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Relationship Between Population of *Cletus fuscescens* (Walker) (Hemiptera: Coreidae), Planting Dates, Lines and Grain Amaranth (*Amaranthus* spp.) Phenology

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ABSTRACT

The effects of planting dates, lines of grain amaranth and their phenological stages on *Cletus fuscescens* populations were studied during the growing seasons of 2009 and 2010 in the experimental field of National Horticultural Research Institute, Ibadan. Lines 'P 373' (*Amaranthus hypochondriacus*), 'Montana-3' (*Amaranthus cruentus*) and 'D 136- 1' (*Amaranthus hybrid*) were transplanted at 3 weeks old on three different planting dates which were at 2 weeks interval in a randomized complete block design replicated three times. *Cletus fuscescens* population levels started increasing when seeds began to form on the head of the amaranth and population levels generally peaked with 6.33 bugs in 2009 and 7.84 bugs in 2010 when the seeds were completely formed but milky. The individual effects of lines, 507.15 (2009), 539.55 (2010) and phenological stages, 116.52 (2009), 291.26 (2010) of grain amaranth significantly ($p>0.05$) affected *Cletus fuscescens* population levels with planting dates, 822.17 (2009), 1116.47 (2010) being the predominant factor. The interaction between planting dates and phenological stages (33.54) of grain amaranth was observed to be the most important factors in the first growing season: 2009 while in 2010, planting dates and lines was the most important interaction (35.36) affecting the population build up of *Cletus fuscescens* on grain amaranth. Planting of early flowering and maturing line early in the growing season assisted the critical phenological stage "milky seeds" to escape the high population levels of bug infestation in the field.

Key words: *Cletus fuscescens*, phenology, planting dates, *Amaranthus hypochondriacus*, *Amaranthus cruentus*, *Amaranthus hybrid*

INTRODUCTION

Amaranth, an alternative cereal is attracting researchers' attention mainly because of the high nutritional value of its seed which can be influenced by nitrogen fertilization (Pospisil *et al.*, 2006).

Grain amaranth has a higher protein quality and quantity than most cereals and grains. In general, the amino acid composition (protein building blocks) of amaranth grain protein compares well with the FAO/WHO protein standard (necessary for good health) in particular, grain amaranth has a relatively high proportion of lysine (an essential amino acid that must be present in the diet for good health) compared to other foods, leading to its effective utilization as a protein source (Sseguya, 2007). Amaranthus species are reported to have a thirty higher protein value than cereals such as rice wheat flour, oats and rye (De Macvean and Poll, 2002).

Consumption of grain amaranth is reported to have nutritional and health benefits, ranging from a general improvement of specific ailments and symptoms including recovery of severely malnourished children and an increase in the body mass index of people formerly wasted by HIV/AIDS (SRLP, 2005; Tagwira *et al.*, 2006). Several studies have shown that like oats, amaranth seed or oil may be of benefit for those with hypertension and cardiovascular disease; regular consumption reduces blood pressure and cholesterol levels while improving antioxidant status and some immune parameters (Czerwinski *et al.*, 2004; Gonor *et al.*, 2006; Martirosyan *et al.*, 2007).

One of the main features of the diet taken by majority of the populace of the tropics and subtropics of the developing world is the deficiency in the supply of protein and vitamin.

In the past, the Federal Government of Nigeria attempted to solve the problem of inadequate protein intake by massive importation of fish, poultry products and meat. This practice is however wasteful in terms of foreign exchange requirement. Instead the government should encourage local sourcing of cheap protein sources and their production of which the grain amaranth, soyabeans and others are recognized as most likely to play an important role (Fasola, 2000).

Because of the quality of amaranth protein and its high ability to meet human needs it could complement other cereals such as maize, sorghum and millet in the eradication of malnutrition facing the peasant.

Grain amaranth like most other vegetables is not free from the attack of insects. Various species of bugs and weevils damage the grain and cause economic yield losses. The most prevalent bugs infesting grain amaranth are *Cletus fuscescens* and *Cletomorpha unifasciata* (Makwali, 2002) whose population often reaches peak during the seed head: the critical milky seeds stage. They feed on the seeds causing discoloration, shriveling and premature drying of seeds thereby reducing seed yield and viability. Studies have been done on the damage caused by these bugs on cowpea pods and seeds but there is no information on grain amaranth.

This study was designed to determine the effects of planting dates, lines and phenological stages of grain amaranth on *Cletus fuscescens* populations.

MATERIALS AND METHODS

The experiment was conducted during the growing seasons of 2009 and 2010, at the vegetable field of the National Horticultural Research Institute, Ibadan, Nigeria, in the humid forest zone located at 3° 5'E, 7° 3'N and 168 m above mean sea level. Grain amaranth lines: 'P 373' (*Amaranthus hypochondriacus*), 'Montana-3' (*Amaranthus cruentus*) and 'D 136- 1' (*Amaranthus hybrid*) were raised in the nursery on sterilized soil and transplanted at 3 weeks old in plots of 2 × 3 m at a spacing of 35 cm within rows and 35 cm between rows on the 12th of May, 28th of May and 9th of June 2009 and repeated on the 4th of May, 18th of May and 1st of June 2010 which is at 2 weeks interval. Plots were replicated three times in a randomized complete block design. Each plot was separated by 1 m space. The plots were not subjected to any pesticide treatment. Nine middle plants were selected per plot for weekly observations on bug populations starting from two weeks after transplanting till grain maturity. Visual counts of insect population were made in the early hours of the morning (7-9 a.m.) when the insects were less active.

Statistical analysis: Data were subjected to analysis of variance and significantly different treatment means were separated using Student-Newman-Keuls (SNK) (SAS Institute, 2009) ($p = 0.05$). Individual effects of lines, planting dates, grain amaranth phenological stages with interactions between the individual effects were evaluated.

RESULTS AND DISCUSSION

During the growing season of 2009, flowering and maturity was first observed in line 'D 136-1' all through the three planting dates while line 'Montana-3', the last to flower and mature, though not significantly different from line 'P 373' except in the third planting date for flowering and second planting date for maturity (Fig. 1). This same trend was observed in 2010 where line 'D 136-1' was first to flower and mature all through the three planting dates while line 'Montana-3'

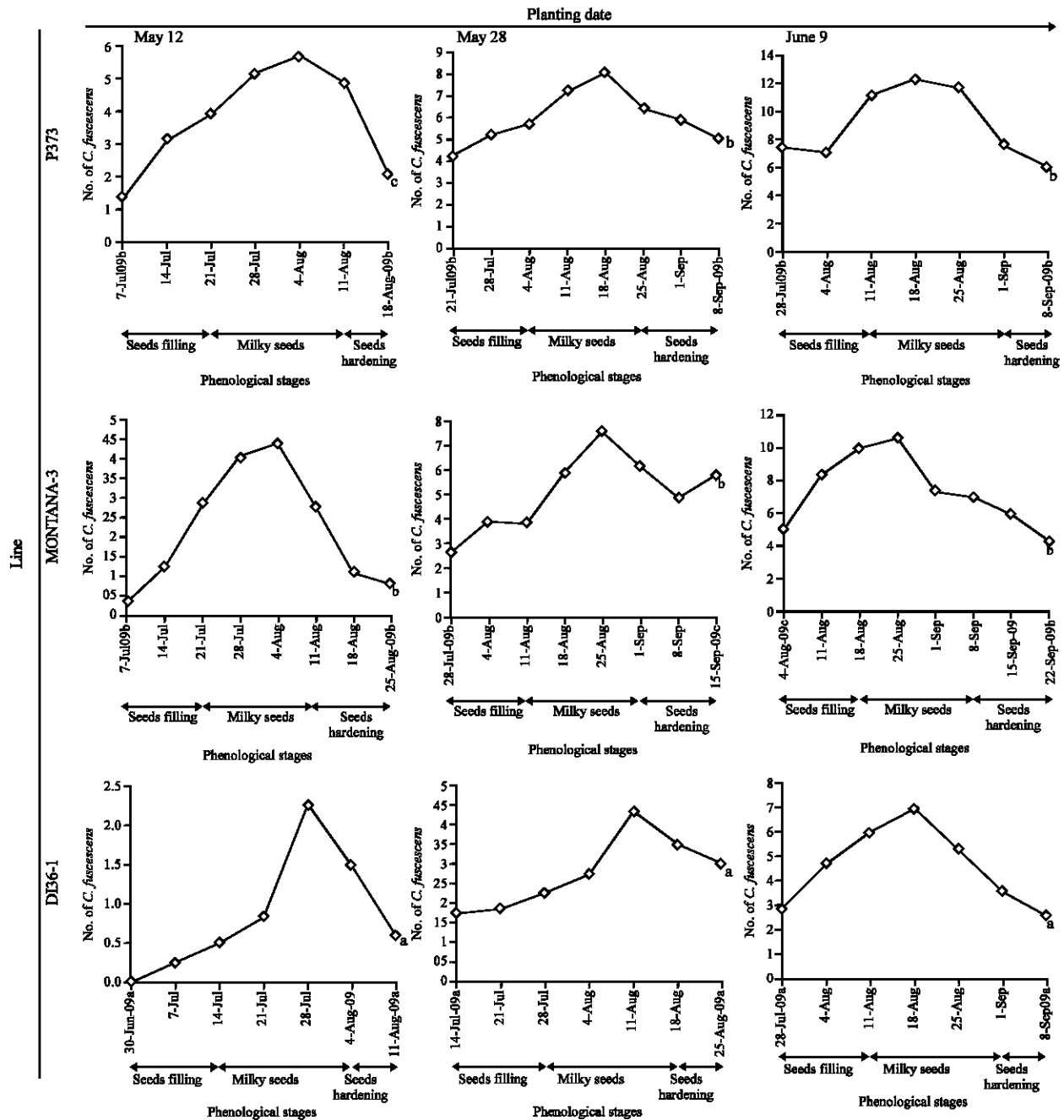


Fig. 1: Population trends of *Cletus fuscescens* in relation to grain amaranth phenological stages, planting dates and lines in 2009

also the last to flower and mature, though not significantly different from line 'P 373' except in the second planting date for flowering and first planting date for maturity (Fig. 2). The significant difference in the mean days of flowering and maturity of line 'D 136-1' from the two other lines in the two seasons all through the planting dates could be used to describe it as an early maturing line.

The seasonal mean bug population increased progressively among the planting dates and lines as the season progressed in the two growing seasons. During 2009 growing season line 'P 373' had

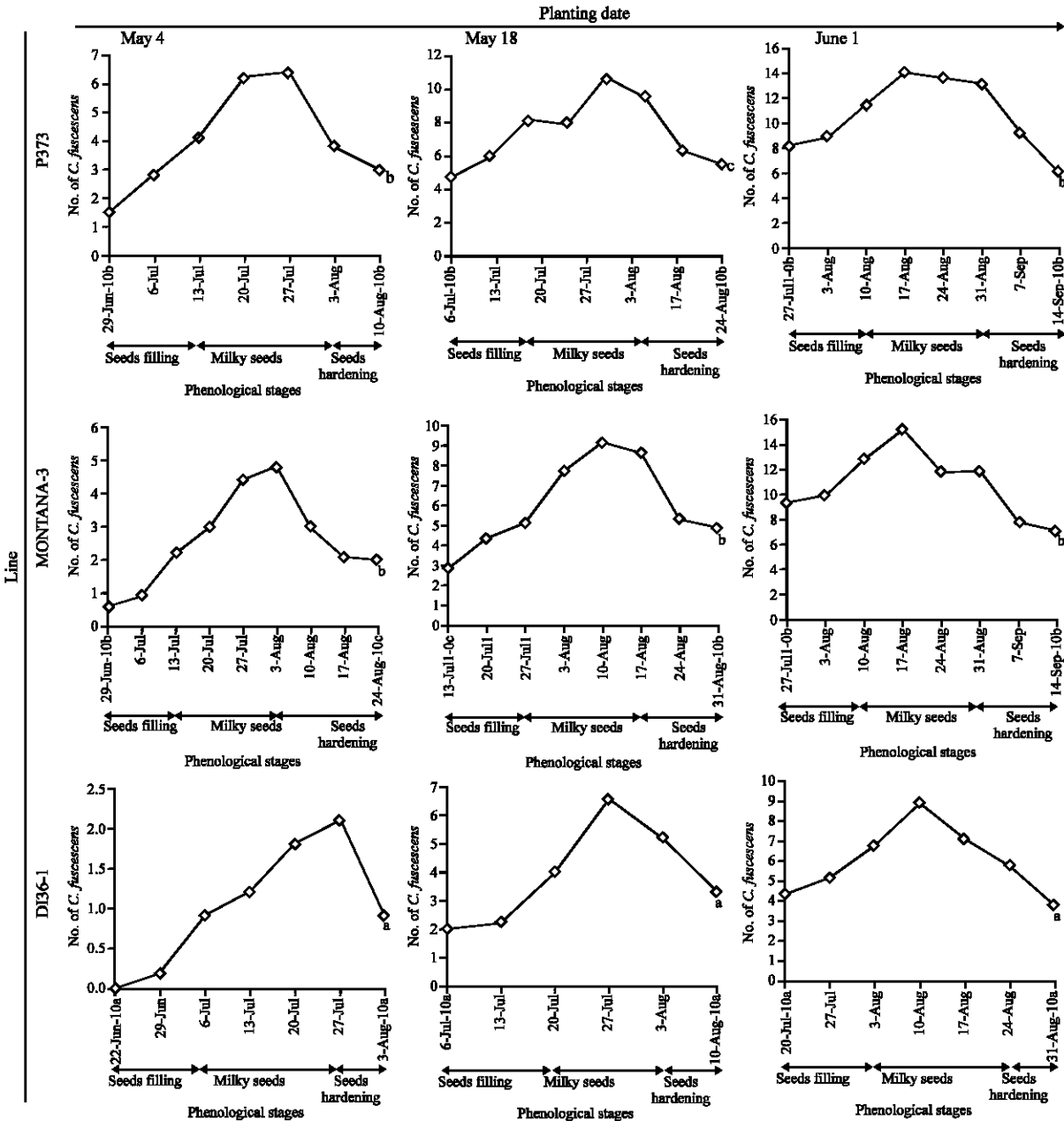


Fig. 2: Population trends of *Cletus fuscescens* in relation to grain amaranth phenological stages, planting dates and lines in 2010

the highest mean bug population among the lines and along the three planting dates though not significantly different from that of line 'Montana' except in the first planting date while line 'D 136-1' had the least bug population among the lines and along the three planting dates (Fig. 1). In 2010, despite the insignificant difference in mean bug population that was also observed between line 'P 373' and line 'Montana' except in the second planting date, line 'P 373' still had the highest mean bug population while line 'D 136-1' again had the least bug population among the lines and along the three planting dates (Fig. 2). The highest mean bug population on 'P 373' in the two growing seasons could be that the bugs preferred line 'P 343' to line 'D 136-1'.

It was observed in the growing season of 2009, that the third planting date: June 9th across the lines had the most bug population than the first and second planting dates (Fig. 1), also the third planting date of 2010: June 1st across the lines had the most bug population than the first and second planting dates (Fig. 2). The highest number of bug population in the third planting date could be as a result of abundance of the bug in the field due to their build up on the 3 lines over the planting dates in the growing season.

All the 3 lines had 3 weeks of milky seeds along the planting dates of 2009 (Fig. 1) and also along the planting dates of 2010 except for line 'D 136-1' in the second planting date (May 18) which had 2 weeks of milky seeds (Fig. 2). The 2 weeks of milky seeds of line 'D 136-1' in the second planting date (May 18) of 2010 could be attributed to its earliest maturity in that planting date compared with the other planting dates of the two (2009 and 2010) growing seasons.

Though the number of weeks of the phenological stages across the lines in the three planting dates in 2009 growing season ranged between 7-8 weeks (Fig. 1) and ranged between 6-9 weeks in 2010 growing season (Fig. 2), the bug population still peaked during the milky seeds stage of the two growing seasons (Fig. 1, 2). The peaking of bug population during the milky seeds stage despite the variation in the number of weeks of the phenological stages across the lines in the three planting dates and the two growing seasons reveals a preference for the milky seeds stage and a strong relationship between the bug population and grain amaranth phenological stages.

Phenology of a host plant plays an important role in the development of its associated pests on it. This was observed by Solangi *et al.* (2008) with maximum sucking insect pests i.e., whitefly: *Bemisia tabaci* (Genn.), thrips: *Thrips tabaci* (Linn.) and jassid: *Amrasca devastans* (Dist.) population on cotton in the last week of August and first week of September with vegetative growth and succulence of leaves coupled with maximum temperature.

Bug population fluctuated relative to over-all phenological stage of grain amaranth. The bug population across the lines in the three planting dates of 2009 growing season (Fig. 1) and 2010 growing season (Fig. 2) began to build up during the seeds filling stage (flowering); it increased and peaked during the milky seeds stage (formed seeds) and towards the end of the milky seeds stage when the seeds have started hardening (harvesting week) it began to decline. The peak in the population of the bug at the milky seeds stage is an indication that the seeds provided the most suitable quality and quantity of food for the bugs. This is most appropriate because at the seeds filling stage when the embryo are just about forming the bugs won't have enough juice "food" to suck and at the seeds hardening stage the embryo is already hard for the bugs to suck.

This observation is in agreement with earlier report of Schumann and Todd (1982) which stated that the preference of *Nezara viridula* for full sized soybean pods as a feeding site was not surprising, since large pods provided the largest quantity and highest quality food and therefore, could support the most concentrated population of *Nezara viridula*.

Also Mveyo-Ndankeu *et al.* (2011), stated that phenology of host plants such as *Leucena* spp., *Hylodendron gabunensis* and *Albizia adiantifolia* justifies the proliferation of *Heterospylla cabana* (Crawford), *Ciriactremum nigeriensis* (Hollis) and *Yangus* spp. on them, respectively during the rainy season when the plants renew their leaves.

Phenological study showed that *Chnootriba similis* (Thunberg) has two generations annually and occurrence of the generations was synchronized with the growing seasons of its hosts, cereal crops which are grown twice a year and the two abundance peaks of the insect were observed during both growing seasons in 2004 and 2005 in Ethiopia (Beyene *et al.*, 2009).

The bug population of 2010 growing season (Fig. 2) was more than that of 2009 growing season (Fig. 1) though the trend of fluctuation was similar. The increase in the bug population in the second growing season could be that the bug population that was built up in the planting dates of the first growing season hibernated in alternative hosts during the off season and returned to infest preferred host: grain amaranth in the field during the next growing season.

Banjo (2007) observed that the onset of rain which marks the termination of the dry season encourages the emergence of some weeds among which is *Amaranthus spinosus* and abandoned farms of fallow field thus flourish for several weeks before sufficient moisture in the soil allow for cultured planting, these probably allow easy build up of the insect which survive on this plant where it survives as alternative host.

Clementine *et al.* (2005) stated that at cowpea flowering stage, adults *Clavigralla tomentosicollis* migrate from their survival site (alternative host plants) towards cowpea plant which offers an oviposition and resting sites (leaves) as well as a feeding substratum (pod). One or two generations of *Clavigralla tomentosicollis* develop on cowpea and the last one migrates at the end of cropping season which coincides with the beginning of dry season (Dabire, 2001).

In 2009 and 2010 growing seasons, phenological stages and lines had influence on the bug population but the greatest individual influence on the bug population was from planting dates 822.17 and 1116.47, respectively (Table 1).

Planting dates which was revealed as the most important factor in this experiment was not so for green stink bug *Nezara viridula* on soybean. Schumann and Todd (1982) stated that although significant interactions occurred between stage of development and planting dates ($p < 0.0001$, F value = 6.71) and stage of development and cultivar ($p < 0.0001$, F value = 22.22), stage of development had the greatest influence on green stink bug populations ($p < 0.0001$, F value = 365.12) while planting date alone affected *Nezara viridula* population dynamics significantly ($p < 0.0001$, F value = 156.59).

In 2009 growing season, significant interactions occurred between planting dates and lines 14.05, lines and phenological stages 11.04 but the greatest interaction occurred between the planting dates and phenological stages 33.54 (Table 1), in 2010 growing season, significant

Table 1: Analysis of variance of factors affecting the population of *Cletus fuscescens* on grain amaranth in 2009 and 2010 growing seasons

Source	2009		2010		PR>F
	Df	F value	Df	F value	
Planting date	2	822.17	2	1116.47	<0.05
Line	2	507.15	2	539.55	<0.05
Phenological stage	7	166.52	8	291.26	<0.05
Date*line	4	14.05	4	35.36	<0.05
Date*phenological stage	14	33.54	16	34.04	<0.05
Line*phenological stage	14	11.04	16	12.69	<0.05

interactions occurred between lines and phenological stages 12.69, planting dates and phenological stages 34.04 but the greatest interaction occurred between the planting dates and lines 35.36 (Table 1).

The greatest interaction between the planting dates and phenological stages 33.54 in 2009 growing season, imply that the availability of grain amaranth seeds at the preferred phenological stage (milky seeds stage) all through the planting dates in the growing season provided an adequate site for reproduction which resulted in the population build up of the bug.

The greatest interaction between the planting dates and lines 35.36 in 2010 growing season, imply that the availability of grain amaranth line whether early or medium maturing in the field all through planting dates in a growing season also provided an adequate site for reproduction which resulted also in the population build up of the bug.

CONCLUSION

From the observation of the effects of planting dates, lines and phenological stages of growth of grain amaranth on *Cletus fuscescens* population dynamics over 2 growing seasons, planting date was most important single factor and interacting factor with line and phenological stage to the relationship. This suggests that grain amaranth whether early, medium or late maturing line should not be planted successively in a growing season to prevent the build up of bug population level in the field that will result in increase in infestation rate in the next growing seasons therefore the development of alternative pest control strategies that will emphasise rotation of grain amaranth in a growing season with crops that are not alternative hosts of its pests should be considered.

Planting of early flowering and maturing line early in the growing season assisted the critical phenological stage "milky seeds" to escape the high population levels of bug infestation in the field.

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