

**FLUOROMETRIC DETERMINATION OF GIBBERELIN IN *Fusarium*  
AND *Gibberella* SPECIES COMPLEX INFECTING  
ECONOMIC CROPS IN NUEVA ECIJA**

**EMMANUEL CAJUCOM NIETO**

**An undergraduate thesis manuscript presented to the faculty of the Department of  
Crop Protection, College of Agriculture, Central Luzon State University  
in partial fulfilment of the requirements for the degree**

**BACHELOR OF SCIENCE IN AGRICULTURE  
(Crop Protection – Plant Pathology)**

**JUNE 2017**



## **BIOGRAPHICAL SKETCH**

The author of this study was born on a Tuesday morning at 7:29 am on April 9, 1996 at Brgy. Mallorca San Leonardo, Nueva Ecija. He was the eldest among the two siblings of Mr. Alberto Interior Nieto and Mrs. Rosenda Cajucom Nieto. His sibling was named John Paul C. Nieto.

He finished his elementary school in San Leonardo Central School at San Bartolome San Leonardo Nueva Ecija (S.Y. 2008). He went to Mallorca National High School at Barangay Mallorca San Leonardo Nueva Ecija (S.Y. 2012).

In year 2012, he entered Central Luzon State University (CLSU), Science City of Muñoz, Nueva Ecija to pursue a degree of Bachelor of Science in Agriculture later on he decided to major in Crop Protection and choose Plant Pathology as his field of specialization. At the same time, he joined the college-based organization the Pest Management Society where he became business manager (S.Y. 2014-2015). The author was a member of performing group in the university called CSLU Concert/Marching band from year 2012-2017, and also due to the influence of one his co majors and because of the blood of a fighter running to his veins he trained in a sport called Pencak Silat a traditional Indonesian martial arts and later become a member of the Pencak silat varsity team in CLSU, and also a member of MKKPI San Jose City Chapter, and Phil Silat Sports Association Incorporated from 2016 up to present.

## ACKNOWLEDGEMENT

I would like to thank the following persons that served as a great help for the accomplishment of this study.

To Dr. Ronaldo T. Alberto my adviser for giving me the light and perseverance during the darkest times of my thesis. For his considerate assistance, unending words of encouragements, helpful remarks and support to my thesis. Without him, I would have failed to finish this thesis.

To Mrs. Annie Melinda-Paz Alberto the director of ICCEM for allowing me to work and used the facilities of their Biodiversity Molecular Laboratory.

I also want to thank the ICCEM family especially Sir Ronnel Runez, Ma'am Darling Salazar and Ma'am Myra Domingo, for their help, advices and sharing their knowledge during the conduct of my study. And also to Kuya Larry and the rest of the ICCEM utility boys who also contributed to the success of this study.

To Ma'am Celyne O. Padilla, for her patience in checking my drafts, pieces of advice and suggestions. To Ma'am Princess Perez for her advice and suggestions and for teasing me from the proposal up to the conduct of this study. I also like to thank the Crop Protection faculty especially to: Dr. Marita S. Labe, Elaida Fiegalan, Dr. Jonathan L. Galindez, Dr. Marilyn G. Patricio, Prof. Jaime R. Quilantang, Mr. Aaron Aguas and also to Ms. Lyka Abayon, for being so considerate of our situation and for all the information that they've shared to me as well as the encouragements and words of wisdom.

I also want to thank to the Director of Philippine Carabao Center Dr. Arnel Del Barrio and also to the head of GIP and Bioinformatics Dr. Ester Flores for their warm

welcome and approval of my request, I also want to thank to Ms. Laila Labonite and Ma'am Hannah for teaching me the use of fluorometer its techniques and also on setting of standard curve.

I also like to thank all my friends, Rhence, Angelo, Carlo and Reynaldo for the heart melting pieces of advise and for their prayers throughout the conduct of this study also to my classmates and co majors, Reuel, Arvee, Jobelle, Anna, Angelica, Pauline for their support to accomplish this study. To Mr. Marlou Naval who was always there when I need help throughout the conduct of this study and to all my Co- CLSU band members and also to Ma'am and Sir Lamson thank you guys.

To my parents, Alberto Nieto and Rosenda Nieto for their unconditional love, financial support, their hardship and sacrifices to finish my thesis and for making all my dreams come true. Also to my brother, to my aunts, uncles and cousins for their concerns and additional support, financially and spiritual help to accomplished this study and to my dearest girlfriend Camille Cabangbang for the inspiration and motivation she gave throughout the good and bad times.

I would also like to thank those persons whose names were not mentioned for their help and support in the completion of this study. Above all, praises and thanks to the almighty God, who gives me strength, guidance and knowledge throughout the conduct of this study.

**EMMANUEL CAJUCOM NIETO**

## TABLE OF CONTENTS

	<b>PAGE</b>
<b>TITLE PAGE</b>	i
<b>APPROVAL SHEET</b>	ii
<b>BIOGRAPHICAL SKETCH</b>	iii
<b>AKNOWLEDGEMENT</b>	iv
<b>LIST OF FIGURES</b>	ix
<b>LIST OF APENDIX</b>	xiii
<b>LIST OF APPENDIX TABLES</b>	xiv
<b>ABSTRACT</b>	xvii
<b>INTRODUCTION</b>	1
Background Information	1
Statement of the Problem	3
Importance of the Study	4
Objectives of the Study	5
Scope and Limitation of the Study	5
Time and Place of the Study	5
<b>REVIEW OF LITERATURE</b>	6
Fusarium	6
Dispersal and Life cycle	7
Gibberellin	11
Secondary Metabolites of <i>Fusarium</i> and <i>Gibberella</i>	12
Fluorometer	12
Advantages of Fluorometer	13

Disadvantages of Fluorometer	15
Chemical, Biological and Cultural Control	15
<b>MATERIALS AND METHODS</b>	17
Collection, Isolation and Maintenance of Isolates	17
Colony and Spore Morphology	18
Pathogenicity Test	18
Fluorometric Determination of <i>Fusarium</i> and <i>Gibberella</i> Species complex	24
Fungal strains	24
Preparation of GA3 for Standard Curve	25
Plotting of Standard Curve	26
Fluorometric Determination of Gibberellin	27
Gibberellic Acid (GA3) Production	27
Data Gathered	28
<b>RESULTS AND DISCUSSION</b>	29
Characteristics of Different Fungal Strains	29
<i>Fusarium</i> sp. on melon from Lupao	29
<i>Gibberella</i> sp. on melon from Quezon	30
<i>Fusarium</i> sp. on melon from Guimba	31
<i>Fusarium</i> sp. on pepper from San Leonardo	32
<i>Fusarium</i> sp. on pepper from Gapan	33
<i>Gibberella</i> sp. on corn from Talugtug	34

<i>Gibberella</i> sp. on corn from San Leonardo	35
<i>Gibberella</i> sp. on corn from Talavera	36
<i>Gibberella</i> sp. on onion from Bongabon	37
<i>Gibberella</i> sp. on onion from San Jose	48
<i>Gibberella</i> sp. on onion from Sto. Domingo	39
<i>Fusarium</i> sp. on rice from San Leonardo	40
<i>Fusarium</i> sp. on rice from Penaranda	41
<i>Gibberella</i> sp. on rice from Gapan	42
<i>Fusarium</i> sp. on banana from Munoz	43
Pathogenecity Test	44
Colony Characteristics	47
Corn	47
Onion	47
Melon	48
Rice	49
Pepper	50
Banana	50
<b>FLUOROMETRIC DETERMNATION OF GIBBERELLIN</b>	51
Gibberellin	52
<b>SUMMARY, CONCLUSION AND RECOMMENDATION</b>	60
<b>LITERATURE CITED</b>	62
<b>APPENDICES</b>	67

## LIST OF FIGURES

FIGURE	TITLE	PAGE
1	Collected diseased samples: (A) corn ear rot, (B) fruit rot of melon, (C) twister disease of onion, (D) anthracnose disease of pepper, (E) bakanae disease of rice, (F) crown rot of banana	17
2	Colony growth of isolated species of <i>Gibberella</i> and <i>Fusarium</i> in PDA medium. Species of <i>Gibberella</i> isolated from corn in areas of: (A) San Leonardo, (B) Talugtug, and (C) Talavera; from melon in (D) Quezon; from onion in areas of (E) Bongabon, (F) San Jose, and (G) Sto. Domingo; and from rice in (H) Gapan. <i>Fusarium</i> sp. isolated from melon in areas of (I) Guimba and; (J) Lupao; from pepper in areas of (K) San Leonardo and (L) Gapan; from rice in areas of (M) San Leonardo and (N) Penaranda; and banana from (O) Muñoz	19
3	Pathogenicity set-up on melon: (A) injured melon, (B) circle marks on melon was inoculated with 20 $\mu$ L fungal suspension, (C) melon covered with plastic bag and sealed with rubber band, (D) Inoculated fruit incubated inside the plastic bag in a tray	21
4	Pathogenicity set up on corn: (A) inoculation sites, circle marks, on corn ear inoculated with fungal suspension, (B) inoculated fruits on petri dish bottom on a basin of water, inoculated fruits covered with plastic bag, (C) inoculated corn ear incubated inside plastic bag in a tray	21
5	Pathogenicity set up on pepper: (A) inoculation sites, circle marks on, pin pricked pepper inoculated with 20 $\mu$ L fungal suspension, (B) inoculated fruits covered with plastic bag, inoculated fruits incubated inside plastic bag in a tray	22
6	Pathogenicity set-up on banana: (A) inoculation sites, circular marks on pin pricked banana crown, inoculated with 20 $\mu$ L fungal suspension, (B) inoculated crown covered with plastic bag, (C) inoculated crown incubated inside plastic bag in a tray	22
7	Pathogenicity set-up on: (A) onion sprayed with 50ml fungal suspension, (B) inoculated onion seedling covered with plastic bag and incubated inside the screen house	23

8	Pathogenicity set-up on rice: (A) rice seedlings sprayed with 50ml fungal suspension. Covered with plastic bag, and (B) incubated inside the screen house	23
9	(A) Reagents for ICI, (B) Dissolving of all reagents in a 1500 ml sterile distilled water, and (C) mixture of fungal isolates and 250 ml 10% ICI medium incubated at 30°C orbital shaker	24
10	Serial dilution set up	25
11	Standard curve for gibberellin production	26
12	(A) Mixture of culture medium 96%, ethanol and equal volumes of sulphuric acid and ethanol, (B) Incubation in a refrigerated shaker for 30 minutes	27
13	(A) Promega Quantifluor Fluorometer, (B) powdered GA3, (C) equal volume of ethanol and sulphuric acid	28
14	<i>Fusarium</i> sp. from Lupao; (A) growing on the surface of the melon fruit, (B) colony growth on PDA medium, (C) photomicrograph showing (1) micro-conidia. and (2) macro-conidia from a 14 day old culture	29
15	<i>Gibberella</i> sp. isolated in Quezon; (A) growing on the surface of inoculated melon, (B) Colony growth on plated medium, (C) photomicrograph of ovate meiospores	30
16	<i>Fusarium</i> sp. from Guimba; (A) growing on the surface of the melon fruit, (B) colony growth on PDA medium, (C) photomicrograph showing micro (1) and (2) macro-conidia	31
17	<i>Fusarium</i> sp. from San Leonardo; (A) growing on the surface of pepper fruit, (B) colony growth on PDA medium, (C) photomicrograph showing micro (1) and (2) macro-conidia	32
18	<i>Fusarium</i> sp. from Gapan; (A) growing on the surface of pepper, (B) colony growth on PDA medium, (C) photomicrograph showing (1) micro and (2) macro-conidia	33
19	<i>Gibberella</i> sp. on corn from Talugutg; (A) fungal growth on the tip of the corn, (B) colony growth on PDA medium, (C) photomicrograph showing the spores of a 14 day-old culture	34

20	<i>Gibberella</i> sp. on corn from San Leonardo; (A) fungal growth on the tip of the corn, (B) colony growth on PDA medium, (C) photomicrograph showing the spores of a 14 day-old culture	35
21	<i>Gibberella</i> sp. on corn from Talavera; (A) fungal growth on the tip of the corn, (B) colony growth on PDA medium, (C) photomicrograph showing the spores of a 14 day-old culture	36
22	<i>Gibberella</i> sp. from Bongabon; (A) onion infected with <i>Gibberella</i> sp., (B) colony growth on PDA medium, (C) photomicrograph showing the spores of a 14 day-old culture	37
23	<i>Gibberella</i> sp. from Bongabon; (A) onion infected with <i>Gibberella</i> sp., (B) colony growth on PDA medium, (C) photomicrograph showing the spores of a 14 day-old culture	38
24	<i>Gibberella</i> sp. from Santo Domingo; (A) onion infected with <i>Gibberella</i> sp., (B) colony growth on PDA medium, (C) photomicrograph showing the spores of a 14 day-old culture	39
25	<i>Fusarium</i> sp. from San Leonardo; (A and B) infected rice, circular mark on figure mycelial growth arising from its base, (C) colony growth on PDA medium, (D) photomicrograph showing (1) micro-conidia (2) macro-conidia of a 14 day-old culture	40
26	<i>Fusarium</i> sp. from Peñaranda; (A and B) infected rice, circular mark on figure A showing mycelial growth arising from its base (C) colony growth on PDA medium (D) photomicrograph showing (1) micro-conidia (2) macro-conidia of a 14 day-old culture	41
27	<i>Gibberella</i> sp. from Gapan; (A and B) infected rice with <i>Gibberella</i> sp., circular mark on figure showing mycelial growth arising from its base (C) colony growth on PDA medium, and (D) photomicrograph showing the spores of a 14 day-old culture	42
28	<i>Fusarium</i> sp. from Muñoz; (A) fungal growth on the surface of the banana crown, (B) colony growth on PDA medium, (C) photomicrograph showing (1) micro and (2) macro-conidia	43
29	Uninjured crop inoculated with <i>Fusarium</i> sp.; (A) banana from Muñoz, and, (B) melon from Guimba and, (C) Quezon; (D) <i>Gibberella</i> sp. in corn from, Talavera and, (E) Talugtug	45

30	Uninjured crops inoculated with (A and B) <i>Fusarium</i> sp. (C,D,E,F) <i>Gibberella</i> sp.	46
31	Colony of <i>Gibberella</i> sp. from corn; (A) San Leonardo, (B) Talavera, and (C) Talugtug	47
32	Colony of <i>Gibberella</i> sp. from onion; (A) Santo Domingo, (B) San Jose, (C) Bongabon	48
33	Colony of <i>Fusarium</i> sp. from melon; (A and B) Lupao and Guimba, (C) <i>Gibberella</i> sp. from Quezon	49
34	Fungal isolates from rice; (A) Gapan ( <i>Gibberella</i> ), (B) San Leonardo ( <i>Fusarium</i> ) and, (C) Penaranda ( <i>Fusarium</i> )	49
35	Isolates from pepper; (A) <i>Fusarium</i> from San Leonardo, (B) <i>Gibberella</i> from Gapan	50
36	<i>Fusarium</i> sp. from banana from Muñoz	51
37	Gibberellin production of <i>Gibberella</i> from different crops from municipalities of Nueva Ecija at 49 days of incubation	53
38	Gibberellin production of <i>Fusarium</i> from different crops from 6 municipalities of Nueva Ecija at 49 days of incubation	54
39	Gibberellin production of <i>Gibberella</i> sp on; corn from Talavera, Talugtug and San Leonardo; onion from San Jose, Sto. Domingo and Bongabon; melon from Quezon, and rice from Gapan Nueva Ecija at 28-56 days of incubation	55
40	Gibberellin production of <i>Fusarium</i> sp; melon from Lupao and Guimba, rice from Peñaranda and San Leonardo, banana from Science City of Muñoz and pepper from San Leonardo and Gapan, Nueva Ecija at 28 to 56 days of incubation	57

## LIST OF APPENDIX

APPENDIX	TITLE	PAGE
A	Composition of Medium	68
B	Operation of Fluorometer	69

## LIST OF APPENDIX TABLES

APPENDIX NO.	TITLE	PAGE
1	Percent (%) Disease Incidence on injured crops	70
2	Percent (%) Disease Severity on injured crops	70
3	Percent (%) Disease Incidence on uninjured crops	71
4	Percent (%) Disease severity uninjured crops	71
5	GA3 standard concentration	72
6	GA3 concentration (mg/ml) of trial I at 28 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	72
7	GA3 concentration (mg/ml) of trial I at 28 days of incubation of <i>Fusarium</i> sp isolates from rice, pepper and banana	73
8	GA3 concentration (mg/ml) of trial II at 28 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	73
9	GA3 concentration (mg/ml) of trial II at 28 days of incubation of <i>Fusarium</i> sp isolates from rice, pepper and banana	74
10	GA3 concentration (mg/ml) of trial III at 28 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	74
11	GA3 concentration (mg/ml) of trial III at 28 days of incubation of <i>Fusarium</i> sp isolates from rice, pepper and banana	75
12	Mean of GA3 concentration (mg/ml) of <i>Gibberella</i> isolates of all trials (I, II, III) at 28 days of incubation	75
13	Mean of GA3 concentration (mg/ml) of <i>Fusarium</i> isolates of all trials (I, II, III) at 28 days of incubation	76

14	GA3 concentration (mg/ml) of trial I at 35 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	76
15	GA3 concentration (mg/ml) of trial I at 35 days of incubation of <i>Fusarium</i> sp isolates from corn, onion, melon and rice	77
16	GA3 concentration (mg/ml) of trial II at 35 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	77
17	GA3 concentration (mg/ml) of trial II at 35 days of incubation of <i>Fusarium</i> sp isolates from corn, onion, melon and rice	78
18	GA3 concentration (mg/ml) of trial III at 35 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	78
19	GA3 concentration (mg/ml) of trial III at 35 days of incubation of <i>Fusarium</i> sp isolates from corn, onion, melon and rice	79
20	Mean of GA3 concentration ( mg/ml ) of <i>Gibberella</i> isolates of all trials (I,II,III) at 35 days of incubation	79
21	Mean of GA3 concentration ( mg/ml ) of <i>Fusarium</i> isolates of all trials (I,II,III) at 35 days of incubation	80
22	GA3 concentration (mg/ml) of trial I at 42 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	80
23	GA3 concentration (mg/ml) of trial I at 42 days of incubation of <i>Fusarium</i> sp isolates from corn, onion, melon and rice	81
24	GA3 concentration (mg/ml) of trial II at 42 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	81

25	GA3 concentration (mg/ml) of trial II at 42 days of incubation of <i>Fusarium</i> sp. isolates from corn, onion, melon and rice	82
26	GA3 concentration (mg/ml) of trial III at 42 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	82
27	GA3 concentration (mg/ml) of trial III at 42 days of incubation of <i>Fusarium</i> sp isolates from melon, rice, pepper and banana	83
28	Mean of GA3 concentration ( mg/ml ) of <i>Gibberella</i> isolates of all trials (I,II,III) at 42 days of incubation	83
29	Mean of GA3 concentration ( mg/ml ) of <i>Fusarium</i> isolates of all trials (I,II,III) at 42 days of incubation	84
30	GA3 concentration (mg/ml) of trial I at 49 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	84
31	GA3 concentration (mg/ml) of trial I at 49 days of incubation of <i>Fusarium</i> sp isolates from melon, rice, pepper and banana	85
32	GA3 concentration (mg/ml) of trial II at 49 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	85
33	GA3 concentration (mg/ml) of trial II at 49 days of incubation of <i>Fusarium</i> sp isolates from melon, rice, pepper and banana	86
34	GA3 concentration (mg/ml) of trial III at 49 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	86
35	GA3 concentration (mg/ml) of trial III at 49 days of incubation of <i>Fusarium</i> sp isolates from melon, rice, pepper and banana	87

36	Mean of GA3 concentration ( mg/ml ) of <i>Gibberella</i> isolates of all trials (I,II,III) at 49 days of incubation.	87
37	Mean of GA3 concentration ( mg/ml ) of <i>Fusarium</i> isolates of all trials (I,II,III) at 49 days of incubation.	88
38	GA3 concentration (mg/ml) of trial I at 56 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	88
39	GA3 concentration (mg/ml) of trial I at 56 days of incubation of <i>Fusarium</i> sp isolates from melon, rice, pepper and banana	89
40	GA3 concentration (mg/ml) of trial II at 56 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	89
41	GA3 concentration (mg/ml) of trial II at 56 days of incubation of <i>Fusarium</i> sp isolates from melon, rice, pepper and banana	90
42	GA3 concentration (mg/ml) of trial III at 56 days of incubation of <i>Gibberella</i> sp isolates from corn, onion, melon and rice	90
43	GA3 concentration (mg/ml) of trial III at 56 days of incubation of <i>Fusarium</i> sp isolates from melon, rice, pepper and banana	91
44	Mean of GA3 concentration (mg/ml) of <i>Gibberella</i> isolates of all trials (I,II,III) at 56 days of incubation.	91
45	Mean of GA3 concentration (mg/ml) of <i>Fusarium</i> iolates of all trials (I, II, III) at 56 days of incubation	92

**FLUOROMETRIC DETERMINATION OF GIBBERELIN IN *Fusarium*  
AND *Gibberella* SPECIES COMPLEX INFECTING  
ECONOMIC CROPS IN NUEVA ECIJA<sup>1</sup>**

**By**

**EMMANUEL CAJUCOM NIETO**

**ABSTRACT**

Seven *Fusarium* species and eight *Gibberella* species were isolated in this study, *Fusarium* species were isolated from melon from Lupao and Guimba, rice from Peñaranda and San Leonardo, pepper from San Leonardo, Gapan, and banana from Muñoz. *Gibberella* species were isolated from melon from Quezon, corn from Talavera, Talugtug, and San Leonardo Nueva Ecija, onion from San Jose, Santo Domingo and Bongabon and rice from Gapan. The amount of gibberellin produced by the *Fusarium* and *Gibberella* species were quantified using fluorometer.

The study shows that all isolates produced gibberellin. *Fusarium* species in pepper from Gapan produced the highest amount of gibberellin at 35 days of incubation. Gibberelin production in *Fusarium* decreased at 42 days of incubation, while *Gibberella* isolates from corn produced the highest amount at 35 up to 49 days of incubation. Gibberellin production decreased at 56 days of incubation.

---

<sup>1</sup>An undergraduate thesis manuscript presented in partial fulfillment of the requirements for graduation with the degree of Bachelor of Science in Agriculture major in Crop Protection from Central Luzon State University, Science City of Muñoz, Nueva Ecija. Prepared in the Department of Crop Protection under the supervision of Dr. Ronaldo T. Alberto with Research Contribution No. CA-03-15-0007

## LITERATURE CITED

- AGRIOS, G. N. 2005. Plant Pathology. Department of Plant Pathology. University of Florida. Elsevier Academic Press. 948p.
- AGRICULTURAL PROFILE OF NUEVA ECIJA. 2013. Agriculture Office, Nueva Ecija Provincial Capitol. unpublished data of the Provincial Profile of Nueva Ecija, Old Capitol Palayan City. 6p.
- ALBERTO R.T. 2014. Pathological response and biochemical changes in *Allium cepa* L. (bulb onions) Infected with anthracnose twister disease. Department of Crop Protection, College of Agriculture, Central Luzon State University, Science City of Muñoz Nueva Ecija. Plant Pathology and Quarantine. 4(1): 23-31.
- BARWIK. V. 2003. Preparation of Calibration Curves. A Guide to Best Practice Setting Standard to Analytical Science, Valid Analytical Measurement. Setting Standards in Analytical Science. 30p.
- BLACK, L. L., S. K. GREEN, G. L. HARTMAN and J. M. POULOS. 1986. Pepper Diseases; A Field Guide Asian Vegetable Research and Development Center, Louisiana State University. 24p.
- CALIFORNIA RICE PRODUCTION WORKSHOP. Retrieved on 04-20-15 Retrieved from (<http://ucanr.edu/sites/UCRiceProject/file.pdf>).
- CANDAU, R., J. AVALOS, and E.C. OLMEDO. 1992. Regulation of Gibberellin Biosynthesis in *Gibberella fujikuroi*, Department de Genetica, Universidad de Sevilla, Sevilla, Spain. Plant Physiol. 100:1184-1188.
- CLARRDEC, 2007. Major Diseases of Onion: A Field Guide, Central Luzon Agriculture and Resources Research and Development Consortium (CLARRDEC). Los Baños, Laguna. 11p.
- DESJARDINS, A.E. 2003. *Gibberella* from A (Venaceae) to Z (eae). Mycotoxin Research, National Center for Agricultural Utilization Research, USDA, ARS. Annual Review on Phytopathology. 41:177-198
- DIAGNOSTIC-KEY OF ANTHRACNOSE-TWISTER/CONTROL OF *Gibberella*. Retrieved on November 25 2014 from [plantdoctor.eastwestseed.com/diagnostic-key/anthracnose-twister](http://plantdoctor.eastwestseed.com/diagnostic-key/anthracnose-twister).
- DISADVANTAGES OF FLUOROMETER. Retrieved on 01-25-15 Retrieved from [www.ncbi.org/disadvantagesof fluorescence](http://www.ncbi.org/disadvantagesof fluorescence).

- FLUOROMETRIC APPROACH. Retrieved on 12-27-14, Retrieved from [www.turnerdesign/fluorometer.com](http://www.turnerdesign/fluorometer.com)
- FORUM FOR AGRICULTURAL RISK MANAGEMENT IN DEVELOPMENT. 2014 The rise of Bakanae disease. Retrieved from [www.agriculture.org](http://www.agriculture.org) Retrieved on 12-14-14
- FOX, E. M. and B. J. HOWLET, 2008 Secondary Metabolism: Regulation and Role in Fungal Biology Current Opinion in Micro Biology. 1:482-487
- Fusarium* EPIDEMIOLOGY. Retrieved on November 27 2014, Retrieved from [www.bashanfoundation.org/dilantha/dilanepidemiology](http://www.bashanfoundation.org/dilantha/dilanepidemiology).
- Fusarium* Wilt. Retrieved on November 27 2014, Retrieved from <http://www.plantdoctor.eastwestseed.com/diagnostic-key/fusarium-wilt-0>
- GROENEWALD, S. 2005. Biology, Pathogenicity and Diversity of *Fusarium oxysporum*, f. sp. *cubense*. University of Pretoria. 23p.
- HARSTOCK, A. 2003 Serial Dilution in Microbiology: Calculation, Method and Technique. Retrieved from [www.study.com](http://www.study.com), Retrieved on 05-02-17.
- HEDDEN, P. and L. PHILIPS. 2000. The Role of Gibberellin in Plant Morphogenesis Trends in Plant Science. 5(12):1360-1385. HISTORY OF NUEVA ECIJA. Retrieved on 12-12-14, from [www.wikiPilipinas.ph/Nueva Ecija](http://www.wikiPilipinas.ph/Nueva_Ecija).
- HISTORY OF NUEVA ECIJA. Retrieved on 12-12-14, from [www.wikiPilipinas.ph/Nueva Ecija](http://www.wikiPilipinas.ph/Nueva_Ecija).
- ILHAN, S. 2011 Check list of *Fusarium* sp. Reported from Turkey Ahmet Asan Trakya. University, Faculty of Science Department of Biology, Balkan Campus, Edirne-Turkey, Position in Clasification. 3:116-479.
- INTEGRATED PEST MANAGEMENT. 2009. An IPM Scouting Guide for Common Problems of Cucurbit Crops in Kentucky. Cooperative Extension Service University of Kentucky College of Agriculture, Lexington. 30p.
- JOHNSON, S. W. AND R. C. COOLBAUGH, 1990. Light stimulated Gibberellin Biosynthesis in *Gibberella fujikuroi*, Department of Botany, Iowa State University, Ames, Iowa. Plant Physiol. 94:1696-1701.
- KLITTITCH, C. J. R., J. F. LESLIE, P. E. NELSON, and W. F. O. MARASAS. 1997. *Fusarium thapsinum* (*Gibberella thapsina*): a new species in section Liseola from sorghum. Mycologia. 89: 643-652.

- MALONEK, S., C. BOMKE, E. BORNBERG-BAUERROJAS, M.C. HEDDEN, P. HOPKINS, and P. TUDZYNSKI, 2008. Distribution of Gibberellin Biosynthetic Genes and Gibberellin Production in the *Gibberella fujikuroi* Species Complex. Westfälische Wilhelms-Universität Münster, Institut für Botanik, Schlobgarten, Münster, Germany. *Fungal Genetics and Biology*. 45:1393-1403.
- MUDDAPUR, U.M., M.V. GADKARI, S.M. KULKARNI, P.G. SABANNAVAR, F.N. NIYONZIMA. and S.S. MORE. 2015. Isolation and Characterization of Gibberellic Acid<sup>3</sup> Producing *Fusarium* sp. from Belgaum Agriculture land and its Impact on Green Pea and Rice Growth Promotion. *Aperito Journal of Advanced Plant Biology*. 1(2):1-106.
- LIFE CYCLE OF *Gibberella*. Retrieved on November 25 2014, Retrieved from [cmr.asm.org/content/20/4/695.full.pdf+html](http://cmr.asm.org/content/20/4/695.full.pdf+html)
- NATIONAL STATISTICS OFFICE. 2002. Agricultural Profile Region III. 2013. Table 2 Top Five Temporary Crops in Terms of Area Planted by Province: Central Luzon. [http://psa.gov.ph/files/2013NSO\\_Annual\\_Report.pdf](http://psa.gov.ph/files/2013NSO_Annual_Report.pdf). 10p.
- NIRENBERG, H. I. and K. O'DONNELL. 1998. New *Fusarium* species and combinations within the *Gibberella fujikuroi* species complex. *Mycologia*. 90: 434-458.
- OERKE E. C. 2005 Crop Losses Due to Pest, Institute for Plant Diseases, Rheinische Friedrich Wilhelm Universität Bonn Nussallee Bonn Germany. *Journal of Agriculture Science*. 144:31-43.
- ONION DISEASES. Retrieved on 12-12-14 Retrieved from [http://nhb.gov.in/bulletin\\_files/vegetable/onion/oni002.pdf](http://nhb.gov.in/bulletin_files/vegetable/onion/oni002.pdf).
- ONION INDUSTRY. Retrieved on December 12 2014 Retrieved from [PhilBAS.gov/onion](http://PhilBAS.gov/onion).
- ONION MARKET. Retrieved on November 26 2014, Retrieved from [www.marketmanila.ph/onion](http://www.marketmanila.ph/onion).
- RODRIGUES, C., P.S.V. LUCIANA, H. OSS, TEODORO, J.F., PANDEY, and C.R. SOCCOL. 2009. A New Alternative to Produce Gibberellic Acid by Solid State Fermentation. Departamento de Engenharia de Bioprocessos e Biotecnologia, Universidade Federal do Paraná, Curitiba Brazil. *Brazilian Archives of Biology and Technology*, an international journal. 52:181-188.
- SAMUELS, G. J., H. I. NIRENBERG and K. A. SEIFERT. 2001. Perithecial Species of *Fusarium* In: Summerell, B.A., J.F. Leslie, D. Backhouse and W.L. Bryden. *Fusarium: Paul E. Nelson Memorial Symposium*, APS Press. 65p.

- SAMUELS, G. J., Y. DOI & C. T. ROGERSON. 1990. Hypocreales. *Memoirs of the New York Botanical Garden* 59: 6-108.
- SEIFERT, K. A. 1996. Notes on the typification of *Gibberella zeae*. *Sydowia*. 48: 83-89.
- SPERKS, A. *Fusarium* Root Rot, Institute of Agriculture and Natural Resources, University of Nebraska Lincoln. Crop Watch <http://cropwatch.unl.edu/plantdisease/corn/fusarium-root-rot>.
- SUMMERELL, B. A., B. SALLEH, & J. F. LESLIE. 2003 . A Utilitarian Approach to *Fusarium* Identification. *Plant Disease* 87:117-128.
- SRIVASTAVA, C. A., S. AHAMAD, D. K. AGARWAL. and A. S. SARBHOY. 2003. Screening of Potential Gibberellin Producing *Fusarium* Strains for the Hybrid Rice Production. Indian Agricultural Research Institute, New Delhi, India. *Food, Agriculture and Environment*. 1(2):250-253.
- SWEETS, L. 2008. Integrated Pest Management Corn Diseases, College of Agriculture Food and Natural Resources, Plant Protection Program. 6:5-8.
- TAGACA, M. V. 2014. Detection of Gibberellin Production in *Fusarium* and *Gibberella* Species Complex Infecting Economic Crops in Nueva Ecija, Unpublished Undergraduate Thesis, Department of Crop Protection, College of Agriculture Central Luzon State University. 60p.
- TRONCOSO, C., X. GONZALEZ, C. BOMKE, B. TUDZYNSKI, F. GONG, P., HEDDEN, and M. C. ROXAS. 2010. Laboratorio de Bioorganica, Departamento de Quimica, Facultad de Ciencias, Universidad de Chile. *Phytochemistry*. 71:1322-1331.
- UTHANDI, S., S. KARTHIKEYAN, and K. G. SABARINATHAN. 2010. Gibberellic Acid Production By *Fusarium fujikuroi* SG2. Department of Microbiology and Cell Science, University of Florida, Museum Rd, Gainesville, Fl, USA. *Journal of Scientific and Industrial Research*. 69:211-214.
- VICENTE, L. P. 2014 Evolution of *Fusarium* Taxonomy: Morphological, Biological and Phylogenetic Diagnostic Concepts Instituto De Investigaciones De Cenidad Vegetal <http://fao.org/file/admin/templates/agphome/evolution>.
- VICENTE, L. P., M. A. DITA and E. M. DELA-PARTE. 2014. Technical Manual Prevention and Diagnostic of *Fusarium* Wilt caused by *Fusarium oxysporum* f. sp. *cubense*. Tropical Race (T4). Instituto De Investigaciones De Cenidad Vegetal. Food and Agriculture Organization of the United Nation. 30p.

- VITTAL, R. J., S.HAUDENSHIELD and G. L. HARTMAAN. 2012. A Multiplexed Immunofluorescence Method Identifies *Phakopsora pachyrhizi* Urediniospores and Determines Their Viability, *Mycology* 102:1143-1152.
- WOPERIES. 2009 Major Diseases in Rice PLAR-IRM Curriculum Technical Manual 3. <http://www.Africarice.org/publications/PLAR/techmanual/reference24.pdf>.
- ZWEIG, G., and J. E. DEVAY. 1959. On the biosynthesis of gibberellins from carbon-14-substrates by *Fusarium moniliforme*. *Mycologia*. 51: 877-886.