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Population Density Effect on Tillering, Biomass and Ground Cover of Two Green Manure Crops

Belay Garoma[1]* Lommen Willemien[2]
1.Bako National Maize Research Centre, Ethiopia Institute of Agricultural Research, P.Box 03,Bako, ,Ethiopia
2.cropping sytem, Wageningen University, NL-6708, Wageningen, the Netherlands

Abstract
Winter rye and Lolium mix are the most commonly used green manure crops that can withstand the low temperature. Its growth is influenced by light interception and different cultural practices such as sowing density and addition of nitrogen fertilizer. The objective of study was to determine the effect of sowing density on tiller number, fresh biomass and ground cover by green leaf blades of two green manure crops for consecutive two years. Split plot design was used with two green manure crop as main factor and sowing density as sub-plot factors as three levels with six blocks. Analysis of variance showed significant ($P < 0.05$) interaction between sowing density and two green manure crops in two years for tiller number, fresh biomass and ground cover (%) by green leaf blades. High number of tiller, biomass production and ground cover was observed for winter rye than Lolium in both years. Winter rye was more likely preformed for tiller number, fresh biomass and ground cover at 100- 200% sowing density. Therefore, further investigation is required for winter rye at 100 % and 200 % sowing density at different locations and economic visibility in order to recommend the optimum sowing density for farming community.
Keywords: sowing density, tiller number, biomass, ground cover

1. Introduction

Cultivation of green manure plays an important role in the soil characteristic and agricultural sustainability in their ecological farming system. Incorporation of green manures in to soil can improve the physical, chemical and biological characteristic of soil and also improves crop production [1]. The decomposition of green manures is processed by microbial activities and mineralized in to nitrate, phosphate and other accessible nutrients for plants. The addition of organic matter might be change the incidence and severity of disease that affect weeds and crops. Green manures have many contributions to agro-ecological system and organic farming. It also serves as cover crop to reduce soil erosion and the amount of nitrogen loss through leaching [2]. It is also an effective technique for weed suppression. For instance, cover crops such as gramineous rye, leguminous clovers and vetch hairy successfully reported to be used as cover crops to suppress weeds [3]. Increasing crop density improves crop competitive ability and speed competition for limited resource, resulted in reduces the population of insect damage and pathogens expansion which associated to weeds [4].According to [5] sowing green manure rye grass at increasing density would maximize dry matter production and minimizes weed growth. Determining the effect of sowing density is an important; because sowing density would affect tiller number, fresh biomass and ground cover productions.

Winter rye (*Secale cereale* L.) and Lolium mix grass species are most commonly used as green manures crops and grown during winter period. These green manure crops can withstand low temperature. Their growth can be influenced by light interception and cultural practices such as sowing density. Sowing density affect tiller number and ground cover of green manure crops [5]. At high density it would be excpeted that high number of tiller prodction. The more number of tiller prodction would expected to more biomass and ground cover. Therefore, the aim of this research was to determine the effect of sowing density on tiller number, fresh biomass and ground cover production of two green manure crops and and identifying which of these two green manure crops was highly affected by sowing density.

2. Methods and Materials

2.1 Description of study area

The experiment was conducted at experimental farm Wageningen University Research, De Haaff, Parcel 15 on sandy soil, Wageningen, the Netherlands during in 2013 and 2014 winter seasons.

2.2 Experimental Setup

The experiment was conducted on two green manure crops, Italian rye grass (*Lolium multiflorium* L.) and winter rye grass (*Secale cereale* L.*).* Split plot design was used with two green manure crop as main factor and sowing density as sub-plot factors at three levels with six blocks. Main plot was randomized first and sub-plots randomized in main plots. The three sowing densities were used 50%, 100% and 200% for both green manure crops. The advisable seed rates were 7.5 kg ha^{-1}, 15 kg ha^{-1}, 30 kg ha^{-1} for Lolium mix and 75 kg ha^{-1}, 150 kg ha^{-1} and 300 kg ha^{-1} for winter rye. The experiment was conducted for two consecutive years in 2013 and 2014

winter period. Each green manure crop has sown on plot of 6 m × 1.25 m = 7.50 m^2. Row spacing 12.5 cm, 10 rows per 1.25 m and the inner 2 rows of 4 m were harvested, total area 0.5m^{-2} harvested.

2.3 Measurements and calculations

Field observation was carried out to estimate the percentage of ground cover of two green manure crops through visual observation. Four observations were made for each plot to estimate the percentage of ground cover and the average was taken**.** For the rest parameters, fresh matters of two inner rows were harvested and samples were put in plastic bags, and taken to laboratory for analysis. The total fresh biomass (g m^{-2}) weighted and recorded in laboratory. After taking total fresh weight, it was divided into sub-samples. One sub sample was used to determine dry matter percentage and other sub-samples were used to determine other parameters. Numbers of tillers were also counted for crop sub-samples. Dry matter concentration was determined by putting sub-samples in oven dry at 105 ^{0}C for 16 hours.

Parameters for number of tiller m^{-2} area, fresh biomass (g m^{-2}) and ground cover by green leaf blades of manure crops in percentage were calculated.

$$Number\ of\ tiller = \frac{Fresh\ weight(g\ m^{-2})\ \times number\ of\ tiller\ per\ crop\ sample}{Samples\ fresh\ weight(\ g\ m^{-2})}$$

$$Fresh\ Biomass\ (g\ m^{-2}) = \frac{Total\ fresh\ mass(g)}{Total\ area\ harvested(m^2)}$$

$$Ground\ cover\ of\ Green\ leaf\ blades\ of\ crops(\%) = \frac{Sum\ of\ Observation}{Number\ of\ visual\ observation\ made}$$

2.4 Statistical analysis

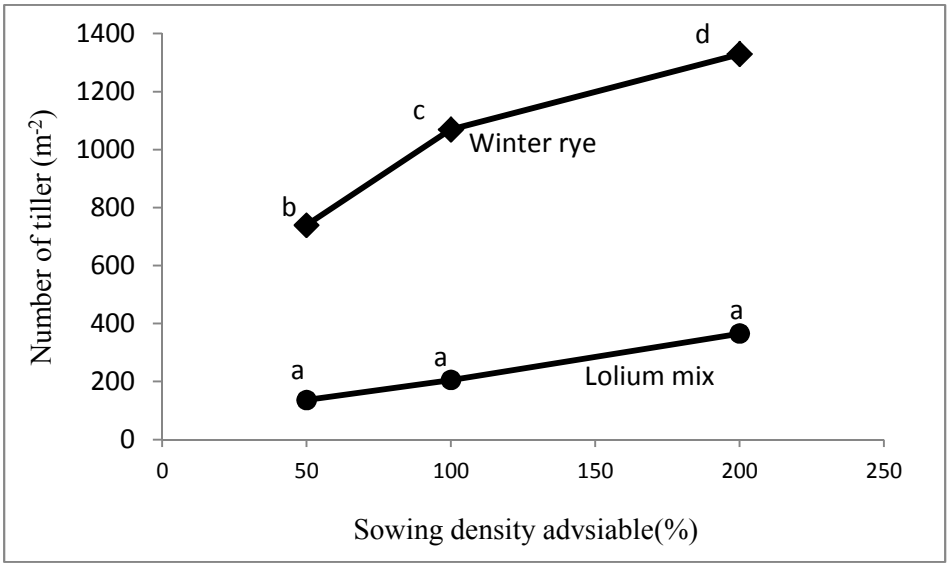
Statistical analysis was conducted using Genstat software version 16. Analysis of variance was performed using split plot design where crops used as main plot factor and sowing densities as subplot factor. The assumptions of normality and equal variance was checked .The effect of quantitative factors, crop types and sowing density were separated into linear and quadratic components. Criterion was used for declaring significance (P <0.05) and mean separation was performed to compare treatment means using Fisher protected LSD-test at 5% level of significance.

3. Result and discussion

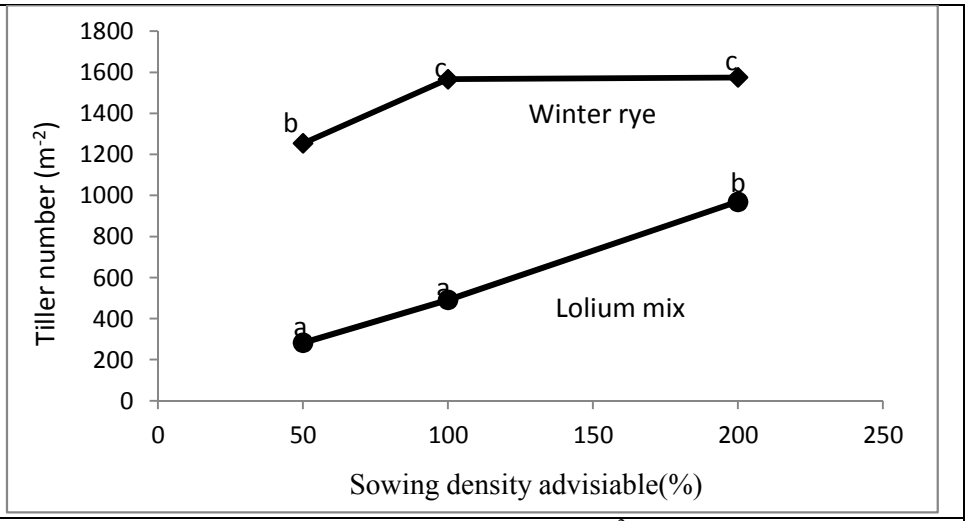
Satisfactory raw data was obtained in 2014 than 2013 winter season due to heavy snow happened during 2013 winter period. Thus, raw data was analyzed for green manure crop, sowing density and crop by sowing interaction in separate years than over year interaction. Linear or quadratic effect of crops and sowing density also analyzed to see strength of significant level.

3.1 Tiller number per m^{-2} area

The current research was carried out to see the effect of sowing density on tiller number, fresh biomass and ground cover (%) by leaf blades production for two green manure crops of winter rye and Lolium mix. Analysis of variance showed that a highly significant interaction between green manure crops and sowing density (p= 0.003, P=0.009) for tiller number m^{-2} for two years (Figure 1A and 2A). The linear effect of green manure crops and sowing density of their significant was high in 2014 than 2013 on number of tiller m^{-2}. As sowing density increased, the number of tillers linearly and significantly increased for winter rye whereas no significant differences on number of tiller per m^{-2} for Lolium mix was observed at three advisable sowing densities (Figure.1A, 2014). Increased in the number of tillers per unit area might be resulted in increasing biomass of crop. But according to [5] increasing seeding rate increased linearly rye height and reduced linearly the number of tillers. Higher number of tiller production was observed for winter rye than Lolium Mix in both years. This might be contribute for competitiveness of weeds and reduce soil erosion [4]



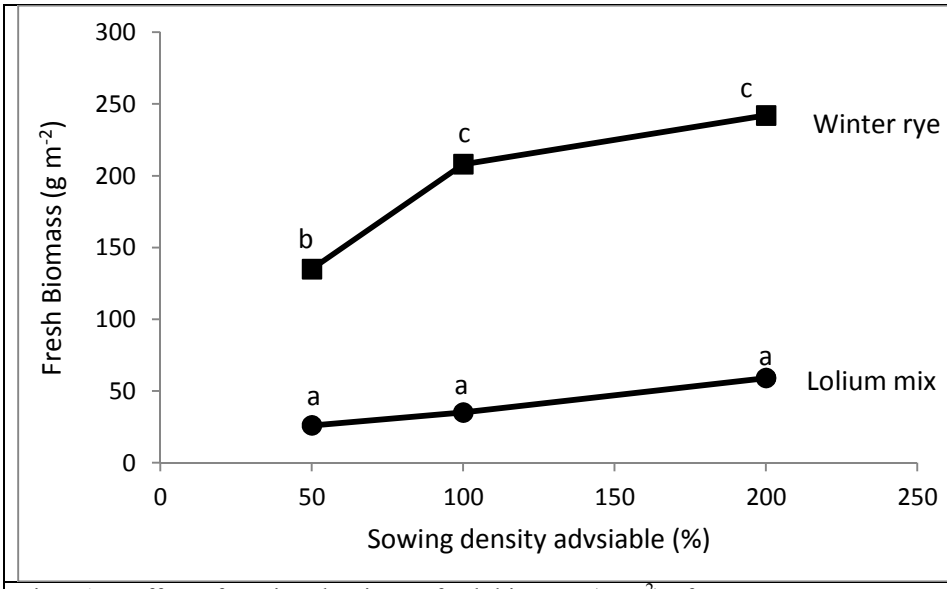
Figur.1A. Effect of sowing density on number of tiller m^{-2} of two green manure crops in 2014 winter season. Points that followed by different small letter differ significantly ($P < 0.05$) at (LSD 0.05=220.4).



Figur.2A. Effect of sowing density on number of tiller m^{-2} of two green manure crops in 2013 winter season result. Points that followed by different small letter differ significantly ($P < 0.05$) at (LSD 0.05=297.2).

3.2 Green manure fresh biomass (g m^{-2})

ANOVA analysis showed that a highly significant interaction between green manure crops and sowing density (p= 0.009) for fresh biomass (g m^{-2}) in 2014 but not in 2013. Similarly, the linear effect of green manure crops and sowing density was highly significant (p<0.01) (Figure.1B, 2014) but not in 2013. As sowing density increased up to 100 advisable sowing densities, fresh biomass linearly and significantly increased for winter rye but then afterward no significant increase in fresh biomass was observed for wither rye (Figure.1B). For Lolium mix no significant increase in fresh biomass was observed at three different sowing densities (Figure.1B). High fresh biomass production was observed for winter rye in both years. This statement was agreed with [7] reported that the higher sowing density of Italian rye grass showed more dry matter yield production and decreases percentage of weeds. The more biomass of green manure is addition of organic matter to the soil [8]. Similarly, the effectiveness of green manure is related to its biomass production, which is dependent on the green manure management and seed rate [9]. However, it varied among genotypes, cultivation methods and seasons.



Figur.1B. Effect of sowing density on fresh biomass (g m^{-2}) of two green manure crops in 2014. Points that followed by different small letter differ significantly ($P < 0.05$) at (*LSD* 0.05=40.).

3.3 Ground cover (%) by green leaf blades

Analysis of variance revealed that a significant interaction effect between two green manure crops and sowing density (p= 0.022) for ground cover by green leaf blades (%) in 2014 but not in 2013. The linear effect of green manure crops and sowing density was highly significant (p<0.01) for ground cover (%) by green leaf blades (Figure. 1C in 2014) but not in 2013. Winter rye performed better than Lolium mix for ground cover by green leaf blade in 2014 (Figure.1C). As sowing density increased, the ground cover by green leaf blades for winter rye was increased than Lolium mix but not significantly (Figure.1C). Thus, the more ground cover for winter rye could be use more efficiently light interception for assimilation, growth and converts into biomass and more number of tiller. In this study, rye has more ground cover and likely suppression of weed. [4] Reported that an increasing ground cover percentage contributes in suppression of weeds and reduces soil erosion. This phenomenon happened through competitiveness of place and light as well shading the soil surface and reducing the opportunity for weeds establishment.

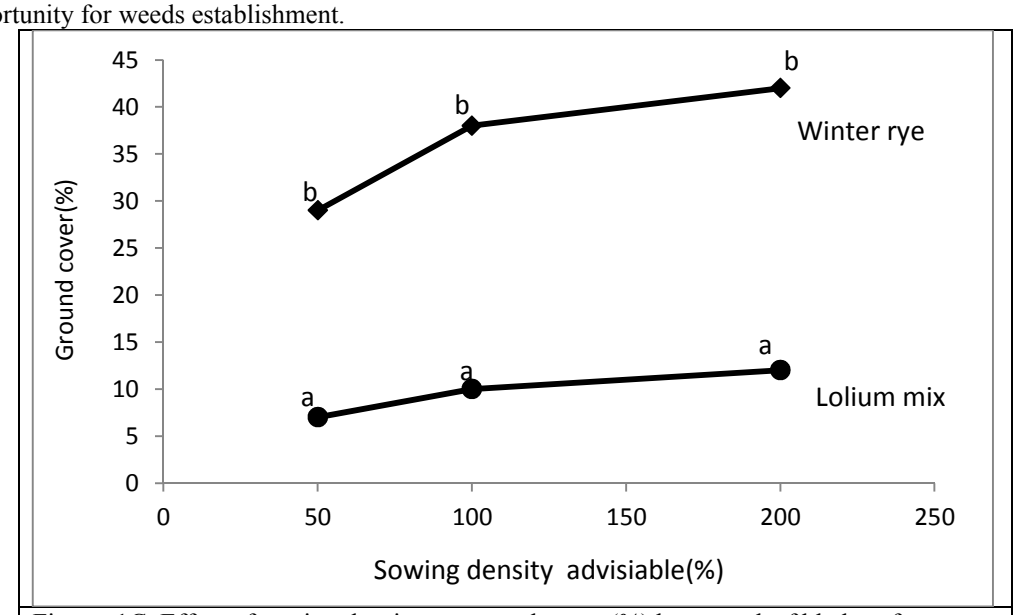


Figure. 1C. Effect of sowing density on ground cover (%) by green leaf blades of two green manure crops in 2014 winter season. Points that followed by different small letter differ significantly ($P < 0.05$) at LSD 5 % test = 13.6

Conclusions

Winter rye produced high number of tiller, fresh biomass and more ground cover at 100% and 200% sowing density. Thus, winter rye has shown good performed for these traits and likely selected to plant during winter season. But , further study is required on winter rye green manure at 100% and 200% sowing density and other important traits at different location, years and on different soil types including economic visibility to give optimum sowing density recommendation for farming communities hence green manure cultivation is a promising technology.

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