## FIRST STEPS TOWARD UNDERSTANDING INSECT PESTS ASSOCIATED WITH QUINOA (*Chenopodium quinoa* Willd.) IN CENTRAL SOUTH AFRICA.

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## Introduction

Quinoa (*Chenopodium quinoa* Willdenow: Amaranthaceae) global expansion has shown continuous acceleration, jumping from 8 countries during 1980 to 95 countries by 2015 (Bazile *et al.* 2016). As a result, quinoa now resides in areas of truly ancient cultivation, medium term cultivation (more than 20 but less than 100 years) and countries of very recent introduction (less than 10 years). According to Bazile *et al.* (2016) global expansion between 2010 and 2015 added 55 countries, which implies that over 58% of quinoa currently cultivated or field tested resorts under "very recently introduced". Serious efforts toward investigating quinoa in South Africa only started during the 2013/14 summer season. Most global introductions also take place into areas where other crops within the Amaranthaceae are already under cultivation. Quinoa's high level of genetic plasticity and the global drive for adaptive cultivar breeding creates a scenario where it might be introduced into ecological zones alien to its native Andes mountain range habitat, with unknown prospects for future pest complex development. Two recent unforeseen pest outbreaks in South Africa highlights possible vulnerability of new *Chenopodium* introductions.

## **Scale of Observations**

Quinoa plantings were limited to the North-West Province and centred on North-West Department of Agriculture and Rural Development (DARD) research farms at Potchefstroom (1340m above sea level) and Taung (1179m above sea level) as well as the Open-Top Chambers Research Facility of the North-West University (Potchefstroom Campus). Insects were randomly sampled from stems, leaves and inflorescences over a five year period. Sampled insects were submitted to the Plant Protection and Health Division of the Agricultural Research Council (Pretoria) when further identification was needed.

## Results

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Table 1: Insect host comparison limited to pest genera occurring on *C. quinoa* only or shared with other cultivated Amaranthaceae species.

Order

Family/ Subfamily

Chenopodium quinoa

Amaranthus spp.

Beta vulgare & Spinacea oleracea

COLUMN AND AND AN ADDRESS OF	Lepidoptera	Noctuidae/ Heliothinae	*Helicoverpa armigera	H. armigera	H. armigera	
		Noctuidae/ Acronictinae	*Spodoptera exigua	S. exigua	S. exigua	
		Noctuidae/ Plusiinae	Cornutiplusia circumflexa	0	0	
			Chrysodeixis acuta	0	0	
1mm		Crambidae	*Spoladea recurvalis	S. recurvalis	S. recurvalis	
Fig. 1 Ahtesapeuta dodonis						
(Top) responsible for total plant						
(Chaetadoretus) transvaalensis (	Coleoptera	Curculionidae	*Athesapeuta dodonis	Ath. dodonis	Ath. dodonos	
(Bottom) responsible for mass			0	Gasteroclisus cuneiformis	G. auricillatus	
defoliation of plants November		Melvridae	Astylus atromaculatus	Δ atromaculatus	0	
		Chrysomelidae/ Cassidinae	Cassida litininsa	C litiniosa	0	
		omysomendae/ Gassianae	*Cassida dorsovittata	C dorsovittata		
/1 Inflorescence		Scarabaoidao/ Putollinao	* Adorotus (Chaotadoratus) transvaalonsis		Adorotus spp	
/ - Flowers		Scalabaeluael Kulelilliae	Auorelus (Criaelauoralus) liansvaalensis	U	Addretus spp.	
- Pollen						
- Grain		Oreillidee	* Nu ciuc notolonoio	N. motolomoio	0	
	nemptera/ neteroptera	Coroldoo	* Clotus hinotulotus	N. Hatalensis	0	
87.5%		Coreidae			U	
			* Cletus ochraceus	C. ochraceus	0	
Occupation	/		^ Cletus varius	C. varius	0	
Occupation		Pentatomidae	*Nezara viridula	N. viridula	0	
			Eysarcoris inconspicuous	E. inconspicuous	0	
			Carbula trisignata	0	0	
		Miridae	*Taylorilygus simonyi	T. simonyi	0	
			Creontiades sp.	Creontiades sp.	0	
			*Eurystylus bellevoyei	E. bellevoyei	0	
2 Leat		Rhopalidae	Agtaphopus bergrothi	0	0	
- Lamina	Hemiptera/ Sternorrhyncha	Aphididae	*Aphis craccivora	A. craccivora	A. fabae	
- Petioles			*Macrosiphum euphorbiae	M. euphorbiae	M. euphorbiae	
50%			Hyadaphis coriandri	0	0	
	Prinsloo & Uys (2015), Scholtz (2016	6), Weeks & Louw (2013)	* Species sampled re	epetatively or responsible for extensive date	mage during single outbreaks.	
Occupation	* To date, 24 potential insec	ct pests were recorded on C	. quinoa (Table 1), with 15 species either	sampled persistently or involve	ed in serious outbreaks.	
	* Low levels of Heteroptera	spp. overlap on <i>B. vulgare</i> a	and <i>S. oleracea</i> (Table 1), possible result	t of niche restriction due to vege	stative stage harvesting.	
	* S. recurvalis and A. cracc	<i>ivora</i> also recognised as <i>C</i> .	quinoa pests in native Andean producti	on areas (Rasmussen <i>et al</i> ., 200	J3).	
	* Genera Helicoverpa and {	Spodoptera are represented	in Andean production areas by several	<i>C. quinoa</i> pest species (Rasmu	, ssen <i>et al</i> ., 2003).	
	* C. guinoa still under-sam	oled in South Africa compare	ed to Amaranthus spp. (26vear pest san	npling). <i>B. vulgare</i> & S. oleracea	a (long term established).	
3 Stem	Value of Biologisc	he Bundesanstalt, Bu	indessortenampt and Chemica	al Industry (BBCH) Phen	ological Scale:	
- Vascular Tissue	✓ Enable similar	sampling norms for investig	ating crops with high genetic plasticity	and rapid expansion into divers	e global ecological zones.	
- Epidermai Tissue	- Epidermal fissue $$ Offers a visual system for development of scouting norms and easy transferral of crop protection principles to farmers.					
16 6%	Scientific Annraisal	- <b>,</b>				
Occupation		use made mandatory for all	Plant Protoction Trials by the Europe	on & Moditorranoan Plant Proto	ction Organisation (EPPO)	
Occupation	(Meier <i>et al.</i> 20	(Meier <i>et al.</i> 2008).				
	$\checkmark$ Sosa-Zuniga $\epsilon$	<i>et al.</i> (2017) adopted 7 out o	of 10 principle growth stages, omitting	stages 3 (stem elongation) and	d 4 (harvestable vegetative	
	parts) for <i>C.</i> q	<i>uinoa.</i> This leaves 3 princ	iple growth stages for vegetative grow	th and 5 principle growth stage	es for reproductive growth	
	(Figure 3).					
	✓ Injuriousness (	Injuriousness of insect pests often linked to plant niche occupation, and plant niche availability is often linked to plant phenology (Figure 2).				
4 Roots	Voqotativo		Done Done	oductive		
0%	vegetative					
Occupation					The second secon	

Fig. 2 Current understanding of plant niche occupation by potential insect pest species (expressed in terms of number of species present) considering all collected species..



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Fig. 3 Visual appraisal of important principal vegetative and reproductive growth stages delineated for *C. quinoa* according to BBCH numerical codes. 0 Germination 1 Leaf development, 2 Side Shoot Development, 5 Inflorescence Emergence, 6 Flowering, 7 Fruit Development, 8 Grain Ripening, 9 Senescence

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