African Journal of Biotechnology Vol. 8 (10), pp. 2195-2201, 18 May, 2009
Available online at http://www.academicjournals.org/AJB
ISSN 1684–5315 © 2009 Academic Journals

Full Length Research Paper

Effects of intrapopulation competition on morphological and agronomic characters of Jute plant (*Corchorus olitorius* L.)

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Accepted 4 October, 2007

The effects of population density on some agronomic traits of *Corchorus olitorius* were investigated by growing the seedlings in a field experiment at densities of 1, 2, 5, 10, 25, 50 and 100 plants per m^2 during the raining season of 2006, at the Ojo campus of Lagos State University (LASU), Nigeria. The randomized block design (RBD) was the experimental design used, with three replicates. The direct effect of competition was investigated on the following agronomic attributes; final height/plant, number of branches/plant, stem girth/plant, number of leaves/plant, total fresh weight, total dry weight, moisture content, total leaf length, leaf petiole length, leaf area, blade length and blade width. A highly significant effect ($p < 0.01$) of competition was observed for final plant height and total moisture content/ plant, while significant effect ($p < 0.05$) was observed for other attributes investigated, except for all leaf parameters where insignificant effect of competition was observed. There was a gradual decline in all attributes except height/plant as population density increased. These observations confirmed the occurrence of intraspecific competition in population of jute plant.

Key words: Intrapopulation, competition, jute plant, morphological and population density.

INTRODUCTION

Corchorus is a genus of about 40 - 100 species of flowering plants in family *Malvaceae* (*Tiliaceae*), native to tropical and subtropical regions throughout the World (Nath, 1976). It has diverse common names, and is used in different contexts, with Jute applying to fibre produced from the plant and melokhia (alternatively spelled molokhiya) applied to the leaves used as vegetables. The molokhiya is also popular in Japan as vegetables, and commonly called monoheiya. Other names include bush okra, nalta jute, jute mallow and Jew's mallow (Schery, 1951). It is popularly known as ewedu in the South-western part of Nigeria, where the boiled and mashed fresh leaf is a delicacy.

Corchorus olitorius (L) are tall, usually annual herbs, reaching a height of ≈ 2.4 m. The plant could be unbranched, or with only a few side branches. The leaves are alternate, simple, lanceolate, finely serrated or lobed margin. The flowers are hermaphrodite, and are pollinated by insects. The flowers are small (≈ 2 - 3 cm diameter) and yellow, with five petals. The fruit is a multi-seeded capsule (Norman, 1972). The plant prefers light (sandy), medium (loamy), and heavy (clay soils) (Epenhuijsen, 1974). It thrives well in acid, neutral and basic (alkaline) soils. It cannot tolerate shady environments and requires moist soil.

Fresh leaves of *C. olitorius* are rich source of vitamins A and C. The small amount of protein present is rich in methionine. The leaves are used in the treatment of chronic cystitis, gonorrhea, dysuria, for toothache (Hillocks, 1998). A cold infusion is used as a tonic to restore the appetite and strength (Sharaf and Negm, 2005). The leaves have also been found to suppress elevation of post prandial bolld glucose levels in rats and humans. (Innami et al, 2005) The seeds are used for fever and as a purgative; they possesses broad antibacterial properties (Pal et al., 2006). Oils from the seeds are also used for skin dis-

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diseases (www.stuartxchange.com/PasauNaBilog.html) and injection of olitoriside, an extract from the plant markedly improves cardiac insufficiencies and has no cumulative attributes; hence, it can serve as a substitute for strophanthin (Chopra et al., 1986).

High (dense) plant population is known to affect behavior of individual plant in terms of vegetative growth and reproductive development (Enyi, 1977; Yayock, 1980). According to Einum and Fleming (2004), if phenotypes differ in habitat preferences, there may be decrease in intraspecific competition with increasing phenotypic variation. In the same concept, Parmakelis and Mylonas (2004) observed that population structure, partial population activation and the species specific reproductive strategy have a profound effect on maintaining the genetic diversity and level of intraspecific competition in such genus.

A number of studies on intraspecific competition have been conducted in different environmental and structural contexts. These include the studies of Bleasdale (1965), Bremner and Taha (1966), Bremner et al. (1967), Gray (1972), Thompson and Taylor (1974), Svensson and Naglicka (1975), Okusanya and Ahmedu (1983), Hammes (1985), Ellisseche and Perennec (1987), Wurr et al. (1990), Okusanya et al.(1990), Rykbost and Maxwell (1993), Creamer et al. (1999), Arsenault et al. (2001), Mauromicale et al. (2003), and Makinde and Macarthy (2006). Most of these studies are on ornamental plants and forest trees, rather than crop plants. This study, therefore, aimed at determining the effects of intra-population competition on agronomic attributes of *C. olitorius* by using a constant plot size and varying plant population density.

MATERIALS AND METHODS

Dried seeds of *C. olitorius* were obtained from the National Institute of Horticulture (NIHORT, Ibadan, Nigeria) for investigation. The seeds were drilled on nursery beds close to the main experimental plot. The experiment was an open field trial, and it was carried out on a parcel of land in front of Faculty of Science building complex at the Ojo campus of Lagos State University, during the raining season (May to August) of 2006. The experimental design used in this investigation was the randomized block design (RBD) with three replicates. Constant plot size of 1 m x 1 m was maintained, with a distance of 1 m between blocks and 0.5 m between treatments. Transplanting was effected when the seedlings reached four leaf-stage, (about three weeks after drilling). Seedlings were transplanted to each treatment at the density of 1, 2, 5, 10, 25, 50 and 100 stands/treatment. Appropriate and adequate cultural practices and farm hygiene were maintained throughout the experimental period. .

At exactly four weeks after transplanting (shortly before the onset of reproductive phase) destructive analysis was done, by harvesting (uprooting carefully) the plants according to treatment, and collected samples were properly labeled and taken to the laboratory for data collection. Agronomic attributes scored were; height per plant (cm) (this is measured using meter rule), number of branches per plant (counted), stem girth per plant (cm) (determined by using rope and meter rule), number of leaves per plant (counted), total fresh weight per plant (g) (determined by using electronic balance), total dry weight per plant (cm) (samples were dried in an oven at 60°C until constant weight was achieved), total moisture content per plant (g) (calculated), total leaf length(measured, using meter rule) (cm), leaf petiole length(measured, using meter rule), leaf blade length (cm) (measured, using meter rule), leaf blade width (cm) (measured, using meter rule), and leaf area (determined, using paton electronic planimeter).

Quantitative data collected were subjected to multivariate analysis of variance, following the procedure of Parker (1980) and Mahalanobis (1936) to determine the significance or otherwise of the effects of intra-population competition on the traits under investigation.

RESULTS AND DISCUSSION

Effects of population density on various agronomic attributes of *C. olitorius* are presented in Table 1. The Table shows the mean value (± standard deviation) of the characters as affected by various population densities. There was gradual decline in the values of all characters under investigation as population density increased, except, for final height/ plant where marked increase in values was observed as the population density increased. The value for final height/plant ranged from 68.90 ± 34.20 to 98.30 ± 47.60 cm for densities of one plant to 100 plants per meter square. The result of the statistical analysis is shown in Table 2. Highly significant ($P < 1\%$) effect of competition was recorded for final height/ plant, total moisture content/ plant and leaf blade length. Significant ($P < 5\%$) effect was observed for all other parameters, except for leaf petiole length and leaf blade width where insignificant effect of intraspecific competition was recorded. It is note worthy that effect of block (replicates) was insignificant for all parameters investigated in this study. Figures 1 - 12 show graphical representations of the effects of competition on the various agronomic attributes studied. A close look at Figure 1 revealed a gradual increase in plant height as population density/m^2 increases, while Figures 2 - 12 revealed a gradual decline in other traits studied as the population density/m^2 increases. The insignificant effects of intraspecific competition recorded for leaf petiole length and leaf blade width was further elaborated by Figures 9 and 11.

Intraspecific competition results in a reduction of population growth rate as population density increases. However, in nature, competition effect may be completely absent until population density reaches some threshold at which resources become limited (Michelle et al., 2005). The result of this study conforms to this observation, as most agronomic attributes investigated responded accordingly to competition. The gradual overall decrease in most characters as population density increased (Table 1), confirmed the presence of intraspecific competition in *C. olitorius.* This was further corroborated by the result of statistical analysis (Table 2), which revealed highly significant and significant effects of intrapopulation competition on most agronomic characters measured in this study. This observation corroborates the earlier report of

Table 1. Mean effect of intra-population competition on agronomic traits of *Corchorus olitorius* (mean ± SD).

Treatment Plants/m^2	Final height/ plant (cm)	No. of branches /plant	Stem girth/ plant (cm)	No. of leaves/ plant	Total fresh weight/ plant (g)	Total dry weight/ plant (g)	Moisture content/ Plant (g)	Total leaf length (cm)	Leaf petiole length (cm)	Leaf blade length(cm)	Leaf blade Width(cm)	Leaf area(cm^2)
1	68.90± 34.20	29.70±5.40	2.80± 5.70	579.78± 296.40	789.90± 123.90	266.40 ± 79.20	523.50 ± 313.70	37.70 ± 21.30	7.40 ± 3.70	30.10 ± 4.80	20.60 ± 9.00	393.87 ± 1.90
2	69.80± 38.10	26.00 ± 7.90	2.70 ± 5.50	483.65 ± 266.90	731.50 ± 145.60	236.10 ± 57.70	495.50 ± 302.90	33.90 ± 10.80	6.50 ± 3.30	27.40 ± 4.30	19.30 ± 8.40	326.34 ± 8.34
5	72.10± 31.30	21.00 ± 5.60	0.81 ± 3.90	381.74 ± 220.30	434.80 ± 127.30	88.50 ± 44.60	246.24 ± 203.30	33.30 ± 10.5	6.60 ± 3.30	26.70 ± 3.20	17.80 ± 7.90	319.23 ± 8.96
10	72.10± 36.60	9.00 ± 4.40	0.80 ± 3.90	230.70 ± 65.70	298.80 ± 93.30	82.60 ± 30.90	216.30 ± 63.80	30.90 ± 9.60	6.10 ± 3.10	24.80 ± 3.90	16.80 ± 7.90	268.60 ± 6.65
25	91.20± 41.20	5.30 ± 3.30	0.72 ± 3.50	221.30 ± 59.30	284.80 ± 90.20	78.60 ± 34.10	226.10 ± 67.90	29.60 ± 9.10	5.60 ± 10.90	24.00 ± 3.30	16.00 ± 7.90	238.90 ± 5.53
50	96.30± 45.50	3.70 ± 2.90	0.67 ± 2.40	201.30 ± 51.60	234.30 ± 88.60	72.50 ± 39.90	161.80 ± 59.50	28.90 ± 2.70	5.80 ± 3.00	23.10 ± 3.60	15.70 ± 7.70	226.80 ± 6.09
100	98.30± 47.60	2.50 ± 1.30	0.57 ± 2.40	101.30 ± 41.67	184.30 ± 82.50	62.50 ± 29.50	121.80 ± 49.50	18.50 ± 7.60	5.58 ± 2.10	12.92 ± 2.00	15.50 ± 7.90	98.76 ± 6.62

Table 2. ANOVA Table showing sum of square (SS) values of agronomic traits in ***Corchorus olitorius*** in response to intra-population competition.

Source of variation	DF	FHP	NBP	SGP	NLP	FWP	DWP	MCP	TLL	LPL	LBL	LBW	LA
Treatment (pop. Density)	6	2563.06**	641.11*	77.71*	379693.83*	810277.03*	27493.32*	545489.73**	156.67*	16.45 ^{NS}	40.63 **	25.49 ^{NS}	70110.67 *
Block (replication)	2	45.91^{NS}	38.00^{NS}	11.55 ^{NS}	39412.33 ^{NS}	4409.18 ^{NS}	3081.35 ^{NS}	1097.56 ^{NS}	4.15 ^{NS}	1.83 ^{NS}	5.86 ^{NS}	5.13 ^{NS}	20666.77 ^{NS}
Error	12	407.04	18.21	9.72	50560.34	4694.62	4612.32	31363.91	20.25	6.47	2.16	0.50	4036.82
Total	20	3016.01	760.32	98.98	469666.50	816050.53	35187.5	577951.11	181.10	4.75	48.65	41.12	1311139.26*

KEY:

DF = Degree of freedom
** = Highly significant (P > 0.01)
* = Significant (P > 0.05)
NS = Not significant.
1. FHP = Final height/plant (cm)
2. NBP = Number of branches/plant
3. SGP = Stem girth/plant (cm)
4. NLP = Number of leaves/plant
5. FWP = Fresh weight/plant (g)
6. DWP = Dry weight/plant (g)
7. MCP = Moisture content/plant (g)
8. TLL = Total leaf length (cm)
9. LPL = Leaf petiole length (cm)
10. LBL = Leaf Blade length (cm)
11. LBW = Leaf blade width (cm)
12. LA = Lead Area (cm^2)

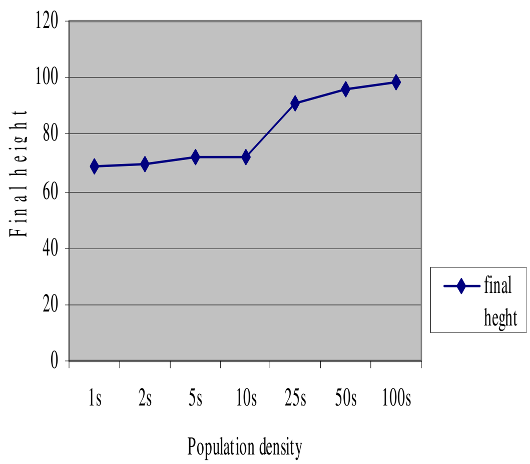

Figure 1. Effect of intraspecific competition on final height per plant in *C. olitorium*.

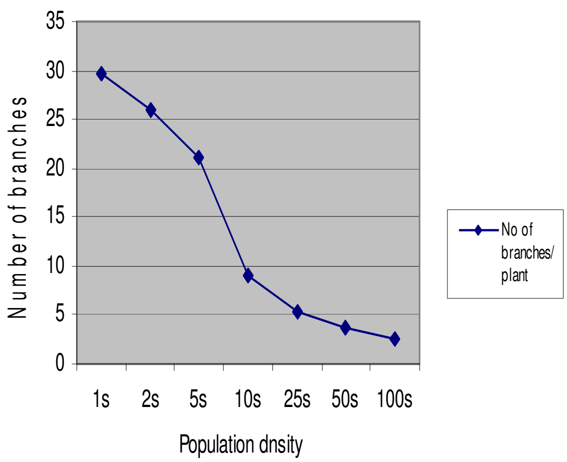

Figure 2. Effect intraspecific competition on number of branches/plant in *C. olitorium*.

Figure 3. Effect of intraspecific competition on stem girth/ plant in *C. olitorius.*

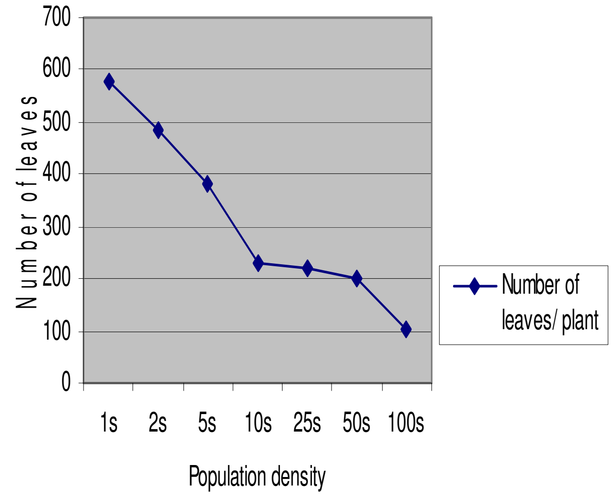

Figure 4. Effect of intraspecific competition on number of leaves/ plant in *C. olitorius.*

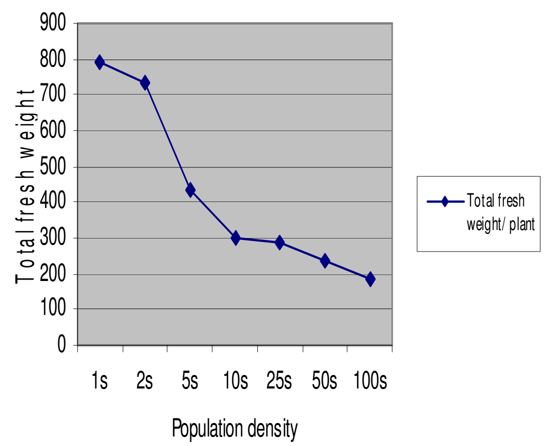

Figure 5. Effect of intraspecific competition on total fresh weight/ plant in *C. olitorius.*

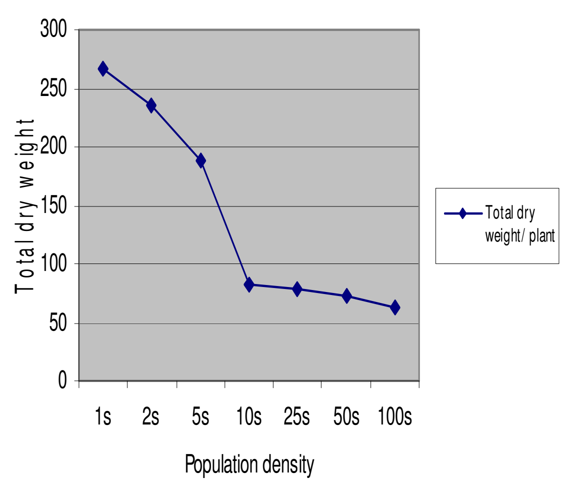

Figure 6. Effect of intraspecific competition on total weight/ plant in *C. olitorius.*

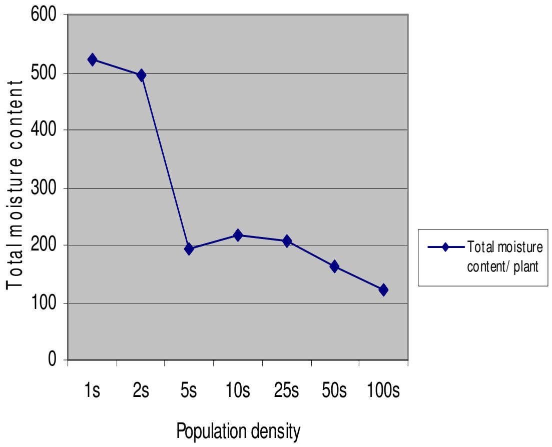

Figure 7. Effect of intraspecific competition on total moisture content/ plant in *C. olitorius.*

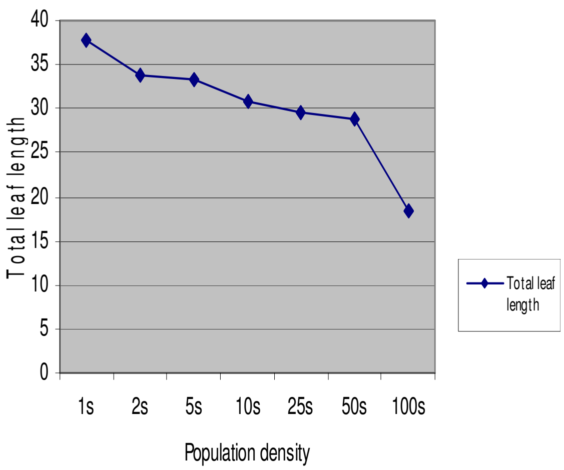

Figure 8. Effect of intraspecific competition on total leaf length in *C. olitorius*.

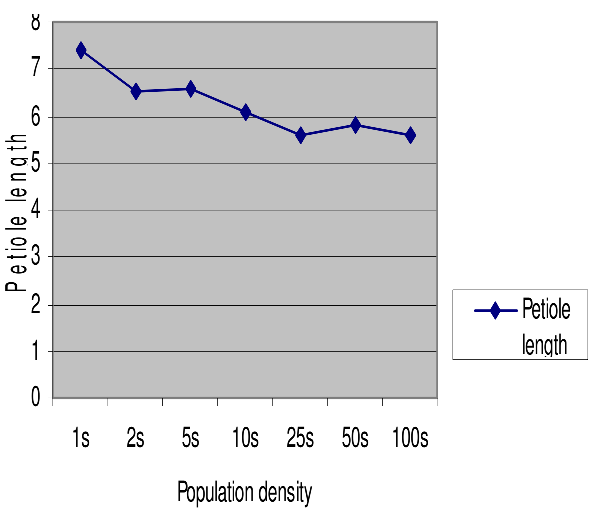

Figure 9: Effect of intraspecific competition on petiole length in *C. olitorius.*

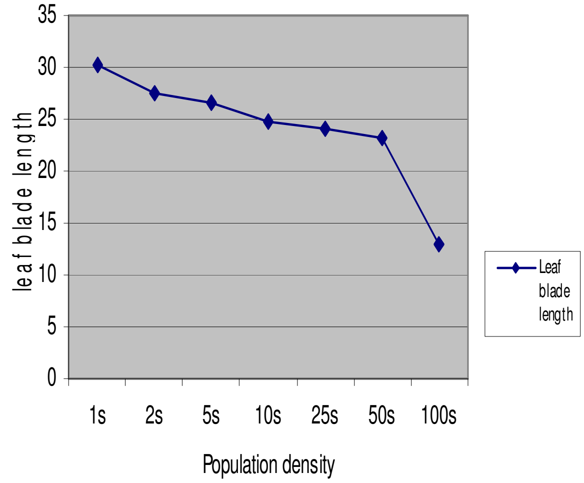

Figure 10. Effect of intraspecific competition on leaf blade length in C. olitorius

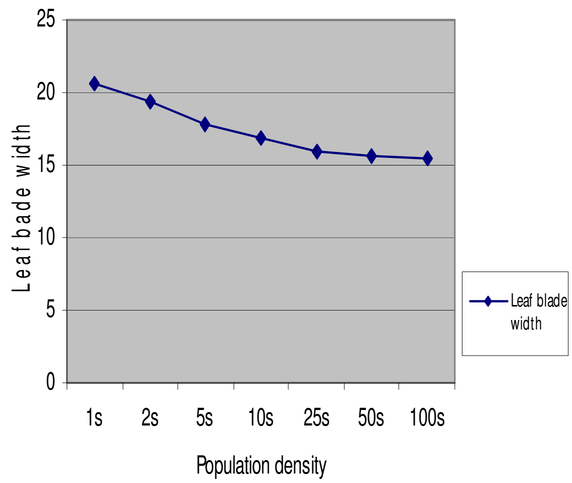

Figure 11. Effect of intraspecific competition leaf blade width in C. olitorius

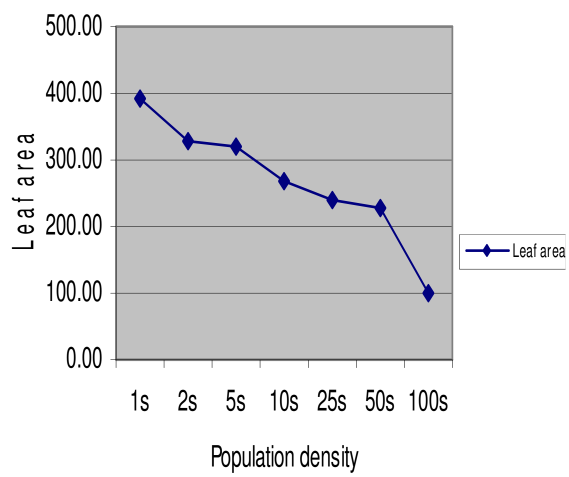

Figure 12. Effect of intraspecific competition on leaf area in *C. Olitorius.*

Makinde and Macarthy (2006), where they affirmed that intraspecific competition has highly sig-nificant effects on most agronomic attributes of *Celosia argentea.*

The observed gradual increase in plant height as population density increased (Figure 1) conform to earlier report by Makinde and Macarthy (2006) on *C. argentea* and is at variance with the report of Okunsanya et al. (1990), that mean plant height in *Treculia africana* seedling decreases as population density increases. The observed increase in plant height as population density increased in this study was as a result of intense competition within the plants, and their desire to reach further for the essentials of life like light (Einum and Fleming, 2004). Hence, increase in height/plant as competition intensified in this study. On the other hand, gradual decline was observed for other attributes investigated as population density increased (Figures 2 - 12).

The observed gradual decline in number of branches/ plant as population density increased is in line with earlier report by Mauronmicale et al. (2003) on early potato plant. In the same vain, negative effect of intraspecific competition observed for stem girth (thickness), number of leaves per plant, total fresh weight/plant, total dry weight/plant, total moisture content/ plant and leaf parameters as the population density increased is a measure of intrapopulation competition for essential requirement for growth and development. This observation is in agreement with the reports of Hauper (1961), Okusanya and Ahmedu (1983), Okusanya et al. (1990), and more recently that of Makinde and Macarthy (2006) that individuals of the same species will have same ecological requirements, and if these are limited, intraspecific competition will result.

The insignificant effect of intraspecific competition recorded for leaf petiole length and leaf blade width (Figures 9 and 11), coupled with their corresponding slight decline as population density decreased could be adduced as a major reason why local vegetable growers for fresh leaf production raised *Corchorus* in more or less clusters without recourse to a particular planting distance. However, it is noteworthy that intraspecific competitions have highly significant effect on leaf area (Figure 12). Thus, for optimum fresh leaf yield, effect of intrapopulation competition cannot be overlooked. The insignificant effect of replicates recorded for all traits investigated was a clear indication that there was a negligible effect of environmental factors in this study. This observation also corroborates earlier report by Makinde and Macarthy (2006) on *C. argentea.*

Conclusion

Considering the aforementioned observations it is obvious that while planting *Corchorus* for fresh leaf purpose, intrapopulation competition must be given serious consideration since significant effect of competition was recorded for total leaf length and leaf area (major components of leaf yield) in leafy vegetables. Going by the result of this study, for optimum fresh leaf yield and economy of space where land space is a limiting factor, a population density of between 10 plants and 25 plants per meter square is recommended.

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