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Effect of Plant Spacing on Seed Yield of Cow Pea in Dilla Substation, Southern Ethiopia

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Abstract
The study was conducted in Dilla sub-station with objective of identifying optimum between plant space for optimum seed yield and quality seed. One high yielding variety, which is in seed multiplication, was used for the experiment. Four different between plant spaces (10 cm, 20 cm, 30 cm and 40 cm) with constant between row spacing (40 cm) were used as experimental treatments in a randomized complete block design (RCBD) with four replications. The results indicated that dry herbage yield has shown significantly ($p<0.05$) higher in plant spacing of 20 cm than other spacing (30 and 40 cm) On contrary to herbage yield, at spacing of 30 and 40 cm seed yield was higher than 20 cm spacing. Seed yield has showed statistically significant variation at 30 cm than at 20 and 10 cm between plants spaces at ($p<0.05$). Hence, there will be two recommendation options for smallholder producers. To secure feed shortage and increased herbage production 20 cm between plant spacing is sufficient while for increased seed yield 30 and 40 cm could be recommended. Further trials might be required in intercropping condition with different cereal crops to utilize resources more efficiently. .
Keywords: Biomass yield, seed yield, plant spacing, cowpea

Introduction

Feed shortage both in quantity and quality is the major constraint influencing animal performance in Ethiopia (Yayneshet et al., 2009). Natural pasture and crop residues are the main feed sources. However, most of the feedstuffs obtained from natural pasture and crop residues have crude protein (CP) levels below 8% and neutral detergent fiber (NDF) above 55% (Seyoum and Zinash, 1995). Feedstuffs of such composition are insufficient to provide year round supply of adequate quantity and quality of nutrients above maintenance requirements (Hindrichsen et al., 2001). Various options have been advocated to improve the scenarios; one of the options is to introduce and adapt leguminous forages. Cowpea is well adapted to harsh environmental conditions, among others low soil fertility, high temperatures and drought (Turk et al., 1980). Cowpea can fix nitrogen to improve soil fertility and productivity of the existing cropping system. Additionally, farmers feed cowpea fodder to livestock to increase income while collecting manure produced thereby reduces farmers' reliance on commercial fertilizers and sustains soil fertility (Odion et al., 2007; Akinlade et al., 2005). Previous studies with cow pea (Gwanzura et al., 2012; Akinlade et al., 2005; Ebro et al., 2004; Alemayehu, 1997) indicated this legume improves soil fertility and enhances intake and utilization of poor quality roughage consequently improves livestock production and productivity. Another important feature of cowpea is its ability to suppress weeds particularly Striga species (Dawit et al., 2009).. This includes feeding of treated and untreated crop residues or integration of forage legumes into the feeding strategies. Legumes are the most important forage plants that substantially improve the feed available for livestock as they can provide the essential protein for animals, improving soil fertility, food crop production and household nutrition through a more reliable supply of milk and meat (Akinlade et al., 2005; Alemayehu, 1997).

The demand for production of improved forage is increasing in southern region due to decreasing trend of grazing land for livestock production and increased awareness of farmers on improved forage production (unpublished AGP-II need assessment, 2016 report). However, supply of improved forage crop seed is below the demand, due to lack of forage seed production and there is no seed rate space that is recommended for seed production. Hence, identifying optimum seed yield production space rather than herbage will encourage seed producers which in turn has significant importance in improving feed quality and soil fertility and productivity. Therefore, this experiment was conducted with the objective of identifying optimum between plant space for optimum seed yielding and quality seed of cowpea for lowlands of Southern Ethiopia.

Materials and Methodology

Description of the study site

Dilla sub-station is characterized by Orthic Luvisols soil, with an average annual rain fall and temperature of 1300 mm and 21^{0}C, respectively. The average minimum and maximum temperature of the area are 13.10 and 28.05 ^{0}C, respectively. It has an altitude of 1572 masl, and is located at latitude and longitude of 38^{0}18'30" E and 6^{0}24'30" N, respectively.

Treatments and data collection

The between plant spacing 10 cm, 20 cm, 30 cm and 40 cm, were used as experimental treatments in a plot size of 3 m x 2 m with spacing of 40 and 1m between replication and plots. Two seeds were sown together at the onset of main rainy season in mid July with extra seedling thinned 14 days after germination, leaving one plant per plot. A 100 kg NPS /ha was applied right before sowing. All plots were weeded two times before flowering. Number of branches per plant was counted by taking five plants per plot randomly. Number of pods per plant was also counted by using five plants per plot. Plants were harvested at ground level and fresh biomass weighed immediately using a 0.1 g scale. Then, a sub-sample of 15-20% of the total weight was separated and put into a paper bag for herbage dry matter determination. The samples were oven dried at 105 0C for 24 hours in soil laboratory, Hawassa Agricultural research center. To determine grain yield, the pods were harvested from the rest rows at optimum physiological maturity by hand picking and threshed.

Statistical analysis

The data was analyzed using analysis of variance in the general linear procedure of SPSS (version 20). Tukey multiple comparisons was used to separate treatment means.

Result and discussion

Number of branches

Maximum yield of a particular crop in a given environment can be obtained at row spacing where competition among the plants is minimum. This can be achieved with optimum spacing which not only utilize soil moisture and nutrients more effectively but also avoids excessive competition among the plants. However, beyond certain limit yield cannot be increased with decreasing/increasing row spacing. Hence, optimum row spacing induces the plant to achieve its potential yield.

There was statistically significant difference in number of branches per plant between plant spacing of 30 cm and 40 cm between plants which is in line with report of Armara *et.al,* 2017 who reported increase in number of branches per plant as space increases. The current study indicated that there was no significant difference in number of branches per plant at 30 cm and 40 cm between plant spacing (Table 2). This might be the indicator of optimum level of spacing for increase in number of branches per plant. Branches per plant higher in higher space between plants than lower space and positively correlated with seed yield. These results are in line with Angne et al. (1993) and Yadav (2003).

Table 1. Effect of between plant spacing on number of branch per plant

Between plant spacing (cm)	Mean	Std. Error	95% confidence interval	
			Lower Bound	**Upper Bound**
10	12.0	0.4	10.7	13.3
20	14.8	0.4	13.2	16.2
30	18.5	0.4	17.5	19.4
40	20.0	0.4	17.7	22.2

Number of pod per plant

There was statistically significant difference in number of pods per plant between plant space of 30cm and 40 cm between rows which is in line with report conducted under irrigation by Armara et.al., 2017 they reported as there is increase in space there is increase number of pods per plant up to the optimum level at 60 x 20 cm number of pods. Our study indicated that there was no significant difference in number of branches per plant at 30 cm and 40 cm between plant spacing (Table 2). This might be the indicator for optimum level of spacing because number of pods increased per plant. Pods per plant higher in higher space between plants than lower space and positively correlated with seed yield. These results is in line with Angne *et al.* (1993) and Yadav (2003) in cowpea.

Table 2. Effect of plant space on pod/plant

Between plant space	Mean	Std. Error	95% confidence interval	
			Lower Bound	**Upper Bound**
10 cm	18.50b	0.774	15.814	20.186
20 cm	19.00b	0.774	16.314	21.686
30 cm	24.25a	0.774	22.564	25.936
40 cm	26.50a	0.774	23.814	28.186

Dry matter yields

There was statistically significant difference in biomass yield in between plant spacing of 20 cm and 40 cm between rows. This finding contradicts reports from study conducted under irrigation condition (Asmare et al., 2017). Armara *et.al.,* 2017 reported that as vegetative growth and number plant population increases there is an associated increase in increase with grain yield. The increase in grain yield and above ground biomass yield with

40 x 20 cm row spacing was mainly due to significantly higher performance of all the growth and yield components compared 40 x 10 cm (Table 3).Thee results of DM yield in line with Angne et al. (1993) and Yadav (2003) in cowpea. Previous studies conducted for herbage and seed yield on different cowpea geno types(Ayana *et al*.,2013) and Agza et al.,2012) idnciated that herbage dry matter yield of different cowpea genotypes ranges between 2.33 and 7.67 t ha-1. Ibrahim et al. (2006) obtained herbage dry matter yield of over 4 t ha-1. The average herbage dry matter yield obtained in our study in the experimental period (Ayana et al., 2013; Ibrahim et al., 2006) but quite lower than Rao and Shahid (2011) who found an average dry matter herbage yield of 18.1 t ha-1 for different cowpea genotypes.

Table 3. Effect of between plant spacing on herbage dry matter (DM) yield

Between plant spacing (cm)	**Mean (DM) (t/ha)**	**Std. Error**	**95% Confidence Interval**	
			Lower Bound	**Upper Bound**
10	4.28b	.06	4.1	4.5
20	4.75a	.06	4.5	4.9
30	4.45a	.06	4.2	4.6
40	4.15b	.06	3.9	4.35

Grain yield

There was significant difference in grain yield at ($p \leq 0.05$) in 30 cm between plant spacing and 40 cm b/n row spacing than at 10 and 20 cm. The increase in grain yield with 40 x 30 cm row spacing was mainly due to significantly higher performance of all yield and yield components compared to 40 x 20 cm and 40 X 10 cm (table 4). These results agree with Armara et.al*.,* 2017, Angne et al., (1993), Yadav (2003) in which grain yield of cowpea is similar with the current findings. Cowpea grain yield ranged between 3.71 quintal to 11.4 quintal ha-1 in the majority parts of the country (Ayana et al., 2013). The current results are in this range (7.05 quintal to 8.12 quintal ha-1) reported for potential cowpea growing areas of country. Lower results, 2-4 quintal/ha, have been reported in Uganda (Omongo et al., 1997), and 2 quintal to 3 quintal ha-1 in Nigeria (Alghali, 1992). Agza et al. (2012) and Goenaga et al. (2011) found that grain yield of different cowpea genotypes ranged between 17.2 t h-1 to 34.7 t ha-1 , which is higher than the current findings. This though there could be due to the variation in genotype, environment, and genotypes by environmental interactions.Table

Table 4. Effect of between plant space on seed yield t/ha

Between plant space	**Mean**	**Std. Error**	**95% Confidence Interval**	
			Lower Bound	**Upper Bound**
10 cm	.705b	.021	.660	.750
20 cm	.758b	.021	.712	.783
30 cm	.812a	.021	.793	.858
40 cm	.805a	.021	.772	.833

Conclusion

There was significant difference in grain yield at ($p \leq 0.05$) in 30 cm between plant spacing than at 10 and 20 cm between plant spacing. On the other hand relatively better DM yield was obtained in 20 cm between plants spacing than others between plant spaces. High biomass yield of crop residues was obtained minimum space between plant than higher between plant spaces. The trend indicated in wider spacing, higher pod per plant was obtained than lower spacing and which positively correlated with seed yield. So, it could be concluded that with increased seed yield it is better to sow at 30 cm between plant spaces. On the other hand relatively better biomass yield was obtained in 20 cm spacing between plants.

It can be recommended that those beneficiaries that need for herbage production; use 40 cm between row spacing and 20 cm between plants spacing while those who need forage seed as business source could use 40 cm between row spacing and 30 cm between plant spacing**.** Further study might be required to evaluate adaptation and spacing of more cowpea genotypes under irrigation condition.

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