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ORIGINAL ARTICLE

YIELD AND YIELD COMPONENT OF PEPPER (*CAPSICUM ANNUM* L.) VERSUS COWPEA (*VIGNA UNGUICULATA* (L.) WALP) INTERCROP AS AFFECTED BY TIME OF INTRODUCTION OF COWPEA VARIETIES

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Abstract

A two location experiment was conducted during the 2020/2021 dry season at the research farms of Institute for Agricultural Research (IAR), Ahmadu Bello University, Zaria at Samaru in the northern guinea and a private farm at Fisheries Institute Chiromawa, Kano in Sudan savanna in order to determine the performance of pepper/cowpea mixed cropping as influenced by time of introduction of cowpea varieties in the Nigerian savanna. Treatments consisted of factorial combinations of five times of cowpea introduction into pepper (simultaneously with pepper at transplanting, 1 week after transplanting (WAT), 2 WAT, 3 WAT, and 4 WAT pepper) and three cowpea varieties (SAMPEA 19, SAMPEA 18 and SAMPEA 17) laid in randomized complete block design replicated three times. The results at both locations showed that flowering in pepper was earlier when cowpea was introduced at 3 and 4 WAT pepper. In case of cowpea, SAMPEA 19 flowered earlier (49, 47 days) and recorded higher yield (1,504.5; 2,031.7kg ha^{-1}) than the other varieties. Pod weight was higher at 4 WAT pepper in Chiromawa only, while grain yield was significantly higher in treatments when cowpea was introduced 3 and 4 WAT pepper at both locations. SAMPEA 19 recorded the highest grain yield and 100-seed weight when introduced at 4 WAT pepper at Samaru only.

Keywords: Pepper, chilli, cowpea, intercrop, soil fertility, WAT

Introduction

Intercropping is the practice of cultivating two or more crop species simultaneously in proximity. It is described by Vandermeer (1989) as one option for cropping diversification. Okigho and Greenland (1976) described intercropping as the most widespread cropping system in Africa. Also, it estimated that 99% of cowpea and 75% of maize grown in Nigeria are intercropped. The benefits of intercropping apart from productive use of land resources include increased total average yield, guard against companion crop failure, protection against pest and disease attacks as well as improvement and sustenance of soil fertility when a legume is involved as companion crop.

While sweet pepper is an important vegetable crop grown under both rain fed and irrigated conditions, more often as a sole crop. Cowpea is also an important grain legume crop that is high in protein. The two crops are in most cases grown sole or in combination with other crops. Some of the common vegetable crops grown in intercrop include pepper/tomato, pepper/onion and tomato/onion. Pepper and all other companion vegetable crops are believed to be heavy feeders of nutrients. This indicate that growing it alone or in combination with other vegetables over a period of time, tend to exhaust the soil. Therefore, it becomes important to find a companion crop that will assist in raising and maintaining the soil fertility whenever the two are grown together. Under cereal based intercrop, intercropping them with a leguminous crop have been found to sustain soil fertility for long period of time (Anitha *et al*., 2001). This is because N-fixing ability of the legumes crops by the root infected rhizobia thereby helping sustain soil fertility. It is in this regard that some researchers believe that deploying this technology into vegetable based crop production will also help in sustaining the soil fertility. However, in some areas in the Sudan savanna,

some farmers grow cowpea during the dry season as fodder (Brolmarn and Stoffella, 1986). Cowpea production is restricted to the rainy season partly due to lack of adaptable varieties for the dry season. Pepper being a high nutrient feeder in particular N and cowpea a Nitrogen fixer and therefore when grown together they are expected to complement each other by sustaining soil fertility for long period of time as found in cereal/legume intercrop. Residues fixing N, cowpea is expected to export N to the companion pepper crop. Though some researchers believed that the benefit of N fixed by the legumes is mostly fed by the succeeding crop rather than by companion non-legume crop.

This is also still under studies as the fact on ground are not adequate enough to establish this assertion. Several studies had been carried out on intercropping of pepper with other food crops and vegetables in Nigeria (Haruna and Usman, 2013). However, these studies did not focus on cowpea varieties as companion crops to pepper as well as the time at which the cowpea varieties should be appropriately introduced into pepper. Agronomic recommendations for pepper/cowpea intercrop is at present scanty; especially, relating to the varieties and the best time of introduction into the crop mixtures. Since growing of cowpea under mixed cropping has been found to be popular among almost all farmers in Nigeria, it is necessary to determine the appropriate time of introducing cowpea as companion crop to pepper and determine the best cowpea variety.

Materials and Methods

Experimental site

Field trial was conducted at two locations during the 2020/2021 dry season at the Research farms of Institute for Agricultural Research at Samaru (11º 11'N, 07º 38'E, 686m above sea level) in the Northern Guinea Savanna and at Chiromawa (11º 38' 0" N, 8 24' 0" E, 530m above sea level) in the Sudan Savanna Agro Ecological Zone of Nigeria (NiMet, 2012).

Experimental layout

The treatments consisted of five times of introducing cowpea (simultaneously with pepper at transplanting, 1 week after transplanting (WAT), 2 WAT, 3 WAT, and 4 WAT pepper and three cowpea varieties (SAMPEA 17, SAMPEA 18 and SAMPEA 19). The factorial combinations of treatments were laid out in a randomized complete block design and replicated three times.

Soil samples were randomly collected from various points at the two experimental sites at a depth of 0-30cm using an auger (10 cm diameter). Samples collected were thoroughly mixed and composite samples taken was subjected to physical and chemical analysis as described by Black (1965).

The net plot size was 4.8 m x 2 m (9.6 m^2) while the gross plot was 4.8 m x 3 m (14.4 m^2). The crops were arranged in 1:1 alternate row arrangement.

The seeds of pepper and cowpea were separately dressed with Apron star before sowing each at the rate of 0.125g to 50g and 1 sachet to 10kg of seeds respectively, in order to protect the seeds from soil borne diseases and pests.

Seedling production

Pepper seedlings were raised on nursery beds of 1.5 x 2m in October at Samaru and Chiromawa. The seedlings of pepper were transplanted at six weeks after sowing (WAS) on 1st December at Samaru and 8th December at Chiromawa at a recommended intra row spacing of 60 cm, the seedlings were transplanted at the side of the ridge. However, a sole of pepper was transplanted for the purpose of determining the LER. Seeds of the cowpea varieties were sown according to the various time of introduction treatment. Cowpea was sown at a recommended intra row spacing of 20 cm in the 1:1 row arrangement of the mixture. Likewise, sole of the three cowpea varieties were established also for the purpose of determining the LER. The seeds were sown on the sides of the ridges and thinning was not carried out.

Varieties of seedlings used

Cayenne pepper (NHCF387): Is a variety of pepper with (5-7cm) long and thin fruit with mild taste. It is characterized by profuse fruiting and has small yellowish or white flowers. Fruits are red in colour when ripe with a potential yield of 1,500 – 2,500 kg/ha.

Sampea 19 (IT08K-150-12): Early maturing cowpea, resistant to alectra and bacterial blight and tolerant to striga and drought, seed colour is white with brown eye, it is large seeded, and it has a rough seed coat or testa. The plant is semi-erect, adapted to Sudan savanna and Sahelian agro-ecologies with yield potential of 2.7 t/ha.

Sampea 18 (IT07K-293-13): Is another early maturing cowpea variety with similar characteristic as SAMPEA 19 though it has a yield potential of 2.5 t/ha.

Sampea 17 (IT07K-318-33): Is also an early maturing cowpea variety with similar characteristic and yield potential as SAMPEA 18.

Data collection and statistical analysis

Data was taken on number of fruit per plant, fruit length, fruit diameter, fresh fruit weight per plant and fruit yield per hectare for pepper while number of pods, pod weight per plant, 100 seed weight, threshing percentage and grain yield for cowpea. Data collected were subjected to statistical analysis using General Linear Model procedure of the Statistical Analysis Software (SAS) package version 9.4. The treatment means were compared using Duncan's Multiple Range Test (Duncan, 1955) at 5% level of probability.

Results

The number of fruits per pepper plant as influenced by cowpea varieties and their time of their introduction into pepper plot during the 2020/2021 dry season. The results obtained showed that none of the factors used or their interaction had significant effect ($p<0.05$) on the number of fruits of pepper.

The use of different cowpea varieties as well as time of their introduction into pepper or the interaction of these factors had no significant effect on fruit length of pepper ($p<0.05$) in both locations (Table 1).

Table 1: Effect of time of introduction of cowpea varieties on number of fruits per plant , fruit length, fruit diameter and fruit weight per plant at different harvest period of pepper in a pepper-cowpea intercrop during the 2020/2021 dry season at Samaru

	No. of fruits/plant		Fruit length (cm)		Fruit diameter (cm)		Fruit weight/plant (g)	
Treatments	Samaru	Chiromawa	Samaru	Chiromawa	Samaru	Chiromawa	Samaru	Chiromawa
Variety (V)								
SAMPEA 19	11.0	7.4	4.8	4.7	2.2	2.2	18.0	14.3
SAMPEA 18	10.9	7.4	4.7	4.7	2.2	2.2	18.7	14.2
SAMPEA 17	11.5	7.2	5.0	4.8	2.2	2.1	18.1	14.7
SE±	0.44	0.34	0.15	0.13	0.05	0.03	1.02	0.47
Time of Introduction (T)								
At T	10.8	7.0	5.1	4.7	2.2	2.2	19.6^{ab}	14.3
1 WAT	10.4	7.1	4.7	4.7	2.2	2.2	15.7^{b}	14.5
2 WAT	11.6	7.5	4.7	4.7	2.1	2.2	18.0^{ab}	14.6
3 WAT	12.0	7.1	4.9	4.7	2.1	2.1	20.2^{a}	14.1
4 WAT	10.6	8.0	4.7	4.8	2.2	2.2	17.9^{ab}	14.4
SE±	0.57	0.44	0.20	0.17	0.06	0.05	0.06	0.98
Interactions								
V X T	NS	NS	NS	NS	NS	NS	NS	NS

WAT=Weeks after transplanting

The diameter of pepper fruits as influenced by time of introduction of three cowpea varieties into pepper plots during 2020/2021 dry season is shown on Table 1. Pepper fruit diameter was not significantly

affected (p>0.05) by both cowpea varieties and times of cowpea introduction into plot of pepper. Factor interaction on pepper fruit diameter was not significant at both location.

The fresh fruit weight per pepper plant as affected by cowpea varieties and time of cowpea introduction to plots of pepper during the 2020/2021 dry season is presented on Table 1. The use of different cowpea varieties did not affect the parameter significantly (p>0.05) at both locations. Time of introduction of cowpea into plots of pepper had significant effect (p<0.05) on pepper fresh fruit weight per plant only at Samaru where plots in which cowpea was introduced 3 weeks later produced the heavier fresh fruits, than for when cowpea was introduced 1 week later but did not differ statistically (p>0.05) with the other times of cowpea introduction. There was no significant interaction between the two factors on fresh pepper fruit weight per plant at both locations.

Table 2 presents fresh fruit yield per hectare for pepper as influenced by varieties and time of introduction of cowpea across different harvest periods in a pepper-cowpea intercrop in both location during 2020/2021 dry season. Results revealed use of different cowpea variety as companion crop had significant effect (p<0.05) on the fresh fruit yield of pepper. Whereas, the use of different periods of cowpea introduction on pepper fresh fruit yield at harvest in both locations was not significant (p>0.05). Factor interaction on pepper fresh fruit yield was generally not significant.

Table 2: Effect of time of introduction of cowpea varieties on fresh fruit yield (kg/ha) at different harvest period of pepper in a pepper-cowpea intercrop during the 2020/2021 dry season at Samaru and Chiromawa

	Samaru							Chiromawa						
Treatments	1	2	3	4	5	6	Total	1	2	3	4	5	6	Total
Variety (V)														
SAMPEA 19	186.8	280.2	373.7	467.1	280.2	186.4	1775.0	148.7	223.1	297.4	371.8	223.1	148.7	1412.8
SAMPEA 18	194.6	291.2	389.2	486.5	291.9	194.6	1848.9	148.0	222.1	296.1	370.1	222.1	148.0	1406.4
SAMPEA 17	188.9	283.4	377.9	472.4	283.4	188.9	1795.1	152.7	229.2	305.5	381.9	229.2	152.7	1451.3
SE±	13.11	19.66	26.22	32.77	19.64	13.10	124.56	6.61	9.91	13.23	16.53	9.92	6.62	62.82
Time of Introduction (T)														
At T	203.9	305.9	407.9	509.9	305.9	203.9	1937.9	148.7	223.1	297.5	371.9	223.1	148.7	1413.2
1 WAT	163.1	244.7	326.2	407.8	244.7	163.1	1549.8	150.5	225.8	301.1	376.3	225.8	150.5	1430.1
2 WAT	187.5	281.3	375.1	468.8	281.3	187.5	1781.8	152.2	228.3	304.4	380.4	228.2	152.2	1445.7
3 WAT	210.1	315.1	420.1	525.2	315.1	210.1	1995.7	147.3	220.9	294.6	363.3	220.9	147.3	1399.6
4 WAT	185.9	278.9	371.8	464.8	278.9	185.9	1766.4	150.5	225.6	300.8	376.1	225.6	150.2	1429.0
SE±	16.92	25.39	33.85	42.31	31.09	16.91	160.81	8.54	12.80	17.07	21.34	12.80	8.53	81.11
Interactions														
V X T	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS

WAT=Weeks after transplanting

The effects of treatment on pod number and weight per plant of cowpea during 2020/2021 dry season is presented in Table 3. At both locations, SAMPEA 19 produced the higher pod number and weight while SAMPEA 18 and 17 which produced less values for pods that were statistically comparable. There was no significant difference (p>0.05) observed among the sequential times of introduction of cowpea on number of pods of cowpea. Likewise factor interaction was not significant at both locations. In Chiromawa, introducing cowpea 4 WAT of pepper produced the heaviest cowpea pods, which was in turn statistically at par when it was introduced 1 and 3 WAT pepper, while simultaneous introduction of the two crops and introduction of the two crops and introducing cowpea 2 WAT pepper recorded the least pod weight which were also statistically similar with values for 1 and 3 WAT pepper.

The 100 seed weight of cowpea as influenced by cowpea varieties and their time of introduction into pepper plots in a pepper-cowpea intercrop during the 2020/2021 dry season is presented on Table 3. At Chiromawa, SAMPEA 19 and 18 recorded the highest 100 seed weight while SAMPEA 17 recorded the least. At both locations, times of introduction of cowpea into pepper had no significant effect (p>0.05) on 100-seed weight of cowpea so, also was the factor interaction.

Table 3 shows the effect of cowpea varieties and time of introducing them into plots of pepper on threshing percentage of cowpea in a pepper-cowpea intercrop during 2020/2021 dry season. At both locations there

was no significant differences in threshing percentage observed among the three cowpea varieties grown in association with pepper and also the times of cowpea introduction into pepper and factor interaction had no significant effect on the parameter.

Table 3 presents seed yield per hectare of cowpea as influenced by cowpea varieties and time of introduction of cowpea in a pepper-cowpea intercrop during 2020/2021 dry season. In both locations, SAMPEA 19 produced the higher yield than SAMPEA 18 and 17 which were similar statistically and recorded the least. At Samaru, cowpea introduced 4 weeks after pepper out yielded other times of introduction but was statistically at par with 3 WAT pepper and cowpea introduced same day with pepper while cowpea relayed 1 and 2 WAT pepper recorded the least. At Chiromawa, cowpea introduced 4 WAT pepper recorded higher yield than those relayed 1, 3 WAT pepper and simultaneous establishment of the two crops which were comparable and more than for cowpea introduced 2 WAT recorded the least.

Table 3: Effect of Time of Introduction of Cowpea Varieties on Number of Pods Per Plant, Pod Weight Per Plot, 100 Seed Weight, Threshing Percentage and Yield per Hectare of Cowpea in a Pepper-Cowpea Intercrop during the 2020/2021 dry season at Samaru and Chiromawa

	Number of Pods Per Plant		Pod Weight Per Plot (Kg/ha)		100 Seed Weight (g)		Threshing Percentage (%)		Yield Per Hectare (kg/ha)	
Treatments	Samaru	Chiromawa	Samaru	Chiromawa	Samaru	Chiromawa	Samaru	Chiromawa	Samaru	Chiromawa
Variety (V)										
SAMPEA 19	41.1^{a}	41.4^{a}	1815^{a}	2395^{a}	26.8	26.2^{a}	90	95	1505^{a}	2032^{a}
SAMPEA 18	31.7^{b}	34.8^{b}	1489^{b}	2085^{b}	27.9	26.7^{a}	91	95	1212^{b}	1704^{b}
SAMPEA 17	32.9^{b}	33.5^{b}	1540^{b}	1977^{b}	25.5	20.0^{b}	87	95	1196^{b}	1600^{b}
SE±	0.91	0.76	22.13	49.50	0.91	1.56	0.95	0.60	71.52	58.65
Time of Introduction (T)										
At T	34.7	37.5	1694	2088^{b}	24.8	23.7	86	95	1332^{ab}	1705^{ab}
1 WAT	34.8	35.3	1514	2130^{ab}	25.8	23.5	88	95	1996^{b}	1754^{ab}
2 WAT	35.3	36.7	1571	2054^{b}	27.1	24.7	87	96	1203^{b}	1684^{b}
3 WAT	35.4	36.4	1551	2190^{ab}	27.7	24.0	91	95	1286^{ab}	1822^{ab}
4 WAT	36.2	37.5	1745	2299^{a}	28.2	25.7	92	95	1504^{a}	1927^{a}
SE±	1.18	0.98	28.57	63.91	1.18	2.02	1.23	0.77	92.33	75.71
Interactions										
V X T	NS	NS	NS	NS	NS	NS	NS	NS	*	NS

WAT=Weeks after transplanting

There was a significant interaction observed among the factors in Samaru only (Table 4). In Samaru, variation in time of introducing cowpea varieties had a significant effect ($p<0.05$) on the yield of SAMPEA 19 and 17, while variation in time of introducing SAMPEA 18 into pepper had no significant effect ($p>0.05$) on the yield of cowpea. In the case of SAMPEA 19 and 17 delaying their introduction to 4 WAT pepper, resulted in the highest seed yield of cowpea though not statistically different from previous introductions for SAMPEA 19 only, then introduction at transplanting. The grain yield of the three cowpea varieties did not differ significant when they were relayed at 1, 2 and 3 WAT pepper. But when the two crops were grown simultaneously SAMPEA 18 had statistically similar grain yield with the higher and lower yield recorded by SAMPEA 19 and 17 respectively. But when cowpea was relayed 4 WAT pepper SAMPEA 19 and 17 had statistically similar and higher grain yield than SAMPEA 17. The other two cowpea varieties generally had similar and highest grain yield when relayed 4 WAT pepper. The least was when SAMPEA 17 was relayed at 0, 2 and 3 WAT pepper.

Table 4: Interaction between cowpea Varieties and Time of Introduction on Yield of Cowpea (kg/ha) in a Pepper-Cowpea Intercrop in Samaru during the 2020/2021 dry season

	Time of introduction (WAT)				
Treatments	At T	1	2	3	4
Variety					
SAMPEA 19	1584^{ab}	1342^{abc}	1479^{abc}	1383^{abc}	1732^{a}
SAMPEA 18	1348^{abc}	1095^{bc}	1120^{bc}	1443^{abc}	1053^{c}
SAMPEA 17	1063^{c}	1148^{bc}	1007^{c}	1032^{c}	1726^{a}
SE±			48.55		

WAT=Weeks after transplanting

Discussion

Fresh fruit yield per hectare of pepper were higher in plots where cowpea was introduced late. This could be attributed to the fact that late introduction of cowpea gave pepper crop opportunity to establish well and make use of environmental resources much earlier than the juvenile companion cowpea. It gave the pepper crop advantage of intercepting more sunlight for longer period when compared to the cowpea crop thereby leading to higher dry matter production at the initial stage of the intercrop.

The stage of development of pepper at which cowpea was introduced could give an initial competitive advantage among the intercropped species and determine the degree of compatibility (Ajayi *et al.*, 2018). Anitha *et al*. (2001) intercropped pepper with bean and amaranth (*Amaranthus* spp.) in India and found that the pepper intercropped with bean yielded more than pepper intercropped with amaranth or monocropped pepper. This might be due to the fact that in pepper/bean intercrop situation, the bean might have less affinity for important growth resource as nitrogen because of its ability to fix atmospheric nitrogen hence, providing less competition for N as well as further benefiting the companion crop with some of the fixed N.

However, in the pepper/amaranth intercrop scenario, both crops tend to be high feeders of N thereby providing an intense competition for the scarce resource (nitrogen) leading to negative effect on the performance of both crops.

Similarly, pepper planted sole recorded the highest fresh fruit yield (1,923, 1,762 kg/ha) in Samaru and in Chiromawa when compared to the intercropped yields in both locations. This could be attributed to the higher harvestable crop stands in sole as compared to half that number in intercrop situation couple with absence of competition from companion crop under sole condition. Yield components of cowpea declined with the delay in their relay into pepper plots but recorded significantly higher grain yield. This might be due to differences in genotype, soil and environmental conditions found in the experimental locations as well as the time in which the early cowpea was introduced into pepper. It was probably harmattan that affected the branching ability of cowpea at the early stage of establishment. The late sown cowpea had advantage of improvement in temperature that favours cowpea growth.

The differences observed in number of pods per plant, 100-seed weight and yield per hectare among the varieties, could be attributed to differences in genetic make-up and how these genes interact with the environment vis-á-vis crop development (Tang, 1982). The varietal difference in 100-seed weight at Chiromawa and number of pods per plant, which recorded higher for SAMPEA 19 than SAMPEA 18 and 17, could be attributed to the fact that it was bred as more yielding variety compared to other two. This confirms the findings of Brolmarn and Stofellia (1986); Siddique and Gupta (1991) and Akbar and Kamram (2006) who reported that weight of 100 seeds was one of the prominent pod yield determinants of cowpea. The superiority of SAMPEA 19 in terms of pod yield could be due to the fact that it was bred as high yielding compared to SAMPEA 18 and 17.

This findings is in agreement with that of Krasilnikoff *et al*. (2003) that some varieties have the ability to out yield others and exhibit superior growth and yield characters. Similar report was made by Krasilnikoff

et al. (2003) that varieties differ in their genetic makeup and this could have reflected their yield. Haruna and Usman (2013) observed a significant variation in growth and yield characters of some improved varieties of cowpea at the same location and attributed it to genetic makeup of the varieties examined.

Conclusion

At both locations, companion cowpea variety did not affect any of the pepper yield and yield attributes while higher values for number of pods per plant, pod weight per plot and pod yield per hectare where recorded by SAMPEA 19 than the other two cowpea. Delaying the time of introducing cowpea to 3-4 weeks into pepper resulted in higher values for as fruit weight per plant, and fresh fruit yield of pepper, cowpea yield and yield attributes. In conclusion, the present study has shown that the possibility of achieving a productive pepper/cowpea combination in the Savannah is when SAMPEA 19 and 17 were introduced at 3 and 4 WAT pepper which resulted in higher fruit yield of pepper and grain yield of cowpea respectively at Samaru and Chiromawa respectively.

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