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Full Length Research Paper

Effects of insecticide sprays on insect damage and yield of soybean at Makurdi, Nigeria

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The effects of application of chlorpyrifos (50g a.i./ha), dimethoate (280g a.i./ha), cypermethrin (75g a.i./ha) and cypermethrin + dimethoate (37.5 + 140g a.i./ha) at mid – vegetative, 50% flowering and 50% podding on damage to and yield of soybean were assessed in 2000 and 2001 cropping seasons at the Teaching and Research Farm of the University of Agriculture, Makurdi. Experimental design was randomized complete block with each of five treatments (including unsprayed control) replicated four times. At the three growth stages of soybean, mean number of leaves plant^{-1} and percentage defoliation did not differed significantly. Mean number of leaves and defoliation ranged from 16-46 and 0.3-0.6, respectively. Similarly, treatment differences for soybean yield and yield parameters were not statistically significant ($p > 0.05$), except for % malformed pods and %damaged seeds, with cypermethrin + dimethoate giving the lowest malformed pods (28.15%) and seed damage (10%). Our data showed very low level of defoliation (<1% on the average) due to insect pest feeding activities. However, seasonal variation in pest density and damage provided premise for reiterating rational basis for insecticide usage in soybean production in the study area.

Key words: Insecticide, soybean, pest density, spray

INTRODUCTION

The cultivation of soybean, *Glycine max* (L.) Merrill, is increasingly gaining importance in tropical and sub – tropical Africa and it is a commercial crop of many developed and developing countries of the world (Adegbite *et al*., 2005). Soybean seed contains 40% protein and 20% edible oil (IITA, 1990; Onwueme and Sinha, 1991). In areas where large scale production of the crop occur, insect pests have been reported one of the limiting factors (Jackai and Singh, 1987; Jackai *et al.*, 1990). When such production levels were sustained for many years, major insect pest species and their corresponding damaging effects were also identified. Control strategies were thus developed based on intensive research on specific pest species problems in different locations (Turnipseed *et al*., 1974; Mueller and Engroff, 1980; McWilliams, 1983; Gianessi, 2009).

In Nigeria, Benue state, in the Southern Guinea Savanna, is a leading producer of soybean (Ashaye *et al*., 1974; Woodworth *et al*., 1992; BNARDA, 1995). Both the land area cropped with soybean and the production level have steadily increased, with total land area from 58,000 ha in 1997 to 83,900 ha in 2001 and mean yield of 1,500MT in 1997 to 1.95MT in 2001 (BNARDA, 2002). Previous studies on the insect fauna of soybean in this

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state were those of Ogun (1987), Ogunwolu (1992) and Ogunwolu and Ekefan (1996), each calling for a regular monitoring of the pest status of the numerous insects associated with the crop, especially when larger land area is being devoted to its cultivation.

Conventional breeding strategies have not produced insect resistant cultivars accepted by soybean growers because insect resistance has not been introgressed into high-yielding cultivars. Both yield and insect resistance are inherited quantitatively, and transferring all desired genes into an adapted cultivar has proven difficult (Hulburt *et al.*, 2004). The use of conventional chemical insecticides constitutes the only presently available tool that affords consistent, economical and effective suppression of insect outbreaks on soybean (Turnipseed and Kogan, 1987). There is therefore, a high tendency for farmers to begin to use insecticides commonly applied for the control of other grain legumes on soybean, especially when alarming population levels of insect pests are reported. The main objective in this study was to test several of the synthetic insecticides (as available in the open market) against the wide spectrum of insects associated with the crop and to determine the impact of such treatments on crop damage and yield.

MATERIAL AND METHODS

A 0.14ha portion of the Teaching and Research Farm, University of Agriculture, Makurdi was ploughed, harrowed, ridged and demarcated into four blocks each containing five plots. The plots were 10 rows wide, with 1m between rows, and 6m long. For two consecutive cropping seasons, seeds of *Samsoy2*, a medium duration variety of soybean adapted to Benue State (BNARDA, 1993), were drilled on ridges (rows) at a depth of 2.5 – 3.0cm in July 13, 2000 and July 17, 2001. Weeds were suppressed with pre –emergence application of butachor (Teer® 50 E.C.) at the rate of 2.5kg a.i./ha using a knapsack sprayer, 24 hours after planting. Hoe weeding was done at 6 weeks after planting (WAP). Seedlings were thinned at 3 WAP to give a density of 266,666 plants/ha. Four insecticidal prays comprising 50g a.i/ha chlorpyrifos, 280g a.i./ha dimethoate, 75g a.i/ha cypermethrin and 37.5g cypermethrin + 140g dimethoate a.i/ha as well as an unsprayed control were randomly assigned to the plots in each of the blocks. The insecticides were sprayed at mid – vegetative growth stage (4WAP), at 50% flowering (8WAP) and at 50% podding (9 WAP). From 3 WAP till harvest, a sample of two plants per plot was taken at random to count the number of leaves per plant, determine leaf area, assess defoliation by insects and determine whole pant dry weight. Leaf area was determined by the methods of Palaniswamy and Gomez (1974), Wiersma and Bailey (1975) and Balakrishnan *et al*. (1986), using length x maximum width of leaf and a predetermined multiplier. Defoliation was measured by visual estimates of portion of each leaf damaged by insects to the nearest $0.5cm^2$ based on a predetermined tracing on grid measurement. Nolting and Edwards (1985) as reported by Nolting and Edwards (1989) as well as Zehnder and Evanylo (1989) have used the visual defoliation rating technique on soybean either solely or in combination with other standard method. The dry weight was determined by drying plant samples in ventilated ovens (model 175 Fisher Scientific Company, USA) set at 70^0c for 96 hours and weighing them thereafter using a triple beam balance (Model Ohaus, USA 610g). At maturity the number of pods plant^{-1} (n = 2 plants/plot) were counted, thereafter 100 pods picked at random in each plot and proportion of malformed recorded. Malformed pods consisted of shriveled, sub sized pods (also employed for assessing bug damage in cowpea by Ameh & Ogunwolu, 2000).

All pods were then shelled and the seeds sorted into damaged and undamaged categories and the former number of seeds expressed as percentage of all seeds (% seed damage). Pitted, sub sized or discolored seeds were described damaged seeds (Ameh & Ogunwolu 2000). Pod yield and seed yield were measured using a top loading spring balance (Salter 10kg) from a harvest of four middle rows in each plot, before and after threshing, respectively. The weight of 100 seed lot per plot was taken using a top loading mettler electronic balance (Model 163 Mettler Instrument 160g A G – Switzerland).

Data were analyzed using analysis of variance (ANOVA) for randomized complete block design; significantly different treatment means were separated using Fisher's least significant difference (Obi, 2002, Steel and Torrie, 1960).

RESULTS

The average number of leaves plant^{-1} at the vegetative, reproductive and maturation growth stages of soybean averaged over the two cropping seasons (2000 and 2001) are presented in Table 1. There was no significant (P<0.05) treatment effects in the mean number of leaves plant^{-1} in both sprayed and unsprayed plots. The seasonal mean number of leaves plant^{-1} differed significantly and ranged from 71-92. The treatment, cypermethrin + dimethoate recorded the highest number of leaves plant^{-1} while the least was recorded in the unsprayed (control) plots.

Percentage defoliation at different plant growth stages of insecticide sprays in soybean averaged over two cropping seasons were statistically similar (Table 2). In all the four insecticide spray regimes and the unsprayed (control) treatment, defoliation values were very narrow and ranged from 0.3-0.5%, while the seasonal defoliation percentage was the same (0.6%) for all the treatments. Dry matter accumulation of soybean plants under insecticide sprays at vegetative, reproductive and maturation averaged over two growing seasons are presented in Figure 1. Dry matter accumulation increased sharply during active vegetative growth of the crop until after podding when the rate of increase slowed down. No significant differences were observed between sprayed and unsprayed plots.

Effects of insecticide spray on yield and yield parameters of soybean averaged over two cropping seasons did not differed significantly, except for %malformed seeds and %damaged seeds (Table 3). Pod yield, seed yield, pods and 100-seed weight ranged from 2.6-3.4t/ha, 1.4-1.9t/ha, 16-22 and 12-13g, respectively. Percentage malformed pods ranged from 28-36, while

Table1. Mean number of leaves per plant at different growth stages and insecticide sprays in soybean averaged over two cropping seasons

Insecticide (g a.i./ha)	Vegetative (V3–V10)	Reproductive (R1–R5)	Maturation (R6 –R7)	Seasonal
Chlorpyrifos (50)	15.7	36.3	24.5	76.4
Dimethoate (280)	17.6	34.3	31.2	87.5
Cypermethrin (75)	16.2	38.7	33.5	88.4
Cypermethrin+ Dimethoate(37.5+ 140)	17.5	46.2	28.7	92.4
Control	16.6	37.5	27.8	71.3
LSD (0.05)	**ns**	**ns**	**ns**	**4.20**

*V1…, R1…, = Soybean growth stage description (Fehr and Caviness, 1977)
n.s. = not significant

Table2. Percent defoliation at different plant growth stages of insecticide sprays in soybean averaged over two cropping seasons

Insecticide (g a.i./ha)	Vegetative (V3–V10)	Reproductive (R1–R5)	Maturation (R6 –R7)	Seasonal
Chlorpyrifos (50)	0.4	0.3	0.3	0.6
Dimethoate (280)	0.4	0.3	0.3	0.6
Cypermethrin (75)	0.5	0.4	0.3	0.6
Cypermethrin+ Dimethoate(37.5+ 140)	0.4	0.3	0.3	0.6
Control	0.5	0.3	0.3	0.6
LSD (0.05)	**ns**	**ns**	**ns**	**ns**

*V1…, R1…, = Soybean growth stage description (Fehr and Caviness, 1977)
n.s. = not significant

seed damage ranged from 10-13%.

DISCUSSION

None of the insecticides applied could be said to have affected leaf production appreciably throughout the growth stages of the crop. The trend of leaf production observed is explained by the diversion of photosynthetic assimilates from the vegetative to the reproductive structures by the plant. The similarities observed in loss of photosynthetic leaf area (defoliation) in both sprayed and unsprayed plots further justifies our earlier explanation on effect of the chemicals on number of leaves. The very low level of defoliation due to insect pest feeding activities reported in this study (<1% on the average) refuted the seemingly high figures quoted by earlier workers: 4.4-8.9 % by Ogun (1987); 13.8 – 15% by Adamu *et al*. (1999) who might have used less sensitive methods for estimation of defoliation under natural infestations. Defoliation due to natural infestations (Huffman and Mueller, 1989, McPherson and Moss, 1989) have been reported to be much lower than when simulation method of estimation was employed (Ostlie and Pedigo, 1985; McPherson and Moss, 1989, Nolting and Edwards, 1989).

The non significant differences in mean number of leaves plant^{-1}, percentage defoliation, pod and seed yields in the sprayed and unsprayed treatments is however, in consonant with the submission of Gianessi (2009) that soybean has a remarkable capacity to withstand much insect injury without significant yield loss. It accomplishes this by both tolerating and compensating for injury. Yield losses are prevented because soybean plants typically produce excess leaves. Soybean plants often compensate for defoliation by producing additional

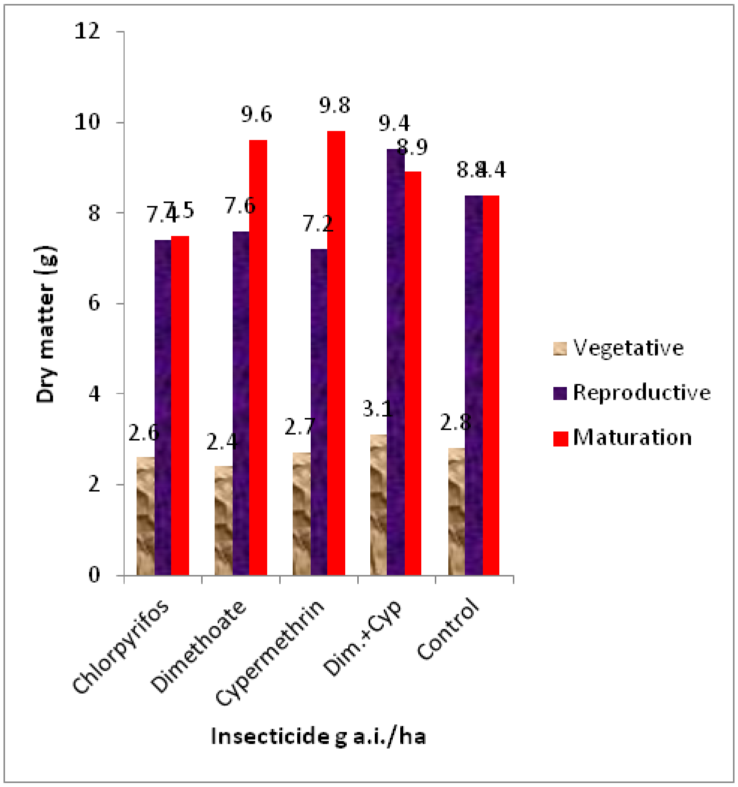

Figure1. Dry matter accumulation (g) of soybean plants under insecticide sprays at vegetative, reproductive and maturation averaged over two growing seasons.

Table3. Effects of insecticide spray on yield and yield parameters of soybean averaged over two cropping seasons

Insecticide (g a.i./ha)	pod yield (t/ha)	Seed yield (t/ha)	pods plant-1	%malformed pods	%damaged seeds	100-seed weight (g)
Chlorpyrifos (50)	2.7	1.5	22.1	34.9	13.2	12.9
Dimethoate (280)	3.4	1.9	21.7	28.6	12.3	13.6
Cypermethrin (75)	2.6	1.4	19.7	35.4	11.4	12.9
Cypermethrin+ Dimethoate(37.5+ 140)	3.3	1.8	18.5	28.2	10.0	13.1
Control	2.9	1.6	16.3	36.0	12.2	13.2
LSD (0.05)	ns	ns	ns	1.02	0.21	ns

*n.s. = not significant

leaves. When leaf loss becomes too great, plant compensate by retaining older leaves and maintaining high levels of photosynthesis.

The rate at which dry matter accumulated in relation to crop growth stage is considered to be a natural phenomenon in which active photosynthetic processes should be positively correlated with plant dry weight increased. This means, too that the impact of phytophagous insect species was not sufficient to show differences in crop damage whether or not insecticidal sprays were applied. Yield trends for the two cropping seasons were similar. The implications of these findings therefore are that only seasonal variation in pest density and damage were observed. This gives credence to our reiterating the use of insecticides in soybean production in this area only when there is sufficient evidence of crop damage at economic levels, still upholding previous workers' recommendations (Jackai *et al.*, 1983, Ogunwolu and Ekejan, 1996). It is however important that insect monitoring exercise be sustained to keep surveillance over species that might change in pest status in view of the dynamic nature of cropping systems in addition to enhancing the use of other control measures that are ecologically viable for the management of the pests (Muthomi *et al*., 2007).

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