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Review Article

Effect of Blended NPSB Fertilizer Rates and Varieties on Productivity of Chickpea (Cicer arietinum L.) in Midland of Guji Zone, Southern Oromia

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Abstract

Low soil fertility comprised of low available phosphorus, total nitrogen and sulphur are the major yield limiting factors for faba bean production in the study area. A field experiment was conducted at Adola Sub-site station of Bore Agricultural Research Centre. The treatments consisted of two varieties namely Dalota and Habru with four levels of NPSB (0, 50, 100 and 150 kg/ha) in randomized complete block design with three replications. The aim of the study conducted to evaluate the effect of application of Blended NPSB fertilizer and to determine economically viable blended NPSB rates that would boost chickpea productivity. Results showed significant effect of various levels of blended fertilizer on all tested parameters except on number of seed per pod and thousand seed weight. Application of 100 kg NPSB kg ha-1 gave highest number of primary branches per plant (3.02), plant height (50.02) and grain yield (2663 kg ha^{-1}), net return (103376.5 ETB) with acceptable MRR (666.0%). Days to flowering (52.62), Days to maturity (108.96), number of pods per plant (40.31) had the highest value with 150 kg/ha with negative agronomic efficiency. Therefore, production of chickpea with the application of 100 kg NPSB ha^{-1} was most productive for economical production.

Key words: Dalota, Habru, Blended NPSB

Introduction

Chickpea, 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 beans [18]. Ethiopia is the largest producer of chickpea in Africa accounting for about 46% of the continent's production during 1994-2006 [18]. The country is also the secondary centre of diversity and the seventh largest producer worldwide and contributes about 2% to the total world chickpea production [18]. Chickpea seed is recognized as a valuable source of dietary proteins (18- 22%), carbohydrate (52 - 70%), fat (4 - 10%), minerals (calcium, phosphorus, iron) and vitamins. Its straw has also good forage value [25]. In addition to its importance in human food and animal feed, chickpea plays an important role in improving soil fertility by fixing the atmospheric nitrogen. It can fix up to 140 kg N per ha from air and meet most of its nitrogen requirement [20].

Nutrient imbalance is one of the major abiotic constraints limiting productivity of pulses. Maintaining soil fertility and use of plant nutrient in balanced amount is one of the key components in increasing crop yield [4]. Among various nutritional requirements for production, nitrogen is known to be an essential element for plant growth and development. Nitrogen deficiency limits cell division, chloroplast development, and enzyme activity and reduces dry matter yields [28]. The inbuilt mechanism of biological N2 fixation enable pulse crops to meet 80- 90 per cent of their nitrogen requirements, hence a small dose of 15-25 kg N ha^{-1} is sufficient to meet out the requirement of most of the pulse crops ([27].

As a legume, chickpea can obtain a significant portion (4-85%) of N requirement through symbiotic N2 fixation when grown in association with effective and compatible rhizobium strain [7]. The rest of N is obtained from soil inorganic N, mineralized organic matter, residual N from the previous and/or fertilizer application [28]. Phosphorus deficiency in soils is wide spread and most of the pulse crops have shown good response to 20-60 kg P_2O_5 ha^{-1} depending upon nutrient status of soil, cropping system and moisture availability. Influence of P on root development and nodule, ni-

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trogen fixation which affects the nutrients uptake is well known. Response to applied P to the tune of 17-26 kg P $^{-1}$ has been observed in most of the pulse crops on low to medium available P soils [2]. Chickpea is more efficient than other pulses in taking up P from soil, as it secretes more acid which helps in solubilising Ca-P [31]. Sulfur (S) is one of the essential nutrients for plant growth and it accumulates 0.2 to 0.5% in plant tissue on dry matter basis. It is required in similar amount as that of phosphorus (Ali *et al.,* 2008). Sulphur plays a vital role in improving vegetative structure for nutrient absorption, strong sink strength through development of reproductive structure and production of assimilates to fill economically important sink. Sulphur nutrition of bean and other plants is important since its application not only increases growth rate but also improves the quality of the seed [8].

The effects of N and P on growth and yield of legumes have been quite varied and largely inconclusive. These inconsistent results could be due to differences in seasons, soil types, management history and genotypes. Desi types require 30–45 kg N ha^{-1}, whereas kabuli types are usually non responsive [29]. This kind of behavior has been ascribed to differences in phenotype, genotype and maturity duration [32]. However, significant responses of kabuli types up to 35 kg N ha^{-1} have been observed at Faisalabad in Pakistan [33]. The varietal differences in N use efficiency have also been reported, and may range from 3.54 to 11.65 kg seed/kg N [34]. The requirement of P in kabuli types is usually higher (40 kg P2O5 ha^{-1}) than in desi types (20 kg P2O5 ha^{-1}). Phosphorus requirement of chickpea may also vary with soil P status. In soils with <15, 15–22.5 and >22.5 kg available P ha^{-1}, kabuli types required 60 and 30 kg P2O5 ha^{-1} and no P, respectively [35].

In this regard, most Ethiopian soils are poor in N, P, S and B contents indicating that areas growing legumes are also low in N, P, S, B (Wassie Haile and Tekalign Mamo, 2013). However, the degree of deficiencies of those nutrients varies depending soil type, crop variety and environmental variables. This implies that there is a need to test and establish optimum nutrient rates for adequate production of chickpeas.

Therefore, the present study was conducted to evaluate the effect of application of Blended NPSB fertilizer and to determine economically viable blended NPSB rates that would boost chickpea productivity in Guji Zone of Southern Ethiopia

Materials and methods

Description of the Study Area

The experiment was conducted at Adola sub-site of Bore Agricultural Research Center (BOARC), Guji Zone, Oromia Regional State in southern Ethiopia under rain-fed condition. The site is located in Adola town in Dufa '*Kebele'* just on the West side of the main road to Negelle town. It is located at about 463 km south from Addis Ababa, capital city of the country. Geographically, the experimental site is situated at latitude of 55°36'31" North and longitude of 38°58'91"East at an altitude of 1721 masl.

The climatic condition of the area is a humid moisture condition, with a relatively shorter growing season. The area receives annual rainfall of 1084 mm with a bimodal pattern extending from April to November. The mean annual minimum and maximum temperature is 15.93 and 9.89, respectively. The type of the soil is red basaltic soil (*Nitisols*) and *Orthic Aerosols*. The soil is clay in texture and moderately acidic with pH of around 5.60

Experimental Materials

Two chickpea varieties, Dalota (Desi type) and Habru (Kabuli type) which were released by DZARC in 2007 and 2009, respectively, were used for the study. They were chosen because of high yielder, well adapted and widely grown in the area by smallholder farmers. Blended NPSB (19% N, 38% P_2O_5, 7% S, and 0.7%) was used as sources of N, P S, and **B** respectively, for the study

Treatments and Experimental Design

The treatments consisted of four rates of NPSB (0, 50, 100 and 150 kg NPSB ha^{-1}), and two chickpea Dalota (Desi type**)** and Habru (Kabuli type)**.** The experiment was laid out as a Randomized Complete Block Design (RCBD) with factorial arrangements of 4x2=8 treatment combinations and replicated three times. The size of each plot was 4 m x 3.20 m (12.8m^2) and the distance between the plots and blocks were kept at 1 m and 1.5 m apart, respectively. Seeds were sown 40 cm between rows and 10 cm between plants. Each plot consisted of 8 rows. The net central unit areas of each plot consisting of 6 central rows of 2.4 m length each (8.64 m^2) were used for data collection and measurements.

Data Collection and Measurements

Phenological parameters

Days to flowering: were recorded as the number of days from sowing to when 50% of plants in a net plot produced flower through visual observation.

Days to physiological maturity: This was recorded as the number of days from sowing to the time when about 90% of the plants in a plot had mature pods in their upper parts with pods in the lower parts of the plants turning yellow. The yellowness and drying of leaves were used as indication of physiological maturity.

Growth parameters

Plant height: This was measured as the height (cm) of ten randomly taken plants from the ground level to the apex of each plant at the time of physiological maturity from the net plot area and the means were recorded as plant height.

Number of primary branches per plant: The average number of primary branches emerged directly from the main shoot was counted from ten randomly taken plants at physiological maturity and the average number of primary branches was reported as number of primary branches per plant.

Yield and yield components

Number of pods per plant: Number of pods was counted from ten randomly taken plants from the net plot area at harvest and the means were recorded as number of total pods per plant.

Number of seeds per pod: This was recorded from ten randomly taken pods from each net plot at harvest.

Hundred seed weight (g): was determined by taking weight of 100 randomly sampled seeds from the total harvest from each net plot area and the weight was adjusted to 10% moisture level.

Seed yield (kg ha^{-1}): The four central rows were threshed to determine seed yield and the seed yield was adjusted to moisture level of 10%. Finally, yield per plot was converted to per hectare basis and the average yield was reported in kg ha^{-1}.

Statistical Data Analysis

All the measured parameters were subjected to analysis of variance (ANOVA) appropriate to factorial experiment in RCBD according to the General Linear Model (GLM) of Gen Stat 15th edition (GenStat, 2012) and the interpretations were made following the procedure described by Gomez and Gomez (1984). Least Significance Difference (LSD) test at 5% probability level was used for mean comparison when the ANOVA showed significant differences.

Economic Analysis

Economic analysis was performed using partial budget analysis following the procedure described by CIMMYT (1988) in which prevailing market prices for inputs at planting and for outputs at harvesting were used. All costs and benefits were calculated on ha basis in Birr. The concepts used in the partial budget analysis were the mean grain yield of each treatment, the field price of common bean grain, and the gross field benefit (GFB) ha^{-1} (the product of field price and the mean yield for each treatment.

The net benefit (NB) was calculated as the difference between the gross benefit and the total cost. The average yield obtained from experimental plot was reduced by 10% to adjust with the expected farmers' yield by the same treatment. Prices of grain (Birr kg^{-1}) were obtained from local market for each variety: Dalota was 43 Birr kg^{-1} and Habru was 48 Birr kg^{-1}, and total sale from one hectare was computed using adjusted yield. Other costs such as cost of fertilizer (3500 Birr 100 kg^{-1} blended NPS) and its application cost were considered as the costs that vary for treatment to treatment.

Results and discussions

Phenological Parameters of chickpea

Days to flowering

The interaction of blended NPSB rate and varieties had significant (P<0.05) effect on days to 50% flowering (Table 1). Significantly, highest number of days (52.62 days) to reach flowering was recorded due to application of 150 kg ha^{-1} of blended NPSB for variety Habru and for variety Dalota (52.44) while the earliest days to flowering (48.39 days) was recorded due to nil application of [1] of blended NPS for variety Dalota (Table 4). Variety Dalota was found to be early maturing as compared to variety Habru across all NPSB rates due to their genetic difference in response to flowering. The result obtained from the current study revealed that the days to flowering were delayed with increment of application rate of blended NPS fertilizer which could be due to the delaying effect of nitrogen obtained from blended NPSB fertilizer. Nitrogen fertilizer increased the leaf area which increases the amount of solar radiation intercepted and consequently, increases days to flowering, days to physiological maturity, plant height and dry matter production of different plant parts [15]. This result was in line with the findings of [1] who reported that increasing N rate from 0 kg N ha^{-1} to 45 kg N ha^{-1} increased the number of days required to reach 50% flowering from 43.7 days to 48.1 days in chickpea at Debre Zeit. Likewise, [12] reported that, significantly longest days (45.86) to flowering due to application of 46 kg ha^{-1} of P_2O_5 and 41 kg ha^{-1} of N.

Table 1: Rate of fertilizer and their nutrient content (kg ha-1) treatments for the experiment.

No	Blended NPS Fertilizer rate (kg ha^{-1})	N	P_2O_5	S	B
1	0 kg NPS	0	0	0	0
2	50 kg NPS	9.5	19	3.5	0.35
3	100 kg NPS	19	38	7	0.7
4	150 kg NPS	28.5	57	10.5	1.4

Days to physiological maturity

The analysis of variance showed that the number of days required to reach physiological maturity of chickpea was not significantly influenced by the main effect of variety. However, blended NPSB application significantly (P<0.05) and interaction effects of varieties with blended NPSB application rates significantly (P<0.05) influenced this parameter (Table 2). Increase in blended NPSB application rate from 0 to 150 kg ha^{-1} lead to a significant increase in the number of days required to reach physiological maturity. The highest number of days required to physiological maturity (108.96 days) was recorded for the highest rate of blended NPSB application rate (150 kg ha^{-1}) for variety Habru while the shortest days to physiological maturity (96.06 days) was recorded without the NPSB application for variety Dalota (Table 2). In line with this result, [19] reported that increasing NPS rate from 0 kg NPS ha^{-1} to 100 kg NPS ha-1 increased the number of days required to reach physiological maturity from 73.56 days to 76.72 days in common bean at at Mekdela. This indicates that the nutrients taken up by plant roots from the soil were used for increased cell division and synthesis of carbohydrate, which will predominantly be partitioned to the vegetative sink of the plants, resulting in plants with a luxurious foliage growth [16].

Growth Parameters of Chickpea

Number of primary branches

Analysis of variance indicated that blended NPSB fertilizer application rates and varieties had highly significant effect on number of primary branches. Variety Dalota recorded the highest number of primary branches per plant (3.02) at 100 kg NPS ha^{-1} while the lowest number of primary branches (2.44) was recorded for variety Habru at no application of fertilizer. The

Table 2: Days to flowering, days to physiological maturity and Number of Primary Branches as influenced by interaction of fertilizer and varieties of chickpea at Adola.

Treatment description	Days to 50 % Flowering		Days to physiological 90% maturity		Number of primary branches	
	Dalota	Habru	Dalota	Habru	Dalota	Habru
0 NPSB kg ha^{-1}	48.39^{d}	46.47^{d}	96.06^{e}	102.91^{d}	2.51^{cd}	2.44^{d}
50 kg NPSB kg ha^{-1}	50.22^{c}	52.23^{c}	104.33^{c}	108.2^{ab}	2.77^{b}	2.87^{b}
100 NPSB kg ha^{-1}	49.06^{b}	51.62^{b}	106.8^{b}	106.36^{c}	3.02^{a}	2.98^{a}
150 NPSB kg ha^{-1}	52.44^{a}	52.62^{a}	107.48^{a}	108.96^{a}	2.54^{c}	2.67^{c}
Mean	50.03	50.74	103.67	106.61	2.71	2.74
LSD (0.05)	0.34		0.45		0.31	
CV (%)	0.63		0.56		5.92	

Table 3: The effects of NPB levels on Plant height (cm) and Number Pod per plant and of chickpea at Adola.

Fertilizer rate NPSB (kg ha^{-1})	Plant height (cm)		Number Pods per plant	
	Dalota	Habru	Dalota	Habru
0	41.50^{c}	43.94^{bc}	17.79^{cd}	14.21^{d}
50	45.92^{a-c}	44.35^{abc}	23.33^{bcd}	20.96^{cd}
100	43.50^{bc}	50.02^{a}	26.56^{bc}	24.77^{bc}
150	49.75^{a}	48.00^{ab}	40.31^{a}	32.46^{ab}
Mean	45.17	46.58	27.00	23.10
LSD (0.05)	5.78		9.172	
CV (%)	7.2		20.9	
F- test	*		**	

possible reason for the highest number of primary branches per plant at 100 kg NPS ha^{-1} might be due to that legumes require phosphorus for optimal symbiotic performance and there was close relationship between phosphorus level and symbiotic mechanism in legumes. Low primary branches at 150 kg NPS kg ha^{-1} rate compared to 100 kg NPS kg ha^{-1} might be due to nutrient imbalance and excess $SO4^{-2}$ interfere $PO4^{-3}$ uptake.

The result was in line with the finding of [19] who reported that the highest number of primary branches (4.956) was observed at 100 kg NPS ha^{-1} for common bean at Mekdela.

The increment in number of primary branches per plant might also be due to the importance of P in NPS fertilizer for cell division activity, leading to the increase of plant height and number of branches and consequently increased the plant dry weight and importance of S and B in NPSB for growth and physiological functioning of plants. This difference might also be due to genetic differences in production of number of primary branches among the varieties. The result was consistent with the finding of [1] who reported that number of primary and secondary branches was highly significantly different among the chickpea varieties at Debre- Zeit with the desi variety Natoli.

Plant height

The analysis of variance showed highly significant (P<0.05) effect of varieties, blended NPSB rates and their interaction on plant height at physiological maturity. Plant height is an important factor that helps to determine the growth achieved during the growing period. Variety Habru showed the highest plant height (50.02 cm) with application of 100 kg NPSB ha^{-1} where as the shortest plants (41.50 cm) were seen for Dalota without NPSB fertilizer application (Table 4).

The results shown in table below indicated that plant height due to interaction of varieties and application of blended NPSB fertilizer was not consistent for both varieties.

Table 4: The effects of NPSB levels on yield and yield components of chickpea at Adola.

Fertilizer rate NPSB (kg/ha	Number of seed per pod		Thousand seed weight (g)		Grain yield (kg/ha)	
	Dalota	Habru	Dalota	Habru	Dalota	Habru
0	1.83	1.85	247.7	257.3	1543^{bc}	1132^{c}
50	1.61	1.60	265.7	255.0	2332^{ab}	1893^{abc}
100	1.75	1.65	257.3	264.0	2663^{a}	2168^{ab}
150	1.69	1.61	269.0	262.5	2169^{ab}	1590^{bc}
Mean	1.72	1.68	259.93	259.58	2176.75	1695.75
LSD (5%)	0.34		32.9		899.49	
CV (%)	11.5		7.2		26.5	
F- test	NS		Ns		*	

Number of pods per plant

Highly significant (P<0.01) effects of blended NPSB fertilizer application rate and varieties were observed on the number of total pods per plant. Variety Dalota produced significantly the highest number of total pods per plant (40.31) at the highest application rate of 150 kg NPSB ha^{-1} whereas the lowest number of total pods (14.21) was noted in case of variety Habru from the control (Table 4). The mean number of pods per plant increased with increased fertilizer levels. The increase in number of total pods with the increased NPSB rates might possibly be due to adequate availability of N, P S and **B** which might have facilitated the production of primary branches and plant height which might in turn have contributed for the production of higher number of total pods. This might be also due to the liberal availability of plant nutrients which stimulated the plants to produce more pods per plant as compared to other treatments as phosphorus powerfully encourages flowering and fruiting. The result was agreed with [6] reported that the highest phosphorus level of 46 kg P_2O_5 ha^{-1} resulted in maximum pods (92.07) plant^{-1} of chickpea at Ejersa Lafo. The result was also agreed with [3] who reported that increasing phosphorus levels simultaneously increased the number of pods plant^{-1} of chickpea.

Number of seeds per pod

The analysis of variance showed that the interaction effect of variety and blended NPS**B** application rates and main effects of blended NPSB application rates were not significant, This indicates that the trait is mainly controlled by genetic factors than the management. Consistent with the results of this study, Mourice and Tryphonne (2012) observed significant variations in number of seeds per pod among common bean genotypes.

Grain yield (kg)

The analysis of variance indicated that the grain yield was significantly (P<0.05) affected by the main effect of variety, and highly significantly (P<0.01) affected due to main effects of blended NPSB fertilizer rate and the interaction of varieties with fertilizer combination. The highest grain yield was recorded for variety Dalota (2663 kg ha^{-1}) at 100 kg NPS ha^{-1} while the lowest yield (1132 kg ha^{-1}) was observed for variety Habru at control fertilizer treatment (Table 5). Grain yield increased as rate of NPSB applied increased from zero (control) up-to 100 kg NPSB ha^{-1} for both varieties and decline at 150 kg NPSB ha^{-1} that showing increase in fertilizer beyond 100 kg NPSB ha-1 would uneconomical. All rates gave highest grain yield than the control for both varieties. The result was supported by the finding of [36] who reported that grain yield of chickpea was significantly affected by the interaction effects of varieties and phosphorus fertilizer levels.

Table 5: Mean agronomic efficiency of influenced by interaction of NPS rate and Variety of chickpea.

Treatment Description	Grain Yield (kg ha^{-1})	Agronomic Efficiency (%
Dalota 0 kg ha^{-1}	1543	-
Dalota×50 kg NPSB kg ha^{-1}	2332	1578
Dalota×100 kg NPSB kg ha^{-1}	2663	662
Dalota×150 kg NPSB kg ha^{-1}	2169	-988
Habru 0 kg ha^{-1}	1132	-
Habru×50 kg NPSB kg ha^{-1}	1893	1522
Habru×100 kg NPSB kg ha^{-1}	2168	550
Habru×150 kg NPSB kg ha^{-1}	1590	-1156

Table 6: Summary of economic analysis for the effects of NPSB fertilizer application rates and variety.

Treatment Description	Grain Yield (kg ha^{-1})	Adjusted Grain Yield (kg ha^{-1})	Total variable cost (ETB ha^{-1})	Total Benefit (ETB ha^{-1})	Net Return (ETB ha^{-1})	MRR (%)
Dalota 0 kg ha^{-1}	1543	1388.7	825.0	62491.5	61666.5	-
Habru 0 kg ha^{-1}	1132	1018.8	825.0	48902.4	48077.4	D
Dalota×50 kg NPS kg ha^{-1}	2332	2098.8	2725	94446.0	91721.0	2297.03
Dalota×100 kg NPS kg ha^{-1}	2663	2396.7	4475	107851.5	103376.5	666.03
Dalota×150 kg NPS kg ha^{-1}	2169	1952.1	6225	87844.5	81619.5	D
Habru×50 kg NPS kg ha^{-1}	1893	1703.7	2725	81777.6	79052.6	73.34
Habru×100 kg NPS kg ha^{-1}	2168	1951.2	4475	93657.6	89182.6	578.86
Habru×150 kg NPS kg ha^{-1}	1590	1431.0	6225	68688.0	62463.0	D

Agronomic Efficiency of Chickpea

Agronomic efficiency (AE) was affected by NPSB rates and varieties. The highest agronomic efficiency (1578 %) was obtained from treatment Dalota × 50 kg NPSB kg ha^{-1} followed by Habru × 50 kg NPSB kg ha^{-1} while the lowest value (-1156%) was recorded for treatment Habru × 150 kg NPSB kg ha^{-1}

The increase in agronomic efficiency at lower rate of NPS application and its decrease at higher rates might be due to the rate of increase in grain yield was lower than the rate of increase in NPSB supply. In agreement with this result, [11] have reported decreases in agronomic efficiency with increasing in P supply for common bean and soybean respectively.

Economic Analysis

The agronomic data upon which the recommendations are based must be relevant to the farmers' own agro-ecological conditions, and the evaluation of those data must be consistent with the farmers' goals and socio-economic circumstances [37].

The net benefit was computed due to chickpea varieties, application of blended NPS fertilizer and interaction of varieties with application of blended NPS fertilizer. The economic analysis revealed that highest net benefit (103376.5ETB ha^{-1}) was obtained from Dalota× 100 kg NPS kg ha^{-1}followed by treatment Dalota × 50 kg NPSB kg ha^{-1} (91721.0 ETB). On the other hand, the highest marginal rate of return (MRR) (2297.03 %) was obtained from the treatment Dalota × 50 kg NPSB kg ha^{-1} followed by treatment Dalota× 100 kg NPS**B** kg ha^{-1} (666.03 %). In contrast, the lowest net benefit was recorded from nil application (48077.4 ETB ha^{-1}) and (61666.5 ETB ha^{-1}) for Habru and Dalota variety respectively (Table 8). The highest cost (6225 ETB ha^{-1}) for treatment Habru × 150 kg NPSB kg ha^{-1} and (6225 ETB ha^{-1}) was recorded for Dalota × 150 kg NPSB kg ha^{-1} respectively. This implies an increased fertilizer rate increased the costs of products directly through increased seed cost, seed treatments, and crop management.

The partial budget, marginal analysis, and minimum rate of return together give the information necessary to arrive at a tentative or candidate recommendation. Therefore, production of chickpea with the application of 50 kg NPS ha^{-1} gave the highest net benefit with a MRR which was higher than the minimum rate of return (100%) for economical production. [14] reported the highest net benefit (67132.20 ETB ha^{-1}) with maximum marginal rate of return (4106.68%) was gained when chickpea was inoculated with rhizobium and 125 kg ha^{-1} NPSB application at Laelay Maichew of Tigray. [38] reported that planting of the cultivar Nasir produced the highest net benefit (15903.1 Birr ha^{-1}) with acceptable marginal rate of return (3040%) compared to other cultivars at Areka. [39] also reported net benefit of 21,070 ETB ha^{-1} with marginal rate of return of 80% by the application of 69 kg P_2O_5 ha^{-1} at Areka

Conclusion and Recommendation

Significant response was observed in growth, yield and yield components 50 up to 100 NPSB kg ha^{-1}, yet above this level those traits were reduced. Similarly, economic analysis shows the highest net benefit (103376.5ETB ha^{-1}) was obtained from Dalota× 100 kg NPS kg with marginal rate of return (666.03%). On the other hand, the highest marginal rate of return (MRR) (2297.03 %), agronomic efficiency (**1578**%) were obtained from the treatment Dalota × 50 kg NPSB kg ha^{-1}. From the above results and discussion it could be suggested that application of 100 kg NPSB per hectare could be the profitable dose for maximizing grain yield of chickpea.

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