Influence of *Vitellaria Paradoxa* Gaertn Depletion on the Incidence, Abundance and Distribution of *Cirina Forda* Westwood (Lepidoptera: Saturniidae) in Niger State, Nigeria

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Abstract

The pallid emperor moth, *Cirina forda*, is a prominent edible insect in Niger State but currently at great risk of extinction. The incidence, abundance and distribution of *Cirina forda*, was investigated for four consecutive seasons, i.e. May-June 2010, 2011, 2012 and 2013 to ascertain the effect of the depletion of its host plant, Shea butter trees, *Vitellaria paradoxa*. in Niger State, Nigeria. *C. forda* egg clusters located on the host plants were enumerated to ascertain the seasonal abundance by visual counting using hand lenses and binoculars (MARCO-model 750/8 m-988000 m). At each location, 100m² land area in which three 10m² portions were mapped as replicate sites, were investigated for host plant density, egg cluster abundance and distribution within three host plant canopy height ranges. The 41 locations in six Local Government Areas (LGAs) where *C. forda* occurred in Niger State in 2010 were investigated. The result indicated the GPS of each of the locations and showed that Niger state had a very rich but fast dwindling population of *V. paradoxa*. *C. forda* egg cluster abundance across the six LGAs showed Niger state as highly endowed but ephemeral and highly unpredictable, especially in terms of location where they occurred. The egg cluster abundance reduced drastically from 58.1± 12.1 and 56.1±24.1 egg cluster/host plant in 2010 and 2011, respectively to 41.3 ± 8.3 and 29.7 ±5.1 egg cluster/host plant in 2012 and 2013 cropping seasons, respectively. Locational similarities were observed in the trends of *C. forda* host plant density reduction and egg cluster abundance over the four cropping seasons and these were corroborated across the State. The decreasing densities of Shea butter trees was identified as posing serious threats to egg laying by *C. forda*. The possibility of the extinction of *C. forda* was identified as imminent and a conservation approach that stems the indiscriminate destruction of host tree, *V. paradoxa* (Shea butter trees) was proposed.

Keywords: Depletion, Egg clusters, and Host trees.

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INTRODUCTION

The declining status of the univoltine edible pallid emperor moth, *Cirina forda* Westwood (Lepidoptera: Saturniidae) whose

sole host is Shea butter tree, *Vitellaria paradoxa* Gaerten, has raised concerns in recent times (Muhammad, 2017). *C. forda* is a biotic resource that naturally features prominently but restricted to Africa, hence frequently referred to as African Emperor Moth. In West Africa, it is reported in Northern Ghana (Dwomoh, 2002) in Burkina Faso (De Forliat, 1994); Cote d'Ivoire (Malaise, 1997); and in Nigeria (Ande, 1991; Ande and Fasoranti, 1995; Agbidye *et al*, 2009) and particularly reported in Niger State (Ande, 2004; Muhammad and Ande, 2014; and Muhammad, 2017) to portend conspicuous resource with economic and nutritional benefits to Nigerians (Ande, 1991; Agbidye *et al*, 2009). Leleup and Deams (1969) and Boorman (1970) explained that the host relationship between *C. forda* and Shea butter tree is such that the trees supply shelter, protection and food to *C. forda*. Unfortunately, shea butter host trees and wild population of *C. forda* are under serious threats in Niger State, Nigeria. The different locations in Niger State where *C. forda* populations had been sampled earlier by various researchers include Wuya Kanti (Ande, 1991), Bida (Akinawo *et al*, 2002) and Matachibo village (Odebiyi *et al*, 2003). Muhammad (2017) however reported that these locations were completely devoid with no record of occurrence of *C. forda*. The occurrence and abundance of African pallid emperor moth, *C. forda*'s in the wild have in recent times assumed a worrisome status such that their harvest sites have become unpredictable. The life cycle of *C. forda* is synchronized with the phenology of their host plant, *V. paradoxa* (NMRS, 2007). Numerous eggs are laid when the host trees are flourishing so that the feeding caterpillar stages will have enough food (Muhammad, 2017). The extent to which the host tree depletion had impacted on the egg clusters

distribution of *C. forda* in Niger State has not been investigated

Plausible reasons need to be proffered for this negative trend to avert the imminent extinction of this moth., There is therefore a dire need to understand the ecological challenges against the sustenance of *C. forda*. To be able to rectify the dwindling status of this biological resource, as well as, conserve its host plant. The aim of the study was to establish the impact of host tree, *V. paradoxa* on the incidence, abundance and distribution of *C. forda* egg clusters in Niger State.

MATERIALS AND METHODS

Study Area

Niger State of Nigeria has 25 Local Government Areas (LGAs), Figure 1, with annual rainfall ranging from about 1,600mm in the south to 1,200 mm in the north with two distinctive seasons, i.e. dry and wet seasons. There are three major soil types, i.e. Ferruginous tropical, hydromorphic and Ferro sols, the most predominant being ferruginous tropical soils (State Bureau of Statistics, Niger State Planning Commission, 2011).

Figure 1: Map of Niger State showing 25 Local Government Areas (LGAs) and the six LGAs with thriving *C. forda* populations

The occurrence of *C. forda* egg clusters on *V. paradoxa* plants was used to identify 41 locations in six LGAs, with thriving populations in 2010. Each of the locations in Gurara, Katcha, Lapai, Lavun, Paikoro and Rafi LGAs were investigated over four consecutive cropping seasons (2010 - 2013). At each sampling location, 100 m² land mass was mapped out within which three 10m² subunits were randomly mapped as replicate sites. On each site the host plant, *V. paradoxa*, density was determined using the line intercept method (Ayodele *et al*, 1999) and expressed as Mean $\pm$ SD individual/10meter/location as well as per LGA and season.

The numbers of egg clusters were noted on three randomly selected mature *V. paradoxa* plants within each subunit by visual counting with the aid of hand lenses and binoculars (MARCO-model 750/8 m-988000 m) (Muhammad, 2017) in each of the 41 locations and the numbers expressed as Standard Error of the Mean (SEM) of egg clusters/ tree/ location. Same were also expressed per LGA and cropping season. The intensity of egg cluster occurrence at various canopy heights ranges of 0-5m, 5.0 – 10m and 10-30m were also noted on the selected host plants. The mean intensity of occurrence per range was determined per location and expressed as individuals $\pm$ SD per host tree.

The Vegetative physiognomy and human environmental influence in each of the locations were noted during each cropping season.

RESULTS

Table 1 shows the mean density of *C. forda* host plants, *V. paradoxa* at the various locations where *C. forda* occurred in Niger state in 2010 and subsequently over three other consecutive seasons.

Niger state had an encouragingly high overall mean density of 6.9 ± 4.2 host

plant/10m² in 2010. All the LGAs and 41 locations investigated had at least 4.7 *V. paradoxa* density in 2010 season. The densities in Gurara and Katcha LGAs were particularly higher than in the other four LGAs. Quite a number of locations sampled across the state such as Suleman Pnapi in Gurara LGA and Goyinekeni and Kambari in Katcha LGA had prominently higher densities of *V. paradoxa* stands in 2010. Majority of the other locations had a range of between 5 and 10 *V. paradoxa* stands per 10m².

Table 1 also showed that overall density of *V. paradoxa* progressively decreased to 2.9 ± 1.8 host plant/10m² in 2013 season. The losses recorded per season stood at 0.1, 0.5, 3.4 plant stands per 10m² by the turn of the 2011, 2012 and 2013 seasons. The same trend of decrease was recorded in all the LGAs investigated. The worst hit LGAs were Katcha, Gurara and Lavun. More than 60% of the 41 locations sampled had only 1 or 2 surviving *V. paradoxa* stands by the fourth cropping season in 2013. Only Fulani and Galadima settlements Sarkin Fulani and Suleman Pnapi in Gurara LGA, Ebba Ganabigi and Goyinekeni in Katcha LGA, Tsohon Lapai in Lapai LGA and Effun tiffin in Lavun LGA had ≥ 5 *V. paradoxa* host plant stands per 10m².

The mean *C. forda* egg cluster densities on Host Plant, *V. paradoxa* at the various locations where they occurred in Niger state in the 2010 season and over four consecutive cropping seasons are as shown in Table 2. In 2010, Niger state had an overall mean *C. forda* egg cluster density of 56.1 ± 24.1 / host plant at the locations where they occurred. The six LGAs with *C. forda* populations had very rich egg cluster numbers on their host plants. Rafi LGA with least had a mean egg cluster distribution of 1.7 egg clusters per host plant while others, particularly Gurara and Katcha LGAs had egg cluster

distribution rates of above 50 per host plant. Some of the locations have a very rich egg cluster distribution that is above 70 egg cluster/ host plant and these include: Kudan, Fulani and Galadima settlements, Sarkin Fulani and Suleman Pnapi in Gurara LGA, Badeggi and Kpatamisu in Katcha LGA and Tungan Fulani in Lapai LGA, while some locations such as Shanuyanbu, Uragi, Unguwar Faranshi and Ushama in Rafi LGA as well as Kataeregi in Katcha LGA were distinctly poor with less than 10 egg clusters per host plant.

The overall mean egg cluster per host plant at the areas where *C. forda* occurred in Niger State increased from 56.1 ± 24.1 egg clusters per host plant in 2010 to 58.1 ± 12.1 egg cluster per plant in 2011 cropping season (Table 2). This rise was informed by increased notice in all the LGAs. This rise was however not sustained in the latter cropping seasons where overall means of 41.3 ± 8.3 and 29.7 ± 5.1 egg clusters/plant were recorded in 2012 and 2013 cropping seasons, respectively. All the LGAs investigated followed this same trend although it seems more severe in Gurara, Katcha, Lapai and Paikoro LGAs. Fulani and Galadima settlements and Suleman Pnapi in Gurara LGA, Ebba, Eshanti and Kpatamisu in Katcha LGA, Tsohon Lapai and shaku in Lapai LGA and Shekpatanko Kutigi in Lavun LG A were however exceptions to this trend as the numbers of egg clusters per plant at these locations did not drop but was maintained at almost the same level. None of the locations had a steady increase in numbers of egg clusters across the cropping seasons. Table 3 shows *C. forda* the egg clusters observed and counted per tree canopy height range on host plants, *V. paradoxa*, at the different locations investigated during the four consecutive cropping seasons (2010 – 2013) in Niger state. The overall number recorded in 2010

was A, B, C at the low (0-5m) medium (5-10m) and high (10 -30m) ranges, respectively. The numbers recorded per range in the 2011 cropping season were relatively higher than the 2010 season. Lower values were noticed in the 2012 and 2013 seasons thus confirming the earlier observation in respect of numbers of egg clusters recorded per host plant. The same trend wherein the lower range had the highest numbers and the high range had the lowest were observed at all the locations in all the LGAs. The mean number of eggs counted per range decreased with the cropping seasons in all LGAs and at all locations investigated. The relative proportion of eggs located in the high range however improved as the seasons went by.

Figure 2 illustrates the trends of the overall *C. forda* host plant, *V. paradoxa*, densities and overall *C. forda* egg cluster numbers per host plant over the four cropping season. Each of these features shows a general trend of decline with subsequent cropping seasons although the numbers of egg cluster showed an initial rise in 2011. Unfortunately, the rates of decline with both factors are quite alarming and would require some immediate actions to forestall the imminent loss of the two biotic resources.

DISCUSSION

Results from this study have confirmed the presence of thriving population of *C. forda* and a very rich *V. paradoxa* flora in Niger State, Nigeria. It has also confirmed Niger state to be a rich source of *C. forda* caterpillar as reported by Ande (1991), Fasoranti and Ajiboye (1993), Ande and Fasoranti (1995; 1996; 1997; 1998), Odebiyi *et al.* (2003a,b), Paiko *et al.* (2014), Muhammad and Ande (2014) and Muhammad (2017). The study has for the

first time, provided valuable information on precise locations of the egg clusters in each local government area in Niger State and has confirmed that *C. forda* population no longer thrives in places where they used to occur.

The sole host plant of *C. forda* is *V. paradoxa* and was noted to occur on all the sampled locations across the state as a dominant flora that is highly revered for its fruits and other economic reasons. Unfortunately, a decreasing trend of the population density of *V. paradoxa* has been confirmed in this study. The results showed that the density of *V. paradoxa* decreased progressively with subsequent cropping seasons in all LGAs sampled and at all locations. The rates of decrease were so alarming that in more than 60% of the 41 locations sampled, the density dropped to between 1 or 2 surviving *V. paradoxa* stands by the fourth cropping season in 2013. The reason for the decrease were mainly anthropogenic and some of the highly noticeable features that brought about this downward population trend were farming activities, deforestation, bush burning and grazing. Indeed, the economically important status of this plant warranted its logging and destruction. These human activities; rather than the defoliatory activities of *C. forda* have drastically reduced the density of shea butter trees. The reports of Odebiyi *et al.*, (2004), Ramos-Elorduy (2006), Schabel (2006) and Muhammad (2017) supported this finding.

The number of *C. forda* egg clusters per plant, as well as, the canopy distribution of on the host plants, *V. paradoxa*, is particularly encouraging and the latter is similarly comparable in all the locations especially at the canopy height of less than 5m. At the onset of the investigation in 2010 cropping season, these were conspicuously higher in Gurara and Katcha LGAs where egg cluster distribution rates of above 70 per host plant were noted at Kudan, Fulani and

Galadima settlements, Sarkin Fulani and Suleiman Pnapi, Badeggi and Kpatamisu.

The rise observed in the overall mean number of *C. forda* egg clusters per host plant in the state between and 2011 cropping season was expected; as *C. forda* population numbers were expected to fester down the generation. The rising trend in egg clustering was however broken in the 2012 and the 2013 cropping seasons, particularly in Gurara, Katcha, Lapai and Paikoro LGAs. Some locations in the state were however exceptions to this rising trend, which presupposes that the factor responsible may not be solely climatic but included a localized ecological factor; especially of the conspicuously dwindling status of *C. forda* host plant, *V. paradoxa*.

The decreasing population of the host *V. paradoxa* plant could easily be explained to be a result of the nocturnal *C. forda* moth choosing to oviposit only on *V. paradoxa* if and only when the plant is available (Ande, 1991). However, in a situation where the host plants are not available, it is suspected that the moth is forced to drift to locations with host plants that may be more favorable. This may also explain why the moths lay relatively higher number of eggs in the high canopy height range when the numbers of host plants are conspicuously reduced as seen in the 2013 cropping season.

CONCLUSION

Cirina forda is a popular and an acceptable food insect among the people of Niger state; with huge nutritional benefits. However this food resource is on the verge of extinction and requires an urgent intervention geared towards its conservation due to anthropogenic activities especially the indiscriminate logging, bush burning and others rather than the feeding activities of the insect. Therefore in order to avert the

extinction of this useful food insect, there is a need for a concerted effort at halting the indiscriminate logging and other inimical human activities such as bush burning and canopy removal which place these plants under undue pressure and decimation.

RECOMMENDATION

Active planting of *V. paradoxa* need be undertaken urgently to ensure these host plants are available and the obvious *C. forda* host plant availability gap is forestalled.

Also, an amendment to Forestry edit for the protection of economic trees in Nigeria to include raising nurseries of shea butter trees, *V. paradoxa*, and distributing them free to farmers for planting to increase their wild population. This conservatory intervention for *Vitellaria paradoxa* would increase the shea butter tree stands in Northern Nigeria and so increase the population of *C. forda*.

Table 1: Host Plant, *Vitellaria paradoxa* density records at the various locations where *Cirina forda* occurred in Niger state over four consecutive cropping seasons

LGA	Location	GPS of Location	Mean Density of <i>Vitellaria paradoxa</i> /season (Individuals/10m ²)			
			2010	2011	2012	2013
Gurara	Kudan	9° 08' 25.44" N; 6° 47' 9.6" E	8±3.96	5±2.30	3±5.19	1±5.10
	Domi	9° 07' 33.6" N; 6° 45' 25.92" E	7±3.56	6±3.36	4±2.33	2±3.39
	Fulani settlement	9° 03' 14.4" N; 6° 42' 24.48" E	9±2.30	10±2.52	8±5.12	6±3.36
	Galadima settlement	9° 05' 24" N; 6° 41' 19.68" E	6±5.32	8±2.12	5±3.12	4±3.32
	Tanko Gbeyidna	9° 05' 24" N; 6° 46' 17.76" E	4±3.12	3±1.01	2±1.29	1±2.59
	Sarkin Fulani	9° 08' 42" N; 6° 46' 30" E	10±2.45	11±3.75	9±5.15	7±3.10
	Suleman Pnapi	9° 07' 30" N; 6° 47' 24" E	21±3.12	26±2.4	12±1.6	8±1.1
	Mean per LGA (n=7)		9.2	9.8	6.1	4.1
Katcha	Badeggi	9° 02' 56.27" N; 6° 08' 30.39" E	8±3.96	5±2.30	3±5.19	1±5.10
	Kataeregi	9° 21' 38.96" N; 6° 17' 39.73" E	7±3.53	6±3.34	4±2.43	2±3.34
	Ebba	9° 12' 54.66" N; 6° 15' 53.32" E	9±2.30	10±2.52	8±5.12	6±3.36
	Eshanti	9° 05' 24" N; 6° 11' 18.24" E	6±5.32	8±2.12	5±3.12	4±3.32
	Kansannagi	9° 04' 12" N; 6° 11' 24" E	4±3.12	3±1.01	2±1.29	1±2.59
	Ganabigi	9° 11' 52.8" N; 6° 11' 6" E	10±2.45	11±3.75	9±5.15	7±3.10
	Goyinekeni	9° 07' 30" N; 6° 47' 24" E	21±3.12	26±2.4	12±1.6	8±1.1
	Kambari	9° 05' 24" N; 6° 17' 12" E	21±3.12	26±2.4	12±1.6	8±1.1
	Kpatamisu	9° 17' 3.84" N; 6° 17' 21.12" E	21±3.1	26±2.4	12±1.3	8±1.2
	Mean per LGA (n=9)		9.5	10.7	12.3	7.4
Lapai	Tungan Fulani	9° 02' 6" N; 6° 43' 30" E	8±6.93	5±7.31	3±2.53	1±4.70
	Saminaka	9° 00' 18" N; 6° 40' 30" E	7±2.50	6±3.33	4±2.41	2±5.30
	Tsohon Lapai	9° 20' 42" N; 6° 40' 30" E	9±2.30	10±2.52	8±5.12	6±3.36
	Shaku	9° 04' 30" N; 6° 47' 42" E	6±5.32	8±2.12	5±3.12	4±3.32
	Tungan Tiv	9° 03' 54" N; 6° 41' 6" E	4±3.12	3±1.01	2±1.29	1±2.59
	Mawogi	9° 59' 6" N; 5° 53' 6" E	4±3.12	3±1.01	2±1.29	1±0.59
	Mean per LGA (n = 6)		6.3	4.5	4.0	2.5
Lavun	FRSC Check-point	9° 11' 42" N; 5° 35' 42" E	7±3.13	4±6.30	3±1.50	1±4.42
	Shekpa-tanko	9° 12' 18" N; 5° 34' 30" E	6±2.20	5±3.23	4±5.31	2±2.10
	Effun tiffin	9° 11' 42" N; 5° 34' 3" E	8±2.33	8±2.23	7±4.10	5±3.32
	Shekpatanko Kutigi	9° 12' 18" N; 5° 34' 30" E	5±3.30	7±2.32	5±2.42	4±2.30
	Tako Tswako	9° 12' 18" N; 5° 30' 18" E	4±3.10	3±1.31	2±1.35	1±2.20
	Mean per LGA (n = 6)		6.0	5.4	4.2	2.6

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Paikoro	Etsupi dobwa	9° 24' 24.48" N; 6° 37' 26.4" E	5±3.46	4±2.35	2±5.18	1±2.11
	Piwawai	9° 24' 18" N; 6° 38' 6" E	9±3.23	7±2.32	4±2.21	1±2.30
	Tsadupi	9° 23' 42" N; 6° 34' 30" E	5±2.34	5±2.52	5±5.22	4±3.32
	Ibrahim dobwa	9° 23' 42" N; 6° 38' 6" E	6±3.30	4±1.10	3±3.10	2±2.30
	Kpadapi	9° 24' 18" N; 6° 39' 18" E	8±2.50	6±3.05	5±3.32	3±1.50
	Badapi	9° 24' 18" N; 6° 40' 30" E	4±2.15	4±2.75	3±2.15	2±2.10
	Haruna farm	9° 23' 42" N; 6° 37' 30" E	4±3.22	4±2.40	3±1.20	2±1.14
	Madam Ibrahim	9° 23' 42" N; 6° 36' 18" E	4±3.10	4±2.41	3±1.23	2±1.23
	Lakutapi	9° 25' 30" N; 6° 40' 30" E	4±3.10	4±2.41	3±1.23	2±1.23
	District head	9° 23' 6" N; 6° 40' 30" E	4±2.10	4±4.19	3±2.24	2±4.27
Mean per LGA (n = 10)			5.3	4.6	3.1	1.9
Rafi	Shanu-yanbu	10° 20' 6" N; 6° 08' 40" E	4±2.40	3±2.30	2±2.10	1±1.10
	Uragi	10° 22' 17.76" N; 6° 04' 49.44" E	4±2.20	3±4.35	2±2.11	1±2.35
	Ushama	9° 53' 6" N; 6° 03' 18" E	7±2.34	8±2.52	5±5.22	4±3.32
	Unguwar Faranshi		4±3.35	3±1.15	2±3.15	1±2.35
	Mean per LGA (n = 4)		4.7	4.2	2.7	1.7
OVERALL MEAN FOR THE SEASON			6.9±4.2	6.8±3.2	6.3±3.4	2.9 ± 1.8

Table 2: Mean *Cirina forda* egg cluster densities on Host Plant, *Vitellaria paradoxa* at the various locations where occurred in Niger state over four consecutive cropping seasons

LGA	Location	GPS of Location	Mean Density of <i>Cirina forda</i> egg cluster/host plant/season (Individuals/Plant)			
			2010	2011	2012	2013
Gurara	Kudan	9° 08' 25.44" N; 6° 47' 9.6" E	70±5.21	75±4.12	54±5.16	41±5.15
	Domi	9° 07' 33.6" N; 6° 45' 25.92" E	60±3.31	61±3.15	36±3.00	33±2.15
	Fulani settlement	9° 03' 14.4" N; 6° 42' 24.48" E	91±2.09	95±5.32	71±5.31	64±6.1
	Galadima settlement	9° 05' 24" N; 6° 41' 19.68" E	94±3.51	96±3.59	73±5.21	63±5.32
	Tanko Gbeyidna	9° 05' 24" N; 6° 46' 17.76" E	46±5.32	51±5.21	35±2.59	22±2.1
	Sarkin Fulani	9° 08' 42" N; 6° 46' 30" E	93±1.67	97±2.65	69±4.65	46±3.15
	Suleman Pnapi	9° 07' 30" N; 6° 47' 24" E	95±3.15	98±3.56	81±5.39	80±3.56
	Mean per LGA		78.4	82.0	59.8	41.7
Katcha	Badeggi	9° 02' 56.27" N; 6° 08' 30.39" E	79±1.01	75±4.12	51±4.16	40±3.15
	Kataeregi	9° 21' 38.96" N; 6° 17' 39.73" E	8±3.96	5±2.30	3±5.19	1±5.10
	Ebba	9° 12' 54.66" N; 6° 15' 53.32" E	63±2.01	91±5.30	61±5.20	53±5.19
	Eshanti	9° 05' 24" N; 6° 11' 18.24" E	65±3.51	68±2.50	63±3.20	60±1.30
	Kansannagi	9° 04' 12" N; 6° 11' 24" E	51±5.02	56±3.20	39±2.50	21±2.18
	Ganabigi	9° 11' 52.8" N; 6° 11' 6" E	38±1.42	58±2.15	29±4.65	23±3.15
	Goyinekeni	9° 07' 30" N; 6° 47' 24" E	59±3.45	68±3.23	41±5.30	30±3.52
	Kambari	9° 05' 24" N; 6° 17' 12" E	47±3.05	58±3.50	41±5.39	40±3.56
	Kpatamisu	9° 17' 3.84" N; 6° 17' 21.12" E	71±3.12	88±3.52	81±5.30	80±1.50
	Mean per LGA		52.8	63.0	45.4	38.6
Lapai	Tungan Fulani	9° 02' 6" N; 6° 43' 30" E	70±5.21	65±4.17	54±5.14	41±5.13
	Saminaka	9° 00' 18" N; 6° 40' 30" E	64±1.32	60±7.45	34±3.62	23±2.57
	Tsohon Lapai	9° 20' 42" N; 6° 40' 30" E	63±2.41	91±2.37	61±4.26	53±5.28
	Shaku	9° 04' 30" N; 6° 47' 42" E	65±5.50	68±2.53	63±3.27	60±1.39
	Tungan Tiv	9° 03' 54" N; 6° 41' 6" E	51±5.06	54±3.24	39±6.51	21±5.11
	Mawogi	9° 59' 6" N; 5° 53' 6" E	60±2.01	62±3.20	39±2.50	21±2.18
	Mean per LGA		62.1	66.6	48.3	36.5
Lavun	FRSC Check-point	9° 11' 42" N; 5° 35' 42" E	57±4.20	68±4.10	52±2.13	45±3.14
	Shekpa-tanko	9° 12' 18" N; 5° 34' 30" E	53±3.31	61±3.40	32±3.32	21±2.54
	Effun tiffin	9° 11' 42" N; 5° 34' 3" E	54±2.21	61±2.30	32±2.32	20±3.16
	Shekpatanko Kutigi	9° 12' 18" N; 5° 34' 30" E	65±2.52	66±2.52	61±3.21	60±1.30
	Tako Tswako	9° 12' 18" N; 5° 30' 18" E	62±5.01	44±3.13	30±3.51	20±2.10

	Mean per LGA		58.2	60.0	41.4	33.2
Paikoro	Etsupi dobwa	9° 24' 24.48" N; 6° 37' 26.4" E	69±1.51	95±2.42	41±3.13	20±4.25
	Piwawai	9° 24' 18" N; 6° 38' 6" E	62±1.34	62±3.40	24±3.42	20±2.57
	Tsadupi	9° 23' 42" N; 6° 34' 30" E	62±2.05	94±5.31	51±5.23	33±5.29
	Ibrahim dobwa	9° 23' 42" N; 6° 38' 6" E	64±3.54	62±1.53	54±3.24	40±2.35
	Kpadapi	9° 24' 18" N; 6° 39' 18" E	50±3.42	52±2.25	33±2.30	26±1.14
	Badapi	9° 24' 18" N; 6° 40' 30" E	34±1.40	52±2.10	19±2.35	13±3.10
	Haruna farm	9° 23' 42" N; 6° 37' 30" E	52±3.25	54±3.10	31±5.30	20±1.22
	Madam Ibrahim	9° 23' 42" N; 6° 36' 18" E	43±3.20	48±3.52	39±5.30	41±3.11
	Lakutapi	9° 25' 30" N; 6° 40' 30" E	52±2.10	62±3.12	41±2.33	30±3.30
	District head	9° 23' 6" N; 6° 40' 30"	56±2.16	61±3.15	31±5.73	23±5.35
	Mean per LGA		52.1	62.2	51.1	26.6
Rafi	Shanu-yanbu	10° 20' 6" N; 6° 08' 40" E	3±3.50	6±4.10	5±5.10	3±5.15
	Uragi	10° 22' 17.7" N; 6° 04' 49.44" E	4±3.2	3±2.10	2±2.3	2±2.02
	Ushama	9° 53' 6" N; 6° 03' 18" E	3±5.47	2±5.10	2±5.10	1±3.04
	Unguwar Faranshi		3±2.13	3±3.32	2±3.21	1±3.22
	Mean per LGA		3.2	3.0	2.7	1.7
OVERALL MEAN FOR THE SEASON			58.1±12.1	56.1±24.1	41.3±8.3	29.7±5.1

Figure 2: Trends of *Cirina forda* host plant densities and egg cluster number per plant over the four cropping seasons

Table 3: Numbers of *Cirina forda* egg clusters noticed per canopy height range on host plants, *Vitellaria paradoxa*, at different locations during four consecutive cropping seasons (2010-2013) in Niger state

LGA	Location	Numbers of <i>Cirina forda</i> egg cluster/canopy range of host plant/season (Individuals/range)											
		2010 season			2011 season			2012 season			2013 season		
		0-5m	5 – 0m	10 – 30m	0 - 5m	5 - 10m	10- 30m	0 - 5m	5 – 10m	10 – 30m	0 - 5m	5 – 10m	10 – 30m
Gurara	Kudan	53	30	20	72	28	12	70	16	8	51	13	7
	Domi	39	25	15	44	32	12	42	12	10	23	12	10
	Fulani settlement	41	16	5	82	15	5	50	35	10	61	16	5
	Galadima settlement	51	15	8	91	27	12	82	14	10	51	22	10
	Tanko Gbeyidna	55	20	15	91	28	12	35	8	2	33	7	2
	Sarkin Fulani	40	32	10	61	27	5	45	16	8	36	7	3
	Suleman Pnapi	55	35	10	106	18	11	62	54	12	74	43	13
	Mean per LGA	47.7	24.7	11.8	78.1	25.0	9.8	55.1	22.1	8.5	47.0	17.1	7.1
Katcha	Badeggi	102	32	10	84	32	12	79	25	5	63	22	8
	Kataeregi	61	23	9	70	22	8	75	18	5	69	12	10
	Ebba	63	21	9	72	21	11	75	22	11	68	11	9
	Eshanti	64	13	8	74	16	6	64	14	10	68	13	7
	Kansannagi	60	14	7	67	18	4	58	13	7	58	16	4
	Ganabigi	62	14	8	65	17	5	61	16	5	64	12	8
	Goyinekeni	61	25	8	67	12	8	57	14	6	53	18	5
	Kambari	60	33	8	71	13	9	60	14	9	57	12	10
	Kpatamisu	81	32	10	105	38	9	91	45	10	92	25	10
	Mean per LGA	68.2	23.0	8.5	75.0	21.0	8.0	68.8	20.1	7.5	65.8	15.5	7.3
Lapai	Tungan Fulani	63	23	7	90	15	8	90	15	6	57	23	7
	Saminaka	66	12	8	70	19	8	5	10	5	44	16	6
	Tsohon Lapai	54	17	8	60	14	8	64	13	7	43	16	4
	Shaku	50	20	0	51	15	9	52	18	9	31	15	5
	Tungan Tiv	60	14	7	67	18	4	58	13	7	58	16	4
	Mawogi	49	14	6	52	16	10	35	18	5	16	7	3
	Mean per LGA	57.0	16.6	6.0	67.0	16.1	7.8	50.6	14.5	6.5	41.5	15.5	5.5
Lavun	FRSC Check-point	84	17	5	101	13	8	73	13	10	40	17	10
	Shekpatanko	64	10	6	78	12	8	53	15	9	53	20	10
	Effun tiffin	50	14	8	50	18	5	46	12	8	40	12	8
	Shekpatanko Kutigi	79	20	0	101	40	20	99	14	8	68	15	5
	Tako Tswako	60	14	7	67	18	4	58	13	7	58	16	4
	Mean per LGA	67.4	15.0	5.2	71.0	20.2	9.0	65.8	13.4	8.4	51.8	16.0	4.4
Paikoro	Etsupi dobwa	63	15	3	74	31	11	59	15	7	43	12	7
	Piwawai	81	18	5	90	24	6	75	14	8	61	14	12
	Tsadupi	64	19	9	62	31	4	52	12	10	48	14	6
	Ibrahim dobwa	64	13	8	74	16	6	64	14	10	68	13	7
	Kpadapi	67	17	5	97	28	4	54	23	5	38	13	6
	Badapi	62	14	8	65	17	5	61	16	5	64	12	8
	Haruna farm	71	15	7	64	15	5	67	14	7	43	16	6
	Madam Ibrahim	62	23	5	61	23	6	45	11	7	47	13	9
	Lakutapi	71	22	11	74	39	9	71	45	8	90	35	9
	District head	71	37	12	68	30	10	71	30	19	93	42	11
	Mean per LGA	67.6	19.3	14.5	73.1	27.4	6.6	61.9	19.4	8.6	59.5	18.4	8.1
Rafi	Shanuyanbu	30	12	6	50	13	11	41	21	14	31	21	8
	Uragi	39	12	8	56	12	8	25	12	7	21	14	7
	Ushama	64	19	9	62	31	4	52	12	10	48	14	6
	Unguwar Faranshi	35	18	5	46	13	7	26	12	8	22	12	3
Mean per LGA		42.0	15.2	7.0	53.5	17.5	7.5	35.7	14.2	9.7	30.5	15.2	6.0
Overall numbers per session		349.9	114.1	53	346.7	127.2	48.7	337.9	103.7	49.2	296.1	97.7	38.4

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