UNIVERSITI PUTRA MALAYSIA

SEED CHARACTERISTICS, GERMINATION BEHAVIOR AND DORMANCY TYPE OF SELECTED Bunium persicum B.FEDTSCH. ECOTYPES

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FP 2012 63

SEED CHARACTERISTICS, GERMINATION BEHAVIOR AND DORMANCY TYPE OF SELECTED *Bunium persicum* B.FEDTSCH. ECOTYPES

By

MOHSEN GHASEMI

Thesis Submitted to the School of Graduate Studies, Universiti Putra Malaysia, in Fulfilment of the Requirement for the Degree of Doctor Philosophy

October 2012

Abstract of thesis presented to the Senate of Universiti Putra Malaysia in fulfilment of the requirements for the degree of Doctor of Philosophy

SEED CHARACTERISTICS, GERMINATION BEHAVIOR AND DORMANCY TYPE OF SELECTED *Bunium persicum* B.FEDTSCH. ECOTYPES

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October 2012

Chairman: Associate Professor Adam B. Puteh, PhD

Faculty: Agriculture

Bunium persicum (Boiss.) B. Fedtsch. (Black cumin) is a perennial herbaceous plant from the *Apiaceae* family. This species is an economically important medicinal plant and grows wildly in cold temperate and the desert regions from southeastern Europe to southern Asia. Dried *B. persicum* fruits are used worldwide as culinary spice. This spice is not cultivated in Iran because of seed dormancy and is only found in certain natural habitats. Despite its importance, there is no comprehensive information on seed characteristics, germination behavior, and type of dormancy in *B. persicum*.

The objectives of this study were to characterize the anatomical and morphological structures of seed, germination behavior and to determine the type of seed dormancy that exists.

Seeds of five ecotypes were collected from different geographical locations in Iran. Histological studies were done to evaluate the anatomical and morphological differences in seeds among the ecotypes. Although there are variations among *B. persicum* ecotypes in their seed size and shape, all of them have similar underdeveloped linear embryo structure surrounded by endosperm and seed coat.

The seed germination behavior, under different temperatures and GA_3 concentrations was found to be different among ecotypes. It was found that the seeds of ecotypes collected from dry areas had the lowest percentage of germination. A narrow range of temperature (i.e. 10-15^{0}C) was found to be effective for breaking the seed dormancy. The fluctuating temperature (5^{0}C/15 ^{0}C) during the imbibition stage provided the best condition to stimulate germination. Intact seeds imbibed water under normal laboratory conditions which indicates that the seed coat of *B. persicum* is permeable to water; thus, the seeds do not have physical dormancy.

Exogenous application of GA_3 was found to be effective in breaking seed dormancy to the extent that the increase in GA_3 concentration led to the increase in germination percentage. In a seed with underdeveloped linear embryo, as found in this species, the embryo has to grow to the full length requiring cold temperature and GA_3 to break the dormancy and promote embryo growth. Therefore, the seed of this species has intermediate complex morphophysiological dormancy (MPD).

Asbtrak tesis yang dikemukakan kepada Senat Universiti Putra Malaysia sebagai memenuhi keperluan untuk ijazah Doktor Falsafah

CIRI BENIH, TAHIAT PERCAMBAHAN DAN JENIS KEDORMANAN BAGI EKOTIP *Bunium persicum* B.FEDTSCH. TERPILIH

Oleh

MOHSEN GHASEMI

Oktober 2012

Pengerusi: Profesor Madya Adam B. Puteh, PhD

Fakulti: Pertanian

Bunium persicum (Boiss.) B. Fedtsch. (Jintan hitam) adalah tumbuhan herba saka daripada keluarga *Apiaceae*. Spesis ini adalah tumbuhan ubatan yang penting dari segi ekonomi dan tumbuh liar di kawasan beriklim sederhana sejuk dan kawasan padang pasir dari tenggara Eropah ke selatan Asia. Biji buah jintan hitam digunakan secara meluas di seluruh dunia sebagai rempah masakan. Rempah ratus ini tidak ditanam di Iran kerana sifat kedormanan benih dan hanya boleh dijumpai di beberapa habitat semula jadi. Di sebalik kepentingannya, tidak ada maklumat secara terperinci mengenai ciri benih, tahiat percambahan, dan jenis kedormanan biji *B. Persicum* tersebut.

Objektif kajian ini adalah untuk menentukan ciri struktur anatomi dan morfologi benih spesis ini. Kajian ini juga bertujuan untuk mengkaji pertumbuhan semasa percambahan dan untuk menentukan jenis kedormanan benih.

Biji benih daripada lima ekotip dikumpulkan dari lokasi yang berbeza dari segi geografi di Iran. Kajian histologi telah dilakukan untuk menilai perbezaan anatomi dan morfologi dalam biji antara genotip. Walaupun terdapat variasi dari segi saiz dan bentuk benih di kalangan ekotip *B. persicum*, semua jenis jintan hitam tersebut mempunyai struktur di bawah perkembangan embrio linear yang sama yang dikelilingi oleh endosperma dan kulit benih. Percambahan biji pada suhu dan kepekatan GA_3 yang berbeza telah menyebabkan perbezaan antara ekotip. Didapati bahawa ekotip benih yang dikutip dari kawasan kering mempunyai peratusan percambahan yang paling rendah. Julat suhu yang rendah (10-15 ^{0} C) didapati berkesan untuk memecahkan kedormanan benih. Keadaan suhu yang berubah-ubah (5^0C/15^0C) semasa imbibisi, adalah keadaan yang paling baik untuk merangsang proses percambahan. Benih yang hidup yang menyerap air pada keadaan biasa makmal menunjukkan bahawa kulit benih *B. persicum* adalah telap terhadap air sehingga dapat diserap oleh air, maka ini membuktikan bahawa benih ini tidak mempunyai kedormanan fizikal.

GA_3 didapati berkesan untuk memecahkan kedormanan benih sehingga ke tahap peningkatan kepekatan GA_3 yang menyebabkan peningkatan peratusan percambahan. Bagi benih di bawah perkembangan embrio linear yang terdapat dalam spesis ini, embrio mestilah tumbuh kepada panjang yang penuh, yang memerlukan suhu yang sejuk dan GA_3

untuk memecahkan kedormanan dan menggalakkan pertumbuhan embrio. Oleh itu, spesis ini mempunyai biji benih dorman jenis morfofisiologi kompleks perantara (MPD).

DEDICATION

To my lovely family

My mother Kobra Tashakkori

and

My wife Aazam Joneid

and

My children Ehsan and Parnian

ACKNOWLEDGEMENTS

It is a fact that a person cannot go through life without the help and guidance from others. One is always indebted, knowingly or unknowingly, to those who have rendered such help and guidance.

However, it might not be possible for me to mention their names here and it is beyond my capacity to verbalize my gratitude personally to each one of them. This present work has materialized with the significant input of these individuals.

I wish to thank the following people who have contributed in different ways to put this project together: My main supervisor, **Associate Professor Dr. Adam B. Puteh.** Thank you for taking on this responsibility and for your invaluable help, guidance and supervision of this study. Your constant support, encouragement and patience have helped me to complete this study. I have learned and experienced a great deal in the process of doing this study. I am also grateful to my other supervisory committee members, namely: **Associate Professor Dr. Uma Rani Sinniah and Professor Dr. Zakaria Bin Wahab**. Thank you for your guidance, assistance and for believing in me. I am also grateful to my former supervisor, **Associate Professor Dr. Mohammad Bin Mohd Lassim,** who supervised me for half of the duration of my study and supported me in my most difficult times at the beginning. I am very thankful to **Dr. Ahmad Selamat** for his valuable advice and help for statistical analysis.

I am equally thankful to all the staff of UPM, especially those in the Faculty of Agriculture who contributed to my learning process, especially Mr. Daud Mustam and Mr Sohaimi for their help during using SEM in Department of Crop Science. I appreciate your kindness. I

would like to extend my appreciation to my family. Words are not enough to express my appreciation to my family for their patience and perseverance during my absence. I owe a lot to my mother, because her faith in me taught me to have faith in myself. To my dear lovely wife for her great support and encouragement, and my son, Ehsan, and my daughter, Parnian, thank you for your understanding and patience during my study. I am also deeply indebted to many individuals who assisted me in conducting this research. Finally, I would like to say "To my friends, thank you for your love, support and encouragement. **Above all, I thank God because "with God, all things are possible".**

APPROVAL

I certify that a Thesis Examination Committee has met on 29 October 2012 to conduct the final examination of Mohsen Ghasemi on his thesis entitled "Seed Characteristics, Germination Behavior and Dormancy Type of Selected *Bunium persicum B.Fedtsch* Ecotypes" in accordance with the Universities and University Colleges Act 1971 and the Constitution of the University Putra Malaysia [P.U. (A) 106] 15 March 1998. The committee recommends that the student be awarded the Doctor of Philosophy.

Members of the Examination Committee are as follows:

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This thesis was submitted to the Senate of Universiti Putra Malaysia and has been accepted as fulfillment of the requirement for the Degree of Doctor of Philosophy. The members of the Supervisory Committee were as follows:

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DECLARATION

I declare that the thesis is my original work except for quotations and citations, which have been duly acknowledged. I also declare that it has not been previously, and is not concurrently, submitted for any other degree at Universiti Putra Malaysia or at any other institution.

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MOHSEN GHASEMI

Date: 29 October 2012

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