



Management of Pod Borer (*Helicoverpa armigera* Hubner) on Pigeonpea (*Cajanus cajan* (L.) Millsp) using Plant Density and Planting Dates for Increased Yield in Owerri, Nigeria

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ABSTRACT: The potential of manipulating planting dates and plant spatial arrangement for management of the pod borers (*Helicoverpa armigera* Hubner) in early maturing pigeonpea (*Cajanus cajan* (L.) Millsp) cultivar for increased yield was evaluated in a field study carried out in the Postgraduate Teaching and Research Farm, Department of Crop Science and Technology, Federal University of Technology, Owerri, Imo State in 2009 and 2010. The experiment was laid out in a randomized complete block design with factorial arrangement of three planting dates (April 7, early-season cropping, July 7, mid-season cropping, and October 7, late-season cropping) and four plant spatial arrangement (15 cm x 35 cm; 20 cm x 40 cm; 25 cm x 50 cm; 30 cm x 60 cm giving densities of 190,474; 125,000; 80,000; 55,556 plants ha⁻¹ respectively). The treatments were replicated three times. *H. armigera* larvae sighted from twelve plants from the three middle rows of each plot between 0630 and 0800 hours, during the podding stage were counted for assessment of larval population. The proportion of damaged pod/seed was weighed and the weight expressed as a percentage of the weight of the 100-pod/seed sample. The results showed that pigeonpea planted at higher plant density of 190,474 plants ha⁻¹ had higher population of *H. armigera* and also recorded significant ($p < 0.05$) pod and seed damage resulting in low values of seed yield (147.90 kg ha⁻¹) in 2009 and (168.80 kg ha⁻¹) in 2010, when compared with pigeonpea planted at lower density of 55,556 plants ha⁻¹ with seed yield (223.33 kg ha⁻¹) in 2009, and (268.83 kg ha⁻¹) in 2010. Plots planted in April gave the highest pod (444.00 kg ha⁻¹); and seed (295.00 kg ha⁻¹) yield in 2009. The respective pod and seed yield values in 2010 were 328.40 kg ha⁻¹ and 287.90 kg ha⁻¹. October planting had poor pod (64.00 kg ha⁻¹; seed yield 57.50 kg ha⁻¹ in 2009 and pod/seed yield of 60.40 kg ha⁻¹; 56.60 kg ha⁻¹ respectively in 2010. Pod borer infestation was lowest in July planted plots and consequently pod and seed yields, 526.00 kg ha⁻¹ and 353.20 kg ha⁻¹, respectively in 2009; and 499.50 kg ha⁻¹ and 368.00 kg ha⁻¹, respectively in 2010, and has higher compared to other planting dates. Therefore, for increased yield of early maturing pigeonpea that may ensure food security, July planting season with minimal *H. armigera* loads should be adopted in Owerri, Nigeria.

Keywords: Pigeonpea, *Helicoverpa armigera*, plant population density, planting dates, yield.

INTRODUCTION

Pigeonpea is among the most important pulses of the developing countries and found extensively in Africa (Duke, 1981). In many countries, pigeonpea is grown in small areas and

as a backyard crop (Dialoke *et al.*, 2010; Nene and Sheila, 1999). Kenya is the second largest pigeonpea producer in the world after India with an estimated production area of 59,000 tonnes from 152,000 hectares (Van der Maesen, 2006). Estimates of dry seed yield of pigeonpea are in the range of 400-600 kg ha⁻¹ in Africa, 700 kg ha⁻¹

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in Asia and 1400 kg ha⁻¹ in North America, whereas green pod yield of the same plant is estimated at between 1000 and 9000 kg/ha in India (Duke, 1981). Pigeonpea is a very good source of protein, Vitamin C, Vitamin K, Vitamin A, Vitamin B6, phosphorus, folate and thiamin (Vitamin B1), Riboflavin (Vitamin B2), manganese, magnesium, copper, zinc, iron, and potassium (Menotti *et al.*, 1999). It is the only legume that can withstand the effect of drought where other pulses fail and as well improve the fertility of the soil by fixing atmospheric nitrogen through symbiotic relationship.

Despite all these importance of pigeonpea, inappropriate pest management has contributed to low yield of pigeonpea in Nigeria (Dialoke *et al.*, 2010). One of the most important of these pests is *Helicoverpa armigera* Hubner larvae which is very common in many areas of Africa and Asia. The older larvae of *H. armigera* chew vigorously into buds, flowers and pods, leaving characteristic round holes and can feed on leaflets if flowers are not available. Severe damage by *H. armigera* during the vegetative stage delays flowering. In India, up to 95% pod damage has been observed (Manjunath *et al.* 1985). In a survey carried out in 2007 and 2008 in parts of the pigeonpea growing areas in Nigeria Dialoke *et al.*, (2010) reported 2.92-40.21% damage by pod bores. In trials carried out at International Crops Research Institute for Semi-Arid Tropics (ICRISAT) during 1975 and 1976 cropping seasons, Lateef and Reed (1980), observed that pigeonpea cultivars and duration to flowering influenced pest status. Lepidopteran pod borers, *H. armigera* larvae were reported to cause higher level of damage to pods of short- and medium-duration determinate pigeonpea cultivars.

The timing of crop development may have a great effect on its susceptibility to insect pests. For many pest and crop systems, planting date will dictate whether or not a pest will be present in sufficient numbers to become a problem (Philips, 2005). Pest appearance, population fluctuation, infestation rate and crop yield are very much dependent on planting date. Hossain *et al.*, (2009) working on appropriate planting date of Mung bean in Bangladesh found that for every 1%

increase of pod borer damage, there was a yield loss of 23.56%.

Farmers in pigeonpea growing areas of Nigeria plant early maturing varieties at any time of the year not taking into cognisance infestation and abundance of insect pests, crop damage and consequent effect on yield. Not much is known about the potential of mitigating pest damage to pigeonpea by manipulating planting date and plant population density. In this study, we investigated the effects of both on *H. armigera* density and damage at Owerri in the rainforest zone of Nigeria.

MATERIALS AND METHODS

The study was carried out at the Postgraduate Teaching and Research Farms, Department of Crop Science and Technology, Federal University of Technology, Owerri (longitude 7° 12' E and latitude 5° 27' N of equator), in the rainforest zone of Nigeria. The experiment was laid in randomized complete block design with factorial arrangement of three planting dates (early-season, mid-season and late-season cropping) and four plant spatial arrangements (15 cm x 35 cm, 20 cm x 40 cm, 25 cm x 50 cm, 30 cm x 60 cm, giving plant population densities of 55,556 plants ha⁻¹, 80,000 plants ha⁻¹, 125,000 plants ha⁻¹ and 190,474 plants ha⁻¹, respectively). The treatments were replicated three times.

Seeds of an early-maturing pigeonpea line (ICP 84023) were treated with Seed Plus Seed Plus[®] 30 (10% imidacloprid + Metalaxyl 10% + 10% Carbendazim WS) at the rate of 10g (one sachet) of Seed Plus[®] 30 WS per 2 kg seed before sowing in plots that were 3 m long x 3.6 m wide and spaced 1 m apart. Three seeds were sown per hole on April 7 (early-season crop), July 7 (mid-season crop), and October 7 (late-season crop) in each of 2009 and 2010; seedlings were thinned to one per hole at 2 weeks after planting (WAP). The plots were hoe-weeded at 2, 4, and 6 WAP. Selected meteorological data (Table 1) during crop growing period were obtained from Federal Ministry of Aviation Meteorological Station, Owerri, Imo State.

Twelve plants from the three middle rows of each plot were tagged for sampling *H. armigera*

larvae, between 0630 and 0800 hours during the podding stage. Larvae sighted were counted and collected. At crop maturity, pods from the three inner rows of each plot were harvested, dried and weighed. The pods were manually threshed and the seeds weighed. Prior to shelling, a random sample of 100 pods was taken, weighed, and examined for the damage depicted in Plate 1a. The proportion damaged was weighed and the weight expressed as a percentage of the weight of the 100-pod sample. Similarly, a sample of 100 seeds was taken at random, weighed and examined for assessment of the seed damage depicted in Plate 2a; the damaged seeds were weighed and expressed as a percentage of 100-seed weight.

Pod and seed yields (kg ha^{-1}): The pod and seed yields were recorded from the harvested dried pods from the three middle rows of each plot. As the pods were harvested during the rains, they were oven dried including October, late-season cropping at 40 °C for one week and thereafter hand threshed and winnowed. The pods and seeds yield per plot were weighed using a sensitive top loading balance (Ohaus model: Av413, capacity 410g) at the Department of Crop Science and Technology Laboratory, Federal

University of Technology, Owerri.

100 pod/seed weight (g): At harvest, 100 pods/seeds per plot were selected at random and weighed in the laboratory using a sensitive top loading balance and weight recorded.

Pod yield per plant (g): This data was obtained by recording the total weight (g) per plot of the harvested pods divided by the total stand count per plot at harvest.

Seed yield per plant (g): This data was obtained by recording the total weight (g) per plot of the harvested seeds divided by the total stand count per plot at harvest.

Number of seeds per pod: The number of seeds per pod was counted from 20 pods per plot selected at random. Each pod was threshed and seeds recorded. The mean values from each plot were recorded.

STATISTICAL ANALYSIS

Data collected were subjected to analysis of variance using Genstat (2009) software after

Table 1: Summary of average monthly temperature, number of rain days, rainfall and relative humidity for the three months of pigeonpea production in the three planting regimes

Year	Cropping season	Maximum Temp. (°C)	Number of rain days (days)	Rainfall (mm)	Relative humidity (%)
2009	Early-season (April)	34.67	11.33	232.00	79.67
	Mid-season (July)	34.33	18.33	394.07	86.33
	Late-season (October)	31.64	7.67	218.83	78.00
2010	Early-season (April)	33.17	10.67	237.90	87.07
	Mid-season (July)	33.60	14.00	511.13	89.67
	Late-season (October)	35.33	7.33	155.33	81.00

transforming *H. armigera* larval counts and percentages of pod and seed damage to square root (Gomez and Gomez, 1984). Significantly different treatment means were separated using Fishers Least Significant Difference at $P=0.05$.

RESULTS

The effect of plant densities and planting dates on population of pod borers (*H. armigera*) during 2009 planting time is shown in (Figs. 1a

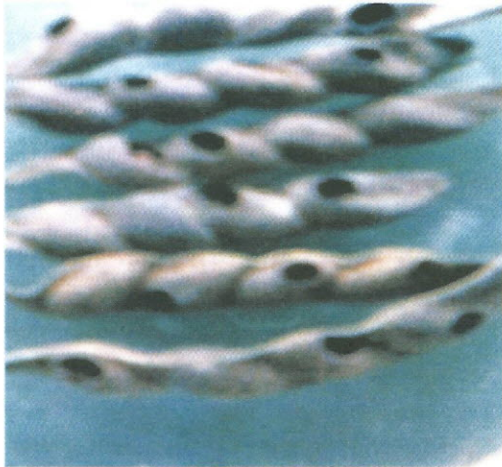


Plate 1(a): Mature pigeonpea pods bored by *H. armigera*

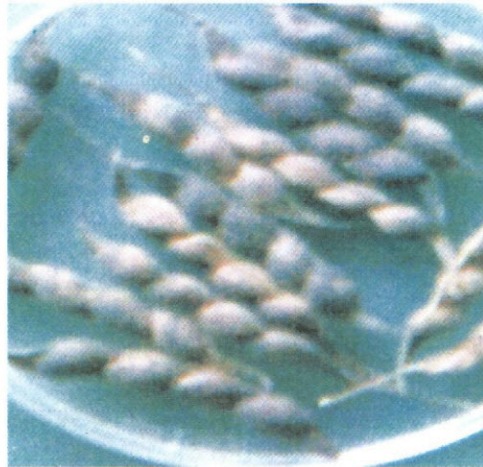


Plate 1(b): Undamaged wholesome pigeonpea pods (Dialoke *et. al.*, 2017)

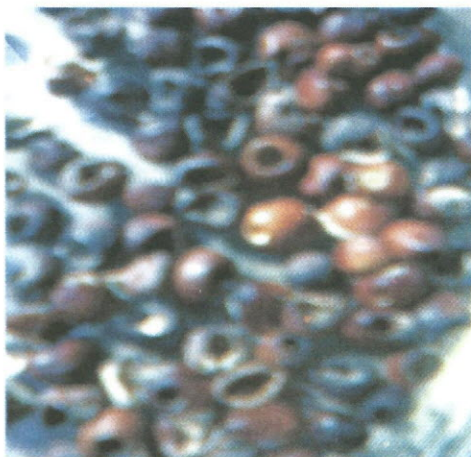


Plate 2(a): Mature pigeonpea seeds bored by *H. armigera*



Plate 2(b): Undamaged wholesome pigeonpea seeds (Dialoke *et. al.*, 2017)

Nature of seed yield from different planting dates



Plate 3 (a) April (Early-cropping) seed yield

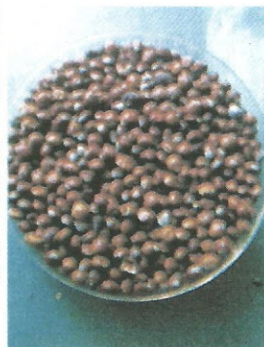


Plate 3 (b) July (mid-cropping) seed yield



Plate 3 (c) October (late cropping) seed yield

and b). Plants at higher plant densities recorded higher population of *H. armigera* at 84 DAP, 98 DAP, and 105 DAP while low plant density (55,556 plants ha⁻¹) recorded lower population of *H. armigera* which at 77 DAP and 105 DAP. April (early cropping) planting recorded the highest population of *H. armigera* with peak population followed by October (late cropping) planting both with peak population at 98 DAP. In July, the mid-season cropping, there was no borer recovery from pods through to 105 DAP; the number recovered was reduced by approximately one-half a week later.

The population trend of *H. armigera* under the influence of plant densities and planting dates during 2010 are presented in Figs. 2a and b. There was high pod borer population at higher plant densities at 77 DAP, and 84 DAP while low population of *H. armigera* was recorded on plants at low density as obtained in 2009 planting. The pigeonpea planted in April (early cropping) had the highest population of *H. armigera* followed by October planting, both of which had peak population of the pest at 84 DAP. The population of *H. armigera* in July (mid-season cropping), reached maximum at 77 DAP which decreased at 84 DAP and maintained zero population at 91, 98, and 105 DAP.

Table 2 presents the percentage pods and seed damage rates in 2009 planting. The results showed that pod and seed damage were significantly ($P < 0.05$) influenced by plant densities and planting dates at $P = 0.05$. Higher percentage pod and seed damage were observed on plant population at higher plant density of 190,474 plants ha⁻¹. The damage by *H. armigera* decreases at lower plant density of 55,556 plants ha⁻¹. Hence, higher plant density (190,474 plants ha⁻¹) recorded poor percentage wholesome pods and seeds (Table 2). There was significant ($P < 0.05$) effect of planting dates on pod damage but no significant ($P > 0.05$) effect on seed damage. Generally, there were very high *H. armigera* loads on the pigeonpea cultivar during April and October with consequent reduction in percentage wholesome pods and seeds. Planting in July (mid-season cropping) recorded the lowest percentage pods and seeds damage by *H. armigera* with high percentage wholesome pods and seeds, compared with April and October plantings.

During 2010 planting, plant density significantly affected percentage pod damage but had no significant effect ($P < 0.05$) on percentage seed damage by *H. armigera* (Table 2). More pods were damaged on plants at high density (closer spacing) compared with low plant density

Table 2: The effect of plant densities and planting dates on the percentage pigeonpea *Helicoverpa armigera* damage in Owerri, Nigeria

Plant pop. PP (ha ⁻¹)	2009				2010			
	Percentage pods bored by <i>H. armigera</i> 100 pods ⁻¹	Percentage seeds bored by <i>H. armigera</i> 100 seeds ⁻¹	Percentage wholesome pods 100 pods ⁻¹	Percentage wholesome seeds 100 seeds ⁻¹	Percentage pods bored by <i>H. armigera</i> 100 pods ⁻¹	Percentage seeds bored by <i>H. armigera</i> 100 pods ⁻¹	Percentage wholesome pods 100 pods ⁻¹	Percentage wholesome seeds 100 seeds ⁻¹
55,556	15.18	0.31	35.33	28.00	19.40	0.24	43.80	28.89
80,000	17.30	0.53	20.22	18.10	21.70	0.43	35.44	21.89
125,000	23.33	0.42	16.11	8.10	25.40	0.25	25.00	15.78
190,474	29.30	3.01	11.22	4.90	27.90	1.56	11.67	9.67
LSD 0.05	5.01	0.55	4.67	6.89	6.08	0.36	5.39	5.39
Planting date (PD)								
April	9.90	0.75	14.08	5.90	28.00	0.92	25.33	3.58
July	4.50	0.27	47.25	35.50	3.60	0.07	61.40	52.67
October	42.60	0.30	0.83	2.90	39.00	0.18	0.00	1.67
LSD 0.05	5.36	N.S	4.28	5.96	5.27	0.67	4.67	4.67
Interaction								
PP × PD	N.S	N.S	9.14	11.93	N.S	N.S	9.33	9.33

Quotient of the weight of bored pods and weight of the 100 pods sampled.

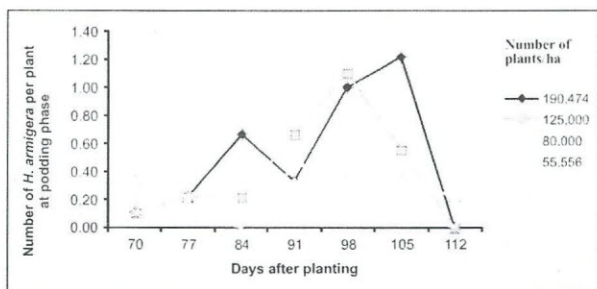


Figure 1 (a): Progressive *H. armigera* infestation per pigeonpea plant at the podding phase under various plant density regimes in 2009 planting season

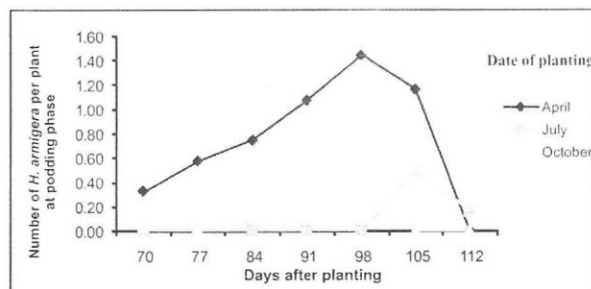


Figure 1 (b): Effect of planting date on *H. armigera* infestation rate per pigeonpea plant at the podding phase in 2009 planting season

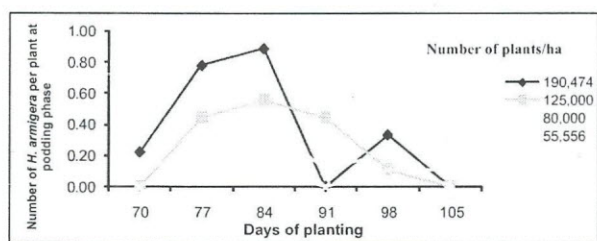


Figure 2 (a): Progressive *H. armigera* infestation per pigeonpea plant at the podding phase under various plant density regimes in 2010 planting season

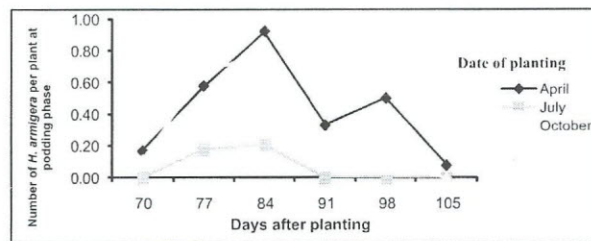


Figure 2 (b): Effect of planting date on *H. armigera* infestation rate per pigeonpea plant at the podding phase in 2010 planting season

(wider spacing). However, planting dates significantly ($P < 0.05$) influenced percentage pod and seed damage by *H. armigera*. July (Mid cropping) 2010 recorded the least percentage pods and seeds damage by *H. armigera* with high percentage wholesome pods and seeds compared with April (early cropping) and October (late cropping) plantings and compared with the values obtained during 2009 planting season. Plates 1 (a) and 2 (a) show the damage

done to pods and seeds by *H. armigera* as well as wholesome pods and seeds (Plates 1 b, 2b).

Both plant population density and planting date significantly ($P < 0.05$) affected pod yield (kg ha^{-1}), seed yield (kg ha^{-1}), and all the yield components (Table 3). Higher plant density (closer spacing) of 190,474 plants ha^{-1} gave higher pod yield (665.00kg ha^{-1}) and pod yield (5.94g) per plant with reduced seed yield (147.90 kg ha^{-1}) while lower plant density (wider spacing)

Table 3: The effect of plant densities and planting dates on the yield of short duration pigeonpea cultivar in Owerri, Nigeria

Plant pop. PP (ha^{-1})	2009						2010							
	pod yield kg^{-1}	seed yield kg^{-1}	100 pod weight (g)	100 seed weight (g)	pod yield plant^{-1} (g)	seed yield plant^{-1} (g)	seeds pod^{-1}	pod yield kg^{-1}	seed yield kg^{-1}	100 pod weight (g)	100 seed weight (g)	pod yield plant^{-1} (g)	seed yield plant^{-1} (g)	seeds pod^{-1}
55,556	296.00	223.33	14.05	3.99	4.64	4.87	3.92	277.10	268.83	17.34	5.00	3.24	5.09	4.04
80,000	343.00	198.70	12.89	3.30	5.76	3.70	3.57	322.30	238.44	14.46	3.91	4.23	3.78	3.68
125,000	475.00	173.88	12.44	2.67	5.00	3.90	2.91	468.90	196.26	12.27	3.57	4.12	3.32	3.00
190,474	665.00	147.90	8.91	2.61	5.94	3.10	2.14	586.00	168.80	9.91	3.18	4.35	3.07	2.19
LSD 0.05	105.00	19.48	3.18	0.87	0.79	0.42	0.68	47.94	25.24	4.72	1.14	0.83	0.69	0.62
Planting date (PD)														
April	444.00	295.30	13.21	2.35	6.71	4.57	3.31	328.40	287.90	9.24	2.87	5.05	4.47	3.13
July	525.00	353.20	19.60	5.77	7.95	5.86	3.59	499.50	368.00	29.85	8.00	7.62	6.13	4.12
October	64.00	57.50	3.40	1.31	0.99	0.87	2.51	60.40	56.60	1.40	0.87	0.91	0.85	2.43
LSD 0.05	90.90	16.87	2.76	0.75	1.18	0.36	0.58	41.94	21.86	4.09	0.99	0.72	0.60	0.54
Interaction														
PP \times PD	181.9	33.73	N.S	N.S	N.S	0.72	N.S	83.04	43.72	N.S	N.S	1.36	1.19	N.S

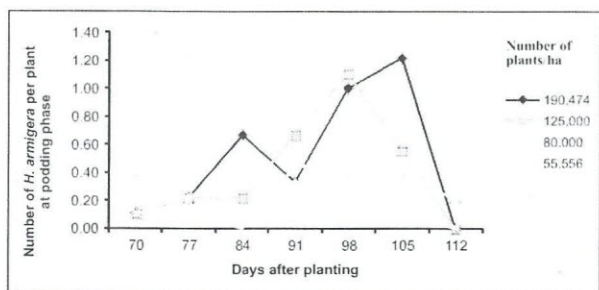


Figure 1 (a): Progressive *H. armigera* infestation per pigeonpea plant at the podding phase under various plant density regimes in 2009 planting season

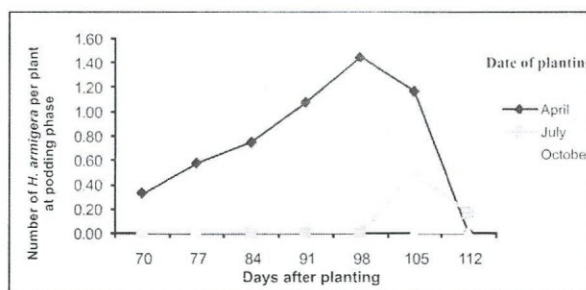


Figure 1 (b): Effect of planting date on *H. armigera* infestation rate per pigeonpea plant at the podding phase in 2009 planting season

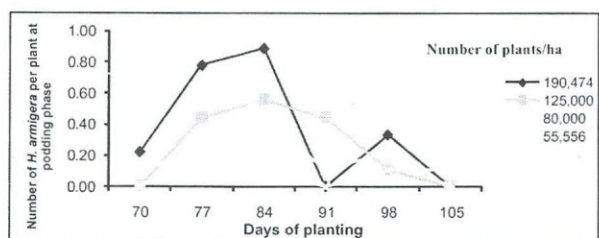


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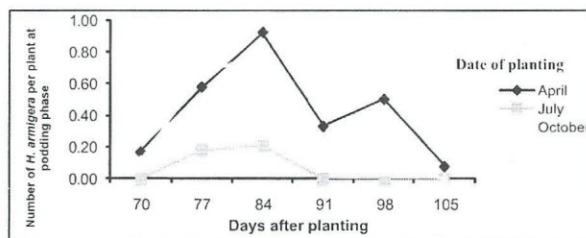


Figure 2 (b): Effect of planting date on *H. armigera* infestation rate per pigeonpea plant at the podding phase in 2010 planting season

(wider spacing). However, planting dates significantly ($P < 0.05$) influenced percentage pod and seed damage by *H. armigera*. July (Mid cropping) 2010 recorded the least percentage pods and seeds damage by *H. armigera* with high percentage wholesome pods and seeds compared with April (early cropping) and October (late cropping) plantings and compared with the values obtained during 2009 planting season. Plates 1 (a) and 2 (a) show the damage

done to pods and seeds by *H. armigera* as well as wholesome pods and seeds (Plates 1 b, 2b).

Both plant population density and planting date significantly ($P < 0.05$) affected pod yield (kg ha^{-1}), seed yield (kg ha^{-1}), and all the yield components (Table 3). Higher plant density (closer spacing) of 190,474 plants ha^{-1} gave higher pod yield ($665.00 \text{ kg ha}^{-1}$) and pod yield (5.94 g) per plant with reduced seed yield ($147.90 \text{ kg ha}^{-1}$) while lower plant density (wider spacing)

Table 3: The effect of plant densities and planting dates on the yield of short duration pigeonpea cultivar in Owerri, Nigeria

Plant pop. PP (ha^{-1})	2009						2010							
	pod yield kg^{-1}	seed yield kg^{-1}	100 pod weight (g)	100 seed weight (g)	pod yield plant^{-1} (g)	seed yield plant^{-1} (g)	seeds pod $^{-1}$	pod yield kg^{-1}	seed yield kg^{-1}	100 pod weight (g)	100 seed weight (g)	pod yield plant^{-1} (g)	seed yield plant^{-1} (g)	seeds pod $^{-1}$
55,556	296.00	223.33	14.05	3.99	4.64	4.87	3.92	277.10	268.83	17.34	5.00	3.24	5.09	4.04
80,000	343.00	198.70	12.89	3.30	5.76	3.70	3.57	322.30	238.44	14.46	3.91	4.23	3.78	3.68
125,000	475.00	173.88	12.44	2.67	5.00	3.90	2.91	468.90	196.26	12.27	3.57	4.12	3.32	3.00
190,474	665.00	147.90	8.91	2.61	5.94	3.10	2.14	586.00	168.80	9.91	3.18	4.35	3.07	2.19
LSD 0.05	105.00	19.48	3.18	0.87	0.79	0.42	0.68	47.94	25.24	4.72	1.14	0.83	0.69	0.62
Planting date (PD)														
April	444.00	295.30	13.21	2.35	6.71	4.57	3.31	328.40	287.90	9.24	2.87	5.05	4.47	3.13
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October	64.00	57.50	3.40	1.31	0.99	0.87	2.51	60.40	56.60	1.40	0.87	0.91	0.85	2.43
LSD 0.05	90.90	16.87	2.76	0.75	1.18	0.36	0.58	41.94	21.86	4.09	0.99	0.72	0.60	0.54
Interaction														
PP x PD	181.9	33.73	N.S	N.S	N.S	0.72	N.S	83.04	43.72	N.S	N.S	1.36	1.19	N.S

of 55,556 plants ha⁻¹ with lower pod yield (296.00 kg ha⁻¹) gave higher seed yield (223.00 kg ha⁻¹). With respect to 100 pod weight (g), and 100 seed weight (g), pigeonpea at higher plant population recorded low pod/seed weights compared to plant population at lower plant populations (wider spacing). Also, seed yield per plant, and number of seeds per pod were higher at lower plant population compared with plants at higher plant density. Excluding number of seeds/pod in 2009, pod and seed productivity were significantly higher in the mid-season cropping (July planting-seed yield from July planting, plate 3 (b), than in the early-season (April planting-seed yield from April planting, plate 3 (a), and late-season (October planting-seed yield from October planting, plate 3 (c). July planting produced high quality seeds with wholesome and brown seed colour while April and October cropping seasons produced very poor seeds quality with black and wrinkled features as can be seen in the plates.

DISCUSSION

The population of *H. armigera* on pods was significantly higher on plants at high densities compared with plants at low densities. Close plant spacing provided more food resource and facilitated movement of larvae from plant to plant as previously reported by Hillocks *et al.* (2000) and Okeyo-Owuor *et al.* (1980). The crop planted in July had the lowest population of pod borers as the crop growth period coincided with period of more abundant and frequent rainfall and higher humidity not conducive for pod borer feeding, reproduction and population growth. Cool and humid conditions had similarly been reported to influence population of *Maruca vitrata* infesting pigeonpea in Malawi (Minja *et al.*, 1999). Higher borer population in April and October plantings contrasted with July planting, and is consistent with the findings of Dialoke and Ezueh (2003) and Dialoke *et al.* (2014). Night and Ogenga-Latigo (1993) reported higher abundance *H. armigera* on short duration pigeonpea cultivars in Uganda during the short rains.

Percentage pod and seed damage was observed more on plants at high plant density than on plants at low plant densities probably due to high population of *H. armigera* larvae on pigeonpea at high plant density during the growth stage of pigeonpea. The cluster nature of the plants at high plant density provided opportunity for the feeding, reproduction and free movement of *H. armigera* larvae on the plants without restriction compared with plants at low densities with wider spacing which probably obstructed the movement and feeding of the larvae. This result agrees with observations by Hillocks *et al.*, (2000) and Okeyo-Owuor *et al.*, (1980) of high damage to pigeonpea pods at high plant population density. Generally, pests that fed on flowers and pods of pigeonpea caused most economic damage (Manjunath *et al.*, 1985).

July planting (mid-cropping season) recorded the lowest percentage pod and seed damage in 2009, and 2010 cropping seasons while the highest percentage pod and seed damage was recorded during April (early cropping season) and October (late-cropping season). The minimal *H. armigera* population on pigeonpea during July might have resulted to reduced pod and seed damage observed compared with high population of *H. armigera* during April and October. More damage to pigeonpea pods in April regarded as early planting is consistent with Afun *et al.*, (1991), who reported more pod/damage of *M. vitrata* on cowpea in the early season than late season. Similar results have been reported from India by Bhosale and Nawale, (1983) and Minja (1996).

Planting early duration pigeonpea cultivar ICPL 84023 at high plant densities had significant effect ($P < 0.05$), on pod and seed yield (kg ha⁻¹) compared with other plant populations. More pods (kg ha⁻¹) were produced by pigeonpea at high plant density than at low plant density but recorded lower seed yield (kg ha⁻¹) than plants at low density. More pod yield at high density might be due to increased plant population per unit area and taller plants under close row spacing. Obuo *et al.*, (1996), Okurut-Akol *et al.*, (1996), Rubaihayo *et al.*, (2000) reported increased seed yield (kg ha⁻¹) at low density of pigeonpea. Also Ali *et al.* (2009), Okeleye *et al.*

(1999), Shetty *et al.* (1995), and Tarawali *et al.* (1997), found that improved varieties of cowpea that are erect in nature could be grown at a higher plant population to maximize yield.

Sowing dates significantly affected the pod and seed yield (kg ha^{-1}) in 2009 and 2010 cropping seasons. More pods were produced in April 2009 ($444.00 \text{ kg ha}^{-1}$), July 2009 ($525.00 \text{ kg ha}^{-1}$), and October 2009 (64.00 kg ha^{-1}), compared with 2010 pod yields of April ($328.40 \text{ kg ha}^{-1}$), July ($499.50 \text{ kg ha}^{-1}$), and October (60.40 kg ha^{-1}).

With regards to seed yield (kg ha^{-1}), sowing pigeonpea within July produced more seed yield, followed by April while October had the poorest seed yield in both cropping seasons. A significant effect of sowing dates on pigeonpea was earlier reported by Rati and Shekhon (1975) in pigeonpea. Planting the early maturing cultivar in July produced the highest seed yield probably because the period received less insect pest infestation compared with April and October plantings that recorded high insect pest infestation and produced lower pod and seed yield (kg ha^{-1}). This result agrees with Dialoke *et al.*, (2014) who reported higher yield of improved pigeonpea in June than in April and August planting at Nsukka. Rupela *et al.* (2004) had earlier shown that moisture deficiency adversely affected the yield of early maturing pigeonpea cultivar (ICPL 88039). In late sown (October) pigeonpea, sudden cessation of rainfall delayed and reduced flowering and pod set; these, coupled with high borer population density culminated in poor pod and seed yield in consonance with the report of Kyamanywa *et al.*, (2001). Minja (1996) and Minja *et al.* (1999) reported increased yield losses due to pod borers in crops which flower and mature during warm weather than in crops which flower and mature in cool weather.

CONCLUSION AND RECOMMENDATION

Farmers in Southeastern Nigeria are used to planting local cultivars of pigeonpea which take up to eight to nine months to mature. Early maturing pigeonpea cultivar which takes up to

three to four months to mature is new in Nigeria and its adoption in our farming systems will help to meet the immediate food security need. This research will make pigeonpea to be popular with farmers than cowpea as a cheap source of protein for man, livestock and poultry feed industries. It is usually the case that planting date and method of planting will be dictated by markets, weather, labour availability, and other factors. However, for key pests with potential to cause serious damage, growers should consider a planting date to grow the crop outside the pest window i.e., when the population of the pest/s on the crop will be most minimal. From the available results, it could be seen that the incidence and population fluctuation and damage of *H. armigera* was very much dependent on prevailing climatic condition of the cropping season and plant densities. Both early (April) and late (October) cropping regimes received high *H. armigera* population, high damage and reduced yield at higher plant densities than the mid cropping period (July). Therefore, ensuring food security with maximum yield in the cropping season with less *H. armigera* infestation, early maturing pigeonpea should be sown within the first week of July, at lower plant density of $55,555 \text{ plants ha}^{-1}$ in Owerri Rainforest Zone, Nigeria.

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