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Table of contents

	pp
ACKNOWLEDGEMENTS	i
Table of contents	iii
List of Abbreviations	x
List of Tables	xiii
List of Figures	xiv
List of Plates	xvii
English Abstract	xviii
Arabic Abstract	xxi
CHAPTER ONE: INTRODUCTION	1
CHAPTER TWO: LITEATURE REVIEW	4
2.1. Parasitic plants	4
2.2. Parasitic plants as agricultural pests.....	5
2.2.1. <i>Striga</i>	6
2.2.2. Germination stimulants.....	9
2.2.3 Control measures.....	13
2.2.3.1. Hand weeding.....	14
2.2.3.2. Crop rotation.....	15
2.2.3.3. Suicidal germination.....	16
2.2.3.4. Improving soil fertility.....	17
2.2.3.5. Fumigants.....	19
2.2.3.6. Herbicides.....	19
2.2.3.7. Biological control.....	21
2.2.3.7.1. Insects.....	21
2.2.3.7.2. Fungi.....	22

2.2.3.8. Resistant crop cultivars.....	25
2.2.3.9. Allelopathy.....	26
CHAPTER THREE: MATERIAL AND METHODS.....	28
3.1. General.....	28
3.1.1. Laboratory experiments.....	28
3.1.1.1. Source of fungal isolates.....	28
3.1.1.2. Preparation of <i>Fusarium</i> cultures.....	28
3.1.1.3. Preparation of inoculum of <i>Fusarium</i> isolate 2 on maize grain...	29
3.1.1.4. Preparation of mesquite compost.....	30
3.1.1.5. <i>Striga</i> seeds cleaning and surface sterilization (disinfection).....	30
3.1.1.6. Preparation of <i>Striga</i> seeds packets.....	30
3.1.1.7. <i>Striga</i> seeds pre- conditioning.....	31
3.1.1.8. Germination assay.....	31
3.1.1.9. Effects of conditioning in <i>Fusarium</i> isolates cultures on <i>Striga</i> germination and radicle length.....	31
3.1.1.10. Effects of alternating conditioning periods in <i>Fusarium</i> cultures and distilled water on <i>S. hermonthica</i> germination and radicle length.....	32
3.1.1.11. Fungal DNA Extraction.....	32
3.1.1.12. 18S rDNA amplification and Sequencing.....	33
3.1.1.13. Effects of amino acids, applied during conditioning, on <i>Striga</i> germination.....	33
3.1.1.14. Effects of tryptophan, applied during conditioning, on <i>Striga</i> germination and radicle length.....	33
3.1.1.15. Effects of Mesquite leaves powder on <i>Striga</i> germination, radicle length and haustorium initiation.....	34

3.1.1.16. Effects of mesquite aqueous extract, applied during conditioning, on <i>Striga</i> germination, radicle length and haustorium initiation.....	34
3.1.1.17. Effects of application time on persistence of active substances in mesquite leave.....	35
3.1.1.18. Effects of time and nature of soil amendments during conditioning on response of <i>Striga</i> seeds to GR24.....	36
3.2. Green house experiments.....	36
3.2.1. General.....	36
3.2.2. Reaction of sorghum genotypes to <i>S. hermothica</i> seedbank size...	37
3.2.3. Effects <i>Fusarium</i> inoculum size and <i>Striga</i> seedbank on parasitism and sorghum performance.....	37
3.3.3. Effects of <i>Fusarium</i> and nitrogen fertilizer on <i>Striga</i> incidence and sorghum performance.....	37
3.3.4. Statistical analysis.....	38
CHAPTER FOUR: RESULTS.....	39
4.1. Laboratory experiments.....	39
4.1.1. Effects of conditioning in <i>Fusarium</i> isolates cultures on <i>Striga</i> germination and radicle length.....	39
4.1.1.1. Experiment I (Isolate 1-3).....	39
4.1.1.1.1. Effects on <i>Striga</i> germination.....	39
4.1.1.1.2. Effects on radicle length.....	40
4.1.1.2. Experiment II (Isolate 4-7).....	41
4.1.1.2.1. Effects on <i>Striga</i> germination.....	41
4.1.1.2.2. Effects on radicle length.....	42
4.1.2. Effects of alternating conditioning periods in <i>Fusarium</i> cultures	

and distilled water on <i>S. hermonthica</i> germination and radicle length.....	44
4.1.2.1. Effects on <i>Striga</i> germination.....	44
4.1.2.2. Effects on radicle length.....	45
4.1.3.18S rDNA amplification and Sequencing.....	47
4.1.4. Effects of amino acids applied during conditioning on <i>Striga</i> germination.....	47
4.1.5. Effects of tryptophan applied during conditioning on <i>Striga</i> germination and radicle length.....	48
4.1.5.1. Effects on <i>Striga</i> germination.....	48
4.1.5.2. Effects on radicle length	49
4.1.6. Effects of Mesquite leaves powder on <i>Striga</i> germination, radicle length and haustorium initiation.....	50
4.1.6.1. Effects on <i>Striga</i> germination.....	50
4.1.6.2. Effects on radicle length and haustorium initiation.....	51
4.1.7. Effects of mesquite aqueous extract applied during conditioning on <i>Striga</i> germination, radicle length and haustorium initiation.....	53
4.1.7.1. Effects on <i>Striga</i> germination.....	53
4.1.7.2. Effects on radicle length.....	53
4.1.8. Effects of application time on persistence of active substance in mesquite leaves.....	54
4.1.8.1. Effects on <i>Striga</i> germination.....	54
4.1.8.2. Effects on radicle length.....	57
4.1.9. Effects of time and nature of soil amendments during conditioning on response of <i>Striga</i> seeds to GR24.....	59
4.1.9.1. Effects on <i>Striga</i> germination.....	59
4.1.9.2. Effects on radicle length.....	61

4.2. Green house experiments.....	63
4.2.1. General.....	63
4.2.1.1. Season 2008.....	63
4.2.1.1.1. Effects on <i>Striga</i>	63
4.2.1.1.1.1. <i>Striga</i> emergence.....	63
4.2.1.1.1.2. <i>Striga</i> dry weight.....	65
4.2.1.1.2. Effects on sorghum.....	67
4.2.1.1.2.1. Sorghum height.....	67
4.2.1.1.2.2. Sorghum dry weight.....	69
4.2.1.2. Season 2012.....	72
4.2.1.2.1. Effects of <i>Fusarium</i> inoculum size and <i>Striga</i> seedbank size on parasitism and sorghum performance.....	72
4.2.1.2.1.1. Effects on <i>Striga</i>	72
4.2.1.2.1.1.1. <i>Striga</i> emergence.....	72
4.2.1.2.1.1.2. <i>Striga</i> dry weight.....	72
4.2.1.2.1.2. Effects on sorghum.....	74
4.2.1.2.1.2.1. Sorghum height.....	74
4.2.1.2.1.2.2. Sorghum dry weight.....	74
4.2.1.2.2. Effects of <i>Fusarium</i> and nitrogen fertilizer on <i>Striga</i> incidence and sorghum performance.....	75
4.2.1.2.2.1. Effects on <i>Striga</i>	75
4.2.1.2.2.1.1. <i>Striga</i> emergence.....	75
4.2.1.2.2.1.2. <i>Striga</i> dry weight.....	76
4.2.1.2.2.2. Effects on sorghum.....	77
4.2.1.2.2.2.1. Sorghum height	77

4.2.1.2.2.2. Sorghum dry weight.....	79
CHAPTER FIVE: DISCUSSION.....	83
Conclusions.....	100
References.....	102
Annexes.....	125

List of Abbreviations

ABA	Abscisic acid
ACC	1- Aminocyclopropane-1- carboxylic acid
AMF	Arbuscular activity relationship
ALS	Acetolactate synthase
BF	Branching factor
°C	Degree centigrade
CD	Czapek Dox
cm	Centimeter
Con	Control
com	Compost
DAS	Days after sowing
DMAE	Diluted mesquite aqueous extract
DW	Distilled water
EPSP	5-enolpyruvylshikimate-3- phosphate synthase
<i>et al.</i>	And others
F	<i>Fusarium</i> Isolate 2

FC	Field capacity
Fig.	Figure
fed	Feddan
g	gram
GEFP	Glass fiber filter paper
GR24	Synthetic germination stimulant
h	hour
i.d.	Internal diametre
Iso	isolate
Leu	Leucine
kg	Kilogram
L	Liter
MAE	Mesquite aqueous extract
Mes	Mesquite dried leaves powder
mg	milligram
Min	Minute
ml	Milliliter
mM	Mille molar
No.	Number
N ₂	Nitrogen
N0	Zero nitrogen
N1	18.6=40 kg urea/fed
N2	37.2 kg= 80 kg urea/fed
PDA	Potato dextrose agar media
pp	page
ppm	Part per million
rpm	Revolution per minute
Thr	Therionine
Trp	Tryptophan
Tyr	Tyrosine
v/v	Volume over volume
WAS	Weeks after sowing
w/w	Weight over weight
w/v	Weight over volume
μL	Micro liter
μM	Micro molar
%	Percent

List of Tables

	PP
Table 4.1. Effect of mesquite leaves powder on germination and radicle length of <i>Striga</i> in response to GR24.....	52

Table 4.2. Effect of mesquite aqueous extract on <i>Striga</i> germination and radicle length.....	55
Table 4.3. Effects of <i>Fusarium</i> and nitrogen fertilizer (urea) on <i>Striga</i> emergence	78
Table 4.4. Effects of <i>Fusarium</i> and nitrogen fertilizer (urea) on <i>Striga</i> dry weight.....	80
Table 4.5. Effects of <i>Fusarium</i> and nitrogen fertilizer (urea) on sorghum growth under <i>Striga</i> infestation (plant height).....	81
Table 4.6. Effects of <i>Fusarium</i> and nitrogen fertilizer (urea) on sorghum growth under <i>Striga</i> infestation.....	82

List of Figures

	pp
Fig. 2.1. Chemical structures of selected germination stimulants.....	10
Fig.4.1. Effects of conditioning in <i>Fusarium</i> (Isolate 1-3) cultures on <i>S. hermonthica</i> germination.....	40
Fig.4.2. Effects of conditioning in <i>Fusarium</i> (Isolate 1-3) cultures on <i>S. hermonthica</i> radicle length	41

Fig.4.3. Effects of conditioning in <i>Fusarium</i> (Isolate 4-7) cultures on <i>S. hermonthica</i> germination	42
Fig.4.4. Effects of conditioning in <i>Fusarium</i> (Isolate 4-7) cultures on <i>S. hermonthica</i> radicle length	43
Fig.4.5. Effects of alternating conditioning periods in <i>Fusarium</i> culture and distilled water on <i>S. hermonthica</i> germination	45
Fig.4.6. Effects of alternating conditioning periods in <i>Fusarium</i> culture and distilled water on <i>S. hermonthica</i> radicle length	46
Fig.4.7. Effects of amino acids, applied during conditioning, on <i>Striga</i> germination.....	48
Fig.4.8. Effects of tryptophan, applied during conditioning, on <i>Striga</i> germination	49
Fig.4.9. Effects of tryptophan, applied during conditioning, on <i>Striga</i> radicle length.....	50
Fig.4.10. Effects of application time on persistence of active substance in mesquite leaves (assessed by <i>Striga</i> germination).....	56
Fig.4.11. Effects of application time on persistence of active substance in mesquite leaves (assessed by germilings radicle length).....	58
Fig.4.12. Effects of time and nature of soil amendments, during conditioning, on <i>Striga</i> germination.....	60
Fig.4.13. Effects of soil amendments, during conditioning, on <i>Striga</i> germilings radicle length.....	62
Fig. 4.14. Relation between <i>Striga</i> emergence and sorghum genotype as a function of <i>Striga</i> seedbank size.....	64
Fig. 4.15. Effects of <i>Striga</i> seedbank size on <i>Striga</i> emergence	65
Fig. 4.16. Relation between <i>Striga</i> dry weight and sorghum genotype as	

a function of <i>Striga</i> seedbank size.....	66
Fig .4.17. Effects of <i>Striga</i> seedbank size on <i>Striga</i> dry weight	67
Fig. 4.18. Relation between sorghum height and sorghum genotype as a function of <i>Striga</i> seedbank size.....	68
Fig. 4.19. Effects of <i>Striga</i> seedbank size on sorghum height	68
Fig. 4.20. Relation between sorghum dry weight and sorghum genotype as a function of <i>Striga</i> seedbank size.....	69
Fig.4.21. Effects of <i>Striga</i> seedbank size on sorghum dry weight	69
Fig.4.22. Effects of <i>Fusarium</i> inoculum size on <i>Striga</i> emergence.....	73
Fig. 4.23. Effects of <i>Fusarium</i> inoculum size on <i>Striga</i> dry weight.....	73
Fig. 4.24. Effects of <i>Fusarium</i> inoculums size on sorghum height.....	74
Fig. 4. 25. Effects of <i>Fusarium</i> inoculum size on sorghum dry weight....	75

List of plates

	pp
Plate 1.2 <i>Striga</i> life cycle.....	7
Plate 4.1. <i>S. hermonthica</i> induced to germinate by GR24 at 0.1 ppm after conditioning in <i>Fusarium</i> isolates	41
Plate.4.2. <i>S. hermonthica</i> induced to germinate by GR24 at 0.1 ppm subsequent to conditioning in tryptophan	49
Plate.4.3. <i>S. hermonthica</i> induced to germinate by GR24 at 0.01 ppm ...	51
Plate 4.4. Morphological symptoms induced by <i>S. hermonthica</i> in sorghum	71

ABSTRACT

Sorghum (*Sorghum bicolor* L. Moench) is an important crop in Sudanese economy and diet. The area under the crop is increasing, but average yields are, invariably, low. The low yields are attributed, among other factors, to heavy infestations by the root parasitic weed *Striga hermonthica*. Research yielded several control measures. However, most of them are not adopted because of erratic performance or high cost. An integrated approach, in which biological control is deployed as a component is imperative. In the present study a series of laboratory experiments was undertaken at the College of Agricultural Studies, Sudan University of Science and Technology at Shambat in 2008-2012 to develop and integrate biological products in *Striga* management. Seven *Fusarium* spp. and /or variants isolated from diseased *Striga* plants, collected from under rainfed sorghum in Sinar State, were tested for efficacy on *Striga*. The amino acids L-leucine, L-therionine, L- tyrosine and L-tryptophan were tested for ability to suppress *Striga* germination and radicle extension with the intention of employing them to enhance fungal virulence. Nitrogen, mesquite powder and mesquite based compost, each alone and in a combination with *Fusarium* isolate 2, identified as *F. brachygibbosum* employing DNA analysis, were evaluated for their effects on *Striga* germination, radicle extension and premature haustorium initiation. The results were further validated in a series of greenhouse experiments. *Striga* seed bank size and sorghum genotype, used in the greenhouse trials, were pre-determined employing the sorghum genotypes Abu Sabeen, Arfa Gdmak and Wad Baco. *Fusarium* isolate 2 (*F. brachygibbosum*) and the sorghum cultivar Arfa Gdmak were, accordingly, selected for the greenhouse experiments. The fungal isolates displayed

differential effects on germination of *Striga* seeds in response to GR24 and on radicle extension of the resulting germilings. Conditioning in *Fusarium* isolates 2, 3, 4 and 6 cultures, for 10 days or more, reduced germination and radicle length by over 90%. Isolates 1, 5 and 7 were less suppressive. A brief exposure (5 days) to fungal toxins, in an alternating conditioning regime, reduced germination and radicle length significantly. Among the amino acids tested, L-tryptophan was the most suppressive to *Striga* germination and radicle extension. Air-dried mesquite leaves powder and aqueous extract promoted germination at low concentrations, but were inhibitory at high concentrations. Irrespective of concentration, mesquite powder induced pre-mature haustoria. Soil amendments with *F. brachygibbosum*, mesquite powder and mesquite based compost; each alone and in various combinations, reduced *Striga* germination and radicle length. Delayed applications were often more effective than early ones. In the greenhouse experiments *Striga* emergence was highest on Abu Sabeen, lowest on Arfa Gdmak and was positively correlated with the seed bank [$r = 0.84-0.63$ ($P < 0.001$)]. *Striga* dry weight, was highly correlated with the seed bank on Abu Sabeen, and Wad Baco [$r = 0.71$ and 0.91 ($P < 0.001$)], but not on Arfa Gdmak ($r = 0.35$, $P < 0.05$). *Striga* reduced height and dry weight of the three sorghum genotypes. Sorghum height and dry weight were less associated with *Striga* seed bank ($r = -0.49$ to -0.35). *F. brachygibbosum* reduced *Striga* emergence and its effects was modulated by inoculum size and *Striga* seedbank. At the highest fungus inoculum (10mg/kg soil) *Striga* emergence was abolished at the lower seed bank and reduced to 28% at the higher seed bank size. *F. brachygibbosum*, irrespective of inoculum levels and *Striga* seedbank, resulted in sorghum height and dry weight comparable to the parasite free control. Nitrogen at 1 and 2N reduced *Striga* dry weight by 11 and 24%, respectively *F. brachygibbosum*, delayed and suppressed *Striga* emergence and growth considerably. *F. brachygibbosum* at 2 and 10g/kg soil reduced *Striga* dry weight

by 54 and 68%, respectively, while the combinations *F. brachygibbosum* at 2g and 10g/kg soil with nitrogen at 1 and 2N reduced *Striga* dry weight by 26 and 85% and 66 and 84%, respectively. *Striga* reduced sorghum height in a time dependent manner. Unchecked *Striga* infestation reduced sorghum height by 21, 27, 41 and 47% 6, 8, 10 and 12 weeks after sowing (WAS), respectively. Nitrogen and *F. brachygibbosum*, each alone, displayed little and moderate effects, respectively. However, their combinations were more effective. In presence of nitrogen at 2N and *F. brachygibbosum* at 10g/kg soil *Striga* reduced sorghum height by 0, 0, 8 and 12% 6, 8, 10 and 12 WAS, respectively. The trends in sorghum dry weight, despite variability, were similar. The study, unequivocally, showed the importance of *Striga* seedbank as a key factor in determining response to treatments and that the fungus *F. brachygibbosum* effected good suppression of the parasite and ameliorated, to a large extent, the parasite devastating effects on sorghum. The study reported isolation and efficacy of *F. brachygibbosum*, for the first time, from diseased *Striga* plant and suggests the plausibility of deploying the fungus as a possible bioagent in an integrated *Striga* management strategy.

الملخص

الذرة الرفيعة (*Sorghum bicolor* (L.) Moench) من المحاصيل الهامة في مجال الاقتصاد السوداني والامن الغذائي، وبالرغم من التوسع في المساحة الا ان الإنتاج مازال منخفضاً. ورغم تعدد الاسباب الا ان الاصابه بطفيل البودا يعد من الاسباب الرئيسييه لإنخفاض انتاج الذرة. هنالك العديد من المخرجات البحثية لمكافحة الطفيل الا انها لم تلق القبول من المزارع لعدم ثبات الفعاله او لارتفاع التكلفة وعليه فان إدخال المكافحه الاحيائية ضمن مكافحه متكامله للطفيل سيكون اكثر جدوي. اشتملت هذه الدراسه علي تجارب معملية اجريت بكنيه الدراسات الزراعيه جامعه السودان للعلوم والتكنولوجيا في الفتره 2008-2012 بهدف عزل سلالات من فطر الفيوزريم من نباتات بودا مصابه جمعت من ولاية سنارمع اجراء دراسات علي تأثير بعض الاحماض الامينيه العطريه والتي شملت الليوسين، السيريونين التايروسين و التريثوفان علي انبات نبات البودا وطول الجزير بهدف زيادة فعالية الفطر. استخدم مسحوق اوراق المسكيت الذي يحتوي علي تركيز عالي من حمض التريثوفان والسماذ العضوي المصنع من المسكيت وسماذ اليوريا وتأثيره عندما يضاف للفطر. تم التعرف علي نوع الفطر من العزله 2 باستخدام التقانه الاحيائية الجزئييه ووجد انه فطر *F. brachygibbosum* والذي أثر علي انبات بذور البودا، طول الجزير و انتاج الممصات من جذور البودا. هذا وقد تم تأكيد نتائج الدراسات المعملية عن طريق دراسات مشثليه اجريت بكنيه الدراسات الزراعيه- جامعه السودان للعلوم والتكنولوجيا في الفتره 2008-2012. تم تحديد صنف الذره و كمية بذور البودا المستخدمه في الدراسه عن طريق تجربه اشتملت علي صنفي الذره الرفيعه ابو سبعين و ارفع قدمك والسلاله المحليه ود باكو. تم اختيار العزله 2 من الفطر مع صنف ارفع قدمك من اجل الدراسات المشثليه. اظهرت البذور المعامله بعزلات الفيوزريم استجابته مختلفه للمعامله بمنشط الانبات الصناعي GR24. تهيئه البذور في العزلات 2, 3, 4 و 6 لمدته 10 ايام او اكثر أدت الي تثبيط الانبات

وطول الجذير بنسبه تزيد علي 90%. اما العزلات 1, 5 و 7 فقد كانت اقل فعالية عند تهيئه البذور لمدة 5 ايام في نظام تهيئه تبادلتي بين بيئه الفطر والشاهد الخالي من الفطر. هذا وقد كانت بيئه الفطر اكثر فعالية في خفض نسبة إنبات البذور والحد من طول الجذير معنوياً. حمض التريتوفان كان أكثر الأحماض الامينية العطرية فعالية في تثبيط الإنبات والحد من طول الجذير. أدي مسحوق أوراق المسكيت المجففة ومستخلصها المائي إلي إنبات بذور البودا علي المستويات الدنيا (5 - 10 ملجرام/ للخلية) بإستخدام طريقة خلايا الآجار، بينما أدي التركيز الاعلي (15 ملجرام / للخلية) إلي تثبيط الإنبات. كما صاحب الإنبات تكوين ممصات ونتج عنه قصر الجذير. مسحوق المسكيت، سماد المسكيت العضوي وسماد اليوريا كل علي حدة او مخلوط مع عزلة الفيوزريم 2 أدت إلي تثبيط الإنبات والحد من نمو الجذير. تأخير المعاملة بالفطر كان أكثر فعالية من المعاملة المبكرة . اشارت نتائج التجارب بالمشتل الي ان ظهور البودا كان عالياً في صنف ابوسبعين ومنخفضاً في الصنف أرفع قدمك وكان ذو إرتباط موجب مع مخزون بذور البودا [P < 0.001 (r = 0.63 - 0.84)]. الوزن الجاف للبودا كان ذو معامل إرتباط عالي مع مخزون البذور في صنفى أبوسبعين وودباكو [r 0.71 (P < 0.001) and 0.91] أما معامل الإرتباط بالنسبة لارفع قدمك فقد كان أقل (P) 0.05, r = 0.35 >. أدي طفيل البودا إلي انخفاض الطول والوزن الجاف في اصناف الذرة الثلاثة. طول نبات الذرة ووزنها الجاف كان أقل إرتباطاً مع مخزون بذور البودا (r = 0.35- 0.49) الفطر *F. brachygibbosum* أدي إلي الحد من ظهور طفيل البودا , ارتبط ذلك مع حجم لقاح الفطر ومخزون بذور البودا. ظهور البودا في المخزون الاقل من بذور البودا كان منخفضاً وذلك عند استخدام الجرعة العالية من لقاح الفطر (10 ملجرام/ كيلوجرام تربة)، أما في المخزون العالي من بذور البودا فقد انخفض ظهور البودا بنسبة 28%. لم يتأثر طول نبات الذرة المصابة بطفيل البودا ووزنها الجاف باستخدام معدلات مختلفة من لقاح الفطر وذلك مقارنة بالشاهد. التسميد بجرعه او جرعتين من النايتروجين أدي إلي انخفاض الوزن الجاف للبودا بنسبة 11% و 24% علي التوالي. اما الفطر *F.brachygibbosum* فقد أدي إلي تأخير و انخفاض إنباتق ونمو البودا. كما أدي إلي تقليل الوزن الجاف للبودا

بنسب 54 و 68% عند استخدامه بمعدل 2 و 10 جرام/ كيلوجرام تربة علي التوالي. بينما أدي تداخل جرعتي الفطر 2 و 10 جرام/ كيلوجرام تربة مع وحدة ووحدين من سماد النايروجين الي تقليل الوزن الجاف للبودا بنسبة 26 و 85%، 66 و 84% علي التوالي. ارتبط تأثير الاصابة بالبودا علي طول نبات الذرة بالفتره الزمنيه. حيث أدت الإصابة بالبودا الي تقليل طول نبات الذرة بنسب 21، 27، 41 و 47% وذلك بعد 6، 8، 10، و 12 اسبوع من الزراعة. استخدام النايروجين والفيوزريم كل علي حدة أدي إلي تأثير محدود ومتوسط علي الاصابه بالطفيل بينما كان التداخل بين المعاملتين اكثر تأثيراً. عند استخدام جرعتين من نايروجين مع الفطر بمعدل 10 جرام/ كيلوجرام تربة ادت الاصابه بالطفيل الي انخفاض في طول نبات الذره بنسبه 0، 0، 8 و 12% بعد 6، 8، 10 و 12 اسبوع من الزراعة. هذا وقد ساد تأثير المعاملات علي الوزن الجاف للذره سار علي نفس النسق رغم التباين. أوضحت الدراسة أهمية مخزون بذور البودا كعامل رئيسي في تحديد التأثير السالب للطفيل علي نبات الذره وعلي فعالية الفطر. كما أدت الي عزل الفطر *F.brachygibbosum* من نباتات البودا المصابة لأول مرة واثبتت فعاليتها في الحد من الاصابة بالطفيل. كما اقترحت الدراسة امكانية استخدام هذا الفطر في استراتيجيه الادارة المتكاملة للبودا.