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INFLUENCE OF COWPEA GENOTYPE AND SORGHUM-CROPPING SYSTEM ON COWPEA INFESTATION BY SOME INSECT PESTS IN THE SUDAN SAVANNAH OF NIGERIA

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ABSTRACT
Field trials were conducted at the International Institute of Tropical Agriculture, Agricultural Research Station at Minjibir, Kano State ($12^0$13'N, $8^0$41'E, 500M above sea level) in the 1999 and 2000 cropping seasons to investigate the influence of cowpea genotypes and sorghum cropping system on cowpea damage by legume pod borer, Maruca testulalis (Fabricius), bean flower thrips, Megalurthrips sjostedti (Trybom) and cowpea aphids, Aphis craccivora Koch. Treatments consisted of a combination of 6 cowpea genotypes, namely, Danila, IT90K-277-2, IT95K-1091-3, IT95K-222-14, IT96D666 and IT96D-759 and 4 row arrangements, which included 1M:1C, 2M:2C, 1M:2C and 2M:4C rows of millet to rows of cowpea, respectively. The treatments were laid out in split plot design with row arrangement and cowpea genotype as main and sub-treatments, respectively. Maruca damage ratings on cowpea were recorded based on damage to flowers and pod on the peduncles using 1-9 scale. For aphids, level of infestation was assessed by estimating number of aphid colonies on plants/plots at flowering stage using 0-9 scale, while for thrips, infestation was estimated at post-flowering stage using a scale of 1-9. Result showed that all treatments, except Danila and IT96D-759 were less susceptible to pod damage by Maruca in both 1999 and 2000. Maruca pod damage was significantly higher in 2S:4C row arrangement compared to other treatments. Significantly lower aphids and thrips population were recorded on all treatments except Danila and IT6D-759 and Danila and IT95K-1091-3 in both 1999 and 2000, respectively. The mean number of aphids was lower in 1S:1C in 2000 (2.14) and thrips infestation was highest at 2S:4C row arrangement in 1999 and 2000, respectively. The total dry matter and grain yield increased progressively from 1S:1C through 4S:4C in both 1999 and 2000. The present study suggests that sorghum-cowpea inter crop and the use of improved cowpea varieties should be adopted as control measures against the devastating effects of Maruca, aphids and thrips, thereby improving the cowpea dry matter and grain yield.

Keywords: Cowpea, Genotype, Insect, Sudan, Maruca

INTRODUCTION

Insect pests have been reported to be the single most important constraint to cowpea production in most parts of West Africa (Booker, 1965; Jackai and Daoust, 1986; Singh *et al*., 1990; Karungi *et al*., 1999) accounting for the low annual harvest of this important grain legume, which contains 22-35% protein and constitute major protein source in third world countries (Singh and Jackai, 1985).

Legume pod borer, *Maruca testulalis* (Fabricius), bean flower thrips, *Megalurthrips sjostedti* (Trybom) and cowpea aphids, *Aphis craccivora* Koch are among insect pests that attack cowpea in the field. *Maruca* larvae feed on flower buds, flowers and pods of leguminous plants. They characteristically attack pods at point of contact between two pods or between a pod and a leaf or stem (Allen *et al*., 1996). Both adult thrips and their nymphs feed at the base of petals and stigma. Severe injury is characterised by flower malformation, distortion and discolouration. Yield loss has been estimated at about 14.5 kg/ha per individual thrips per plant (Allen *et al*., 1996). *A. craccivora* is an important pest of cowpea during the seedling stage. Both adult and juvenile aphids suck sap from young leaf and stem tissues. Aphids also infest the reproductive structures but the damage is more devastating during the seedling phase when they also transmit the cowpea aphid-borne mosaic virus (Roberts *et al*., 1993; Jackai *et al*., 2001).

The search for viable non-chemical means of controlling insect pests attacking cowpea in the field has been vigorous and significant progress has already been made. This search was necessitated mainly by the harmful side effects and high costs of insecticides and their ability to leave harmful residue in the harvested grains, and of course, causing the emergence of resistant strains of pests (Agboola, 1992), which suggest the need for the use of plant varieties with host-resistant qualities (Bamaiyi *et al*., 2000; Ahmed and Yusuf, 2007), and the use of cereal-cowpea intercrop in avoiding insect pest infestation in cowpea crop (Willey, 1979 and Anon, 1977). The use of resistant varieties is a cheap, effective and ecologically safe method of protecting crops against pests since there is no special technology which has to be adopted by the farmer (Helbig, 1997).

Intercropping, apart from spreading the labour peak of the farmer, has also been shown to reduce the incidence of pest through the creation of a less favourable environment than that of the monocrop (Steiner, 1982; Fisher *et al.*, 1987). This study was undertaken to assess the susceptibility of five cowpea cultivars and row arrangements in cowpea-sorghum intercrop to *Maruca*, thrips and aphid damage.

MATERIALS AND METHODS

Field trials were conducted at the IITA Agricultural Research Station at Minjibir, Kano (12^0 13'N 8^0 41'E, 500m above sea level) in the 1999 and 2000 cropping seasons. The soil of the Experimental site was sandy loam. The treatments consisted of a combination of 6 cowpea genotypes and 4 row arrangements. The genotypes included 1 local (Danila, a medium maturiting) and 5 improved medium maturing (1T96D-772, IT90K-277-2, IT95K-1091-3, IT96D-740 and IT96D-757). The row arrangements included 1S:1C, 2S:2C, 1S:2C and 2S:4C rows of sorghum to rows of cowpea respectively. The treatments were laid down in split plot design with row arrangement and cowpea genotype as main and sub-treatments respectively. The gross plot varied from 14 ridges 75cm apart by 6m long to 6 ridges by 6m long and the net plot from 6 ridges 4 m long to 2 ridges 4 m long, depending on the row arrangement.

The plots received a basal application of 30kg N, 30kg P_20_5 and 30kg k_20/ha in form of Urea, Single superphosphate and Muriate of potash before planting. Sorghum was top-dressed with 30kg N/ha at 5 weeks after planting. The seeds (cowpea and sorghum) dressed with Farnasan D, were sown at 20cm on 75cm apart ridges for cowpea, and 1m on 75cm ridges for sorghum. Sorghum was planted 2 weeks after cowpea in 1999, but in 2000 the two crops were planted simultaneously. The variation was determined by the on set and establishment of the rains. The crops were sown as per the row arrangement. Weeds were controlled manually as and when due.

Maruca and thrips damage ratings on cowpea were recorded using the following visual ratings as described by Jackai and Singh, (1988). For Maruca the rating was based on damage on flowers and pod on the peduncles using 1-9 scale as follows: 1 (0-10%), 2 (11-20%),3 (21-30%),4 (31-40%),5 (41-50%),6 (51-60%),7 (61-70%),8 (71-81%),9 (81-100%); for aphids, level of infestation was assessed by estimating number of aphid colonies on plants/plot at flowering stage using 0-9 scale thus, 0 (no infestation), 1 (a few individual aphids), 3 (a few isolated colonies), 5 (several small colonies), 7 (large isolated colonies), 9 (large continuous colonies), while for thrips, infestation was estimated at post flowering stage (52-58 days after planting) using a scale of 1-9 as follows: 1 (browning/drying (i.e, scaling) of stipules, leaf or flower buds; no bud abscission), 3 (initiation of browning of stipules, leaf or flower; no bud abscission), 5 (distinct browning/drying of stipule and leaf or flower buds; some bud abscission), 7 (serious bud abscission accompanied by browning/drying stipules and bud; non elongation of peduncles), 9 (very severe bud abscission, heavy browning/drying of stipules and buds; distinct non elongation of (most or all) peduncles). At harvest, data on dry matter and grain yields were recorded. The data were analyzed statistically as described by Snedecor and Cochran (1967). Multiple comparison of the means was done using Duncan's Multiple range test (Duncan, 1955).

RESULTS

Table 1 shows the influence of cowpea genotype and row arrangement on number of days to 50% flowering and *Maruca* damage on cowpea mixture with sorghum at Minjibir, Kano State. Danila recorded the highest number of days to 50% flowering in both 1999 and 2000 (54.50 and 50.50 days, respectively), and the lowest was recorded with IT90K277-2 (44.92days) in 1999, although this was at par with IT95K-1091-3 and IT95K-222-14, while the lowest was recorded with IT95K-1091-3 (39.58) in 2000. However, data on *Maruca* damage shows that in 1999, IT96D-759 recorded the highest mean pod damage (1.50) but this was not significantly different from Danila. There was no significant difference among the rest of the treatments. In 2000, the highest mean pod damage was recorded with Danila (2.21), followed by IT96D-759 (1.88), although the difference between them was significant. There was no significant difference among the rest of the treatments.

Data on the influence of row arrangement on number of days to 50% flowering shows that in 1999, the highest number of days to 50% flowering was recorded with 1S: 1C (49.06). The rest of the treatments were similar statistically. Similarly, there was no significant difference among treatments in 2000 and the interaction between cowpea genotype (CG) and row arrangement (RA) on number of days to 50% flowering in both 1999 and 2000 was non significant (Table 1). The influence of row arrangement on *Maruca* damage in 1999 shows that the highest mean pod damage was recorded with 2 rows of sorghum: 4 rows of cowpea (2S:4C) in both 1999 and 2000 (1.42 and 1.92, respectively) but there was no significant difference among the rest of the treatments in 1999. In 2000 however, 1S:2C recorded the lowest mean pod damage (1.42) although, this was at par with 2S:2C. The interaction between CG and RA in both 1999 and 2000 were non significant.

The influence of cowpea genotype and row arrangement on aphids and thrips infestation on cowpea in mixture with sorghum is shown on Table 2. In 1999, the highest mean aphid infestation (1.25) was recorded with IT96D-759. There was no significant difference among the rest of the treatments, although the lowest mean infestation (1.00) was recorded with Danila and IT96D-759. In contrast, highest mean aphid infestation in 2000 was recorded with Danila (2.46) even though this was at par with IT96D-759, while the lowest was recorded with IT90K-277-2 and IT95K-222-14 (1.50). The interaction between row arrangement and aphid infestation shows that in 1999, the lowest aphid infestation was recorded with 1S:1C and 1S:2C row arrangements (1.03), although, these were not significantly different with 2S:2C while 2S:4C recorded the highest mean aphid infestation (1.17) and the CG x RA interaction was non significant.

In 2000, 1S:1C row arrangement recorded the highest aphid infestation (2.14), but the difference among the rest of the treatments was non significant, although the lowest aphid infestation was recorded with 1S:2C row arrangement (1.81) and the CG x RA interaction was also non significant.

However, the influence of cowpea genotype treatments on thrips infestation showed that in 1999, the lowest mean infestation was recorded with IT95K-222-14 (1.00), although this had no significant difference with all other treatments except IT95K-1091-3, which recorded the highest infestation (1.25). In 2000, the lowest thrips infestation was recorded with IT90K-277-2 and IT95L-222-14 (1.29) and these were significantly different from the rest of the treatments, while Danila recorded the highest thrips infestation (2.00), although it was at par with IT90K-277-2, IT96D-666 and IT96D-759. The influence of row arrangement on thrips infestation shows that in 1999, 2S:4C recorded the highest thrips infestation (1.25). There was no significant difference among the rest of the treatments and CG x RA interaction was non significant. Treatment means between row arrangement and thrips infestation in 2000 was non significant and the CG x RA interaction was also non significant.

Table 3 shows the influence of cowpea genotype and row arrangements on total dry matter and grain yield of cowpea in mixture with sorghum. The highest total dry matter at 12 WAS in 1999 and 2000 was recorded with Danila (62.86 and 41.88 g, respectively) and these were significantly different from the rest of the treatments ($P<0.05$). The lowest total dry matter was recorded with IT96D-759 in both 1999 and 2000 (33.84 and 32.69 g, respectively). IT95K-222-14 recorded the highest grain yield in 1999 (855 Kg/ha) and was significantly different from the rest of the treatments, while the lowest was recorded with IT96D-666 (340 Kg/ha) although this was at par with Danila. In 2000, the highest grain yield was recorded with IT90K-277-2 (999 Kg/ha), except that it had no significant difference with IT90K-222-14. There was no significant difference among the rest of the treatments. There was no significant CG x RA interaction on total dry matter. However, the CG X RA interaction indicated that except for IT96D-759, all the genotypes recorded significantly higher grain yield at 2S:4C row arrangement compared with other treatments. For IT96D-759, it produced higher yield at 2S:2S than the other treatments with 2S:4S row arrangement recording the least.

Table 1. Influence of cowpea genotype and row arrangement on number of days to 50% flowering and Maruca damage on cowpea in mixture with sorghum at Minjibir, Kano State.

Treatments	Number of days to 50% flowering		Mean maruca damage	
	1999	2000	1999	2000
Cowpea genotype				
Danila	54.50a	50.50a	1.42a	2.21a
IT90K-277-2	44.92d	43.08c	1.08b	1.33c
IT95K-1091-3	45.50d	39.58d	1.08b	1.5.00c
IT95K-222-14	45.92cd	43.83c	1.08b	1.38c
IT96D-666	51.42b	45.33b	1.08b	1.58bc
IT96D-759	46.92c	46.00b	1.5a	1.88b
SE ±	0.46	0.48	0.06	0.11
Row arrangement				
1S[1] : 1C[2]	49.06a	44.83	1.14b	1.67b
2S : 2C	48.00b	44.72	1.14b	1.58bc
1S : 2C	47.94b	44.44	1.14b	1.42c
2S : 4C	47.78b	44.89	1.42a	1.92a
SE ±	0.24	0.34	0.04	0.06
CG x RA interaction	ns	ns	ns	ns

Table 2. Influence of cowpea genotype and row arrangement on aphids and thrips infestation to cowpea in mixture with sorghum at Minjibir, Kano State.

Treatments	Mean aphids infestation		Mean thrips infestation	
	1999	2000	1999	2000
Cowpea genotype				
Danila	1.00b	2.46a	1.08ab	2.00a
IT90K-277-2	1.08b	1.50d	1.08ab	1.29b
IT95K-1091-3	1.08b	1.83c	1.25a	1.96a
IT95K-222-14	1.13b	1.50d	1.00b	1.29b
IT96D-666	1.00b	2.04bc	1.04b	1.79a
IT96D-759	1.25a	2.21ab	1.08ab	1.83a
SE ±	0.04	0.09	0.06	0.09
Row arrangement				
1S[1] : 1C[2]	1.03b	2.14a	1.02b	1.83
2S : 2C	1.14ab	1.89b	1.06b	1.61
1S : 2C	1.03b	1.81b	1.02b	1.64
2S : 4C	1.17a	1.86b	1.25a	1.69
SE ±	0.03	0.05	0.02	0.11
CG x RA interaction	ns	ns	ns	ns

Means followed by the same letter (s) within treatment are not significantly different at 5% using DMRT.
[1]S= sorghum; [2]C= cowpea ; ns= non significant

Table 3. Influence of cowpea genotype and row arrangement on total dry matter and grain yield of cowpea in mixture with sorghum at Minjibir, Kano State.

Treatments	Total dry matter at 12 WAS (g)		Grain yield (kg/ha)	
	1999	2000	1999	2000
Cowpea genotype				
Danila	62.86a	41.88a	424d	660bc
IT90K-277-2	43.85b	36.56b	682b	999a
IT95K-1091-3	39.32bc	35.46b	554c	772b
IT95K-222-14	42.83b	35.82b	835a	938a
IT96D-666	36.43c	34.07b	340d	632bc
IT96D-759	33.84c	32.69b	607bc	558c
SE ±	2.12	1.24	34.22	53.81
Row arrangement				
1S[1] : 1C[2]	33.24c	25.66c	410b	604b
2S : 2C	42.72b	36.15b	462b	675b
1S : 2C	44.40b	37.46b	497b	737b
2S : 4C	52.38a	45.05a	926a	1023a
SE ±	1.21	0.79	75.66	64.35
CG x RA interaction	ns	ns	*	ns

Means followed by the same letter (s) within treatment are not significantly different at 5% using DMRT.
[1]S= sorghum; [2]C= cowpea; ns= non significant

DISCUSSION

Danila and IT96D-759 offered the least resistance to pod damage by *Maruca* in both 1999 and 2000. The rest of the treatments offered some kind of resistance to pod damage by recording lower *Maruca* damage (range: 1.08-1.42 in 1999 and 1.33-2.21 in 2000) and this was probably influenced mainly by plant resistance in the resistant cultivers. *Maruca* damage at 2S:4C row arrangement was highest, indicating that the presence of sorghum in this intercrop offered little protection against the devastating effect of the pest. The combined effect of the varietal resistance and intercropping seems rather additive than synergistic in nature because of the higher damage recorded by the local Danila variety compared with the rest of the treatments. This result corroborates that of Olabanji *et al.* (2002) on millet/cowpea intercropping studies.

The result of this study showed that varietal resistance offered protection to cowpea in the sorghum/cowpea mixture by way of reducing the level of aphids and thrips infestation although higher aphid infestation was recorded on the spreading local Danila and IT96D-759 compared to other genotypes. Similarly, higher thrips infestation was recorded on Danila and IT95K-1091-3 in both 1999 and 2000 indicating that the improved varieties were resistant to thrips infestation. This corroborates the work of Singh (1980) and Ansari *et al.* (1992), who reported many cowpea accessions with resistance to aphids and thrips infestations. According to Ofuya, (1993), the resistance to aphids in resistant cultivers is attributed to strong antibiosis. It is also probable that apparent resistance exhibited by some of the cowpea genotypes to thrips infestation was due to inherent genetic properties.

The lower infestation by aphids in 1S:1C and 1S:2C row arrangements in 1999 compared with other treatments indicates that the presence of sorghum plants acted as barriers to aphids' invasion of the intercropped plots, which have accounted for the lower aphids infestation at the more intimate (1S:1C) than at the wider (2S:4C) row arrangement. This corroborates the work of Uvah (1978), who indicated that intercropping sorghum with a relay crop of cowpea reduced the abundance of cowpea herbivore, *A. craccivora, M. vitrata, M. sjostedti* and pod-sucking bugs by 92%, 45%, 35% and 90%, respectively compared to their number on monocropped cowpea. However, in 2000 only 1S:1C row arrangement was not effective in reducing the number of aphids in the sorghum/cowpea intercrops. It is likely that this row arrangement had supported favourable microclimatic conditions (cool and moist environment) for high aphid infestation. A similar report was made by Umaru *et al.* (2003) in a millet/groundnut study.

The highest thrips infestation recorded at wider 2S:4C row arrangement demonstrated the influence of intercrop and barrier effects of tall canopy crops (sorghum) on pest infestation and damage to intercropped cowpea. This effect as observed in this study was more effective at close cropping patterns 1S:1C, and decreases as the density of or distance between the component crops increases or approaches monocropped arrangement. Umaru *et al.* (2003), using millet/groundnut mixture reported decrease in aphids infestation in intercropped groundnut, which they attributed to the millet barrier in the intercrop, adding that the barriers hinder their easy movement across plots. Burleigh (1973) had earlier observed that in intercropping, the taller components act as physical barrier to pests attacking shorter components.

The three insects monitored on cowpea, *Maruca*, aphids and thrips did not affect the yield of cowpea seriously due most likely, to their lower infestation level, which did not allow them to cause economic damage. This could probably explain the obvious advantages in the combination of plant resistance with intercropping for the control of these insects. Jackai *et al.* (2001) reported that combination of appropriate intercrop with the inherent plant resistance ensure a rapid decline of the insects' populations.

The total dry matter and grain yield increased progressively from 1S:1C through 4S:4C in both 1999 and 2000 indicating that among other things, the competition imposed by sorghum on cowpea, especially in the one plant combination, not only affected total dry matter but also the yield of the cowpea crop. The difference in dry matter among the genotypes appears to have been influenced by *Maruca* infestation than by aphids or thrips. In both seasons Danila recorded the highest dry matter in spite of high *Maruca* infestation.

This is not surprising since Danila being a local variety has low harvest index and highly susceptible to attack by *Maruca* and other cowpea pests. In both years, cowpea dry matter and yield were highest at 2S:4C than 1S:1C indicating that the superiority was possibly due to better environmental/growth factors than to low pest attack. For example in 1999 and 2000, *Maruca* damage was highest at 2S:4C, and so also for aphids and thrips infestation in 1999. Competition for growth resources and reduction in yields, have been reported to be high at the more intimate 1S:1C cropping arrangement (Umaru *et al.* 2003).

The results generally show a reduced damage to cowpea by the three pests investigated in this study. Further, the study indicates that sorghum/cowpea intercrop is a feasible cropping system ensuring less pest problems for cowpea with the concomitant high yields (Egharevba, 1984 and Raheja, 1977), making it appropriate for improving the productivity of the system in the Sudan savanna were both crops are important.

CONCLUSION

Sorghum inter-sown with cowpea as well as the use of improved varieties may reduce the effect of *Maruca* damage, and aphids and thrips infestation, thereby improving the cowpea dry matter and grain yield. Further based on results, IT90K-277-2 and IT95K-222-14 and sowing of cowpea at 2S:4C row arrangement could be recommended improving sorghum/cowpea intercrop productivity in the Sudan of Nigeria.

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