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Evaluation of Chickpea (*Cicer arietinum* L.) varieties at different rates of phosphorus fertilizer at Damot Gale, Southern Ethiopia

Research Article

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Abstract

Chickpea is one of the important pulse crops in Ethiopia where the country is being a secondary diversity for the crop which plays major role in the daily diet of the rural community and poor sectors of urban population. The experiment was conducted during 2019/20 cropping season at Damot Gale district in southern Ethiopia with objective evaluating the response of chickpea varieties to different rates of P fertilizer. Treatments consisted in four chickpea varieties (Teketay, Naatolii, Habru and Ejeri) and four rates of P fertilizer (0, 10, 20 and 30 kg/ha) were combined in factorial and laid out in a randomized complete block design (RCBD) with three replications. Phenological, growth, yield components and yield responded to varieties, P fertilizer rates and their interactions differently. Varieties exhibited differences in days to flowering with the longest days to flowering was observed for variety Ejeri and the shortest day to flowering for variety Teketay. Chickpea varieties showed differences in days to physiological maturity with the longest days to physiological maturity were achieved from variety Ejeri and the shortest days to physiological maturity for variety Naatolii. The longest days to flowering and physiological maturity were observed at P fertilizer rate of 30 kg/ha. Plant height increased with increasing P fertilizer rates where the tallest plant height was obtained P fertilizer rate of 30 kg/ha and the shortest plant height was achieved from unfertilized plots. The highest TSW was achieved from variety Habru at P fertilizer rate of 10 kg/ha and the lowest TSW was obtained for Teketay from unfertilized plots. Biomass and grain yield were highest for variety Naatolii at P fertilizer rate of 10 kg/ha and both parameters were lowest at P fertilizer rate of 0 kg/ha. Based on this finding it could be concluded that P fertilizer rate 10 kg/ha seems to optimum for all varieties tested in the location. Varieties Naatolii and Habru are preferably could be used for production because both varieties exhibited superiority over others.

Keywords: Chickpea; Phosphorus Fertilizer; Varieties; Yield.

Introduction

Chickpea is one of the important pulse crops that play a vital role in human diet. It is a source of carbohydrate ranges from 54 to 71% for Kabuli and 51 to 65% for Desi type; protein from 12.6 to 29% for Kabuli and from 16.7 to 30.6 % for Desi; lipid from 3.4 to 8.8% for Kabuli and from 2.9 to 7.4% for Desi; and energy from 357 to 447 kcal/100 g and from 334 to 437 kcal/100 g for Kabuli and Desi, respectively [2]. Chickpea is an excellent source of vitamins B6, C and zinc [2]. It is locally known as '*shimbra*' is one of the major pulse crops in Ethiopia and in terms of production it is the second most important legume crop after faba bean. It contains fibre, minerals such as calcium and phosphorus, vitamins and health-beneficial phytochemicals (low in sodium and fat and cholesterol free). Chickpea plays a significant role in maintaining soil fertility, can be grown as a second crop using residual moisture, used as animal feed, as fuel and source of cash [12]. It is also widely used as green manure. Most of the chickpea production is used for domestic consumption.

Phosphorus (P) is the most important element for proper grain production and its adequate supply at early life of a plant is essential in the development of its reproductive parts [17, 19, 3]. Legumes including chickpea have high P requirement due to production of protein containing compounds which N and P are major constitutes, [26] where P concentration in legumes is generally much higher than that found in grasses. High seed production of legumes is primarily dependent on the amount of P absorbed [16, 9]. The presence of large quantities of P in seed and fruit is an indication of essentiality of P in seed formation. A proper supply of P is associated with increased root growth and early

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maturity of crops, particularly grain crops. Indeed, the quality of certain fruits, forages, vegetables and grain crops is improved and disease resistance increased when these crops have satisfactory P nutrition [7, 18]. On the other hand, inadequate P nutrition affects various metabolic processes such as retarded growth ,poor root system ,small thin erect darkish green colour appear on old leaves ,reddish colour stems ,falling of leaves prematurely and impaired fruit setting. Moreover, P is essential for the general health and vigorous all in plant some specific factor that have been associated to P are root development increasing stack and more stem strength ,improve flower formation and seed production more uniform and earlier crop maturity increase nitrogen fixing capacity of legumes ,improve in crop quality and resistant to plant disease. Therefore, further development of desirable genotypes with high yield potential is essential for the improvement of production and productivity of the crop. These depend upon the extent of genetic variability in the base population [23]. Moreover, the yield potential of the crop varies according to the management practices such selection of high yielding varieties and proper amount of fertilization including P fertilizer. Hence, this study was initiated with objective to evaluate the response of chickpea varieties to different rates of P fertilizer.

Materials and Methods

Description of Experimental Site

Field experiment was conducted during 2019/20 cropping season on farm at Taba on farmer's field of Damot Gale district in southern Ethiopia. An approximate geographical coordinates of the site is 06^{0}83' N latitude and 37^{0}73' E longitude having an altitude of 1907 meters above sea level. The mean maximum and minimum temperatures are 21 and 11.5^{o}C, respectively. The experimental area receives mean annual rainfall of 1200-1300 mm where high amount of rainfall occurs during "*belg*" from February to June cropping season whereas relatively low amount of rainfall received in "*meher*" from July to October. Indeed, the area is characterized with bimodal pattern of rainfall of erratic type. The soil texture of the study site was sandy loam with soil pH of 7.6 which is nearly neutral in reaction and thus within an ideal range for chickpea production [24]. The available P level was 18.2 % which was very low according to Olsen et al. (1954) [15] and Hazelton and Murphy (2007) [14].

Treatments and Experimental Design

Treatments consisted in four varieties of chickpea (Teketay, Naatolii, Habru and Ejeri) and four rates of P (0, 10, 20 and 30 kg/ha) were combined in factorial and laid out in a randomized complete block design (RCBD) with three replications. With respect to varieties chickpea Teketay and Naatolii were Dessi type with small seed size and golden sees colour whereas Habro and Ejeri were Kabuli types with large sized seeds and creamy seed colour. Each plot was 2 m wide and 2 m long with total gross plot area of 4m^2. Seeds were hand planted following the planting time of the respective location and on set of rainfall. Two seeds were planted per hill and thinned after emergence to maintain the proposed plant density per plot. Inter and intra rows spacing used were 30 and 10 cm, respectively. Triple super phosphate (TSP) was used as P source and the rated amount applied at planting to each plot. The recommended amount urea which was non-treatment part was applied at rate of 100 kg/ha uniformly to all plots in split where first at planting and the remaining half near flowering. All crop management practices such as cultivation, weeding etc., carried out as desired. Diseases and insect damage were visually monitored during the crop growing season. Spray was made to control boll worm and ascochyta blight (*Ascochyta rabiei*) disease using Curate and Mancozeb, respectively.

Data Collection and Measurements

Plant parameters recorded were days to flowering, physiological maturity, plant height, number of primary branches, number of secondary branches per plant, number of pods per plant, number of seeds per pod, thousand seed weight, biomass yield, grain yield, harvest index, agronomic efficiency and economic analysis. Days to flowering were recorded as the number of days from planting to 50% of the plants exhibit flowering. Days to maturity was recorded when 50% of plant in the plot lose green colour of pod. Plant height was measured for ten randomly selected plants per plot at physiological maturity from the ground level to tip of a plant. Number of primary branches was determined by counting basal primary branches emerged directly from the main shoot for 10 randomly selected plants per plot at physiological maturity. Number of secondary branches per plant: was determined by counting number of secondary branches emerged from primary branches for ten randomly selected plants per plot at physiological maturity. Number of pods per plant was counted for ten randomly selected plants per plot at physiological maturity. Number of seeds per pod was counted for 10 randomly selected plants per plot at physiological maturity. Thousand seed weight (TSW) was measured by counting 100 representative samples from each plot and weighed with sensitive balance and converted into thousand seed weight base. Biomass yield was determined as the sum of straw weighted and total grain yield. Grain yield was manually harvested from a plot net area and converted to kg ha^{-1} after adjusting the moisture content to 10%. Harvest index (HI) calculated as the ratio of grain yield to the total biomass yield and estimated as:

$$HI = \frac{Grain\ yield}{Biomass\ yield}$$

Data were subjected to analysis of variance (ANOVA) according to the Generalized Linear Model (GLM) procedure of SAS Version 9.1 [22] and interpretations were made following the procedure of Gomez and Gomez (1984) [6]. When there was detection of significance difference among treatments means separation was done using least significance difference (LSD) test at 5% probability level.

Results & Discussion

Days to flowering and physiological maturity

Analysis of variance showed the main effect of varieties resulted in significant differences on days to flowering and physiological maturity (Table 1). Days to flowering for chickpea varieties, averaged over P rates, varied from 45.42 to 51.92 whereas physiological maturity from 106.42 to 112.50. The longest days to flowering (51.92) was observed for variety Ejeri followed by variety Habru with mean days to flowering of 48.92. The shortest day to flowering (45.42) was seen for variety Teketay. The difference of 6.5 days was observed between the longest and shortest days to flowering. In line with this, the longest days to physiological maturity (112.50) was achieved from variety Ejeri followed by variety Habru with mean days to physiological maturity of 110.75. The shortest days to physiological maturity (106.42) was obtained from variety Naatolii (Table 1). The difference of 6.08 days was observed between the longest and shortest days to physiological maturity. As this result indicated that variety Ejeri was relatively late flowering whereas the remaining three varieties were relatively earlier in days to flowering without statistically non differences among them with respect to days to flowering. With respect to days to physiological maturity, that varieties Ejeri and Habru were relatively late maturing while varieties Teketay and Naatolii were relatively early maturing types. This might be attributed to the fact that day to flowering and physiological maturity in chickpea is considered to be varietal characteristics, which is genetically controlled. Tripathi *et al.* (1978) [25] reported that there were differences among varieties of chickpea in days to flowering. Similarly, P fertilizer rates had significant effect on days to flowering and physiological maturity (Table 1). Generally days to flowering and physiological maturity were prolonged with increasing P fertilizer rates from 0 to 30 kg/ha. The longest days to flowering (50.33) and physiological maturity (111.33) were obtained from P fertilizer rate of 30 kg/ha followed by P fertilizer rate of 20 kg/ha with mean days to flowering of 49.83 physiological maturity of 110.33. The shortest days to flowering (44.42) and physiological maturity (106.08) were achieved from non fertilized plots (Table 1). As this investigation clearly indicated that increasing P rates extended vegetative growth phase of chickpea plants that prolonged days to flowering and physiological maturity. Khan and Mazid (2015) [10] reported that increasing P fertilizer rates delayed days to flowering in chickpea varieties while non fertilization shortened days to flowering. However, varieties by P fertilizer rates interactions did not have significant effect on days to flowering and physiological maturity (Table 1).

Plant height and number of primary branches

Analysis of variance showed that chickpea varieties exhibited significant differences on plant heights and number of primary branches per plant (Table 1). The tallest plant height (55.58 cm) was observed for variety Ejeri followed by variety Naatolii with mean plant height of 54.17 cm. The shortest plant height (44.50 cm) was seen for variety Teketay. With respect to number of primary branches per plant, variety Naatolii produced the greatest (2.69) number of primary branches per plant followed by variety Habru with mean number branches per plant of 2.67. The least number of primary branches (2.08) was counted from variety Teketay. The variations of chickpea varieties with respect to plant height and number of primary branches per plant might have attributed to their genetic differences. Muehlbauer and Singh (2001) [13] and Shamsi et al. (2010) [21] reported that there were differences in plant heights among chickpea genotypes. Similarly, P fertilizer rates had significant differences on plant height and number of primary branches per plant of chickpea varieties (Table 1). Generally plant height increased with increasing P fertilizer rates from 0 to 30 kg/ha. The tallest plant height (56.42 cm) was obtained from P fertilizer rate of 30 kg/ha followed by P fertilizer rate of 20 kg/ha with mean plant height of 53.33 cm. The shortest plant (45.09 cm) was achieved from unfertilized plots. In

Table 1. Days to flowering, physiological maturity, plant height and primary branches per plant as affected by varieties and P rates.

Varieties	P rates (kg/ha)	Days to flowering	Days to physiological maturity	Plant height (cm)	Number of primary branches
Teketaky	0	43.67	107.33	37.67	2
	10	44.67	108	45.67	2.33
	20	46	108	46	2
	30	47.33	108	48.67	2
Naatolii	0	43.33	103.67	48	2
	10	46	107	52.33	3.33
	20	47.33	107	56.33	2.67
	30	47.67	108	60	2.67
Habru	0	44.67	107	45.67	2.33
	10	48	111	46	3
	20	50.33	112	49.33	2.67
	30	52.67	113	54.33	2.67
Ejeri	0	46	106.33	45.33	2
	10	52.33	113	49	3
	20	54	114.33	62.3	2.67
	30	55.33	116.33	65.67	2.33
	LSD	NS	NS	NS	NS
Variety mean	Teketaky	45.42^{b}	107.83^{bc}	44.50^{b}	2.08^{b}
	Naatolii	46.08^{b}	106.42^{c}	54.17^{a}	2.69^{a}
	Habru	48.92^{ab}	110.75^{ab}	48.83^{ab}	2.67^{a}
	Ejeri	51.92^{a}	112.50^{a}	55.58^{a}	2.50^{ab}
	LSD	4.23	3.44	7.53	0.42
P rates mean	0	44.42^{b}	106.08^{b}	45.09^{c}	2.08^{b}
	10	47.75^{ab}	109.75^{a}	48.25^{bc}	2.92^{a}
	20	49.83^{a}	110.33^{a}	53.33^{ab}	2.50^{ab}
	30	50.33^{a}	111.33^{a}	56.42^{a}	2.42^{b}
	LSD	4.23	3.44	7.53	0.42
	CV (%)	10.58	3.77	17.79	20.45

Means followed by the same letters within a column are not significantly different at 5% probability level, NS=not significant line with this, the highest number of primary branches per plant (2.92) was achieved from P fertilizer rate of 10 kg/ha followed by P fertilizer rate 20 kg/ha with mean number of primary branches of 2.50. The lowest number of primary branches per plant (2.08) was achieved from unfertilized plots. This result was supported by Khan (2015) [10] as it is evident from the results that highest P level of 55 kg/ha increased plant height. Hence, increasing P fertilizer rates probably promoted the production of dry matter that led to increment of plant height. Conversely, varieties by P fertilizer interaction did not show significant differences on plant height and number of primary branches per plot (Table 1).

Analysis of variance showed that chickpea varieties significantly differed for number of pods per plant and TSW (Table 2). Number of pods per plant for varieties varied from 43.00 to 53.75 whereas TWS from 242.17 to 266.75 g. The greatest number of pods per plant (53.75) and TSW (266.75 g) were recorded for variety Habru followed by variety Naatolii with mean number of pods per plant of 53.25 and TSW of 258.58 g. The lowest number of pods per plant (43.00) and TSW (242.17 g) were achieved from variety Teketay. The difference among the varieties with respect number of pod per plant and TSW might be attributed to genetic differences among the varieties. Adisu (2013) [1] reported the varietal differences among the varieties in yielding number of pods per plant. This finding is in concomitant with results of Shamsi (2010) [21] and Tripathi *et al.* (1978) [25] reported that chickpea genotypes showed variability regarding TSW. In line with this, P fertilizer rates resulted in significant differences on number of pods per plant and TSW (Table 2). Both parameters tended to increase with increasing P fertilizer rates up to 10 kg/ha and then declined for further increase above that rate. The greatest number of pods per plant (56.67) and TSW (269.50 g) observed at P fertilizer rate 10 kg/ha followed by P fertilizer rate of 20 kg/ha with mean number of pods per plant of 49.17 and TSW of 254.25 g. The lowest number of pods per plant (44.75) and TSW (243.92 g) were achieved from unfertilized plots (Table 2).

Pod per plant, seeds per pod and thousand seed weight

Analysis of variance indicated significant differences were detected due to effect of varieties by P fertilizer rates interaction on number of pods per plant and TSW (Table 2). In general number of pods per plant and TSW increased with increasing P fertilizer rates for all varieties up to P fertilizer rate of 10 kg/ha and then declined above that rate. Thus, all varieties produced higher number of pods per plant and TSW at P fertilizer rate of 10 kg/ha. Regarding the overall effect, the greatest number of pods per plant (60.00) and TSW (280.68 g) were recorded for variety Habru at P fertilizer rate of 10 kg/ha followed by variety Ejeri at the same P fertilizer rate with mean number of pods per plant of 58.33 and TSW of 280.67 g. The lowest number of pods per plant (38.33) and TSW (233.67 g) were seen for variety Teketay from unfertilized plots (Table 2). Similar result was reported by Lemma et al. (2013) [11] that the maximum number of pods per plant and TSW were recorded at P fertilizer rate of 10/ha. On the other hand, main effects of varieties and P fertilizer rates as well as their interaction did not have significant effect on number of seeds per pod (Table 2).

Table 2. Pods per plant, seeds per pod, TSW, biomass, grain yield and HI as affected by varieties and P rates.

Varieties	P rates (kg/ha)	Pods per plant	Seeds per pod	TSW (g)	Biomass yield (kg/ha)	Grain yield (kg/ha)	HI
Teketaky	0	38.33^{e}	1.25	233.67^{c}	2866^{e}	1633^{d}	0.51
	10	51.00^{ae}	1.31	252.33^{ac}	3133^{e}	2400^{bd}	0.57
	20	43.00^{ce}	1.3	242.33^{bc}	3033^{e}	2233^{bd}	0.54
	30	39.67^{de}	1.26	240.33^{bc}	3033^{e}	2200^{bd}	0.53
Naatolii	0	46.67^{ae}	1.36	251.00^{ac}	3566^{bc}	1766cd	0.25
	10	57.33^{ac}	1.75	264.33^{ac}	5166^{a}	2900^{a}	0.36
	20	56.67^{ac}	1.58	263.67^{ac}	5100^{a}	2567^{ab}	0.3
	30	54.33^{ad}	1.55	255.33^{ac}	4966^{ab}	2533^{ab}	0.31
Habru	0	49.33^{ad}	1.31	257.67^{ac}	3266^{cd}	1800^{cd}	0.36
	10	60.00^{a}	1.71	280.68^{a}	4533^{bc}	2566^{ab}	0.37
	20	52.00^{ae}	1.48	266.33^{ac}	4433^{c}	2500^{ac}	0.36
	30	51.67^{ae}	1.48	262.00^{ac}	4200^{cd}	2466^{ad}	0.4
Ejeri	0	44.67^{be}	1.13	233.33^{c}	3800^{d}	1940^{cd}	0.43
	10	58.33^{ab}	1.65	280.67^{a}	4200c^{d}	2566^{ab}	0.42
	20	47.33^{ae}	1.4	248.33^{bc}	4133^{cd}	2400^{bd}	0.37
	30	43.33^{be}	1.38	252.67^{ac}	3866^{d}	2366^{bd}	0.41
	LSD	15.26	NS	31.56	466	453	NS
Variety mean	Teketaky	43.00^{b}	1.28	242.17^{b}	3016^{d}	2217^{b}	0.54
	Naatolii	53.25^{a}	1.56	258.58^{a}	4950^{a}	2517^{a}	0.31
	Habru	53.75^{a}	1.49	266.75a	4358^{b}	2483^{a}	0.37
	Ejeri	48.42^{ab}	1.39	253.75^{ab}	4000^{c}	2433^{ab}	0.41
	LSD	7.63	NS	13.78	233	227	NS
P rates mean	0	44.75^{b}	1.26	243.92^{b}	2875^{b}	1785^{c}	0.37
	10	56.67^{a}	1.61	269.50^{a}	4241^{a}	2608^{a}	0.41
	20	49.17^{ab}	1.44	254.25^{ab}	4133^{a}	2408ab	0.38
	30	47.83^{b}	1.42	253.58^{b}	4075^{ab}	2308^{b}	0.39
	LSD	7.63	NS	13.78	233	227	NS
	CV (%)	18.46	15.28	7.42	6.86	11.29	16.61

Means followed by the same letters within a column are not significantly different at 5% probability level, NS=not significant.

Biomass yield

Analysis of variance revealed that chickpea varieties were significantly differed for biomass yield (Table 2). Biomass yield as affected by varieties, averaged over P fertilizer rates, ranged from 3016 to 4950 kg/ha. The highest biomass yield (4950 kg/ha) recorded for variety Naatolii followed by variety Habru with mean biomass yield of 4358 kg/ha. The lowest biomass yield (3016 kg/ha) was obtained from variety Teketay (Table 2). Similarly, analysis of variance revealed that chickpea varieties were significantly differed for biomass yield in response to P fertilizer rates (Table 2). Biomass yield in response to P fertilizer rates ranged from 2875 to 4241 kg/ha. The highest biomass yield (4241 kg/ha) was observed at P fertilizer rate of 10 kg/ha followed by P fertilizer rate of 20 kg/ha with mean biomass yield of 4133 kg/ha. The lowest biomass yield (2875 kg/ha) was seen at P fertilizer rate of 0 kg/ha (Table 2). Increasing P fertilizer rate from 0 to 10 kg/ha led a biomass yield gain of 47.51% where as increasing from 10 to 20 kg/ha led to a biomass yield of 2.55%. Moreover, increasing P fertilizer rate from 10 to 30 kg/ha resulted in biomass yield loss of 3.91%. On the other hand, a biomass yield gain advantages of 47.51%, 43.76% and 41.74% over control for P fertilizer rates 10, 20 and 30 kg/ha, respectively. This probably suggests that P fertilization rate above 10 kg/ha impact on biomass yield accumulation in this particular investigation was observed to be negligible.

Analysis of variance revealed that the effect of varieties by P fertilizer rates interactions on biomass yield was significant (Table 2). Biomass yield as affected by interactions of varieties and P fertilizer rates varied from 2866 to 5166 kg/ha. All varieties attained higher biomass yield at P fertilizer rate of 10 kg/ha with declined in biomass yield for P fertilizer further increase above that rate. The highest biomass yield (5166 kg/ha) for variety Naatolii at P fertilizer rate of 10 kg/ha followed by the same variety at P fertilizer rate of 20 kg/ha with mean biomass yield of 5100.kg/ha. The lowest biomass yield (2866 kg/ha) was achieved from variety Teketay from unfertilized plots (Table 2). At biomass yield of peak for all varieties a biomass yield gain of 9.32% for variety Teketay, 44.87% for Naatolii, 38.79% for Habru and 10.53% for Ejeri over their respective control. This is probably an evidence that varieties Naatolii and Habru exhibited better response P fertilization with respect to dry matter accumulate as it reflected on higher biomass yield. In contrast, varieties Teketay and Ejeri showed relatively lower response to P fertilization regarding dry matter accumulation. Hence, biomass is a function of numerous interacting environmental and genetic factors and its production is directly related to potential growth and development factors such as solar radiation, water supply, availability of mineral nutrients and crop management practices. This clearly indicated that P fertilizer rate beyond the optimum level (10 kg/ha) led to decline in dry matter accumulation in plants due to underutilization of available resources.

Grain yield

Analysis of variance revealed that chickpea varieties were significantly differed for grain yield. The highest biomass yield (2517 kg/ha) recorded for variety Naatolii followed by variety Habru with mean biomass yield of 2483 kg/ha. The lowest biomass yield (2217 kg/ha) was obtained from variety Teketay (Table 2). Variety Naatolii exhibited a grain yield advantage of 13.53%, 1.37% and 3.45% over Teketay, Habru and Ejeri, respectively. This is probably an indication that there are differences among chickpea varieties closer to each other and narrow genetic distance with respect grain yield potential. Fageria *et al.* (2009) [4], Girma et al. (2009) [5] and Zewide (2012) [27] indicated that there is existence of yielding differences with respect to genotypes. Similarly, significant differences were measured due to effect of P fertilizer rates on grain yield (Table 2). Grain yield in response to P fertilizer rates, averaged over varieties, increased with increasing P fertilizer rate up to 10 kg/ha and then tended to decline for P fertilizer rate above that level. The highest grain yield (2608 kg/ha) was recorded at P fertilizer rate of 10 kg/ha. The lowest grain yield (1785 kg/ha) was obtained from unfertilized plots (Table 2). Analysis of variance revealed that varieties by P fertilizer rates interaction had significant effect on grain yield (Table 2). Grain yield due to interaction effect of varieties by P fertilizer rates ranged from 2033 to 2900. For all varieties grain yield peaked at P fertilizer rate of 10 kg/ha. Moreover, all varieties gave higher grain yield over their respective unfertilized plots. The highest grain yield (2900 kg/ha) was observed for variety Naatolii at P fertilizer rate of 10 kg/ha followed by the same variety at P fertilizer rate of 20 kg/ha with mean grain yield of 2567 kg/ha. The lowest grain yield (1333 kg/ha) was achieved from variety Teketay from unfertilized plots. Grain yield is a function of numerous interacting environmental and genetic factors and its production is directly related to potential growth and development factors such as solar radiation, water supply, availability of mineral nutrients and crop management practices. Indeed, increasing P fertilizer rate to an optimum resulted in a positive impact on grain yield primarily due to availability of nutrients in the soil for plant uptake. Hence, alteration of fertilizer rate above or below an optimum results in a negative impact on grain yield presumably due to underutilization or severe shortage of resources, respectively. Increasing P fertilizer rates from 0 to 10 kg/ha was accompanied with a progressive advancement in grain yield for all varieties. This suggests P fertilizer rate levels below 10 kg/ha does meet the crop plant demand for proper growth and development. On other hand, grain yield reached the plateau for all varieties at P fertilizer rate of 10 kg/ha and then increasing fertilization rate above this plateau surprisingly showed a decline in grain yield for all varieties. Based on this finding it could be concluded that P fertilizer rate 10 kg/ha seems to optimum for all varieties tested in the location. The result of the present study with P is in line with Johansen and Sahrawat (1991)[8] reported that the optimum P rate for chickpea production is in the range of 10-30 kg/ha. There are several reports indicating that chickpea varieties respond to P application in soils with available P in the range of 2- 5 mg/kg [15] which very low level soil P for most of crops [20]. It is also in line with finding of Lemma et al. (2013) [11] that significantly higher grain yield of chickpea was obtained from 10 kg/ha. Regarding the varieties, the two improved varieties Naatolii and Habru are preferably could be used for production because both varieties exhibited superiority over others. Conversely, main effect of varieties, P fertilizer rates and their interactions did not have significant effect on HI (Table 2).

Conclusion

Phenological, growth, yield components and yield of chickpea varieties reacted to P fertilizer rates differently. Based on this finding it could be concluded that P fertilizer rate 10 kg/ha seems to optimum for all varieties tested in the location. Varieties Naatolii and Habru are preferably could be used for production because both varieties exhibited superiority over others.

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