المعزولة هى المكورات العنقودية(ستافيلوكوكس)، الباستوريلا، الايروموناس، المايكروكوكس، الاشريشية، الكلبسيلا، اما ستريبتوكوكس، الكورانيباكترم، الانتيروباكتر فقد تم عزلهم بصورة اقل. اثبتت النتائج ان الماعز النوبى اكثر مقاومة للبكتريا المسببة للمرض (بمستوى اصابة 33%) ثم السعانين (بمستوى اصابة 66.6%) والهجين (بمستوى اصابة 66.8%). تم اجراء اختبار فعالية المضادات الحيوية بطريقة الانتشار القرصى فى اجار مولر هنتون. بين المضادات الست التى تم اختبارها اظهر كل من سبروفلاكسين و جنتاميسين فعالية بنسبة 100% ضد البكتريا الموجبة والسالبة لصبغة جرام، بينما اظهر كلورامفينوكول فعالية بنسبة 100% و 60% ضد البكتريا الموجبة لصبغة جرام والبكتريا السالبة لصبغة جرام، على التوالى. اظهرت 77.7% من البكتريا المعزولة مقاومة للاموكسسلين. اختبار CMT كان اكثر دقة من اختبار WAS فى الكشف عن التهاب الضرع.

كلمات مفتاحية: الماعز، التهاب الضرع السريرى، اختبار كاليفورنيا، اختبار وايت سايد

Introduction

Subclinical mastitis is an invisible abnormality of milk and udder in goats which is characterized by an increase in somatic cell and/or leukocyte counts (Radostitis *et al*., 1994). The importance of goats as a source of meat and dairy products has been well discussed and documented in a recent review by Haenlein (2004). This importance is also reflected by increase in goat population during the last two decades.

Subclinical and chronic mastitis are most persistent and widespread forms of intermammary infection (IMI) affecting high milk producing breeds of goats (Bergonier *et al.*, 2003). The proportion of udder halves with subclinical IMI in goats in deferent countries ranges from 35% to 70% (Menzies and Ramanoon, 2001 and Leitner *et al*., 2004). Subclinical mastitis in goats is by far, the most expensive disease as it reduces milk and cheese yields because of deterioration of milk quality in infected glands, reflected by elevated Somatic Cell Count (SCC) and the presence of microorganisms (Countreras *et al*., 2007). In goats IMI, the coagulase-negative S*taphylococci* (CNS) are the most prevalent microorganisms isolated from chronic and subclinical infections (Bergonier *et al*., 2003).

Mastitis is a disease of considerable economic importance worldwide for both dairy goats and cattle (Radostitis *et al*., 1994). Poor management of sanitary conditions, lack of therapeutics and control measures play vital role in the development of this disease in goats.

In developed countries proper strategies of disease monitoring and control have been developed, however in the River Nile State, little information is available regarding prevalence of subclinical mastitis in goats. This study aims to investigate the prevalence of Caprine Subclinical Mastitis in the mentioned area as well as its etiological agents and their susceptibility to different antibiotics to support effective measure treatment.

Materials and methods

Source and collection of samples

A total of one hundred half-udder milk samples from different locations (twenty samples each) were collected from apparently healthy 50 goats (with no evidence of acute mastitis) of varying age (1-10 years). Samples represented three breeds of goats: Local breed (Nubian), Sannen and Cross breed (Nubian+Sannen). Milk samples were drawn after morning milking. After discarding the first few mls of milk, the teat end of each half-udder was thoroughly cleaned with cotton soaked in 70% ethanol. Two mls of milk samples were squeezed from each half into the cup of the test plate for CMT and WST at the field (location of samples) and 10ml milk samples were collected into sterile bottles immersed in ice. Samples were analyzed in Atbara Veterinary Research Laboratory.

Field screening tests

The CMT and WST were performed as primary filed screening tests on milk samples to detect subclinical mastitis and determine the prevalence rate of disease according to both methods by taking positive samples as a numerator and the total tested samples as a denominator.

Bacteriological examination

For primary isolation of bacteria blood base agar (Columbia, scharlau, 01.034) and Nutrient agar [PLASMATEC, M8] were prepared according to instructions of the manufacturer. Primary isolated bacteria were inoculated on blood agar slants, incubated overnight at 37°C to allow growth and then preserved at 4°C. For bacterial identification all inoculated plates incubated aerobically at 37°C daily for up to 7 days and evaluated by growth and changes in the medium. Further identification was done according to Cowan and Steel (1993) which included; Gram's stain, aerobic growth, motility test, spore formation and biochemical tests including catalase activity and oxidase test.

Antibiotic susceptibility test

The test was carried out by the disc diffusion method using commercial separated discs of the following antibiotics:

1. Tetracycline (T)30 (HIMEDIA, SD 037-5CT) 30 mcg /disc
2. Amoxicillin (AM)10 (MIMEDIA, SD 001-5CT) 10 mcg/disc.
3. Streptomycin (S)10 (HIMEDIA, SD 031-5CT) 10 mcg/disc
4. Ciprofloxacin (CF)5 (HIMEDIA. SD 060-5CT) 5 mcg/disc.
5. Gentamicin (G)10 (HIMEDIA. SD 016 – 5 CT) 10 mcg/disc.
6. Chloramphenicol (C)30 (HIMEDM, SD 006-5CT) 30mcg/disc.

The test was done according to the guidelines of Clinical Laboratory Standard Institute (CLSI, 2000). The Mulleler Hinton agar was used to perform the antibiotic susceptibility test. Results were interpreted according to the zone size interpretative chart as "susceptible", "intermediate" or " resistant".

Results

Table (1) shows results of field screening tests. The total number of milk samples with positive CMT were 56% while samples with positive WST were 44%. The percentage of positive samples in different locations ranged from 35-70% and 20-70% with CMT and WST, respectively. The results of the screening tests for the 50 goats revealed that the overall prevalence rate was 28 (56%) and 22 (44%) on the basic of CMT and WST, respectively.

Table (2) shows the influence and prevalence of caprine subclinical mastitis on the basis of age, breed and parity. The results revealed that goats above four years of age showed higher prevalence rate of mastitis, 57.1% and 59.1% for CMT and WST, respectively. Goats in category of 2-4 years of age showed prevalence rate of mastitis with 35.7 and 36.3% by CMT and WST, respectively. In category of 1 – 2 years of age goats showed further decrease to 7.1 and 4.5% by CMT and WST, respectively. Regarding breeds results, prevalence rate of mastitis for Nubian goats was 10.7 and 18.1%, for Saanen was 39.2 and 27.2% and for cross breed was 50 and 54.5% on the basis of CMT and WST, respectively. On the basis of parity, the highest prevalence rate was 46.4 and 50% recorded with CMT and WST, respectively in goats having three or more parities.

Table (3) shows the overall bacterial isolation confirmed in 76 samples out of 100 half-udder examined milk samples, which represent 76%. Out of 76 positive samples, there was 61 (80.1%) were single isolates and 15 (19.9%) were mixed infection.

Table (4) illustrates the correlation between screening test and bacterial isolation. All +ve bacterial isolates showed false-negative reactions in the field screening test. This reveals that false negative reactions of bacterial isolates were 20 (26.3%) and 32 (42.1%) in CMT and WST, respectively.

Table (5) represent the identification of the bacterial isolates to the genus level. It shows that all the isolates belonged to nine different genera. Four genera were Gram positive bacteria isolated bacteria namely, *Staphylococcus, Streptococcus, Micrococcus* and Corynebecteria. The rest were Gram negative bacteria genera (*Pasteurella, Klebisella, Escherichia, Entrobacter* and *Aeromonas*). The most common bacterial genera recovered from positive studied samples were *Staphylococcus* (25%), *Pasteurella* (19.7%), *Aeromonas* (13.1%), *Micrococcus* (8%), *Escherichia* (6.5%) and *Klebsiella* (4%). *Streptococcus, Corynebateriim* and *Enterobacter* were isolated with lesser frequencies.

Table (6) shows the results of goat breeds susceptibility test to the different genera of bacterial isolates which revealed that the Nubian breed (local breed) was more resistant to subclinical mastitis and susceptible only to 33.3% of causative bacteria, which were, *Staphylocaccus, Corynebcaterium* and *Aeromonas*. The Saanen breed was susceptible to 66.6% and cross breed showed minimum resistant and had been susceptible to 88.8% of isolated bacteria.

Table (7) illustrate the effectiveness of six antibiotics, Ciprofloxacin (CF), Streptomycin (S), Amoxicillin (Am), Chloramphenicol (C), Gentamicin (G) and Tetracycline (T) against each of the nine isolated genera of bacteria. The results showed that Ciprofloxacin and Gentamicin were very effective against both G+ve and G-ve bacteria (100%). Further, Chloramphenicol showed 100% and 60% effectiveness against G+ve and G-ve organisms, respectively.

Discussion

In this study, the test of CMT was effective in field screening for the presence of subclinical mastitis, because it was positively correlated with SCC (Mcdougall *et al*., 2001). Previous studies reported that CMT might be useful for detection of healthy udders (Karzis *et al*., 2007 and Petzer *et al*., 2008). Somatic cell count is the most widely used indicator of udder health in cow, sheep and goat milk, but unfortunately SCC is difficult to interpret in goats. Compared with sheep and cows, SCC in goat milk and healthy udder is relatively high and it increases throughout the lactation and also with parity (Paape and Capuco, 1997). The highest prevalence rate was recorded in goats having three or more parities. Age and parity are the most significant factors in determining the prevalence of mastitis in goats. Milk somatic cell count increases with age and lactation as reported by Zeng *et al*. (2008) and Zamin *et al*. (2010). Further, an increase in prevalence related to parity was reported in goats by Leitner *et al*. (2001) and Bergonier *et al*. (2003).

Schaeren and Maurer (2006) reported a great variation in SCC among farms and among individual animals. Similarly, in this study, the percentage of false negative reaction of CMT regarding to the bacterial isolates proved that no correlation between the field screening test (CMT) and SCC for individual animals. However, elevated SCC is mainly a response to infection (Poutrel *et al*., 1997). Therefore, measurement of SCC seems likely to be a reliable way to detect goats with intermammary infection (IMI).

Regarding overall bacterial isolation, false- negative reaction of CMT was less about 15.8% than WST. Accordingly, CMT is more sensitive and more accurate than WST in screening subclinical mastitis in tested goats. These results agreed with that obtained by Iqbal *et al*. (2003), who approved that WST is not very responsive in detecting mastitis positive cases. The negative result of CMT and positive bacterial isolation for the same samples, may be attributed to the fact that some of the bacteria could not be detect by CMT due to their lower pathogenicity or otherwise their mere presence as udder microflora (Elliot *et al.*, 1976 and Motie *et al*., 1985).

The most dominant bacteria in milk samples was *Staphylococcus* (25%). However, Zamin *et al*. (2010) found that the presence of *Staphylococcus* as the causative agent of subclinical mastitis in goats was (45.3%). Similar results were also reported in other countries such as, USA (38.2%), Spain (70.0%) and Kenya (60.3%) (White and Hinckley, 1999; Sanchez *et al*., 1999 and Ndegwa *et al*., 2001).

The highest prevalence percentage of subclinical mastitis was detected in the Cross breed, followed by Saanen and Nubian breeds, respectively. This may be due to the fact that Nubian goat (local breed) had more adaptation to the regional environment compared to others. Breed differences in susceptibility to SCM could be attributed to differences in intramammary infection, milk yield or genetic factors (Gonzalo *et al*., 2005).

Susceptibility test of the bacterial isolates in vitro showed that Ciprofloxacin and Gentamicin were the most effective antibiotics in controlling Caprine Subclinical Mastitis, followed by Chloramphenicol. However, the isolated bacteria are more resistant to Amoxicillin. In relation to antibiotic susceptibility Castro *et al*. (2001) reported that Gentamicin shows high susceptibility to bacteria in vitro. On the other hand, Da Silva *et al*. (2004) found that bacteria in Caprine mastitis are more resistant to Penicillin G. This may be due to the frequently use of the same antibiotics which may lead to antibiotic resistant (Tras *et al*., 2007). Further, different results obtained from antibiotics susceptibility may be mainly due to misuse of antibiotics and difference of bacterial strains. Similarly, Gentamycin, Ampicillin and Tetracycline were reported to be the most effective drugs in treating CSM in Camels (Hawari and Hassawi, 2008).

Table (1): Overall prevalence rate (%) of subclinical mastitis according to the field screening tests

Locations	Examined samples	+ve samples (%)	
		CMT	WST
1	20	14 (70%)	14 (70%)
2	20	8 (40%)	8 (40%)
3	20	7 (35%)	4 (20%)
4	20	14 (70%)	9 (45%)
5	20	13 (65%)	9 (45%)
Total	**100**	**56 (56%)**	**44 (44%)**

CMT: California mastitis test; WST: White Side test

Table (2): Prevalence of Caprine subclinical mastitis related to age, breed and parity

Test	Age/years			Breed			Parity		
	1-2	2-4	>4	Nubian	Sannen	Cross	First	Second	≥ third
CMT	2 (7.1%)	10 (35.7%)	16 (57.1%)	3 (10.7%)	11 (39.2%)	14 (50.0%)	6 (21.4%)	9 (32.1%)	13 (46.4%)
WST	1 (4.5%)	8 (36.3%)	13 (59.1%)	4 (18.1%)	6 (27.2%)	12 (54.5%)	4 (18.1%)	7 (31.8%)	11 (50%)

Table (3): The percentage of overall bacterial isolation

Total of examined samples (%)	Overall +ve sample (%)	+ ve with single isolates (%)	+ ve with mixed isolated (%)
100	76	61	15
%	76%	80.1%	19.9%

Table (4): Percentage of false-negative reaction of both CMT and WST regarding bacterial isolation results

+Ve B.Iso*	Test	+ve Results	False – ve reaction (%)
76	CMT	56	20 (26.3%)
	WST	44	32 (42.1%)

* Bacterial isolation

Table (5): Percentage of different genera of both G+ve and G-ve bacterial isolates

Infection	Gram positive isolates	No. & % of +ve samples
Single	*Staphylococcus*	19 (25%)
	Streptococcus	01 (1.3%)
	Micrococcus	06 (8%)
	Corynebacterium	01 (1.3%)
	Pastcurella	15 (19.7%)
	Klebisella	03 (04.0%)
	Escherichia	05 (06.5%)
	Enterobacter	01 (01.3%)
	Acromonas	10 (13.1%)
Mixed	*Micrococcus + Streptococcus*	01 (1.3%)
	Staphylococcus + Aeromonas	03 (4.0%)
	Escherchia + Pasteurella	03 (4.0%)
	Staphylococcus + Streptococcus	03 (4.0%)
	Pasteurella + Aeromonas	02 (2.6%)
	Streptococcus + Aeromanas	03 (4.0%)

Table (6): Susceptibility of tested goat breeds to different genera of bacterial isolates

Bacterial Genera	Nubian breed	Sannen breed	Cross breed
Staphylococcus	+	+	+
Streptococcus	-	+	-
Micrococcus	-	+	+
Corynebcaterium	-	-	+
Pasteurella	+	+	+
Klebisella	-	-	+
Enterobactor	-	-	+
Escherichia	-	+	+
Aeromonas	+	+	+

Table (7): Antibiotic susceptibility of different genera of bacterial isolates

Type of Isolate	Genera	The antibiotics susceptibility					
		CF	S	Am	C	G	T
Gram positive	*Staphylococcus*	S	M	R	S	S	M
	Streptococcus	S	S	S	S	S	M
	Micrococcus	S	M	R	S	S	M
	Corynebacterium	S	M	R	S	S	S
Gram negative	*Pasteurella*	S	M	R	S	S	R
	Klebsiella	S	S	M	M	S	S
	Enterobacter	S	S	R	S	S	R
	Escherichia	S	M	R	M	S	R
	Aeromonas	S	R	R	S	S	S

S= Susceptible M= Moderate R= Resistant

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Research paper

Genetic Variability, Heritability and Genetic Advance in Bread Wheat (*Triticum aestivum* L.)

Fatih Elaliem A. Hamza[1], Hussein A. Idris[2] and Galal A. El Toum[3]

1 Agricultural Research Corporation. Merawe Research Station. Sudan.

2 Department of Horticulture, faculty of Agricultural Sciences, University of Dongola, Sudan.

3 Department of Agronomy, faculty of Agricultural Sciences, University of Dongola, Sudan.

Corresponding Author: galaleltoum98@gmail.com

ABSTRACT

Genetic variability is important for crop improvement. This study aimed to determine genetic variability, heritability and genetic advance for yield and other agronomic traits of bread wheat. Each experiment was laid out in a randomized complete block with three replications. The analysis of variance showed significant variation among the genotypes for all tested characters. Genotypic coefficient of variation (GCV) and phenotypic coefficient of variation (PCV) were highest for number of spikes per m^2 and plant height. High heritability was recorded on plant height and 1000 – grain weight.

Key words: Agronomic traits, genotypic variation, phenotypic variability.

التباين الوراثي والتوريث والتقدم الوراثي في قمح الخبز

فتح العليم عوض حمزة[1] وحسين عبد الرحمن إدريس[2] وجلال احمد التوم[3]

1 هيئة البحوث الزراعية، محطة بحوث مروى، السودان

2 قسم البساتين، كلية العلوم الزراعية، جامعة دنقلا، السودان

3 قسم انتاج المحاصيل، كلية العلوم الزراعية، جامعة دنقلا، السودان

التباين الوراثي مهم لتحسين المحاصيل. هدفت هذه الدراسة الي تحديد التباين الوراثي والتوريث والتقدم الوراثي للإنتاجية وبعض الصفات الحقلية الأخرى لقمح الخبز. تم استخدام تصميم القطاعات العشوائية الكاملة بثلاث مكررات لتنفيذ كل تجربه. اوضح تحليل التباين وجود اختلافات معنويه بين اصناف القمح في كل الصفات المدروسة اعطي معامل التغير الوراثي ومعامل التغير المظهري اعلى نسبه لعدد السنابل في المتر المربع وطول النبات. التوريث العالي المتقدم سجل في طول النبات ووزن ال 1000 حبه.

الكلمات المفتاحية: الصفات الحقلية، التباين الوراثي، الاختلاف المظهري

Introduction

Wheat (*Triticum aestivum* L.) is one of the most widely grown cereal crops, contributing to the global food supply and economic security. Globally, the total cultivated area is 221.61 million ha producing739.53 million tones with an average yield of 3289 kg per hectare (FAOSTAT, 2018). The enhancement in wheat productivity and the development of improved crop management technologies played crucial roles in its expansion to new non-traditional and less favorable areas. For instance, wheat yield was estimated to be 30.2kg/ha/year during the period from 1960 to 1990 (Tahir *et al.,* 2000). The growing season of wheat in Sudan is short (about 100-110 days from mid-November to early March) leading to heat stress being one of the major factors that affect wheat grain yield and quality (Ishag and Ageeb, 1991; Elahmadi, 1996; Tahir *et al*, 2006). Genetic variation is required to achieve genetic gains in a breeding program. Estimation of genetic variation among genotypes can be based on qualitative and quantitative traits (Souza and Sorrells, 1991; Barbosa-Neto *et al.*, 1996; Cao *et al.*, 1998; Fahima *et al.*, 1999). Demand of wheat is increasing by population growth and always be felt new method which can select high yielding varieties fast and accurate. Selection of genotypes based on high value of heritability and forecasted genetic conditions would be an effective method (Ghandorah and El -Shawaf, 1993). Heritability estimates need to be considered together with genetic advance, which is more important than heritability alone to predict the resulting effect of selecting the best individuals. It had been generally believed that the higher the heritability estimates of given traits, the simpler the selection procedure and the better would be the response to selection (Baloch, 2004).

A number of researchers in their studies have reported the presence of high heritability and genetic progress in different yield related attributes in wheat; Afiah *et al.*, (2000); Ashraf *et al.*, (2002); Arshad and Chowdhry (2003); Baloch *et al.* (2003); Khalil and Afridi (2004); Shabana *et al.* (2007) and Kumar *et al*. (2014).

The present study was carried out to estimate genetic variation, heritability and genetic advance in 24 bread wheat genotypes for utilization in selection programs aimed at productivity increase of future genotypes.

Materials and methods

Area of experiment, genetic material and cultural practices

Two experiments were conducted during the winter seasons of 2013/14 and 2014/15 at Merowe Research Station Farm (M.R.S.F), Northern State, Sudan (Latitude: 18° 27' 0'' N, Longitude: 31° 49' 59'' E, Elevation: 258 meters). The geotypes used in the experiments included 24 advanced breeding lines and varieties of wheat (*Triticum aestivum* L.), which were selected from the national wheat breeding program of the Agricultural Research Corporation (ARC), Sudan. Twenty genotypes were advanced breeding lines and the others were released varieties namely; Wadi El Neel, Debeira, Imam and El Nielain. Pedigree of the pracices as advanced genotypes used in the study were given in Table (1). All cultural practices were recommended by Agricultural Research Corporation (ARC), Sudan. Each plot consisted of seven rows, each row was 5 m in length and the distance between rows was 20 cm apart at a seed rate of 120 kg/ha.

Statistical analysis

The collected data were subjected to standard procedure of analysis of variance and means separated using Duncan's Multiple Range Test (DMRT) method as described by Gomez and Gomez (1984) using MSTAT C software package.

Estimation of genetic variability, heritability and genetic advance

Heritability in broad sense (H^2) was estimated according to Falconer (1989) as follows:

$$\text{Heritability } (H^2) = (\sigma^2 g / \delta^2 ph) \times 100$$

H^2: Heritability; $\delta^2 g$: genotypic variance and $\delta^2 ph$: phenotypic variance. Genotypic ($\delta^2 g$) and phenotypic variances ($\delta^2 ph$) were obtained from the analysis of variance Table according to Comstock and Robinson (1952) as follows:

$$\delta^2 g = (MS1 - MS2) / r \times s$$

$$\delta^2 ph = (MS1) / r \times s$$

Where:

r: replication, s: season, MS1: Mean square for cultivar, MS2: Mean square for genotype × season.

Table (1): Twenty four bread wheat advanced genotypes used in the study

Entry no.	Cultivar / line
1	Wadi El Neel (released commercial cultivar)
2	Debeira (released commercial cultivar)
3	Imam (released commercial cultivar)
4	El Nielain (released commercial cultivar)
5	TRCH*2//PFAU/WEAVER
6	SERI.IB*2/3/KAUZ*2/BOW//KAUZ/4/PBW343*2/…
7	HUAYUN-INIA
8	CHUM18/7*BCN
9	HUBARA-2/QAFZAH-21//DOVIN-2
10	KAUZ'S'/FLORKWA-1//GOUMRIA-3
11	PBW343*2/KUKUNA//KIRITATI
12	KAUZ'S'/SERI/3/KAUZ//KAUZ/STAR
13	BAJ #1/3/KIRITATI//ATTILA*2/PASTOR
14	WBLL1/KUKUNA//TACUPETO F2001/4/WHEAR/KUKUNA/3/C80.1/3*BATAVIA//2*WBLL1
15	ATTILA/3*BCN//BAV92/3/PASTOR/4/TACUPETO F2001*2/BRAMBLING/5/PAURAQ
16	SOMAMA-9/ICARDA-SRRL-2
17	ATTILA 50Y//ATTILA/BCN /3/STAR*3/MUSK-3
18	KAUZ'S'/SERI/3/KAUZ//KAUZ/STAR
19	YAV_3/SCO//JO69/CRA/3/YAV79/4/AE.SQUARROSA(498)/5/LINE 1073/6/KAUZ*2/4/CAR//KAL/BB/3/NAC/5/KAUZ/7/KRONSTAD F2004/8/KAUZ/PASTOR//PBW343
20	Kavir
21	Kauz //Trap # 1 / Bow
22	KAUZ'S'/SERI/3/TEVEES"S'// CROW/VEES
23	Panar
24	RUSHI

The mean values were used for genetic analyses to determine phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV), according to Singh and Chaudhury (1985) as follow:

Phenotypic coefficient of variation (PCV) = $(\sqrt{\delta^2 g} / \bar{x})$ x100

Genotypic coefficient of variation (GCV) = $(\sqrt{\delta^2 ph} / \bar{x})$ x 100

Where:

$\delta^2 g$ = genotypic variance.

$\delta^2 ph$ = phenotypic variance.

$\bar{x}$ = sample mean.

Genetic advance (GA) was calculated with the method suggested by Allard (1960); Singh and Chaudhury (1985) as follows:

$GA = K. \sigma ph. \ H^2$

Where:

GA: genetic advance, K: constant = 2.06 at 5% selection intensity, σph: square root of phenotypic variance, H^2: Heritability.

GA as % of mean (GAM) = (GA / mean value) x 100

Results and discussion

Analysis of variance and genotypes mean performance

Results on Table 2 revealed that the studied genotypes showed highly significantly variation ($p \leq 0.001$) for all the traits in combined analyses. This provides evidence for sufficient variability and selection on the basis of these traits can be useful. The result was inconformity with the results reported by many authors, Garcia Del-Moral *et al.* (2003) reported significant differences between genotypes for grain yield, number of grains per spike and grain weight. Also, Ahmadizadeh *et al.* (2011b) in studying genetic diversity of durum wheat landraces from Iran and Azerbaijan reported highly significant differences among the genotypes in all of the morphological traits. Furthermore, Mollasadeghi *et al.* (2011); Molasadeghi and Shahryari, (2011) and Ahmadizadeh *et al.* (2011a) reported similar results.

The results showed that the mean square of environments (seasons) and genotypes x environments interaction were significant for all characters measured except the genotypes x environments interaction were not significant in the plant height, number of spikes per m^2, number of grains per spike and 1000 - grain weight.

Yield related characters

Results in Table 3 showed the number of days to 50% heading, days to 90% maturity and plant height combined over two seasons. Number of days to 50% heading of the twenty four genotypes ranged from 53 to 62 days whereas number of days to 90% maturity ranged from 85 to 95 days. The earliest genotype combined over the two seasons in heading and maturity was entry no. 22 (85 days), whereas the latest one was entry no. 5 and the cultivar El Nielain (95 days). The tallest genotype (89 cm) was entry no. 19 whereas the shortest one (66 cm) was entry no. 12. Results in table 4 showed highly significant differences ($p \leq 0.001$) for average number of spikes per m^2, number of grains per spike 1000 – grain weight and harvest index (%). Comparison of genotypic means showed that entries no. 16, 10, 19 and 18 had the highest number of spikes per m^2 (Table

4). The highest number of grains per spike (49.30) was recorded for entries no. 21 and 7 whereas, the lowest number (34) was scored for entry no. 19. Entries no. 22 and 23 had the maximum harvest index (%). Whereas, the entry no. 11 recorded the lowest harvest index (Table 4).

Grain yield

Table 4 shows the average grain yield (tons ha^{-1}) of the tested genotypes combined over two seasons. Highly significant differences were detected among the tested genotypes for this character. Grain yield productivity among wheat genotypes tested ranged from 5.06 tons/ha (Entry no. 23) to 3.74 tons/ha (Entry no.9) with a grand average yield of 4.40 tons/ha. Grain yields in generally high for experimental plots. The top yielder was obtained by the entries no. 23, 21, 17 and 18. These entries gave higher yielded than the three checks Wadi El Neel, Debeira and El Nielain. Also these entries out - yielded the check wadi El Neel by about 22, 20, 18.3 and 16.6%, respectively (Table 4). Eleven of the tested genotypes had yield exceeding the overall mean of the trial.

Genetic characters

Combined analysis revealed a wide range of genetic variability for all the tested traits. The genotypic variance, Phenotypic variance, genotypic coefficient of variation (GCV), phenotypic coefficient of variation (PCV), heritability, genetic advance and genetic advance as percentage of mean are given in table 5. The maximum phenotypic variance value of 2107.92 was noticed for number of spikes per m^2 and 19.83 for plant height. The genotypic variance for these characters were also high, indicating that the genotype was reflected by the phenotype and the effectiveness of selection based on the phenotypic performance for these characters. The phenotypic coefficient of variation (PCV) and genotypic coefficient of variation (GCV) ranged from 11.31% (harvest index) to 333.50% (number of spikes per m^2) and 5.69% (harvest index) to 191.30% (number of spikes per m^2), respectively. Generally, the PCV values were higher than GCV values for all the traits studied that reflect the influence of environment on the expression of all traits. Results on genetic characters have similarity with Singh *et al.* (2006) and Sharma and Garg (2002).

The heritability indicates that number of spikes per m^2, number of grains per spike, 1000 - grain weight and plant height were highly low (Table 5). Only spikes per m^2 and harvest index were moderately low indicating that the characters were more influenced by environment. Although high heritability estimate have been found to be effective in the selection for superior genotypes on the basis of phenotypic performance. Johnson *et al*. (1955) suggested that heritability estimates along with genetic advance will be more useful in predicting the effect for selecting the best individual.

The high heritability estimates along with low genetic advance indicates that genotype - environment interaction plays a significant role in the expression of the trait as observed in days to 90% maturity in the present study. Genetic advance expressed as percentage of mean was high for number of spikes per m^2 (9.89%) followed by number of grains per spike (9.59%), 1000 – grain weight (9.27%) and plant height (8.77%). The high genetic advance accompanied with high estimate of heritability observed for plant height and 1000 – grain weight indicates that heritability is mainly due to additive gene effect and selection may be effective to improve the traits.

Conclusion

Results indicated that the following conclusion could be drawn:

Sufficient genetic variability for yield and its components existed among the genotypes under study. These plant materials could be successively used production in different environmental conditions, as they have a good perspective from various aspects. Our data have isolated a nine candidate genotypes that out – yielded the check varieties. These lines included; entries no.23, 21, 17, 18, 22, 16, 19, 5 and 20. High genotypic coefficients of variation (191.30%) were observed for number of spikes per m^2 followed by plant height (18.55%). Genotypic coefficients of variation (GCV) values were lower than phenotypic coefficients of variation (PCV) values for all the traits which reflect the influence of environment on the expression of traits. High heritability estimates were recorded for days to 90% maturity (80.7%) followed by days to 50% heading (55.4%), plant height (52.9%) and 1000 – grain weight (51.1%).

Authors contribution

In this research, all authors contributed effectively. Fatih E. A. Hamza designed and achieved experiments and wrote the paper; Hussein A. Yagoub performed research, Galal A. El Toum analyzed the data and performed data interpretation.

Table (2): Mean squares of the different characters in 24 bread wheat advanced genotypes grown during two seasons 2013/14 and 2014/15

Characters	Season (d.f = 1)	Genotype (d.f = 23)	Seas. X geno. (d.f = 23)	Pooled error (d.f = 92)
Days to 50 % heading	269.507***	36.376***	10.116***	0.917
Days to 90 % maturity	171.174***	42.497***	4.536***	0.046
Plant height (cm)	1058.418*	151.495***	32.490n.s	40.897
No. of spikes/m^2	232203.516*	21489.543***	8842.019n.s	8108.159
No. of grains/spike	1599.333**	81.646***	27.984n.s	22.182
1000 – grain weight (g)	448.028*	43.722***	11.178n.s	8.812
Harvest index (%)	1324.353**	24.526***	13.250*	6.591
Grain yield (kg ha^{-1})	448447576.694**	766077.883***	952266.057***	219568.847

*, ** and *** Significant at 0.05, 0.01 and 0.001 levels of probability, respectively
n.s indicates not significant at 0.05 level of probability.

Table (3): Mean performance of 24 genotypes for some vegetative characters in wheat

Entry no.	DH	DM	PH	Entry no.	DH	DM	PH
1	54	93	78	**15**	56	87	80
2	54	89	73	**16**	59	94	78
3	59	90	76	**17**	60	90	74
4	56	95	84	**18**	60	91	73
5	60	95	80	**19**	62	93	89
6	57	90	76	**20**	53	92	78
7	59	91	69	**21**	60	92	76
8	57	89	71	**22**	54	85	74
9	60	94	76	**23**	55	88	71
10	62	92	73	**24**	60	92	78
11	59	92	82	**Mean**	58	91	76
12	58	87	66	**S.E±**	0.39	0.41	2.61
13	56	88	78	**C.V (%)**	1.6	1.1	8.3
14	57	90	80				

DH: Days to 50 % heading, DM: Days to 90 % maturity, PH: Plant height (cm)

Table (4): Mean performance of 24 genotypes for yield and yield components characters in wheat

Entry no.	G.Y	NS/ m^2	NGS	1000-g.w	HI (%)	Entry no.	G.Y	NS/ m^2	NGS	1000-g.w	HI (%)
1	4.15	583	38	34	36	**15**	3.98	525	43	41	34
2	4.20	545	40	39	36	**16**	4.47	659	40	34	33
3	4.41	582	40	36	34	**17**	4.91	549	38	36	33
4	4.23	467	38	39	35	**18**	4.84	606	43	33	36
5	4.44	544	41	39	33	**19**	4.47	612	34	38	34
6	4.15	504	42	41	37	**20**	4.43	551	47	34	37
7	4.00	516	48	32	36	**21**	4.98	427	49	37	37
8	4.29	494	45	35	36	**22**	4.72	507	40	37	40
9	3.74	598	40	38	34	**23**	5.06	547	42	36	40
10	4.41	649	38	34	35	**24**	4.30	557	37	38	35
11	4.12	585	41	36	32	**Mean**	4348	548	41	37	35
12	4.29	510	47	32	38	**S.E±**	191.3	36.76	1.92	1.21	1.04
13	3.75	508	41	40	37	**C.V(%)**	10.7	16.4	11.2	8.0	7.1
14	4.01	428	41	40	34						

GY: grain yield (tons ha^{-1}), NS/ m^2: Number of spikes per meter square, NGS: Number of grains per spike, 1000-g.w:Thousand grain weight (g), HI: Harvest index (%).

Table (5): Genotypic, phenotypic variance, coefficient of variability, heritability (broad sense) and genetic advance for seven characters in wheat.

Characters	δ^2ph	δ^2g	GCV (%)	PCV (%)	H^2 (%)	GA	GAM (%)
Days to heading	7.89	4.37	8.71	11.70	55.4	3.21	5.53
Days to maturity	7.83	6.32	10.47	11.65	80.7	4.66	5.12
Plant height	37.47	19.83	18.55	25.50	52.9	6.67	8.77
Spikes/m^2	6406.60	2107.92	191.30	333.50	32.9	54.25	9.89
Grains/ spike	21.95	8.94	12.45	19.52	40.7	3.93	9.58
1000-grain weight	10.61	5.42	9.70	13.57	51.1	3.43	9.27
Harvest index	7.38	1.87	5.69	11.31	25.3	1.42	4.05

(δ2ph): phenotypic variation, (δ2g) genotypic variation, (GCV) genotypic coefficient of variation, (PCV) phenotypic coefficient of variation, (H^2) broad sense heritability, (GA) genetic advance, (GAM) genetic advance as a percentage of the mean.

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Research paper

Chemical Weed Control in Okra (*Abelmeschus esculentus* L. Moench) in Dongola Locality-Northern State-Sudan

Mukhtar Abdel Aziz Mohamed[1], Suhair Mohammed Elamin[2] and Amal Abdel Haleem Naser[3]

1 Faculty of Agricultural studies- Sudan University of Science and Technology, Sudan

2 Ministry of Agriculture and Animal Resources- Northern State, Sudan

3 Faculty of Agricultural Sciences- University of Dongola- Sudan

Corresponding Author: mukhtarazizm@gmail.com, Tel: 0920345890&0122843150&0911162653

ABSTRACT

The herbicides experiment was conducted for two consecutive summer seasons (2014, 2015) at Altraa village, Sharg Elneel Unit, Dongola Locality, Northern State – Sudan, located within latitude 16° and 22° N and longitude 20° and 32° E., to determine fresh pod yield loss due to weed competition and to evaluate and compare the effects of Fusilade applied as post-emergence at 0.7, 1.1, 1.3 and 1.5 l/fed and glyphosate applied pre-emergence at 0.3, 0.4, 0.5 and 0.6 l/fed and applied post-emergence at the same rates. Results obtained from this experiment indicated that, unrestricted weed growth significantly reduced fresh pod yield (kg/fed) by 67.40% in both summer seasons. Results also showed that, Fusilade herbicide was the best in controlling Graminae weeds while Glyphosate herbicide was the best in controlling broad-leaved weeds in both summer seasons. Further, among the two herbicides treatments the best weed control was achieved by Glyphosate which applied post-emergence at 0.6 l/fed while Fusilade at 1.5l/fed treatment applied post-emergence gave higher fresh pod yield in both summer seasons. The use of the two herbicides treatments reduced significantly weed biomass (g/m^2).

Keywords: Broad-leaved weeds, Graminae, herbicides, weed free

المكافحة الكيميائية للحشائش في البامية (*Abelmeschus esculentus* (L.) Moench) بمحلية دنقلا-الولاية الشمالية-السودان

مختار عبد العزيز محمد[1]، سهير محمد الامين[2]، امال عبد الحليم ناصر[3]

1 كلية الدراسات الزراعية - جامعة السودان للعلوم والتكنولوجيا- السودان
2 وزارة الزراعة والثروة الحيوانية- الولاية الشمالية- السودان
3 كلية العلوم الزراعية- جامعة دنقلا- السودان

أجريت تجربة مبيدات الحشائش لموسمين صيفيين متعاقبين 2014 و 2015م بقرية الترعة– وحدة شرق النيل– محلية دنقلا – الولاية الشمالية – السودان، الواقعة بين خطى عرض'2 16^0 شمال وخطى طول '20 32^0 شرق لتحديد الفقد في إنتاجية القرون الرطبة الناجم من منافسة الحشائش ولتقييم ومقارنة تأثيرات الفيوزيليد المستخدم بعد الانبثاق بمعدل 0.7، 1.1، 1.3 و1,5 لتر للفدان والجلايفوسيت المستخدم قبل الانبثاق بمعدل 0.3، 0.4، 0.5، و0.6 لتر للفدان وبعد الانبثاق بنفس المعدلات. أشارت النتائج المتحصلة من هذه التجربة إلى أن النمو غير المحدود للحشائش قلل معنوياً إنتاجية القرون الرطبة (كجم /فدان) ب 67.40% في الموسمين الصيفين. أوضحت النتائج المتحصلة من هذه التجربة أن مبيد الحشائش فيوزيليد كان أفضل في مكافحة الحشائش النجيلية بينما مبيد الحشائش جلايفوسيت كان أفضل في مكافحة الحشائش عريضة الأوراق في الموسمين الصيفيين. أيضاً أوضحت النتائج المتحصلة من هذه التجربة أن من بين معاملات مبيدي الحشائش، جلايفوسيت المستعمل بعد الانبثاق بمعدل 0.6 لتر/فدان أنجز أفضل مكافحة للحشائش بينما فيوزيليد المستعمل بعد الانبثاق بمعدل 1.5 لتر/فدان أعطى اعلى إنتاجية للقرون الرطبة في الموسمين الصيفيين. استخدام معاملات مبيدي الحشائش قلل معنوياً الوزن الجاف للحشائش بالجم في المتر المربع.

كلمات مفتاحية: الحشائش ذات الاوراق العريضة، النجيليات، مبيدات حشائش، خالية من الحشائش

Introduction

Okra (*Abelmeschus e*sculentus (L) Moench), sometimes called Gumbo, is a tall, handsome, tropical annual plant with a much branched coarse stem that grows to a height of three feet and produce large-petaled flowers and long slender, pointed seed pods (Victor, 1973). It is one of the most important and popular vegetables grown in the Sudan and the world. It is a member of the plant family Malvaceae cultivated in Sudan, it is ranking third after onion and tomato with annual average area and yield of 58014 feddans and 291376 tons, respectively. It grows well under irrigation and rain-fed area, in most parts of the country (Ahmmed, 2007 and Ali, 2012). It is grown mainly for its green pods which are used as vegetable, fresh canned cooked with meat (Weika) making a favorable and popular dish by most Sudanese (Umrogaiga and Tagalia), or conserved by drying and grinding into powder. The leaves are also cooked in many areas. It is a typical food in combination with sorghum bread (Kisra). The seeds, roasted and ground to powder are used as a substitute of coffee. Okra is used principally in soups and stews. It is grown in the tropical and subtropical area, almost in all parts of the country. It's main producing countries are India, Nigeria, Pakistan and Ghiana, where India at the top with a total production of 3,550,000 metric tons (FAO, 2004). The world production of okra as fresh fruit vegetable is estimated at 6 million tons per hectare (Lyagba *et al.*, 2012).

One of the main problems that affect yield and quality of okra vegetable is weed interference and their competition with the crop. Weeds in okra must be controlled (Imoloame, 2013). In developing countries manual weeding is the most common method of weed control but in many instances the available labor is unable to remove weeds from vast areas of land during critical periods, thus, the use of herbicides is a necessity (Elamin, 1991; Abdel Rasoul, 1998 and Abdel Marouf, 2004). Herbicides play a major role in controlling weeds in crop production. They constitute a new and highly efficient technique for controlling weeds, increasing yield, improving quality and reducing labor in crop production (Yousif, 2002 and Abdel Marouf, 2004).

In Sudan okra vegetable received little attention with inadequate information is especially in area of weed control. Thus, this study was conducted to assess the magnitude of fresh pod yield losses in okra due to weed infestation and to evaluate the efficacy of a pre and post-emergence herbicides namely, Glyphosate and Fusilade on weed control, tolerance and yield of okra.

Materials and Methods

An experiment was conducted during two consecutive summer seasons of the years 2014 and 2015 at Altra - Dongola locality-Northern State-Sudan. The area is located within latitudes 16° and 22° N, and longitude 20° and 32° E. (Osman, 2004). Dongola locality is a true desert and characterized by extremely high temperatures and radiation in summer, low temperature in winter, scarce rainfall and high wind speed. The mean maximum and minimum temperatures are 36.8 and 19.5°C, respectively. The climate is hyper arid with a vapor pressure of only 10.8 mb and a relative humidity of less than 20% (Osman, 2004). The soil in the experimental site is a sandy clay loam, with 57.34% sand, 19.83% silt and 22.50% clay (Damirgi and Al-agidi, 1982). The herbicides treatments were: phloaziaphop-p-putyle as Fusilade (150g) Ec, applied post-emergence at 0.7, 1.1, 1.3 and 1.5 litre/fed. (1 fed= 0.42ha); Glyphosate as Touchdown 41% Ec, applied pre-emergence at 0.3, 0.4, 0.5 and 0.6 litre/fed, and post-emergence at 0.3, 0.4, 0.5 and 0.6 litre /fed.

Weedy and weed-free treatments were included for comparison. Pre-emergence herbicides were applied, immediately after sowing, with a knapsack sprayer at a volume rate of 80 liters per feddan, application of the pre-emergence herbicides was followed by irrigation while the post-emergence herbicides were applied at 4 weeks after crop sowing. Treatments were arranged in a randomized block design with four replications. In each season the experimental site was ploughed, harrowed, leveled and divided into 3x3.5 m plots. Each plot was made of five rows. Okra, variety Khartuomia was planted by hand in rows on flat, three seeds/hole in rows 70 cm a part and 25 cm between holes, on 23 February for both summer seasons. The seedlings were later thinned to two plants per hole, to give a population of approximately 48000 plants per feddan. Nitrogen fertilizer, as urea, was applied at a rate of 2 N (80lb of nitrogen/fed (halve the dose after 2 weeks from sowing and the other halve after 4 weeks from the first dose). In the weed free treatment, weeds were removed frequently by repeated hand weeding to keep the crop free from weeds up to harvest. However, in the weedy treatment, weeds were left to grow, unrestrictedly, with the crop until harvest. Visual observations of phytotoxicity of the herbicides treatments on the crop were assessed periodically. However, Glyphosate treatments which applied post - emergence at 0.4, 0.5 and 0.6 l/fed were toxic to the okra crop.

The effect of treatments on weeds was assessed by counting the individual weed species at 4 weeks after herbicides application. This was done by randomly placing 1x1m quadrate in each plot. Weeds inside each quadrate were identified and individual weed species counted. The percentage control of grassy and broad-leaved weeds, as compared with the un-weeded control, for each treatment was calculated. Weed species and their dry weights were also determined at ten weeks after sowing. Ten plants were randomly selected from the three inner rows in each plot to determine plant height (cm), number of branches/plant, number of leaves/plant, leaf area index and shoot dry weight (g)/plant. At each picking, ten plants were randomly selected in each plot to determine mean number of pods/plant and mean fresh pod yield (kg/fed). Two rows in each plot were left unpicked until harvest, ten plants were randomly selected in each plot from those rows left unpicked, their pods were cut and threshed in bulk to determine number of seeds/pod and 100 seed weight (g) (Baada, 1995).

Yield data were analyzed by the analysis of variance, and means were separated by the Duncan's Multiple Rang Test. Combined analysis was done for the data of the two seasons.

Results and Discussion

Visual observations showed that, Glyphosate treatments which applied post- emergence at 0.4, 0.5 and 0.6 l/fed were toxic to the okra crop. Okra plants were attacked by aphids in both summer seasons which controlled by Folimat. The infection by aphids was heavy in the first summer season. The weed flora in the experimental site consisted of grassy and broad-leaved weeds. In both summer seasons broad-leaved weeds were predominant. The same result was found by Mohamed and Elamin (2012). The dominant weed species were:

The combined analysis of both summer seasons, showed that, Fusilade treatments at 0.7, 1.1, 1.3 and 1.5 l.a.i/fed significantly decreased weed biomass (g/m^2)

as compared to the weedy full season treatment (Table 1). Fusilade herbicide was the best between the two herbicides used which gave the lowest dry weight of weeds. These findings are in line with those obtained by Bhalla and Parmar (1986) and Bhalla and Parmar (1982).

The predominant weed species in the experimental site

Chenopodium album (L.), *Malva parviflora* (L), *Convolvulus arvensis* (L.), *Amaranthus graecizanth parviflora*, *Sorghum arundinaceum*, *Gynandropsis gynandra* (L.) *Briq*, *Sinapis arvensis* (L.), *Tribulus terrestris* (L.), *Datura stramonium* (L.), *Cynodon dactylon* (L.) *Pers*, *Cyperus rotundus* (L.), *Eruca sativa*, *Portulaca oleracea* (L.), *Dactyloctenium aegyptium* (L.) *Beauv*., *Sporobolus pyramidatus* (Lam.) *Hitchc*., *Sonchus oleraceus* (L). *Hyoscyamus reticulates*, *Echinochloa colona* (L.) *Link*, *Tephrosia apollinea* (Del.), *Cassia italica* (Mill.) *Lam. Ex Steud*, *Calotropis procera* (Ait.) *Ait. f., Aerva javanica (Burm. f.), Rhynchosia memnonia (Del.) cooke and Lotus arabicus* (L).

The mean readings of both summer seasons confirmed that, Fusilade treatment which applied post-emergence at 0.7, 1.1, 1.3 and 1.5 l.a.i/fed achieved excellent control of Graminae weeds. However, Glyphosate treatments which applied pre-emergence at 0.3, 0.4, 0.5 and 0.6 l.a.i/fed gave moderate control of Graminae weeds while Glyphosate treatments at the same mentioned rates which applied post-emergence gave poor control of Graminae weeds (Table 1). Fusilade herbicide was the best between the two herbicides used which achieved effective control of Graminae weeds.

The mean results of both summer seasons indicated that, Fusilade treatments which applied post- emergence at 0.7, 1.1, 1.3 and 1.5 l/fed did not achieve any control of broad-leaved weeds. However, glyphosate treatments which applied pre and post-emergence gave poor to good control of broad leaved weeds, respectively (Table 1). Glyphosate was the best between the two herbicides used. Glyphosate herbicide at the rate of 0.6 l.a.i/fed was the best treatment among the treatments of the two herbicides used which achieved good control of broad leaved weeds while Fusilade treatment at 1.5 l.a.i./fed was the best between the treatments of the two herbicides used which gave the best fresh pod yield (kg/fed). Similar results were found by Covindra *et al*. (1982);

Tiwari *et al*. (1985); Kumar and Charanjit (1986) and Ramachandra-Boopathi *et al*. (1992).

Table (1): Effects of herbicides treatments on Graminae, broad leaved percentage weeds control and weed biomass during summer seasons (2014- 2015, combined)

Treatments	Herbicide rate kg a.i/fed	Percentage Graminae weed control	Percentage broad-leaved weed control	Weed biomass (g/m^2)
Fusilade post	0.7	89.39	0	47c
Fusilade post	1.1	92.18	0	41.5c
Fusilade post	1.3	92.21	0	45.5c
Fusilade post	1.5	91.39	0	43c
Glyphosate pre	0.3	53.36	18.98	71ab
Glyphosate pre	0.4	59.65	30.80	96.5a
Glyphosate pre	0.5	64.88	9.99	56bc
Glyphosate pre	0.6	63.69	21.33	71ab
Glyphosate post	0.3	45.07	46.52	74ab
Glyphosate post	0.4	33.73	52.84	75ab
Glyphosate post	0.5	44.79	54.1	61.25c
Glyphosate post	0.6	48.84	64.63	66ab
Weed free full	-	100	100	89.5ab
Weedy full	-	0.00	0	-
C.V%	-	-	0	44.79%
S.E%	-	-	0	15.0704

Treatment means in the same column with the same letters are not significantly different at p (0.05) according to Duncan's Multiple Range Test.
a.i = Active ingredient.

The combined analysis of both summer seasons (Table 2) showed that, Fusilade herbicide treatments at 0.7, 1.3 and 1.5l.a.i/fed and the weed free full season treatment significantly increased plant height (cm) as compared to the weedy full season treatment. These treatments of Fusilade herbicide gave plant height (cm) comparable to that obtained in the weed free full season treatment. Further, all herbicides treatments and the weed free full season treatment did not significantly increased number of branches/plant as compared to the weedy full season treatment. Furthermore, Fusilade herbicide treatments at 0.7, 1.1 and 1.5 l.a.i/fed and the weed free full season treatment significantly increased number of leaves/plant and leaf area index/m^2 as compared to the weedy full season treatment.

The combined analysis of both seasons showed that, the weed free full season treatment only significantly increased shoot dry weight (g/plant) as compared to the weedy full season treatment (Table 2). Similarly, Ramachandra-Boopathi *et al*. (1992) indicated that, okra growth components were positively affected by herbicides treatments, growth components were significantly increased in treated plots as compared to the weedy full season treatment.

Table (2): Effects of herbicides treatments on okra vegetable growth components during summer seasons (2014, 2015, combined)

Treatments	Herbicide rate kg a.i/fed	Plant height (cm)	Number of branches/ plant	Number of leaves/ plant	Leaf area index (m^2)	Shoot dry weight (g)/plant
Fusilade post	0.7	86.8 ab	1.9abc	26.1 bc	8.8 bc	25.1 bc
Fusilade post	1.1	83.5 abc	2.4ab	26.5 bc	8.5 bc	32.0 bc
Fusilade post	1.3	86.4 ab	2.1abc	24.6 bcd	9.3 b	30.4 5bc
Fusilade post	1.5	84.7 ab	2.0abc	28.3 b	8.3 bc	39.4 ab
Glyphosate pre	0.3	65.0 de	1.8abc	18.5 e	5.8 cdef	21.2 bc
Glyphosate pre	0.4	80.8 bc	1.8abc	19.3 de	5.5 cdef	26.6 bc
Glyphosate pre	0.5	63.1 de	1.6bc	15.6 e	4.8 def	20.9 bc
Glyphosate pre	0.6	74.8 bcd	1.9abc	20.9 cde	7.0 bcde	27.0 bc
Glyphosate post	0.3	66.6 de	1.6bc	18.3 e	4.5 def	38.8 ab
Glyphosate post	0.4	62.6 de	1.6abc	17.4 e	4.3 ef	16.4 c
Glyphosate post	0.5	58.9 e	1.4c	17.4 e	3.8 ef	15.0 c
Glyphosate post	0.6	63.3 de	1.9abc	17.5 e	2.5 f	18.5 bc
Weed free	-	97.3 a	2.6a	43.3 a	16.8 a	55.4 a
Weedy	-	70.3 cde	1.9abc	20.de	7.8 bcd	24.6 bc
C.V%		17.28%	41.%	23.4%	30.0%	65.4 %
S.E%		6.4	0.3985	2.6	1.0 1	9.1

Means followed by the same letter (s) within each column do not differ significantly at p (0.05)
a.i = Active ingredient.

The combined analysis of both summer seasons showed that, the weed free full season treatment only significantly increased number of pods/plant and number of seeds/pod as compared to the weedy full season treatment (Table 3). Further, results indicated that, all herbicides treatments and the weed free full season treatment did not significantly increased 100 seed weight (g) as compared to the weedy full season treatment.

Further, the Fusilade treatments at 1.3 and 1.5 l.a.i/fed and the weed free full season treatment significantly increased fresh pod yield (kg/fed) as compared to the weedy full season treatment (Table 3). It is also indicated that, within the two herbicides the best fresh pod yield was achieved with Fusilade at 1.5 l.a.i/fed which applied post-emergence. These increases could be attributed to the use of herbicides treatments which suppressed weeds and freed okra to reach its potential growth parameters and hence reflected in an increased okra fresh pod yield. Further, these increases may be as a result of the beneficial effects of other cultural operations such as the fertilizer uptake. Similar results were obtained by Kumar and Charanjit (1986); Ramachandra-Boopathi *et al*. (1992) and Lyagba *et al*. (2012).

Table (3): Effect of herbicides treatments on okra vegetable fresh pod yield and its components during summer seasons (2014- 2015, combined)

Treatments	Herbicide rate kg a.i/fed	No. of pods/plant	No. of seeds/pod	100 seed weight (g)	Fresh pod yield (kg/fed)
Fusilade post	0.7	16.9 b	59.9 ab	6.0 a	2846bc
Fusilade post	1.1	15.9bc	60.6 ab	6.0 a	2131cd
Fusilade post	1.3	15.3 bcd	60.1 ab	5.8 a	2316c
Fusilade post	1.5	16.1 bc	59.0 ab	5.3 a	3193.b
Glyphosate pre	0.3	11.8 e	58.6 ab	6.0 a	1065e
Glyphosate pre	0.4	13.6 cde	60.3 ab	6.0 a	2059cd
Glyphosate pre	0.5	12.6 de	57.6 ab	5.8 a	1427de
Glyphosate pre	0.6	13.5 cde	59.5 ab	6.0 a	1298de
Glyphosate post	0.3	13.6 cde	52.5 bc	5.5 a	804e
Glyphosate post	0.4	13.1 de	53.6 bc	5.8 a	1053e
Glyphosate post	0.5	12.5 e	47.1 cd	5.8 a	740.e
Glyphosate post	0.6	13.0 de	45.6 d	5.8 a	761e
Weed free full	-	19.9 a	65.3 a	6.0 a	4199a
Weedy full	-	14.4 bcde	54.4 bc	5.3 a	1369de
C.V%	-	16.3 %	12.4%	12.0%	45.3%
S.E%	-	1.2 1	3.5	0.4	408.3

Means in the same column with the same letter(s) are not significantly different at p (0.05)
a.i = Active ingredient.

Conclusions

- The positive effect of herbicides on weed control lead to a significant increase in okra vegetable fresh pod yield (kg/fed). While, unrestricted weed growth significantly reduced fresh pod yield (kg/fed) by 67.40%.
- Within the two herbicides treatments, the best fresh pod yield (kg/fed) was achieved with Fusilade treatment at 1.5 l.a.i./fed.
- Among the two herbicides treatments, the best weed control was achieved in terms of total weed biomass reduction with Fusilade treatments at 0.7, 1.1, 1.3 and 1.5 l.a.i/fed.

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Research paper

المكافحة الكيميائية للحشائش في الفول المصري (*vicia faba* L.) بمحلية دنقلا- الولاية الشمالية- السودان

مختار عبد العزيز محمد عثمان[1]، عاطف خضر عوض الله [2] و صلاح التوم الأمين [3]

1 كلية الدراسات الزراعية، جامعة السودان للعلوم والتكنولوجيا، السودان
2 كلية العلوم الزراعة، جامعة دنقلا ، السودان
3 كلية الزراعة، جامعة الخرطوم، السودان

ممثل المؤلفين: **mukhtarazizm@gmail.com, Tel: 0920345890 & 0122843150**

المستخلص

أجريت تجربة بمزرعة محطة بحوث دنقلا – دنقلا، الولاية الشمالية، السودان في موسمي 2014/ 2015 و 2016/2015م لتقييم الضرر الذى تحدثه الحشائش في نمو وانتاجية الفول المصري ولتحديد فعالية مبيدى الحشائش بيرسوت وقول ومخاليطهما قبل الإنبثاق في مكافحتهما للحشائش واثرهما علي الفول المصري بالولاية الشمالية. اوضحت الدراسة ان وجود الحشائش في الفول المصري يؤدى الي انخفاض معنوي في انتاجيته من ارتفاع النبات، عدد الاوراق في النبات، عدد القرون فى النبات، عدد البذور في القرن، وزن المائة بذرة وانتاجية البذور بنسبة 44، 46، 79، 69، 59 و78% علي التوالي مقارنة بالشاهد المنظف يدويا من الحشائش. مخاليط المبيدين بيرسوت وقول أعطت مكافحة فعالة للحشائش الحولية تراوحت من جيدة جداً (76-79%) إلى ممتازة (82-94%) كما ادت الي انخفاض معنوي للوزن الجاف للحشائش في التحليل المشترك للموسمين (78-85%) مقارنة بالشاهد الموبوء بالحشائش. كل معاملات مبيدات الحشائش اضافة الى الشاهد النظيف من الحشائش بالتحليل المشترك للموسمين أدت الى زياده معنوية في انتاج البذور تراوحت ما بين 148 الى 345% فوق الشاهد الموبوء بالحشائش. وفقا للدراسة يوصى باستعمال خليط بيرسوت (0.075 kg a.i./ha) مع قول (0.44 a.i,/ha) تضاف قبل الزراعة مع ازالة الحشائش المقاومة للمبيدات باليد.

كلمات مفتاحية: بيرسوت، قول ومكافحة الحشائش

Chemical Weed Control in Faba Bean (*Vicia faba* L.) in Dongola Locality-Northern State-Sudan

Mukhtar, A. M.[1]; Aatif, K. A.[2] and Salah, E. E.[3]

1 Faculty of Agricultural studies, Shambat, Khartoum, Sudan University of Science & Technology-Sudan
2 Faculty of Agricultural Science, El Selaim, University of Dongola, Sudan
3 Faculty of Agriculture, Shambat, Khartoum, University of Khartoum, Sudan.

Corresponding author: email: mukhtarazizm@gmail.com , Tel: 0920345890 & 0122843150

ABSTRACT

An experiment was conducted at Dongola Research Station farm, in Northern State, Sudan, during 2014/15 and 2015/16 seasons to find out the damage caused by weeds on the yield of faba bean (*Vicia faba* L.) and to determine the efficacy of the pre-emergence herbicides imazathepyr (Pursuit) and oxyfluorfen (Goal) and their tank-mixtures on weeds and their effects on faba bean yield. The study revealed that the weeds reduced plant height, number of leaves per plant, number of pods per plant, number of seeds per pod, 100 seeds weight and seed yield by 44, 46, 79, 69, 59 and 78%, respectively, compared with the hand weeded control. All herbicides tank-mixtures gave efficient control of annual weeds ranged from very good (76-79%) to excellent (82-94%) and significantly reduced weed dry biomass of the two seasons (by 78-85%) compared to weedy check. All herbicides treatments together with the weed-free check resulted in significant increase in seed yield ranged between 148.71 to 345.47% in the two seasons compared the weedy check. According to the study, it is recommended to use the pre-emergence application of the tank-mixtures of pursuit (0.075 kg a.i./ha) with Goal (0.44 kg a.i./ha) for weed control in faba bean beside the removal of resistant weeds by hand.

Keywords: Pursuit, Goal, weed control.

المقدمة

يعتبر الفول المصري محصول إستراتيجي وأحد أهم المصادر الرئيسة للغذاء في العالم النامي وهو من المحاصيل البقولية الشعبية الهامة لكثير من سكان أقطار البحر المتوسط وبعض البلاد الآسيوية لاحتواء حبوبه على نسبة عالية من البروتين. تنتشر زراعته في ليبيا ومصر وإيطاليا والسودان والمغرب وإسبانيا والصين والبرازيل هذا و تنتج الصين حوالي 65% من إنتاج الفول في العالم (5 مليون طن) (موسي، 2005 و Amin, 2013). كما يزرع الفول المصري في تركيا وأثيوبيا. في السودان تتركز زراعة الفول في المناطق الشمالية وبصفة خاصة في ولايتي الشمالية ونهر النيل وتزرع الولايتان 77 و 21% على التوالي من المساحة الكلية للمحصول في السودان علماً بأن الإنتاج يتركز في حوض السليم في الولاية الشمالية وفي ود حامد في ولاية نهر النيل (موسي، 2005). أيضاً يزرع المحصول في ولاية الخرطوم ومشروع الجزيرة والرهد والقاش وفي دارفور في منطقة جبل مرة وحلفا الجديدة (Salih, 1994).

تشكل الآفات المختلفة وخاصة الحشائش أهم عوائق الإنتاج الزراعي (Osman and Elamin, 2011). الحشائش من أخطر الآفات الزراعية التي تسبب خسائر كبيرة في إنتاجية المحاصيل عن طريق منافستها على الماء، الغذاء، المكان والضوء حيث تقلل إنتاج ونوعية المحاصيل وتستنفذ خصوبة التربة وتعوق الرؤية في تقاطعات الطرق والخطوط الحديدية وتقلل جودة المنتجات الزراعية وتزيد تكاليف الحصاد (تاج الدين، 1978 وعبد الجواد وآخرون، 2007). وجود الحشائش يعوق انسياب مياه الري ويزيد كمية المياه المفقودة من البحيرات والمسطحات المائية الأخرى وذلك عن طريق النتح. أيضاً الحشائش تعول مسببات أمراض النبات والحشرات والطيور التي تهاجم المحاصيل (Babiker, 1976، وشعبة وقاية النبات، 1977). حتى السنوات الأخيرة الماضية كانت الحشائش لا تشكل أية مشاكل للمحاصيل الحقلية في الولاية الشمالية، لكن استعمال التقاوي الملوثة، رعي الحيوانات وفيضان نهر النيل أدى إلى انتشار بعض الحشائش الحولية الخطيرة فيها مثل العدار (الجراو)، الفجيلة (القرلة) والزربيح (الدرورة) (Berdy and Abbas, 2011). الحشائش تسبب خسائر كبيرة للمحاصيل المختلفة على سبيل المثال قللت إنتاج الفول المصري بنسبة 41- 95% (Amin, 2013).

يمكن مكافحة الحشائش الحولية وذات حولين تقليدياً باستخدام الطرق الطبيعية أو الميكانيكية مثل الإزالة اليدوية مرة واحدة وذلك قبل تكوين بذورها، أما الحشائش المعمرة فلا يمكن مكافحتها تقليدياً إلا بالإزالة اليدوية المستمرة. أيضاً يمكن مكافحة الحشائش كيميائياً عن طريق استخدام مبيدات الحشائش الاختيارية التي تتميز بقدرتها على مكافحة الحشائش دون حدوث ضرر للمحاصيل النامية معها.

في الوقت الحالي تشكل الحشائش مشكلة كبيرة في إنتاج الفول المصري في الولاية الشمالية وذلك بسبب استخدام تقاوي ملوثة ببذور الحشائش أو بسبب تأخير مكافحة الحشائش أو عدم مكافحتها نهائياً مما يؤدى إلى زيادة مخزون التربة من بذور الحشائش. الطريقة التقليدية لمكافحة الحشائش تتمثل في الإزالة اليدوية بعد أن تكبر الحشائش وتنافس المحصول على الضوء، الماء، الغذاء والمكان وذلك لاستخدامها كعلف لتغذية الحيوانات، مما يؤثر سلباً على إنتاجية المحصول (Berdy, 2009).

الهدف من إجراء هذه التجربة هو تحديد حجم الخسائر التي تحدثها منافسة الحشائش للفول المصري، تقييم تأثير مبيدي الحشائش البيرسوت والقول ومخاليطهما المستعملة كمعاملات قبل الانبثاق على الحشائش من حيث عددها ووزنها الجاف وتحمل وإنتاجية الفول المصري في محاولة لتحديد أنسب معاملة لمكافحة الحشائش والتي تحقق أعلى إنتاجية.

المواد والطرق

أجريت التجربة شتاءاً خلال موسمي 15/2014، 16/2015م بمزرعة البحوث الزراعية- دنقلا- الولاية الشمالية - السودان. تقع الولاية الشمالية بين خطي عرض 16^0 و22^0 شمالاً وخطي طول 20^0 و32^0 شرقاً وحدودها الشمالية هي الحدود المشتركة بين السودان ومصر وتمتد غرباً حتى حدود الجماهيرية الليبية (ابراهيم، 2012). التربة التي أجريت فيها التجربة تربة طينية تحتوى على 20.67% رمل، 17% غرين و 33.62.% طين أو طفل (صالح ووليد، 1982).

صممت التجربة عن طريق التصميم العشوائي الكامل للمكررات بأربع مكررات تم حرثها وتنعيمها وتسويتها وتقسيمها إلى أحواض في كل موسم، ابعاد الحوض 2×2 $م^2$. يحتوى كل حوض على خمسة صفوف و في كل حوض تمت زراعة بذور الفول المصري صنف سليم محسن يدوياً في صفوف مسطحة تبعد عن بعضها مسافة 60 سم والمسافة بين الحفر 20 سم وذلك في 13 نوفمبر من كل موسم، كان يتم الري بعد فترة تتراوح من أسبوع إلى أسبوعين حتى الحصاد حسب الأحوال الجوية السائدة.

تم تطبيق مبيدات الحشائش بيرسوت (إيمازيثابير) 10% EC بمعدل 0.050، 0.075 و0.100 كجم.م.ف للهكتار، قول (أوكسى فلوروفين) 24% EC بمعدل 0.24، 0.44 و0.64 كجم. م.ف للهكتار بالإضافة إلى البيرسوت بمعدل 0.050و0.075 كجم. م.ف للهكتار خلطاً مع القول بمعدل 0.24، 0.44 و 0.64 كجم .م.ف للهكتار. تم تطبيق المبيدات قبل الانبثاق باستخدام رشاشة ظهرية بمعدل 150 لتر للفدان. بالإضافة إلي معاملات المبيدات احتوت التجربة على معاملة خالية من الحشائش وأخرى موبوءة بالحشائش للمقارنة.

تم قياس تعداد الحشائش في كل معاملة عن طريق حساب عدد كل نوع بمفرده في المتر المربع وذلك باستخدام خشبة مستطيلة بعد 4 أسابيع من تطبيق مبيدات الحشائش. تم تحديد الوزن الجاف للحشائش بالجرام في المتر المربع في كل معاملة عدا المعاملة الخالية من الحشائش طول الموسم. لتجفيف الحشائش وضعت تحت اشعة الشمس لمدة تزيد عن 10 أسابيع. أيضاً تم حساب النسبة المئوية لمكافحة الحشائش النجيلية وعريضة الأوراق مقارنة بالشاهد في كل معاملة. تم تسجيل ارتفاع النبات بالسنتمتر وعدد الأوراق في النبات في كل معاملة بعد 8 أسابيع من الزراعة. اختيرت 10 نباتات عشوائياً من كل معاملة بعد وصول النباتات لمرحلة النضج لتحديد مكونات الإنتاجية المتمثلة في عدد القرون في النبات، عدد البذور في القرن ووزن 100 بذرة بالجرام. أيضاً تم حصاد متر مربع من كل معاملة لإيجاد إنتاجية البذور (طن للهكتار).

تم تحليل البيانات المتحصل عليها إحصائياً كما جاء في كتاب Gomez and Gomez (1984) عن طريق تحليل التباين (ANOVA) باستخدام حزمة التحليل لبرنامج (SPSS) لمعرفة التأثيرات المعنوية بين المعاملات والوحدات التجريبية. أيضاً تم حساب العمليات الإحصائية البسيطة مثل الوسط الحسابي، الانحراف المعياري، الخطأ القياسي ومعامل الاختلاف.

النتائج والمناقشة

عدد الحشائش في المتر المربع للحشائش التي كانت سائدة في التجربة موضح في داخل القوسين أمام كل وهي الحندقوق (96.6) *Trigonella hamosa* L.، الخبيزة *Malva parviflora* L. (90.8)، الضريسة *Tribulus terrestris* L. (78.4)، الجرجير *Eruca sativa* Mill. (51.8)، الكبر *Sinapis alba* L. (39.6)، الرجلة *Portulaca oleraceae* L. (21.4)، الدفرة *Echinochlloa colona* L. (16.8)، النجيل *Cynodon dactylon* L. (16.8)، الأدنة *Rhyncosia memnonia* L. (11.4)، العليق *Convolvulus arvensis* L. (9.8) والسعدة *Cyperus rotundus* (9.0)

تم ضم نتائج الموسمين الشتويين ووضعها في جداول لتسهيل المقارنة بين المعاملات المختلفة. للحشائش النجيلية، مبيد البيرسوت بجرعاته الثلاث أعطى مكافحة ضعيفة (41.14 - 44.91%) بينما مبيد القول بجرعاته الثلاث أعطى مكافحة معتدلة (58.14 - 72.50%) وذلك في الموسمين الشتويين مجتمعة (جدول 1). هذه النتائج تطابق نتائج Osman (1998)، ونتائج Osman and Elamin (2011) الذين ذكروا أن تطبيق مبيد الحشائش قول كمعاملة قبل الانبثاق في الفول المصري أعطى فعالية متوسطة إلي جيدة في مكافحة الحشائش النجيلية. كذلك هذه النتائج تماثل نتائج Babiker (1998).

للحشائش عريضة الاوراق اعطى مبيد بيرسوت بجرعاته الثلاث مكافحة ضعيفة (42.28 - 45.88%) للحشائش بينما الجرعات الثلاث لمبيد القول أعطت مكافحة فعالة تراوحت من متوسطة (61.92 - 67.35%) إلى جيدة جداً (73.41%) في الموسمين الشتويين مجتمعة (جدول 1). هذه النتائج تشابه نتائج Babiker *et al*. (1990) ، Mohamed *et al*. (1994) و Bedry and Abbas (2011) الذين أشاروا إلى أن استخدام مبيد القول رشاً قبل الانبثاق في محصول الفول المصري في ولاية نهر النيل أعطى مكافحة ممتازة للحشائش.

خليط كل من الجرعتين المنخفضة والمتوسطة للبيرسوت مع كل من الجرعات الثلاث لمبيد القول أعطى مكافحة فعالة للحشائش الحولية النجيلية وعريضة الأوراق تراوحت من جيدة جداً (76.09 - 93.37%) إلى ممتازة (78.99 - 94.35%) وذلك فى الموسمين الشتويين مجتمعة (جدول 1). هذه النتائج تؤيد ما توصل إليه بدري (1998) الذى أوضح أن استخدام خليط مبيد الحشائش بيرسوت ومبيد الحشائش قول كمعاملة قبل الانبثاق أعطى مكافحة فعالة ومستمرة للحشائش الحولية بالولاية الشمالية. أيضاً هذه النتائج تطابق النتائج التي توصل إليها Mohamed (1992)، و Mohamed (1996) ، اللذان أشارا إلى أن تطبيق خليط القول مع مبيد البيرسوت رشاً قبل الانبثاق أعطى مكافحة فعالة للحشائش النجيلية وعريضة الأوراق. كذلك هذه النتائج تماثل تلك التي توصلت إليها إدارة نقل التقانة والإرشاد (2009) .

بمقارنة مبيدات الحشائش مع بعضها البعض أوضحت التجربة أن خليط الجرعة المتوسطة من البيرسوت مع كل من الجرعتين المتوسطة والعالية للقول هي من أحسن المعاملات التي كافحت الحشائش بصورة فعالة في الموسمين الشتويين. هذه النتائج مطابقة للنتائج التي تحصل عليها Osman (2006).

كل معاملات مبيدات الحشائش أدت إلى نقص معنوي في الوزن الجاف للحشائش في الموسمين الشتويين مجتمعة مقارنةً بالشاهد (جدول 1). هذه النتائج تماثل نتائج Osman (1998) و Osman and Elamin (2011) حيث اشارا الى أن تطبيق مبيد الحشائش قول كمعاملة قبل الانبثاق في الفول المصري أدى إلى نقص معنوي في الوزن الجاف للحشائش. من أحسن

المعاملات التي أدت إلى نقص معنوي في الوزن الجاف للحشائش كانت كل مخاليط مبيدات الحشائش في الموسمين الشتويين مجتمعة (جدول 1). هذه النتائج مطابقة لتلك التي تحصل عليها Osman (2006).

أوضح التحليل المشترك للموسمين الشتويين أن كل معاملات مبيدات الحشائش تحت الجرعات المختلفة والإزالة اليدوية المستمرة للحشائش أدى إلى زيادة معنوية في ارتفاع النبات (24.00 – 29.61سم)، عدد الأوراق في النبات (3.97 – 11.42)، عدد القرون في النبات (1.00 – 11.50)، عدد البذور في القرن (1.00 – 4.50) و وزن 100 بذرة بالجم (15.50 – 46.13) (جدول 2 وجدول 3).

حسب التحليل المشترك للموسمين الشتويين اتضح أن منافسة الحشائش لمحصول الفول المصري أدت إلى نقص معنوي في الإنتاجية بنسبة 77.55% مقارنة بالإزالة اليدوية المستمرة للحشائش (جدول 3). هذا النقص في الإنتاجية يؤيد ما توصل إليه Dawood (1989) ، Babiker (1990) وبدري (1998) الذين وجدوا أن منافسة الحشائش لمحصول الفول المصري أدت إلى نقص في إنتاجيته بنسبة تتراوح من 36 إلى 55% في الولاية الشمالية وولاية نهر النيل. هذا النقص الكبير فى إنتاجية الفول المصري يرجع جزئياً إلى تأثير الحشائش سلباً على مختلف مكونات الإنتاجية وذلك عن طريق منافستها للمحصول على الماء، الغذاء، الضوء والمكان.

كل معاملات مبيدات الحشائش بجرعاتها المختلفة والإزالة اليدوية المستمرة للحشائش أدى إلى زيادة معنوية في الإنتاجية مقارنة بالشاهد وتراوحت هذه الزيادة من 148.71 إلى 345.47% (جدول 3). هذه النتائج تؤيد نتائج بدري (1998) الذى أشار إلى أن تطبيق خليط مبيد البيرسوت مع مبيد القول رشاً قبل الانبثاق لمكافحة حشائش الفول المصري في مروى بالولاية الشمالية أدى إلى زيادة إنتاجية الفول المصري بنسبة 63%. أيضاً هذه النتائج تطابق نتائج Mohamed (1996) الذى ذكر أن تطبيق خليط مبيد البيرسوت مع مبيد القول أعطى زيادة معنوية فى إنتاجية حبوب الفول المصري. كذلك هذه النتائج تؤيد نتائج Mohamed *et al*. (1994) وMohamed *et al*. (2004) الذين أوضحوا أن تطبيق مبيد البيرسوت كمعاملة قبل الانبثاق أعطى زيادة معنوية في إنتاجية بذور الفول المصري. هذه النتائج تماثل نتائج Osman and Elamin (2011) . هذه الزيادة في إنتاجية بذور الفول المصري ربما تكون نتيجة منع منافسة الحشائش للمحصول بواسطة تطبيق مبيدات الحشائش والذى انعكس إيجاباً على زيادة النمو الخضري للنبات. ايضاً هذه الزيادة ربما تعزى إلى أن مكافحة الحشائش مبكراً في فترة نمو الفول المصري بواسطة مبيدات الحشائش تمكن المحصول من الاستفادة من المصادر المتاحة في التربة بكميات كبيرة وهذا ينعكس إيجاباً على التأسيس الجيد لنمو المحصول.

بمقارنة مبيدات الحشائش مع بعضها البعض أوضحت التجربة أن خليط الجرعة المتوسطة للبيرسوت (0.075 كجم مادة فعالة للهكتار) مع كل من الجرعتين المتوسطة والعالية للقول (0.44 و 0.64 كجم مادة فعالة للهكتار) هي من أحسن المعاملات التي أدت إلى زيادة معنوية في إنتاجية الحبوب في الموسمين الشتويين مجتمعة. هذه النتائج مؤيدة الي ما توصل اليه Osman (1998).

هذه الزيادة ربما تعزي إلى مكافحة الحشائش بصورة فعالة بواسطة مبيدات الحشائش ومخاليطها المستعملة بجرعاتها المختلفة مما يؤثر إيجاباً على زيادة ارتفاع النبات، عدد الاوراق في النبات، عدد القرون في النبات، عدد البذور في القرن ووزن

100حبة. أيضاً هذه الزيادة من المحتمل أن تكون بسبب قوة النمو الخضري للنبات نتيجة منع منافسة الحشائش للمحصول والتأثير المفيد لبعض العمليات الزراعية مثل التسميد. وهذه الزيادة ربما تعزى إلي مكافحة الحشائش فور ظهورها عن طريق مبيدات الحشائش المستخدمة وهذا يترتب عليه منع منافسة الحشائش للمحصول مما يمكن المحصول من الاستفادة القصوى للعناصر الضرورية والماء الممتصة بواسطة الجذور من التربة وكذلك الضوء الذى يساعد في عملية التمثيل الضوئي.

توصى الدراسة باستخدام خليط الجرعة المتوسطة للبيرسوت (0.075 كجم مادة فعالة للهكتار) مع الجرعة المتوسطة للقول (0.44 كجم مادة فعالة للهكتار) لمكافحة حشائش الفول المصري. اضافة الى ازالة الحشائش المقاومة للمبيدات باليد قبل الفترة الحرجة 4 اسابيع من الزراعة.

جدول (1): تأثير معاملات مبيدات بيرسوت وقول علي الحشائش النجيلية، الحشائش عريضة الاوراق والوزن الجاف للحشائش (جم /م^2) بتحليل مشترك خلال الموسمين 15/2014 و 16/2015.

المعاملات	معدل المبيد (كجم.م.ف/للهكتار)	النسبة المئوية لمكافحة الحشائش النجيلية بعد 4 اسابيع (%)	النسبة المئوية لمكافحة الحشائش عريضة الاوراق بعد 4 اسابيع (%)	الوزن الجاف للحشائش (جم/م^2)
بيرسوت	0.050	41.14	42.28	24.63c
بيرسوت	0.075	42.25	43.69	40.88b
بيرسوت	0.100	44.91	45.88	19.88cd
قول	0.24	58.14	61.92	23.13cd
قول	0.44	65.57	67.35	26.38bcd
قول	0.64	72.50	73.41	24.88c
بيرسوت + قول	0.24 + 0.050	76.09	78.99	10.75de
بيرسوت + قول	0.44 + 0.050	78.49	84.12	10.25de
بيرسوت + قول	0.64 + 0.050	81.93	87.03	10.00de
بيرسوت + قول	0.24 + 0.075	82.72	87.74	13.63de
بيرسوت + قول	0.44+ 0.075	93.37	94.35	11.75de
بيرسوت + قول	0.64 + 0.075	89.04	92.51	8.94de
نظيفة طول الموسم	-	100.00	100.00	-
موبوءة طول الموسم	-	0.00	0.00	61.19a
مستوي المعنوية	-	-	-	م
معامل الاختلاف	-	-	-	45.53
الخطأ القياسي	-	-	-	5.69

المتوسطات التي لها حروف متشابهة داخل العمود الواحد لا تختلف معنوياً عن بعضها تحت مستوى الاحتمالية 5% وفقاً لDMRT
م: معنوي، غ م: غير معنوي.

جدول (2): تأثير معاملات مبيدى الحشائش بيرسوت وقول على ارتفاع النبات وعدد والأوراق في النبات خلال الموسمين 15/2014 و16/2015 (بتحليل مشترك).

المعاملات	معدل المبيد (كجم.م.ف/للهكتار)	ارتفاع النبات (سم)	عدد الأوراق فى النبات
بيرسوت	0.050	64.69ab	17.55c
بيرسوت	0.075	65.25ab	20.85b
بيرسوت	0.100	65.38ab	20.43b
قول	0.24	64.78ab	17.65c
قول	0.44	62.63ab	22.03ab
قول	0.64	64.50ab	18.93bc
بيرسوت + قول	0.24 + 0.050	62.13ab	21.53ab
بيرسوت + قول	0.44 + 0.050	68.5a	21.93ab
بيرسوت + قول	0.64 + 0.050	69.50a	21.60ab
بيرسوت + قول	0.24 + 0.075	69.63a	18.18bc
بيرسوت + قول	0.44+ 0.075	67.00a	19.78b
بيرسوت + قول	0.64 + 0.075	70.00a	20.53bc
نظيفة طول الموسم	-	67.74a	25.00a
موبوءة طول الموسم	-	38.13c	13.58d
معامل الاختلاف	-	10.80	16.61
الخطأ القياسي	-	3.44	1.65

المتوسطات التي لها حروف متشابهة داخل العمود الواحد لا تختلف معنوياً عن بعضها تحت مستوى الاحتمالية 5% وفقاً لDMRT

جدول (3): تأثير مبيدى الحشائش بيرسوت وقول على إنتاجية الحبوب ومكوناتها خلال موسمي 15/2014 و16/2015 (بتحليل مشترك).

المعاملات	معدل المبيد (كجم.م.ف/للهكتار)	عدد القرون في النبات	عدد البذور في القرن	وزن 100 بذرة (جم)	الإنتاجية (كجم/هكتار)
بيرسوت	0.050	4.50d	3.00c	50.00e	630f
بيرسوت	0.075	4.00d	3.50c	50.50e	645.28e
بيرسوت	0.100	5.50d	3.50c	55.50d	699.30d
قول	0.24	6.00cd	4.00bc	47.50f	623.10f
قول	0.44	6.50c	4.00bc	50.00e	621.48f
قول	0.64	8.00bc	3.00cd	50.00e	627.68f
بيرسوت + قول	0.24 + 0.050	8.00bc	4.50ab	64.00c	673.98d
بيرسوت + قول	0.44 + 0.050	9.00b	4.50ab	68.00b	711.88c
بيرسوت + قول	0.64 + 0.050	9.50b	5.00ab	70.00b	747.55c
بيرسوت + قول	0.24 + 0.075	11.00ab	5.50ab	71.00b	858.80c
بيرسوت + قول	0.44+ 0.075	11.50a	6.00a	74.00ab	959.73b
بيرسوت + قول	0.64 + 0.075	12.50a	5.50ab	73.00b	935.00b
نظيفة طول الموسم	-	14.50a	6.50a	78.13a	1113.13a
موبوءة طول الموسم	-	3.00e	2.00d	32.00g	249.88g
معامل الاختلاف	-	17.77	29.70	4.12	1.08
الخطأ القياسي	-	0.72	0.65	1.23	3.89

المتوسطات التي لها حروف متشابهة داخل العمود الواحد لاتختلف معنوياً عن بعضها تحت مستوى الإحتمالية 5%

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