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RESEARCH ARTICLE

EFFECT OF PLANTING DENSITY AND TIME OF PRUNING ON THE PRODUCTION OF OILSEED *CITRULLUS LANATUS*.

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Abstract

Improvement of traditional system of crops is an important step to face food security in sub-Saharan Africa. Thus for sustainable production of oilseed *Citrullus lanatus*((Thumb.)Matsum.&Nakai) a study was undertakento investigate the effect of pruning time and planting density on yield and its components in 2015 and 2016 at Gbokora (Ivory Coast). Three times of pruning (early, late and control) and two plants densities (low and high) were tested in a 3x2 factorial, laid out in randomized complete three block design (RCBD). Each treatment was replicated three times and the data collected were: vine length, days to first male flowering, days to first female flowering, number of fruit per plant, weight of fruit per plant, number of seeds per fruit, seeds weight per fruit; and 100-seeds weight per fruit and seed yield. Statistical analysis indicated that both factors (time of pruning and planting density) influenced significantly ($P<0.05$) seed yield and most of the yield components. These results showed that early pruning increased seed yield than late pruning and non-pruning. Regarding the second factors both planting densities recorded the highest value of seed yield. However, interaction between time of pruning and planting density indicated that early pruning with low densityrecorded the best value of seed yield.

Introduction:-

Security and food self-sufficiency are the major problems of many people in developing countries. During the next years, African agriculture will face a challenge, to support the food needs of its growing population. This policy will be based on the production improvement of subsistence crop (de Graaff et al., 2011). External to its insufficiency production, this crop is still unable to generate income for rural population. Search for new solutions to stabilize the income of farmers is imperativefor an acceptable living conditions in rural areas. It is in this waythat crop diversification offers opportunities to promote new agricultural resources. The exploitation of local resources particularly neglected crops could diversify agricultural activities (Bannayan et al., 2011). In Ivory Coast, oilseed cucurbits particularly *Citrullus lanatus*((Thumb.)Matsum.&Nakai) could profit withnew income to farmers (Zoro Bi et al., 2006). *C. lanatus* grows as a vine that sends out long runners along the ground with leaves deeply divided into 5-7 more or less subdivided lobes. Individual plants produce both male and female flowers. The male flowering

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period begins about 4 weeks after sowing and then followed by female flowers ten days later (Achigan-Dako et al., 2006). The flowers open shortly after sunrise and remain open only during one day. The pollen is usually released before the flower opens but stays on the anthers in sticky masses. Their transfer to the stigma of the female flowers is achievedby the pollinators. Those insects are essential to the production of seeds and fruits of monoceous species (Laghetti and Hammer, 2007). The species produces fruits containing edible seeds rich in lipids and proteins (Loukou et al., 2007). Besides its culinary value, *C. lanatus* is a source of income to producers mainly women. On the various Ivorian markets the price of the kilogram of cleaned and dried seeds is sold at 1.500 FCFA (Zoro Bi et al., 2003). Economically, attractive and deeply integrated in traditional African cultures, farmers embarck on large scale production of this cucurbit. However, its production remains very low in agro-systems due to a traditional cultural practice. For sustainable production of this oilseed cucurbit, it is imperious to research for alternative approach such as planting density and time of pruning.Planting density (number of plant unit area) is a major issuefaced by farmers in their production. The use of spacing in crop production is very important and good because it reduces competition between adjacent plants or plant and weed for the necessary natural resources. When adequate spacing is done in plant production, it increases crop growth and yield. Nerson(2002) indicated that the yield of muskmelon improved with increasing of plant population. A similar result was found on pumpkin by El-Hamedet al.(2011a). Despite importance of this cultural technique, it is strongly influenced by pruning method. Indeed, Khoshkam(2016) showed that the yield of *Cucumis. sativus* (L) was twice superior on plot pruning with high planting density than those non pruning with high density. Also, Minh and Eufemio(1988) indicated increasing of *Luffacylindrica* (L) Roem yield on plot pruning with high planting density. Pruning is one of the oldest cultural practice which is used in temperate and sub-tropical fruit crops to bring a balance between vegetative and reproductive growth of the plant. It consists of removing the plant branches in order to increase flowering or fruiting. Also, this practice allows increasing the flow of air around the plant that helps to reduce pests and diseases (Holb, 2005). Working on relationships between fruit yield and yield components in several cucumber (*C. sativus*L.), Cramer and Wehner(2000) showed that the number of branches per plant affected this cucurbit production. Also Utoboet al.(2010) noted that the removal of the lateral branch had a positive effect on the total yield. A similar result was found by Umekweet al. (2015).Such as database is not available for oilseed *C. lanatus*. This study aimed to investigate the effect of planting density and pruning time on yield and its components ofoilseed *C. lanatus*.

Material and methods:-

Study site:-

Field experiments were conducted in 2015 -2016 at Gbokora (latitude: 06^{o} 53´ 58´´ N and longitude: 06^{o} 26´ 32´´W) located in the town of Daloa (Ivory Coast). This site is characterized by two rainy seasons separated by a short dry period (mid-July-mid-September) and a long dry season (December-March). Annual rainfall varies from 1000 to 1500 mm. This sitereceives abundant sunshining during the day with a maximum mean daily temperature ranging between 21-35^{o}C, all alongthe year. Its vegetation is largely constituted by the dense forest (Koffi et al., 2014; Morel, 2014).

Plant material and experimental design:-

The planting material was obtained from the cucurbit germplasm atthe University of Nangui Abrogoua (Abidjan, Côte d'Ivoire). A medium seed size cultivar of the indigenous oilseed *C. lanatus*widely cultivated in Côte d'Ivoire was selected.

Experimental design was conducted as 2 x 3 factorials in three blocks complete randomized with three replications by treatments. Each block contains a total of six plots. In plots, planting was done according to two planting densities: (a) Low density: 12 plants per 24 m^2 which corresponds to 5000 plants per hectare, (b) High density: 35 plants per 24 m^2 whichcorresponds to 14583 plants per hectare.

In order to improve the growth and production of fruits three times of pruning were performed: (1) Non-pruning: Control; (2) Early pruning: Pruning started from first stem emergence until first male flower opening; (3) Late pruning: Pruning started from first male flower opening until first female flower opening. To ensure proper stand, five seeds per hole were sown directly and thinned to one plant per hole at the two-leaf stage. All plants per treatment including control were investigated. Any fertilizer or irrigation was applied during the trials. Weeds were manually controlled and the crop was sprayed with insecticide (Cypercal EC 50) to protect the crop against cucumber beetle, *Zonocerusvariegatus* and lady beetle identified in study site.

Data collections and statistical analysis:-

Seed Yield (seeds dry weight ha^{-1}) and 8 agronomical traits identified as yield components in indigenous cucurbits were selected (Koffi et al., 2009). These yield component concerned: vine length (VL), days to first male flowering per plant (1st DMF), days to first female flowering per plant (1st DFF), number of fruit per plant (NF), weight of fruit (WF), number of seeds per fruit (NS), seeds weight per fruit (SW) and 100-seeds weight per fruit (100-SW).Seeds were weighted at 5% moisture content. Significant effect of pruning time, planting density, year and their interaction were tested with MANOVA. When a significant effect is found for a factor, each parameter was examined by using the software SAS statistical package. In case of a significant difference the Least Significant Difference (LSD) multiple range-tests were used to identify the means thosediffer.

Results:-

Results MANOVA analyzing the effects of pruning time, planting density, year and theirinteractions on nine agronomic parameters of oilseed Citrullus lanatus:-

The table 1 indicates that pruning time, planting density and interaction between pruning time and planting density had significant effects on the nine parameters. No significant effect was observed for the year and the three others interactions. Thus for the following statistical analysis we will put together the data of both years.

Table 1:- Results MANOVA analyzing the effects of pruning time, planting density, year and their interactions on nine agronomic parameters of oilseed *Citrullus lanatus*

Factors	Statistics	
	F	***P***
Year	1.395	0.256
Pruning time	3.654	0.003
Plantingdensity	15.762	0.000
Year * Pruning time	2.212	0.065
Year * Plantingdensity	1.425	0.071
Pruning time * Planting density	6.200	0.025
Year *Pruning time*planting density	2.756	0.087

Effect of pruning time on yield and its components yield of oilseed *C. lanatus*:-

The results of MANOVA show that the three periods of pruning had significant effect at $P = 0.05$ on yield and its components. The earliest male and female flowers were appeared at early pruning plot. Also the highest values of seed yield, number of fruits, vine length, fruit weight, 100-seeds weight and number of seeds were obtained at early pruning plot (Table 2).

Effect of planting density on yield and its components yield of oilseed *C. lanatus*:-

The table 3 indicated comparison between both densities. The earliest male flowers were appeared on plot with low density. On the same plot, the highest values of number of seeds, 100-seeds weight and fruit weight were recorded. While the highest values of seeds weight and vine length were obtained on the plot with high density. No significant difference was observed between the two densities with the three others parameters mainly the seed yield, day to first female flower and number of fruit per plant.

Effect of pruning time and planting density on yield and its components yield of oilseed *C. lanatus*:-

Statistical analysis shows that interaction between the time of pruning and density was influenced by all the parameters tested. The earliest male and female flowers were appeared on early pruning plot with both densities. Similar values were found with only high density on late pruning plot and non-pruning plot. The highest values of yield, number of fruits, fruit weight, 100-seeds weight and number of seeds were recorded on early pruning plot with low density. Statistically similar value of seeds weight was obtained on early pruning plot, late pruning plot and non-pruning plot with high density. Only non-pruning plot with high density produced the longest vine (Table 4).

Table 2:- Effect of pruning time on yield and its components yield of oilseed *C. lanatus.*

Parameters	Early pruning	Late pruning	Non-pruning	Statistics	
				F	*P*
Days to first male flowering	29.684 ± 1.056[a]	32.348 ± 5.483[b]	35 ± 4.960[c]	12.602	0.000
Days to first female flowering	39.737 ± 4.688[a]	41.869 ± 7.066[b]	45.636 ± 5.045[c]	3.206	0.048
Vine length (m)	5.057 ± 0.954[a]	4.469 ± 0.578[b]	4.954 ± 0.967[ab]	3.459	0.039
Number of fruit	8.421 ± 4.180[a]	5.086 ± 3.146[b]	4.545 ± 2.841[b]	2.949	0.039
Weight of fruit (g)	974.211 ± 339.187[a]	695.652 ± 163.702[b]	529.091 ± 228.711[c]	9.807	0.000
Number of seeds	374.141 ± 240.682[a]	237.347 ± 106.015[b]	237.618 ± 95.086[b]	5.969	0.004
Seeds weight (g)	7.398 ± 3.495[a]	8.024 ± 5.466[a]	8.144 ± 3.555[a]	1.357	0.266
100-seeds weight (g)	11.630 ± 9.834[a]	9.668 ± 6.018[ab]	7.023 ± 4.011[b]	4.308	0.018
Seed yield (kg/ha)	96.481 ± 45.018[a]	45.979 ± 33.609[b]	47.685 ± 32.129[b]	4.092	0.048

*Mean values within rows by parameter followed by the same letter(s) were not significantly different at $P = 0.05$ level, on the basis of the Least Significant Difference (LSD) test

Table 3:- Effect of plant density on yield and its components yield of oilseed *C. lanatus*

Parameters	High density	Low density	Statistics	
			F	*P*
Days to first male flowering	29.346 ± 1.354[a]	34.444 ± 5.337[b]	34.067	0.000
Days to first female flowering	39.384 ± 5.299[a]	44.296 ± 6.106[a]	2.299	0.135
Vine length	5.050 ± 1.022[a]	4.522 ± 0.530[b]	10.596	0.002
Number of fruit	5.653 ± 3.058[a]	6.666 ± 4.463[a]	1.876	0.176
Weight of fruit	671.538 ± 160.740[b]	847.037 ± 376.377[a]	15.290	0.000
Number of seeds	227.860 ± 101.438[b]	342.855 ± 212.654[a]	4.695	0.034
Seeds weight	10.451 ± 5.002[a]	5.296 ± 1.102[b]	27.854	0.000
100-seeds weight	5.000 ± 1.200[b]	14.467 ± 7.903[a]	20.394	0.000
Seed yield	61.933 ± 35.144[a]	68.657 ± 52.735[a]	0.897	0.414

*Mean values within rows by parameter followed by the same letter(s) were not significantly different at $P = 0.05$ level, on the basis of the Least Significant Difference (LSD) test

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Table 4:- Effect of pruning time and plant density on yield and its components yield of oilseed *C. lanatus.*

Parameters	Early pruning		Late pruning		Non-pruning		Statistics	
	Low density	High density	Low density	High density	Low density	High density	*F*	*P*
1st DMF	29.0 ±0.666[a]	30.444 ±0.881[a]	28.909±1.578[a]	35.5 ±5.931[b]	31.0 ±0.0[a]	38.333 ±4.457[b]	12.503	0.000
1st DFF	40.5 ±5.40[a]	38.888 ±3.887[a]	37.727±5.917[a]	45.666 ±5.928[bc]	40.8±3.033[ab]	49.666 ±0.816[c]	4.697	0.001
VL	5.25 ±1.165[ab]	4.844 ±0.65[abc]	4.609±0.699[bc]	4.341 ±0.433[c]	5.62 ±1.103[a]	4.4 ±0.296[c]	3.257	0.013
NF	6.9 ±3.510[b]	10.111 ±4.4[a]	4.818 ±2.315[b]	5.333 ±3.845[b]	5.0 ±3.316[b]	4.166 ±2.639[b]	1.823	0.012
WF	741.0 ±144.41[b]	1233.34±303.19[a]	681.818±114.62[bc]	708.333±203.194[bc]	510.0±191.702[c]	545 ±273.038[bc]	2.463	0.046
NS	222.8 ±103.23[b]	542.21±240.79[a]	210.35±114.343[b]	262.093 ±95.895[b]	276.33±61.699[b]	205.358±110.859[b]	6.974	0.000
SW	9.158 ±4.061[a]	5.444 ±0.881[b]	11.05 ±6.648[a]	5.250 ±1.422[b]	11.718±1.275[a]	5.166 ±0.752[b]	10.443	0.000
100-SW	4.90 ±1.100[c]	19.108 ±9.834[a]	5.363 ±1.433[c]	13.615 ±5.919[b]	4.4 ±0.547[c]	9.21 ±4.395[bc]	8.485	0.000
SY	65.59 ±34.155[b]	97.375±31.482[a]	57.617±36.956[bc]	35.312 ±27.531[bc]	64.12±39.869[bc]	31.25 ±7.603[c]	3.585	0.007

Vine length per plant (VL), Days to first male flowering per plant(1stDMF), Days to first female flowering per plant (1stDFF), Number of fruit per plant (NF), Weight of fruit per plant (WF), Number of seeds per fruit (NS), Seeds weight per fruit (SW); and 100-seeds weight per fruit (100-SW) and Seed yield (SY).
*Mean values within rows by parameter followed by the same letter (s) were not significantly different at $P = 0.05$ level, on the basis of the Least Significant Difference (LSD) test

Discussion:-

The result of the analysis of variance show that the periods of pruning affected yield and its components on oilseed *Citrullus lanatus*((Thumb.) Matsum.&Nakai). The highest seed yield was recorded in early pruning plot. On this plot, removal of the lateral branchs took place between sprouting and opening the first male flower on each plant. This involves that the reproductive stage of this cucurbit was not affected by the pruning. In general, cucurbit and particularly, *C. lanatus* needs four month to reach their physiologic maturity. In this case, plants compensated the earliest loss of shoots and produced normally. Similar observation was doneby Minh et al. (1988) on the cucurbit *Luffacylindrica.* They noted that when the pruning occurs in the early stage of plant growth resulted in early branching, more branches per plant. Absence of new stress, increasing ramifications of this cucurbit could produce more fruit per plant. This result fitwith Hoza's(2013) who indicated that when the pruning of shoots of cucumber occurs during the early stage leads to a higher number of fruits per plant on main stem. Thus, the important number of fruit produced on this plot would have greatly contributed to increasing the yield seed of this cucurbit.

It was observed during this study that the days to first male and female flowers of *C. lanatus* decreased on early pruning plot as compare to late pruning plot and control. A similar trend was noted on cucumber by Hidayatullah(2013). The highest level of endogenous gibberellins during the initiation flower stage after pruning practice explained these observations. However, it is necessary to note that the expression of these phytohormones depends onenvironment factors such as temperature (Singh and Asthir, 2009). The experience period was characterized by dry seasonwith high temperature. This certainly stimulated on stressed plants of *C. lanatus* an important production of gibberelin on pruning plots.

The result also showed the values of seed yield and fruit number are statistically similar with both densities. This resultis opposed to Nerson(2005) and El-Hamed and Elwan(2011b)on muskmelon (*Cucumusmelo*) and Pumpkin (*CucurbitaPepo*, *CucurbitaMoschata*),respectively.According to them, fruits number and seed yield increase with increasing plant population. Basing on the authors results' and weak fruit weight recorded with low density, the balance between both densities could be due to abortion of several fruits before their physiological maturity and a higher competition between plants for uptake natural resources (nutriments).

Interaction between pruning time and planting density indicated that the highest values of seed yield, come from on early pruning plot with low density. The result highlightsthat pruned plants need to exploit a great soil surface to uptake nutriments in order to produce more fruits. A similar result was found by Umekweet al. (2015) on cucumber (*Cucumissativus*). They indicated that an addition of fertilizer (60 kg/ha) after pruning plants contribute increasing fruit number per plant. Such result could be also be dueto the highest values of seed number and number of fruit. According to Nerson(2007), seed yield per area is product of the multiplication of three components, the number of fruits per unit area, the number of seeds per fruit and the mean weight of the individual seed.

Conclusion:-

To face malnutrition and food security, farmers insub-Saharan Africa must improve their traditional system of crop. The currentstudy indicated the increasing of oilseed *Citrullus lanatus* production by time of pruning and planting density. Thus, it could be recommended to farmers to practice early pruning with 12 plants per24/m^{2}during cropping season of this crop.

References:-

1. Achigan-Dako, G.E., Fanou, N., Kouke, A., Avohou, H., Vodouhe, R.S.,Ahanchede, A., 2006. Evaluation agronomique de trois espèces de egussi (Cucurbitaceae) utilisées dans l'alimentation au Benin et élaboration d'un modèle de prédiction du rendement. Biotechnol. Agron. Soc. Environ. 10, 121-129.
2. Bannayan, M., Rezael, E.E., Alizadeh, A., 2011. Climatic suitability of growing summer squash (*Cucurbita pepo* L.) as a medicinal plant in Iran. Notulae Scientia Biologicae. 3, 39-46.
3. Cramer, C.S., Wehner, T.C., 2000. Path analysis of the correlation between fruit number and plant traits of Cucumber populations. HortScience. 35, 708-711.
4. de Graaff, J., Kessler, A.,Nibbering, J.W., 2011. Agriculture and food security in selected countries in Sub-Saharan Africa: diversity in trends and opportunities. Food. Secur. 3, 195-213.
5. El-Hamed, K.E.S.A., Elwan, M.W.M., 2011a. Dependence of pumpkin yield on plant density and variety. Am. J. Plant. Sci. 2, 636-643.
6. Hidayatullah, Bano, A., Khokhar, M.A., 2013. Phytohormones content in cucumber leaves by using pruning as a mechanical stress. W.J.A.S. 9, 220-226.
7. Holb, I.J., 2005. Effect of pruning on apple scab in organic apple production. Plant. Dis. 89, 611-618.
8. Hoza, G., 2013. Research regarding the influence of various pruning systems at Cornichon cucumber cultivated in solarium. J. Hortic. For. 17, 219- 222.
9. Khoshkam, S., 2016. The effect of pruning and planting density on yield of greenhouses cucumber in Jiroft. I.J.S.E.A.S. 2, 212-227.
10. Koffi, K.K., Anzara, G.K., Malice, M., Djè, Y., Bertin, P., Baudoin, J.P., Zoro Bi, I.A., 2009. Morphological and allozyme variation in a collection of *Lagenaria siceraria* (Molina) Standl. from Côte d'Ivoire. Biotechnol. Agron. Soc. Environ. 13, 257-270.
11. Koffi, M., Anoh, J., N'Djetchi, M., Konan, T., Djè, Y., 2014. Genetic-based investigation of three prevalent waterborne protozoa parasites in drinking water sources in Daloa district in Côte d'Ivoire. J. Appl. Biosci. 77, 6534-6542.
12. Laghetti, G., Hammer, K., 2007. The corsican citron melon (*Citrullus lanatus* (Thunb.) Matsum. et Nakai subsp. *lanatus* var. *citroides* (Bailey) Mansf. ex Greb.) a traditional and neglected crop. Genet. Resour. Crop Evol. 54, 913-916.
13. Loukou, A.L., Gnakri, D., Djé, Y., Kippré, A.V., Baudoin, J.P., Malice, M., Zoro Bi, I.A., 2007. Macronutrient composition of three cucurbit species cultivated for seed consumption in Côte d'Ivoire. Afr. J. Biotechnol. 6, 529-533.
14. Minh, T.L.A., Eufemio, T.R.J., 1988. Increasing yield in Luffa cylindrica (L.) Roem by pruning and high density planting. Philipp. J. Crop. Sci 13, 87-90.
15. Morel, R., 2014. Le climat et l'implication des hommes : le cas de la Côte d'ivoire. Climatologie. 1, 117-132.
16. Nerson, H., 2002. Relationship between plant density and fruit and seed production in Muskmelon. J. Am. Soc. Hortic. Sci. 127, 855-859.
17. Nerson, H., 2005. Effects of fruit shape and plant density on seeds yield and quality of squash. Sci. Hort. 105, 293-304.
18. Nerson, H., 2007. Seed production and germinability of cucurbit crops. S. S. B. 1, 1-10.
19. Singh, S., Asthir, B., 2009. Interactive effects of high temperature and phytohormones on carbohydrate metabolism in barley seedlings. S.S.B. 3, 44-47.
20. Umekwe, P.N., Okpani, F.M.,Okocha, I.O., 2015. Effects of different rates of NPK 15:15:15 and pruning methods on the growth and yield of cucumber (*Cucumis Sativus* L.) in Unwana-Afikpo. I.J.S.R. 4, 36-39.
21. Utobo, E.B., Ekwu, L.G., Ogah, E.O.,Nwokwu, G.N., 2010. Growth and yield of cucumber varieties as influenced by pruning at abakaliki agricultural area southeastern Nigeria. C.J.Agric.Sci. 4, 23-24.
22. Zoro Bi, I.A., Djé, Y., Koffi, K.K., Malice, M.,Baudoin, J.P., 2006. Indigenous cucurbits of Côte d'Ivoire: a review of their genetic resources. S.N. 3, 1-9.
23. Zoro Bi, I.A., Koffi, K.K.,Djé, Y., 2003. Caracterisation botanique et agronomique de trois espèces de curcubites consommées en sauce en Afrique de l'ouest:*Citrullus sp., Cucumeropsis mannii* Naudinet *Lagenaria siceraria* (Molina) Standl. Biotechnol. Agron. Soc. Environ. 7, 189-199.