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EFFECT OF SEVERITY OF PRUNING ON GROWTH, YIELD AND SURVIVABILITY OF PIGEON PEA (*Cajanus cajan*) IN PIGEON PEA/PEPPER ALLEY CROPPING

***T.O. FABUNMI, S.O. ADIGBO AND J.N. ODEDINA**

Department of Plant Physiology and Crop Production, University of Agriculture, Abeokuta, Nigeria.
***Corresponding author:** tomideji@yahoo.com **Tel:** +2348039423605

ABSTRACT

A study was conducted at the University of Agriculture, Abeokuta, Nigeria to determine the effect of severity of pruning on performance and survival of pigeon pea and fruit yield of pepper in a pigeon pea/pepper alley cropping. Six treatments arranged in randomized complete block design include pigeon pea pruned to 25 cm, 50 cm, 75 cm and 100 cm above the soil, un-pruned (check) and sole pepper plot. In 2007, pruning of pigeon pea was done on 6th of August- at 12 WAP (weeks after planting) across all pruned treatments. This was repeated in pigeon pea pruned to 75 cm and 100 cm at 19 WAP (27th September), and partially on treatment cut to 50 cm at 22 WAP (18thOctober) in 2007. In 2008 pruning across all treatments was carried out once at 17 WAP on 6th October**.** The total prunings, days to 50% flowering, height at flowering, grain yield percentage survival of pigeon pea were significantly different ($p<0.05$). Pigeon pea flowering was 6 -21 days and 25-46 days earlier ($p<0.05$) in the un–pruned plot relative to other treatments in the two years. Pigeon pea pruned to 25 cm had the least ($p<0.05$) percentage survival. Grain yield was highest in un-pruned plot and least in plot pruned to 25 cm. Pruning pigeon pea to 50 cm above the soil was the best in terms of combining fresh fruit yield of pepper, with optimum pruning biomass, early flowering, grain yield and survivability of pigeon pea.

Keywords: pruning, severity, pigeon pea, pepper.

INTRODUCTION

Planting and managing sustainable perennial species as part of annual crop production system have been found to raise crop yield significantly (Koudokpon *et al.,* 1992). The leafy and woody material of trees and shrubs in alley cropping is used as mulch and also often as fodder, timber, fuel etc, (Rijntjes *et al*. (1992). Pigeon pea (*Cajanus cajan*) has the ability to flourish in harsh environment with severe drought stress and poor soil fertility (Bohringer and Leihgner, 1997) . It is the only fast growing shrub species introduced for alley cropping which combines production of green manures with grain yield (Kang and Mulongoy, 1992). Rao and Gill (1995) observed that amounts of nutrient recycled in a growth season from litter of pigeon pea were 39.5N, 2.1P, 7.3K and 2.15kg/ha . Similarly Mapfumo *et al.* (2001) attributed increase in maize yield to high amount of leaf litter released by pigeon pea.

Pepper (*Capsicum annum*) is a crop that is considered to be shade tolerant (Onwubuya and Ikuenobe, 1988), it is, however, easily affected by other component crop under intercropping condition. The fruit set of chili, both during and after intercrop period with maize was reduced compared to sole crop. The response was due to competition for light and in part, space with the associated maize crop (AVRDC, 1992). Fruit quality especially fruit colour, was upgraded by growing it as intercrop with pigeon pea spaced 4.5 m apart without any reduction in the yield of the pepper (Arulnandhy, 1991).

Minimizing shading of associated food crops by alley species is one of the management strategies required for the success of the alley cropping system. The regular pruning of the alley species in addition to production of green manures is a means of managing competition for light in this system. Information on the response of pigeon pea to different pruning regimes in the South Western Nigeria is, however, scarce. Similarly, the height at which pigeon pea must be maintained in mixtures with pepper for optimum performance of pepper has not been documented. This study therefore aimed at evaluating the effect of severity of pruning on the performance of pigeon pea and its effect on the fruit yield of pepper grown in the alley.

MATERIALS AND METHODS

The experiment was carried out between May 2007 – March 2009 at University of Agriculture, Abeokuta (70 15'N, 3 25'E). The area receives an annual rainfall of about 1000mm and the mean annual temperature ranged between 19.9 -27.2^{0}C; meteorological observations of the site for the duration of the trial are shown in Table1. Six treatments were arranged in Randomized Complete Block Design (RCBD) replicated three times. The treatments were pigeon pea alley cropped with pepper and the pigeon pea cut at 25 cm, 50 cm,75 cm and 100 cm above the soil, un-pruned (check) and sole pepper plot. The land was cleared manually. The pepper was raised in nursery for five weeks. Planting of pigeon and transplanting of pepper was done simultaneously. Planting dates for 2007 and 2008 were 21st and 31st May respectively. Resupply of both pigeon pea seed and pepper seedling were carried out on the 19th of July 2008 due to rodent attack on the field. Pigeon pea was planted at 1.5m x 0 .25m, while two pepper rows, spaced at 0.5m x 0.5m, occupied the alley of pigeon pea. In 2007, pruning of pigeon pea was done on 6th of August- at 12 WAP (weeks after planting) across all pruned treatments. This was repeated on 27th September for pigeon pea pruned to 75 cm and 100 cm at 19 WAP; and partially on 18th October 2007 for treatment cut to 50 cm at 22 WAP. In 2008, pruning across all treatments was carried out once at 17 WAP on 6th October. This was because initial rodent attack made pruning unnecessary (due to loss of stands by the attack) before this time as compared to that done in 2007. Further pruning was also unnecessary because as dry season approached, rainfall frequency reduced. Clippings in all cases were left *in situ*. Complete pruning was done by cutting the whole stem at the specified points; while partial pruning was done by cutting only branches below 150cm on the stem. Prunings were applied *in situ* as mulch. Data were collected on the following: pigeon pea, height and canopy width at flowering (cm), days to 50% flowering, pruning biomass (t/ha), grain yield (Kg/ha) stand count at 23WAP and pepper fruit yield (Kg/ha) and fruit number. Data were subjected to analysis of variance and means separation was done using the Duncan's multiple range tests.

Table 1: Meteorological observations for the duration of the trial

Month	Rain fall (mm)		Mean temperature (OC)		Relative Humidity (%)		Sunshine Hours	
	2007	2008	2007	2008	2007	2008	2007	2008
January	0.2	0.0	26.7	27.9	68.4	53.0	0.1	1.5
February	0.0	0.0	29	29.5	77	76.4	1.54	1.12
March	11.0	101.0	28	29.4	73.6	75.4	1.96	1.4
April	5.0	143	29.5	29	57.8	81.4	1.7	1.2
May	39	67	17.4	27.7	51.1	78.1	1.11	13.5
June	71	186	16.7	26.4	50.8	85.4	2.06	1.22
July	119.2	214	26.5	26.2	86	88.3	3.21	0.9
August	45	89	25	26.3	86	86.6	0.64	0.74
September	120	114	26.2	26.1	87.1	86.7	0.95	1.7
October	119.2	70.4	27.2	28.15	84.6	84.5	1.38	1.4
November	3.6	0.0	28.4	30.0	82.5	80.9	1.24	1.03
December	0.4	135	28.4	28.25	76.2	75.9	1.36	1.12

Source: Department of Agro-meteorology and Water Resources Management, University of Agriculture, Abeokuta. Nigeria

RESULTS

Growth and Development of Pigeon pea as affected by Pruning severity

Effect of pruning severity on pigeon pea plant height and canopy width is shown in Table 2, while the response of flowering of pigeon pea to severity of pruning is shown in Table 3. The results showed that the unpruned (check) was taller ($p<0.05$) than all pruned treatments at flowering. Amongst the pruned plots, treatments with pigeon pea cut at 50cm and 25 cm above the soil was significantly ($p<0.05$) taller than the other two treatments in 2007. Pigeon pea cut to 100 cm above the soil level in 2008 was significantly taller at flowering compared to the 25 cm, 50 cm and 75 cm pruned treatments. Pigeon pea canopy width showed a similar response to that observed in the plant height in 2008, but there was no significant response in 2007. Switch from vegetative to reproductive phase was faster in the un-pruned plot relative to other treatments in the period of the study. Flowering was more significantly delayed ($p<0.05$) in plots cut at 75cm and 100cm compared with when cut at 25cm and 50cm above the soil in 2007 the reverse was however the case in 2008.

Effect of severity of pruning on pigeon pea biomass, grain yield and survivability

Effects of severity of pruning on pruning biomass and grain yield are shown in Table 4, while effect of pruning severity on survival of pigeon pea is shown in Table 5. Total pruning biomass of pigeon pea was significantly ($p<0.05$) affected by the height at which the cutting was done. While biomass production decreased with increased pruning severity in 2007, in 2008 production of biomass decreased with decrease in the severity of pruning. Grain yield of pigeon pea was also significantly ($p< 0.05$) affected by the severity of pruning. Grain yield was higher across all treatments in 2007 compared to 2008. The un-pruned plot gave the highest significant grain yield. In the pruned treatments, pigeon pea cut at 50 cm and 100cm had significantly higher yield than the other two in 2007; in 2008 however, pruning at 100 and 75 cm produced significantly higher grain yield than the other two pruning treatments. The percentage of pigeon pea that survived after the pruning treatment was also statistically significant ($p<0.05$), pigeon pea cut at 25cm recorded the highest significant mortality in 2007 relative to the other treatment. In 2008 highest mortality also occurred form cutting the stem back to 25 cm; this was followed by treatment pruned to 50 cm above the soil, while the other treatments and control ranked the same. Apart from the treatment cut at 25 cm above the soil surface where survival percentage was the same for both years, there was a general reduction in the percentage of plant that survived in the second year compared with the first year across all treatments.

Effect of pruning severity of pigeon pea on fruit yield and fruit number of pepper

Pruning severity of pigeon pea had no statistically significant effect on fruit number and fruit yield of pepper (Table 6). Highest fruit yield ($p>0.05$) was obtained from treatment with pigeon pea cut at 25 cm above soil level in 2007;while in 2008, highest pepper fruit yield and fruit number ($p>0.05$) were obtained from treatments pruned to 50 cm above the soil level.

Table 2: Effect of pruning severity on Plant height at flowering of pigeon pea

	Plant height at flowering (cm)		Canopy width at flowering (cm)	
Pruning regime	2007	2008	2007	2008
25 cm	253.7b7	91.7c	115.7a	41.7c
50 cm	297.3b	88.3c	120.7a	71.1bc
75 cm	246.3c	120.8bc	116.7a	78.9b
100 cm	251.0c	158.9b	114.3a	99.5b
Un pruned check	362.8a	298.3a	148.3a	166.9a
S.E+	9.82	15.52	10.06	9.63

Means followed by the same letter in the column are not significantly different according to Duncan's Multiple Range Test at $\alpha = 0.05$

Table 3: Effect of pruning severity on number of days to 50% flowering of pigeon pea

Pruning regime	2007	2008
25 cm	188b	228d
50 cm	187b	223c
75 cm	202c	209b
100 cm	202c	207b
Un pruned check	181a	182a
S.E+	0.675	1.278

Means followed by the same letter in the column are not significantly different according to Duncan's Multiple Range Test at $\alpha = 0.05$

Table 4: Effect of pruning severity on grain yield and pruning biomass of pigeon pea

	Grain yield (kg/ha)		Percentage decrease In grain yield in 2008	Pruning's biomass (t/ha)	
Pruning regime	2007	2008		2007	2008
25 cm	647c	35d	94.6	2.035d	13.307a
50 cm	1174b	73c	93.8	8.689c	12.483a
75 cm	839c	162b	80.7	10.700b	8.850b
100 cm	1080b	176b	83.7	14.658a	6.297b
Un pruned check	1985a	261a	86.9	-	-
S.E+	0.067	6.95		0.947	1.009

Means followed by the same letter in the column are not significantly different according to Duncan's Multiple Range Test at $\alpha = 0.05$

Table 5: Effect of pruning severity on Survival percentage of pigeon pea

Pruning regime	Survival percentage 2007	Survival percentage 2008
25 cm	30.3b	30.3c
50 cm	79.9a	50.5b
75 cm	75.9b	64.6a
100 cm	75.9b	69.7a
Un pruned check	75.0a	71.7a
S.E+	6.63	3.396

Means followed by the same letter in the column are not significantly different according to Duncan's Multiple Range Test at $\alpha = 0.05$

Table 6: Effect of pruning severity of pigeon pea on fruit yield and fruit number of pepper

Treatments	Fresh Fruit yield per plant (Kg/ha)		Number fruits per plant	
	2007	2008	2007	2008
Pepper + pigeon pea cut to 25 cm	2,621	664	15	12
Pepper + pigeon pea cut to 50 cm	1,968	730	11	12
Pepper + pigeon pea cut to 75 cm	1,569	495	8	10
Pepper + pigeon pea cut to 100 cm	1,268	301	7	5
Sole pepper	2,412	680	15	11
SE +	559.6	128	3.25	2.04

DISCUSSION

Varying response of plant height to pruning severity in 2007 compared with 2008 is due to the fact that while total pruning of plants cut at 75 and 100 cm above soil level was done twice in 2007; all treatments were pruned once in 2008. The significant influence of severity of pruning on days to 50% flowering of pigeon pea observed in this study could be attributed to the need for production of more leaves for photosynthesis to continue after pruning. This became necessary in order to produce enough assimilate to be partitioned for both vegetative growth and seed filling. According to Fukai and Trenbath (1993), in potentially perennial crop such as pigeon pea, not all assimilate produced during the development of harvested organ are translocated to them, but rather stem continue to grow and new leaves appear; and that growth of vegetative parts is an initial investment for future plant development. The relatively smaller difference between time of flowering of un-pruned (check) and those cut at 25 cm and 50 cm could be due to longer period between the time of pruning and the commencement of flowering (since the crop is photosensitive), compared with shorter period between the time of pruning and commencement of flowering in treatments pruned at 75 cm and 100 cm in 2007. In other words, pruning twice in 2007 made development to be slower in treatments cut at 75 and 100 cm above the soil level; this is confirmed by the different response obtained in 2008 when pruning was done once across all treatments.

Pruning severity, however, delayed recovery, thereby making pruning to be possible only once, thus leading to reduced total biomass production in treatments cut at 25 cm and 50 cm in 2007. In 2008 however, the severe the pruning the higher the biomass since pruning was done once. Significantly higher grain yield of pigeon pea in treatment cut at 50 cm amongst the pruned treatments in 2007 could be attributed to the fact that, although pruning severity was more, total pruning was done only once; second pruning was not necessary but for the pruning of the branches. This was because recovery after pruning took place faster in treatments pruned to 75 and 100 cm compared to that pruned to 50 cm. Thus in treatment cut at 50 cm, competition for assimilate by the growing vegetative parts was reduced at the time of grain filling, since enough photosynthetic apparatus were available. On the other hand, rapid recovery after the first pruning in treatments cut at 75 and 100 cm necessitated second pruning close to the time of flowering; thereby increasing the demand for partition of assimilates for vegetative growth at the expense of grain filling. In perennial species such as pigeon pea, not all assimilates produced during development of harvested organs are translocated to them, as stems continue to grow and new leaves appear. The growth of the vegetative parts may however compete with the growth of harvested organs (Fukai and Trenbath, 1993) the competition will however be more severe in this case as the pruned pigeon pea tries to recover. In 2008 however, pruning once and relatively shorter period between time of pruning and commencement of flowering made the grain yield to be patterned after the severity of pruning as observed in the different treatments; in other words the more severe the pruning, the lower the grain yield. Reduction in yield observed in 2008 across all treatments was due to relatively early planting in 2007 compared to 2008; as well as initial pest attack on the field. Significantly higher mortality observed in pigeon pea cut at 25 cm especially in 2007 suggests that cutting pigeon pea below 50cm will reduce its survivability. Although, the severity of pruning of pigeon pea had no statistically significant effect on total fresh fruit yield and number of fruit per plant of pepper in this study, the increment in fruit number and fruit yield of pepper as the severity of pruning of pigeon pea increases, suggests response of pepper to shading effect of pigeon pea. Pepper fruit yield was reduced under shading and the reduction in fruit yield had been attributed to reduction in number of fruit per plant and not in the fruit sizes (AVRDC, 1992). This could be due to heavy abscission of flowers when pepper was shaded as reported by Shifriss *et al*. (1994).

CONCLUSION

Early and simultaneous establishment of *Cajanus cajan* with other arable crops will increase its biomass production, grain yield and chances of survival after pruning. This will, however, add to the labour and cost of pruning. Pigeon pea should not be pruned below 50 cm above the soil level; since pruning pigeon pea at 50 cm above the soil was the best treatment in this study. In 2007, cutting at 50 cm above soil level was the only treatment that well combined optimum pigeon pea biomass production, early flowering, optimum grain yield and high survival rate after pruning on one hand, and optimum fruit yield of pepper grown in the alley on the other hand. In 2008, it also gave appreciably significantly high ($p<0.05$) biomass and had as high as 50% survival percentage and gave the highest ($p>0.05$) fruit yield of pepper. This has implications in growing of pigeon pea with crops of shorter growth habit on both increasing productivity through increment of organic matter as well as reduction of light stress on shorter component crops.

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