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Research Article

Determination of Inter-Row Spacing on Pod Yield and Yield Components of Snap Bean (*Phaseolus vulgaris L.*) at Teda, Central Gondar, Ethiopia

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ABSTRACT

Snap bean is one of the important legume vegetable crops. Snap bean production in Ethiopia has both challenge and opportunity. Among them, higher response opportunities, the appropriate row spacing, suitable production area, export potential, and finally its nutritional value can be stated. However, there are limited researches regarding the response of snap bean to different row spacing. Currently Ethiopia is establishing the use of appropriate row spacing in different part of the country to manage the loose of pods. But, site and crop specific optimum row spacing is not done yet. eight treatments (row spacing) was evaluated during 2017 offseason by irrigation at Teda experimental site of University of Gondar, northwest part of Ethiopia. The objective of this study was evaluating the' response of melka verities for different levels of row spacing in the study area. The trail was laid out in the randomized complete block design with three replications. Analysis of variance (ANOVA) show significant variation among spacing for all the parameters studying such as number of pods/plant, pod length, pod diameters, plant height, pod yield and biomass, use LSD method of mean separation at 5% probability level. From the current study, one of the eight spacing 35x10cm identified and recommended.

Keywords: Snap bean; Pod yield; Row spacing

INTRODUCTION

Snap bean (*Pharsalus vulgaris L.*) which belongs to legumes (fabacea) family comprises a bunch of common bean that has been selected for succulent pods with reduced fiber which primarily grown for its young, edible fleshly pods. The immature pods and seeds were produced and marketed as fresh, canned or frozen products (Lemma, 2006). As a harvest, green bean is produced worldwide for export and canning industries. green bean could be a crop of world importance, and it's grown in China, India, Indonesia, Turkey, Italy, Thailand, Egypt, Spain, USA, Canada, Mexico and Ethiopia (Lemma et al., 2006) [1].

In Ethiopia, different plant types (bush/pole) of diverse pod characters (bobby/fine bean) of this crop are produced for export purposes. within the last five years its production has been steadily increasing thanks to the involvement of state horticultural enterprises, the local and foreign private investors and farmers and thus occupies the very best share (94%) of export potential among all vegetables (Lemma, 2003) [2].

The crop is widely cultivated thanks to its goo both green pods and dry seeds, considered as an honest source of protein.

The total annual production of green beans within the world reaches 6,814,403 tons from the realm of 960,272 ha (FAO, 2009). About 50% and 30% of world production comes from Asia and Europe. Of this, China and Turkey produce 17% and 13% of the globe production, respectively.

Green bean is that the immature green pod of the P. vulgares primarily grown for export. Kenya, Tanzania, Uganda and more recently Rwanda are the foremost producing and exporting

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countries of vegetable commodity. Kenya exported about 44 thousand metric plenty of snap beans in 2012 valued at about KES 1.7 billion.

More than 90% of snap bean produced in east Africa is exported to within Africa and to other international markets (CIAT, 2006). Snap bean pods are the largest vegetable exported from Africa to Europe. Snap bean production in Ethiopia both for export and for local consumption was started very recently even if local people had traditionally consumed common bean seeds at the green pod stage. (Mehmet, OZ., 2008) [3].

In Ethiopia, there is no exact information on when green bean was first introduced; however, the crop is under cultivation in several major growing areas of the country. Currently, the overall area coverage of green bean in Ethiopia is quite 15,379 ha with a mean total production of 6,803 tones (FAO, 2009) [4].

It's been among the foremost important and highly prioritized crops as a way of foreign currency earning in Ethiopia (Gezahegn and Dawit, 2006). Nowadays, it's becoming a high value commodity, which has the potential for improving the incomes and livelihoods of thousands of smallholder farmers in Ethiopia. it's also contributing lots for diversifying and increasing of Ethiopia's export. Agricultural

The nitrogen fertilizer requirement of green bean plant is high, thanks to it's weak within the fixation of atmospheric nitrogen (sign et al.,2003) mentioned that a coffee content of nitrogen within the soil (45 kg -1ha) affected rate and caused chlorosis in bean leaves the recommended amount is 90 kg per hectare. Green bean with quality features demanded by target markets is significant to increasing consumption and export value (Ndegwa et al., 2008; Kimani et al., 2009) [5].

Major production constraints in Ethiopia includes given the minimum genotype screening undertaken across different climatic zones, the genotype entries had not been consistent, diseases and pests were higher with rain-fed varietal screening than with those under irrigated conditions, when no crop protection measures were taken and high post-harvest losses (Lemma, 2003). Site-specific factors, like cultural practices and sowing date influence yield and yield related characteristics of green bean. Selection of the foremost suitable variety, determining suitable sowing date and applying appropriate cultural practices are important for increasing quality and yield of green bean. Among various factors, optimum sowing date and best variety are of primary importance to get potential yield (Amanullah et al., 2002) [6].

Various variety trials and agronomic experiments of the country used planting density of 50 cm x 25 cm and 40 cm x 20 cm for rain-fed and irrigated conditions, respectively. Later, a regular spacing of 40 cm x 10 cm has been adopted; no matter rain-fed or irrigated conditions (Godfery et al., 1985), which wasn't clear how this standard planting was firm without having planting density study including number of plants per hill. Research works to improve the yield potential of snap bean research programmers have not received desired attention. Spacing at 40 cm x 7 cm with variety of Melak-5 recommended for optimum yield of green bean production at Jimma conditions but not in Central Gondar environmental condition.

Gondar Agricultural Research Center (GARC) tries to conduct variety adaptation and NP fertilizer rate determination experiment. But, no researches were done on the response of snap bean to row spacing for both rain feed as well as under irrigation system for this environmental condition. Since optimum plant density of a crop at one location may not apply at other locations because of variation in soil type, rainfall, nutrient availability, and other environmental conditions, there is a need to develop site-specific recommendations (Singh, 1982). There is dearth information on the response of snap bean to row spacing with respect to pod yield. Therefore, this study was conducted to find out the influence of row spacing on production of snap bean in Vertis soil under irrigation condition. There for the objective is to increase pod yield of snap bean using optimum spacing.

MATERIAL AND METHOD

Description of the experimental site

The experiment was conducted at Experimental site of College of Agricultural & Rural Transformation during 2017 irrigation season. The area is located near to the main road to

Bahirdar and under the administration of university of Gondar in agricultural campus.

It has an altitude of 2380 m.a.s.l and longitude of 37.479682 E, 12.4776 N. Mean annual rainfall of the area is 992.5mm and the average maximum, and minimum Temperatures are 28.5 C and 13.5 C respectively. The soil were black Vertis soil and characterized with pH of 5.5 (Melaku et al.,2008) [7].

Experimental Material

The experiment had seven row spacing of, seven level inter-row and intra-row spacing (20 x 10 cm, 25 x 10 cm, 30 x 10 cm,35 x 10 cm ,45 x 10 ,50 x 10 and 55 x 10) with the recommended row spacing (40 × 10 cm) used as standard cheek.

Experimental Design

Each treatment were arranged in Randomized Complete Block Design (RCBD) with three replications. The seeds of the improved variety "melka" were sown on a plot having 2m length and 1m width, with each treatment row spacing and 10cm between plants and 0.5m x 1m between plot & between block respectively. the seed was drilled in each treatment of row spacing and thinned to 10 cm spacing between plants 15 days after sowing. Blended fertilizer was applied at planting time and the remaining fertilizer was applied at vegetative and flowering stage of the crop at equal amount. The split application of fertilizer in three growth stage (1/3 at planting, 1/3 at vegetative, and 1/3 at flowering stage) were used, All agronomic management were applied equally for each plot.

Data Collection and Measurements

Phonological data

Days to 50% flowering: This parameter of the plant was determined by counting the number of days from sowing to the time when 50% of the plants started to emerge the tip of panicles through visual observation.

Days to maturity: Days to maturity was determined as the number of days from sowing to the time when the plants reached maturity based on visual observation. There is indicated by physiological maturity of fresh edible pods from the plant before seeds matured and fibers.

Growth, yield and yield component

Plant height: Plant height was measured at physiological maturity from the ground level to the tip of plant from five randomly selected plants in each plot.

Pod diameter: It is the diameter of the pod from central part of the pod and which was determined from an average of five pods from randomly selected five plants per plot

Pod yield: Fresh pod yield was measured by harvesting the picking the fresh marketable pod from the net middle plot area of each spacing to avoid border effects.

Data analysis

The analysis of variance (ANOVA) was done to evaluate the performance of agronomic and yield related parameters among different spacing following the standard procedure given by Gomez and Gomez using SAS, institute 2009 soft ware. Mean separation was done using LSD at 5% probability level if there is statically significant difference among the levels of spacing.

RESULTS AND DISCUSSION

Table 1: ANOVA Table.

Spacing	Plant height (cm)	Number of branch /plot	Flowering date	Pod/ plant	Pod dimeter (mm)	Seed/ Pod	Pod Yield kg/ha
20 x 10 cm	40.33^{ab}	3.1^{a}	42.33^{a}	14.4^{a}	7.36^{a}	2.1^{b}	1407^{c}
25 x 10 cm	32.66^{b}	3.1^{a}	41.33^{a}	14.2^{a}	7^{a}	2.7^{b}	3426^{bc}
30 x 10 cm	35^{ab}	3.1^{a}	42.33^{a}	15.0^{a}	7.13^{a}	5.06^{a}	6963^{a}
35 x 10 cm	44.66^{a}	3.2^{a}	42.00^{a}	14.2^{a}	7.4^{a}	5.2^{a}	8111^{a}
40 x 10 cm	38^{ab}	2.8^{ab}	41.66^{a}	12.2^{a}	8.13^{a}	5.06^{a}	4218^{b}
45 x 10 cm	36.66^{ab}	2.5^{ab}	41.33^{a}	12.13^{a}	7.93^{a}	4.4^{b}	4556^{b}
50 x 10 cm	33^{b}	2.46^{b}	42.66^{a}	11.86^{a}	7.13^{a}	3.56^{a}	3630^{b}
55 x 10 cm	36.66^{ab}	2.06^{ab}	41.66^{a}	13.8^{a}	8.1^{a}	4.53^{a}	3067^{bc}
CV %	17.34	17.54	2.71	16.06	12.86	26.13	28.61
LSD	11.27	0.85	1.99	3.75	1.69	2.08	2215.9
Mean	37.125	2.79	41.91	13.36	7.52	4.54	4422.1

N.B. = Means with the same letter are not statically significant, LSD = least significant difference, **CV** = coefficient of variation

Plant height

Highly significant variation ($P<0.05$) was observed among the studied spacing rates for plant height. This increase in plant height could be justified on the bases of increase in the number of plants per unit area coupled with high plant to plant competition. Due to this lower amount of light intercepted by a single plant resulting into increased inter node length and also under higher plant density there might be comparatively low solar interception through crop canopy and under increased inter and intra row spacing probably the reduced interplant competition for light might have resulted in such variation in plant height. Beruktawit (2012). This result was in line to Taj et al. (2002) who worked on mung bean. Similarly, Shamsi and Kobraee (2009) worked on spacing experiment on soybean, observed that increasing the density of plants led to significant increases in plant height. The longer plant height was recorded (44.66 cm) for spacing of (35 x 10 cm) which was statically similar with other six treatments except at 50 x 10 cm, whiles the shortest plant height (33 cm) at level (50 x 10 cm) it is statically similar with other treatments except 35 x 10 (Table 1). The result showed that snap bean crop respond well to spacing.

Number of branch per plant: Number of fruiting branches is one of the yield contributing parameters directly related to yield. There was a highly significant variation ($P<0.05$) among the studied spacing level for number of branches per plant. The more number of branches was observed by the use of 35 x 10 cm (3.2) spacing and the lowest by the 50 x 10 [8-10].

This result was in line with the finding of Mehmet (2008) who obtained increased number of branches at the wider plant spacing for soybean and attributed this to more interception of sunlight for photosynthesis, which may have resulted in production of more assimilate for partitioning towards the development of more branches. In agreement to this study, Loss et al. (1998) obtained that number of branches per plant declined with increasing plant density and less number of branches survived through to maturity in faba bean.

Days to 50% flowering: Days to 50 % flowering is one of the pod qualities determining parameter. There was no significant differences ($P<0.05$) among the studied spacing level on early flowering. But there was statically influenced by the application of different levels of spacing (25 x 10 and 45 x 10) on early flower formation and late flowering observed in 50 x 10 cm spacing [11].

In agreement with this result, Kueneman and Wallance (2008) reported that days to flowering were not significantly affected by increasing or decreasing plant density of dry beans.

Number of pod per plant: Snap bean as a vegetable crop grown for its fresh pod production, which is the economical yield of snap bean. The current study result indicated that number of pod per plant was no significant deferent (P< 0.005) but there was difference between different levels of spacing on pod number. The highest pod number was observed by level of 20 x 10 cm (15) and the lowest by the 55 x 10 cm (11.867) Table (5). In agreement to the result of this study In addition to this, Lopaze et al. (2005) reported that the common bean crop displays considerable plasticity in response to variations in plant density, mainly with regard to number of pods per plant. In wide rows an increase in the number of pods per plant was noted but when it greater then 35 x 10 it reduce due weed competition (Gahdiril and Bayat 2004, Esubalew et,al 2014) [12].

Pod diameter: Pod diameter is the circumference of the pod measured before fiber formation. The result indicated that there was no significant variation (P<0.05) but there was statically influenced by different spacing level. The highest pod measured from 40 x 10cm (8.13) and the lowest recorded from 25 x 10cm (7.0). The result is in line with Solomon et,al (2012) and Gezachew et,al2014). Who stated that pod diameter was not influenced by spacing instead it affected by verities [13].

Pod yield kg/ha: The analysis of variance showed that pod yield of snap bean was very highly significantly (P < 0.05) influenced by the applied spacing. Snap bean yield generally increased with the reducing in the rate of spacing and higher response by the use of 35 x 10 cm [14,15].

Seed per Pod : Number of seed per pod is one of the yield attributes of snap bean that contribute to total yield. Crops with higher seed could have higher nutritional value.seed per pod was highly significantly (P< 0.005) influenced by the application of different levels of spacing. The highest seed per pod get from 35 x 10 cm(5.2) and lowest seed per pod get from 20 x 10 (2.1).

Figure 1: Cultivation of Snap Bean (*Phaseolus vulgaris L.*).

CONCLUSION

From this study we conclude that snap bean production has its own prospect and constraint among those prospect ,availability of huge production area ,its preference by farmers response to bio fertilizer ,response to manure nutritional benefit ,response to N Fertilizer exportability good response to row spacing. However there are constraints that reduce its production of snap bean drought, pest, and disease lack of high yielding Varity gender in equality marketing problems in appropriate agronomic practice, and untimed rain fall The world demand for common bean is highly increasing because of its significance to human nutrition as a source of proteins, complex carbohydrates, vitamins, and minerals. Its importance in reducing blood cholesterol level and combating chronic heart diseases, cancers and diabetics is also gaining recognition from human health point of view.

Using the optimum plant spacing is very important factors to increase the productivity and marketability of snap bean. Resource utilization such as light, nutrients and water, the rate and extent of vegetative growth and development of crops particularly that of, plant height, pod yield number of branch , yield , yield components and development of important diseases and pests.

RECOMMENDATION

Effect of plant spacing on yield and quality was also shown from the above sentences that plant spacing had significant effect on number of pods per plant, plant height, branch number, and pod yield per hectare. Could be concluded that snap beans should be sown in 35 x 10 cm spacing to avoid competitions, disease incidence and to increase growth of pod. The experiment was conducted by using eight inter-row spacing, where as the result indicated that, with the application of spacing 35 x 10 cm pod yield to get the maximum yield level. So use 35 x 10 cm to increase the production of this crop.

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