Developing Integrated Management for Dubas Bug *Ommatissus lybicus* de Bergevin, in the Sultanate of Oman

Call for Proposal

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1. Overview

The date palm *Phoenix dactylifera* L. is a major crop grown in the Sultanate of Oman and the Gulf countries. The total cultivated area of date palms in the Sultanate is about 35.5 thousand hectares, which occupies more than 82% of the total fruit area and about 42% of the total agricultural land. The number of date palms in the Sultanate is about 8 million palms, of which 6 million are productive. However, of the productive date palms, 64% are for fresh consumption and 36% are used for industrial consumption. More than 250 varieties of date palms are grown throughout Oman with a total production of about 281 thousand tons per year.

Date palm plantations have been suffering from a number of destructive insect pests. Some of them attack fronds and some attack fruits whereas others attack the main trunk. The surveys of insect pests of date palm conducted so far indicates that there are more than 54 arthropod species (insects and mites) that attack date plantations in the Sultanate. Among those of major economic importance that affect growth and yield of date palms quantitatively and qualitatively are Dubas bug *Ommatissus lybicus* de Bergevin, Red palm weevil *Rhynchophorus ferrugineus* Olivier, Lesser date moth *Batrachedra amydraula* Meyer and Old world date mite *Oligonychus afrasiaticus* McGregor.

The Dubas bug, *Ommatissus lybicus* (Homoptera: Tropiduchidae), is considered as the most destructive sucking insect pest attacking date palms in Oman, causing serious damage to date palms by affecting growth and yield. In General, Dubas bug has two generations per year, i.e., spring generation and autumn generation. During the spring generation, the eggs start hatching from February to April where young nymphs pass through 5 instars to become adults in about 7 weeks. The female has a strong chitinous saw-like tool surrounding the ovipositor used to borrow a lane tunnels. Each tunnel is about 0.4 to 0.5 mm deep and containing only one egg. The top of the laid egg usually protrudes from the tunnel. The lifespan of the adult is about 10 weeks and the female lays an average of 140 eggs.

The eggs aestivate (dormancy during a hot or dry season) until the autumn generation where they start hatching from the last week of August until last week of October. This is followed by the nymph stage which takes about 6 weeks to develop into an adult, which lives for about 12 weeks. In autumn the female lays more eggs than in the spring generation averaging about 180 eggs per female. Both nymphs and adults suck the sap and produce honeydew, in conspicuous amount over the leaf surface and fruit stalks which results in the reduction of the palm yield and makes the fruits unacceptable for human consumption. In addition, necrotic areas develop on the surface of fronds due to the egg laying scars.

This sap-feeder insect, *O. lybicus* is also a monoecious species where all of its stages spend their life on only date palm trees. Nymphs and adults cause damage directly to the tree through sap draining and indirectly by producing honeydew. The profuse feeding of *O. lybicus* weakens the tree, while the honeydew produced contaminates the foliage and provides a substrate for growth of black sooty mould that reduces photosynthesis of the frond (the compound leaf). Following months of Dubas bug infestation, the frond surfaces tend to become chlorotic. Extremely heavy populations are believed to cause the death of some palms. Moreover, the dense oviposition causes the green plant tissues of the area of eggs insertion to dry up. Up to 50% of economic losses were recorded in Iraq due to the infestation on date palms by this insect whereas 28% in Oman. It has been reported that, dates of infested palms

would be smaller and ripe more slowly, with a high percentage of reducing sugars and low percentage of sucrose. The honey dew produced is relevant to the size of Dubas population. Honey dew has been used as indicator, of Dubas bug populations where a new method based on collecting and counting honeydew droplets produced by the insect was developed during 1989-1990. This method was established to determine the effectiveness of control measures used against Dubas bug. It is effective, rapid and less hazardous and saves labor and time.

Since the recording of Dubas bug in Oman in 1962 the Ministry of Agriculture has made efforts to manage the Dubas bug infestation. In the 1980's, several pesticides were evaluated for controlling Dubas bug by aerial and ground spraying.

The recommended insecticides were Nogos 50 EC (dichlorvos) @ 3.75 L ha^{-1}, Malathion 96% ULV (malathion) @ 2 L ha^{-1}, Sumithion 99% ULV (fenitrothion) @ 1 L ha^{-1}, Sumicombi alfa 50% ULV (fenitrothion + esfenvalerate) @ 2 L ha^{-1} and Trebon 30% ULV (etofenprox) @ 3.6 L ha^{-1}, for aerial application. On the other hand, Nogos 50 EC @ 200 ml/100L, Decis 25 EC (deltamethrin), Elsan 50 EC (phenthoate) and Sumi-Alpha 5% EC (esfenvalerate) @ 100ml/100L were used for ground spray. All these insecticides belong to either Organophosphate group (e.g. malathion, dichlorvos and fenitrothion), or Pyrethroid group (e.g. deltamethrin and esfenvalerate), except etofenprox which was a non-ester pyrethroid.

About 400 tons of insecticides have been used for aerial spray to control Dubas bug during the period from 1993 to 2006 with an estimated cost of 9 million Omani Rials. This also raises concerns on the negative impact that could have occurred on the human health, environment and non targeted organisms.

2. Scope

Despite the efforts made so far to control Dubas bug, it is still a serious problem indicating the necessity of promoting the management strategy of Dubas to integrate several techniques and tactics. The achievement of this goal requires solid research to investigate and build up informative databases and develop advanced tactics to manage the Dubas problem and preserve the agricultural environment.

Consequently, to solve the serious problems caused by Dubas bug, there is a need for developing a sustainable strategy based on integrated dubas bug management. In recognition of such seriousness of the Dubas bug problem in Oman, The Research Council formed a program committee made up of representatives from relevant sectors including the public sector organizations, to initiate a research program on Dubas bug control in Oman. The Program Committee has set clear objectives for the research program and identified research themes that will guide researchers in submitting proposals leading to the advancement of existing knowledge on Dubas bug management in Oman.

3. Objectives of the program and the research themes

The Developing integrated management of Dubas bug Research Program operates on the basis of competitive research grants offered as a means to promote research projects that would have a direct bearing on reducing the pest infestation in the Sultanate. The program is designed to support research work that will contribute to the pool of IPM knowledge. The outcome of the research should contribute evidence-based policy on the interrelated themes presented in the following sections. The following five sections provide guidance on identified research areas, while leaving enough room for suggestions of different innovative topics and approaches. Research proposals covering one or more of the five identified research areas are encouraged.

a. Ecology and biology of Dubas bug and its biological control

Ecology is the study of the interaction between living organisms and their environment. Biology is the study of the physical and biochemical factors controlling the growth and development of a living organism. The population dynamics of autumn and spring generations of Dubas bug were investigated in Oman during 1994 to 1996 seasons. Proposals are welcomed that address: (i) Defining the area of origin of Dubas bug *Ommatissus lybicus* using molecular techniques for sampled individuals from all countries which have recorded the presence of this species; (ii) Identifying tolerance level in the date varieties existing in Oman; (iii) Recording all available

research results and documenting all observations of specialists and farmers and subjecting all for analysis; (iv) Constructing life-tables for *O. lybicus* to be used in modelling and prediction of the future populations of the pest; (v) Using modern technologies of satellite images (GIS) for locating infested areas; (vi) Recording intercropped crops in different areas of the Sultanate of Oman to look for their water needs in relation to the microenvironment in the palm groves and to levels of infestation with Dubas bug and level of infestation; (vii) Survey of Indigenous natural enemies, and (viii) Establishing Long Term Research and Facilities for Mass Production of Certain Natural Enemies.

b. Insecticide screening and resistance management

Bioassay is commonly perceived as biological assay to measure qualitative or quantitative effects of a given substance on a living organism. Qualitative bioassays are used to assess the physical effects of a substance that may not be quantified, such as abnormal development or deformity, while the quantitative bioassays involve the estimation of the concentration or potency of a given substance by measuring its biological response. Bioassays are essential to estimate or evaluate toxicity of new chemicals/insecticides. The responses of insects to pesticides vary between species or different strains or biotypes in the same species. Examples of research topics that potential researchers can target may include: (i) Screening of novel modes of action of chemical classes, and microbial agents, as made available; (ii) Development of bioassay techniques to monitor and document resistance to existing control agents, Identify potentially effective novel modes of action and assess pesticide toxicity to key non-target organisms, and (iii) Development an insecticide resistance management scheme.

c. Improved biocide application and evaluation

Although the chemical control is still a part of the IPM programmes every where, the preservation of the environment and the safety of the human health has became major concerns when applying Insecticides in agriculture. In this respect, the use of

chemicals against Dubas bug is a very risky operation because date palm plantations are mostly present at the places near the settlement of people in Oman and this is true in all date palm growing areas of the world. Therefore, research aiming at selecting effective chemicals against Dubas bug with little side effects is of utmost importance. Proposals are welcomed that address: (i) Investigation of possible insecticide-induced Dubas bug resurgence phenomena; (iii) Aerial application improvement; (iv) development improved machinery to meet farmers' needs on a local scale, and (vi) Field evaluation of promising novel insecticides against Dubas bug.

d. Cultural practice

In Oman, Dubas bug *Ommatissus lybicus* is well established and a number of detailed studies have been carried out on its biology and seasonal distribution and abundance. There is still a need for more research on its effects on the fruit yield and quality in different cultivars and under different planting situations. Furthermore, pesticides are often misused, leading to environmental and human-health risks. Research is needed to generate information about the relation between the cultural practices of date palm production and pest infestation to formulate successful IPM strategies. Horticultural and cultural practices (e. g. planting space, pruning, removing or keeping suckers, irrigation..etc) should be investigated to estimate their influence on the infestation of Dubas bug. The theme embraces diverse issues including: (i) Need to study an adoption of cultural methods; (iii) Motivations for growing date palms, and (iv) Review the history over the past 30 to 40 years.

e. Socioeconomics and implementation of IPM

The outcomes or results of research should be socially and economically viable in application and implementation of integrated Dubas bug management in ineffectively controlling Dubas bug as against traditional practises date palm cultivation. In this respect, relevant studies on socio-economic impact of integrated Dubas bug

management among the date palm growers need to be proposed. The transfer of knowledge from research to the end users via extension agents represents a key factor for the development of agriculture. The current era is witnessing a vast development in all fields of agriculture and the need for unconventional methods to transfer the knowledge of experts to the general public of farmers. On-farm trials are one of the ways of information transfer in agriculture domain, and the on-farm experiments are designed and managed by the research team, or researcher-designed and farmer-managed. Furthermore, bringing the research experiments, to some extent, to the farmers field can broaden the range of IPM understanding and encourage interaction with farmers.

Proposals are encouraged to address the following socio-economic aspects: (i) Understanding the socio-economic impact of IPM on the date palm growers and the ecosystem; (ii) Determining the socio-economic impact of IPM cultural practices on existing date palm cultivation, and (iii) Conducting on-farm demonstration/pilot trials in farmers field for showing merits of IPM to date palm growers.

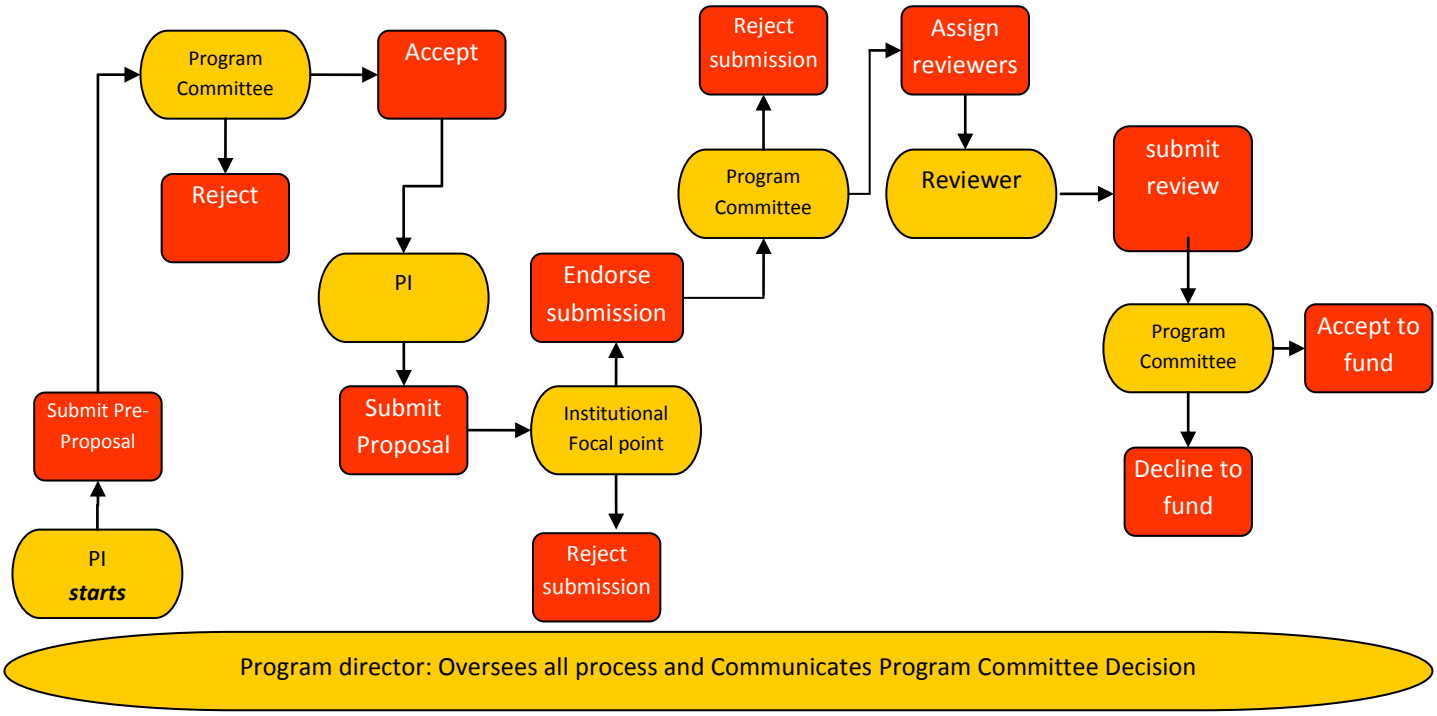
4. Eligibility criteria

The Research Council welcomes proposals from all the qualified scientists/ researchers of the Universities/ Research Institutes/ Centers, with a minimum of a PhD or an equivalent qualification. Researchers whose qualifications do not include a PhD can seek collaboration with an institution or/and an individual with a PhD who will act as Principal Investigator (PI) for the project and he/she will work with them as a research assistant. The research proposal(s) submitted by any international scientists/ researchers of the Universities/ Research Institutes/ Centers, have to be linked through institution with a local partner(s) in Oman such as Ministry of Agriculture, Ministry of Environment and Climate Affairs, Ministry of Health, Sultan Qaboos University and Royal Court Affairs.

5. Submitting a proposal

A Principal Investigator, in conjunction with his or her team, must prepare and submit an application using The Research Electronic Submission System (TRESS).

The steps of submission process are clarified in the diagram below:



6. Timing of Calls for Proposals

Pre-Proposals can be submitted at any time using The Research Council webpage (www.trc.gov.om). All received pre-proposals will be evaluated by the program committee and only the successful ones will lead to invitation for full proposals. The full proposals can be submitted only in response to an invitation from the program Director. Call for pre-proposals details are published on the TRC website. Deadlines

for the submission of full-proposals are specified in the invitation email from the program Director.

The steering committee may request a researcher or institute specializing in one or more of the Dubas bug IPM program's themes to submit a proposal. However, such proposals will be evaluated in the same way as those which are unsolicited in order to ensure that the quality of the proposal meets all criteria.

7. Summary of the Process

The Program Committee (identified in the process diagram above) shall be assisted in its role by:

- A Program Director who shall coordinate activities, provide research administration support and ensure the smooth running of the evaluation and follow-up processes
- External peer reviewers who shall provide the technical input necessary for the evaluation of the proposals.

The process shall follow the steps below:

1. The PI prepares a pre-proposal which summarize the objective of the research work along with an estimate for the required budget and time to execute the research work. The PI needs to attach his/her CV and contact information.
2. The program Director calls for a meeting of the program committee to evaluate the received pre-proposals. The committee then makes decisions on approving or rejecting the submitted pre-proposals.
3. The program Director communicates the decision of the committee to all PIs who submitted research pre-proposals. Only PIs with approved pre-proposals will be invited to prepare and submit full proposal.

4. All PIs with approved pre-proposals will be provided with a user ID and password in order to submit their full proposals using TRESS.

5. The PI prepares the full proposal using the TRESS form, circulates it to all co-investigators and submits it electronically using the Research Electronic Submission System (TRESS) at http://www.trc.gov.om/TRCWebsite/index.htm

6. The institutional Focal Point of the PI endorses or rejects the submission before it reaches the Research Council (TRC).

7. The Program Committee and the Program Director receive electronic notifications of the proposal's arrival and thus can access it electronically via the TRESS system.

8. Members of the Committee, including the Chair and Deputy-Chair, state whether there is a conflict of interest – as defined by TRC policy guidelines – in participating in the process. If this is the case, they withdraw from the evaluation process.

9. The Program Committee performs an initial screening and prepares a shortlist of proposals that meet the relevant eligibility criteria to be submitted to the external peer reviewers. If any of the short-listed proposals is deemed to require clearance from the Research Ethics Committee, it must be sent for clearance in parallel with the review process.

10. The Committee members propose a list of External Peer Reviewers based on the topic of the proposal. TRC will build a database of reviewers so that Committee Members can search for appropriate reviewers.

11. The Program Committee Chair assigns three Reviewers from the list and sends an email of intent, guidelines on peer reviewing and a request for acceptance.

12. The Program Director ensures the availability and willingness of External Peer Reviewers to participate in the review process.

13. The Program Director, on behalf of the Chair, receives a formal acceptance from the External Peer Reviewers.

14. Each External Peer Reviewer evaluates the proposal based on the set of criteria provided by TRC (the Reviewers may request clarifications on the proposal from the Principal Investigators through the Program Director).

15. The Program Director ensures that evaluations for all proposals have been received and completed. In cases where evaluations are incomplete, the Program Director contacts the External Peer Reviewer(s) to obtain the relevant information or sends a request for an additional Reviewer after seeking the approval of the Committee Chair.

16. The Program Director seeks written comments from the TRC Financial Controller on the budgets requested for each of the short-listed proposals.

17. The Program Director forwards the proposal evaluations and other relevant material to the Committee.

18. In a meeting held at TRC, the Committee discusses the evaluation outcomes prepared by the External Peer Reviewers on each proposal in terms of the scientific merit of the proposal, the relevance of the proposal to the Program and the funds requested in the proposal. After discussion, the proposals shall then be ranked by the Committee.

19. The Governing Board of TRC chooses the approved proposals based on the ranking and the budget it sees as appropriate for the call. TRC may request that certain proposals are re-submitted in a revised form before being re-considered for funding.

20. The Program Director notifies the institutional Focal Point and the PI of the decision of the Governing Board of TRC.

21. Signature of the grant agreement (Negotiation between TRC and PI may be required over the requested budget).

22. Post award, the Program Director ensures that research teams provide the necessary progress and financial reports.

23. The Program Director sends progress and financial reports to the Program Committee and the Financial Controller.

24. The Committee agrees with the research team on an action plan to address any possible issues and/or recommend early termination of the funding.

8. Evaluation Criteria

The general framework to evaluate the proposals is based on the following indicators:

Relevance to the program themes:

The focus of the proposal should match the themes of "Developing Integrated Pest Management for Dubas bug *Ommatissus lybicus* de Bergevin, in Sultanate of Oman".

Novelty of proposal:

The proposal should aim to advance existing knowledge on IPM for Dubas bug and, in turn, contribute to the pool of knowledge on Dubas bug control that would lead to establishment of sustainable Dubas bug management.

Clarity of proposal:

The proposal should be comprehensive so as to meet the requirements of the multidisciplinary team which scrutinizes the merits of the proposal.

Survey of relevant literature:

A comprehensive literature review is essential in order to highlight the existing body of knowledge as well as to justify the motivation of the present proposal.

Measurable outcomes of the proposal:

Although any research paradigm is acceptable, it is important that the investigator(s) clearly operationalize the scope of their study. The outcome measures should have

heuristic value and direct relevance to the situation in Oman and such relevance should be tangible.

Methodology:

The investigator(s) must concisely state who the research participants are, what materials are to be used and when, where and how data will be collected.

Plan and management of the project:

The investigator(s) should clearly articulate the plan and management of the project including a clearly demarcated division of labour and manpower involved in the different phases of the study as well as the viability of proposed team work, if any.

Research team capability to conduct the project:

The investigator(s) should be ostensibly equipped with both the knowledge and skills to undertake the proposed research. This means that the PI as well as team members should have the qualifications and background knowledge in the field that would equip them to execute the proposed study. Although there is some flexibility, those who have sound research and academic backgrounds relevant to the proposed study will be preferred.

Budget estimation and adequate time allocated to the project:

The proposal should contain logical and realistic time chart for the execution of the study with clear compartmentalization of each phase. The budget should be economical in meeting the required expenditure.

Ethical standard:

The proposal should clearly state how the execution of the study meets the required best practice in ethical standards. Good practice here also entails setting up mechanisms so as not to offend social modesty, tradition and harmony among Oman's diverse population.

Building National Research Capacity on Dubas bug Management:

The proposal should contribute to building national research capacity such as training of a cadre of Omani researchers leading to graduate/ post graduate qualifications.

9. Reporting requirements

- The project must have a maximum duration of 36 months. A draft final report is to be submitted to TRC within 3 months of the commencement of the grant. Applicants are required to submit a realistic project schedule with their applications.
- A brief report summarizing progress is also required mid-way or annually through the project, or at a time agreed with TRC.
- Research reports are to be prepared to a standard suitable for publication in a reputable scientific journal. Report writing must be clear, concise, non-repetitive, accurate and able to withstand technical scrutiny.
- Grant recipients will be responsible for applying appropriate editorial and quality control before the draft of the final report is delivered to TRC.
- TRC reserves the right to publish and disseminate grant reports, and to make them available for download from TRC website. An electronic report template will be supplied to grant recipients at the commencement of the project so that reports can be prepared and delivered in TRC standard format.
- The patent that comes from funded research by the Research Council will apply to IP rules and regulation of the Council

10. Strategic research grant policy guideline

Applicants should ensure they understand the conditions under which funding is provided and be aware of the grant rules and regulations presented in **the Strategic**

directed Research Grant Program Policy and Regulations which can be found on the TRC website (http://www.trc.gov.om)