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Effect of Color Sticky Traps on the Population of Major Pests of Improved Pigeon Pea (*Cajanus Cajan* (L) Millsp) Cultivar and Its Yield in Owerri, Imo State, Nigeria

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Abstract:
Study on the management of major insect of pigeonpea with colored sticky traps was conducted at the Department of Crop Science and Technology Teaching and Research Farm, Federal University of Technology Owerri, Imo State, in 2013. The experiment was laid out using randomized complete block design (RCBD) with six treatments comprising different colors of sticky traps, namely blue, black, white, red, yellow sticky traps and the uncolored sticky trap as a check (control). Results revealed that yellow sticky traps attracted and trapped the highest number of insect pest, and also had the highest pod yield of 186.90 kg ha^{-1} and seed yield of 163.80 kg ha^{-1} compared to other treatments. To produce organic pigeonpea seeds free from chemical metabolites, the use of yellow sticky traps to manage the population of insect pests in the farmers' field can be incorporated into pigeonpea IPM control strategy in, Nigeria.

Keywords: *Improved pigeonpea, color, sticky traps, insect, population, yield*

1. Introduction

Pigeonpea (*Cajanus cajan* (L) Millsp) belongs to the genus cajanus, tribe phaseoleae, subtribe cajaninae, and family fabaceae. It is also called redgram, tur, arthar, gandul (Spanish) and pois d'Angola (Sharma and Green 1980), congo bean (English), pois de Congo (French), and envilba de Congo in Angola (Baldev, 1988). Several authors considered eastern Africa to be the centre of origin of pigeon pea, as it occurs there in the wild form (Zeven and Zhukorshky 1975). However, De (1974) and Vernon Royes (1976) reviewed the pigeonpea origin and agreed in favour of India. Van der Maesen (1980) concluded that India was the primary centre of origin and Africa was the secondary centre of origin. It is cultivated in many countries in the tropics and subtropics. Its drought tolerance and the ability to use residual moisture during the dry season make it an important crop (Sheldrake 1984). Pigeonpea is cultivated on about 4.23 million hectares in the world, with an average annual production of 2.95 million tone (FAO, 1990). Its average productivity is 700 kg ha^{-1} (FAO, 1990). The major pigeonpea growing area (3.58mha) was in India with a production of 2.72 million tones. or a productivity of 760 kg ha^{-1} (FAO 1990; personal communication by ICRISAT Economics Group). Africa mainly Kenya and Uganda, accounts for 4% of the world's production while the Caribbean and Central and South America produce 2% of the total pigeonpea of the world (Sharma, 1981).Pigeon peas are both a food crop (dried peas, flour or green vegetable peas) and forage/cover crop. They contain high level of protein and important amino acid methionine, lysine and tryptophan (Zemede, 1995). In combination with cereals, pigeon peas make a well-balanced human food (Dialoke, et al.2010). In India, split pigeon pea (toor dhal) also called togori bele (kannada) is one of the most popular pulses, being an important source of protein in a mostly vegetarian diet. In regions where it grows, fresh young pods are eaten as a vegetable in dishes such as sambar. In Ethiopia, not only the pods but also the young shoots and leaves are cooked (Zemede 1995).Pod borer, *Helicovepa armygera*, blister beetles (*Mylabris pustulata*), Pod sucking bugs such as *Riptortus dentipes, Clavigralla tomentosicollis*, *Anoplocnemis curvpes, Dollicoris inducus* and aphids (*Aphis craccivora*) are known to be destructive at flowering and pod phases of pigeonpea (Dialoke et al. 2010, Reed et al. 1989). The damage caused by insect pest to pods significantly reduces the crop yield. Pod borers are widely distributed throughout the tropics, sub-tropic and Australia. They feed on buds, flowers, and pods. When flowers and pods are not available, they feed upon leaf lets, leaving the veins. Larvae enter into the pod by making hole and eats developing and partially mature seed. (Reed et. al.1989). Species of pod borer, *Helicovepa armigera*, the caterpillar is 1.5 to 4cm long. They bore holes on pod and feed on seed, usually developing seed. (Oestermann and Dryer, 1995). Bugs can be found in Africa, Asia and India. They suck developing seed of pigeonpea through the pod wall which makes the seed to become shriveled with dark patches. Attacked seeds do not germinate and are unfit for human consumption. Fungi spores are sometimes transmitted with their mouth parts during feeding; resulting in rotting of seeds (Reed et el. 1989). Thrips are small (1.5mm long), long slender, brown insects with pale yellow hind wings. Several species of thrips are common on pigeopeas in eastern Africa and are considered important pests. They feed on leave and flowers. Hence heavy infestation can lead to shedding of buds and flowers. (Ikison, 2000). Blister beetle; adults feed on flowers and reduce the number of pods that are set (Dialoke et al. 2014). However, in small pigeopea plots that are in flowering stage during the period of peak adults' activity, most of the flowers may be eaten by the blister beetle and crop losses may be substantial. (Snapp et al, 2003). The adults are medium to large sizes beetles (2 to 5cm in length), usually black and yellow or black or red in colour. The immature stages (larvae) do not feed on plants rather live in the soil and eat grasshopper eggs, and are therefore beneficial (Snapp et al, 2003).All these pigeonpea pests have been controlled manually by hand picking and killing or by collecting them with an insect net followed by killing (Reed et al. 1989). The uses of chemical pesticides have been shown as another effective control measure of pigeonpea pests. Chemical pesticides are spread evenly over the target areas of the pigeonpea crop (usually the upper foliage, flowers and pods) in order to control the pests. Most application is in the form of sprays using water as the carrier, through manually operated pumps. Large quantities of water are usually required to ensure adequate coverage (Reed et al. 1990). Although these practices have substantially increased yield, they also increased production costs, pesticide resistance and have affected ecosystem and human health (Matson et al. 1997; Krebs et al. 1999; Tilman et al. 2002). At the ecosystem level, they caused serious ecological problems such as water contamination, habitat degradation and loss of biodiversity (Matson et al. 1997; Kreb et al. 1999; Tilman et al. 2002). World Health Organization estimates that 300,000 people die from insecticide injury (self-harm) each year in the Asia-Pacific region alone (WHO, 2004). Control of pest have largely relied on the use of insecticide and is believed to be one of the major factors behind the increase in agricultural productivity in the 20th century (Emden, 1996). Self-poisoning with synthetic insecticide represents a major hidden public health problem accounting for approximately one-third of all suicides worldwide. Plant based insecticides (PBI) or Botanicals have been used for many centuries (Jacobson, 1975). They are very effective in controlling the insect pest because they possess repellent, knock down, anti-feedant, broad spectrum properties and also important because they are less hazardous, bio-degradable and maintain biodiversity of insect pest (Jacobson 1975). Among limited resources farmers use botanicals in developing countries to control insect's pest of both field crops and stored produced, but their potential was initial limited and ignored. Nicotine, rotenone and the pyrethrum were popular among the PBI used to some extent for storage pest control and other pests in green houses (Schmutterer, 1981). However, most of them are either insecticidally weak or may require other plant species with different mode of action to increase their potency. Most insect traps either use glue (gum) to immobilize insects or have funnel structures to prevent them from escaping (Lewis, 1997).

This research therefore is aimed at sourcing for a cheap, available, effective and environmentally friendly pigeonpea major pests control mechanism other than the use of synthetic insecticide or botanical pesticides. Information on the use of colour sticky traps to control major pests of pigeonpea is scarce. Hence this research was undertaken primarily to determine the effect of colour sticky traps on population of pests that decimate pigeonpea plant in Imo state.

2. Materials and Methods

2.1. Experimental Site

The experiment was carried out at the Department of Crop Science and Technology Undergraduate Teaching and Research Farm, Federal University of Technology Owerri, from April to October, 2013, on soils classified as ultisoils (Eshet, 1993). The site is geographically located between latitude 05^0 – 27^0N and longitude of 02^0 – 07^0E at an elevation of 91m above sea level. Average minimum and maximum temperatures are 29.4^0C and 31.7^0C, respectively with, average rainfall of 130mm.

2.2. Land Preparation

An area of land 13m x 18m ($243m^2$) was cleared manually using matchet and spade and the trash was packed away. Marking out was done with 50m measuring tape, ranging poles, ropes and pegs.

2.3. Experimental Design, Plant Materials and Planting

The experimental design was a Randomized Complete Block Design (RCBD) with three (3) replications. There were six (6) treatments comprising of 5 colours of sticky traps (red, blue, yellow, black, white) and no colour sticky trap as control. Each treatment was replicated three (3) times which gives a total of eighteen (18) treatment combinations. Each plot measured 1.2 m x 2 m while the distance between plots and blocks was 1m apart. The variety of pigeonpea seed used for this study was short duration pigeonpea cultivar (ICPL 84023), which was collected from ICRISAT (International Crops Research Institute for the Semi-Arid Tropics, India). Fungicide was applied for three consecutive days after planting to prevent the damage of young growing pigeonpea seedlings due to fungi attack. Seeds were planted on small ridges using the spacing of 20cm × 40cm at the rate of 2 seeds per hole. Each ridge contained 6 pigeonpea plants which gave 30 plants per plot and a total plant population of 540 plants for the experiment, hence plant population of 54,000 plants/ha.

2.4. Cultural practices.

The site was kept weed free by manual weeding throughout the experiment.

2.5. Design of Sticky Traps

The sticky traps (plates 1-6) comprised of metal plates painted red, yellow, blue, black, white etc. The top is flat, measuring 30cm × 30cm and suspended with 1m iron stand which was pinned to the ground leaving about 0.5m above the soil surface at the height of pigeonpea. The surface of the metal plates was coated with a gum called trapcoll. Trapcoll has an immediate and high stickiness suitable for this experiment. It is not toxic, not inflammable, odourless, colourless and does not dry on time. The essence of painting the trap is to attract insects whereas the gum helped to capture them as they come in contact with it.

2.6. Data Collection

2.6.1. Insect Count

During flowering and podding phases of the plant, insect count was done by observing and taking records of the number of insects caught by each trap at weekly intervals between the hours of 7-8am. Insects caught by sticky traps were collected and preserved in 70% ethyl alcohol for identification. Weight of dry pod (g): After harvesting pods of pigeonpea were weighed (g) with a sensitive weighing balance and weight converted to kg/ha.Weight of dry seed (g): After threshing and winnowing, the seeds were weighed (g) and weight converted to kg/ha.

2.6.2. Data Analysis

All data collected were analyzed using the analysis of variance (ANOVA) as outlined by Steel and Torrie (1981), while means were separated using least significant difference (L.S.D) at 5% level of probability.

3. Results

Table 1 shows that in the month of April, total number of 102 mm rainfall and a maximum temperature of 31.5^0C with a minimum temperature of 29.7^0C were recorded. The rainfall from 114 mm to 155 mm was observed between May and July.

Figure 7, shows that yellow sticky trap recorded the highest population of flower beetle (*Aulacophora vinula*) and podborer, (*Helicoverpa armigera*) with mean values of 4.7 and 45.9 respectively compared with control. There was significant difference among the treatment levels ($P<0.05$). However, control captured the lowest population of the above insects' species.

Figure 8, indicates that the largest population of butterfly (*Lampides boeticus*) and grasshopper (*Zonocerus veriegatus*) were captured by yellow trap with the mean number of 3.3 and 10.6 respectively compared to population caught by control trap. There was significant difference ($P<0.05$) among treatment levels.

Figure 9, shows that yellow sticky trap captured the highest number of blister beetles followed by red and blue sticky traps when compared with the control trap.

The overall insect population captured by individual traps is presented in figure.4. Meanwhile, the largest insect pest populations were caught by yellow sticky traps followed by red sticky and blue sticky traps when compared with control which captured the lowest insect pest population.

Table 2, presents the pod/seed yield of early maturing pigeonpea cultivar. The pod yield was significant difference ($P<0.05$) among treatment means. The highest pod yield was recorded by yellow sticky traps with the mean of 186.90 kg/ha compared to control with 98.70 kg/ha. Seed yield also shows significant difference ($P<0.05$) among the treatment levels, with yellow sticky traps recording the highest seed yield of 163.80 kg/ha compared to control with 83.10 kg/ha.

Figure 1: Control Sticky Trap

Figure 2: Black Sticky Trap

Figure 3: White Sticky Trap

Figure 4: Yellow Sticky Trap

Figure 5: Red Sticky Trap

Figure 6: Blue Sticky Trap

Months	Rainfall	Rain Days	Temperature		Relative
	(mm)	(days)	°C Max.	Min.	Humidity (%)
January	Nil	Nil	32.5	29.0	78.20
February	120	3	32.2	29.5	78.30
March	68	6	32.4	29.0	80.00
April	102	8	31.5	29.7	80.50
May	114	12	32.0	29.5	79.60
June	145	14	32.5	29.3	79.80
July	155	16	31.8	29.5	78.50
August	130	10	31.0	29.0	78.30
September	135	12	31.5	29.5	78.80
October	132	10	31.6	29.4	78.50
Average	130.4	11.7	31.7	29.4	90.40

Table 1: Meteorological Data from Agricultural Development Programme (ADP) Owerri, Imo State, from April to October, 2013

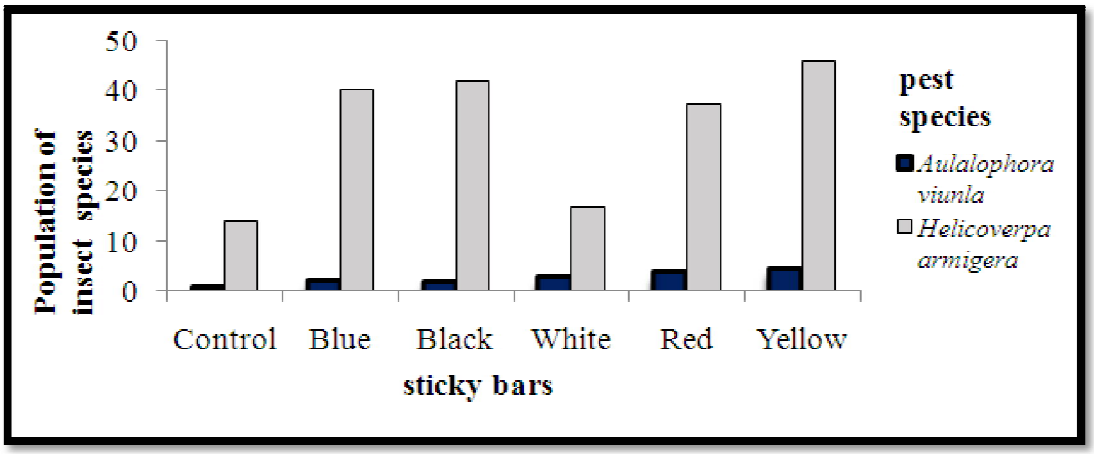

Figure 7: Effect of Colour Sticky Traps on Population of Pigeonpea Leaf Beetle and Podborer

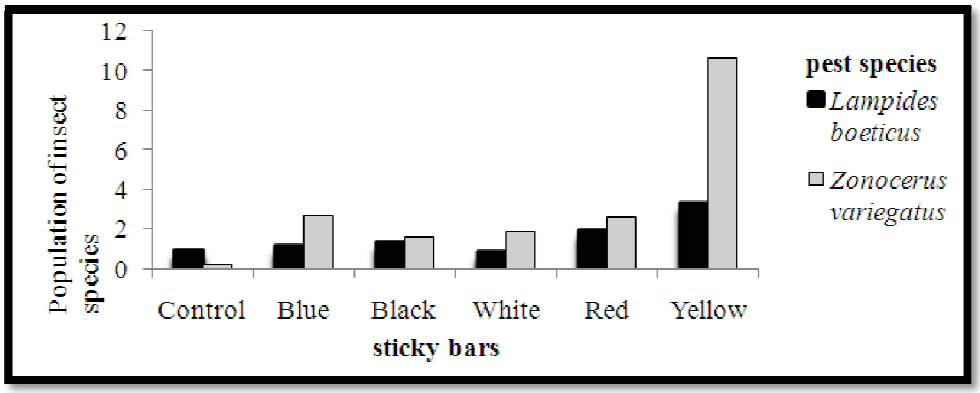

Figure 8: Effect of Colour Sticky Traps on Population of Pigeonpea Herbivores

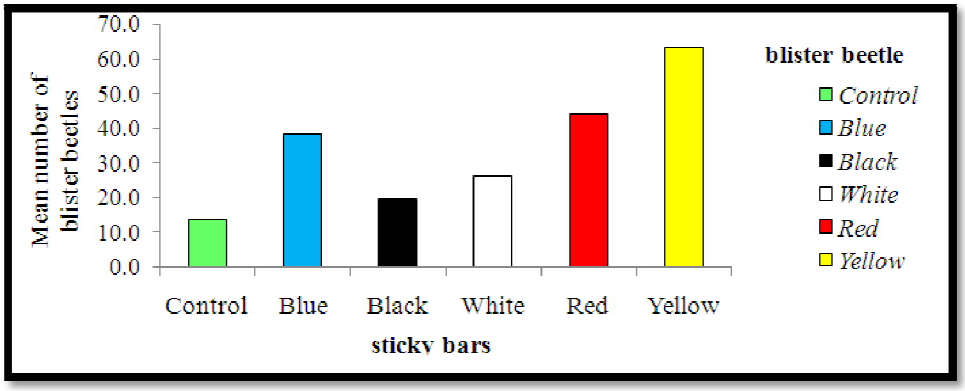

Figure 9: Effect of Colour Sticky Traps on Population of Pigeonpea Blister Beetles

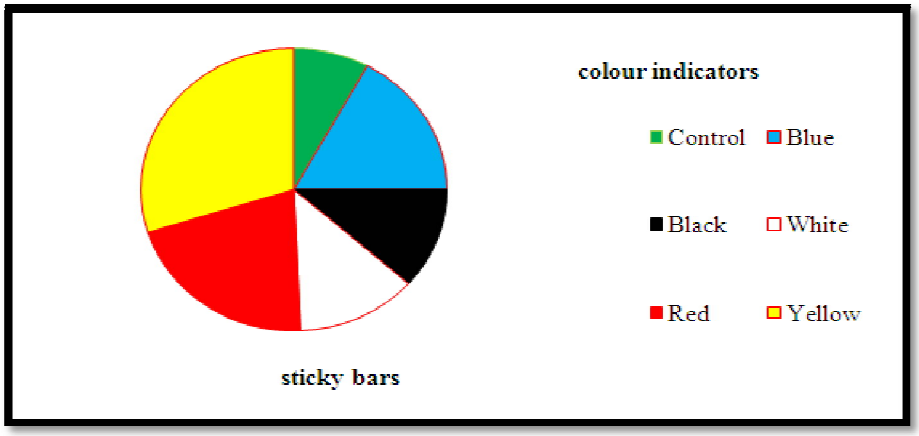

Figure 10: Effect of Colour Sticky Traps on Overall Population of Pigeon pea Insect Pests Captured By Individual Traps

Treatments	Pod Yield (Kg/Ha)	Seed Yield (Kg/Ha)
Control	98.70	83.10
blue	153.10	146.20
black	130.50	123.40
white	148.90	132.20
Red	158.60	149.90
yellow	186.90	163.80
LSD 0.05	14.90	13.50

Table 2: Effects of Colour Sticky Traps on the Yield (Kg/Ha) of Improved Pigeon pea Cultivar in Owerri

4. Discussion

The effect of colour sticky traps on *Lampides boeticus* and *Zonocerus variegatus* insect pests of pigeonpea was statistically significance ($P<0.05$) among treatment levels. Yellow sticky traps captured the highest *Lampides boeticus* and *Zonocerus variegatus* pest's population having the mean numbers of 3.3 and 10.6 compared to control. Meanwhile, these facts are in agreement with the earlier findings by Lewis, (1997) who reported that colour sticky traps (such as yellow, blue or red) or water trap are useful for monitoring adult insects in the nursery or field. Yellow sticky traps resemble pigeonpea flowers and so both pests on visitation to the colour of the traps got trapped. Effect of colour sticky traps on *Aulacophora vinula* was statistically significance among treatment means. Control and black sticky traps had the lowest *Aulacophora vinula* insects caught with mean number of 0.9 and 1.9, while yellow experienced the highest *Aulacophora vinula* insects with the mean number of 4.7 compared to control. This is line with the findings of Lewis, (1997) who reported that yellow colour attracts many insects' species (including beneficial insects), use yellow sticky traps only where necessary. Yellow sticky traps have been used for monitoring adult leaf miners, beetles, white flies among other insect pests (Lewis, 1997).Effect of colour sticky traps on *Helicoverpa armigera* was statistically significance ($P<0.05$) among treatment means. Control had the lowest *Helicoverpa armigera* insect caught while yellow experienced the highest population of *Helicoverpa armigera* insects with the mean of 45.90 compared to control with the mean of 14.00. This is in agreement with earlier findings by Lewis, (1997) who reported that yellow sticky traps have been used for monitoring adults leafminers, beetles, whiteflies among other insects. In overall insect population, yellow and white experienced the highest pest's population with the mean numbers of 50.00 and 33.50 compared to control with 29.70. Blue had considerable high insect population. Several authors, including Lewis, (1997) have noted that colour sticky traps (blue, yellow, or white) are useful for monitoring insects in the field or nursery. Thrips are attracted to white and blue. Bright colours attract more thrips than darker ones (Lewis, 1997). Adult thrips can be monitored and in some cases be reduced by mass trapping with coloured (blue, yellow or white) sticky traps in the nursery or field (Lewis, 1997). Blister beetles are attracted to blue and possibly pink, purple and red colours (Weinzieel, et al.1995). This fact can be utilized to create traps for them; for instance, take any light blue container fill with soapy water and place around susceptible crops like beans, cowpeas and pigeopeas, the beetles fall in and drown. (Weinzieerl, et al. 1996). The colour spectrum of the boards is important for the efficiency of sticky traps. Colour sticky traps have been used for controlling (monitoring) adult's leaf miners, white flies, aphids (winged form), thrips among other insect pests of Pigeon-pea (Lewis, 1997).Yield obtained from short duration pigeon-pea cultivar was statistically significant ($P<0.05$) among treatment levels and generally poor yields were observed probably due to high pest infestation. Yellow sticky trap recorded highest pod and seed yield with 186.90 kg/ha and 163.80 kg ha^{-1} compared to pod and seed yield from control with 98.70 kg ha^{-1} and 83.10 kg ha^{-1}, due to reduction of pest infestation, thus resulting to considerable high yield. Yellow sticky trap has been used in control of pigeonpea pests (Lewis, 1997). Other colours as at data collection for yield experienced considerable yield loses as a result of pest infestation. These facts are in line with Reed and Lateef (1990) who reported that the seed and other parts of pigeonpea plants are fed upon by over 200 insects' species, which enhance yield loss or reduction

5. Conclusion and Recommendation

During the field work, all the colour sticky traps were equally exposed to pigeon-pea pests' control. Control sticky trap caught the lowest insect pests while yellow sticky trap caught the highest insect pests. Pod and seed yield also indicated that plots protected with yellow sticky trap had the highest pod and seed yield followed by red sticky traps. Finally, we recommend putting yellow sticky traps at different locations in the farmer's farms as alternative pigeonpea insect pest control strategy in Owerri Zone, Imo State. Nigeria. In this way consumers will be free from eating pigeonpea sprayed with chemical poisons which often have resulted to complicated illness and death.

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