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Influence of Inter and intra-Row Spacing on Hot Pepper (Capsicum Annum L.) Growth,Yield and Yield Component of Under Rain Fed at Guraferda and Gimbo, Southwest Ethiopia

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Abstract

Inappropriate plant population density and other limitation factors are among the key reasons for the low hot pepper yield in Ethiopia, including South West Ethiopia. To increase the productivity of hot pepper use of appropriate population spacing is vital. Hence, a field experiment was conducted at Guraferda and Gimbo during the main rainy season to evaluate the response of hot pepper for growth and yield and yield components. A factorial arrangement of three inter-row spacings (50, 60, and 70 cm) and three intra-row spacings (30, 40, and 50 cm) was used in a randomized complete block design (RCBD) with three replications. Growth, yield, and yield component data were all recorded and statistically analyzed. The results indicated that, Number of pod per plant was significantly affected by both factors at Gimbo and Guraferda locations. Combined mean value also revealed that variation in interaction effect on number of pod per plant, marketable yield, Unmarketable yield, total dry pod yield. The highest marketable pod yield (1354.56 kg/ha and 1269kg/ha) was harvested from 60 cm inter-row spacing with 30 cm intra-row spacing (55,555 plants/ha) and 50 cm inter-row with 40 cm intra-row spacing (50,000plants/ha) respectively. Likewise the marketable pod yield, maximum total dried pod yield (1461.72 kg/ha and 1461.97kg/ha) was also obtained in 60cm inter-row and 30 cm intra-row spacing and 50 cm inter and 40 cm intra-row spacing respectively. As compared to national recommendation (70cm x 30cm), at 60cm x 30cm and 50cm x 40 cm there were 399.32kg/ha and 350.57kg/ha total dry pod yield increment. As a result of the high marketable pod yield and total dry pod yield, hot pepper producers in the research locations can benefit more from using 60cm inter-row spacing with 30cm intra row spacing and 50cm inter-row with 40cm intra-row spacing.

Keywords: Inter, intra, marketable, spacing, unmarketable

INTRODUCTION

Hot pepper [*Capsicum annuum* (L.)] belongs to Solanaceae family and is one of the major cash crops in several areas of south western Ethiopia. Though it has good economic importance, however, growers are not able to produce good quality hot pepper with high productivity. The low productivity was attributed to several biotic and abiotic constraints, which included -sub-optimal application of fertilizer, agronomic recommendations, and lack of suitable varieties. Among agronomic factors spacing has a significant effect on competition and light intensity thus may affect the flower initiation, fruiting, yield, and quality of the crops. Spacing requirements depends on the types of variety and fertility status of the soil. Hence agroecology in study areas is

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different from the areas in which spacing recommendation was made. Although it is an important crop in Guraferda and Gojeb areas, improper or inadequate crop management practices resulted in poor crop yields. Therefore, this study was conducted to determine the optimum inter-row and intra-row spacing to growth and yield of hot pepper in Guraferda and Gojeb areas.

MATERIALS AND METHODS

The experiment was conducted on a farmer's field at Gojeb and the experimental site of BARC at Guraferda during the main rainy season from October 2020 to February 2020. Guraferda is located 590 km from Addis Ababa and situated at 06° 50' 368" N latitude and 035° 17' 16" E longitude with an altitude of 1138 m.a.s.l. The annual average temperatures range from 25 to 39°C. The area receives the most rainfall from June to September, with an annual average of 1200 to 1332 mm. The soil type of Guraferda is Acrisol with sandy clay loam texture (Asfaha *et al.,* 2015 and Mebratu *et al.,* 2015).

The treatments were factorial combinations of three inter-row spacings (50, 60, and 70 cm) and three intra-row spacings (30, 40, and 30 cm). The treatments were implemented in a randomized complete block design (RCBD) with three replications. The gross plot size for each treatment was 3 m x 4.8 m. The distance between plots and replications was 1 m and 1.5 m, respectively.

Seedlings were grown in nursery beds after being sowed in rows spaced 15 cm apart and lightly coated with fine soil. Agronomic management procedures such as watering, weeding, mulching, and shade were used to create healthy seedlings. Seven weeks following emergence, the seedlings were carefully placed into the experimental plots. During the growth season, all plots adhered to recommended agronomic techniques such as weeding, cultivation, irrigation, fertilizer application, and disease management.

Data Collected

Data were collected from the center five plants in central rows, excluding the border rows, and the other response variables were calculated using the average of those five selected sample plants per plot.

Growth Parameters

Plant Height (cm)

The plant's height was measured from the soil's surface to its maximum growth points above ground.

The length was measured from five plants in each plot's center rows at the last harvesting period.

Number of Branches Per Stem

The Numbers of primary and secondary branches per stem of randomly selected five middle row plants at final harvest was counted.

Yield and Yield-Related Parameters

Marketable Yield (kg/ha)

The marketable yield was determined at each harvesting by sorting dried fruits based on their color, shape, shininess, hardness, and size. After drying, the dried marketable fruits were segregated, and the weights of each category were recorded and converted to kilograms per hectare.

Unmarketable Yield (kg/ha)

This is the yield that was achieved by separating the diseased, discolored, shrunken shape, and small sized at each harvest and converted to kg/ha.

Total Dry Fruit Yield (kg/ha)

The weight of all (marketable and unmarketable) fruits taken from the sample plants at each successive harvesting was recorded and added together to estimate yield per hectare.

Data Analysis

The data were subjected to analysis of variance (ANOVA) utilizing statistical analysis software (SAS version 9.3) and with a general linear model procedure. All significant treatment mean differences were separated using the Least Significant Difference (LSD) test at a probability level of 5%.

RESULTS AND DISCUSSION\

Growth Parameters

Plant Height

Based on the results obtained from analysis of variance, plant height was significantly by inter and intra-row spacing at Guraferda location. At Gimbo location plant height was significantly affected by intra-row spacing but it was not significant to inter-row spacing (Table 1.)

The maximum plant height (57.98cm and 56.12cm) was obtained from 60 cm and 50 cm inter-row spaced plants respectively (Table 2). At both locations significantly the highest plant height was recorded from 30 cm intra-row spaced plants while the lowest from 50 cm spaced plants. The higher plant height at closer inter-row spacing may be due to stronger competition between plants for sun radiation. This result is in purity with finding of Abuzar et al. (2011) and Islam et al. (2011)

Number of Branches Per Plant

The number of branches per plant in this study was significantly affected by both intra- and inter-row spacing. However, the interaction of intra-row spacing and inter-row spacing had no significant effect on the number of branches per plant (Table1).

Table1. Mean squares from ANOVA for growth parameters of hot pepper.

		Gimbo		Gojeb	
Source of variation	DF	PH	NBPP	PH	NBPP
Rep	2	50.47^{ns}	0.3^{ns}	2.89^{ns}	1.86^{ns}
Inter-row	2	5.23^{ns}	2.04*	23.38*	18.89***
Intra-row	2	121.42*	14.16**	16.02*	24.4***
Inter X Intra	4	8.17^{ns}	0.8^{ns}	33.93^{ns}	5.43^{ns}
Error	16	19.39	0.44	3.12	0.16
CV (%)		6.4	9.2	3.17	4.44

, ** and *, significant at P<5%, P<1% and P<0.1% respectively and ns= non-significant DF= degree of freedom, CV(%)=coefficient of variation in percent, PH= plant height, NB= number of branch per plant*

Table 2. Effect of inter-row and intra- row spacing on growth parameters of hot pepper at Gimbo and Guraferda, South West Ethiopia.

	Gojeb		Guraferda	
Treatment	PH	NBPP	PH	NBPP
Inter-row				
50	69.6	6.64^{b}	56.12^{a}	16.04^{b}
60	68.3	7.42^{a}	57.98^{a}	18.2^{a}
70	69.5	7.51^{a}	54.84^{b}	18.8^{a}
LSD (0.05)	NS	0.72	1.85	0.85
Intra-row				
30	73.35^{a}	6.87^{b}	56.46^{a}	16.26^{c}
40	66.51^{b}	6.13^{c}	56.03^{a}	17.28^{b}
50	67.62^{b}	8.58^{a}	54.15^{b}	19.48^{a}
LSD(0.05)	4.78	0.72	1.83	1.02

LSD(5%)= Least significant difference, CV(%)= coefficient of variation ,NS= non-significant, PH= plant height, NB= number of branch per plant

The plants with inter-row spacing of 70 cm produced the greatest number of branches, whereas plants spaced 50 cm apart produced less branches. Significantly, the list was derived from 30 cm intra-raw spacing, whereas the largest number of branches was achieved from 50 cm intra-raw plant spacing (Table 2).

Similar findings were noted by Islam et al. (2011), who found that plants with the widest spacing had the highest average number of branches per plant. A consistent maturity is achieved by delaying flowering by the formation of several lateral branches, which is encouraged by the broad spacing (Van Gastel et al., 1996). More branches were consistently produced with the widest spacing, on average.

The lower number of branch per plant at narrow intra-raw spacing might be due to intensive competition for solar radiation, thus allocation of growth resources for vegetative growth than branches.

Yield and Yield Related Parameters

Inter-row and intra-row spacing and the interaction effect of the two factors significantly influenced all yield parameters considered in this study: number of pods per plant, marketable yield, unmarketable yield and total dry pod yield (Table 3).

Number of pods per plant

The results of the analysis of variance showed that the interaction between intra- and inter-row spacing had a substantial impact on the number of pods per plant.

Table 3. Mean squares from ANOVA for yield parameters of hot pepper.

Source of variation	DF	NPP	MY (kg/ha)	UMY (kg/ha)	TY
Rep	2	81.98*	122^{ns}	239.52^{ns}	12464.87^{ns}
Inter-row	2	9.56*	20195.4*	4062.99*	44925.93**
Intra-row	2	100.58*	19910.92**	4269.25*	34905.89*
Inter X intra	4	21.12**	17311.52*	3876.97*	34265.61**
Error	16	24.94	5882.13	975.54	6617.56
CV (%)		18.8	13.56	17.84	10.64

, and ***, significant at P<5%, P<1% and P<0.1% respectively and ns= non-significant DF= degree of freedom , CV(%)=coefficient of variation in percent, NPP= number of pod per plant, MY= marketable yield, UMY= Unmarketable yield, TY= total dry pod yield*

Table 4. Effect of inter-row and intra- row spacing on yield parameters of hot pepper at Gimbo and Guraferda, South West Ethiopia

Inter-row	Intra-row	NPP	MY (kg/ha)	UMY (kg/ha)	TY
50	30	22.5^{c}	1098.28^{abc}	117.65abc	1215.93^{bc}
	40	23.6^{bc}	1269^{a}	143.97a	1412.97^{a}
	50	29.5^{a}	1182.84^{ab}	90.82cd	1273.66b
60	30	28.9^{ab}	1354.56^{a}	107.16bc	1461.72^{a}
	40	26.8^{abc}	1197.92^{ab}	124.71abc	1322.63^{ab}
	50	26.9^{abc}	1165.44^{ab}	109.51abc	1274.95^{b}
70	30	26.7^{abc}	982.52^{b}	129.88ab	1062.4^{c}
	40	25.9^{abc}	837.96^{bc}	71.48d	909.44^{cd}
	50	31^{a}	714.24^{c}	68.07d	782.31^{d}
Lsd		5.8	97.48	34.69	140.61

NPP= number of pod per plant, MY= marketable yield, UMY= Unmarketable yield, TY= total dry pod yield

The highest average number of pods per plant (31 and 29.55) was recorded when 70cm inter-row interacted with 50 cm intra-row spacing and 50cm inter-row spacing interacted with 50cm intra-row. It is statistically at par with combination of inter-row of 60cm with intra-row of 30 cm, 40cm and 50cm and inter-row spacing of 70cm with 30cm and 40cm intra-row spacing. The lower number of pods per plant at narrow spaced plants might be due to intensive competition for growth requirements. This result was also in conformity with the works of Awoke and Yimegnushal (2021)

Marketable and Unmarketable Pod Yield

The interaction between inter-row spacing and intra-row spacing was significant to marketable and unmarketable yield as shown in Table 3.

The higher marketable yield (1269 and 1354.56 kg/ha) was obtained from interaction of inter-row spacing of 50cm by 40cm intra-row spacing and 60 cm by 40 cm spaced plants respectively. Statistically similar results (51182.84kg/ha, 1197.92kg/ha and 1165.44kg/ha) were recorded from 50cm by 50 cm, 60cm by 40cm and 60cm by respectively while the minimum marketable yield (89.9 kg/ha) was recorded from interaction of 70 cm inter-row spacing with 50cm intra-row spacing. On the other hand the maximum (143.97) unmarketable yield was found from 50cm inter-row spacing by 40cm intra-row spacing was statistically similar with inter-row spacing of 70cm by intra-row spacing of 30cm whereas the list (71.48kg/ha and 68.07kg/ha) was harvested from 70cm inter-row spacing interacted with 40cm and 50 cm intra-row spacing respectively.

Total Dry Pod Yield (kg/ha)

According to the analysis of variance, inter-row spacing, intra-row spacing, and the interaction of inter-row and intra-row spacing all had a significant impact on total dry pod yield.

The maximum dry pod yield (1461.72 and 1412.97kg/ha) obtained from interaction of 60 cm inter-row spacing with 30cm intra-row spaced plants and 50cm inter-row spacing interacted with 40cm intra-row spacing respectively was statistically similar with dry pod yield obtained from inter-row spacing of 60cm by 40cm intra-row spacing. While the minimum (782.31kg/ha) dry pod yield was recorded from interaction of 70cm inter-row spacing with 50cm intra-row spacing. Similar result was reported by Awoke and Yimegnushal (2021) who reported that the maximum dry pod yield obtained inter-row spacing of 60 cm and intra-row spacing of 30 cm.

SUMMARY AND CONCLUSION

In crop production, plant population, row arrangement, variety selection, soil fertility and crop management practices are major variables that can be manipulated by producer to influence the production of a given crop. Among agronomic practices, plant spacing deserves special attention. A factorial research experiment was carried out to evaluate the influence of three (30, 40 and 50) cm intra row spacing and three (50cm, 60cm and 70 cm) inter row spacing during 2021 at Gimbo woreda (Gojeb) and Guraferda during the main rainy season. The combined mean values revealed that inter-row spacing, intra-row spacing and interaction of the two factors significantly affects most of the growth and yield parameters considered in this experiment. The interaction effect of intra-row and inter-row spacing had a substantial impact on the number of pods per plant, marketable yield, unmarketable yield, and total dry pod yield.

The highest marketable pod yield (1354.56 kg/ha and 1269kg/ha) was harvested from 60 cm inter-row spacing with 30 cm intra-row spacing (55,555 plants/ha) and 50 cm inter-row with 40 cm intra-row spacing (50,000plants/ha) respectively. Like a marketable yield, maximum total dried pod yield (1461.72 kg/ha and 1461.97kg/ha) was also obtained in 60cm inter and 30 cm intra-row spacing and 50 cm inter and 40 cm intra-row spacing respectively. As compared to national recommendation (70cm x 30cm), at 60cm x 30cm and 50cm x 40 cm there were 399.32kg/ha and 350.57kg/ha total dry pod yield reduction. Therefore, for it's the maximum total dry pod yield and marketable pod yield, 60cm inter with 30cm intra and 50cm inter with 40cm intra-row spacing should be encouraged for the study area

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