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RESEARCH ARTICLE

Comparative assessment well adapted popular lettuce varieties performances under different cropping densities for yield and yield related traits

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Abstract

Lettuce (*Lactuca sativa* L.) is one of the outmost important vegetable crops in Niger. Planting density is an important criterion for lettuce production and to breed for high density planting. The aim of this study was to know the responses of lettuce varieties to different planting densities. Thus, two well adapted cultivars (trinity, and minetto) were evaluated in a split-plot design at three planting densities: 66, 25, and 11 plants per m^2. Significant differences were observed between varieties for the studied traits. Results also showed significant increase of yield with increased of planting density while individual weight significantly decreased. However, planting density did not affect significantly plant height and leaves number. The higher (66 plant/m^2) density appeared to be the best for small scale farmers. The results may help lettuce breeders in deciding breeding strategy for the high density planting.

Key words: Lettuce, planting density, Niger, yield

Introduction

Lettuce (*Lactuca sativa* L) contributes to the population diet and is rich in vitamins, minerals and fiber. The plant is cultivated in urban areas and generates substantial income to small scale farmers. Niger is facing a chronic food deficit that is becoming increasingly acute. Rapid population growth (3.2% per year) and droughts of the last two decades are the main causes of this shortage. Agricultural production has been stagnant or decreased for several years. The situation is worsened because the crops are mainly rainfed cereals (millet, sorghum) and the natural resources (soil, water, plant cover) are threatened with degradation. One of the measures taken by the Government to overcome this situation is the intensification and diversification of agricultural production, in particular through the production of off-season irrigated crops and more particularly market gardening crops such as lettuce.

Lettuce (*Lactuca sativa* L.) belongs to the Asteraceae family. It is an annual plant with a short vegetation period and cold resistance (Milena and Asen, 2017). Lettuce is an important leafy salad vegetable, rich in vitamins and minerals, that is mainly grown in cool season of the year in tropical and sub-tropical countries (Moniruzzaman, 2006). According to Iraj *et. al.,* (2013) lettuce is 26th among 39 vegetables and fruits of nutrition value and is fourth of consumption. It‘s the most popular salad crop in the world (FAO, 2017). Lettuce is one of the most important vegetables in human diet. The plant is full of vitamins and minerals with lots of fiber which facilitates colon

peristalsis (FAO, 2017). It is the species of major economic importance among the leafy vegetables and the most consumed worldwide (Keiko and Antonio, 2013). Lettuce in one of the most important vegetables in Niger Republic, it is grown during the cool dry season all over the country. Plant density is an important factor for lettuce production. Planting density is an important criterion for lettuce production and very few varieties have been breed for high density planting. Thus, inappropriate plant spacing may cause either too dense or too sparse population resulting in yield reduction. But optimum plant density ensures the plants to grow uniformly and properly through efficient utilization of moisture, nutrients, light and hence, leads maximum yield of lettuce (Firoz *et. al.*, 2009).

Many studies have been conducted world while on lettuce growing spacing (Aminifard *et. al.*, 2010, Khazaei *et. al.*, 2013, Moniruzzaman, 2006, Sadeghi *et. al.*, 2009). According to these authors the spacing ranged from 20 to 50cm between rows and 20 to 45 cm between plants. It has been found that plant height and diameter of the lettuce are greater when the growing spacing is increased (Milena and Asen, 2017).

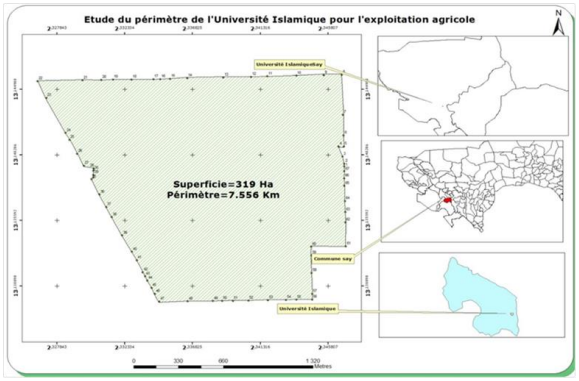
In Niger some studies have been conducted on lettuce to improve the productivity and availability across time. These studies ranged from varietal creation to optimum fertilizer application. However, few studies have been carried out on the effect of plant density on the crop yield. Also inadequate information is available for the lettuce breeders in deciding breeding strategy and to develop genotype for the high density planting. At the same time it is necessary to capture basic idea based on plant height, number of leaves and planting density to develop an ideotype in lettuce. The objective of this study was to study the responses of well adapted lettuce varieties to different planting densities.

Material and methods

The study was carried out from January 09th to March 16th, 2019 for a total duration of 65 days. The experimentation site (Fig. 1) is located in the western part of Niger republic at Say Islamic University. Plant material was composed of two lettuce varieties namely: trinity and minetto. The experimental design was a split plot with two replications and two factors: the variety and the density. The factor variety was assigned to the mains plot and the planting density served as sub-plot. The varieties were evaluated under three different spacing rates. These were D1= 10*15 Cm, D2=20*20 Cm, and D3=30x30 Cm. This corresponded to 66, 25, and 11 plants per m^2 respectively. Each sub-plot measured 2.25m^2. The two nurseries (one for each variety) were seeded after preliminary land preparation and leveling. The nurseries were then mulched using the millet straws. This was to maintain the soil moisture, protect the nursery from bird damage and to reduce the impact of irrigation water droplets. Germination was observed 3 days after sowing and at 4 days after germination; the straws were removed and replaced with mosquito nets. Two weeks before transplanting, 10kg of cow manure was applied to each small plot of 2.25m^2, during land preparation. Regular watering has been done to facilitate the decomposition of organic matter. Before transplanting, the soil was slightly moistened, plowed and then leveled. Transplanting was done at 5 leaves stage that corresponded to 25 days after sowing at one plant per hill and at 3 different densities as follow: 10x15cm, 20x20 cm and 30x30cm. The transplanting was performed in the evening when the temperatures were low. Weeding was done manually at 14, 19 and 25 days after transplanting and the water supply was performed 2 times daily. Data were collected 40 days after transplanting from middle plants lines. The traits measured were: the total leaves weight, the plant height and the

number of leaves. The total weight of the plants was measured using an electric scale. Plant height was measured using a graduated ruler. The statistical analyzes were performed out using Genstat software version 18.

Fig 1: Study site of present investigation



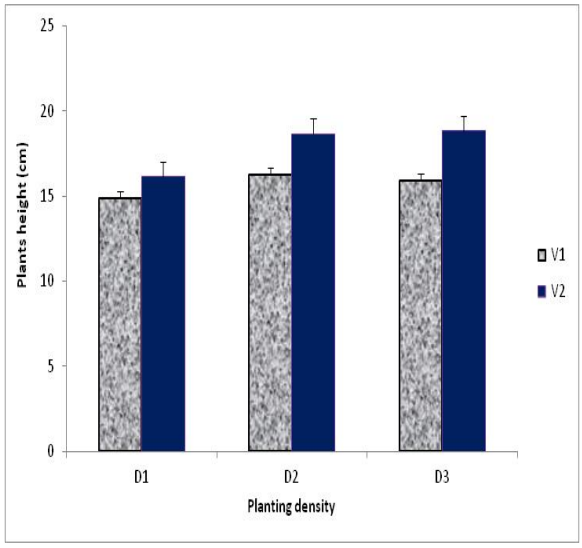
Results and discussion

Analysis of variance (Table1) showed that there were significant differences among varieties in terms of plant height. Hence, the variety 2 (minetto) was significantly higher than the variety 1 (trinity) (Fig.2) across all the treatments. However, planting densities did not have significant different effect on the lettuce varieties height. The interaction, varieties treatments was also not significant.

Table 1: ANOVA table of plant height

Source of variation	DF	SS	MS	Vr	Fpr
Replication	1	24.51	24.51	9.27	
Treatment	2	9.09	19.55	7.40	0.11
Residual1	2	5.29	2.64	0.49	
Variable	1	58.30	58.30	10.83	0.04
Treatment Variable	2	5.87	2.94	0.55	0.62
Residual2	3	6.15	5.38	1.14	
Error	36	69.87	4.72		
Total	47	319.09			

Fig 2: Plant height at different planting densities

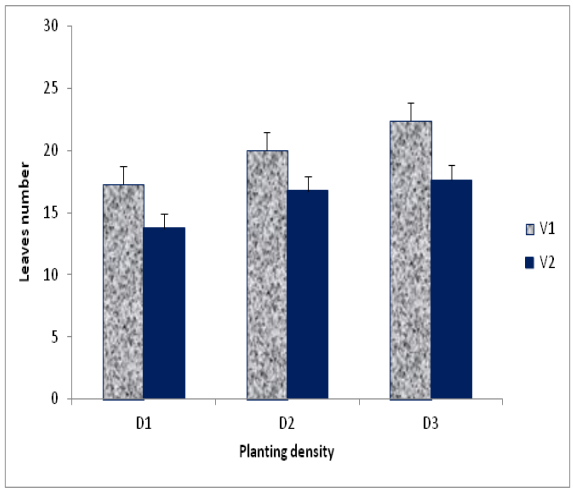


Analysis of variance of plants leaves number (Table 2) showed that planting density did not significant affect on the number of leaves of the lettuce varieties. However, across all the planting densities the variety 1 (trinity) bore significantly higher leaves than variety 2 (minetto) (Fig 3). Thus, no significant interaction was found between planting density and leaves number. It is important for breeders to breed varieties for more number of leaves in lettuce. If number of leaves is more increased, greater is yield.

Table 2: ANOVA table of plant leaves number

Source of variation	DF	SS	MS	Vr	Fpr
Replication	1	2.08	2.08	0.37	
Treatment	2	166.17	83.08	14.88	0.0
Residual1	2	11.17	5.58	0.44	
Variable	1	176.33	176.33	13.92	0.03
Treatment Variable	2	5.16	2.583	0.20	0.82
Residual2	3	38.00	12.66	2.27	
Error	36	201.00	5.583		
Total	47	599.92			

Fig. 3: Leaves number across different densities



Significant differences existed among planting densities in terms of total fresh biomass weight (Table3). Varieties also differed significantly for this trait. Hence, the variety 1 (trinity) yield performances were significantly higher than variety 2 (minetto) across all the treatments (Figure4). In Addition, varieties individual plant fresh was significantly high in density D1 (30*30Cm) than in density D2 (20*20Cm) which was significantly higher than D3 (10*15Cm). However, the opposite was observed in terms of total yield (fresh biomass weight per m^2) (Figure5). Thus, the yield is higher in treatment D3 than D2 and D1.

Table3: ANOVA table biomass weight

Source of variation	DF	SS	MS	Vr	Fpr
Rep	1	6348	6348	5.78	
Traitmt	2	267322	133661	121.67	0.008
Residual1	2	2197	1099	0.23	
Var	1	2945	2945	0.61	0.492
Traitmt.Var	2	2288	1144	0.24	0.803
Residual2	3	14518	4839	1.22	
Error	36	143184	3977		
Total	47	438802			

Fig 3: Plant weight across planting densities

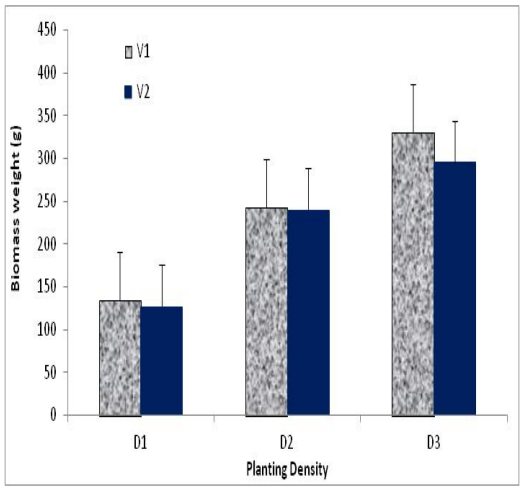
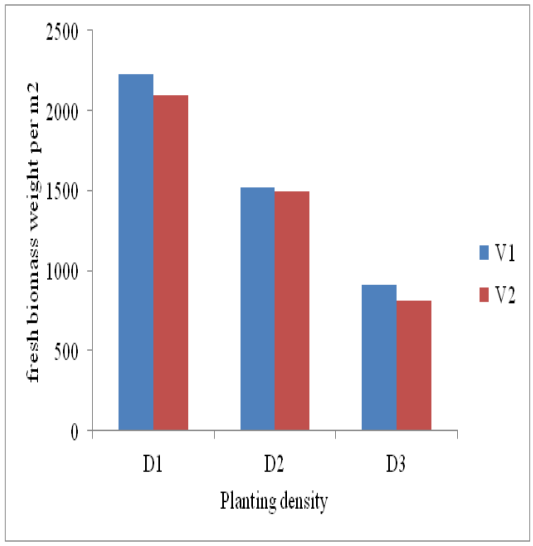


Fig 4: Total fresh biomass weight across planting densities



Results showed that there was significant difference among varieties in terms of plant height and leaves number. This may be caused by genetic potential of each variety that can differ from one to another. According to Mikel (2007) there are different types of lettuce namely; Romaine (Cos), Iceberg (Crisp head), Butter head, Stem (Asparagus), Leaf (Cutting) and Oilseed. Lebeda *et. al.*, (2004) partitioned the different varieties of lettuce according the cultivation areas. They hence, stated that there

are 98 species out of which, 17 are from Europe, 15 from African, 12 from American, 3 from Australia and 51 species from Asia. Although, Trinity and Minetto are Iceberg types they are different cultivars with different traits.

Results showed no significant effect of planting density on plant height. This result is confirmed by the study conducted by (Castoldi *et. al.*, 2012) on 3 crisp mini lettuce cultivars. They showed that plant density did not affect plant height in lettuce cultivar. However, earlier on Moniruzzaman (2006) observed that for cultivar Green Wave, plant height increased with the decrease in spacing. According to the same author several traits can be influenced by planting density including, plant architecture, fresh weight, height and yield. Hence, optimum use of physical is necessary to know the productive potential of varieties (Moniruzzaman, 2006).

Results showed that there was no significant effect of planting density and leaves number. This is not conform with results observed in Ethiopia (Beyenesh *et. al.,* 2017) who reported that plant spacing had significant effects on leaves number per plant.

Results showed significant effect of planting density on yield (fresh weight). Several authors reported similar results. Maboko and DuPlooy (2009) indicated that an increase in plant population results in a significant increase in yield and yield components of leafy lettuce. However, according to Keiko and Antonio (2013) the increasing in yield due to plant density has a limit. After this, the competition among plants is so high that the decreasing in plant characteristics is not compensated by increasing plant number. This is because an increase in population density can thus, increase the competition among species for light, water and nutrients and interfere upon the growth, productivity and quality of the vegetable crops (Nascimento *et. al.,* 2018). In this study, it did not occur. In the case of the cultivars studied, the highest plant densities appeared to be the best option for yield even with lesser individual plant weight.

Hence, we conclude that two lettuce cultivars had significant different agronomic performances across planting densities. Increasing plant density increases lettuce yield and decreases individual plant weight. However, leaves number and height were not significantly affected by density. Hence, because of a smaller area available for farmers to produce quantity of marketable product in urban area this planting density will provide more income to farmers. This study gives clue to breeders to develop varies with more number of leaves. The study helps lettuce breeders to develop varieties suitable for the high planting density.

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