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Effects of Synthetic (Carbofuran) and non Synthetic insecticides on Maize Growth and Yield in Stem Borers Infested Zones of Cross River State, Nigeria.

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Abstract

Field experiment was conducted in the early and late planting season of 2009 and 2010 at Akampa and Bekwarra to evaluate the effects of carbofuran, a synthetic insecticide, Neem and Gmelina seed powder on maize agronomic characters in maize stem borer endermic zones. The treatments consisted of 2 levels carbofuran (1.0 and 1.5kga.i/ha) and 2 levels each of neem and Gmelina arborea seed powder (20 and 30kg/ha). The treatments were laid out in a randomized complete block design (RCBD) with 3 replications. Data collected included stem borer population per plant, plant heights at six (6) and eight (8) weeks after planting, and grain yield. Carbofuran and Neem seed powder significantly increased plant height and yield while Gmelina seed powder application significantly ($P \leq 0.05$) reduced maize growth and yield. The treatments significantly reduced borer population compared with control. It is possible that the neem powder at 30kg/ha may be used as a boost to maize development outside its insecticidal properties on maize used by resource poor farmers.

Key words: Agronomic characters, Carbofuran, Gmelina, Neem, powder, Stem borers.

INTRODUCTION

Maize or corn is a cereal crop that is grown widely throughout the world in a range of agro-ecological environments. Maize is the most important cereal crop in sub-Saharan Africa (SSA) and an important staple food for more than 1.2 billion people in SSA and Latin America (Iken and Amusa, 2004). All parts of the crop can be used for food and non-food products. In industrialized countries, maize is largely used as livestock feed and as a raw material for industrial products. Maize accounts for 30−50% of low-income household expenditures in Eastern and Southern Africa. Worldwide production of maize is 785 million tons, with the largest producer, the United States, producing 42%. Africa produces 6.5% and the largest African producer is Nigeria with nearly 8 million tons, followed by South Africa. Africa imports 28% of the required maize from countries outside the continent (FAO, 2009). Most maize production in Africa is rain fed. Irregular rainfall can trigger famines during occasional droughts. Farmers in Africa depend solely on local methods of farming with little or no idea of pesticides. Pests continue to ravage farms causing low level of productivity. Even in areas where pesticides are used, poisonous substances such as organophosphates and organochlorines are used. These chemicals are highly toxic to humans and soil organisms. The use of natural pesticides is a panacea to the environmental problems posed by the use of these synthetic pesticides. The natural materials used in preparing the pesticides are found almost in every home, they are cheap to collect and are found all year round. Excessive use of synthetic insecticides worldwide warrants environmental and human health concerns, and urges researchers to develop safer alternatives for eco-friendly pest management (Cherry et al., 1997), insect resistance to synthetic insecticides (Ahmad et al., 2003; 2007) and development of awareness of their detrimental effects has prompted the introduction of integrated pest management programs (Nathan and Kalaivani, 2006). Therefore, the findings from the study would provide useful insights into the predominant borer species in some agro-ecological zones in Nigeria, the efficacy of synthetic and non synthetic chemicals on the management of stem borers and yield loss due to stem borers as well as the intensity of stem borers attack on early and late maize. The aim and objective of the trial was to determine the effect synthetic and non synthetic insecticides on borer population and agronomic characters in early and late maize.

Materials and methods

The experiment was conducted in Awi (Akamkpa) and Ibiaragidi (Bekwarra), Cross River State, Nigeria. Akamkpa lies on latitude 50 18'38''N and longitude 8022'16''E in the tropical rain forest while Bekwarra lies on latitude 6040'N and longitudes 8045'E in the tropical guinea savanna zone of Nigeria. The mean annual temperature of the areas range between 230C and 350C with daily range of about 30C and a relative humidity of 75-85%. Akamkpa and Bekwarra have bimodal rainfall of between 2290-2680mm (Akamkpa) and 1500-1800mm (Bekwarra) fairly distributed over a period of six months.. The wet season has double rainfall peaks during July and October with a short break in rainfall (August break) in between the two peaks (Iwena, 2008).

Planting materials, Treatment, Experimental Design and Plot Size

The maize variety (OBA Super 1 Op-yellow) used for the experiment was obtained from the Cross River Agricultural Development Programme (CRADP), Ogoja, Cross River State, Nigeria. The treatment included Neem seed powder (NSP), Gmelina seed powder (GSP) at the rate of, 20kg and 30 kg/ha and Carbofuran applied at the rates of 1.0 kg and 1.5 kg a.i/ha and control. The treatments were replicated three times in a randomized complete block design (RCBD). The experiment occupied 0.05 ha demarcated into three blocks containing seven plots each measuring 4 m x 2 m wide. Adjacent plots were separated by 0.5 m path while 1.0m path was used to separate blocks.

Preparation of Neem and *Gmelina* Seed Powder.

Matured ripe fruits from Azadirachta indica and Gmelina arborea trees in Calabar were collected, washed and sun dried for 8 days then ground into powder, using a mechanical grinder as adopted by Emosairue and Ukeh (1996). The powder of both products was weighed into 0.19g and 0.28g using electronic weighing balance.

Sowing, weeding and fertilizer application

Three seeds were sown at a spacing of 75cm x 25cm and a depth of 3cm in April and September for early and late planting of 2009 and 2010 planting seasons respectively, seedlings were thinned to one plant per stand at two weeks after sowing to maintain a population of about 53,333plants/ha. Weeding was carried out at 4 and 6 weeks after planting (WAP) using weeding hoes and cutlasses. Compound fertilizer N.P.K (20:10:10) was applied in a ring at the rate of 90kg N/ha, 45kg P2O5/ha and 45kg K2O/ha.

Application of treatments

The treatments, (Carbofuran, neem seed powder (NSP) and Gmelina seed powder (GSP)) were applied in two equal doses at 4 WAP and at 7 WAP. Each treatment was band placed into the furrow 4cm away from each plant stand and covered up. NSP and GSP were applied at the rate of 20 kg and 30 kg/ha, while Carbofuran, was applied at the rate of 1.0 and 1.5 kg a.i/ha (13.33kg and 20kg/ha)

Data collection

Parameter assessed included plant heights at 6 and 8 weeks **a**fter planting while at harvest, borer population per plant and grain yield (tones/ha) were assessed. Data were subjected to analyses of variance and means were separated using Fisher's Least Significance Difference.

Results

Effect of treatments on larval population

The effects of treatments on larval population per plant in the two location as affected by the rates of application for both years and season are shown on Figures 1 and 2. Significant reduction in larval population was observed in plots treated with insecticides in the two locations in both years and seasons. In Akamkpa (Figure 1), neem at 30 kg/ha was as effective as Carbofuran at 1.5 kga.i/ha in 2009 early season, while in late season planting, neem and Carbofuran at all levels had the same level of efficacy. *Gmelina* at 30 kg/ha was however as effective as Carbofuran at 1.5 kga.i/ha and neem at 30 kg/ha. In early season of 2010, neem and Carbofuran at all rates had the same level of potency in reducing stem borer population. In late season planting, neem at 30 kg/ha was as effective as Carbofuran at all levels. In Bekwarra location (Figure 2), neem at all rates had the same efficacy as Carbofuran at all rates . In untreated plots, larval population was significantly ($P<0.05$) lower in the early season than late in the two location and years.

Effect of treatments on agronomic variables

The effect of treatments on the growth of maize at six weeks after planting (6WAP) for the two seasons in Akamkpa and Bekwarra are presented on Tables 1 and 2. In Akamkpa location (Table 1), Plots treated with Carbofuran and neem at 6WAP in early season of 2009 led to increase in plant height although they were not significantly (P>0.05) taller than the untreated plots. However, *Gmelina* treated plants were significantly (P<0.05) shorter than other treatments and the control.Similar result was found in the late planting season of same year. In 2010, Carbofuran and neem application significantly (P≤0.05) increased the growth of maize plants compared with the control in both seasons. However, both rates of *Gmelina* application significantly (P<0.05) inhibited the growth of maize compared with control and other treatments. In Bekwarra location (Table 2), Carbofuran and neem at all rates were not significantly (P>0.05) different from the control plots in both seasons and years, however, *Gmelina* seed powder at all rates significantly (P<0.05) inhibited growth compared with other insecticides rates and the control. At eight weeks after planting (8WAP), in Akamkpa location, Carbofuran and neem significantly (P<0.05) promoted growth of maize plant in the early season of 2009 compared with control. Figures 3 and 4 show the effect of treatments on yield (tonnes/ha) for the two locations, years and seasons. In Akamkpa (Figure 1), early planting of 2009, neem seed powder at all rates and Carbofuran at 1.5 kg a.i/ha significantly increased maize yield compared with other treatments. There was a significant yield reduction in plots treated with *Gmelina* seed powder at all rates and in untreated plots. In the late season of the same year, neem seed powder and Carbofuran at all levels significantly (P<0.05) increased yield compared with *Gmelina* seed powder and the control. Similar trend was observed in early and late seasons of 2010. In Bekwarra location (Figure 2), Carbofuran and neem seed powder significantly (P<0.05) increased grain yield in 2009 (early and late) and early season of 2010. *Gmelina* seed powder significantly (P<0.05) reduced grain yield compared with other treatments in 2009 and early season of 2010, however, it was not significantly (P>0.05) different from the control. Yield obtained from both treated and untreated plots was significantly (P<0.05) higher in the early season compared with late in both locations.

DISCUSSION

The results of the study indicated that treated plots recorded considerable reduction of the stem borer population compared to the untreated plots. Emosairue and Ukeh (1996) reported that the behavior of insect towards a neem-treated plants is a manifestation of repellence and phagodeterrence due to antifeedant effects. Ukeh *et al.* (2007) reported that neem has high contact toxicity on maize stem borer larvae. The low borer population found inside the tunnel from neem, Carbofuran and *Gmelina* treated plants confirmed their insecticidal properties. Okweche *et al* (2012) reported that borer populations vary with location and species and the feeding habit of the borers. In the trial, vigorous growth was found in neem and Carbofuran treated plants, than in the *Gmelina* treated ones as expressed by the plant height. The reduction in maize plant height as observed in this study compared to plant height observed on neem, Carbofuran and the untreated plots has confirmed the alellopathic action of *Gmelina* as reported by Akobundu (1987). Oparaeke (2005) reported that *Gmelina* extract exhibits slow acting effect on insect pests thus confirming its inferiority to the neem extract and Carbofuran. The effects of stem borers on the grain yield and quality of maize have been assessed by a number of research workers including Schulthess *et al.* (1991) and Okweche, *et al* (2010). This trial revealed a significant difference between yield of treated plants and untreated plants. The reduction in borer population and damage parameters in treated plots significantly affected yield in both locations and seasons. Higher yield which was recorded in the Carbofuran and neem seed powder treated plants could be attributed to the lower larval population recorded in the trial while the low yield recorded on the *Gmelina* treated plants could be attributed to the high larval population and its effect on the plant height. Again, yields obtained from early season plantings were significantly higher than late season planting, this agrees with the findings of Okweche *et al*. (2010) which reported higher yield of maize in early planting than in late planting.

Conclusion : Neem seed extract, a pesticidal plant was effective in the reduction of stem borer population and enhancement of growth and yield of maize in the trial. This shows that it can be used as a surrogate for Carbofuran, a synthetic insecticide. *G. arborea* seed extract exhibited phytotoxic effect on maize growth thereby reducing plant height and yield in spite of pesticidal properties.

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Table 1 : Effects of different levels of Carbofuran, neem and Gmelina on height at Akamkpa

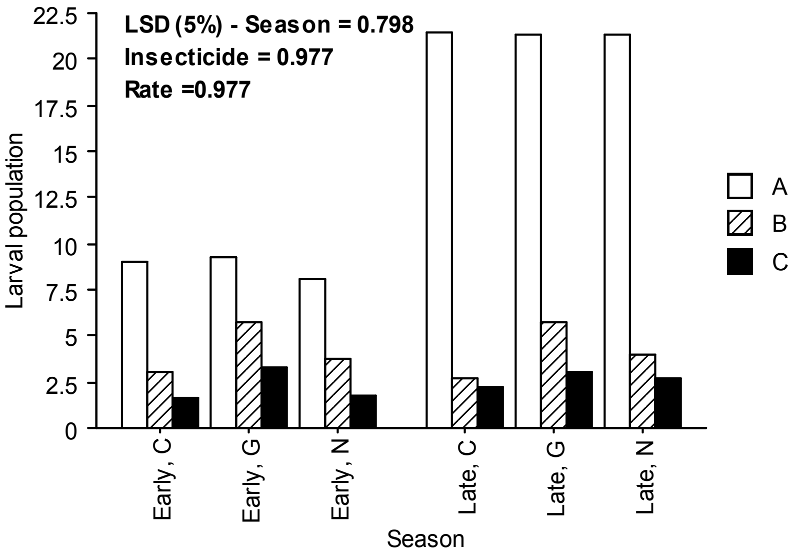
			2009		**2010**	
Seasons	Treatments	Rates	6 WAP	8 WAP	6WAP	8WAP
		0	88.60 ±2.19	145.67 ±1.50	89.33 ±2.40	140.33 ±0.88
	C	1	96.40 ±1.36	153.53 ±2.94	96.00 ±3.22	156.47 ±6.80
		1.5	92.40 ±3.52	151.73 ±2.14	99.33 ±2.33	154.33 ±6.36
Early		0	91.33 ±2.56	152.40 ±1.40	93.33 ±2.67	135.33 ±1.45
	N	20	88.60 ±1.90	151.87 ±1.57	106.00 ±1.16	162.87 ±3.75
		30	88.33 ±2.68	151.67 ±3.47	105.00 ±2.52	171.33 ±3.76
		0	94.33 ±0.55	150.60 ±2.81	87.33 ±2.60	134.33 ±2.40
	G	20	68.53 ±3.28	119.40 ±0.81	64.33 ±2.03	104.00 ± 1.53
		30	68.80 ±3.01	120.27 ±0.37	60.67 ±0.88	95.67 ±1.20
	LSD		**2.46**	**3.45**	**2.69**	**3.76**
		0	65.87 ±1.21	134.13 ±2.58	90.33 ±2.96	139.67 ±1.76
Late	C	1	73.00 ±1.53	143.20 ±2.23	102.33 ±1.67	167.67 ±1.33
		1.5	68.87 ±2.29	139.40 ±1.33	100.07 ±2.24	172.33 ±2.33
		0	70.47 ±0.96	138.07 ±0.64	86.20 ±2.11	148.67 ±4.70
	N	20	72.00 ±2.31	136.73 ±1.12	103.20 ±1.32	171.67 ±1.76
		30	69.33 ±1.85	135.87 ±4.38	105.33 ±0.94	169.67 ±2.91
		0	70.27 ±0.90	137.73 ±0.37	89.47 ±3.80	138.33 ±2.03
	G	20	70.87 ±0.94	131.40 ±8.70	70.27 ±2.73	112.00 ±1.73
		30	53.20 ±1.62	110.00 ±2.37	65.87 ±1.04	105.67 ±2.60
	LSD		**2.46**	**3.45**	**2.69**	**3.76**

Key – C = Carbfuran, N= neem, G = *Gmelina,* WAP = weeks after planting, LSD = least significant difference (5%)

Table 2 : Effects of different levels of Carbofuran, neem and Gmelina on height at Akamkpa

			2009		2010	
Seasons	Treatments	Rates	6 WAP	8 WAP	6WAP	8WAP
		0	104.93 ±1.09	143.07 ±5.29	86.20 ±1.82	153.00 ±6.44
	C	1	103.80 ±3.14	153.93 ±3.05	86.47 ±1.51	164.00 ±3.79
		1.5	107.07 ±0.37	147.00 ±1.30	87.00 ±0.80	160.53 ±6.79
Early		0	101.87 ±2.86	150.93 ±5.53	85.00 ±0.72	158.93 ±2.68
	N	20	104.40 ±1.72	146.47 ±0.77	85.27 ±1.85	160.80 ±1.94
		30	108.27 ±2.17	145.53 ±0.81	85.27 ±0.79	169.93 ±1.35
		0	98.20 ±0.92	154.60 ±2.60	85.47 ±0.64	142.93 ±0.84
	G	20	87.53 ±3.32	118.87 ±0.94	63.53 ±0.88	100.33 ±1.20
		30	90.47 ±1.91	119.20 ±1.71	67.67 ±1.51	95.40 ±0.70
	LSD		**2.54**	**2.82**	**2.34**	**3.63**
		0	85.93 ±3.08	140.00 ±1.14	107.47 ±0.58	148.00 ±1.45
Late	C	1	89.67 ±0.97	148.40 ±1.04	108.17 ±1.77	151.13 ±2.02
		1.5	89.67 ±0.48	138.93 ±1.54	107.40 ±2.76	159.00 ±2.08
		0	87.53 ±2.24	146.53 ±2.03	108.30 ±1.93	154.87 ±1.50
	N	20	88.00 ±2.01	140.60 ±1.21	111.13 ±0.70	159.10 ±2.16
		30	87.87 ±1.94	139.33 ±1.24	110.13 ±1.57	157.40 ±4.86
		0	85.93 ±1.43	140.60 ±1.14	104.47 ±1.44	151.67 ±3.47
	G	20	70.53 ±3.07	115.20 ±1.51	75.60 ±4.15	119.53 ±0.37
		30	75.93 ±2.67	113.47 ±1.92	77.33 ±4.59	121.13 ±1.62
	LSD		**2.54**	**2.82**	**2.34**	**3.63**

Key – C = Carbfuran, N= neem, G = *Gmelina,* WAP = weeks after planting, LSD = least significant difference (5%)



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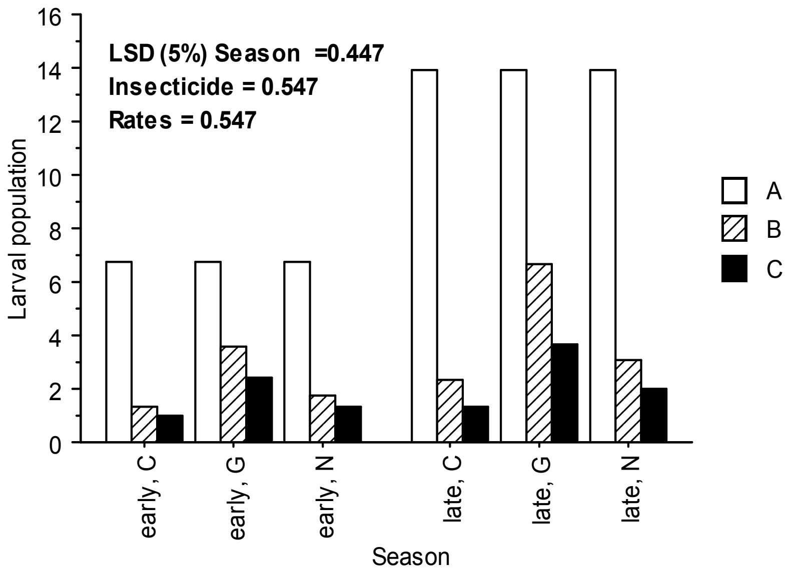

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Figure 1 : Effects of different levels of Carbofuran, neem and *Gmelina* on larval population at Akamkpa

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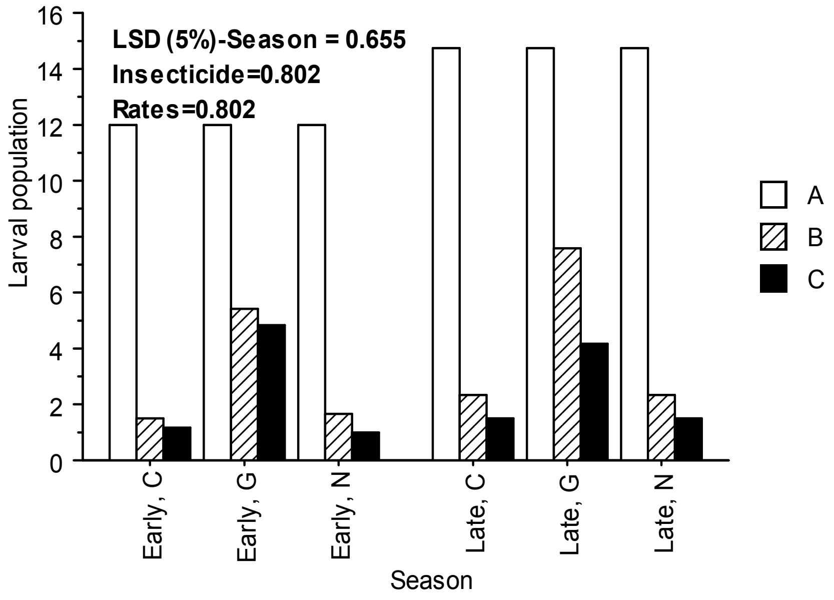

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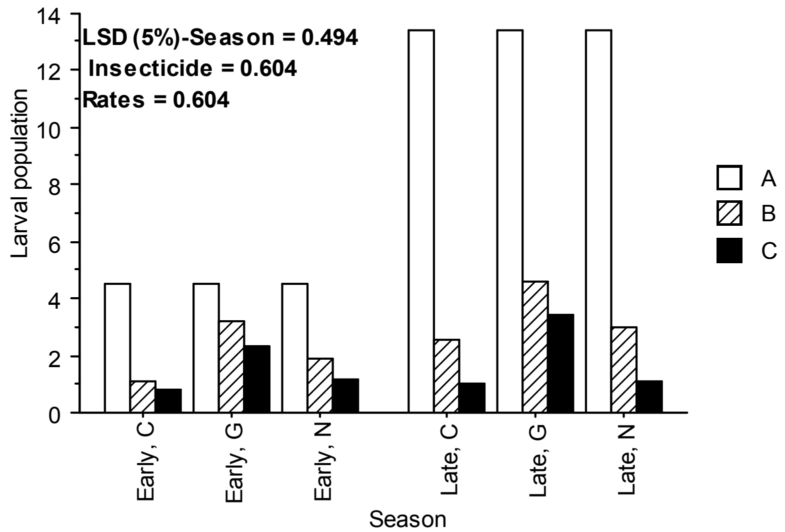

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Figure 2 : Effects of different levels of Carbofuran, neem and *Gmelina* on larval population at Bekwarra

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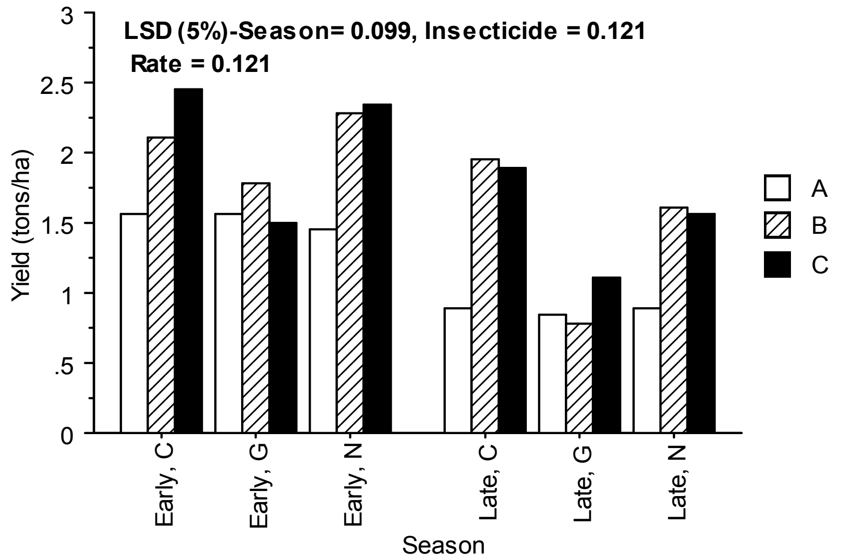

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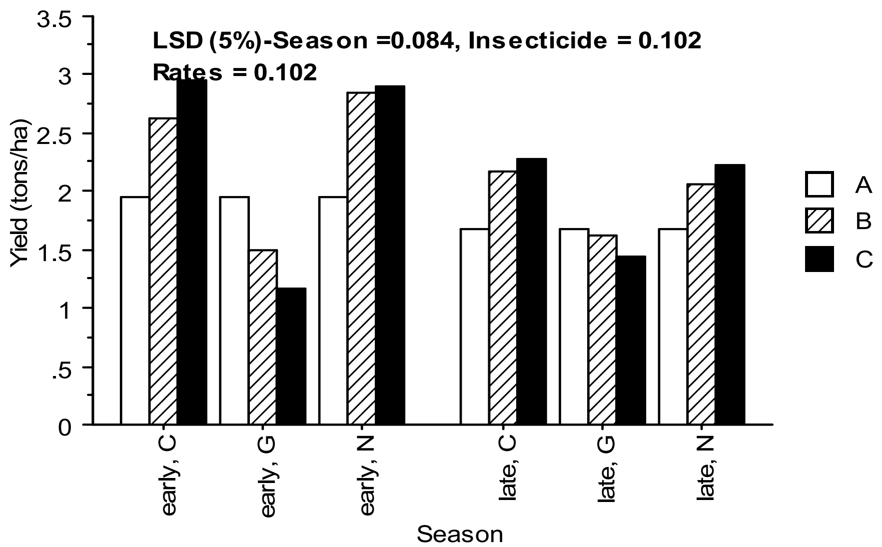

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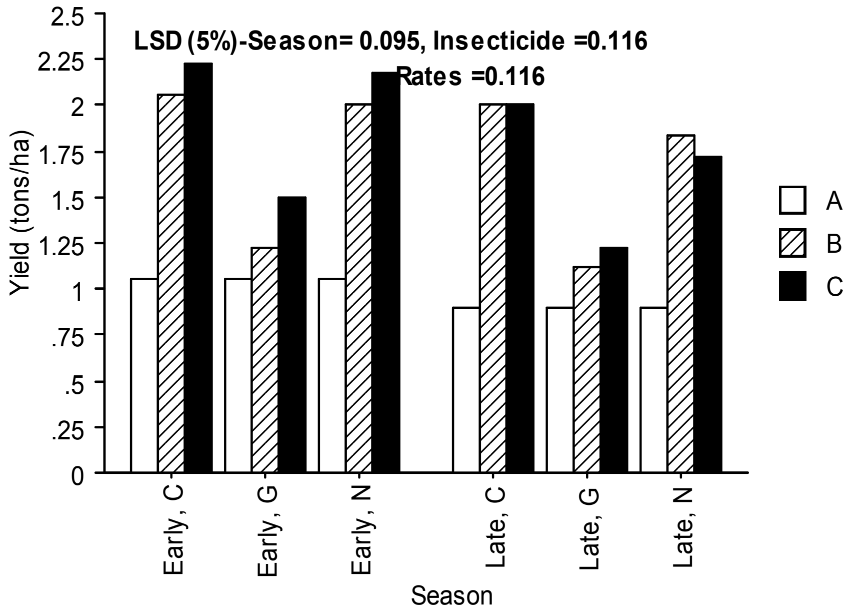
Figure 3 : Effects of different levels of Carbofuran, neem and *Gmelina* on yield at Akamkp8a



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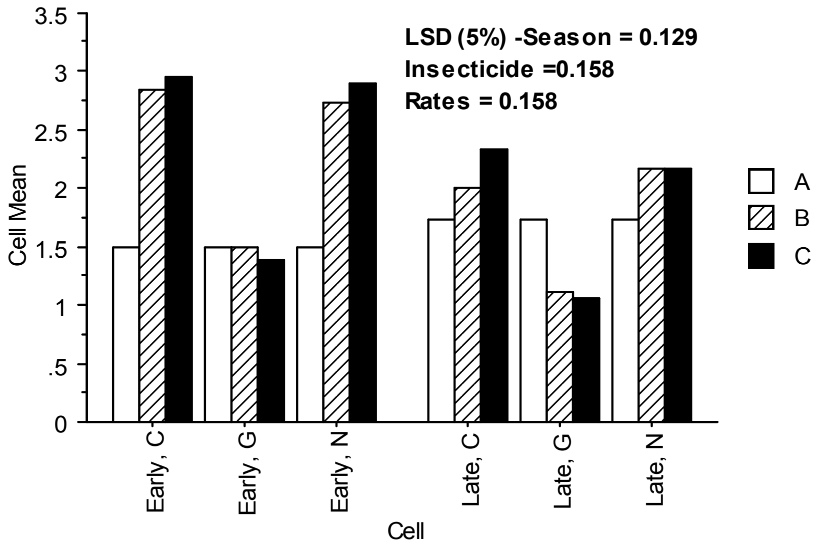

2010

Figure 4 : Effects of different levels of Carbofuran, neem and *Gmelina* on yield at Bekwarra

Key : C – Carbofuran, G – *Gmelina,* N – neem, A – control, B – 20 kg/ha and 1.0 kg a.i/ha, C – 30 kg/ha and 1.5 kg a.i/ha

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