Annex 6-1: Abstract of Symposium 2018 Sep

SATREPS Symposium on Striga Management

Date & Time: 11:30 — 14:00 on September 18th, 2018
Venue: Conference Hall, Ministry of Higher Education and Scientific Research2018

(MC: Prof. Migdam)

:35Quran recitation

:40Opening address
(Prof. Elgasim, D.C. NCR & Project Director)

50Introduction of the project by Prof. Sugimoto
(Prof. Sugimoto, Kobe Univ. Japan & Project Leader)

:05Literature survey on the management of root parasitic weeds
(Dr. Samejima)

:20Elucidation of sorgomol synthase as a step for clarifying strigolactone biosynthesis
(Dr. Wakabayashi)

:35A plausible tool for Striga hermonthica management in cereals
(Dr. Somaya)

:50Glomus mosseae, and Bacillus megaterium var. phosphoticum plausible bioagents for Striga hermonthica management in sorghum
(Dr. suha)

:05Carbohydrate metabolism during seed germination of Orobanchaceae parasitic weeds as a potential target for their selective control
(Dr. Okazawa)

:20Integrated management of broomrape (Orabanche crenata Forsk.) in faba bean (Vicia faba L.)
(Dr. Mahdi)

:35Towards maximum utilization of the noxious invasive root parasitic weeds, Striga spp.
(Dr. Kuse)

13:35-1400 Discussion

The SATREPS project: Development of countermeasures against *Striga* to conquer poverty and improve food security in Sudan

Sugimoto, Y.[1] and Babiker, A. G. T.[2]

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The genera *Striga*, *Orobanche* and *Phelipanche* (Orobanchaceae) are widely spread root parasitic weeds. Among the species, the obligate hemiparasite *Striga hermonthica* is considered to be the most important. The parasite, which attacks poaceous plants, is a copious seed producer. The seeds are endowed with prolonged dormancy and a huge seed bank soon develops after inception of infestation. Currently over 50 million hectares of the land under cereals is infected in Africa. The parasite life cycle is strongly cued to that of its host. For host recognition, location and infection *Striga* follows a series of orderly events based on interplay of signals between the host and the parasite. Starting with germination, haustorium initiation, attachment, penetration, establishment of a connection with host xylem, development, emergence, flowering, seeds setting and enrichment of the seed bank. Prior to emergence *Striga* is fully dependent on its host and is most damaging. Further, *Striga* parasitism is linked to soil fertility particularly low nitrogen and low phosphorus. Nitrogen and phosphorus deficiency, predominant in the Sudan central clay plains, where most of agricultural activities are practiced, makes the latter an ideal ground for the parasite to thrive. The goal of the project is to go from laboratory to screen house, on station trials and on farm validation followed by demonstration plots and technology transfer employing a participatory approach and tuning the technology to farmers needs. Practicability, environmental benignity and economic and technical feasibilities are of concerns. The activities the project is to address are i) development and verification of germination stimulants for weedy Orobanchaceae, ii) development of germination inhibitors for root parasitic weeds iii) demonstration and development of an arsenal of microorganisms for control of *Striga*, iv) verification of stability and durability of Striga–resistance v) identification of useful substances in *Striga* to promote management through utilization vi) dissemination of *Striga* control measures and increase of awareness though Farmers Field Schools and vii) establishment of a national functional research and implementation structure to address noxious weeds.

Keywords: parasitic weeds; *Striga hermonthica*; Orobanchaceae

Literature survey on the management of root parasitic weeds

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Parasitic weeds are classified as root or stem parasites according to the host organs to which they are attached. Among root parasitic weeds, the obligate parasitic Orobanchaceae, witchweed (*Striga* spp.) and broomrape (*Orobanche* and *Phelipanche* spp.) parasitize economically important food crops. Root parasitic Orobanchaceae are the most devastating agricultural weedy pests worldwide. Based on analysis of climatic requirements of the species, very large areas of new territories are at risk of invasion if special measures are not undertaken to limit the introduction of seeds and educate farmers and others to be alert for signs of new infestation. Recent research in combating root parasitic weeds was surveyed based on scientific papers published in 2010 onwards. The countermeasures in vogue include: resistant and tolerant varieties, microbiological approach, cultural practices, chemical control, host-induced gene silencing, integrated management and dissemination of technologies including current situation surveys. Recently, several approaches are ongoing with reasonable success in combating root parasitic weeds, such as maize varieties possessing concurrent resistance to *Striga* and tolerance to prevalent abiotic stresses in West Africa, a simple method using toothpicks for fungal delivery to farmers in Kenya, push-pull technology in East Africa and a decision support system for controlling *Phelipanche* spp. in Israel. Further work based on current scientific and endogenous knowledge is required for development of an integrated management strategy which offers several options to match the low-input farming systems and the prevalent climatic and socioeconomic conditions in Striga endemic areas. Regular surveys employing modern technologies to delineate root parasitic Orobanchaceae infested and free areas are to be organized. Available technologies are to be disseminated, validated and tuned to farmers' needs.

Keywords: broomrape, *Orobanche*, pest management, *Phelipanche*, *Striga*, witchweed

Elucidation of sorgomol synthase as a step for clarifying strigolactone biosynthesis

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Root parasitic weeds have evolved many adaptations and have unique life cycles that are tightly coupled with the ecological behavior of the host plants. For example, the seeds of root parasitic Orobanchaceae require host-derived germination stimulants such as strigolactones (SLs) to germinate. SLs have been shown to induce hyphal branching in arbuscular mycorrhizal fungi, and to function as a phytohormone to modulate plant's structure and optimize growth and development to cope with limiting resources. In order to control root parasitic weeds and improve food security, SLs, which have the function of inducing germination of parasitic Orobanchaceae and modulating plant growth and thus linked to the amount of biomass, are key compounds. Elucidation of SLs biosynthesis is a prerequisite for full utilization in agriculture. In SLs biosynthesis, the direct precursor carlactone (CL) is biosynthesized from β-carotene by sequential reactions catalyzed by D27, CCD7, and CCD8 enzymes. Downstream of the three enzymes, cytochrome P450 711A (CYP711A), encoded by *MORE AXILLARY GROWTH 1* (*MAX1*), oxidizes C19 of CL to produce carlactonoic acid (CLA). In rice, CLA is converted to 4-deoxyorobanchol (4DO) and 4DO to orobanchol by MAX1 homologs CYP711A2 and A3, respectively. However, SL biosynthetic pathway subsequent to CLA has not been clarified in other plants. In this study, we investigated the genes involved in the conversion of 5-deoxystrigol (5DS) to sorgomol in sorghum. We probed genes responsible for sorgomol biosynthesis based on the changes in the gene expressions and the premise that SLs biosynthetic genes are up-regulated under phosphorous deficiency conditions. Some genes co-expressed with known SL biosynthesis genes were selected as candidates of sorgomol synthase, and those were heterologously expressed in *Escherichia coli*. Among them, a recombinant cytochrome P450 enzyme, CYP-SM, converted 5DS to sorgomol when incubated with 5DS as a substrate in vitro. Moreover, *CYP-SM* gene was overexpressed in *Lotus japonicus* hairy roots, a high 5DS producer with no detectable amount of sorgomol, to characterize the function of the gene in planta. As a result, the *CYP-SM* transformed *L. japonicus* produced high amounts of sorgomol using its internal 5DS as a substrate. Based on these results, we concluded that CYP-SM is the sorgomol synthase in sorghum. This is the first report on an enzyme catalyzing structure derivatisation of 5DS and provides a clue and shed light on the complicated SL biosynthesis.

Keywords: Strigolactone, 5-deoxystrigol, sorgomol, sorghum, biosynthesis

Carotenoids inhibiting herbicides: A plausible tool for *Striga hermonthica* management in cereals

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Striga hermonthica, a root parasitic plant that attacks important cereal food crops, is a difficult to control weed. In nature *S. hermothica* seeds only germinate in response to stimulants, apocarotenoids hormones, exuded by roots of hosts and some non-host plants. Following germination, the parasite develops and remains subterranean for 6 to 8 weeks during which period it is most damaging. Production of the stimulant is promoted by low soil fertility. Several methods of control have been released however; most of them mismatch the prevalent low input production systems. Among the proposed control measures resistance based on low stimulant production is the cheapest and most practical. However, paucity of resistance genes, farmers and consumers preference and adaptability to environment pose serious barriers. To overcome adoption barriers the present investigation was set to study the possibility of chemical manipulations of germination stimulants using the carotenoids inhibiting herbicide norflurazon. Sorghum seeds cv Abu Sabeen (5g) were soaked in 5 mL of norflurazon at 7.2 and 9.6 µg a.i mL^{-1}., as Zorial, aqueous suspension, for 30 min. The seeds, air-dried for 24 h, were planted in water washed sand, allowed to grow for 1, 2 and 4 weeks, recovered and their roots washed free of sand, were transferred, each, to a test tube containing distilled water (10mL) and allowed to stand for 48 h. Aliquots of the root exudates (20 µLeach) were applied to glass fiber discs containing conditioned *S. hermonthica* seeds collected from under sorghum. Striga seeds showed high response to GR24 (> 80% germination). Root exudates from seedlings grown for one week induced negligible to moderate germination (2-31%germination). Undiluted and 50% diluted roots exudates from 2 weeks old seedlings induced negligible germination (<10%), however, on further dilutions to 25 and 20% high germination (>70%) was attained. Roots exudates from untreated 4 weeks seedlings undiluted or diluted to 50 and 25% induced high germination (>80%). However, on further dilution to 20% germination decreased to 63%. The results showed that root exudates from sorghum cv Abu sabeen contain both germination inhibitor(s) and promoter(s) and that norflurazon is more suppressive to the germination promoter. Further the results suggest that norfluorazone by virtue of its ability to inhibit biosynthesis of the apocarotnoids phytohormones, strigolactones and abscisic acid, has the potentials to be deployed as a component of an integrated management strategy for root parasitic weeds at large.

Key words: *Sorghum,* norflurazone, Fluoridone, strigolactones, abscisic acid

Glomus mosseae, and *Bacillus megaterium var phosphoticum* plausible bioagents for *Striga hermonthica* management in sorghum

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Environment, Natural resources and Desertification Institute. The National Centre for Research Khartoum, Sudan

Striga hermonthica., is a debilitating root parasitic weed on cereals in sub-Saharan Africa where low inputs farming systems are practiced in soils with low fertility. Striga seeds only germinate on perception of stimulants exuded by roots of hosts and some none host plants. The stimulant(s) also modulates plants architecture and promotes hyphal branching in germinating spores of arbuscular mycorrhizal fungi (AMF). Two experiments were undertaken in a green house to study the effects of *Glomus mosseae*, an arbuscular mycorrhizal fungus, alone, and in combinations with *Bacillus megaterium* var *phosphaticum* (BMP), a phosphorus releasing bacterium, and inorganic phosphorus (P) on *S. hermontica* incidence, sorghum growth and AM colonization. *S. hermonthica* emergence was earlier on the untreated controls and was 6- 16 and 32-62 plants per pots early and late in the season, respectively. Unrestricted *Striga* parasitism reduced sorghum height by 20-60%, and biomass by 20-71%. Arbuscular mycorrhiza (AM) reduced *S. hermonthica* emergence and biomass by 87-100% and 93% and increased sorghum height and biomass by 89.12-115.29% and 207-402.2%, respectively. BMP, alone, reduced *Striga* emergence and biomass by 57-65% and 68% and increased sorghum height and biomass by 67-103.4% and 361.8%, respectively. P, alone, decreased *Striga* emergence and biomass by 28.7-56.4% and 51% and increased sorghum height and biomass by 45.33-74.24% and 133.7%, respectively. AM in a combination with BMP increased sorghum height and biomass by116.2-139 and 156.75%, respectively. The analogues data for the combination AM and P were 84.96-110.65% and 216.3%. The results indicate the potential of AM and BMP and their combinations as plausible bioagents for *S. hermonthica* management, improvement of sorghum growth and promotion of sustainable agriculture under the prevalent low-inputs crop production systems in sub-Saharan Africa.

Keywords: *Striga hermonthica*, *Glomus mosseae*, *Bacillus megatrium var* phosphoticum, sorghum

Carbohydrate metabolism during seed germination of Orobanchaceae parasitic weeds as a potential target for their selective control

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The seed germination process ofroot parasitic Orobanchaceae is unique for the need to percept germination stimulants released from the host roots. This process is the most fragile part in their life cycle since they have to survive with limited storage materials until completion of vascular connection to the host. Metabolism of planteose (Pla), a galactosyl sucrose, immediately after the perception of germination stimulants is required for germination. Preliminary screening of glycosylhydrolase inhibitors revealed that nojirimycin (NJ) suppressedthe germination through disruption of invertases catalyzing the second step in Pla metabolism. An effective culture of *Streptomyces ficellus*for high NJ production, which demonstrated high inhibition of germination without any purification, was developed. Currently preparations for evaluation of the effects of cultures of *S. ficellus*and 40 *Streptomyces* spp. on *Striga*seed germination and capacity for NJ production are ongoing in Sudan. The first step of Pla metabolism is hydrolysis of the galactosyl bond, however, the enzyme involved remained unknown. Transcriptome analysis on germinating seeds of *Orobanche minor* highlighted a putative α-galactosidase (OmAGAL) highly expressed in the early stage of germination. Heterologous expressionin *Escherichia coli* revealedthat OmAGAL is an acidic α-galactosidase capable of Pla hydrolysis. Germinating seeds of *O. minor* treated with 5-bromo-4-chloro-3-indolyl-α-D-galacotoside (X-α-Gal), which reacts with α-galactosidase to give a blue color, showed blue spots in limited cells near the micropyles. Screening of Pla hydrolysis inhibitors (PIs), using a chemical library composed of ca. 15,000 compounds, revealed 28 PIs which inhibit OmAGAL activity. Further, screening of several PIs for their effects on the germination of *O. minor* revealed significant suppression of radicle elongation. The results show clearly that Pla metabolism is important for the germination of root parasitic weeds and could be a potential target for their selective control.

Keywords:α-galacotosidase, metabolic inhibitors, nojirimycin, planteose

Integrated management of broomrape (*Orabanche crenata* Forsk.) in faba bean (*Vicia faba* L.)

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Broomrapes (Orobanche spp.) are devastating holoparasitic weeds on many economically important crops. The present investigation was undertaken to study the effects of *Trichderma harzanium,* imazethapyr (Herbicide), B*acillus megatherium var Phosphaticum* (BMP) and *Rhizobium* Tal 1399 (RH), in various combinations on *Orobanche crenata* incidence and faba bean cv; Bsabeer growth and yield, under laboratory and field conditions. For field experiments treatments were arranged in Complete Randomized Block Design (RCBD) with four replicates. Parameters measured were *Orobanche* emergence and dry weight and selected faba bean growth attributes. *T. harzanium* alone, reduced *Orobanche* emergence by 69. -74%, improved faba bean height by11.5-13.7 % and total dry weight by 24%. BMP and RH reduced *Orobanche* emergence by 34.5-46.3% and improved faba bean height by 4.47-5.75%, respectively. The combinations *T. harzanium*, BMP and RH further reduced *Orobanche* emergence by 72-75% and increased faba bean height and total shoot dry weight by 7.1% and 25%, respectively. Imazethapyr at 47.6 g a.i, ha^{-1}reduced *Orobanche* emergence by 48 and 49% early and late in the season, respectively. Supplementation of the combination, *T. harzanium,* BMP and RH, with the herbicide decreased *Orobanche* infestation by 65-73%, increased faba bean height by 7-11.3% and total dry weight by 20%. Unrestricted *Orobanche* growth reduced faba bean height by 12.2 , 13.6 and 12.8% at 65, 80 and 90 DAS, respectively. Imazethapyr alone and in combination with *T. harzanium,* BMP and RH increased faba bean height by15, 4.9% and 23% respectively. The results indicate that all treatments suppressed *O. crenata* infection and improved faba bean growth in both the greenhouse and field experiments. Of all treatments *T. harzanium* was the best as it suppressed *O. crenata* emergence by 45-75% and improved faba bean growth by 7-13% and grain yield by48-120%.

Towards maximum utilization of the noxious invasive root parasitic weeds, *Striga* spp.

Kuse, M.[1], Tsugita, K.[1], Abdelkareen, H. H.[2], Suliman, M. B.[2], Moglad, E.[2], Siribel, A. A. M.[2], Babiker, A. G. T.[3] and Sugimoto, Y.[1]

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The witchweeds (*Striga* spp.), root parasitic angiosperms predominant in sub-Saharan Africa, are major constraints to cereals production including the main food crops sorghum, millet and maize. The parasites, induced to germinate by host-derived chemical signals, attach, penetrate the host roots, establish connection with the vascular system and remain subterranean for 6-8 weeks during which period they inflict most of their damage. Post-emergence control methods including hand-pulling, albeit curtail seed bank replenishment, are not acceptable to farmers as early damage by the parasite precludes financial returns. Our goal is to promote *Striga* spp. control and curtail their spread through commercial utilization of the plants before flowering. Metabolomic analysis of *S. hermintheca* showed important classes of secondary metabolites including flavonoids and terpenoids. These compounds are well known for their curative properties. Furthermore, chemical analysis revealed the presence of other biologically active compounds having great therapeutic potential *viz* the vermifuge santonine. Challenges have been continued to establish simple and efficient methods to isolate these compounds and maximize utilization of *Striga* spp. as medicinal plants. Field surveys were also conducted in the suburbs of Khartoum and infested areas were located. *S. hermonthica* plants at different growth stages were collected, dried and powdered. Extraction method, using Soxhlet extractors, was developed to yield crude materials efficiently from the dried powder. Isolation and structure determination of the major metabolites from the crude material are ongoing in our laboratories.

Keywords: *Striga* species, medicinal plants, sorghum, pearl millet, maize, vermifuge, santonine

NATIONAL SEMINAR

INTEGRATED MANAGEMENT OF PARASITEC WEEDS

OCTOBER 6, 2021

9:00 – 13:00

Sudan

Sharjah Hall – University of Khartoum

ABSTRACTS

JICA STRIGA PROJECT

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NATIONAL SEMINAR ON INTEGRATED MANAGEMENT OF PARASITIC WEEDS

OCTOBER 6, 2021

Venue: Sharjah Hall - University of Khartoum

Time	Programs/Topic	Speakers
October 6, 2021		
8:30 – 9:00	Registration	
9:00 – 9:30	MC: Dr. Randa Elsalahi Opening Remarks - DG of NCR - SUST Representative - DG of ARC - JICA Chief Representative - Minister of Higher Education and Scientific Research	Prof. Zeinab Osman Prof. Abdel Monim Taha Ahmed Mr. Koji Sakane Prof. Intisar Soghayroun
9:30 – 9:40	Introductory note on the project	Prof. Yukihiro Sugimoto
9:40 – 9:55	Weedy Orobanchaceae	Prof. Babiker AG
9:55 – 10:30	- Break	
Chairperson:Prof. Abdel Monim Taha Ahmed/ DG of ARC Raporteur: Dr. Hanan Ibrahim Modawi		
10:30 – 10:45	Actinomycete metabolites for control root parasitic Orobanchaceae	Prof. Atsushi Okazawa, Osaka Prefecture Univ.
10:45 – 11:00	Yield Adaptability and Stability of Grain Sorghum Crosses Across Environments Under *S. hermonthica* Infestation in Sudan	Dr. Mohamed Ahmed Hamad / ARC Wadmedani
11:00 – 11:15	Development and verification of suicidal germination agents on *Striga*	Dr. Khogali Izzeldain / ARC Shambat
11:15 – 11:30	Influence of chlorsulfuron and *Glomus moasse*, an arbuscular mycorrhizal fungus, on *Striga hermonthica* incidence and sorghum growth	Prof. Babiker AG
11:30 – 11:45	Cultural practices and post-emergence herbicides for management of *Striga hermonthica* on wheat	Prof. Khari. N.A/ ARC River Nile
11:45 – 12:00	Dissemination of Integrated Striga Management (ISM) Practices in sorghum through Farmer Field School (FFS)	Prof. Dafalla Dawoud / ARC Wadmedani
12:00 – 12:15	Striga hermonthica as a medicinal plant	Prof. Kuse/ Kobe Univ.
12:15 – 12:30	Potential microbes, resistant varieties and imazethapyr for *Orobanche crenata* management in faba beans	Prof. M.M. Hassan / M.of Higher Education

Time	Programs/Topic	Speakers
12:30 – 13:00	Discussion and the way forwards	Prof. Babiker AG

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Prof. Babiker AG of Sudan University of Science and Technology and Consultant National Centre for Research

The SATREPS project: Development of countermeasures against *Striga* to conquer poverty and improve food security in Sudan

Yukihiro SUGIMOTO

Kobe University

The SATREPS project "Development of countermeasures against *Striga* to conquer poverty and improve food security in Sudan" is designed to promote activities related to management of Orobanchaceae root parasitic weeds in Sudan, from basic science in the laboratory to agricultural practice in the field. SATREPS is abbreviation of Science and Technology Research Partnership for Sustainable Development, co-funded by Japan Science and Technology Agency (JST), and Japan International Cooperation Agency (JICA). The Sudanese side is supported by JICA under the scheme of technical cooperation, which is composed mainly of 1) dispatching Japanese researchers to Sudan, 2) inviting Sudanese researchers to Japan, and 3) providing equipment, for technical transfer. Due to the political turmoil in 2019 and the worldwide COVID-19 pandemic in 2020 and 2021, the binational collaboration has been sluggish for more than two years. I, as the leader of the project, would appreciate that National Center for Research (NCR) hosts the national seminar in this difficult period to raise awareness of Sudanese people about the project and to share with them achievements and future plans. I hope that the seminar will provide the participants with opportunities to fortify their motivation and strengthen their relations.

Weedy Orobanchaceae

AG Babiker

Sudan University of Science and Technology, Consultant National Research Centre,

Weedy Orobanchaceae are invasive destructive agricultural pests of global economic importance. Members of the genera *Orbanche*, *Phelipanche* and *Striga* are the most important. In Sudan *O. crenata* and *P. ramosa* on leguminous and Solanaceous crops, are alien presumably introduced with crops seeds. *O. crenata* and *P. ramosa* on fab bean and tomatoes, respectively, are widely spread across riparian soils and present serious production constraints Of all the weedy Orobanchaceae *Striga hermonthica*, a native of East Africa, is the most damaging and the most difficult to control. *S. hermonthica* parasitizes the major food crops, sorghum, millet and maize. and is considered to be the most important biotic threat to food security across the region. Currently the area infested by the parasite in the E CA regions is estimated to be over 50 million hectares and losses, in monetary terms, are estimated to be over 7 billion US$. The parasites are characterized by a complex life cycle, which is strongly cued to that of their hosts and the environment. The parasites are copious seeds producer. The seeds are endowed with prolonged dormancy and extended longevity. To germinate the seeds, normally produced towards the end of the season, require an-after ripening period, a subsequent exposure to warm moist conditions followed by a germination stimulant produced by hosts and some non-host. In Sudan *O. crenata* was first reported in 1991 in an area of 2 ha in the northern state introduced presumably with faba bean seeds from Egypt. Currently the parasite has become a naturalized weed in the legume belt in central and northern Sudan mainly in the Nile valley from Khartoum to Wadi Halfa on the southern border of Egypt . *P. ramosa* was first reported in 1948 in the then Khartoum province. Currently the parasite is a plague on tomatoes, potatoes and egg plants across the country with dominance in the Gezira, Khartoum, the River Nile and the Northern state. The wide spread of the parasite could be attributed to repeated uncoordinated introduction of the parasite seeds with those of crops from countries where the parasite is known to be an epidemic. As an example introduction of tomato seeds to establish a tomato paste in Karima in the northern state led to closure of the factory in the first year of production. In Sudan *S. hermonthica*, the primary focus of this project "Developing Countermeasures against *Striga* to Conquer Poverty and Improve Food Security in Sudan", attacks sorghum and millet which are the major food crops and inflicts considerable damage on yield leading to abandonment of land, migration of villages and conflicts on land use. Advancement of agriculture on pastoral lands with the primary objectives of feeding the burgeoning populations is a main reason in conflicts between pastoralists and sedentary farmers thus giving the parasite a dimension of a havoc initiator.

Actinomycete metabolites for control of root parasitic Orobanchaceae

Atsushi Okazawa[1], Somaya Sirelkhatim Mohamed Salih[2]

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Utilization of microorganisms or their metabolites is one of the feasible approaches for sustainable agriculture. Previously, we found that nojirimycin (NJ) produced by *Streptomyces ficellus* significantly retarded germination of root parasitic Orobanchaceae through its effect on carbohydrate metabolism (Wakabayashi *et al.*, 2015). Transcriptome analysis of the effect of NJ indicated that it alters carbohydrate metabolism and/or signaling, which is required to promote seed germination, at gene expression level (Okazawa *et al.*, 2020). The productivity of NJ by *S. ficellus* was enhanced using marine broth, and the culture filtrate without further purification of NJ retarded *Orobanche minor* seed germination as purified NJ (Harada *et al.*, 2017). In the SATREPS Activity 2, more than 40 *Streptomyces* spp. were collected in Sudan, and the effect of the culture on germination of *Striga hermonthica* has been investigated. Cultures of some isolates exhibited potent inhibitory activities against *S. hermonthica* seed germination. Optimization of culture condition including culture broths and periods is ongoing to utilize the cultures as tools for *Striga* and *Orobanche* control.

Additionally, we serendipitously found that butenolide hormones produced by *Streptomyces avermitilis* can induce germination of *O. minor*. The effect was specific to *O. minor* among the four parasitic species including *S. hermonthica* (Okazawa *et al.*, 2021). The finding shows the possibility that actinomycete metabolites or actinomycetes themselves are utilized as not only germination inhibitors but also germination stimulants.

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Yield Adaptability and Stability of Grain Sorghum Crosses Across Environments Under *S. hermonthica* Infestation in Sudan

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Sorghum (*Sorghum bicolor* (Monech) L.), an important staple food and feed crop in the Sudan, is annually planted in 4-7 million ha constituting 73% of the total cultivated area. However, grain yield is low (600 kg ha^{-1}) compared to the international average (1.3-1.5 t ha^{-1}). The low yield is attributed to a plethora of biotic and abiotic constraints of which the root parasitic weed *Striga hermonthica* is the most important. Several methods of control were released however, due to high cost they are a mismatch to the prevalent low input production systems in vogue and are poorly adopted Resistant/tolerant varieties would offer the easiest and most economical solution. However, paucity of resistance genes, lack of immunity, rapid adaptability of the parasite to its host and environment coupled with producers and consumers preference impose serious limitations on their adoption and make identification of *Striga* resistant/tolerant high yielding, phenotypically stable genotypes, with uniform performance across environments imperative. The present investigation was therefore undertaken to study grain yield adaptability and stability of 42 crosses made between the *Striga* resistant genotypes IS9830, 555, SAR33, Framida, N13, ICSV006, ICSV007, PQ-34 Brhan and SRN39 and its derivatives P401, P402 and P405 as donors with four improved, elite Sudanese sorghum cultivars, Wad Ahmed (WA), Tabat (TA), Butana (BU) and Arfagadamek-8 (AG-8) as recurrent parents. The experiment, laid in *S. hermonthica* sick plots was undertaken in two consecutive seasons (2016/17 and 2017/18) at three sites constituting six environments representing the irrigated and rain-fed sectors. Data analyses, showed highly significant differences ($P \leq 0.01$) among environments, genotypes and their interactions for grain yield. Twenty seven crosses, showed an increase in grain yield of 20.4-72.4% over the grand mean (898.1 kg ha^{-1}) and 218.5- 1475% over the maternal parents across the environments. Based on Additive Main Effect and Multiplicative Interaction (AMMI) analysis the crosses Framida x AG-8, PQ-34 x BU, ICSV006 x BU, ICSV007 x BU, SAR33 x BU, SAR33 x TA, P402 x TA, PQ-34 x WA, P405 x WA, P401 x WA, Framida x WA, SAR33 x WA and Brhan x WA were identified as the most stable, endowed with Striga resistant and/or tolerance and high grain yield (1139-1548 kg ha^{-1}). The crosses are scheduled to be examined for grain and nutrimental qualities, resistance mechanisms and potentials for deployment as components of *S. hermonthica* integrated management strategies and/or sources for resistance and/or tolerance.

Development and verification of suicidal germination agents on *Striga*

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Abstract:

Striga spp. are copious, seeds producers. The seeds produced are endowed with prolonged viability and pronounced dormancy. To germinate the seeds, require stimulant which in nature is produced by hosts and some non- host plants. The first natural germination stimulant, strigol, was isolated from cotton, a non- host. Several germination stimulants, based on strigol, were synthetized and proved to be effective under laboratory conditions. However, their performance under field conditions was not satisfactory due to short persistence. Work at Kobe University, Japan, showed that T-010 is adequately active. Further, research conducted at Shambat Research Station Khartoum Sudan showed that the stimulant resulted in adequate reductions in *Striga* emergence under greenhouse and field conditions. Subsequent work, investigating effects of repeated application on efficacy of T-010 using bathtubs showed that emergence of *S. hermonthic* reached its peak in August. *Striga* emergence was delayed and reduced by over 40% in bathtubs treated with T-010. However, no clear discretion could be made in emergence of the parasite in bathtubs treated with T-010 once, twice or thrice. Unrestricted *Striga* parasitism reduced sorghum shoot height by 10-36%, shoot dry weight by 42-63%.

Influence of chlorsulfuron and *Glomus moasse*, an arbuscular mycorrhizal fungus, on *Striga hermonthica* incidence and sorghum growth

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The present investigation, undertaken in a screen house at the College of Agricultural Studies, Sudan University of Science and Technology, was designed to evaluate the efficacy of *Glomus mosseae,* an arbuscular mycorrhizal fungus, the herbicide chlorsulfuron, and their combinations on *S. hermonthica* on sorghum. *Striga* emergence was invariably maximal on the untreated *Striga*-infested control. Unrestricted *Striga* parasitism reduced sorghum height, leaf area, number of leaves, relative chlorophyll content, sorghum shoot and sorghum root biomass by19.7-23, 9.8-22.6, 19.14-29.76, 18,27-55.91. and 58 and 61% respectively. Mycorrhization reduced *S. heermonthica* emergence and biomass by 88.5-100% and 74%, respectively and increased sorghum height, leaf area, number of leaves, relative chlorophyll content, sorghum shoot and sorghum root biomass by 42.6-92.36., 27.5 -51.2, 66.6-151,5, 61.4-205.7, 207.7 and 277.6%, respectively, over the Striga-infested control. Similarly chlorsulfuron at 1.79-2.98 g a.i. ha^{-1} reduced *Striga* emergence and biomass by 41.62-79.36%) and biomass by 54.87-73.64%) and increased sorghum height, leaf area, number, of leaves, relative chlorophyll content, sorghum shoot and sorghum root biomass by 24-70, 27.5-51.2 The combinations *G. mossae* and chlorsulfuron, reduced *Striga* emergence and biomass by 82.32-100 % and 66.78-78.79 %, respectively, and increased sorghum height, leaf area, number of leaves, relative chlorophyll content, sorghum shoot and sorghum root biomass by 48.8-103.4% The combination comprising the lowest rate of chlorsulfuron was the most suppressive to the parasite, least suppressive to mycorrhization and affected the highest increments in sorghum growth attributes over both the *Striga* infested and *Striga* free controls. The study reveals the potential of the combination *G. mosseae* and chlorsulfuron at the lowest rate for *Striga* management in sorghum.

Cultural practices and post-emergence herbicides for management of *Striga hermonthica* on wheat

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Striga hermonthica is a parasitic weed which has Sudan and Ethiopia as centres of origin. Under natural field conditions it is prevalent and devastating on major staple cereals except wheat. Despite the notable susceptibility of the latter to the parasite under laboratory conditions, there were no reports on infections under field conditions in traditional production areas which were confined to riparian soils in the River Nile and the Northern states nor in their congeners south of Khartoum. However, recently heavy , albeit localized infection of the crop was reported in the high terrace soils of the River Nile where expansion of wheat production for attainment of self-sufficiency is envisaged. Though temperature and length of the winter season are relatively suitable for wheat production, these soils are characterized by low fertility. An on-farm trial was undertaken at Ed-Damer food security project in the River Nile state on a plot where wheat was heavily infested by the parasite in the previous season to develop a quick solution to the problem, provide guide lines for future research and introduce remote sensing to estimate the magnitude of the infestation. The plot was divided (breadthwise) into 2 sub-plots, planted to sorghum (cv Abusabeen) as a catch crop, or left fallow. At sowing the plot was divided into 2 sub-plots (lengthwise), treated with DAP or left untreated. Further, each of the latter sub-plot was divided into 3 sub-sub-plots treated at 3-weeks after emergence with 2,4-D or triclopyr or left untreated. Striga emergence was very high on the catch crop (99 plants m^{-2}). On the subsequent wheat the parasite emergence was 6.4 plants m^{-2} in the untreated control. Catch cropping, 2,4-D and triclopyr, each alone, reduced *Striga* emergence by 28.1-33%. Catch cropping, triclopyr and 2,4-D, each supplemented by DAP, reduced *Striga* emergence by 46.9-65.6%. Catch copping supplemented by 2,4-D or 2,4-D and DAP reduced *Striga* emergence by 78.1 and 96.9%, respectively. Catch cropping supplemented by triclopyr and triclopyr and DAP, reduced Striga emergence to 0%. Among all treatments catch cropping supplemented by triclopyr and DAP or 2,4-D and DAP affected significantly higher plant population than the untreated control. All treatments yielded comparable number of grains per spike, however, only catch cropping supplemented by triclopyr or triclopyr and DAP affected significantly higher 1000 grain weight than the untreated control. Catch cropping supplemented by triclopyr, triclopyr and DAP, 2,4-D and DAP and 2,4-D supplemented by DAP significantly out yielded the untreated control and the realized increments were 44.6-65.8%. The results showed that catch cropping when supplemented by DAP and 2,4-D realized the highest yield increments, albeit slightly less effective in suppressing Striga emergence than when supplemented by DAP and triclopyr thus indicating that *Striga* on wheat grown on the high terrace soils could easily be harnessed if catch cropping is deployed with the package of practices released by the Agricultural Research Corporation (ARC) for wheat production.

Dissemination of Integrated Striga Management (ISM) Practices in sorghum through Farmer Field School (FFS)

Dafalla A. Dawoud[1], Hanan Abdeltawab[2] and A.G.T. Babiker[3,4]

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Abstract

Sorghum is the main staple cereal crop in the Sudan with an annual grown area of about 7- 8 million ha. Most of the crop is grown by rains (about 90%) and Gedarif represents one of the major areas for rainfed sorghum production. Striga is the major constraint to sorghum production in the rainfed sector leading to drastic reduction of sorghum productivity that may reach to total crop loss under severe infestation. Further Low inputs, traditional production methods and farmers' practice of continuous sorghum monocropping aggravated the problem. Research on striga showed that many non-host crops, suitable to the area could be used, in rotation with sorghum, as trap crops to deplete striga seed bank in the soil in addition to other effective striga control measures, suitable and economically feasible for framers in the area, such as water harvesting in low rainfall areas, growing of striga tolerant sorghum varieties (eg Arfagdamak8, fertilizers (urea) and herbicides (chlorsulfuron) in an integrated package to manage striga coupled with good crop husbandry practices. In this study Farmers' Field Schools (FFS) were used to transfer to farmers effective Integrated Striga Management (ISM) to improve sorghum productivity. In each FFS a demonstration field (10 feddans) in a two-course rotation (sorghum/trap crop) is used. Other implemented ISM practices include water harvesting in low rainfall areas (North Gedarif), sowing of striga tolerant sorghum variety (Arfagadamak8), fertilizer (urea at 40kg/fed) to be applied at sowing and the herbicide chlorsulfuron at 1.0 g a.i./fed to be applied as soil directed spray 3-4 weeks after sowing sorghum. In each FFS around 25 farmers directly participated in the school and many others indirectly participated by attending field days or through messages broadcasted in the local mass media or by direct contact of farmer-to-farmer. During seasons 2018/19 - 2020/2021, the FFS were implemented in 2-3 locations per season. Results showed the positive impact of intervention by implementing ISM in lowering striga damage and increasing sorghum grain yield by 70% to > 400% compared to traditional farmers' production methods. In view of the positive results and JICA support to the project with a tractor and necessary associate 10 FFS were established in the current season to enhance dissemination of ISM in the context of integrated crop management practices to other striga affected areas.

Striga hermonthica as a medicinal plant

Masaki Kuse, Awatif Siribel

The witchweeds (*Striga* spp.), root parasitic angiosperms predominant in sub-Saharan Africa, are major constraints to cereals production including the main food crops sorghum, millet and maize. The parasites induced to germinate by host-derived chemical signals, attach, penetrate the host roots, establish connection with the vascular system and remain subterranean for 6-8 weeks during which period they inflict most of their damage. Post-emergence control methods including hand-pulling, albeit curtail seed bank replenishment, are not acceptable to farmers as early damage by the parasite preclude financial returns. Our goal is to promote *Striga* spp. control and curtail their spread through commercial utilization of seedlings.

Metabolome analysis of *Striga* showed pre-dominance of optically active flavonoids and terpenoids that have high commercial values as sources of fine chemicals and lead compounds of medical importance. Further analysis indicated the presence of other biologically useful compounds including the famous vermifuge santonine.

Extraction and isolation of active ingredients from Striga were then operated. *Striga* was collected in Saleit and Soba and dried. After finely grinded, the resulting powder of Striga was engaged in Soxhlet extraction method using methanol. The obtained extracts were dried under reduced pressure. The major metabolites were then isolated by using a column chromatography and thin-layer chromatography with silica gels. The major compounds were chlorophylls and flavonoids, their structures were deduced by NMR (nuclear magnetic resonance) and MS (mass spectrometry).

Challenges have been continued to establish simple and efficient methods to isolate these compounds and maximize utilization of *Striga* spp. as medicinal plants.

Potential microbes, resistant varieties and imazethapyr for *Orobanche crenata* management in faba beans

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Orobanche crenata is one of the main factors limiting leguminous crops productivity in Sudan. A lot of work has been done to develop a strategy residing on beneficial soil microorganisms for its management. A series of laboratory, greenhouse and field experiments was therefore conducted at the laboratories and experimental farms (Soba) of the Bio-pesticides and Bio-fertilizers Department, Environment, Natural Resources and Desertification Research Institute (ENDRI), National Centre for Research (NCR), Khartoum, Sudan and Shendi Research station farm, Agricultural Research Corporation, Sudan and a farmer field at Dongola, North of Sudan, to study the effects of *Trichoderma harzianum*, the herbicide imazethapyr, *Bacillus megatherium* var. *phosphaticum* (BMP), *Rhizobium leguminosarum* biovar *viceae* strain (TAL1399) and the herbicide imazethapyr (Pursuit) on *O. crenata* germination and incidence and growth and yield of two faba bean varieties. Results of germination experiment showed that all treatments reduced germination of *O. crenata* by 53.42 – 89.62%. The combination of *T. harzianum,* BMP, TAL1399 and imazethapyr affected the highest and most significant inhibition of seed germination (89.62%) followed by *T. harzianum* and imazethapyr (87.67%). The greenhouse experiments, showed that the combination *T. harzianum* and imazethapyr significantly reduced *O. crenata* emergence and increased faba bean biomass and plant height in comparison to the infested un-inoculated un-treated control. The combination BMP and TAL1399 significantly increased plant height, faba bean biomass, number of nodules and decreased *O. crenata* emergence in comparison to the infested control. In the farmers' field experiment the combination *T. harzianum*, BMP, TAL1399 and imazethapyr reduced *O. crenata* emergence on Masri 3 (resistant variety) by 100% and 89% at Shendi and Dongla, respectively. The corresponding reductions in the parasite emergence on BB7 (local susceptible variety) were 82% and 49%. The combination *T. harzianum*, BMP, TAL1399 and imazethapyr applied to Masri 3 increased yield by 175% and 246% at Shendi ans Dongla, respectively. The corresponding yield increments in BB7 were 496% and 369%, respectively. The highest yields affected by the treatment, 3.38 and 3.17ton ha^{-1} were realized by Masri 3 at Shendi and Dongola, respectively. Further investigations are needed to identify the active metabolites, study the interaction between potential microbes and agricultural practices and development of appropriate formulations.

The way forwards

Babiker, A. G. T.

Sudan University of Science and Technology and Consultant National Centre for Research

Weedy Orobanchaceae are pernicious invasive plants, difficult to control, endowed with a complex biology, comprising copious seed production, prolonged viability and pronounced dormancy and ease of dissemination aided by numerous vectors including biotic and abiotic ones. Principles of invasive plants management comprising prevention of movements across borders and within borders employing all feasible quarantine measures, containment, control and eradication, when relevant, in accord with the stage of the invasion process are imperative. Early detection, rapid response, increasing stakeholders awareness about the parasite, gaining their support and participation are hubs for success. Increased awareness of stakeholders through seminars, mass media, demonstration farms, field days, training on preventive measures and handling incipient infestations are paramount. Among parasitic Orobanchaceae *Striga hermonthica* is unique in being an out crosser and has the capacity to adapt to the environment and increase its host range. Two distinct strains were identified and ecological and physiological variants are suspected. Further, *S. hermonthica* parasitism by its very nature is a function of the triad the parasite, the environment and/or the host genotype. Pyramiding of resistance/tolerance mechanisms and delineating their basis at molecular level together with adoption of an integrated management approach should be targets. *Striga hermonthica* is an indigenous plant while *Phelipanche ramosa* and *Orobanche crenata* are naturalized aliens that have become part of the guild of the natural flora. The three parasites are copious seeds producers. based on the premise that plants are means by which a seed produces more seeds management of the seed bank is an enchanting possibility. Prevention of replenishment of seeds reserves through physical, chemical or biological means should be thought. Metabolics and proteomics changes during conditioning, or perception of germination stimulants or inhibitors and at early stages of development prior to and at the inception of the parasitic phase should be addressed. Promotion of suicidal germination through synthetic and/or natural stimulants together with increasing seeds sensitivity to stimulants and/or inhibitors and curtailment of haustorial initiation or induction of pre-mature haustoria are to be considered. However, economy, practicability and environmental safety should be of concern. The three parasites inflict their damage during the subterranean phase which entails the need for suppression of early developmental stages. Search for natural enemies should be a primary target. Research on natural enemies was more or less confined to insects and pathogens, however work on suppressive soils should be intensified and could be merged with the emerging approach of increasing virulence of bioagents. In essence infection by parasitic Orobanchaceae is a symptom of an ailing soil and replenishment of soil health through promotion of proliferation of beneficial soil microbes is paramount to increased crop productivity and improved quality. Further, can the dice be turned and *Striga* be transformed into a useful plant?

INTERNATIONAL SYMPOSIUM

DEVELOPMENT OF COUNTERMEASURES AGAINST STRIGA

JANUARY 9, 2023

8:30 – 13:00

Sudan

Conference Hall of Ministry of Higher Education

ABSTRACTS

SATREPS STRIGA PROJECT

JICA/JST SATREPS
INTERNATIONAL SYMPOSIUM
ON
DEVELOPMENT OF COUNTERMEASURES AGAINST *STRIGA*
TO CONQUER POVERTY AND IMPROVE FOOD SECURITY IN SUDAN
JANUARY 9, 2023
Venue: Conference Hall of Ministry of Higher Education

Time	Programs/Topic	Speakers
January 9, 2023		MC: Prof. Randa Elsalahi
8:00 – 8:30	Registration	
8:30 – 8:45	Opening Remarks - DG of NCR - DG of ARC - JICA Chief Representative - Minister of Higher Education	 Prof. Zeinab Osman Prof. Abdel Monim Taha Ahmed Mr. Koji Sakane Prof. Mohamed Hassan Dahab
8:45 – 9:00	Outline of Symposium	Prof. Yukihiro Sugimoto
Part 1: Germination Control – Chemical Approach Chairperson: Prof. M. M. Hassan		
9:00 – 9:20	1-1 Host Plant Manipulation to Reduce Strigolactone Production	Dr. Takatoshi Wakabayashi
9:20 – 9:40	1-2 Suicidal Germination Induction by Strigolactone Mimics	Dr. Hiroaki Samejima
9:40 – 10:00	1-3 Germination Inhibition based on Parasite Carbohydrate Metabolism	Prof. Atsushi Okazawa
10:00 – 10:50	**Break**	
Part 2: Germination Control – Microbial Approach Chairperson: Prof. Atsushi Okazawa		
10:50 – 11:10	2-1 Probing Microbes Effective in Parasite Germination Control	Prof. M. M. Hassan
11:10 – 11:30	2-2 Identification of Germination Control Metabolites of Microbial Origin	Prof. Shuji Tani
Part 3: Young researchers training in Japan Chairperson: Prof. Yukihiro Sugimoto		
11:30 – 11:40	3-1 Identification of Striga metabolites of commercial value	Dr. Hanaa H. A. Mohmed
11:40 – 11:50	3-2 Acquiring knowledge and techniques related to molecular biology	Dr. Rihab Ishag
11:50 – 12:10	**Break**	

Time	Programs/Topic	Speakers
Part 4: Cultural Practice of Striga Management Chairperson: Prof. Randa Elsalahi		
12:10 – 12:40	Established Integrated Striga Management Package	Prof. Dafalla Dawoud
Part 5: Recommendation and Closing Chairperson: Prof. Zeinab Osman		
12:40– 12:55	Summary and Future Prospect	Prof. Randa Elsalahi
12:55 – 13:00	Closing Remarks - Representative of JST	Dr. Tsukasa Nagamine

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Host plant manipulation to reduce strigolactone production

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Strigolactones (SLs), a class of phytohormones that regulate diverse plant developmental processes, were initially characterized as host-derived germination stimulants for seeds belonging to the genera *Striga*, *Orobanche*, and *Phelipanche*. SLs can be classified into canonical and non-canonical SLs. Canonical SLs consist of a tricyclic lactone ring system (ABC-ring) connected to a methyl butenolide (D-ring) via an enol ether bridge, and non-canonical SLs have an unclosed BC-ring. To date, more than 30 SLs have been identified in root exudates of a variety of plant species. In plants, up-regulation of the synthesis of SLs may be an adaptive defense against phosphate starvation through minimization of shoot branching and maximization of symbiotic interaction with arbuscular mycorrhizal fungi, providing phosphate. On the other hand, SLs secreted into the soil could also serve as germination stimulants for seeds of root parasitic weeds. Thus, crops producing a limited amounts of SLs can avoid adverse effects caused by the parasites. Throughout our SL biosynthesis studies, we have identified a cytochrome P450 subfamily gene, *CYP722C*, that catalyzes the conversion of a SL biosynthetic intermediate to canonical SLs. Disruption of this gene in tomato using genome-editing technology resulted in the loss of canonical SL production, and consequently, this genome-edited tomato plants hardly induced germination of the noxious root parasitic weed, *P. aegyptiaca*. Interestingly, the genome-edited tomato plants appeared similar to the wild-type plants and they did not show the prominent phenotypes of an SL-deficient mutant, such as increased shoot branching. These results indicated that the genome-edited tomato plants have the potential to combat noxious root parasitic weeds. Using more practical tomato varieties and other crops artificially lacking canonical SLs and evaluating their impact on agriculture will contribute to the development of root parasitic weed resistant crops.

Keywords: genome editing, germination, strigolactone, tomato

Suicidal Germination Induction by Strigolactone Mimics

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Germination of the seeds of root parasitic weeds, such as *Striga hermonthica*, is initiated by chemical substances, generally known as germination stimulants, exuded from the roots of their host plants. The gross structure of strigol, which was the first natural germination stimulant, were determined in 1972. At present several germination stimulants, collectively called strigolactones (SLs), have been reported. Germination stimulants that can be synthesized less costly is essential if suicidal germination is to be used as an approach to the parasitic weed problem. The idea of suicidal germination approach is to induce germination of parasite seeds with the help of germination stimulants in the absence of host plants to reduce the seedbank of the weed. Difficulty of stimulant preparation in a sizeable amount at a reasonable cost had been one of the problems in demonstrating practicality of the approach under field conditions. It was the development of a germination stimulant, T-010, that enabled to conduct pot and field trials, which demonstrated for the first time that suicidal germination approach is practical to control *S. hermonthica*. Formulated T-010 (10% wettable powder) applied at 0.1 kg ai ha^{-1} to potted soil containing *S. hermonthica* seeds, previously conditioned by judicious irrigation, reduced *S. hermonthica* emergence by > 90%. Results of the field trial showed that the formulated T-010, at the same rate as for the pot experiment, delayed and reduced *S. hermonthica* emergence by 33% and increased sorghum head dry weight significantly. In those experiments, *S. hermonthica* seeds were artificially applied into soil (5 mg, ca 1,000 seeds, per pot or hill). The next step was to test a hypothesis that *S. hermonthica* problem would be gradually eliminated by repeated annual applications of the formulated T-010 into bathtubs containing six sorghum plants and 100 mg *S. hermonthica* seeds (16.7 mg per hill). However, the hypothesis was not verified in the bathtub experiment. The effectiveness of the formulated T-010 to reduce *S. hermonthica* emergence has become less with each passing year. Under high seedbank conditions, relying solely on the suicidal germination approach may be unpromising to reduce *Striga* incidence.

Keywords: *Striga hermonthica*, suicidal germination, T-010, sorghum, repeated applications, seedbank

Germination inhibition strategy based on carbohydrate metabolism in root parasitic weeds

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Orobanchaceae root parasitic weeds disperse a huge number of extremely small (0.2–0.3 mm) seeds. The parasitic weeds are required to invade the hosts soon after germination because of the limited amount of storage substances. Previously, planteose was found to be a storage carbohydrate in the dry seeds of root parasitic weeds (Wakabayashi *et al.*, *J. Exp. Bot.*, 2015). Planteose is hydrolyzed to hexoses via sucrose through two-step enzymatic reactions. We have assumed if the planteose metabolism is inhibited, the germination process will be suppressed and set this strategy as the object of Activity 2 in the SATREPS project.

α-Galactosidases (AGALs) were focused on elucidating the enzyme catalyzing the first step of planteose metabolism because the galactose moiety is hydrolyzed. Transcriptome data suggested three AGAL genes and *OmAGAL2* was chosen for molecular characterization based on the gene expression profile during seed germination of *Orobanche minor*. Recombinant OmAGAL2 expressed in *Escherichia coli* was shown to hydrolyze planteose to sucrose at pH 5. Additionally, OmAGAL2 fused with fluorescent proteins localized in the outer space of cells, apoplast, in *Nicotiana benthamiana* and *Arabidopsis thaliana*. Mass spectrometry imaging of planteose revealed that it accumulates in the endosperm, perisperm, and seed coat, but not in the embryo in the dry seeds of *O. minor*. Taken together, it is suggested that planteose is hydrolyzed in apoplast in endosperm by OmAGAL2 during germination (Okazawa *et al.*, *J. Exp. Bot.*, 2022). Chemical library screening using the recombinant enzyme revealed 28 OmAGAL2 inhibitors. PI-28 in the 28 inhibitors inhibited radicle elongation of *O. minor* germinating seeds in a dose-dependent manner, indicating the validity of the strategy based on carbohydrate metabolism.

The second step of planteose metabolism is the hydrolysis of sucrose by invertases. Previously, nojirimycin (NJ), a metabolite produced by *Streptomyces* spp., was shown to inhibit seed germination of *O. minor* by inhibiting the activation of invertase. Therefore, *Streptomyces* spp. were collected in fields in Sudan and the effect of their culture on the germination of parasitic weeds was evaluated, resulting in some cultures exhibiting potent inhibitory effects on parasite germination

Keywords: carbohydrate metabolism, α-galactosidase, germination, inhibitor, nojirimycin planteose, *Streptomyces* spp.

Advances in Integrated Parasitic weeds management II

Hassan, M.M[1].;Yahia M.A.[2];Abdalla N.K[3].; Abakeer, R.E; Rugheim, A.M[2].; Ahmed, M.M.;;Elslahi, R.H [1];Osman, A.G[1].; Abdelgani, M.E.[1]; Babiker, A.GE.T.[1]

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Abstract

Parasitic weeds are one of the main factors limiting crops productivity in Sudan. A lot of works has been done to develop a clear strategy residing on beneficial soil microorganisms for their management.

On *Striga hermonthica*: A series of laboratory, green house and field experiments were conducted to investigate the effect of potential microbes, *Bacillus megatherium var phosphaticum* (BMP), *Trichoderma* spp and mycorrhiza fungi (isolates) and intercropping with cowpea on *Striga hermonthica* germination and incidence. Under laboratory and green house experiments results displayed that *Trichoderma*spp and/or mycorrhiza fungi were significantly reduced *Striga* germination as compared to the control. On farmer filed results showed that sorghum intercropped with cowpea and treated with the combination of mycorrhiza fungi plus *Trichoderma,* significantly reduced *Striga* emergence and dry weight as compared the corresponding control. Also the treatment increased sorghum yield 3.5fold as compared to corresponding control.

On *Orobanche crenata*: A series of laboratory, greenhouse and field experiments were conducted to study the effects of *Trichoderma harzianum* (isolates and strain), the herbicide imazethapyr, *Bacillus megatherium* var. *phosphaticum* (BMP), *Bacillus polymyxa, Rhizobium leguminosarum* biovar *viceae* strain (TAL1399) and the herbicide imazethapyr (Pursuit) on *O. crenata* germination and incidence on three faba bean cultivars growth. Results displayed that the combination of *T. harzianum* + BMP + TAL1399 + imazethapyr (at half dose) significantly reduced *Orobanche* germination (89.62%) followed by the combination *T. harzianum* + imazethapyr (87.67%). However, in the greenhouse experiments, results showed that the combination of *T. harzianum* plus imazethapyr significantly reduced *O. crenata* emergence and increased faba bean biomass and plant height in comparison to the infested un-inoculated un-treated control. The combination of BMP plus TAL1399 significantly increased plant height, faba bean biomass, number of nodules and decreased *O. crenata* emergence in comparison to the corresponding control. While in the farmers' field experiment results showed that the combination of *T. harzianum* + BMP + TAL1399 + imazethapyr reduced O. *crenata*emergence on Masri 3 or Geiza (resistant varieties) by 95% and 88% at Shendi, respectively. The corresponding reductions in the parasite emergence on BB7 (local susceptible variety) was78%. The combination of *T. harzianum* + BMP + TAL1399 + imazethapyr applied to Masri 3, Geza and BB7 increased faba productivity threefold compared to control. Further studies are needed to investigate the interaction between potential microbes and agricultural practices.

Keywords: Striga, *O. crenata,* germination, *T. harzianum,* mycorrhiza, *Bacillus polymyxa*

Controlling seed germination of parasitic plants using microbes and their compounds

Tani, S., Nagata, M., Imada, R., Sugita, T., Sato, N., Nogami, R.

Graduate School of Agriculture, Osaka Metropolitan University, Osaka, Japan

Our goal is to suppress the infestation of Orobanchaceae by using microbes or compounds produced by microbes. To identify useful microbes to achieve our goals, we isolated approximately 1,800 microbes, which were mainly actinomycetes, from soils in various parts of Japan. We then prepared acetone extracts from the cultures of the isolated microbes and applied them to screen for the active compounds inhibiting or promoting seed germination of Orobanchaceae.

<Identification of the inhibitor>

Since 45% of the acetone extracts inhibited seed germination of *Orobanche minor*, we selected oneextract out of the 992 samples that inhibited seed germination of *O. minor*and had little effect on the growth of *Trifolium pratense*, *Aspergillus oryzae*, and *Escherichia coli*. After several purification steps, we obtained 4.6 mg of the purified compound from 52 L of the culture. LC/MS analysis and H^1- and C^{13}-NMR analysis revealed that the purified compound is cycloheximide. Cycloheximide is a known antifungal agent, but its IC_{50} for seed germination of *O. minor* was 1/1000th of the IC_{50} for spore germination of fungi. Cycloheximide inhibits the translation by binding to a subunit of 60S ribosomal protein in fungi, but a corresponding factor in *O. minor* seems not to be sensitive to cycloheximide, suggesting that cycloheximide inhibits seed germination of *O. minor* by a mechanism other than its originally known action.

<Identification of the promoter>

We identified that the strain named *Streptomyces* sp. no. 1721 producesa compound promoting the seed germination of *O. minor* in the presence of a synthetic strigolactone, GR24. Radicles treated with the extracts of no. 1721 were short and seemed to form haustoria. Addition of the no. 1721 strain to soil with *O. minor* seeds tended to reduce the infection of *O. minor* to its host, *T. pratense*. After several purification steps and synthesis of candidate compounds, we founda compound that promotes seed germination in the presence of GR24, namely compound A. Treatment of *O. minor* seeds with a culture extract of a related species of no. 1721 and the compound A-producing actinomycetes showed seed germination-promoting activity and a tendency to form short radicles, like no. 1721. These data suggest that the identification of active compounds can reduce laborious tasks to screen for microorganisms with similar activities.

Identification of *Striga hermonthica* metabolities of commercial value

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[1]Medicinal and aromatic plants and traditional medicine institute, National Centre for Research, Khartoum, Sudan

[2]Graduate School of Agricultural Science, Kobe University, Japan

Striga hermonthica is a hemi−parasitic plant, which is devastating to significant crops in Sudan such as millet (*Pennisetum glaucum* (L.) Leeke), maize (*Zea mays* L.) and sorghum (*Sorghum bicolor* L. Moench). On the other hand, *S. hermonthica* is well-known as a medicinal plant in some parts of Africa. It has been used in folk medicine for years to treat many ailments, such as leprosy, leprous ulcers, and pneumonia. Our aim is to identify the metabolites of *Striga* spp that have therapeutic benefit in treating diseases, and used as a resource of pharmaceutical manufacture to provide useful medicine. The whole dried plant was macerated and separated with liquid−liquid fractionation. The metabolites of the ethyl acetate extract have been purified and isolated with silica gel chromatography and plate-coated silica gel. The structures of the isolated compounds were identified using Nuclear Magnetic Resonance spectroscopy (NMR). The results showed four of secondary metabolites of the ethyl acetate extract of *S. hermonthica* plant and have been identified as chrysoeriol, apigenin, luteolin, and apigenin 7−*O*−β−glucoside, and their yield in the dried plant is 0.003, 0.025, 0.004, and 0.003%, respectively. These compounds have a high commercial value, and reported to have biological activities.

Keywords: flavonoids, Nuclear magnetic resonance (NMR), medicinal plant, parasitic plant, *Striga hermonthica*.

Acquiring knowledge and techniques related to molecular biology

Rihab E.M.H.[1], **Okazawa, A.**[2], **Inas, I.A.I.**[1]

[1]National Center for Research, Khartoum, Sudan

[2] Graduate School of Agriculture, Osaka Metropolitan University, Sakai, Japan

The purpose of the training course at Osaka Metropolitan University is to gain knowledge on handing laboratory equipment and methods used for RNA extraction, DNA synthesis, and primers design, and also be familiar with the types of vectors, and bacteria their uses for gene transfer. Additionally, we analyzed and interpreted the results obtained by DNA sequencing. Finally, we got experiences in dealing with experimental plants such as tobacco, transient expression of the transferred gene and the analysis of its product.

Keywords: RNA extraction, DNA synthesis, primer design, DNA sequencing, tobacco plants, gene expression

Dissemination of Integrated Striga Management (ISM) Practices in sorghum through Farmer Field School (FFS)

Dafalla A. Dawoud[1], Hanan Abdeltawab[2] Ibrahim Bakri[4], Mubarak Kakki[2], A.G.T. Babiker[3,4] and Y. Sugimoto[5]

[1]Agricultural Research Corporation, [2]Gedarif Research Station, [3]Sudan University of Science and Technology, [4]National Research Center and [5]Kobe University, Japan

Sorghum is the main staple cereal crop in the Sudan with an annual grown area of about 7- 8 million ha. Most of the crop is grown by rains (about 90%) and Gedarif represents one of the major areas for rainfed sorghum production. Striga is the major constraint to sorghum production in the rainfed sector leading to drastic reduction of sorghum productivity that may reach to total crop loss under severe infestation. Further, low inputs, traditional production methods and farmers' practice of continuous sorghum monocropping aggravated the problem. Research on striga showed that many non-host crops, suitable to the area could be used, in rotation with sorghum, as trap crops to deplete striga seed bank in the soil in addition to other effective striga control measures, suitable and economically feasible for framers in the area, such as water harvesting in low rainfall areas, growing of striga tolerant sorghum varieties (eg Arfagdamak8, fertilizers (urea) and herbicides (chlorsulfuron) in an integrated package to manage striga coupled with good crop husbandry practices. In this study Farmers' Field Schools (FFS) were used to transfer to farmers effective Integrated Striga Management (ISM) to improve sorghum productivity. In each FFS a demonstration field in a two-course rotation (sorghum/trap crop) is used. Other implemented ISM practices include water harvesting in low rainfall areas (North Gedarif), sowing of striga tolerant sorghum variety (Arfagadamak8), fertilizer (urea at 40 kg/fed) to be applied at sowing and the herbicide chlorsulfuron at 1.0 g a.i./fed to be applied as soil directed spray 3-4 weeks after sowing sorghum. In each FFS around 25 farmers directly participated in the school and many others indirectly participated by attending field days or through messages broadcasted in the local mass media or by direct contact of farmer-to-farmer. During seasons 2018/19 - 2020/2021 the FFS were implemented in 2-3 locations per season. In view of the positive results and Japan International Cooperation Agency (JICA) support to the project with a tractor and necessary associate 10 FFS were established in seasons 2021/2022 and 2022/2023. Results showed the positive impact of intervention by implementing ISM in lowering striga damage and increasing sorghum grain yield by 30% to many folds compared to traditional farmers' production methods. Socioeconomics studies depicted the positive effects of implementing ISM practices in the FFS demonstration fields that increased gross margin of return in comparison to traditional farming practices. The study also showed that most of the participating farmers are females (89%) and 83% of the participants are young farmers (less than 50 years old).

Keywords: *Striga hermonthica*, witchweed management, subsistence farming

Summery and Future Prospect

Randa, H.E.[1] + all project members and collaborators

[4]National Center for Research, Khartoum, Sudan

The project targets seed bank depletion and inhibition of parasitic weed germination through 7 approaches.

Suicidal germination was confirmed employing synthetic and natural germination inducers such as T010, trap crops, and rotation with efficiencies of 40 to 70%.

Inhibitors of planteose metabolism and cytokinin oxidase inhibitors are developed as control of *Orobanche minor* either as microbial extracts or as potential microbes as well such as *Streptomyces spp.*

Ability of microorganisms to control Striga and Orobanche through inhibition /induction and or growth promotion was verified. Examples are Arbuscular mycorrhizal fungi, nitrogen fixing and phosphate solubilizing microbes.

Stability and durability of resistance was studied in rice where cultivars Umgar and NERICA 5 maintained sustainability while NERICA4 showed increased susceptibility.

Breeding for *Striga* resistance in sorghum produced 13 high yielding crosses with stable resistance/tolerance to *S. hermonthica* across environments within both the irrigated and the rain-fed sectors are achieved.

A bioassay-guided fractionation of active ingredients is undertaken and the active compound is characterized. Metabolites specifically accumulated in *Striga* before flowering are identified by metabolome analysis.

An effecient integrated management package of *Striga* was disseminated through Farmers Field Schools and farmers' awareness and adoption rate was raised. Socio-economic impact of FFS was a 2-4-fold yield increase over yield by traditional practice. Microbes are introduced for the first time at the site of FFS.

Exchanged scientific visits of experts, young researchers' training, university higher degrees, publications and lab establishment and equipment took place.

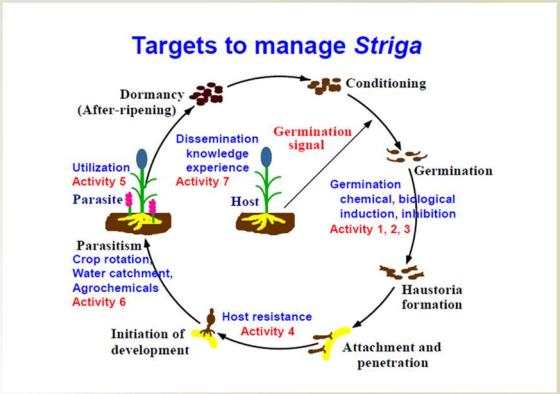
Future prospects should target completion of studies, integrate to package and disseminate besides tackling emerging threats on wheat using smart technologies to assess areas of heavy weed infestation.

Keywords: Striga, suicidal germination, resistance, inhibitor, microbes, ethnobotanic, FFS, socioeconomic

Activity 7: Establishment of a functional implementation structure to forward Striga control measures by Sudan's lead

Prof. Zeinab / Prof. Babiker /Prof. Sugimoto

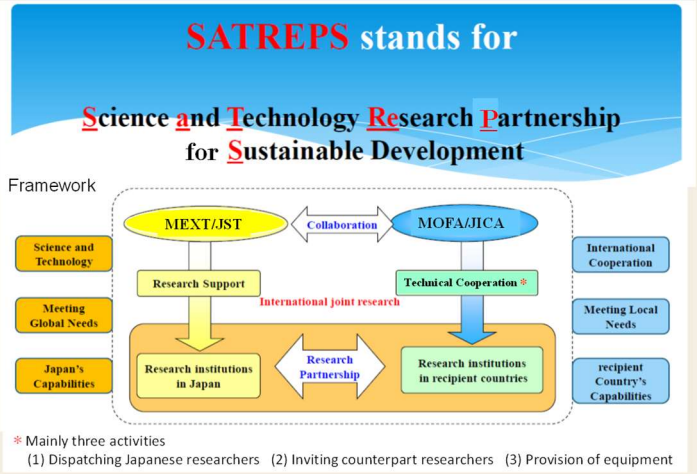
<<Targets to manage Striga>>



SATREPS Project

SATREPS is a collaboration between JST and JICA with the following aims.

1. International Cooperation
2. Addressing Global issues and Advancing Science
3. Capacity Development



Research Institutes in Japan:
Kobe University / Osaka Prefecture University
Principal: Prof. Yukihiro Sugimoto

Research Institutes in Sudan:
National Center for Research (NCR) / Agricultural Research Corporation (ARC) / Sudan University of Science and Technology (SUST)
Principal: Prof. Zeinab Osman

SATREPS Project

Development of Countermeasures against STRIGA to Conquer Poverty and improve Food Security

Getting back our food that is being robbed by Root Parasitic Weeds!

<General Description>

Analysis of root parasitic weeds from a chemical perspective to provide information that facilitates development of an integrated management strategy.

Increased food production through parasitic weeds control and creation of a new biological resource.

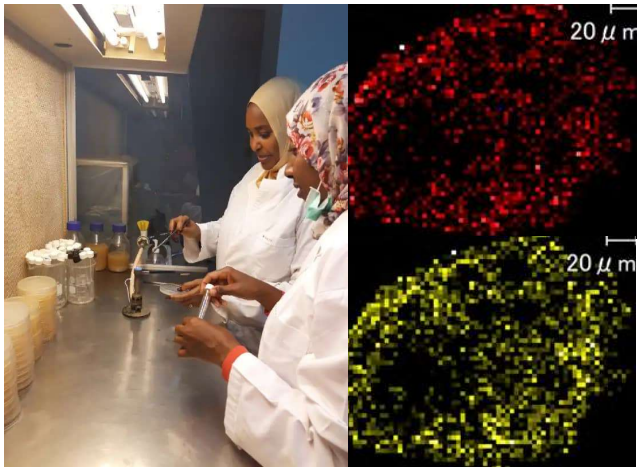
<<Activity Plan>>

Activity 1: Development and verification of suicidal germination agents on Striga and Orobanche

Prof. Babiker / Dr. Khogali

Activity 2: Development of germination inhibitors for root parasitic weeds

Prof. Okazawa / Prof. Somaya



* Okazawa, et al., bioRxiv, oi:10.1101/2021.06.16.448768

Activity 3: Demonstration of microorganisms to control germination of Striga

Prof. Tani / Prof. Hassan

Activity 4. Verification of stability and durability of Striga-resistance in rice

Dr. Khogali

Activity 5. Identification of useful substances in Striga that will encourage farmers to remove and utilize the weed

Prof. Kuse / Ms. Hanaa

Activity 6: Dissemination of Striga control measures through Farmer Field Schools

Prof. Babiker / Prof. Dafalla

بسم الله الرحمن الرحيم

الإدارة المتكاملة للبودا لتحسين الأمن العذائي و محاربة الفقر
Development of counter measures against *Striga* to conquer poverty and improve food security

المركز القومي للبحوث

جامعة كوبي - اليابان

هيئة البحوث الزراعية

جامعة السودان للعلوم والتكنلوجيا

الوكالة اليابانية للتعاون الدولي (JICA)

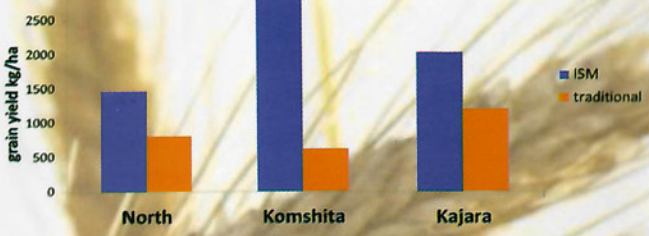
الوسائل العامة:

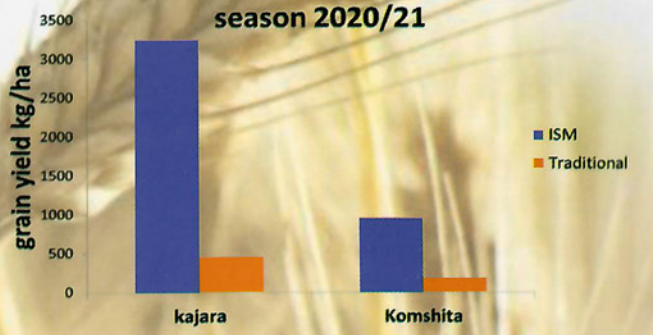
- من أهمها المنع الذي يرتكز علي قاعدة منع دخول أو تكاثر الطفيل في الحقل.
- عند الحراثة أو الزراعة تحضر الأماكن الخالية من الطفيل أولاً ثم المناطق المصابة مع الحرص علي نظافة الآليات عند خروجها من الحقل المصاب.
- زراعة بذور محاصيل معروفة المصدر منتجة في حقول خالية من البودا.
- عدم الزراعة المتواصلة للذرة وإنتهاج دورة زراعية السمسم، القطن، الفول السوداني وزهرة الشمس (محاصيل صائدة) حسب رغبة المزارع وكمية الأمطار.
- مراقبة المحاصيل في الأراضي الخالية من الطفيل وإزالة الطفيل عند الإزهار ثم جمعه خارج الحقل وحرقه.
- القضاء علي كل نباتات البودا التي تنمو علي الحشائش داخل المشروع أو عند الأطراف عند مرحلة الإزهار وذلك بجمعها وحرقها.

نقل التقانة عن طريق مدارس المزارعين

القمح:

- زراعة الذرة الرفيعة الصنف أبو سبعين في شهر يوليو أو أغسطس ثم حرثه داخل الأراض بعد 6-8 أسابيع من الانبات.
- إتباع توصيات هيئة البحوث الزراعية من الزراعة، التسميد مع رش مبيد 2,4-D حسب الجرعة والوقت الموصى بها.





أثر الإدارة المتكاملة للبودا علي إنتاجية الذرة

ب/ المناطق ذات الأمطار 500 ملم أو أقل.

- حصاد المياه مع بداية الموسم بإستعمال المحراث الحفار.
- زراعة أصناف محسنه سريعة النضج مثل أرفع قدمكم-8 أو بطانه فى المواعيد المثلى على أشوار (60-80 سم بين الأشوار) بمعدل 10-12 نبات فى المتر المربع.
- إضافة جرعه واحده من سماد اليوريا (40 كجم للفدان) ونصف جرعه من سماد الفوسفات (20 كجم/ فدان).
- رش خليط من مبيدى الكلورسلفيورون والـ 2,4- D حسب الجرعه الموصى بها.

مقدمة:

- يُصيب طفيل البودا محاصيل الذرة الرفيعه الذرة الشامي وقصب السكر وحديثاً أكتشفت إصابات بالغه ومؤرقه فى القمح بإراضي التروس العليا بولاية نهر النيل مما يُعتبر مهدداً للإكتفاء الذاتي إذ أن الطفيل يتأقلم علي النبات العائل.
- تقدر الأراضي المصابه بالسودان بأكثر من 3 مليون فدان.
- السهول الطينية الوسطى واراضى التروس العليا والأراضي الرمليه بدارفور وكردفان بيئة مثلى لتكاثر الطفيل لإفتقارها لعنصري الأوزوت (النيتروجين) والفسفور.
- تفرز جذور العديد من النباتات محفزاً لإنبات الطفيل ويرتبط الإفراز إرتباطاً وثيقاً بخصوبة التربة.

الأسباب الرئيسية لتعاظم الإصابة:

- الزراعة المتكرره للنبات العائل
- الجفاف
- تدني خصوبة التربة

وسائل إنتشار الطفيل:

- الإنسان، الحيوان، الماء، الآلات الزراعية، البذور والهواء و الأراضي البور الموبؤة.

دوره حياة الطفيل:

- ينتج نبات البودا الواحد مايربو على 90 ألف بذره تمتاز بخاصية الكمون بصغر الحجم، خفة الوزن وطول فترة البقاء بالتربة.
- تنت البذور فى وجود محفز تفرزه جزور العديد من النباتات.
- ينبت الطفيل ويكون مماص يلتصق بجزور النبات العائل ويرتبط بالأوعية الخشبية ليعتمد إعتماداً كلياً فى غذائه على النبات العائل.
- يواصل الطفيل نموءه تحت الأرض لمدة 6 إلى 8 أسابيع ويلحق معظم أضراره وهو داخل التربة.
- ينبثق الطفيل على سطح الأرض ويبدأ الإزهار بعد 4 أسابيع لتنضج البذور بعد 4 أسابيع أخرى.
- لاتنبت البذور بعد النضج مباشرة وتحتاج من شهر إلى6 اشهر لتصبح قابلة للإنبات عند توفر الظروف المناسبه.
- تدخل البذور فى مرحلة كمون ثانوي عند مرور شهر من بداية الخريف أو مثله فى حالة الري الدائم.
- يكمل الطفيل دورة حياته على النجليات مثل الذره الرفيعه، العدار، الذره الشامي ولا يكملها على المحاصيل عريضة الأوراق مثل السمسم، الفول السوداني، زهرة الشمس والقطن والتى يمكن أن تستعمل كمحاصيل صائدة تؤدي إلى تقليل المخزون البذري للطفيل في التربة.

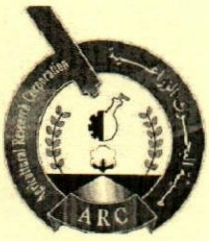
الطرق المثلى لإدارة الطفيل:

لا تجدي وسيلة واحده لإدارة الطفيل ولابد من إتباع إستراتيجية متكامله تشمل منظومة من الوسائل . وسائل عامه تطبق فى كل الأحوال وأخرى خاصه تعتمد على الموقع وكميه الأمطار.

الوسائل الخاصه:

أ/ المناطق ذات معدلات أمطار لاتقل عن 600 ملم أو تحت ظروف الري.

- زراعة الصنف ود احمد فى المواعيد المثلى على أشوار 60-80 سم بين الأشوار بمعدل 14-16 نبات فى المتر المربع.
- إضافة سماد اليوريا بمعدل 40 كجم للفدان والفسفات بمعدل 20 كجم للفدان.
- رش خليط من مبيدى الكلورسلفيرون والـ 2,4-D ثلاثة أسابيع بعد إنبثاق المحصول حسب الجرعه الموصى بها على أن يكون الرش موجهاً نحو الأرض ويغطى بين الشوريين.
- إزالة أي نبات للبودا عند الأزهار يدوياً مع الجمع والحرق.



مذكرة تفاهم بين

الطرف الأول

جامعة السودان للعلوم والتكنولوجيا

(الخرطوم – السودان)

والطرف الثاني

المركز القومي للبحوث

(الخرطوم – السودان)

والطرف الثالث

هيئة البحوث الزراعية

(الخرطوم – السودان)

يناير 2021م

مذكرة تفاهم بين
جامعة السودان للعلوم والتكنولوجيا – السودان
و المركز القومي للبحوث– السودان
و هيئة البحوث الزراعية– السودان

إيماناً بضرورة توثيق التعاون العلمي، وإدراكاً لضرورة تنمية سبل التطوير والتوسع في مجالات التعليم العالي والبحث العلمي ، فقد أبرمت هذه المذكرة بتاريخ **الثلاثاء** الموافق **السادس** من شهر **جمادي الثاني** من سنة **1442هـ** الموافق **التاسع عشر** من شهر **يناير** سنة **2021م** في مدينة الخرطوم بين كل من:

جامعة السودان للعلوم والتكنولوجيا ويشار اليها لأغراض هذه المذكرة **بالطرف الأول** ويمثلها قانوناً: **أ.د / عوض سعد حسن – مدير جامعة السودان للعلوم والتكنولوجيا** وهي إحدى الجامعات الحكومية في السودان ومقرها الرئيسي الجناح الغربي، المقرن، الخرطوم، السودان، صندوق بريد 407.

و المركز القومي للبحوث ويشار إليه لأغراض هذه المذكرة **بالطرف الثاني** ويمثله قانوناً **أ.د زينب عبدالرحيم عثمان**–مدير عام **المركز القومي للبحوث** وهو مركز بحثي حكومي في السودان ومقره الخرطوم، السودان، صندوق بريد 2404 .

وهيئة البحوث الزراعية ويشار إليها لأغراض هذه المذكرة **بالطرف الثالث** ويمثلها قانوناً **أ.د / عبدالمنعم طه أحمد الصويلح – المدير العام لهيئة البحوث الزراعية** وهي هيئة بحثية حكومية ومقرها الخرطوم.

تمهيد:

حيث أن جامعة السودان للعلوم والتكنولوجيا والمركز القومي للبحوث وهيئة البحوث الزراعية يزاولون نشاط في مجال التعليم العالي والبحث العلمي بالإضافة إلى التدريب والخدمات العلمية والإستشارات الأكاديمية والفنية ويعملون على تطوير تلك الأنشطة وتقديمها على المستوى المحلي والإقليمي والدولي، فقد التقت رغبة الأطراف الثلاثة في التعاون المشترك من أجل تطوير تلك الخدمات والأنشطة، وذلك بهدف:

1- تحقيق المصلحة للأطراف الثلاثة.

2- تكامل الأنشطة الأكاديمية والبحثية والتدريبية والإستغلال الأمثل لقدراتهم العلمية والبنيات التحتية لديهم وترشيداً لإمكانياتهم ومواردهم المتاحة لتحقيق الأهداف المشتركة وتقديم خدمات متميزة في ذات الصلة.

3- تبادل الخبرات وتلاقح الأفكار وإنصهار المدارس العلمية المختلفة.

حيث يرغب الأطراف الثلاثة في تحديد إطار التفاهم حول هذا الموضوع، فقد تم التفاهم والإتفاق بين الأطراف الثلاثة على المواد الآتية:

المادة الأولى:

يعتبر التمهيد السابق جزءاً لا يتجزأ من المذكرة.

المادة الثانية: نطاق التعاون

يوافق الأطراف الثلاثة على التعاون المشترك في المجالات الأكاديمية والدراسات العليا والبحث العلمي والتدريب بما في ذلك:

- المشاريع البحثية المشتركة المحلية والعالمية .
- الإشراف المشترك على بحوث الدراسات العليا .
- التحكيم والنشر العلمي.
- التفرغ العلمي والإجازات الدراسية .
- تبادل التمثيل في المجالس العلمية واللجان الفنية ذات الصلة .
- التبادل الطلابي وتبادل هيئة التدريس .
- التدريب الاكاديمي والمهني.

المادة الثالثة: التنفيذ

- يوافق الأطراف الثلاثة على إجراء المشاورات اللازمة قبل بداية كل عام جامعي وقبل وضع وإجازة الخطط البحثية وخطط التدريب بمدة كافية بهدف الإعداد لبرامج مشتركة مع تحديد الموضوعات والمجالات الخاصة بالبرامج المزمع تنفذيها خلال العام.
- يقوم كل طرف بتسمية شخصين من ذوى الكفاءة والإلمام بمجالات الاتفاقية للتشاور والتنسيق بين الثلاث أطراف .
- يقوم كل طرف بإبلاغ الآخر باللقاءات الأكاديمية والعلمية المزمع تنظيمها مثل (المؤتمرات والحلقات وورش العمل والموائد المستديرة وغيرها) بهدف المشاركة فيها.

المادة الرابعة: التطوير والجودة

يوافق الأطراف الثلاثة على التعاون المشترك في مجالات مراجعة التقارير والتقويم الذاتي للكليات والأقسام والبرامج المختلفة .

المادة الخامسة: الاحكام المالية

يتفق الأطراف الثلاثة لاحقاً على الالتزامات والاستحقاقات المالية والخدمية لمنسوبي الأطراف ضمن الاتفاق على إقامة أي نشاط مشترك (المحاضرات أو التدريس أو البحوث أو الدورات التدريبية المتخصصة) **بعقد قانوني موثق**.

المادة السادسة: المدة والتجديد

- اتفق الأطراف الثلاثة على أن تصبح هذه الاتفاقية سارية ونافذة من تاريخ التوقيع عليها وتستمر لمدة ثلاثة أعوام ويجوز باتفاق الأطراف تجديدها كتابة لذات المدة أو غيرها بذات البنود أو بنود أخرى يتفق عليها جميع الأطراف .
- في حالة رغبة أي طرف في إنهاء الاتفاقية قبل مدتها يلتزم بإخطار بقية الأطراف قبل ستة أشهر ليتم خلالها تسوية العلاقات القائمة .
- عند نهاية هذه المذكرة تكون جميع التعهدات والالتزامات سارية المفعول تجاه البرامج غير المكتملة فيما يخص النشاطات المشتركة في مؤسسات الأطراف الثلاثة حتى استكمال هذه البرامج والنشاطات التي تمت الموافقة عليها.

المادة السابعة: الإلتزامات والواجبات

- إجراء بحوث مشتركة وفقاً لإهتمامات مكونات الأطراف .
- إقامة وحدات بحثية ذات اهتمام مشترك .
- تشجيع التعاون في أنشطة علمية مختلفة يتم الاتفاق عليها بين الأطراف .
- تنظيم المؤتمرات العلمية والندوات والسمنارات المشتركة وعقد دورات تدريبية متخصصة .
- الإشراف المشترك على طلاب الدراسات العليا .
- تبادل المطبوعات والنشرات والدوريات .

- تشجيع النشر العلمي في المجالات والنشرات العلمية ، والتعاون في مجال التأليف والترجمة .
- يتبادل الأطراف عدد من الباحثين وأعضاء هيئة التدريس ومساعديهم بحسب العدد و المده التي يتفق عليها بين الأطراف ، بهدف التدريب أو الاطلاع أو إلقاء المحاضرات أو التدريس أو الإعارة أو إجراء البحوث العلمية أو بحوث مشتركة وفقاً للأنظمة النافذة .

المادة الثامنة : التعديل والاضافة

لا يجوز تعديل هذه الاتفاقية أو أي جزء منها إلا بالاتفاق بين الأطراف الثلاثة على أن يتم تحرير التعديل كتابة .

المادة التاسعة : أحكام عامة :

- يتبادل الأطراف الدعوات للمشاركة في المؤتمرات والندوات والأنشطة العلمية والاجتماعية الأخرى التي تُعقد في كل من المؤسسات الثلاثة ويتم ذلك بالمراسلات الرسمية .
- إعداد ملاحق لتنظيم كافة الأنشطة حسب اللوائح والأنظمة السائدة بين الأطراف .
- يتم الاتفاق على التفصيلات المتعلقة بكافة الزيارات بالمراسلات الرسمية بين الأطراف
- لا تعتبر الأنشطة التي تشملها الاتفاقية حصرياً على الاتفاقية بل يحق لكل طرف تنفيذها بمفرده أو بالتعاون مع جهات أخرى .
- عمل الربط الشبكي بين مواقع المؤسسات فيما يلي الأنشطة التي تشملها الاتفاقية
- تتم كل المعاملات بين الأطراف عن طريق المُنسق المختار من كل طرف .

المادة العاشرة: المنازعات :

في حالة نشوء أي نزاع بين الاطراف بخصوص أحكام هذا العقد يسعى الأطراف إلى حله ودياً عن طريق لجنة يرتضيها الأطراف وفي حالة الفشل في الوصول إلى التسوية الودية يحال النزاع للتحكيم وفقاً لقانون التحكيم لسنة 2005م .

المراسلات:

أي مراسلة أو إشعار بموجب هذه الاتفاقية يتم إرسالها إلى العناوين التالية:

الطـــرف الأول :جامعـــة الســـودان للعلـــوم والتكنولوجيا، المقرن، الخرطوم، ص ب 407.

توجيه المراسلة إلى إدارة العلاقات الخارجية

تلفون: 1765-66-155-249+

فاكس: 792721-183-249+

ايميل: ero@sustech.edu

erosust@gmail.com

الطـرف الثـاني: المركـز القـومي للبحـوث.

الخرطوم السودان ص ب 2404

توجيه المراسلة إلى ادارة العلاقات الخارجية

تلفون: 118901186-249+

فاكس: 770701 183 249+

ايميل: eltayb@ncr.gov.sd

الطرف الثالث: هيئة البحوث الزراعية

توجيه المراسلة إلى نائب المدير العام للبرامج البحثية و التعاون الدولي

تلفون: 00249917232979 – 00249113242710

ايميل: arcexedirector@gmail.com

حُررت هذه المذكرة من ثلاثة أُصول باللغة العربية للعمل بموجبها اعتباراً من تاريخ اليوم **الثلاثاء** الموافق **السادس** من شهر **جمادي الثاني** من سنة **1442هـ** الموافق **التاسع عشر** من شهر **يناير** سنة **2021م** . وتم التوقيع عليها من قبل ممثلي الأطراف الثلاثة وبالأختام المعتمدة لكل طرف .

الطرف الأول

.....

أ. د. عوض سعد حسن

مدير جامعة السودان للعلوم والتكنولوجيا

الخرطوم جمهورية السودان

الطرف الثاني

.....

أ. د. زينب عبدالرحيم

مدير عام المركز القومي للبحوث

الخرطوم جمهورية السودان

الطرف الثالث

.....

أ. د. عبدالمنعم طه أحمد الصويلح

المدير العام لهيئة البحوث الزراعية

الخرطوم جمهورية السودان

Basic data form for projects for the year 2023

Three Years Action Plan

Project title:

Dissemination of technical packages to control the noxious weed Striga (Buda) in sorghum

The ministry to which the project is affiliated:

Ministry of Higher Education and Scientific Research

Project description:

The project is an application of the results of scientific and practical research experiments during two phases of the Japanese-Sudanese Collaboration Project for Combating Poverty (SATREPS) through the control of Striga that was conducted inside Sudan, where technical packages of agricultural operations for the integrated management of Striga were achieved for sorghum cultivation of so that it can resist Striga infection and at the same time increase productivity. In addition, some microbial treatments have been tested and found to increase soil fertility, suppress the growth of Striga, and enhance plant resistance against it besides being environmentally friendly and of low cost. The integrated packages have been implemented in farmer schools and are on the way to be extended to all sorghum -growing areas.

Sector:

Agricultural (agricultural biotechnologies, agricultural operations)

The executing agency:

National Center for Research (NCR)

Brief background of the project:

The parasitic weed are considered one of the most dangerous agricultural pests, which feeds on the host plant entirely, such as Orobanche, or partially as in Stiga which may lead to crop losses approaching a 100%, owing to the high ability to spread through their super fine seeds, as well as the pronounced ability of these seeds to maintain vitality for decades, given that these plants do not appear on soil surface unless after having already maintained strong attachment to the host plant and started sucking nutrients from it. These plants infect a number of important field crops such as sorghum and wheat, as well as tomatoes and faba beans.

Laboratory results and field studies at the National Center for Research demonstrated the great potential of a number of beneficial soil microbes in controlling Striga, which might reach up to 98% efficacy, such as mycorrhizal and Trichoderma fungi, and nitrogen-fixing and phosphorus-solubilizing bacteria. Also, field experiments on the adoption of an integrated pest management system through technical packages in terms of land preparation, planting timing, improved seeds with fertilization and the addition of herbicides

has led to excellent results in the control of Striga and resistance of sorghum in farmers' schools at the Agricultural Research Corporation (ARC) station in Gedaref state.

Due to the high prices of Chemical agricultural inputs and their potential harmful effects on humans, animals and the environment in general, the importance of environmentally safe and low-cost treatments at the same time is evident. Accordingly, the application of microbial treatments began in the experimental farm of Gedaref Research Station this year as a preliminary step for their inclusion among the integrated control packages after examining their field performance.

Also, this year, the economic and social assessment surveys of the applied packages have been carried out to determine the economic feasibility and the amount of social change occurring in the livelihoods of farmers within the study area.

Accordingly, it becomes evident the urgent need to develop the current packages and work to spread them and increase their adoption in the various affected regions of Sudan in order to spread the benefits and ensure continuity of implementation of the outputs of the project, in which huge facilities and efforts have been made by both the governments and researchers of Sudan and Japan.

Project implementation site(s):

A/ Homoginization of mixed packages phase: laboratories of the National Center for Research , experimental farms of Agricultural Research Corporation at Shambat, Khartoum, Gedaref, River Nile and Northern States.

B/ Applying agricultural packages in the targeted areas: Gezira, Gedaref, North Kordofan, Blue Nile State, River Nile and the Northern States.

C/ The final stage (dissemination integrated packages and their adoption together with the results of the economic and social assessment).

General goals:

Alleviation of poverty and providing food security in Sudan using sustainable methods to combat Striga and improving productivity of crops in their cultivation areas.

Special goals:

A/ Developing sustainable integrated technical packages to combat Striga and increase the productivity of sorghum, wheat and Millet.

B/ Reducing the cost of agricultural production and the environmental impact of agrochemicals.

C/ Measuring the effect of introducing these packages on farmers' livelihood, improving the individual's income and living standard in the targeted areas.

D/ Disseminating the packages on the targeted agricultural areas infested with Striga.

Total cost of the project:

Fifty million Sudanese pounds.(50,000,000 Sudanese pounds). (**Approved 30,000,000SDG)**

Components of the project:

A/ Field works for homogenizing the packages (fertilizers, pesticides, measuring tools, harvest aid, chemical analysis, fuel, technicians, workers, and others).

B / Spreading the application of the selected packages in the areas of sorghum, wheat and millet cultivation (demonstration fields and farmers' schools)

C/ Measuring the economic and social impact on the targeted farmers (socio-economic analysis)

Funding sources (local / foreign):

There is no funding from other parties due to the end of the collaboration project period.

Yearly expenditures on the project components according to financing sources (cash / guarantees / grants / loans):

Nothing

Exemptions: customs / value added / ports / standards / others:

There are customs exemptions for research instruments and equipment

Project implementation period:

Three years

Implementation starting date:

April 2023

Implementation ending date:

March 2026

Target quantitative goals for the year 2023:

Increasing the productivity of sorghum, wheat and millet crops and reducing production costs through the use of the best packages of agricultural treatments and microbial fertilizers.

Applying the new package to farmer schools in target areas.

Measurement indicators:

Socioeconomic evaluation of the application of the developed package.

Project targets:

Sorghum, wheat and millet farmers in Striga affected areas in all states of Sudan, focusing on the poor segment.

The economic and social outputs of the project:

Increasing productivity and thus increasing the farmer's income and supporting their food security, contributes to their social stability.

Performance and achievements been realized:

This project is a result of extensive previous research efforts by researchers from the National Center for Research, the University of Sudan and the Agricultural Research Corporation, as well as researchers from the Universities of Kobe and Osaka in Japan, where the researchers isolated 86 effective microbes in combating Striga and inhibiting its growth in various stages, with rates ranging from 21 to 100 %. Also, laboratory analyses were carried out to assess the potential active substances in the Striga that encourages people to collect to take advantage of its therapeutic properties for some diseases. Moreover, a number of agricultural treatments were tested until the best integrated package was achieved through a series of field experiments and in farmer field schools for several seasons. The integrated package was applied to farmers' schools at Gedaref Research Station, and a socioeconomic survey evaluation was conducted for the project.

Since the project will come to its end at the beginning of the year 2023, an inter-ministerial committee was formed, involving all relevant ministries and institutions, to follow up the implementation, dissemination and evaluation of the project outputs to ensure its sustainability and maximize benefit out of it based on its scientific and practical achievements.

استمارة البيانات الاساسية للمشروعات للعام2023م

خطة عمل لمدة ثلاث سنوات

اسم المشروع :

نشر الحزم التقنية لمكافحة حشيشة (البودا) الضارة في محصول الذرة

الوزارة التي يتبع إليها المشروع :

وزارة التعليم العالي والبحث العلمي

وصف المشروع :

المشروع هو تطبيق لنتائج تجارب بحثية علمية وعملية خلال مرحلتين من مشروع التعاون الياباني السوداني لمكافحة الفقر(SATREPS) من خلال مكافحة البودا التي أجريت داخل السودان حيث تم التوصل إلي حزم تقنية من العمليات الفلاحية للإدارة المتكاملة لحشيشة البودا لزراعة الذرة بحيث تقاوم الإصابة بالبودا وتعمل على رفع الإنتاجية كما تم التوصل إلى معاملات ميكروبية تزيد من خصوبة التربة وتعمل على تثبيط نمو البودا كما تعمل على تعزيز مقاومة النبات لها إلى جانب أنها صديقة للبيئة وقليلة التكلفة. تم تطبيق الحزم المتكاملة بمدارس المزارعين وهي في الطريق للتعميم على كل مناطق زراعة الذرة.

القطاع :

الزراعي (التقنيات الحيوية الزراعية, العمليات الفلاحية)

الجهة المنفذة :

المركز القومي للبحوث

خلفية مختصرة للمشروع: تعتبر الحشاش الطفيلية من أخطر الآفات الزراعية والتي تتغذى على النبات العائل بصورة كلية مثل الهالوك أو جزية كما في البودا مما قد تؤدي إلى خسائر في المحصول قد تصل إلى حوالي 100% وذلك نسبة لمقدرتها العالية على الإنتشار بواسطة بذورها متناهية الصغر وكذلك لمقدرة هذه البذور الفائقة في الحفاظ على الحيوية لعشرات السنين, كما وأن هذه النباتات لا تظهر على السطح إلا عندما تكون قد تمكنت من الإلتصاق بالنبات العائل وبدأت عملية امتصاص الغذاء منه .تصيب هذه النباتات عدد من المحاصيل الحقلية الهامة كالذرة والقمح وكذلك الطماطم والفول المصري.

أثبتت النتائج المعملية والدراسات الحقلية بالمركز القومي للبحوث فعالية كبيرة لعدد من ميكروبات التربة المفيدة في مكافحة حشيشة البودا بما قد يصل إلى نسبة 98% ومن أمثلتها فطريات الميكوريزا والترايكوديرما والبكتيريا المثبتة للنيتروجين والمذيبة للفوسفور . كذلك أدت التجارب الحقلية من خلال تبني نظام المكافحة المتكاملة عن طريق الحزم التقنية من حيث

تحضير الأرض توقيت الزراعة والبذور المحسنة مع التسميد وإضافة مبيدات الحشاش إلى نتائج ممتازة في مكافحة ومقاومة البودا في الذرة في مدارس المزارعين في محطة هيئة البحوث الزراعية بولاية القضارف.

نسبة لارتفاع أسعار المدخلات الزراعية الكيميائية وآثارها المحتملة على الإنسان والحيوان و البيئية بصفة عامة تتضح أهمية المعاملات الآمنة بيئيا والقليلة التكلفة في آن معا. عليه بدأ تطبيق المعالجة الميكروبية بالمزرعة التجريبية بمحطة بحوث القضارف في هذا العام توطئة لإدخالها ضمن حزم المكافحة المتكاملة بعد الوقوف على نتاجها حقليا.

تم أيضا هذا العام البدء بإجراء مسوحات التقييم الإقتصادي والإجتماعي للحزم المطبقة للوقوف على الجدوى الإقتصادية ومقدار التغيير الاجتماعي الحادث على حياة المزارعين ضمن مجال التجربة.

عليه تتضح الحاجة الماسة لتطوير الحزم الحالية و والعمل على نشرها و زيادة التبني لها في مختلف المناطق المتأثرة من السودان لتعميم الفائدة وضمان الاستمرارية في تنفيذ مخرجات المشروع الذي بذلت فيه إمكانيات مهولة من كل من حكومتي وباحثي السودان واليابان.

موقع/ مو اقع تنفيذ المشروع:

أ/ **مرحلة مواءمة الحزم المختلطة**: معامل المركز القومي للبحوث, المزارع التجريبية هيئة البحوث الزراعية, شمبات, الخرطوم, القضارف ,نهر النيل والشمالية.

ب/ تطبيق الحزم **الزراعة بالمناطق المستهدفة**: ولاية الجزيرة , ولايةالقضارف, ولاية شمال كردفان, ولاية النيل الأزرق ولاية نهر النيل والولاية الشمالية.

ج/ المرحلة النهائية (نشر الحزم المتكاملة وتبنيها مع نتائج التقييم الإقتصادي والاجتماعي).

الاهداف العامة :

مكافحة الفقر وتوفير الأمن الغذائي في السودان باستخدام طرق مستدامة لمكافحة البودا في المناطق المتأثره مما يعزز زيادة انتاجية المحاصيل.

الاهداف الخاصة :

أ/تطوير حزم تقنية متكاملة مستدامة لمكافحة البودا وزيادة انتاجية الذرة والقمح والدخن.

ب/ تقليل تكلفة الإنتاج والكلفة البيئية للكيماويات الزراعية.

ج/ قياس تأثير ادخال هذه الحزم على تحسين مستوى دخل ومعيشة الفرد في المناطق المستهدفة.

د/ تعميم الحزم على مناطق الزراعة المستهدفة الموبوءة بالبودا.

التكلفة الكلية للمشروع :

خمسون مليون جنية سوداني.

50000000 جنيه سوداني.(تم التصديق بمبلف **30,000.000** جنيه سودانى)

مكونات المشروع :

أ/ أعمال حقليه وميدانية بغرض مواءمة الحزم (أسمده, مبيدات, أدوات قياس, معينات حصاد, تحليل كيميائي, وقود,فنيين, عمال, وأخري).

ب/ نشر تطبيق الحزم المختارة في مناطق زراعة الذرة والقمح (حقول ايضاحية ومدارس مزارعين)

ج/ قياس التأثير القتصادي والاجتماعي علي المزارعين المستهدفين (تحليل إقتصادي اجتماعي)

مصادر التمويل(محلي / اجنبي) :

لا يوجد تمويل من جهات أخري نسبة لانتهاء فترة مشروع التعاون.

الصرف علي مكونات المشروع بالسنوات ووفق مصادر التمويل(نقدي / ضمانات / صكوك / منح / قروض):

لا توجد

الاعفاءات :جمارك/قيمة مضافة/مو اني/مواصفات /اخرى:

توجد إعفاءات جمركية للأجهزة والمعدات البحثية

فترة تنفيذ المشروع :

ثلاثة أعوام

تاريخ بدء التنفيذ :

أبريل 2023

تاريخ انتهاء التنفيذ :

مارس 2026

الاهداف الكمية المستهدفة للعام 2023م :

زيادة انتاجية كل من محصولي الذرة والقمح وتقليل تكاليف الإنتاج من خلال إستخدام أفضل الحزم من المعاملات الفلاحية والأسمدة الميكروبية.

تطبيق الحزمة الجديدة على مدارس المزارعين في المناطق المستهدفة.

مؤشرات القياس :

التقييم الاقتصادي والاجتماعي لتطبيق الحزمة المطورة.

المستهدفون بالمشروع:

مزارعو الذرة والقمح والدخن في المناطق الموبوءة بالبودا في كل ولايات السودان, بالتركيز على شريحة الفقراء منهم.

النتائج والاثار الاقتصادية والاجتماعية المترتبة علي قيام المشروع:

زيادة الانتاجية وبالتالي زيادة دخل المزارع ودعم الأمن الغذائي بالنسبة له مما يسهم في استقراره الاجتماعي .

سير الاداء والانجازات التي تم تحقيقها :

هذا المشروع هو نتاج لمجهودات بحثية سابقه مكثفه من باحثي المركز القومي للبحوث , وجامعة السودان وهيئة البحوث الزراعية إلى جانب باحثي جامعتي كوبي وأوساكا باليابان, حيث قام الباحثون باستنباط عدد 86 ميكروب فعال في مكافحة البودا وتثبيط نموها في مختلف المراحل بنسب تتفاوت ما بين 21 إلى 100% تم أيضا التحليل المعملي للمواد الفعالة المحتملة في البودا والتي يمكن أن تجعل منها نبتة يسعى الناس لجمعها للاستفادة من خصاصها العلاجية لبعض الأمراض. كما كذلك تم اختبار عدد من المعاملات الفلاحية حتى تم الوصول إلى أفضل حزمة متكاملة في سلسلة من التجارب الحقليه وفي مدارس لعده مواسم. تم تطبيق الحزمة المتكاملة على مدارس المزارعين بمحطة بحوث القضارف كما تم عمل المسح الأولي للتقييم الإتصادي والإجتماعي للمشروع.

بما أن المشروع سوف يصل لنهايه مع مطلع العام ,2023 تم تكوين لجنة وزارية ممثلة فيها بكل الجهات ذات الصلة لمتابعة تطبيق وتعميم وتقييم مخرجات المشروع لضمان استدامتها والاستفادة من بصورة فعالة تأسيسا على مكتسباته العلمية والعملية.

Resolution of the Minister of Higher Education and Scientific Research

Resolution No. (10)

In pursuance to article number (H) of the act of the regulation of Higher Education and Scientific Research, and with reference to the transional supreme council resolution number (44) for the year 2022 which appointed the minister in charge of Higher Education and Scientific Research together with the recommendation of the Director of the National Center for Research, I hereby Issue the following Decree:

Firstly: Name and commencement of the decree

The decree is to be named as Decree for formation of permanent committee to implement and disseminate the outcomes of the Striga Control Project, and be effective from the date was signed by the minister in charge.

Secondly: Formation of the committee

A permanent committee to be formed to implement and disperse the outcomes of the Striga control project as follows:

1.	Deputy Director of the National Center for Research, and Project Manager	Chairman
2.	Professor. Dafalla Ahmed Daoud, Head of Famers field schools	Member
3.	Representative of the Extension Department, Fedral Ministry of Agriculture	Member
4.	Dr. Randa Hassan Elsalahi, Director, Environment and Natural Resoures and Desertification Research Institute	Member
5.	Prof. Mohamed Hassan Ahmed Mahgoub, NCR	Member
6.	Dr. Hanan Ibrahim Mudawi, Scientific Affairs Directorate, NCR	Member
7.	Dr. Khogali Izzeldin Idris, Agricultural Research Corporation	Member
8.	Dean of Faculty of Agricultural, Sudan University of Science and Technology	Member
9.	Dean of Faculty of Agricultural, University of El-Gadarif	Member
10.	Head of Gadarif Research Station, ARC	Member
11.	Representative of the Fedral Ministry of Finance	
12.	Representative of the Agricultural Bank	Member
13.	Formers Representative	Member
14.	Representative of Arab Organization for Agricultural Development	Member
15.	Representative of Gadarif Farmers	Member
16.	Representative of Central Trading Company (CTC)	Member
17.	Representative of Arab Sudanese Seed Company	Member
18.	Director of Technology Transfer Commission, NCR	Member

Thirdly: Authorities and Duties of the Committee:

1) To follow the implementation of the outcomes and packages of the Striga control Project and other parasitic weeds.
2) To develop mechanism for the follow up of its duties.
3) To mitigate all challenges facing the project and facilitate the application of the project outcomes.

4) To present recommendation on how to deal with new changes up to date and developments according to rotational reports.
5) To submit regular rotational report to the minister about its performance.

Issued under my signature and seal in the day of 25th of Safar (Higri) year's corresponding the day of 21st of September 2022.

Professor. Mohamed Hassan Dahab
Minister in charge, Higher Education and Scientific Research

بسم الله الرحمن الرحيم

THE REPUBLIC OF THE SUDAN
MINISTRY OF HIGHER EDUCATION
AND SCIENTIFIC RESEARCH
THE MINISTERIAL EXECUTIVE OFFICE

جمهورية السودان
وزارة التعليم العالي والبحث العلمي
المكتب التنفيذي الوزاري

التاريخ :٢٩ صفر ١٤٤٤هـ
الموافق :٢٥ سبتمبر ٢٠٢٢م

السيد/ مدير المركز القومي للبحوث

السلام عليكم ورحمة الله وبركاته ،،،،،،،

الموضوع: قرار السيد وزير التعليم العالي والبحث العلمي
قرار رقم (١٠) لسنة ٢٠٢٢م

بالإشارة للموضوع أعلاه، أرفق لكم نسخة من قرار السيد وزير التعليم العالي والبحث العلمي رقم (١٠) لسنة ٢٠٢٢م والخاص بتشكيل لجنة دائمة لتطبيق ونشر مخرجات مشروع مكافحة الحشائش (البودا).

للتكرم مشكورين باتخاذ ما يلزم.

ولكم وافر الشكر والتقدير .....

د. عايدة وداعة الله محمد
المدير التنفيذي للمكتب الوزاري

P.O.Box :2081 . Khartoum ، Sudan
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ص ب : ٢٠٨١ الخرطوم - السودان
هاتف : ٠١٥٥١٥٩٦٠٧

بسم الله الرحمن الرحيم

جمهورية السودان
وزارة التعليم العالي والبحث العلمي
الوزير

THE REPUBLIC OF THE SUDAN
MINISTRY OF HIGHER EDUCATION
AND SCIENTIFIC RESEARCH
THE MINISTER

قرارات وزير التعليم العالي والبحث العلمي

قرار رقم (10) لسنة ٢٠٢٢م

استناداً إلى أحكام المادة ٩(هـ) من قانون تنظيم التعليم العالي والبحث العلمي لسنة ٢٠٢١م، والتكليف الصادر بقرار رئيس مجلس السيادة الانتقالي رقم (٤٤) لسنة ٢٠٢٢م بمهام وزير التعليم العالي والبحث العلمي بتاريخ ١/ ٢/ ٢٠٢٢م وتوصية مدير عام المركز القومي للبحوث، أُصدر القرار الآتي نصه :-

أولاً :إسم القرار وبدء العمل به

١/ يُسمى هذا القرار قرار تشكيل لجنة دائمة لتطبيق ونشر مخرجات مشروع مكافحة الحشائش (البودا)، ويُعمل به من تاريخ التوقيع عليه.

ثانياً فحوى : القرار

٢/ تُشكل لجنة دائمة لتطبيق ونشر مخرجات مشروع مكافحة الحشائش (البودا) من الآتية أسماؤهم:

١. السيدة/ نائب مدير عام المركز القومي للبحوث ومدير مشروع مكافحة البودا	رئيساً
٢. البروفيسور / دفع الله أحمد داؤود رئيس فعالية التطبيق الحقلي ومدارس المزارعين	عضواً
٣. السيد/ ممثل الإرشاد الزراعي وزارة الزراعة الإتحادية	عضواً
٤. الدكتورة/ رندا حسن الصلحي- مدير معهد أبحاث البيئة والموارد الطبيعية والتصحر	عضواً
٥. البروفيسور / محمد حسن أحمد محجوب – المركز القومي للبحوث	عضواً
٦. الدكتورة/ حنان إبراهيم مضوي – إدارة الشئون العلمية المركز القومي للبحوث	عضواً
٧. الدكتور / خوجلي عز الدين إدريس – محطة بحوث شندي – هيئة البحوث الزراعية	عضواً
٨. السيد/ عميد كلية الزراعة جامعة السودان	عضواً
٩. السيد/ عميد كلية الزراعة جامعة القضارف	عضواً
١٠. السيد/ رئيس محطة أبحاث القضارف – هيئة البحوث الزراعية	عضواً
١١. السيد/ ممثل وزارة المالية والتخطيط الإقتصادي	عضواً
١٢. السيد/ ممثل البنك الزراعي السوداني	عضواً
١٣. السيد/ ممثل المزارعين	عضواً
١٤. السيد/ ممثل المنظمة العربية للتنمية الزراعية	عضواً
١٥. السيد/ ممثل مزارعي ولاية القضارف	عضواً
١٦. السيد/ ممثل الشركة التجارية الوسطى	عضواً

ص.ب :٢٠٨١ – الخرطوم – السودان – هاتف : ٢٤٩١٨٣٧٩٣١٢٩+ – ٢٤٩٧٧٨٦١٢+
P.o.Box : 2081.Khartoum, Sudan, Tel: +249 183 793129 - +249778612
الموقع على الانترنت: www.mohe.gov.sd البريد الإلكتروني: exec@mohe.gov.sd

١٧. السيد/ ممثل الشركة العربية للبذور عضواً

١٨. السيد/ مدير هيئة نقل التقانة – المركز القومي للبحوث عضواً

ثالثاً : مهام اختصاصات اللجنة

١/ متابعة تطبيق نتائج ومخرجات مشروع مكافحة البودا والحشائش الأُخرى في الولايات المتضررة.

٢/ عمل آلية لمتابعة تطبيق ونشر مخرجات المشروع.

٣/ تذليل التحديات لتسهيل تطبيق نتائج مشروع مكافحة البودا والحشائش الأُخرى.

٤/ التوصية بشأن المستجدات أو المتغيرات حسب التقارير الواردة.

٥/ ترفع اللجنة تقارير دورية لوزير التعليم العالي والبحث العلمي عبر مدير عام المركز القومي للبحوث.

صدر تحت اسمي وتوقيعي في اليوم الخامس والعشرين من صفر لسنة ١٤٤٤هـ
الموافق الواحد والعشرين من شهر سبتمبر لسنة ٢٠٢٢م

أ.د. محمد حسن دهب أحمد
المكلف بمهام وزارة التعليم العالي والبحث العلمي

Scientific report

Assessing socioeconomics studies of farmers' field schools (FFSs) for combating *Striga hermonthica* in Elgadarif

For Developing Counter measures against Striga to Conquer Poverty and Improve Food Security in Sudan

Ibrahim Bakri Elnour Breima

National Center for Research

Acronyms

FFS: farmers field school

NCR: National center for research

ARC: Agricultural Research Corporation

JICA: Japanese International Corporation Agency

Acknowledgment:

Thanks are given to the National Center for Research which is the focal point of the project and the report funder. Also, great appreciation is to JICA for supporting FFS with tractors, planters, and herbicides. Thanks as well are extended to the Gadarif Research Station researchers and staff conducting demonstration fields and field days at FFS. And to the farmers who were patient during questionnaire filling- in and interviews.

Executive summary:

Farmer Field Schools represent a significant step forward in agricultural education and extension (Godrick, 2004). FFS have spread rapidly to all continents since their first introduction in 1989 in Indonesia, where Integrated Pest Management FFSs were developed to help farmers deal with the pesticide-induced problem of rice brown plant hoppers in irrigated rice (Arnoud, 2006). However, the socioeconomics survey was conducted to evaluate the impact of applied applications of *Striga hermonthica* measures in the production of sorghum and millet at a farmer's field school in (FFS) Elgadarif. The study depended on primary data which was collected through questionnaires and focus group discussions. Ten FFS and 80 neighbor farmers were selected randomly. The data analyzed using statistical and gross margin methods. Results revealed that 93.5% of the farmer's education was basic, secondary, and university level education, while the rest (7.5%) were illiterate. Regarding farmers' age, only 2.5% of farmers' aged above 60 years and 68.8 % of them were females. The economic analysis showed that FFS sorghum gross margin was found to be SDG 21600\ fed, and neighbor farmers (traditional farmers)gross margin was SDG -66200 \ fed, while FFS and traditional farmers of millet gross margin were SDG 61000, and SDG-5000 in 2022\2023 cropping season. Nonetheless, FFS and traditional farmers sold their products at farm gate prices to cover the cost of production and to meet their urgent expenses. It found that FFS had benefited from the extension services and technical packages provided by the project to increase their agricultural productivity and generated high returns.

1. Introduction: farmers' field school is a type of informal education aimed to provide farmers with extension services, and technical packages to improve crop production, especially; sorghum and millet productivity. National Center for Research (NCR) and Japan International Cooperation Agency (JICA) in collaboration with Agricultural Research Corporation (ARC) have intensively conducted farmers filed school programs to combat *Striga hermonthica* in the productivity of sorghum and millet in Elgadarief. That improves the production of cereal crops and the standard of livelihood of farmers. Accordingly, socioeconomic factors are considered crucial for technology transfer and policymaking in development projects.

2. Purpose:

The study will evaluate the socioeconomic condition in response to the applications of *striga hermonthica* measures in the production of sorghum and millet at a farmer's field schools in ELgadarif.

3. Goals and objectives:

The overall goal is to evaluate the effect of the application of striga control measures on the socioeconomic status of farmers at farmer's field schools in the study area.

To meet the goals there is a need to:

1. Compute the gross margin of field crops in FFS
2. Provide information on access to agricultural support services (access to financial services, machinery services, and agricultural extension).
3. Provide information on how and where small farmers in the study area are currently selling their crops.

4. Project methodology and approaches

The purposive random sample was used in all 10 FFS who represent project beneficiaries. And 80 traditional farmers were also randomly selected. The questionnaires, and focus group discussions, were also used for collecting data. The study processed the data through SPSS, and Excel to organize raw data and figure out means, STD, and charts. The gross margin was used to calculate the economic value of the project impact.

4.1. Gross margin formula:

Gross margin analysis is the difference between the gross farm income and total variable cost. In farm get price (Breima, 2016)

GM. = TR –TVC (1)

But,

Profit = Total Revenue – Total Cost; expressed as;

π = TR− TC (2)

5. Result and discussion

5.1 Socioeconomics studies of farmers' field schools in Gadarif

5.1.1. Education:

The educational status of the respondents was that about 93.5% of the farmers had an education basic, secondary, and university education, while the rest (7.5%) were illiterate. These results emphasized the positive farmer's perception of improved technologies used in the project. As well as build their capacities to select highly profitable crops, shown in figure 1.

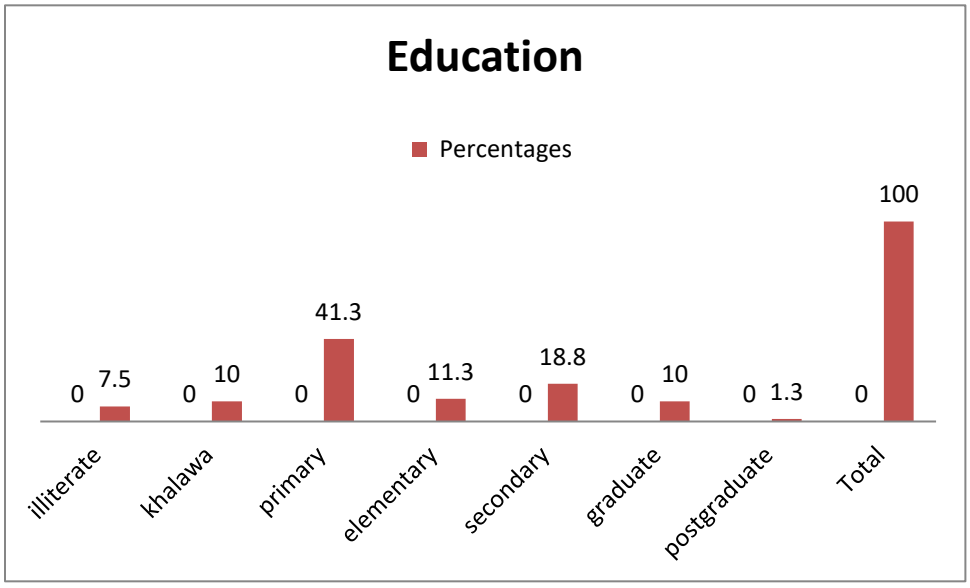

Figure 1: Distribution of respondents by education

Source: FFS survey 2022

5. 1.2. Occupation:

The occupation status showed that agriculture was the main occupation for the majority of respondents, 80%, while 20 % of them have different types of occupations as herders,

traders, and employees beside agriculture. It signed out that agriculture is the main source of income for the respondents, showed in figure 2.

Figure2. Distribution of respondents by occupation
Source: FFS survey 2022

5.1.3. Age:

The highest percentage of respondents' age was 42.5 % ranging from 31-40 years, followed by 26%, 15%, 13%, and 2.5% their ages ranged from 41-50, 51-60, less than 30, and more than 60 respectively. It meant that the majority of respondents are in the age of working force, shown in figure 3.

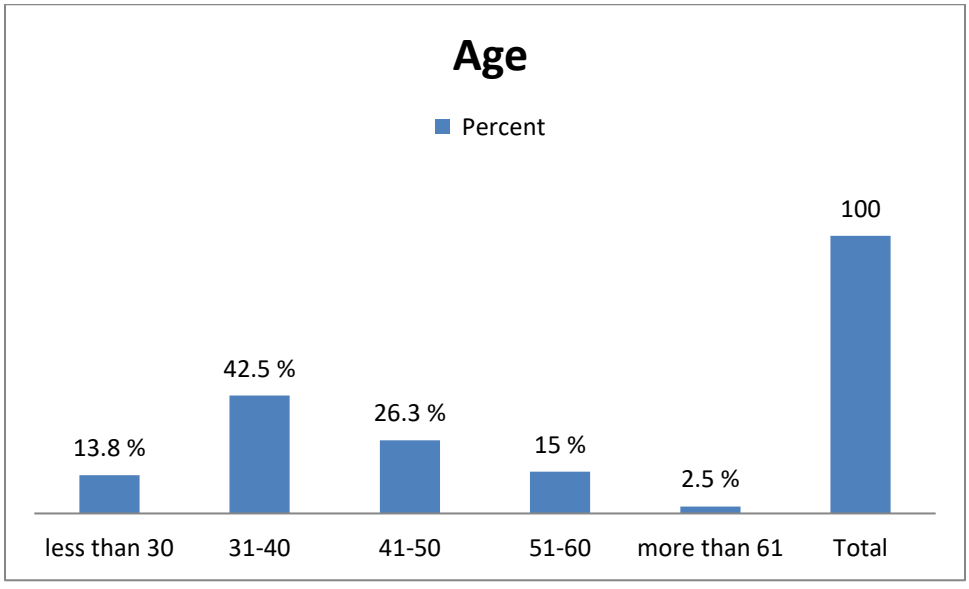

Figure3. Distribution of respondents by age
Source: FFS survey 2022

5.1.4. Gender:

Based on gender 68.8 % of respondents were females, while 31.39% were males. The results showed that females were involved actively in agriculture figure 3.

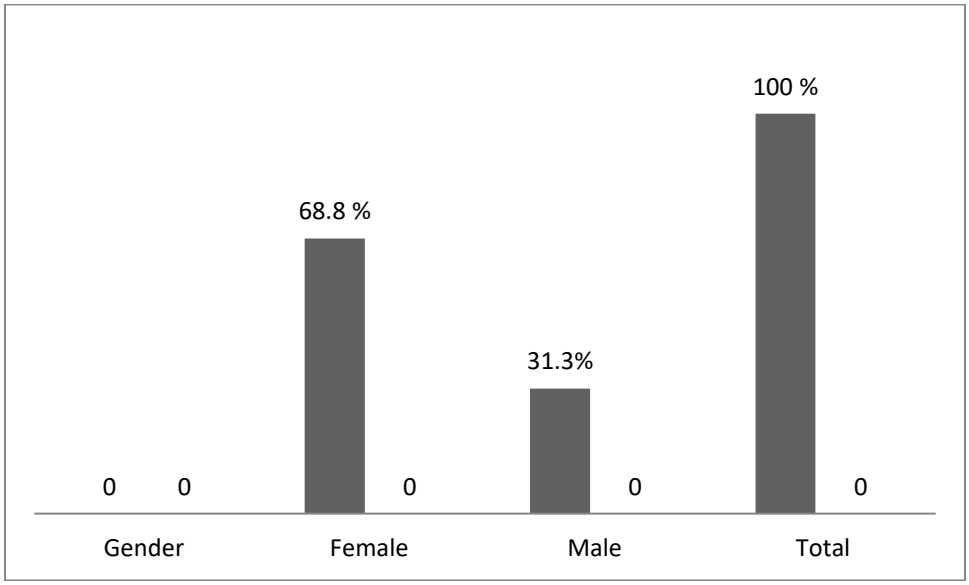

Figure4. Distribution of respondents by gender
Source: FFS survey 2022

5.2. Gross margin of FFS compared to neighboring farms for sorghum and millet production at Gadarif season 2022/2023

Gross margin analysis indicated that all crops were financially given positive returns. Average costs were assessed using 2022/2023 cropping season price/SDG, costs of labors /man day for bush cleaning, second weeding, harvesting, thrashing, packaging, and loading; costs of seeds/ SDG; from the village market and agricultural centers, ploughing and sowing/ by using the machine. Yield revenue and straw value were evaluated at the farm gate price for the same season. The highest profit of FFS for sorghum and millet were (SDG 21600), and (SDG 61000). On the other hand, the profit of traditional farmers for sorghum and millet was (SDG -66200), and SDG-500, this still entailed that FFS is profitable from growing field crops, and traditional farmers are not due to the low productivity as shown in (Table, 1).

Table 1. Gross margin of FFS and rational farms in Gedarief in 2022/2023

	Sorghum		Millet	
item	FFS	Traditional	FFS	Traditional
operations				
Bush cleaning	20000	2000	20000	20000
seed	700	700	1000	1000
ploughing	5000	5000	5000	5000
sowing	2000	5000	2000	5000
Weeding	16000	41000	16000	16000
Harvesting	6000	6000	6000	6000
Threshing &packing	2000	2000	3000	3000
Transportation\SDG	1000	1000	1000	1000
Total variable cost	**52700**	**80700**	54000	**57000**
Yield /sack/fed	5.6	1	5	2
Straw value/fed	1500	1500	10000	*10000*
farm price\sack	13000	13000	21000	**21000**
Gross income	**74300**	**14500**	115000	52000
Gross margin (return)	**21600**	-66200	**61000**	**-5000**

Source: FFS survey, 2022

In the 2021\2022 cropping season, the highest profits FFS generated from growing sorghum and millet were (SDG18800), and (SDG 15500). On the other hand, the profit of traditional farmers from sorghum and millet were (SDG 30300), and SDG15300, this revealed that FFS and traditional farmers profited from growing field crops, and traditional farmers are not due to the low productivity as shown in (Table, 2).

Table 2.Gross margin of FFS and traditional farmers in Gadarif in 2021\2022

	Sorghum		Millet	
Crops operations	**FFS**	**Traditional**	**FFS**	**Traditional**
Bush cleaning	10000	10000	10000	10000
Seed	500	500	700	700
Ploughing	3000	3000	3000	3000
Sowing	2000	3000	2000	3000
Weeding	16000	16000	10000	10000
Harvesting	5000	5000	5000	5000
Threshing &packing	2000	3000	1000	2000
Transportation\sack	1000	1000	2000	2000
Total variable cost	39500	41500	33700	35700
Yield /sack/fed	7.1	7	4	3
Straw value/fed	1500	1000	4000	6000
farm price	8000	8000	15000	15000
Outcomes	58300	57000	64000	51000
Gross margin	**18800**	**15500**	**30300**	**15300**

Source: FFS survey, 2022

In the 2020\2021 cropping season, the highest profit FFS gained from sorghum and millet were (SDG 29600), and (SDG 8600). While the profit traditional farmers generated from sorghum and millet were (SDG 96800), and SDG 48800, this led to FFS being profitable from growing field crops, and traditional farmers are not due to the low productivity as shown in (Table, 3).

Table3. Gross margin of farmers' field schools in Gadarif in 2020\2021

Crops	Sorghum		Millet	
	FFS	Traditional	FFS	Traditional
operations				
Bush cleaning	4000	4000	4000	4000
Seed	200	200	500	500
Ploughing	2500	2500	2500	2500
Sowing	1700	1700	1700	1700
Weeding	6500	6500	6500	6500
Harvesting	4500	4500	4500	4500
Threshing &packing	1000	1000	3000	3000
Transportation\sack	500	500	500	500
Total variable cost	20900	20900	23200	23200
Yield /sack/fed	7	4	9	5
Straw value/fed	1500	1500	3000	3000
farm gate price	7000	7000	13000	13000
Outcome	**50500**	**29500**	**120000**	**68000**
Gross margin	**29600**	**8600**	**96800**	**48800**

Source: FFS survey, 2022

In the 2019\2020 cropping season, the highest profit FFS gained from sorghum and millet were (SDG 10800), and (SDG -**4200**). While the profit traditional farmers generated from sorghum and millet was (SDG 29500), and SDG 14000, this led to FFS being profitable from growing field crops, and traditional farmers are not due to the low productivity as shown in (Table, 4).

Table 4. Gross margin of farmers' field schools in Gadarif in 2019\2020

Crops	Sorghum		Millet	
Operation	FFS	Traditional	FFS	Traditional
Bush cleaning	2000	2000	2000	2000
Seed	200	200	500	500
Ploughing	2500	2500	2500	2500
Sowing	1700	1700	1700	1700
Weeding	3500	3500	3000	3500
Harvesting	4500	4500	4500	4500
Threshing &packing	1000	1000	1000	2000
Transportation\sack	300	300	300	300
Total variable cost	15700	15700	15500	17000
Yield /sack/fed	5	2	6	4
Straw value/fed	1500	1500	3000	3000
farm price	5000	5000	7000	7000
Outcome	26500	11500	45000	31000
Gross margin	**10800**	**4200-**	**29500**	**14000**

Sources: FFS survey, 2022

In the 2018\2019 cropping season, the highest profit FFS gained from sorghum and millet were (SDG 19333), and (SDG 4333). While the profit traditional farmers generated from sorghum and millet were (SDG 22383), and SDG 17383, this led to FFS being profitable from growing field crops, and traditional farmers are not due to the low productivity as shown in (Table, 5).

Table 5. Gross margin of farmer's field schools in Gadarif in 2018\2019

Crops	Sorghum		Millet	
Operation	FFS	Traditional	FFS	Traditional
Bush cleaning	1361	1361	1361	1361
Seed	150	150	200	200
Ploughing	2500	2500	2500	2500
Sowing	1700	1700	1700	1700
Weeding	256	256	256	256
Harvesting	2250	2250	2500	2500
Threshing &packing	850	850	1000	1000
Transportation\sack	100	100	100	100
Total variable cost	9167	9167	9617	9617
Yield /sack/fed	9	4	6	5
Straw value/fed	1500	1500	2000	2000
farm price	3000	3000	5000	5000
outcome	28500	13500	32000	27000
Gross margin	**19333**	**4333**	**22383**	**17383**

Source:FFS survey

6. Conclusion

- Education and agricultural experience assisted FFS in easily selecting highly profitable crops and adapting technology.
- A percentage of 91.3 % of the respondents were married meaning that marital status is socially an important variable considering agricultural production to sustain family food security and tends toward the production for marketing.
- The crop productivities of FFS farmers are remarkably increased compared to those of the neighborg farmers.
- FFS's gross margin was economical and generated positive financial returns.
- FFS had benefited from technical packages and extension services besides the high awareness resulted in improved sorghum productivity.
- FFS sold their production at farm gate price which made them receive a small income from the product sold.

- The seasonal increase in the cost of production lowers the return of both FFS and traditional farmers.

7. Recommendations:

1. Expansion of extension and mechanization services among farmers in Gadarif

2. Provision of certified striga resistant seed varieties to increase sorghum

3. Increasing farmer's income during postharvest through launching small marketing enterprises

8. References

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The Republic of The Sudan
Ministry of Higher Education & Scientific Research
The National Center for Research
DIRECTOR GENERAL

جمهورية السودان
وزارة التعليم العالي والبحث العلمي
المركز القومي للبحوث
المدير العام

Date: 15 th , July ,2021

To: JICA Sudan Office

Reference: Development of Counter Measures Against Striga to Conquer Poverty and Improve Food Security in Sudan(Equipment)

This is to confirm that NCR will be responsible from the following:

1. **Custom Clearance and Transportation:**

When the 2nd Batch equipment arrived at Khartoum Airport, NCR will be responsible from the custom clearance and transportation of equipment to NCR as soon as possible according to R/D.

2. **Equipment Ownership and Maintenance responsibility:**

All the equipment will be owned by NCR and DG will be responsible for maintenance.

3. **Equipment management after the project is over**:

After the termination of the project, all the equipment provided by JICA will be properly maintained and managed by the NCR.

4. **JICA survey after the project is completed:**

Subsequent to termination of project, the NCR acknowledged that JICA has the right to check and inspect on status of the equipment whenever they requested.

Yours sincerely,

National Center for Research
General Manager

Professor. Zeinab Osman
Director General

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