Improving the yield of *Celosia argentea in* organic farming system with system of crop intensification

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Key words: *Celosia argentea,* System of Crop Intensification

Abstract

A field study was conducted at the University of Ibadan, Nigeria to investigate the effect of System of Crop Intensification (SCI) on the growth and yield performance of Celosia argentea. Two seeding rates were used; lower seed rate at 13 kg/ha and farmers' traditional seed rate at 26 kg/ha as high seed rate. The results showed that growth and yield of celosia were significantly (P<0.05) influenced by SCI. The result of seeding rates' effects on number of leaves, stem width and yield showed that low seed rate performed better than high seed rate. Low seed rate resulted in higher marketable fresh leaf yield of 12.24 t/ha compared to high seed rate of 8.82 t/ha. The accrued revenue ranges between ₦882,000 to ₦1,224,000 [₦150 = $1 (US Dollar)] for high seed rate and low seed rate respectively, subsequently increasing farmers' income. Overall, this investigation revealed that both growth and yield of Celosia argentea can be improved with low seeding rate, a feature of SCI.

Introduction

Celosia argentea is a leafy vegetable of the genus *Celosia* and Amaranthaceae family. The crop is produced in Nigeria by small holders' farmers; solely or intercropped with arable starchy staples to produce enough food to satisfy their dietary and cash requirements. The average yield of this crop (7.60 t/ha) has been limited by obsolete cultural practices employed in its production, such as seeding rates and non-use of fertilizer input among others (FAO, 2004). Optimum production on limited area of agricucltural land is another concern by many small holders organic vegetable farmers in most parts of the world. This has resulted into SCI. SCI is a methodology for increasing crop productivity by reducing crop population per unit land area, improving the management of crop and soil while reducing external inputs. A reasonable increase in yield of rice and millet has been obtained with SCI. Therefore, there is a need to consider if the yield of Celosia could also be improved with SCI.

Material and methods

This participatory research was conducted with a group of 8 farmers. It was conducted on the farmers' plots at the Ajibode end of the Teaching and Research farm of University of Ibadan, Nigeria from January to April, 2011(Latitude $7^0\,27^1$ N, Longitude $3^0\,54^1$ E). It was carried out on raised seedbeds of 4.0 m width, 5.0 m long and 0.2 m height. Poultry manure extract at the rate of 100 kg N ha^{-1} (Aduayi *et al.*, 2002) was applied as basal application at 2 weeks after sowing. The experiment laid in a randomized complete block design with four replicates. The experimental treatments were low seed rate and high seed rate which was the farmers' traditional seed rate. The quantity of seeds sowed was 26 kg ha^{-1} for high seed rate and low seed rate of 13 kg ha^{-1}. Harvesting was done at 5 Weeks after Sowing (WAS). All data obtained were subjected to Analysis of Variance and means separated using least significant difference ($p<0.05$). Economic analysis was used to determine the cost and economic return for *Celosia argentea* production.

Results and discussions

Reduction in seeding rate of celosia which is one of the feature of System of Crop Intensification resulted in significant ($p > 0.05$) increase in the numbers of leaf during the growth stage. Changes in the number of leaves are bound to affect the general plant growth and vigour, as they are the major organs of photosynthesis of the plant. Number of leaves increased progressively throughout data collection period. High seed rate resulted in a greater the number of leaf per unit area (m^2). Number of leaves in low seed rate showed significant ($P<0.05$) difference as compared to high seed rate at 4 and 5 WAS (Table 1). Changes in stem girth were significant ($p < 0.05$) at 4 and 5 WAS (Table 1). This observation is supported by work of Law-Ogbomo and Ekunwe (2011) who reported that planting density significantly affect stem girth. Low seed rate led to an increase in the stem girth. This was due to differences in improved light interception, nutrients

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absorption and utilization capacity of plants (Law-Ogbomo and Ekunwe, 2011). The height of plant is an important growth character directly linked with the productive potential of a plant. An optimum plant height was reported to be positively correlated with productivity of the plant (Saeed *et al.*, 2001). In this investigation, plant height generally increased progressively throughout data collection periods. This may be attributed to the basal application of poultry manure extract. Low seed rate had taller plants (Table 1) however, there was no significant ($p > 0.05$) difference between treatments. The effect of seeding rate on yield (Table 2) gives a better fresh weight of leaf, root and total weight of plant. The yield observed for leaf, root and total fresh weight (g/plant) for low seed rate were 6.8, 2.45 and 16.22 respectively. This was significantly ($p > 0.05$) different from high seed rate (g/plant) with 2.45, 1.42 and 9.22 for leaf, root and total fresh weight respectively. The result was in line with finds of Madakadze *et al.* (2007), who reported that spacing significantly affect leaf area, fresh and dry weight of celosia. An average yield of 7.60 ton ha^{-1} of celosia has being reported by FAO (2004). In this investigation, reduction in seeding rate of celosia which is a feature of System of Crop Intensification improved yield. This ultimately resulted in an increase in the marketable yield of celosia (Figure 1) at 12.24 ton ha^{-1} for low seed rate as compared to 8.82 ton ha^{-1} for high seed rate. This in itself is an interesting outcome, since the research was farmers' participatory. High seeding rate lead to increased competetion for sunlight and soil nutrients among the crops. This may have resulted in the reduced yield observed in the high seeding rate.

Table 1: Effect of crop intensification on growth parameter of *Celosia argentea*

Parameter	Treatments (Seed rate)	3 WAS	4 WAS	5 WAS
Plant height (cm)	Low seed rate	7.51	20.43	33.48
	High seed rate	7.21	19.47	31.50
	LSD	ns	Ns	ns
No. of Leaves	Low seed rate	6.66	12.44	18.87
	High seed rate	6.78	9.96	16.17
	LSD	ns	1.66	1.12
Stem girth (cm)	Low seed rate	0.88	1.98	2.43
	High seed rate	0.84	1.75	2.00
	LSD	ns	0.06	0.06

Table 2: Effect of crop intensification on fresh weight (ton ha^{-1}) of *Celosia argentea*

Parameters	Low seed rate	High seed rate	LSD	
Leaf	6.80	2.45	1.17	***
Stem	6.97	5.35	ns	
Root	2.45	1.42	0.63	**
Total (g/plant)	16.22	9.22	4.01	*
Total (ton / ha^{-1})	29.20	33.19		

*,**,*** Significant at P<0.05, P<0.01 and P<0.001, ns: Not Significant

Table 3: Economic analysis of crop intensification on the performance of *Celosia argentea*

Treatments	Low seed rate	High seed rate
Gross revenue (₦100 kg^{-1})	1,224,000	882,000
Variable cost (Seed cost) (₦)	35,415	59,625
Net variable and fixed cost (₦)	457,740	457,740
Total cost (₦)	493,155	517,365
Net Profit (₦)	730,845	364,635

Assumption for economic analysis: Exchange rate, ₦150 = $1 (US Dollar)

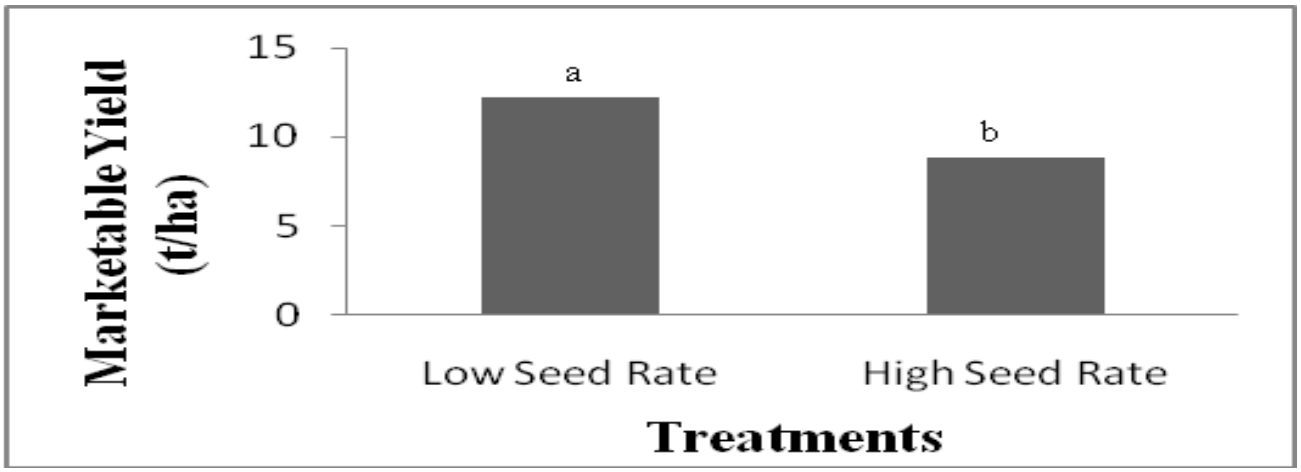

Figure 1: Marketable yield of *Celosia argentea* in ton ha^{-1}

Economic Analysis

The gross margin and net return was highly influenced by seed rate reduction. Total cost of production increased as seed rate increased (Table 3). However, higher revenue was obtained at lower seed rates. The accrued revenue / ha ranged between ₦882,000 to ₦1,224,000 for high seed rate and low seed rate respectively, which inferred 38.8% difference. A net profit of ₦730,845 and ₦364,635 was obtained for low seed rate and high seed rate respectively. These findings imply that profitable crop production depends on adequate seeding rates but not excessive plant stands.

Conclusions

In the present investigation, it can be concluded that reduction in planting density of *Celosia argentea* (which is a feature of system of crop intensification), resulted into an increase in the marketable yield of *Celosia argentea* and subsequently increased farmers' income. Thus, seed rate of celosia at 13 kg ha^{-1} is recommended for improve yield of the crop and higher income for farmers.

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