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CONTROLLING BEAN POD MOTTLE VIRUS (BPMV) (GENUS COMOVIRUS) OF SOYBEAN WITH SPATIAL ARRANGEMENT OF MAIZE-SOYBEAN IN SOUTHEASTERN NIGERIA

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ABSTRACT

Field cultural practices of controlling Bean Pod Mottle Virus (BPMV) (genus comovirus) disease, involving thirteen spatial arrangements of maize/soybean (M:S) were studied for 2 years in Nsukka agro-ecological zone of Nigeria. Factorial arrangement of treatments in a randomized complete block design with three replications was used. Thirteen spatial arrangements of maize/soybean (M:S) constituted a factor while the health conditions of soybean plants (healthy and infected) constituted another factor. The thirteen spatial arrangements of maize/soybean (M:S) studied differed significantly in the incidence of BPMV disease. Spatial arrangement of 2:4 recorded the highest (82.5%) incidence, though statistically similar with spatial arrangements of 0:4(sole soyabean) (71.3%), 1:4 (76.3%) and 3:4 (70.0%). spatial arrangement of 3:1 recorded the lowest (7.5%) incidence though statistically similar with spatial arrangement of 1:1 (13.8%) and 1:2 (18.9%). Spatial arrangement of 1:2 recorded the highest (69.4) number of pods and grain yields (1.42t/ha), while the spatial arrangement, 3:1 recorded the lowest (40.80) number of pods and grain yield. Health conditions of the soybean plant affected significantly the yield. Healthy soybean plant produced the highest (1.49t/ha) grain yield while infected soybean plant produced the lowest grain yield.of 0..82 t / ha.

Key words: Spatial arrangement, Bean leaf beetle, Bean pod Mottl virus, Maize, Soybean.

INTRODUCTION

Bean Pod Mottle Virus genus comovirus (BPMV) infect soybeans (Zaumeyer and Thomas 1957). Virus disease of legumes have a world wide distribution and are of great importance to agriculture (Suzanne 2001). BPMV is a sap-transmitted virus and several beetles move the infective sap around to spread the virus disease (Suzanne, 2001). Rayda and Marlin (2002) reported that the main path for BPMV entry into soybean plant is through insect feeding. According to their report, the effect of BPMV on yield vary by soybean variety and growing conditions, but losses could reach up to 50%. *Finlay et al* (1974) reported that in a cereal/legume intercrop, the cereal crop may impede the movement of legume insects, causing them to be more aggregated than in monoculture system. Alegbejor and Uvah (1986) reported that maize (*Zea mays L*) and guinea corn (*Sorghum bicolor (Linn.) Moench*) when intercropped with peppers, served as barrier crops against aphid vectors of pepper veinal mottle virus genus potyvirus and caused a reduction of virus spread in the intercrops. This

study on spatial arrangement of maize/soybean intercrop is conducted as a step towards cultural measures for containing the BPMV disease of soybean.

MATERIALS AND METHODS

The experiment was conducted for 2 years. The experimental design used was factorial arrangement of treatment in a Randomized Complete Block Design (RCBD) with three replications. Thirteen spatial arrangements, maize/soybean (M:S) constituted a factor. Health conditions of soybean seedlings (healthy and infected) constituted another factor. The land was cleared, ploughed, harrowed and marked out into 3 blocks, each measuring 109.5m x 2m. Each block was divided into 13 plots each measuring 7.5m x 2m and separated by 1m path. A mixed fertilizer of single superphosphate and NPK 15:15:15 compound fertilizer at the rate of 200kg/ha and 150kg/ha respectively were worked into the soil (0.3kg/plot of SSP and 0.225kg/plot of NPK 15:15:15) at two weeks after planting. The 13 spatial arrangements maize/soybean were randomly assigned to each of the 13 plot in each of the three blocks. There were 10 rows spaced 75cm apart in each plot. The seeds of maize and soybean were sown the same day. The maize seeds were sown on the maize row at a spacing of 25cm within row and 8 maize seeds in a row. The soybean seeds were sown on the soybean row at a spacing of 5cm within row and 40 soybean seeds in a row. Maize variety used was Orba supper 2. Soybean variety used was TGX 1878 –30E. Weeding was manually done using hoe at three weekly intervals. The 13 spatial arrangements (maize/soybean) used were sole soyabean 1:1, 1:2, 1:3, 1:4, 2:1, 2:2, 2:3, 2:4, 3:1, 3:2, 3:3, 3:4. Incidence of BPMV disease was determined 10 weeks after planting. The field was surveyed for soybean plant with typical symptom of BPMV and the total number recorded. Infected plants in each plot of every block were tagged with yellow tag to distinguish them from healthy plants.

Severity rating was done by scoring using a five point scale ranging from 0-4. 5soybean plants with yellow tags in each pot of every block was randomly taken and scored. Scoring was on the two youngest leaves of infected plant. The two youngest leaves of each plant were scored separately and average of the two leaves, taken for a plant score and final average of 5 scored plants were recorded for each pot. The number of pods borne per healthy and infected soyban plants (5 of each) randomly sampled from the treatment plots were counted at maturity for each factor. The pods from the sampled plants were shelled and seeds weighed to determine the grain Yield. Data were collected on the following: BPMV disease incidence, severity rating of BPMV disease, plant height, number of branches, number of pods per plant and grain yield (metric tonnes) per hectare.

RESULTS

Results of the two-year study (Tables 1 –5) show that spatial arrangement has significant ($p<0.05$) effect on the incidence of BPMV disease, plant height, number of branches, number of pods and grain yields (t/ha). There was no significant difference on the severity ratings of BPMV disease.

Although spatial arrangement of 2:4 had the highest incidence of BPMV (82.5%) (Table 1) and spatial arrangement of 3:1 had the lowest incidence of BPMV (7.5%), there was no significant differences on the BPMV disease incidence in years 2000 and 2001.

Spatial arrangement of 3:4 had the highest plant height of 55.6cm and 55.7cm in years 2000 and 2001 respectively (Table 2). Spatial arrangement of 2:1 had the lowest plant height of 44.0cm in both year 2000 and 2001. There were significant difference ($p<0.05$) in the height of healthy and infected soybean plants in both years. The height of infected soybean plant in 2000 and 2001 were 45.6cm and 46.0cm respectively. There were significant interaction effects in the heights of healthy and infected soybean plants with the spatial arrangements in both years.

Table 1: Effect of spatial Arrangement (maize/soybean) on the incidence and severity ratings of BPMV disease infection on soybean grown in 2000 and 2001 cropping seasons at 10 weeks after planting (WAP)

Spatial arrangements maize/soybean	Incidence and severity			
	2000		2001	
	Incidence	Severity	Incidence	Severity
Sole soybean	72.5	2.7	70.0	2.8
1:1	15.0	2.7	12.5	2.7
1:2	20.0	2.8	17.5	2.7
1:3	50.0	2.7	50.0	2.8
1:4	77.5	2.7	75.0	2.7
2:1	25.0	2.8	22.5	2.7
2:2	25.0	2.7	25.0	2.7
2:3	60.0	2.7	57.5	2.7
2:4	82.5	2.8	82.5	2.7
3:1	7.5	2.7	7.5	2.8
3:2	35.0	2.7	35.0	2.7
3:3	45.0	2.7	47.5	2.7
3:4	72.5	2.7	70.0	2.7
Mean	45.2	2.7	44.0	2.7

	2000	2001
F – LSD ($p<0.05$) for comparing diseases incidence	10.26	14.00
F – LSD ($p<0.05$) for comparing severity rating	NS	NS

Table 2: Effect of spatial arrangement (maize/soybean) on the height (cm) of BPMV infected and healthy soybean grown in 2000 and 2001 cropping seasons

Spatial arrangements maize/soybean	Health conditions			
	2000		2001	
	Healthy	Infected	Healthy	Infected
Sole soybean	45.1	44.7	44.4	44.6
1:1	51.0	47.3	53.0	46.3
1:2	47.3	45.5	48.3	45.9
1:3	51.2	46.1	52.2	47.1
1:4	50.4	42.8	41.3	43.8
2:1	45.7	42.3	45.6	42.4
2:2	49.9	45.3	49.9	45.8
2:3	49.7	43.0	48.8	43.6
2:4	49.3	41.7	49.0	41.6
3:1	49.7	42.2	49.9	43.2
3:2	52.0	47.3	51.9	50.4
3:3	48.7	18.4	48.2	48.4
3:4	55.6	55.7	55.8	55.6

	2000	2001
F – LSD ($p<0.05$) for comparing any two spatial arrangement mean	7.14	7.38
F – LSD ($p<0.05$) for comparing any two spatial arrangement x health condition mean	10.10	10.45
F – LSD ($p<0.05$) for comparing any two state of health	2.80	2.89

Table 3: Effect of Spatial Arrangement (maize/soybean) on number of branches of BPMV infected and healthy soybean grown in 2000 and 2001 cropping seasons

Spatial arrangements maize/soybean	Health condition 2000		2001	
	Health	Infected	Health	Infected
Sole soybean	4.2	1.7	4.1	1.6
1:1	3.7	2.1	3.4	1.8
1:2	5.0	3.1	4.8	2.9
1:3	4.3	3.1	4.0	2.7
1:4	3.8	2.3	3.6	2.0
2:1	3.3	2.0	3.0	1.7
2:2	3.7	2.4	3.7	2.6
02:3	4.5	3.3	4.5	3.2
2:4	4.0	2.6	4.1	2.5
3:1	2.3	1.5	2.3	1.2
3:2	4.7	2.3	4.8	1.8
3:3	4.0	4.0	3.7	2.8
3:4	4.3	2.2	4.0	1.9
Mean	4.0	2.5	3.8	2.2

	2000	2001
F – LSD ($p<0.05$) for comparing any two spatial arrangement mean	1.01	1.03
F – LSD ($p<0.05$) for comparing any two spatial arrangement x health condition mean	1.43	1.46
F – LSD ($p<0.05$) for comparing any two state of health	0.40	0.40

In year 2000, Spatial arrangement of 3:3 and 1:2 had the highest number of branches of 4.0 and was closely followed by spatial arrangement of 2:3 which had 3.9 branches (Table 3). In year 2001 spatial arrangement of 2:3 had the highest number of branches of 3.9 and was closely followed by spatial arrangement of 1:2 which had 3.8 branches. Spatial arrangement of 3:1 had the lowest number of branches of 1.9 and 1.8 in year 2000 and 2001 respectively. There were significant differences ($p<0.05$) in the number of branches of healthy and infected soybean plants in both years. The mean number of branches of healthy soybean plant in year 2000 and 2001 were 4.3 and 4.0 respectively, while the mean number of branches for infected soybean plant in year 2000 and 2001 were 2.2 and 1.9 respectively. There were significant interaction effects in the number of branches of healthy and infected soybean plants with the spatial arrangements. Spatial arrangement of 1:2 had the highest number of pods of 67.4 and 67.3 in year 2000 and 2001 respectively (Table 4). Spatial arrangement of 3:1 had the least number of pods of 41.7 and 39.9 in year 2000 and 2001 respectively. There were significant differences ($p<0.05$) in the number of pods of healthy and infected soybean plants in both years. The mean number of pods of healthy soybean plant in 2000 and 2001 were 70.9 and 70.2 respectively, while the number of pods of infected soybean plant in year 2000 and 2001 were 39.3 and 38.2 respectively. There were significant interaction effects in the number of pods of healthy and infected soybean with the spatial arrangements.

Spatial arrangement of 1:2 had the highest grain yields (t/ha) of 1.42t/ha (Table 5) while spatial arrangement of 3:1 had the lowest grain yield of 0.86t/ha. There were significant differences ($p<0.05$) in the grain yields of healthy and infected soybean plants. The grain yield of healthy soybean plant was 1.49t/ha while the grain yield of infected soybean plant was 0.82t/ha. There were significant interaction effects in grain yields of healthy and infected soybean plant with the spatial arrangements.

Table 4: Effect of spatial arrangement (maize/soybean) on number of pods of BPMV infected and healthy soybeans grown in 2000 and 2001 cropping seasons

	Health condition			
	2000		2001	
Spatial arrangements maize/soybean	Health	Infected	Health	Infected
Sole soybean	81.4	30.7	79.8	28.3
1:1	59.0	24.8	58.6	24.0
1:2	78.2	56.6	79.2	55.3
1:3	71.3	48.3	70.5	47.4
1:4	77.2	35.4	77.0	34.8
2:1	56.0	33.8	56.6	32.0
2:2	76.2	42.1	74.7	44.1
2:3	76.1	47.3	75.0	46.3
2:4	66.8	36.5	66.2	36.0
3:1	57.0	26.3	55.1	24.7
3:2	76.7	35.0	76.1	31.9
3:3	61.5	53.3	61.5	54.4
3:4	83.7	40.3	82.9	37.4
Mean	70.9	39.3	70.2	38.2

	2000	2001
F – LSD ($p<0.05$) for comparing any two spatial arrangement mean	20.15	21.38
F – LSD ($p<0.05$) for comparing any two spatial arrangement x health condition mean	28.50	30.24
F – LSD ($p<0.05$) for comparing any two state of health	7.90	8.39

Table 5: Effect of spatial arrangement (maize/soybean) on grain yields (tons) per Hectare of BPMV infected and healthy soybean cropping season

	Health conditions 2001		
Spatial arrangemer	Health	Infected	Mean
Sole soybean	1.699	0.622	1.160
1:1	1.239	0.515	0.877
1:2	1.659	1.179	1.419
1:3	1.494	1.008	1.252
1:4	1.625	0.740	1.183
2:1	1.186	0.693	0.940
2:2	1.590	0.909	1.249
2:3	1.593	0.987	1.290
2:4	1.404	0.764	1.083
3:1	1.181	0.538	0.860
3:2	1.610	0.705	1.158
3:3	1.296	1.135	1.216
3:4	1.756	0.819	1.287
Mean	1.487	0.816	1.152

	2001
F – LSD ($p<0.05$) for comparing any two spatial arrangement mean	0.0258
F – LSD ($p<0.05$) for comparing any two spatial arrangement x health condition mean	0.0364
F – LSD ($p<0.05$) for comparing any two state of health	0.0101

DISCUSSION

Virus diseases spread more easily to adjacent rather than to distant plants (Litsinger and Moody, 1976). Intercropping soybean with maize provided maize as a barrier to soybean plants from the invading vectors. BPMV is transmitted by leaf feeding beetles, the most important of which is the bean leaf beetle (*Cerotoma trifurcata*) (Chryl, 2002). Rayda and Marlin (2002) reported that Bean leaf beetles flew on average, 26 feet height. The significant difference ($p<0.05$) of different spatial arrangements maize/soybean on the incidence of BPMV is attributed to the hindrance of bean leaf beetle movement by the maize rows in the mixture. Barrier crops have been reported to be useful in controlling aphid transmitted viruses. Alegbejo and Uvah (1986) reported that barrier crops afforded protection to pepper by causing the aphid vectors of pepper Venial mottle virus genus potyvirus to alight less frequently on pepper but more on the tall barrier crops. Alegbejor and Kashina (2002) also reported that aphid vectors loose the virus after probing on the cereals or after settling on them for some hours.

The significant differences ($p<0.05$) in plant soybean height, number of branches, number of pods, grain yield of soybean plants in the varying spatial arrangement is attributed to the variation in spatial arrangements reaction to the interaction of infection of BPMV and the environment. The result of this work suggests that different spatial arrangement has different ability to make for efficient use of the soil and solar radiation by the soybean in obtaining and synthesizing food substrate. Spatial arrangement of 1:2 recorded the highest pod yield in both years of study of 67.4 and 67.3 in 2000 and 2001 respectively while spatial arrangement of 3:1 recorded the lowest pod yield of 41.7 and 39.9 in 2000 and 2001 respectively. It is evident that spatial arrangement of 1:2 produced better open space and root interaction than spatial arrangement of 3:1 which tends to over crowd the soybean allowing less penetration of the solar radiation. This is reflected in the low number of branches produced by soybean grown in the arrangement.

CONCLUSION

Cultural practice involving spatial arrangement maize/soybean is effective in reducing the incidence of BPMV disease and in increasing the yield of soybean.

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