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Effects of planting date, cultivar and insecticide spray application for the management of insect pests of cowpea in northern Ghana

Mumuni Abudulai [a, *], Francis Kusi [a], Shaibu S. Seini [a], Ahmed Seidu [a], Jerry A. Nboyine [a], Asamoah Larbi [b]

[a] Council for Scientific and Industrial Research -Savanna Agricultural Research Institute (CSIR-SARI), P. O. Box TL 52, Tamale, Ghana
[b] International Institute of Tropical Agriculture- Tamale, Ghana

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ABSTRACT

Insect pests are a major constraint to cowpea production in northern Ghana where it is widely cultivated. Field experiments were conducted to evaluate the effects of planting date, cultivar and insecticide applications for the management of major insect pests attacking cowpea. There were 4 planting dates, 6 cowpea cultivars of medium maturity periods and 2 insecticide spraying regimes. Data were collected on densities of the major insect pests, including the legume pod borer *Maruca vitrata* F., thrips *Megalurothrips sjostedti* Trybom, and the pod-sucking bug complex dominated by *Clavigalla tomentosicollis* Stal., and grain yield. Early planting of cowpea in mid- or late July resulted in the lowest pest densities compared with those planted at later dates. Two of the six cowpea varieties (IT99-573-2-1 and IT99-573-1-1) supported the lowest numbers of insects across planting dates and irrespective of insecticide spraying regime. However, insecticide sprays significantly lowered pest densities and improved yields in all varieties, and yields were the highest when treatments were combined with early planting in mid-July. The results suggest that for maximum yield, cowpea in the study area should be planted in mid-to-late July and sprayed with insecticide. Where available, these treatments can also be integrated with varieties such as IT99K-573-2-1 and IT99k-573-1-1 which appeared to be less susceptible to insects in the current study.

1. Introduction

Cowpea, *Vigna unguiculata* (L) Walp, is an important indigenous African grain legume grown by millions of resource-poor farmers (Ajeigbe and Singh, 2006). It is a major staple food crop in Ghana, where the leaves, green pods, green peas and the dry grain are eaten. With a grain content of 23–38% protein, cowpea constitutes the cheapest source of dietary protein for the majority of rural and urban poor in Africa. The haulms are also an important source of nutritious fodder for livestock (Bressani, 1985; Blade et al., 1997; Tarawali et al., 1997). In addition, sale of the grain provides a major source of income to farmers and traders in Ghana. The crop is particularly favored by many small holder farmers because of its ability to fix nitrogen into the soil and compatibility as an intercrop in the widely practiced mixed cropping systems (Singh and Sharma, 1996).

Despite its importance, cowpea yields on farmers' fields are relatively low in Ghana due mainly to problems of insect pests, particularly those that attack the flowers and pods (Jackai et al., 1985; Kyamanywa, 1996; Karungi et al., 2000; Ajeigbe and Singh, 2006; Dzemo et al., 2010). The most important insects include the flower thrips *Megalurothrips sjostedti* Trybom, the legume pod borer *Maruca vitrata* Fabricius and a complex of pod-sucking bugs (PSBs) of which *Clavigralla tomentosicollis* Stål is the most dominant species (Jackai et al., 1985; Jackai and Adalla, 1997). *Megalurothrips sjostedi* and *M. vitrata* feed on flower buds and flowers resulting in their abscission or premature dropping. In addition, *M. vitrata* chew into developing pods causing severe damage to the grain. PSBs suck the sap from developing pods, which results in pod and seed shriveling. Apart from the feeding damage, PSBs are also implicated in transmitting fungal pathogens that cause seed decay or rotting (Mitchell, 2004). Yield losses can be as high as 100% if no control measures are taken against these insects (Jackai and Daoust, 1986; Asiwe et al., 2005; Tanzubil et al., 2008).

Conventionally, insecticide application is the principal recourse

* Corresponding author.
E-mail address: mabudulai@yahoo.com (M. Abudulai).

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for control of insect pests on cowpea (Jackai and Daoust, 1986; Karungi et al., 2000; Opolot et al., 2006). Although, this control can increase yields by several fold (Asante et al., 2001; Kamara et al., 2010), most small holder farmers are resource-poor and cannot afford recommended insecticides (Bottenberg, 1995). For these farmers, other control options, particularly those that are cheap, should be exploited. Bio-pesticides such as those extracted from the neem tree (*Azadirachta indica* A. Juss), which is widely distributed in Africa, are reported to be effective against many insect pests including those of cowpea and can be suitable alternatives to synthetic insecticides (Abudulai et al., 2003; Oparaeke et al., 2006a, b; Ahmed et al., 2009; Mnif and Ghribi, 2015; Sokame et al., 2015). For example, neem applied alone or as mixtures with other botanicals effectively lowered populations and damage of *M. vitrata* and pod-sucking bugs and increased yields in cowpea (Abudulai et al., 2003; Oparaeke et al., 2005). However, there are limitations that hinder effective large-scale use of bio-pesticides. In most developing countries like Ghana farmers use crude formulations which, although are cheaper and more affordable, are less effective compared to the industry processed commercial formulations (Gahukar, 2014). Use of resistant varieties has been suggested as one of the most viable control measures for small holder farmers. Unfortunately, however, no single variety has yet been found to be resistant to the wide array of insect pests that attack cowpea (Asante et al., 2001; Dzemo et al., 2010). Often, varieties found to be resistant are only resistant against one or a few insect pests which when used alone cannot provide satisfactory control (Jackai and Daoust, 1986). Manipulation of planting date is another tactic that has been used to manage insect populations and damage in crops (Pulakkatu-Thodi et al., 2014). The usefulness of this tactic relies on timing of planting to desynchronize the period of pest population build-up with the most vulnerable stage of the crop (Javaid et al., 2005). In Nigeria, cowpea planted early in June/July escapes from pest attack and produces higher yields than those planted late in August (Asante et al., 2001; Kamara et al., 2010). Similarly, Karungi et al. (2000) reported that early planted cowpea suffers less insect infestation resulting in high yields in Uganda. In northern Ghana where this study was conducted, cowpea is normally planted in late July to early August. The objective of the current study was to identify the appropriate combinations of planting date, cowpea variety and insecticide spray for control of insect pests of cowpea in northern Ghana. Bio-pesticides, though another promising option, were not included in the study.

2. Materials and methods

2.1. Study area

The study was conducted on-farm at Tingoli (09° 42′ N, 00° 92′ W, 184 m ASL) in the northern Region and Googo (11° 00′ N, 00° 24′ W, 163 m ASL) in the Upper East Region of Ghana during 2012 and 2013. These areas are characterized by a single rainfall season that spans from May to October followed by a dry season from November to April. Tingoli falls within the Guinea Savanna zone while Googo is located in the Sudan Savanna zone. The soils in both areas were sandy loam, with a pH of 4.5–5.5. At Tingoli, total rainfall was 1032.2 mm in 2012 and 1079 mm in 2013. Minimum and maximum temperatures were 23.3° C and 33.3° C in 2012, and 23.1° C and 33.6° C in 2013. At Googo, total rainfall was 1008.7 mm in 2012 and 888.7 mm in 2013 while minimum and maximum temperatures were 21.9° C and 32.2° C in 2012 and 24.3° C and 37.4° C in 2013. The rainfall in both years and locations stabilized in June and was evenly distributed across the growing season in 2012. However, the rainfall season suffered an unusual drought in August in 2013.

2.2. Treatments and experimental design

Treatments in this experiment consisted of 4 planting dates and 6 cowpea varieties of medium maturity periods, which were sprayed with insecticide or unsprayed. Planting dates were mid-July, late-July, mid-August and late-August. Planting for mid-July was made between 13 and 16 July, late July between 27 and 30 July, mid-August between 13 and 17 August and late August between 27 and 31 August in each year. Cowpea is usually planted in late July to early August in the study areas. The six cowpea cultivars used were IT99 K-573-1-1 and IT99 K-573-2-1 obtained from the International Institute of Tropical Agriculture (IITA), Bawutawuta, Songotra and Padi Tuya obtained from the breeding program at CSIR-SARI, and a farmer's own variety (FOV). The cultivars from IITA were elite and candidate cultivars for possible release to farmers while those from the CSIR-SARI breeding program were released and farmer preferred cultivars in Ghana. The treatments were arranged in a split-split-plot in a randomized complete block design with three replications. Insecticide sprays constituted the main plot treatments, while planting dates were the sub-plots and cowpea cultivars were the sub-sub-plot treatments. On sprayed plots, three sprays were made against thrips, *Maruca* pod borer and pod-sucking bugs at 10 days intervals from flower bud initiation through podding (Kamara et al., 2010). The sprays were accomplished using Lambda Super 2.5 EC (lambda-cyhaolothrin, Kumark Company, Kumasi) applied with a CP-15 Knapsack sprayer at the rate of 0.02 kg a.i. ha^{-1} in 150 L of water. This insecticide is recommended and used for cowpea pests in Ghana. Sub-sub-plots consisted of 4 rows 5 m long spaced at 0.60 m between rows and 0.20 m between plants in a row. The replicates and main plots were separated by 2 m alleys while the sub and sub-sub plots were spaced 1 m apart.

2.3. Sampling of insect pests

Arthropod data were taken from the two middle rows of each sub-sub plot. Thrips and *Maruca* infestations in flowers were assessed twice at five-day intervals beginning at 35 days after planting. On each sampling day, twenty flowers were randomly collected from plots into vials containing 40% ethanol. The samples were taken to the laboratory and dissected to count the insects under a binocular microscope. Populations of PSBs (dominated by *C. tomentosicollis* but included *Riptortus dentipes* F, *Anoplocnemis curvipes* F and *Nezara viridula* L.) were estimated by visual counts of adults and nymphs in the two middle rows of each plot at weekly intervals from flowering till harvest. Since PSBs inflict a common damage, the different PSB species were counted together as one pest guild (Afun et al., 1991).

2.4. Grain yield and damage assessment

At maturity, plants in the two middle rows of each sub-sub plot excluding 1 m from each border were harvested to determine grain yield. The pods were sun-dried for 3 days and then threshed manually to separate the grain from the shells. The grain yield in each plot was weighed and converted to kilogram per hectare for analysis. Grain damage was subsequently assessed from a random sample of 100 seeds from each plot. Shriveled grains and those with characteristic PSB feeding punctures or stains were sorted out as damaged grain and converted to percentage damage.

2.5. Statistical analysis

Data on arthropod counts where appropriate, were transformed to logarithmic scale to normalize variances before analyses (Gomez