

INFLUENCE OF SOME AGRONOMICAL PRACTICES ON INCIDENCE OF VIRUSES INFECTING SOYBEAN

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ABSTRACT

Soybean is a valuable source of dietary protein and oil for human consumption. However, viral diseases are the most militating cause of its poor growth, low yield and reduction in the quality of the crop. Weeds have been observed to be alternative hosts to viral pathogens, while Insect vectors were agents of viral transmission in the field. The objective of this study therefore was to assess the effect of weeding and insecticidal applications on the incidence and severity of viral disease. Four weeding regimes and four levels of insecticide applications were factorially combined and fitted in randomized complete block in a field experiment. All data were subjected to analysis of variance and means were separated using the new Duncan's Multiple Range Test at 5 % level of significance. The findings of the study revealed that Weeding twice and application of insecticide twice during growth period significantly reduced disease incidence and increased yield of soybean. These were recommended to growers as control strategy of viral diseases and their weedhosts.

Keywords: Influence, Weeding regime, Insecticidal regime, Incidence, Soybean, Kwara State

INTRODUCTION

Soybean (*Glycine max*) is economically important as its by-products have use in many areas. Advancements in research and technology of soybean, focuses efforts on five target areas including: adhesives, printing inks, lubricants coatings, plastics and specialty products. New uses for soybeans including soy plastics, soy methyl esters and foams, and soy ink. Improving hallmark product performances with soy are prompting manufacturers to substitute petrochemicals with the renewable product (Lance and Garren, 2005).

Soybean's properties also allow its use in several applications from animal feed and human nutrition, to road fuel and other industrial uses. Again, soybean farmers use more sustainable farming practices by reducing energy use, and eco-friendly cultural techniques that reduce contaminants into the environment (Hymowitz and Newell, 1981). Soybean protein accounts for 80 percent of the nutritional content of the soybean, essentially serves as animal feed and equally incorporated in many human foods. Soybean oil is used for purposes such as cooking, baking and frying. The remaining soybean oil is applied in industrial applications and biofuel

(Hymowitz and Newell, 1981).

Recent research on soy has underscored many of the impressive antioxidant benefits that we derive from this legume. No phytonutrient in soybean has received more widespread attention than genistein—an isoflavone that has been extensively researched into in relation to cancer risk. Increased activity of antioxidant enzymes—including superoxide dismutase, glutathione peroxidase, catalase, and glutathione reductase—has now been linked to intake of genistein from soybean (Shaun, 2010).

Biotic constraints, such as pathogens, insect pests and weeds, can be detrimental to soybean production and result in significant yield losses of up to 80% have been reported in experimental plots (Miles *et al.*, 2007; Mueller *et al.*, 2009).

Weeds are likely to be more genetically diverse than their cultivated counterparts and therefore less prone to diseases. Thus, when a new genetically uniform crop is introduced into an area, it becomes a reservoir for pathogens that would otherwise exist in low population in wild plants. Changes in vector population can also influence the disease incidence in weeds and surrounding crops (Thottappilly and Rossel, 1992).

The severity in yield losses and significant reduction in the quality of the seeds due to soybean viruses could have been one of the reasons why the soybean is not well grown in Nigeria. Soybean viruses usually results in severe yield losses and seed quality reduction. ..Therefore it must be protected against diseases, most especially viral diseases that could be transmitted through vectors and seeds with the weeds as host reservoir of viral pathogens. The objectives of this study, therefore, were to evaluate the effect of some agronomic practices such as

weeding regime and insecticide application to mitigate against the incidence and severity of viral diseases on growth and yield responses of soybean.

MATERIALS AND METHODS

Field experiment

The field experiment was carried out at the Teaching and Research Farm of the Faculty of Agriculture, University of Ilorin. The site was located Latitude 08° 26N Longitude 04° 29E in the Southern Guinea Savanna agroecological zone of Nigeria.

The field experiment covering 2500 m². This was subdivided into 48 sub plots with each plot size of 9 m by 5 m (45 m²). An interval of 1m was created between the plots in a block and 1 m between the block to demarcate each of the plots. Each experiment was, therefore executed on 4 ridges and replicated three times. The treatments were randomly assigned to plots. 3 to 4 seeds/hole at a spacing of 75 cm between rows and 10 cm between stands were planted manually. Seeds were not sowed more than 2.5 cm deep. Deeper planting may results in loss or vigor or failure of seedlings to emerge. Weeding regime and insecticide application were treatments applied in a factorial fitted into a randomized completely block design (RCBD). Weeding regime categorized into: w⁰ as none herbicide application, w¹ as pre-emergence herbicide application, w² as pre-emergence herbicide application +weeding once, w³ as pre-emergence herbicide application +weeding twice. In addition, insecticide application are into: I⁰ as none insecticide application, I¹ as pre-flowering application, I² as pre-flowering + flowering application, I³ as pre-flowering + flowering + post flowering application. Pendimethalin (missle) was applied as pre-

emergence herbicide at 3 litres/ha and interval of 3 weeks. followed by manual hoeing for subsequent treatments. Cypermethrin (cropthrin) was used as insecticide at 500 ml/500 litre at

RESULTS AND DISCUSSION

Table 1: Main effect of weeding regime on plant height and leaf number of soybean

Weeding regime	Plant height (cm) 5week	Plant height (cm) 6week	Plant height (cm) 7week	Plant height (cm) 8week	Number of leaf 5week	Number of leaf 6week	Number of leaf 7week	Number of leaf 8week	Number of leaf 9week
None weeding	21.95a	30.93a	38.29b	46.74	20.82b	33.21b	45.33b	54.39b	55.75b
Weeding once	24.59a	35.06a	41.51a	56.49a	24.08a	42.41b	53.92b	65.65b	65.33b
Weeding twice	24.32a	37.39a	46.66a	59.79a	25.43a	54.02a	79.84a	107.75a	116.21a
Weeding thrice	23.76a	65.38a	46.09a	59.99a	24.75a	55.16a	84.07a	104.95a	113.61a
SEM	0.909	15.584	1.776	2.666	1.442	3.245	3.926	6.764	6.081

Means in the same column followed by the same letter(s) are not significantly different at $p < 0.05$ using the New Duncan's multiple range test

The main effect of weeding regime on number of leaves in soybean. There were considerable significant differences in leaf number of soybean on varying weeding regime over the period of experiment.

The similar pattern was observed at 9th week after planting. Weeding twice and weeding thrice were significantly high (116.21 and 113.61) while none weeding and weeding once were significantly low (55.75 and 65.33) as shown in Table 1

Application of weeding and preemergence herbicide on soybean increased the height of soybean probably due to reduction in

competition for nutrients, light and space by the weeds. It could equally be suggested that removal of weeds that were potential reservoir for viral diseases in plots of weeding twice and thrice with 59.79 cm and 59.99 cm respectively gave rise to lesser incidence of viral disease symptoms that include stunting as compared with 46.74 cm in none weeding regime.

Glyphosate did not affect weeds that emerge after application because of adsorption to soil Colloids (Sprankle *et al.*, 1975); thus, the soybean canopy must suppress any late emerging weeds to maintain full-season control. The competitive advantage for Soybean provided by early removal of weeds may have allowed the soybean to compete effectively with the high densities of late-

Emerging weeds. The reduction in weed biomass associated with increasing soybean population indicates that higher planting rates increased the competitiveness of the crop with weeds (Hartzler *et al.*, 2004).

The elimination of primary sources of virus inoculum by crop isolation in time and space, and by elimination of alternate hosts, is potential management strategies that have been successful for some virus diseases (Sylvester, 1989.).

Table 2: Main effect of insecticide application on plant height and leaf number of soybean

Insecticide application	Plant height (cm) 5week	Plant height (cm) 6week	Plant height (cm) 7week	Plant height (cm) 8week	Number of leaf 5week	Number of leaf 6week	Number of leaf 7week	Number of leaf 8week	Number of leaf 9week
None insecticide	24.50a	33.56a	43.95a	54.91a	24.18a	45.69a	67.61a	88.78a	92.84a
application Insecticide	23.84a	65.59a	44.13a	58.38a	23.53a	48.16a	68.61a	84.71a	89.07a
Application once Insecticide	23.04a	35.16a	42.49a	54.42a	23.53a	47.21a	65.53a	77.69a	83.87a
application twice Insecticide	23.23	34.45a	41.99a	55.31a	23.82a	43.73a	61.40a	81.58a	85.12a
application thrice SEM	0.909	15.58	1.776	2.666	1.442	3.245	3.926	6.764	6.081

Table 2 shows the main effect of insecticide application on plant height of soybean. There was no significant different on insecticide application on plant height of soybean in the period of observation. There was no significant different in the means of leaf number of soybean with different insecticide applications over the period of observation.

Although insecticide did decrease the number of colonizing aphids, it did not completely eliminate them. When the number of colonizing aphids was managed by the use of insecticide, plant height was

increased in both years of the study, and canopy density increased in 2001 (Giesler, and Ziems, 2006). However, *Aphis spiraecola* Patch and *Myzocallis punctatus* Monell land more frequently in a more dense canopy (Halbert, and Irwin, 1981). Intense feeding by *A. glycines* causes symptoms of chlorosis, rolled leaves, stunted plants, early maturity, defoliation, and sooty mold growth (*Capnodium* spp.) on honeydew excreted by the aphids (Wang, *et al.*, 1996; Wu *et al.*, 2004.).

Table 3: Main effect of weeding regime and insecticide application on stem girth of soybean

Weeding regime	Stem girth 5week	Stem girth 6week	Stem girth 7week	Stem girth 8week	Insecticide application	Stem girth 5week	Stem girth 6week	Stem girth 7week	Stem girth 8week
None weeding	1.02c	1.26c	1.34b	1.46b	None Insecticide application	1.42a	1.55a	1.99a	2.11a
Weeding once	1.29b	1.43bc	1.63b	1.69b	Insecticide application once	1.32ab	1.56a	1.93a	2.00a
Weeding twice	1.47a	1.70a	2.36a	2.47a	Insecticide application twice	1.23b	1.46a	1.74a	1.87a
Weeding thrice	1.44a	1.64ab	2.32a	2.43a	Insecticide application thrice	1.25b	1.44a	1.97a	2.06a
SEM	0.053	0.076	0.137	0.126	SEM	0.053	0.076	0.137	0.126

Means in the same column followed by the same letter(s) are not significantly different at $p < 0.05$ using the Duncan's multiple range test

Table 3 shows the main effect of weeding regime on stem girth of soybean over the period of observation. There were significant differences in stem girth of soybean from 5th week after planting to 9th week after planting. At 5th week after planting, weeding twice and weeding thrice were higher in stem girth (1.47 and 1.44) respectively. However, none weeding was significantly lower (1.02) while weeding once (1.29) was in-between the two extremes.

At 7th weeks after planting, weeding twice and weeding thrice were significantly higher in stem girth (2.36 and 2.32) respectively. However, none weeding and weeding once were significantly lower (1.34 and 1.63).

On the main effect of insecticide application on stem girth of soybean as shown in Table 3 above. At 5th week after planting, none insecticide application was significantly high (1.42), while insecticide

application twice and thrice were significantly low. Insecticide application once was in between the two extremes (1.32). In the subsequent weeks of observations, there was no significant different in the stem girth of soybean.

Weeding and herbicide application were statistically significant in stem girth resulting from reduction in competition with the weeds and limiting weed population that serve as source primary viral inoculums. However, this was not obvious under insecticide application. There was no statistically significant.

Soybean was a weak competitor up to the V4 stage of soybean growth, and control of common waterhemp emerging before this growth stage would be critical to prevent future infestations. However, transplants into soybean after the V5 stage of soybean produced few seeds, and those transplanted after V6 did not survive (Uscanga-Mortera, et al., 2007 Under low wind conditions, low-flying alates searching for feeding hosts are attracted to long wavelength light reflected from Contrasting edges of soil and plant interfaces, i.e., isolated patches

of vegetation bordered by bare ground increased in fields where plant density is low (Klingauf, 1987, Taylor, 1986. Toba, *et al.*, 1977.). As a result, occurrence of virus disease is

Table 4 : Main effect of weeding regime on yield components of soybean

Weeding regime	Average weight/plant (g)	Average weight of pod /plant (g)	Average weight of a pod (g)	Average weight of seed/pod (g)	Average weight of a seed (g)	Number of seed /pod	Average number of pod /plant
None weeding	15.08b	10.35b	0.35c	0.29b	0.14a	2.28b	40.89b
Weeding once	20.81b	14.85b	0.35c	0.29b	0.14a	2.19b	51.14b
Weeding twice	47.75a	36.59a	0.42b	0.34a	0.15a	2.44a	106.67a
Weeding thrice	51.08a	39.97a	0.44a	0.35a	0.15a	2.46a	116.94a
SEM	3.056	2.608	0.008	0.007	0.004	0.062	7.406

Means in the same column followed by the same letter(s) are not significantly different at $p < 0.05$ using the Duncan's multiple range test

Table 4. shows the main effect of weeding regime on yield parameters of soybean. The yield parameters include: average weight per plant, average weight of pod per plant, average weight of a pod, average weight of seed per pod, average weight of a seed, number of seed per pod and average number of pod per plant.

In consideration average weight per plant, weeding twice and weeding thrice were significantly high (47.75g and 51.08g) respectively. However, none weeding and weeding once were significantly low (15.08g and 20.81g) respectively.

The effect of weeding regime on average weight of pod per plant indicated that weeding twice and weeding thrice were significantly high (36.59g and 39.97g) respectively. While none weeding and

weeding once were significantly low (10.35g and 14.85g) respectively.

Observation of average weight of a pod revealed that weeding thrice was significantly high (0.44g). However, none weeding and weeding once were significantly low (0.35g and 0.35g). Weeding twice was in between the two extremes (0.42g).

The effect of weeding regime on average weight of seed per pod indicated that significant differences existed in the treatments. The weeding twice and weeding thrice were significantly high (0.34g and 0.35g) respectively. However, none weeding and weeding once were significantly low (0.29g and 0.29g) respectively.

The result revealed that average weight of a seed on different weeding regime, there was no significant difference in observation. However, on number of seed per pod, weeding twice and weeding thrice

were significantly high (2.44g and 2.46g) respectively. While, none weeding and weeding once were significantly low (2.28g and 2.19g) respectively.

On average number of pod per plant, weeding twice and weeding thrice were significantly high (106.67 and 116.94) respectively. However, none weeding and weeding once were significantly low (40.89 and 51.14) respectively.

While the potential seed production of a plant population may be very high, seed production of an individual can be influenced by factors such as time of emergence, plant size, and the amount of interference or competition exerted by

surrounding plants (Murphy *et al.*, 1996; Knezevic and Horak, 1998; Clay *et al.*, 2005)]

Infection by SMV may result in severe yield losses due to abortion of flowers, reduced pod set, reduction in the number and weight of seeds (Hill, 1999. Ross, 1969), and early plant infection usually results in greater losses (Bryant, *et al.*, 1982., Halbert and Irwin, 1981. Ross, 1969). Water stress has been linked to a loss of plant turgour, which results in an increase in sap viscosity. This makes it more difficult for vectors to feed and ultimately leads to an increase in restlessness of vectors (Kennedy *et al.*, 1958; Miles *et al.*, 1982).

Table 5: Main effect of insecticide application on yield components of soybean

Insecticide application	Average weight/plant (g)	Average weight of pod /plant (g)	Average weight of a pod (g)	Average weight of seed/pod (g)	Average weight of a seed (g)	Number of seed /pod (g)	Average number of pod /plant
None	32.89a	25.27a	0.38b	0.33a	0.15a	2.22b	78.36a
Insecticide application	36.36a	26.38a	0.39ab	0.32a	0.14a	2.37ab	81.31a
Insecticide application once	36.36a	26.38a	0.39ab	0.32a	0.14a	2.37ab	81.31a
Insecticide application once	30.19a	22.87a	0.39ab	0.31a	0.14a	2.37ab	68.26a
Insecticide application twice	35.28a	27.24a	0.41a	0.32a	0.14a	2.41a	87.71a
Insecticide application thrice							
SEM	3.056	2.608	0.008	0.007	0.004	0.062	7.406

Means in the same column followed by the same letter(s) are not significantly different at $p < 0.05$ using the New Duncan's multiple range test

Table 5 shows the main effect of insecticide application on yield attributes of soybean. Consideration of average weight per plant there was no significant different among the treatments. In addition, average weight of pod per plant did not indicate any significant differences.

However, significant different existed in average weight of a pod. Insecticide application thrice was significantly high (0.41g) while none insecticide application was significantly low (0.38g). Insecticide application once and insecticide application twice were significantly in between the two extremes (0.39g and 0.39g) respectively.

The result from average weight of seed per pod did not indicate any significant differences. Similar result was revealed in Average weight of a seed, there was no significant difference among the treatments. On number of seeds per pod, the result indicated that insecticide application thrice was significantly high (2.41g). However; this was significantly low in none insecticide application (2.22g). While insecticide application once and insecticide application twice were in between the two extremes. There was no significant difference in Average number of pod per plant.

Furthermore, the model timing suggested that applications of insecticides earlier in the season, presumably interfering with PVY (potato virus y) transmission then, better explained reductions in the later spread of PVY than did late applications of insecticides (MacKenzie, *et al.*, 2014).

The study show that virus and vector abundance can generate a great potential for substantial PVY spread during the season, whereas crop management practices, specifically insecticide and mineral oil spraying, can greatly reduce PVY spread (MacKenzie, *et al.*, 2014).

Grain yield is reduced by Amino. glycines by direct physiologic stress (Macedo, *et al.*, 2003.) and indirectly by transmitting Soybean mosaic virus (SMV) and other soybean viruses (Clark, and Perry, 2002., Hill, *et al.*, 2001., Wang and Ghabrial, 2002. Wu, *et al.*, 2004.).

Landing rates of aphids were significantly influenced by insecticide treatment ($p = 0.0715$). There were a higher number of aphids that landed in the insecticide treated plots. This difference is presumed to be a result of canopy differences as measured by leaf area index. The application of insecticides resulted in a much fuller canopy, as measured by LAI (Leaf Area Index). Generally, aphids are thought to prefer less dense canopies, but this has been shown to be species dependent (Halbert and Irwin, 1981)

Insecticide treated plots generally had lower numbers of colonizing aphids. Insecticide resulted in taller plants after the arrival of the soybean aphid. Insecticide seemed to decrease the expression of SMV (Soybean Mosaic Virus) symptoms on 6 August and 28 August, but not 17 August. This is presumed to be due to the warm temperatures. Insecticide did not significantly affect yield ($p = 0.95$), number of nodes per plant ($p = 0.69$) or number of pods per plant ($p = 0.28$). There was no significant effect on seed weight ($p = 0.59$) or seed mottling ($p = 0.97$). Overall virus-like symptoms were generally not significantly different between treatments,

with a couple of exceptions. On 6 August, Insecticide treated plots had lower symptoms ($p < 0.001$) and on 10 September, insecticide treated plots had higher symptom expression ($p < 0.001$) (Burrows, et al., 2005).

However, insecticide-treated plants were much taller and fuller; the field had a very high amount of SMV, which has been shown to cause yield loss (Hill, 1987). Yield losses due to SMV are greatest when plants are infected early, especially before flowering (Irwin and Schultz, 1981; Ruesink and Irwin, 1986).

This change in eddy structure alters the fluctuations of wind speed, heat and moisture in and near the crop canopy, directly impacting energy exchanges between the air and leaf, which in turn influences leaf surface temperature (Rosenberg *et al.*, 1983) and the rates of vector reproduction and viral replication.

Wind speed and temperature also have an impact on an insect's ability to initiate flight and on the insect's subsequent flight path (Johnson, 1969; Pedgley, 1982). Thus, all of these cascading and overlapping factors influence virus epidemics.

The radiant flux also impacts many aspects of the biotic components, including plant photosynthesis and heating of the plant, virus, and vector; it can further provide orientation and movement cues for vectors (Johnson, 1969).

The greater effect of early virus inoculation on yield reduction is critical for developing management strategies for producers (Ziems, *et al.*, 2007). Another possibility for BPMV management might be the use of soybean cultivars that are resistant to insect feeding (Hammond *et al.*, 2001).

Table 6: Effect of Weeding Regime and Insecticide Application on Incidence and Severity of Viral Diseases on Experiment Plots

	Treatment combination	Incidence %	Severity %
1	None weeding/none insecticide	71	75
2	None weeding/ insecticide once	70	74
3	None weeding/ insecticide twice	61	63
4	None weeding/ insecticide thrice	60	60
5	Weeding once/none insecticide	52	50
6	Weeding once/ insecticide once	51	50
7	Weeding once/ insecticide twice	48	45
8	Weeding once/ insecticide thrice	47	43
9	Weeding twice/ none insecticide	46	38
10	Weeding twice/ insecticide once	45	35
11	Weeding twice/ insecticide twice	20	25
12	Weeding twice/ insecticide thrice	21	24
13	Weeding thrice/none insecticide	15	14
14	Weeding thrice/ insecticide once	10	12
15	Weeding thrice/ insecticide twice	2	5
16	Weeding thrice/ insecticide thrice	1	2

Table 6 showed the effect of weeding regime and insecticide application on incidence and severity of viral diseases of soybean. The treatment combination of none weeding and none insecticide had 71% incidence and 75% severity. On none weeding and insecticide thrice had incidence 60% and severity 60%. There was a progressive decline in the percentage of incidence and severity of viral diseases with treatments in the Table. Considering weeding once and none insecticide, it had 52% incidence and 50% severity. In addition, Weeding once and insecticide thrice, had 47% incidence and 43% severity. Similar trend was observed in weeding twice and none insecticide with 46% incidence and 38% severity. However, there was a reduction in percentage incidence and severity with weeding twice and insecticide thrice.(21%

incidence and 24% severity). Weeding thrice and none insecticide had 15% incidence and 14% severity. Weeding thrice and insecticide thrice had 1% incidence and 2% severity.

CONCLUSION

The practical manipulation of agronomic practices such as herbicide application and appropriate weeding techniques, insecticide application, identification of resistant varieties, early time of planting and use of pathogen free seeds have in this study been shown to be experimental variables that influenced the incidence and severity of virus diseases. The combination of these cultural practices could be effectively applied in soybean virus disease management.

A major outcome of this study has been the accurate and timely diagnosis of the viruses

infecting soybean in Kwara State and development of approaches that can be used optimize virus disease control in soybean. The study has also shown that the interrelations between farming system, virus host vector and environment influence the virus ecology and epidemiology. It's therefore important to monitor the interactions on virus evolution.

RECOMMENDATIONS

Weeding thrice and application of insecticide thrice is recommended as a tool in the management of virus diseases in soybean.

Early planting of soybean in late May or early June is recommended to prevent insect vector population build up and early transmission of the virus by insect vector from the weed to soybean.

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