

**DETECTION, SPATIAL TRACKING, DAMAGE AND YIELD ASSESSMENT
AND MAPPING OF ANTHRACNOSE TWISTER OF ONION USING
REMOTE SENSING TECHNOLOGY IN GABALDON,
NUEVA ECILJA**

LIMMUEL O. MACABANTE

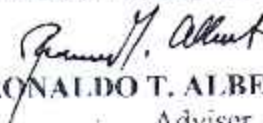
An Undergraduate Thesis Manuscript Submitted to the Faculty of the Department of
Crop Protection, College of Agriculture, Central Luzon State University,
Science City of Muñoz, Nueva Ecija, Philippines
in Partial Fulfillment of the Requirements
for the Degree of

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

JUNE 2019

ACCEPTANCE SHEET

This undergraduate thesis manuscript entitled "DETECTION, SPATIAL TRACKING, DAMAGE AND YIELD ASSESSMENT AND MAPPING OF ANTHRACNOSE TWISTER OF ONION USING REMOTE SENSING TECHNOLOGY IN GABALDON, NUEVA ECIJA," prepared and submitted by LIMMUEL O. MACABANTE, in partial fulfillment of the requirements for the degree of BACHELOR OF SCIENCE IN AGRICULTURE (CROP PROTECTION-Plant Pathology), is hereby accepted:


RONALDO T. ALBERTO, Ph.D.
Adviser

6/7/19
Date Signed



CELYNNE O. PADILLA, M.Sc.
Critic

6/7/19
Date Signed

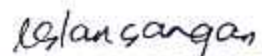

CELYNNE O. PADILLA, M.Sc.
Department Research Coordinator

6/7/19
Date Signed

Accepted as the final fulfillment of the requirements for the degree of BACHELOR OF SCIENCE IN AGRICULTURE (CROP PROTECTION-Plant Pathology)


RONALDO T. ALBERTO, Ph.D.
Chair, Department of Crop Protection

6/7/19
Date Signed


EDILYN V. LANSANGAN, Ph.D.
College Research Coordinator

8 June 2019
Date Signed


ERNESTO A. MARTIN, Ph.D.
Dean, College of Agriculture

6-8-19
Date Signed

BIOGRAPHICAL SKETCH

The author was born on September 24, 1999 at the remarkable land of Gapan City. He is the fourth son of Ronald F. Macabante and Arlene O. Macabante.

He took the first step of his education in Marelo Elementary school located at their Barangay and completed in 2010. He decided to take his secondary education at San Roque National High School where he discovered and found out his sole of interest which were in the field of science and mathematics. High school life taught him many things about compassion and trusting himself and others is enough to finish his race. He graduated as 3rd honorable mention in the year 2015.

Finishing his studies in prestigious university is one of his dreams. He decided to take Bachelor of Science of Agriculture in Central Luzon State University carrying the scholarship from ESGP-PA. Soon after, he had chosen Crop Protection as his major field and Plant pathology as his specialization. He knew that in this field, he can maximize his own potential and to learn the most amazing things in the world of studies.

During his stay in CLSU, he has been part of Pest Management Society; a college based organization which helped him enhanced his different capabilities and skills towards the improvement of his own self.

ACKNOWLEDGEMENT

First of all, the author would like to thank Almighty God for the strength, wisdom, and knowledge he gave to him during the toughness times and for bringing the persons which he needed most for the quality of this study.

The author would like express his sincere gratitude to his adviser, Dr. Ronaldo T. Alberto for providing invaluable guidance, comments and suggestions throughout course of his study; to her critic Ms. Celynne O. Padilla for her constructive criticisms for the betterment of this study.

To the faculty and staff of Crop Protection Department, for their support and some advices they have shared while pursuing this study.

Also, the author would like to thank Dr. Annie Melinda Paz-Alberto, the director of the Institute of Climate Change and Environmental Management (ICCEM) for her permission for allowing him to avail technical assistance to the staff of Phil-LIDAR Processing Center, especially to Mr. Romnick Tagaca, Mr. Kevin Manipon, Ms. Karla Trisha Alejandro, Mr. Miguelito Isip, and Mr. Ariel Biagtan and for allowing him to used their Personal Computer while doing this study

To my amazing colleagues whom he treated just like his brothers: Jerome, Adrian, Rogelio, Carlos, for being his “bespren” from the very start of his journey in college up until now and to his ever supportive Crop Prot. Fam. For all the encouragement, immeasurable happiness, and care and for the indescribable friendship they have offered to him.

Acquisition of Data Sets/Images	23
Data Processing Workflow	24
Image Pre-processing	24
Crop Mapping	25
Generation of Spectral Indices	25
Anomaly Detection	26
Field/Crop Scouting	26
Field Validation	26
Sampling of Diseases	27
Determination of Percent Disease Incidence and Severity Level	27
Accuracy Assessment	27
RESULTS AND DISCUSSION	29
Description of the Study Area	29
Field Data Gathering	32
Varieties Planted, Pesticides, and Methods of Planting Crops in Surveyed Areas	32
Processing of Spectral Data	33
Survey Maps of Anthracnose-Twister of Onion	34
Damage and Surveillance of Anthracnose-Twister in Different Barangays of Gabaldon, Nueva Ecija	44
Remotely Sensed Imagery from Unmanned Aerial Vehicle (UAV)	51
Yield Assessment	53
SUMMARY, CONCLUSION AND RECOMMENDATION	55
LITERATURE CITED	58
APPENDICES	62

LIST OF TABLES

TABLE		PAGE
1	Physiological reflectance indices	22
2	Rating scales for onion anthracnose-twister	28
3	Estimated onion production in Gabaldon, Nueva Ecija	54

16	Final survey of anthracnose-twister of onion in fields of Gabaldon, Nueva Ecija	43
17	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Bagong Sikat Gabaldon, Nueva Ecija	44
18	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Bantug Gabaldon, Nueva Ecija	45
19	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Bantug Gabaldon, Nueva Ecija	46
20	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Calabasa Gabaldon, Nueva Ecija	47
21	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Camachile Gabaldon, Nueva Ecija	48
22	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Ligaya Gabaldon, Nueva Ecija	49
23	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Tagumpay Gabaldon, Nueva Ecija	50
24	Normalized Difference Vegetation Index (NDVI) image in Brgy. Bagong Sikat, Gabaldon, Nueva Ecija	52

16	Final survey of anthracnose-twister of onion in fields of Gabaldon, Nueva Ecija	43
17	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Bagong Sikat Gabaldon, Nueva Ecija	44
18	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Bantug Gabaldon, Nueva Ecija	45
19	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Bantug Gabaldon, Nueva Ecija	46
20	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Calabasa Gabaldon, Nueva Ecija	47
21	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Camachile Gabaldon, Nueva Ecija	48
22	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Ligaya Gabaldon, Nueva Ecija	49
23	Disease progress of anthracnose-twister of onion (incidence and severity) in Brgy. Tagumpay Gabaldon, Nueva Ecija	50
24	Normalized Difference Vegetation Index (NDVI) image in Brgy. Bagong Sikat, Gabaldon, Nueva Ecija	52

LIST OF APPENDIX TABLE

APPENDIX TABLE		PAGE
1	The coordinates, incidence and severity level of infected plants samples.	63

LIST OF APPENDIX FIGURES

APPENDIX FIGURE		PAGE
1	First to fifth survey of anthracnose-twister of onion in fields of Brgy. Bagong Sikat Gabaldon, Nueva Ecija	67
2	Sixth survey of anthracnose-twister of onion in fields of Brgy. Bagong Sikat Gabaldon, Nueva Ecija	68
3	Seventh survey of anthracnose-twister of onion in fields of Brgy. Bagong Sikat Gabaldon, Nueva Ecija	69
4	Eight survey of anthracnose-twister of onion in fields of Brgy. Bagong Sikat Gabaldon, Nueva Ecija	70
5	Ninth survey of anthracnose-twister of onion in fields of Brgy. Bagong Sikat Gabaldon, Nueva Ecija	71
6	Tenth survey of anthracnose-twister of onion in fields of Brgy. Bagong Sikat Gabaldon, Nueva Ecija	72
7	First to fifth survey of anthracnose-twister of onion in fields of Brgy. Bantug Gabaldon, Nueva Ecija	73
8	Sixth survey of anthracnose-twister of onion in fields of Brgy. Bantug Gabaldon, Nueva Ecija	74
9	Seventh survey of anthracnose-twister of onion in fields of Brgy. Bantug Gabaldon, Nueva Ecija	75
10	Eight survey of anthracnose-twister of onion in fields of Brgy. Bantug Gabaldon, Nueva Ecija	76
11	Ninth survey of anthracnose-twister of onion in fields of Brgy. Bantug Gabaldon, Nueva Ecija	77
12	Tenth survey of anthracnose-twister of onion in fields of Brgy. Bantug Gabaldon, Nueva Ecija	78
13	First to fifth survey of anthracnose-twister of onion in fields of Brgy. Bugnan Gabaldon, Nueva Ecija	79
14	Sixth survey of anthracnose-twister of onion in fields of Brgy. Bugnan Gabaldon, Nueva Ecija	80

15	Seventh to tenth survey of anthracnose-twister of onion in fields of Brgy Bugnan Gabaldon, Nueva Ecija	81
16	First to fourth survey of anthracnose-twister of onion in fields of Brgy. Calabasa Gabaldon, Nueva Ecija	82
17	Fifth survey of anthracnose-twister of onion in fields of Brgy. Calabasa Gabaldon, Nueva Ecija	83
18	Sixth survey of anthracnose-twister of onion in fields of Brgy. Calabasa Gabaldon, Nueva Ecija	84
19	Seventh survey of anthracnose-twister of onion in fields of Brgy. Calabasa Gabaldon, Nueva Ecija	85
20	Eight survey of anthracnose-twister of onion in fields of Brgy. Calabasa Gabaldon, Nueva Ecija	86
21	Ninth to tenth survey of anthracnose-twister of onion in fields of Brgy. Calabasa Gabaldon, Nueva Ecija	87
22	First to fifth survey of anthracnose-twister of onion in fields of Brgy. Camachile Gabaldon, Nueva Ecija	88
23	Sixth survey of anthracnose-twister of onion in fields of Brgy. Camachile Gabaldon, Nueva Ecija	89
24	Seventh to eight survey of anthracnose-twister of onion in fields of Brgy. Camachile Gabaldon, Nueva Ecija	90
25	Ninth survey of anthracnose-twister of onion in fields of Brgy. Camachile Gabaldon, Nueva Ecija	91
26	Tenth survey of anthracnose-twister of onion in fields of Brgy. Camachile Gabaldon, Nueva Ecija	92
27	First to fourth survey of anthracnose-twister of onion in fields of Brgy. Ligaya Gabaldon, Nueva Ecija	93
28	Fifth survey of anthracnose-twister of onion in fields of Brgy. Ligaya Gabaldon, Nueva Ecija	94
29	Sixth survey of anthracnose-twister of onion in fields of Brgy. Ligaya Gabaldon, Nueva Ecija	95

30	Seventh survey of anthracnose-twister of onion in fields of Brgy. Ligaya Gabaldon, Nueva Ecija	96
31	Eight survey of anthracnose-twister of onion in fields of Brgy. Ligaya Gabaldon, Nueva Ecija	97
32	Ninth survey of anthracnose-twister of onion in fields of Brgy. Ligaya Gabaldon, Nueva Ecija	98
33	Tenth survey of anthracnose-twister of onion in fields of Brgy. Ligaya Gabaldon, Nueva Ecija	99
34	First to fourth survey of anthracnose-twister of onion in fields of Brgy. Tagumpay Gabaldon, Nueva Ecija	100
35	Fifth survey of anthracnose-twister of onion in fields of Brgy. Tagumpay Gabaldon, Nueva Ecija	101
36	Sixth survey of anthracnose-twister of onion in fields of Brgy. Tagumpay Gabaldon, Nueva Ecija	102
37	Seventh survey of anthracnose-twister of onion in fields of Brgy. Tagumpay Gabaldon, Nueva Ecija	103
38	Eight survey of anthracnose-twister of onion in fields of Brgy. Tagumpay Gabaldon, Nueva Ecija	104
39	Ninth survey of anthracnose-twister of onion in fields of Brgy. Tagumpay Gabaldon, Nueva Ecija	105
40	Tenth survey of anthracnose-twister of onion in fields of Brgy. Tagumpay Gabaldon, Nueva Ecija	106

ABSTRACT

MACABANTE, LIMMUEL O., Department of Crop Protection, College of Agriculture, Central Luzon State University, Science City of Muñoz, Nueva Ecija, Philippines; **June 2019, DETECTION, SPATIAL TRACKING, DAMAGE AND YIELD ASSESSMENT AND MAPPING OF ANTHRACNOSE TWISTER OF ONION USING REMOTE SENSING TECHNOLOGY IN GABALDON, NUEVA ECIJA.**

Adviser: RONALDO T. ALBERTO, Ph.D.

This study was conducted by utilizing remote sensing technology in detection, tracking of anthracnose-twister of onion by mapping the geographical distribution of the disease using Geographical Distribution System (GIS). The 11 Barangays of Gabaldon was surveyed and monitored from January to April 2019 by determining the incidence and severity level of anthracnose-twister in onion fields. As the monitoring progresses, Barangay Calabasa with 107.74 hectares was found to have the highest percentage of incidence in 50.04 hectares (48.24%) and the damage ranging from 50.01%-75.00%. Spectrometer and Unmanned Aerial Vehicle (UAV) determined the deviation in the amount of chlorophyll in plant that corresponds to the physical condition of the plant. Gabaldon has an estimated area of 1,493.46 ha devoted for onion production with an estimated production of 29,869.2 MT. The occurrence and proliferation of the disease was due to favorable environment such as high relative humidity, high wind speed, and low temperature. These factors showed significant roles in the incidence and severity level of the anthracnose-twister in onion fields of Gabaldon, Nueva Ecija.

Keywords: Geographical Information System (GIS); Spectrometer; Unmanned Aerial Vehicle (UAV)

LITERATURE CITED

- Alberto, R. T. (2014). Pathological response and biochemical changes in *Allium cepa* L. (bulb onions) infected with anthracnose-twister disease. *Plant Pathology and Quarantine* 4(1), 23-31, DOI: 10.5943/ppq/4/1/4.\
- Adegoke, J. O., & Carleton, A. M., 2002. Relations between soil moisture and satellite vegetation indices in the U.S. corn belt. *American Meteorological Society*, vol. 3, pp. 395–405.
- Alberto, R. T., & Aquino V. M. (2010). Characterization of *Colletotrichum gloeosporioides* (Penzig) Penzig and Sacc. (Anthracnose) and *Gibberella moniliformis* Wineland (Twister) infecting onions in the Philippines. *Asia Life Sciences*, 19(1) 1–36.
- Ali, A. K. 2010. Remote sensing, 1st ed. Republic of Iraq Ministry of Higher Education and Scientific Research University of Technology. Laser Branch Department of Applied Sciences University of Technology, 33 pp.
- Apan, A., Datt, B., and Kelly, R. (2005). Detection of pests and diseases in vegetable crops using hyperspectral sensing: A comparison of reflectance data for different sets of symptoms. ISBN 0-9581366-2-9.
- BAS. (2007). Costs and returns of onion productions. Republic of the Philippines, Department of Agriculture, Bureau of Agricultural Statistics. July 2007.
- Campbell, J. B. (1996). Introduction to remote sensing. Second edition. ISBN: 1572300418.
- CENTRAL LUZON AGRICULTURE AND RESOURCES RESEARCH AND DEVELOPMENT CONSORTIUM (CLARRDEC). 2007. Major diseases of onion: A field guide. Los Baños, Laguna: PCARRDDOST, CLARRDEC-CLSU. 18p. – (CLARRDEC Farm Primer No. 02/2007).
- Dean, R., Van kan, J. A., Pretorius, Z. A., Hammond-kosack, K. E., & Di pietro, A., Spanu, P. D., Rudd, J. J., Dickman, M., Kahmann, R., Ellis, J., & Foster, G. D. (2012). The top 10 fungal pathogens in molecular plant pathology. *Mol Plant Pathol* 13: 414-430.
- Dickman, M. B. (1993). *Colletotrichum gloeosporioides*. Retrieved on June 19, 2018 at http://www.extento.hawaii.edu/kbase/crop/type/c/_gloeo.htm#references.
- Ebenebe, A. C. (1980), Onion twister disease caused by *Glomerella cingulata* in northern Nigeria. *Pl. Dis.* 64 : 1030-1032.

- FAO. (2012). World onion production. Food and Agriculture Organization of the United Nations. <http://faostat.fao.org>, accessed June 19, 2018.
- Franklin, P., Pearlstine, L., Dewitt B., Smith S., Watts A., Ifju, P. 2006. Autonomous unmanned aerial vehicle (UAV) for ecological research.
- Fundamentals of remote sensing. Retrieved on June, 29 2018 at https://www.nrcan.gc.ca/sites/www.nrcan.gc.ca/files/earthsciences/pdf/resource/tutor/fundam/pdf/fundamentals_e.pdf
- Gautam, A. K. (2014). *Colletotrichum gloeosporioides*: Biology, pathogenicity and management in India. A Scientific Journals. DOI: 10.4172/2329-955X.1000125.
- Gibberella moniliformis*. Retrieved on June 26, 2018 at <http://www.metapathogen.com/gibberella>
- Griffiths, G., Trueman, L., Crowther, T., Thomas, B., & Smith, B. (2002). Onions: a global benefit to health. *Phytother Res*, 16(7):603–615.
- Harmon, T., Kvie, C., Mulla, D., Hoggenboom, G., Judy, J., & Hook, J. 2005. Precision agriculture scenario. In P. Arzberger (Ed), NSF workshop on sensors for environmental observatories. Baltimore, MD, USA: World tech. Evaluation Center.
- Hosseini, G. (2011). Pathogen of the Month- February. Apps Article. Retrieved on July 1, 2018 at <http://www.appsnet.org/pdf/feb11/>
- Hotean, J., Komlan, F. A., Miller, S. A., Winter, S., Reeden, S., & Beed, F. D. (2011). First report of anthracnose caused by *Colletotrichum gloeosporioides* on Onion (*Allium cepa*) in Benin. *New Disease Reports* (2011) 23,7. DOI: 10.5197/J.2044.0588.2011.023.007.
- Introduction to remote sensing. Retrieved on July 1, 2018 at http://www.ccpo.edu.edu/SEES/veget/class/Chap_5/5_3.htm
- Kerr, J. T., & Ostrovsky, M. 2003. From space to species: ecological applications for remote sensing. *Trends in Ecology and Evolution*, vol. 18, pp. 299–305.
- Kunwar, S. 2014. *Colletotrichum gloeosporioides*. BUGWOOD Wiki.
- Larson, W., & Roberti, P. 1991. Farming by soil. *Soil management for sustainability*, 103-112.

- Labilerte, A., Rango, A., Slaughter, A. 2006. Unmanned aerial vehicle (UAVs) for rangeland remote sensing. Proc. 3rd annual symposium research insights in semiarid ecosystem RISE. USDA-ARS Walnut Experimental Watershed.
- Lutman, P. J. W., & Perry, N. H. (1999). Methods of weed patch detection in cereal crops. In: Weeds, 1-3, Brighton Conference, British Crop Protection Council, UK, pp 627-634.
- Mishra, R. K., Jaiswal, R. K., Kumar, D., Saabale, P. R., & Singh, A. (2014). Management of major diseases of onion and garlic: A comprehensive review. Academic Journals, 6 (11) 160-170. DOI: 10.5897/JPBCS2014.0467.
- Moran, M. S., Inoue, Y., & Barnes, E. M. (1997). Opportunities and limitations for image-based remote sensing in precision crop management. Remote Sens. Environ., 61: 319- 346.
- “Municipal Profile”. Retrieved on June 19, 2018 at <http://gabaldon.gov.ph/wp-content/uploads/2016/02/MUNICIPAL-PROFILE-updated-.pdf>
- Onion (*Allium cepa* L.)-Twister. Pest Management Handbooks. Retrieved on June 19,2018 at <https://pnwhandbooks.org/plantdisease/host-disease/onion-allium-cepa-twister>
- Pascual, M.P., Lorenzo, G. A., & Gabriel, A. G. (2018). Vertical farming using hydroponic system: Toward a sustainable onion production in Nueva Ecija, Philippines. Open Journal of Ecology, 8, 25-41
- Peregrine, W. T. H, (1970), A Serious disease of Annats Caused by *Glottierclln cingzilntn* - Pans 16: 331-333.
- PHILIPPINE DAILY INQUIRER. 2016. FAST FACTS: Onion growing in Nueva Ecija. Retrieved on June 19, 2018 at <http://newsinfo.inquirer.net/762430/fast-facts-onion-growing-in-nueva-ecija#ixzz5Ik01sDjZ>
- Rajintha, G. (2016). Hyperspectral radiometry: An introduction and methodology. Published by; Canadian research publication: ISBN : 978-1-68418-558-0.
- Selvaraj, S. (1976). Onion: Queen of the kitchen. Kisan World, 3(12) 32–34.
- Sharma, M., & Kulshrestha, S. (2015). *Colletotrichum gloeosporioides*: An athracnose causing pathogen of fruits and vegetable, 12(2), Proof. DOI: 10.13005/bbra/1776.

- Takebe, M., Yoneyama, T., Inada, K., & Murakami, T. (1990). Spectral reflectance ratio of rice canopy for estimating crop nitrogen status. *Plant Soil*. 122: 295-297.
- White, L. P., 1997. Aerial photography and remote sensing for soil survey. Oxford: Clarendon Press, 104 pp.
- Yadav, S. K., Raj, S., & Roy, S. S. (2013). Remote sensing technology and its applications. *International Journal of Advancements in Research & Technology*, 2:2278-7763.
- Yiding, H. 2009. An autonomous unmanned aerial vehicle-based imagery system development and remote sensing images classification for agricultural applications. Utah State University.
- Zhang, M., Liu, X., & Oncill, M. (2002). Spectral discrimination of *Phytophthora infestans* infection on tomatoes based on principal component and cluster analyses. *Int. J. Remote Sens.*, 23: 1095-1107.
- Zhang., Wang, M., & Wang, N. 2002. Precision agriculture-a worldwide overview. *Computers and electronics in agriculture*, 36(2), 113-132.