
Effect of NPS Fertilizer and Intra-row Spacing Effect on Growth, Yield and Yield Components of Chickpea Varieties Under Midland Conditions of Bale, South-eastern Ethiopia

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Abstract: Variety and location specific plant density recommendation is one of the agronomic practices used to increase the production and productivity of chickpea. However, there is a blanket recommendation across locations and varieties of chickpea in Ethiopia. Hence, Effects of blended NPS fertilizer rates and intra-row spacing on some agronomic traits of chickpea varieties were evaluated with the objective to find out the optimum amount of NPS fertilizer and intra-row spacing for chickpea production under midland conditions of Bale. The experiment was conducted using split plot design using chickpea varieties (ACOS Dubie and Habru) as main plots and NPS fertilizer rate and intra-row spacing as sub-plots with three replications. The main effect of variety showed significant effect on the number of days to mature, number of days to flower, plant height, biological and seed yield and hundred seed weight whereas, main effect of intra-row spacing did not show significant difference on all studied agronomic parameters. Similarly, main effect of blended NPS fertilizer rates did not reveal significant difference for the studied parameters. Blended NPS fertilizer rates utilized in the study areas did not show differences in most of studied traits. From this, it can be preliminarily concluded that reasonable intra-row spacing of 10 cm for both varieties of chickpea could be used for the studied areas.

Keywords: Acos Dubie, Habru, Intra-row Spacing, NPS Fertilizer

1. Introduction

Chickpea (*Cicer arietinum*) is an ancient crop that belongs to the legume family. It is produced worldwide and it is the world's third most important food legume next to haricot bean and soybean [6]. Ethiopia is the leading chickpea producer in Africa with a share of 39% of the total production [4]. Chickpea was the third most widely cultivated legume crop in Ethiopia next to faba bean and haricot bean. Chickpea considered as a Multi-functional crop, since it has an important role in Ethiopian diets and serves as a protein source, generates cash and plays a major role in Ethiopia's foreign exchange earnings [4].

In Oromia regional state, Bale Zone of Ginnir and Goro districts chickpea is the leading pulse crop grown in large areas by the farmers' next to cereals and spice crops. The crop is

known for its soil nitrogen enrichment, rotational advantages and cheaper cost of production [1]. Despite the importance of the crop in farming systems, the average yield of the crop is generally low due to several factors, among which low genetic potential of farmers' varieties, biotic and abiotic factors, insufficient application of Phosphorus fertilizer. Moreover, most of the Ethiopian soils are low in nitrogen and phosphorus, which limit crop production and productivity [1]. Thus, application of inorganic phosphorus fertilizer is a crucial component to reduce yield loss caused by the nutrient. This is because, an adequate amount of Phosphorus nutrition enhances the physiological activities of legume crops, including stimulation of early root formation, growth, nodulation, photosynthesis and flowering [2]. In addition, the biological nitrogen fixation is a process that is dependent on the energy supplied from the sugars that need to be translocated

downward from the host plant shoots [3]. Phosphorus is therefore, the basis for the formation of useful energy, which is essential for sugar formation and translocation.

On the other hand, Plant density is an important factor that affects yield and yield components of legumes. If the plant population is too high, plants compete with each other for resources and low yield was realized. On the other hand, if the population is too low, more growing space was wasted and it lowers yield. In line with these facts Kakiuchi and Kobata (2004) found that lower plant density increased the pod number per plant whereas; the higher plant density decreased the parameter. Similarly, [5] also reported that plant density had shining influences on plant height, biological and seed yield (kg/ha) where the parameters increased by increasing plant densities. But, in the study areas, research work regarding integrated role of Phosphorus fertilizer and seed rates on growth, yield and yield components is very limited. Therefore, in view of this, this paper explores the effect of blended NPS fertilizer and Intra-row space on chickpea production under midland conditions of Bale.

2. Materials and Methods

The experiment was conducted at Ginir District of Bale Zone on-farmers field. The experiment was laid out in split plot with chickpea varieties (ACOS Dubie and Habru) as main plots and NPS fertilizer rate and intra-row spacing as sub-plots with three replications. The treatments consisted of five rates of NPS fertilizer (0, 25, 50, 75 and 100 kg ha⁻¹) and three intra-rows spacing (5, 10 and 15cm). Gross plot size was 3 m x 1.2m (3.6 m²). Spacing of 1 m and 1.5 m were allocated between plots and blocks, respectively. Before planting, ten soil samples (0-20 cm depth) were taken randomly in a W-shaped pattern from representative spots of the entire experimental field using an auger and composited to one representative samples for the purpose of soil characterization. The composite samples were air-dried at room temperature, thoroughly mixed and ground to pass through a 2 mm sieve and then, analyzed for: particle size

distribution, pH, organic carbon, cation exchange capacity, total nitrogen, and available P.

3. Result and Discussion

Soils Chemical Properties of Experimental Site

The laboratory analysis of soil samples from the top soil (0-30 cm) taken before planting was done for the major soil physical and chemical properties. The results of the analysis are summarized below in Table 1.

Table 1. Chemical and physical characteristics of the soil of experimental Site.

Properties	Result	Rating
Physical properties		-
Sand (%)	21	-
Silt (%)	27	-
Clay (%)	52	-
Textural Class	Clay	-
Chemical properties		
PH (1:2.5 H ₂ O)	6.82	Neutral
Organic Carbon/OC/ (%)	1.18	Low
CEC (cmolkg ⁻¹)	47.46	Very high
Total nitrogen/TN/ (%)	0.16	Medium
Available Phosphorus/P/(ppm)	10.23	Medium
Available sulfur/S/(ppm)	21.42	Very Low

Effects of NPS Fertilizer and Varieties on yield component and yield of Chickpea at Ginir.

Days to 50% flowering: The analysis of variance revealed that there is a significant differences main effect of Varieties on days to 50% flowering. Varieties Acos Dubie flowered more early (67. 8 days) as compared to variety Harbu (74. 02 days). This might be attributed to the fact that a day to flowering in chickpea is considered to be varietal characteristics, which is genetically controlled. Previous studies showed that, the differential response to flowering among varieties was distinct. For instance, [10] reported differences among varieties of chickpea in days to 50% flowering. Nevertheless, there was no significant difference among intra-row spacing and blended NPS fertilizer rates as well as all the interaction components on days to 50% flowering (Table 2).

Table 2. Days to 50% flowering, days to 90% physiological maturity, plant height and number of primary and secondary branches as affected by the main effects of variety, NPS fertilizer rate and intra-row spacing

Row Labels	Flowering Date	Maturity Date	Plant Height	Number of primarybranch	Number of secondarybranch
Varities					
Acos Dubie	67.87	125.51	57.93	2.91	10.42
Habru	74.02	128.07	62.24	3.00	11.58
LSD (0.05)	0.73*	0.62*	1.64*	NS	0.65*
Blended NPS Fertilizer Rate					
0 kg/ha NPS	70.56	127.00	60.28	2.94	10.28
25 kg/ha NPS	71.11	127.28	59.78	3.17	10.67
50 kg/ha NPS	71.33	126.44	59.00	2.83	11.22
75 kg/ha NPS	70.67	126.72	60.33	2.94	11.94
100 kg/ha NPS	71.06	126.50	61.06	2.89	10.89
LSD (0.05)	NS	NS	NS	NS	NS
Intra-row spacing					
5 cm	70.23	126.67	59.83	2.97	10.63
10 cm	71.10	126.43	60.73	2.90	11.13
15 cm	71.50	127.27	59.70	3.00	11.23
LSD (0.05)	NS	NS	NS	NS	NS
CV%	2.39	1.45	6.36	15.75	13.80

Days to 90% physiological maturity: Highly significant differences ($P < 0.01$) were recorded on the number of days to 90% physiological maturity by the main effects of variety. The number of days taken to reach 90% physiological maturity for varieties Acos Dubie and Habru were 125.51 and 128.07 days, respectively (Table 2). Acos Dubie matured significantly earlier than Habru. Similarly, [10] reported differences among varieties of chickpea in time to physiological maturity; However, there was no significant difference between intra-row and Blended NPS fertilizer. Besides, interaction effects of variety and blended fertilizer application rates did not significantly influence days to physiological maturity (Table 2).

Plant height: Analysis of variance showed significant differences ($P < 0.05$) due to the main effects of variety on plant height at 90% physiological maturity (Table 1). The highest plant height was recorded for Habru (62.24 cm) while the lowest height was recorded for Acos Dubie (57.93 cm). The variation in height might be due to genetic characteristics of the varieties for this trait. This result was in agreement with [7]. reported significant differences among the genotypes of chickpea in plant height. Plant height was not affected significantly by the main effects of blended NPS fertilizer rate and intra-row spacing. The non-significant effect of crop density on mean plant height observed in this study might be attributed to the fact that crop density has often, but not always been associated with increased plant height.

Number of primary and secondary branches per plant: Branching is basically a genetic character and plays an important role in enhancing seed yield. The main effects of variety had a significant influence on the number of secondary branches plant⁻¹. The significant differences among varieties could be due to the differences in growth habit since varieties Habru relatively have spreading or bushy growth habit while variety Acos Dubie has relatively semi erect type of growth habit. In agreement with this, significant variations in number of primary and secondary branches per plant among the different genotypes of chickpea was reported

by [8] While other main effect and interaction effect had not showed significant influence on number of primary and secondary branches per plant. Acos Dubie gave significantly lower number (10.42) of primary branches than Habru (11.58). Nevertheless, the intra row spacing main effect and interaction of fertilizer rate and varieties effects depicted a statistically non significant variation (Table 2).

Number of pods per plant: Number of pods plant⁻¹ is a key factor for determining the yield performance in leguminous plants. The productive capacity of chickpea is ultimately dependant on the number of fertile pods plant⁻¹. Analysis of variance showed that varieties highly significantly differed ($P < 0.01$) for number of pods plant⁻¹. The highest number of pods plant⁻¹ was recorded for Habru (42.98) while the lowest number of pods plant⁻¹ was recorded for Acos Dubie (37.12). The differences in number of pods plant⁻¹ might have been caused due to varietal differences. In line with this result, [10] reported significant differences among genotypes of chickpea for number of pods plant⁻¹. However, intra-row spacing, blended NPS fertilizer rate and the interaction effects of all factors (variety, blended NPS and intra-row spacing) were non-significant difference for number of pods per plant (Table 3).

Biological yield: The productivity of a crop is largely determined by the biological yield. Production of large amount of biomass is among the attributes of seed yield. Biological yield showed significant effect due to the main effects of variety (Table 2). However, Habru (4701.23 kg ha⁻¹) had the higher biological yield whereas Acos Dubie had the lower biological yield (4014.57 kg ha⁻¹). The decrease in biological yield of Acos Dubie due to low branching habit might have been compensated by the increase in other parameters such as plant height and stem thickness. This might be the reason for the non-significant difference in biological yield among the varieties. In line with this, [9] reported statistically non-significant differences of the biological yield among varieties of chickpea. Regarding main effect intra-row spacing and blended fertilizer rates and their interaction effect did not show a significant difference on biomass production.

Table 3. Number of pods per plant, number of seeds per pod, biological yield, thousand seed weight and seed yield as affected by the main effects of variety, NPS fertilizer rate and intra-row spacing

Row Labels	Number of pod per plant	Biomass Yield kg/ha	Grain Yield kg/ha	Thousand grain Weight (gm)
Varieties				
Acos Dubie	37.76	4014.57	2226.75	426.28
Habru	42.98	4701.23	2374.63	279.52
LSD (0.05)	3.38*	253.61*	124.65*	11.75*
Blended NPS fertilizer Rate				
0 kg/ha NPS	38.11	4086.42	2156.44	355.20
25 kg/ha NPS	41.06	4581.48	2501.12	346.33
50 kg/ha NPS	41.83	4149.38	2238.77	341.59
75 kg/ha NPS	40.17	4358.03	2365.17	359.92
100 kg/ha NPS	40.67	4314.20	2241.93	341.46
LSD (0.05)	NS	NS	NS	NS
Intra-row spacing				
5 cm	40.40	4240.37	2325.53	387.97
10 cm	41.83	4500.00	2401.94	331.61
15 cm	38.87	4133.33	2174.59	339.12
LSD (0.05)	NS	NS	NS	NS
CV%	19.54	13.55	12.61	7.56

Grain yield: Dry matter production and its transformation into economic yield is the ultimate outcome of various physiological, biochemical, phenological and morphological events occurring in the plant system. Seed yield of a variety is the result of interplay of its genetic makeup and environmental factors in which plant grow. Table 3 indicated significant differences among the varieties on the grain yield. The higher seed yield of 2374.63 kg ha⁻¹ was recorded for Habru while the lower seed yield was obtained for Acos Dubie (2226.75kg ha⁻¹). Despite that the intra-row spacing main effect did not show any statistical difference for grain yield. In addition, interaction effect of variety and blended fertilizer did not show significant effect on yield.

Thousand seed weight: Among the various parameters contributing towards final yield of a crop, thousand seed weight is of prime importance. Table 3 reveal that varieties had a highly significant difference ($P < 0.01$) on thousand seed weight. The higher thousand seed weight was recorded for Acos Dubie (426.28 g) while the lower thousand seed weight was recorded for Habru (279.52 g). In line with this, [10] reported significant differences among genotypes of chickpea on hundred seed weight. However, intra-row spacing and blended NPS and had statistically non-significant differences on thousand seed weights (Table 3).

4. Conclusion and Recommendation

The study on the growth and yield response of two chickpea varieties, namely Acos Dubie and Habru were statically significant. From the result Acos Dubie chickpea variety flowered and matured earlier than Habru chickpea variety, but in terms of yield parameters and yield Habru is better. Based on the present findings, blended fertilizer rates utilized in the study area did not show differences in most of studied traits. Reasonably intra-row spacing of 10cm for both chickpea varieties could be used for the studied area.

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