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Effect of Different Level of Nitrogen and Phosphorus (NP) Fertilizer Rates on Green Pepper Cultivars Pod Yield Production in Central Rift Valley of Ethiopia

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Abstract: The effect of Nitrogen and Phosphorus (NP) NP fertilizers on pod yields of Green Pepper cultivars were evaluated in some parts of central rift valley of Ethiopia, Dugda, Fentele and Adama (Melkassa) districts for three cropping seasons (2018-2020). The experiment laid out in split plot design, three varieties as a main factor and NP rates (16 NP fertilizer rates including 0, 0) as sub-factors. The result reviled that the application of NP fertilizers significantly boosted pod yields of the three green pepper cultivars in the three experimental sites at $P<0.05$ level. Partial budget analysis results revealed that the application of 46kgN ha^{-1} gave the highest MRR (1, 838 and 1, 820 %) with high net benefit for both Melka Awaze and Shotte varieties respectively. Vigro variety gave the highest net benefit (272, 057.7 EtB ha^{-1}) at 138 kg N with 40kg P ha^{-1} and high MRR=1034%. In conclusion, the combined (NP) fertilizer application 46N with 20P or 92N with 20P kg ha^{-1} for farmers having low fanatical ability for Green pepper pod production could be recommended at Melkassa, Fentalle, Dugda and similar locations.

Key words: Green Pepper · NP rates · Pod Yield · Cultivars · Ethiopia

INTRODUCTION

Various types of vegetable crops are grown and produced in Ethiopia under rain-fed and/or irrigation systems [1]. Ethiopia has favorable climate and edaphic conditions for the production of tropical, sub-tropical and temperate vegetables in the lowlands [2]. Commercial production of horticultural crops, including vegetables, has also been increasing in recent years because of expansion of state farms (e.g., Ethiopian Horticulture Development Corporation) and increasing private investment in the sector by national and international entrepreneurs [2].

Vegetable production is an important economic activity in Ethiopia, ranging from smallholder farming to large scale commercial farms [3]. While smallholders usually use the largest part of their vegetable produce for home consumption and sell the surplus, the commercial state and private farms produce solely for market. According to CSA [4] report, about 876, 139.018 tons of vegetables, were produced on 238, 505.79 ha of land, creating means of livelihood for more than 1 million households.

Vegetable growers in the Central Rift Valley (CRV) areas and other agro ecologies of Ethiopia are trying to amend the soil fertility of rainfed and irrigated lands through applying fertilizers, crop residues, animal wastes and use of crop rotations. They use variable rate of fertilizers for onion, tomato, pepper and other vegetable crops productions. Taha [5] in Dugda Bora District of East Showa reported that the average rate of fertilizer applied by sample households' onion grower during the 2005/06 was 414.78 kg ha^{-1} where the majorities (60.6%) have applied 400 kg ha^{-1}; with the maximum amount of fertilizer used was 800 kg ha^{-1} while the minimum was 200 kg ha^{-1}. The early recommendation had contributed to blanket applications of 200 kg Urea (92 kg N) + 200 kg DAP (40kg P and 36 kgN) ha^{-1} for tomato and 200 kg Urea (92 kg N) + 150 kg DAP (30kg P and 27 kg N) ha^{-1} for onion in the CRV parts of Ethiopia. On the other hand, survey studies conducted at Melkasa agricultural research center indicated that 32.46% of tomato and 45.73% of onion growers apply 200kg (92 kg N) and ≥400kg urea (184 kg N) per ha respectively. Similarly, 33.76% of tomato and 43.61% of onion growers in CRV area apply 200kg DAP (40 kg P and 36 kg N) per hectare

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for each crop [6]. This probably indicated that research based recommended fertilizer application rate under balanced fertilizer for each vegetable crop does not exist across soil types in the central rift valley of Ethiopia. Thus, it was important to quantify the rate of N and P fertilizer under balanced fertilization to enhance productivity of green pepper under irrigated condition in some parts of Central Rift Valley Ethiopia. Therefore, this experiment was conducted to determine optimum rates of Nitrogen and Phosphorous fertilizers for green pod production of pepper cultivars under balanced fertilization and to assess economic feasibility of N and P fertilizer rate for green peppers production.

MATERIALS AND METHODS

The experiment was conducted at Adama (Melkassa), Fentale (Gidara) and Dugda (Bekele Grissa) districtsunder irrigated condition (Figure 1). Treatments were arranged in split plot design in factorial arrangement of the NP fertilizers rate in three replications. The compound fertilizer NPS was used as source of N and P. Urea was used as supplementary source of N to adjust the rate of the treatment.

Treatments were arranged in the following ways (0N, 46N, 92N and 138N) with (0P, 20P, 40P and 60P) kg ha^{-1}rates combined factorially. Three green pepper cultivars (Melka Awaze, MelkaShotte and Vigro) were used for the experiment. Plot size, distance between plants 40cm and between rows 70 cm were used, distance between plots and replications was 1m. The gross experimental plot size was 2.4 m by 3.5 m, which had 5 rows of peppers and 7 plants per row, thereby had a total of 35 plants per plot. The varieties used were Melka Awaze, Melka Shotte and Vigro. Three central rows were harvested for green pepper pod yield determination as the pod reach physiological matured. All management practices such as soil and crop managements recommended for green pepper production were uniformly applied to all plots.

Data Analysis: The collected data were subjected to analysis of variance (ANOVA) using SAS 9.0 software [7]. When significant differences between treatment means were evident from ANOVA, mean separation was computed using the least significant difference (LSD) at 0.05 level of probability [8].

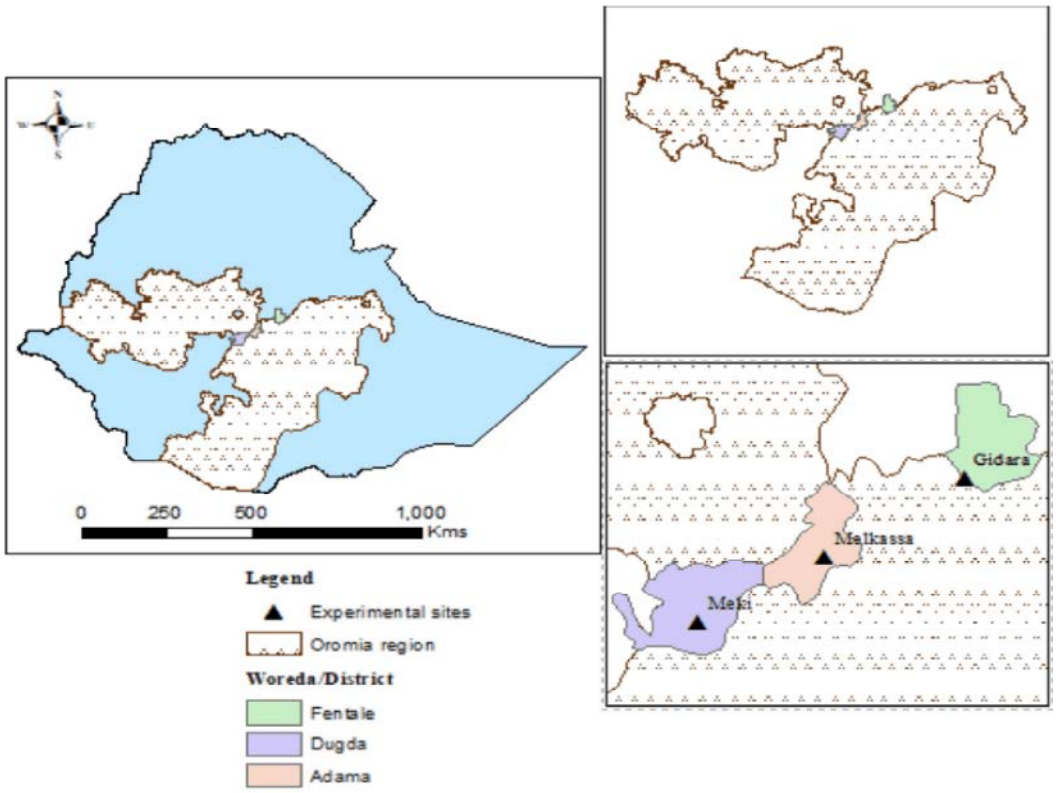

Fig. 1: Map of study areas

Partial budget analysis was performed to investigate the economic feasibility of treatments. Partial budget, dominance and marginal analyses were carried out. The average yields were adjusted downwards by 10% to reflect the differences in pod yields between the experimental plot and the farmer fields from the same treatment. The average open market price for green pepper podyield were12.00 for M.Awaze and M. Shotte, 10 ETB kg^{-1} for Vigro. The farm gate prices of NPS, TSP, Urea and potassium chloride were 14.5, 17.00, 14.00 and 15.00 ETB kg^{-1}, respectively. For a treatment to be considered as worthwhile option to farmers, the minimum acceptable rate of return was greater than or equal to 100% [9]. Partial budget analysis was also considered farmers financial abilities. Low financial ability: this can invest not more than 3, 000 EtB ha^{-1} for the green pod production of pepper. Medium financial ability: this can invest above 3, 000 but not more than 6, 000EtB ha^{-1} for the green pod production of pepper. High financial ability: this can invest more than 6, 000 EtB ha^{-1} for the green pod production of pepper.

RESULTS AND DISCUSSION

The result of green pepper cultivars conducted in three districts for the consecutive three years (2018-2020) presented in the following four Tables (1-4). The analysis of variance revealed that green pepper pod yield significantly affected in both main plot (varieties) and sub plot factors (NP fertilizers rate) at $p<0.05$ level in all experimental sites (Melkassa, Dugdaand Fentalle). At Melkassa (on Station) Melka Awaze pod yield significantly boosted (14.72 and 13.34 Mt ha^{-1}) by the application of 46kg N with 20kg P/ha and 92kgN/ha alone respectively at 0.05 level as compared to other treatments (Table 1). These results in agreement with Aminifard and Bayat [10], statistical significances differences was occurred among fruit weight and volume from the application of 50 kg N ha^{-1} as compared to the control treatments. Melka Shotte pod yield significantly increased (18.93 and 18.18 Mt ha^{-1}) by the application of 138kg N with 40kg P and 92kg N ha^{-1} alone at $P<0.05$ level respectively in subplot factors.

The main plot factors (Varieties) M. shotte pod yield was significantly higher than M. Awaze at $p<0.05$ level. The varietal deference was significantly affected pod yield. Using M. Shotte 39.8% yield advantage over M. Awaze at Melkassa.

Table 1: Nitrogen and Phosphorus application effect on pepper cultivars green pod mean yield, lower and upper boundaries at Adama (Melkassa) districts in 2018 cropping season

	Melkassa on Station	
N, P– Rate†	M. Awaze	M. Shotte
kg ha^{-1}	Mt ha^{-1}	
0,0	4.33 (3.81-4.45)$^{\gamma f}$	8.22(7.09-9.35)^{h}
0,20	6.27(5.63-6.90)^{ef}	13.15(13.06-13.24)^{def}
0,40	6.49(5.45-7.53)^{e}	13.43(12.0-14.85)^{de}
0,60	6.03(4.53-7.53)^{ef}	14.07(11.24-16.87)^{cd}
46,0	10.26(9.54-10.98)^{b}	16.33(14.90-17.76)^{bc}
46,20	14.72(11.60-17.83)^{a}	14.05(12.21-15.89)^{cd}
46,40	7.70(5.80-9.59)^{cde}	10.63(9.10-12.15)^{fgh}
46,60	6.15(5.32-6.98)^{ef}	16.04(15.76-16.32)^{bc}
92,0	13.34(12.63-14.04)^{a}	18.18(16.93-19.42)^{ab}
92,20	8.69(8.02-9.36)^{bcd}	9.59(9.17-10.00)^{gh}
92,40	7.19(6.86-7.51)^{de}	12.51(11.67-13.35)^{def}
92,60	6.42(5.34-7.50)^{ef}	12.16(11.12-13.20)^{def}
138,0	10.09(9.06-11.12)^{b}	12.66(11.41-13.90)^{def}
138,20	6.30(4.97-7.64)^{ef}	11.50(11.18-11.81)^{efg}
138,40	9.34(9.23-9.45)^{bc}	18.93(17.92-19.93)^{a}
138,60	8.12(7.91-8.32)$^{b-e}$	17.04(13.86-20.22)^{ab}
Mean	8.22	13.66
$LSD_{(<0.05)}$	2.15	2.54
$CV_{(\%)}$	15.7	11.15
Var‡	8.21(7.97-8.35)^{b}	13.65(13.24-14.17)^{a}
$LSD_{(<0.05)}$	0.84	
$CV_{(\%)}$	18.99	

†=Sub-factors N and P rates kg ha^{-1}, ‡= Main factors (Varieties) Metric tons per hectare, □ =Lower and Upper boundary, CV= Coefficient of variation in %, LSD= List significant difference at 5% probability

At Fentalle, the green pepper responded well for the highest fertilizers rate. Table 2 showed that the application of 138kgN with 40kg P significantly improved the three green pepper cultivars (M. Awaze, Vigro and M. Shotte) pod yield at $P<0.05$ level of probability in the sub-factors (NP rates). These results are in line with Magdalena [11], Akanbi *et al.* [12] and Aujla *et al.* [13] who's reported that increasing the rate of N fertilizers improved the mean fruit weight of pepper. Phosphorus induces earliness in flowering and fruiting including seed formation [14].

The main plot factors (Varieties) also significantly affected at $P<0.05$ level at Fentalle. Vigro is hybrid the others Awaze and Shotte are OPV thus Vigro was significantly highest as compared to the OP varieties. The yield advantage of vigro 83.67% and 145% greater than M. Shotteand M. Awaze respectively.

The combined analysis over years (2918-2020) result showed than (Table 3) the three pepper cultivars significantly boosted by the sub plot effects at Dugda district. The application of nitrogen or phosphorus fertilizer alone not significantly affected pod yield of all green pepper cultivars. All green pepper cultivars, green

Table 2: Nitrogen and Phosphorus application effect on pepper cultivars green pod mean yield, lower and upper boundaries at Fentale in 2019 cropping season

	Fentalle		
N, P–Rate kg ha^{-1}	M.Awaze	Vigro	M. Shotte
	Mt ha^{-1}		
0, 0	2.43(1.44-3.41)^{j}	5.15(3.86-6.44)^{i}	4.63(4.51-4.75)^{f}
0, 20	2.73(1.63-3.82)^{hij}	7.32(6.09-8.54)^{hij}	5.16(4.70-5.62)^{ef}
0, 40	3.63(3.35-3.90)$^{g-j}$	6.02(4.92-7.12)^{ij}	4.53(4.44-4.62)^{f}
0, 60	3.91(2.80-5.02)$^{g-j}$	8.38(7.87-8.89)^{hi}	4.86(4.74-4.98)^{f}
46, 0	4.33(4.19-4.47)^{fgh}	9.63(8.10-11.15)^{gh}	5.77(5.35-6.20)^{def}
46, 20	2.50(2.17-2.83)^{ij}	14.54(11.31-17.77)^{e}	8.22(6.51-9.92)^{bc}
46, 40	6.55(5.96-7.19)^{cde}	14.41(14.32-14.50)^{e}	5.06(4.56-5.57)^{ef}
46, 60	4.11(3.95-4.27)^{ghi}	11.51(10.74-12.27)^{g}	8.09(7.99-8.19)^{bcd}
92, 0	8.45(7.85-9.05)^{b}	14.04(13.52-14.55)^{ef}	10.44(9.35-11.53)^{ab}
92, 20	6.12(5.04-7.19)^{de}	15.83(15.78-15.87)^{de}	9.63(7.56-11.70)^{bc}
92, 40	7.82(7.42-8.22)^{bc}	25.07(24.14-26.00)^{b}	9.05(6.89-11.21)^{bc}
92, 60	5.85(5.15-6.55)^{def}	11.81(11.68-11.94)^{fg}	10.15(7.38-12.92)^{b}
138, 0	4.99(4.10-5.87)^{efg}	17.11(16.87-17.34)^{d}	7.47(5.14-9.81)^{cde}
138, 20	7.44(6.26-8.61)^{bcd}	19.82(19.26-20.37)^{c}	10.40(9.03-11.77)^{ab}
138, 40	12.70(10.47-14.93)^{a}	27.74(24.72-30.76)^{a}	12.75(12.32-13.19)^{a}
138, 60	11.17(10.25-12.08)^{a}	23.80(22.35-25.25)^{b}	10.21(9.26-11.17)^{b}
Mean	5.92	14.51	7.90
$LSD_{(<0.05)}$	1.67	2.39	2.43
$CV_{(\%)}$	16.92	9.88	18.43
Var	5.92(5.77-6.08)^{c}	14.51(14.22-14.96)^{a}	7.90(7.67-8.05)^{b}
$LSD_{(<0.05)}$		1.10	
$CV_{(\%)}$		28.90	

Table 3: Nitrogen and Phosphorus application effect on pepper cultivars green pod mean yield, lower and upper boundaries at Dugda pooled over years (2018-2020)

	Dugda		
NP kgha^{-1}	M. Awaze (n=3)	Vigro (n=2)	M. Shotte (n=3)
	Mt ha^{-1}		
0, 0	9.97(7.82-12.13)^{f}	21.27(17.01-25.53)^{de}	12.27(8.78-15-15.76)^{f}
0, 20	12.10(9.42-14.78)$^{c-f}$	24.10(20.04-28.16)^{bcd}	12.43(9.37-15.49)^{f}
0, 40	10.81(8.51-13.10)^{ef}	16.21(10.71-21.70)^{e}	15.29(12.46-18.12)^{def}
0, 60	13.58(7.97-19.19)$^{a-e}$	23.53(21.33-25.72)^{cde}	13.96(9.66-18.27)^{ef}
46, 0	12.76(10.68-14.84)$^{b-f}$	24.71(18.48-30.94)^{bcd}	15.57(13.67-17.47)$^{c-f}$
46, 20	14.68(10.39-18.98)$^{a-d}$	27.06(22.99-31.13)$^{a-d}$	19.62(13.10-26.14)^{ab}
46, 40	12.31(9.67-14.95)$^{b-f}$	29.13(26.62-31.64)^{abc}	19.11(15.71-22.50)$^{a-d}$
46, 60	13.45(9.79-17.10)$^{a-e}$	29.75(20.40-39.10)^{abc}	17.22(13.68-20.76)$^{b-e}$
92, 0	13.72(10.62-16.82)$^{a-e}$	30.43(22.85-38.01)^{abc}	15.70(11.99-19.40)$^{c-f}$
92, 20	14.39(11.16-17.63)$^{a-d}$	30.30(23.74-36.85)^{abc}	21.92(16.79-27.04)^{a}
92, 40	14.98(12.13-17.83)^{abc}	31.31(25.63-36.98)^{ab}	20.20(15.74-24.65)^{ab}
92, 60	11.46(8.25-14.68)^{def}	30.21(18.87-41.55)^{abc}	17.70(13.92-21.49)$^{b-e}$
138, 0	12.62(8.88-16.36)$^{b-f}$	25.43(20.33-30.53)$^{a-d}$	15.34(11.27-19.41)^{def}
138, 20	16.20(12.40-20.01)^{a}	30.23(24.65-35.80)^{abc}	19.29(14.21-24.36)^{abc}
138, 40	15.50(11.36-19.65)^{ab}	32.81(27.05-38.58)^{a}	21.74(18.38-25.10)^{a}
138, 60	16.15(12.86-19.44)^{a}	32.72(25.46-39.98)^{a}	17.87(15.70-20.03)^{bcd}
Mean	13.42	27.45	17.20
$LSD_{(<0.05)}$	3.33	7.41	3.86
$CV_{(\%)}$	13.42	21.88	24.05
Var	13.42(13.03-13.90)^{c}	27.45(25.95-28.91)^{a}	17.20(16.86-17.74)^{b}
$LSD_{(<0.05)}$		1.22	
$CV_{(\%)}$		24.37	

pod yields were significantly improved by the combined application of NP fertilizers at different rates, there were no a significant yield differences between smallest rates 46N 20P and 138N 60P kgha^{-1} at P<0.05 level (Table 3). In agreement with this study, El-Tohamy *et al.* [15] observed that maximum marketable dry fruit yield was obtained from plots fertilized 41 kg Nha^{-1} + 20 kg Pha^{-1} +5 t ha^{-1} FYM. The main effects (Varieties) were also significantly difference between each other, Vigro (hybrid) was significantly higher than both M. Shotte and M. Awaze, also M. Shotte significantly higher than M. awaze at 5% probability. Vigro variety has 57.78 and 104.5 % yield advantage over M. Shotte and M. Awaze varieties, respectively, also M. Shotte has 28.17% yield advantage over M. Awaze at Dugda district. In this study site the control plots pod yields of all tested cultivars were high. This may be due to the residual effects of the continuous applications of high amount of NP fertilizers for vegetables production.

The pooled mean analysis of three green peppers cultivars pod yields over years and across locations (Dugda, Fentalle and Melkassa) from 2018-2020 is presented in Table 4. The mean pod yield of green pepper significantly increased by the sub-factors and main-factors at p<0.05 level. The mean table showed that the three green pepper cultivars M. Awaze significantly lower than M. Shotte and Vigro, M. Shotte also significantly lower pod yield than Vigro in the main plot factor. The application of NP at different rates significantly boosted the pod yield as compared to N or P fertilizers alone at P<0.05 level. The application of 46kg N with 20 kg P ha^{-1} not significantly different from 138kgN with 60kg P ha^{-1} pod yield of M. Awaze and M. Shotte. Vigro pod yield significantly improved by the application of higher P level. The application of 46kgN with 40kgP statistically not different from the highest rate 138kgN with 60kg P ha^{-1} at P<0.05 level. The application of P improved the pod yield though statistically not significant in the three green pepper varieties pod yields as compared to the zero control at p<0.05 level. However, the application of the smallest dose of N 46kg ha^{-1} alone improved the pod yield of three green pepper cultivars as compared to the highest dose of P (60kg ha^{-1}) alone, this N rate 4.16, 11.63 and 6.05% yield advantage of M. Awaze, M. Shotte and vigro respectively over the highest dose of P (60kg) alone. The application of the smallest dose of N with P (46, 20) kg improved the pod yield as compared to the highest N rate (138kg) alone, the application of smallest dose of N with P 15.68, 22.68 and 1.02 % yield advantage of M. Awaze, M. Shotte and Vigro respectively over the highest N dose this implies that the combined application of N and P very important in the production of green pepper in the study areas. Lodhi *et al*. [16] described that, phosphorus is also one of the important nutrients show a major role in crop growth as it is involved in numerous key plant cellular activities like energy transfer, photosynthesis, transformation of sugars and starches and transfer of genetic characteristics from one generation to the next. It also promotes root proliferation that increases root volume and advances soil nutrient exploration. Phosphorus shortage restricted the plant growth and remains immature [17].

Partial Budget Analysis: The results of partial budget analysis for this study are presented in the following three tables (Table 5-7), the dominated treatments were not included in the Tables.

Partial budget analysis was conducted to identify the promising treatment(s) for economically feasible production of green pepper in the study area. In this partial budget analysis four rewarding treatments were observed for green pepper production. The application of N alone or N with P at different rates showed a significant economic advantage for the production of M. Awaze in the experimental sites. These rewarding treatments for the green pod production divided in to three farmers having three different financial abilities.

The application of 46kg N fertilizer alone provided the highest a marginal rate of return (MRR) of 1, 838.0 % with a net benefit (112, 356 ETB ha^{-1}) (Table 5), suggesting for each Birr invested in the production of M. Awaze green pod, the farmers having low financial abilities (can invest up to3, 000.00Et.Birr) earn additional Birr11.23 after recovering their cost of production.

The application of 46kg N with 20kg P ha^{-1} and the application of 92kg N alone gave higher net benefits 129, 027.70 and 132, 672 EtB ha^{-1} with MRR (1, 132.36 and 1, 315.32 %) respectively. Thus, these suggesting that the farmers having medium financial ability (can invest up to 6, 000.00Et. Birr) for each birr invested in the production of M. Awaze green pod the farmer earns additional Birr 11.32 and 13.15 respectively after recovering their cost of green pod productions.

The application of 138kg N with 40kg P ha^{-1} provided the highest net benefit 140, 045.70 ETB ha^{-1} with MRR=156.15%. This implying that the farmers having high financial ability, for each birr invested in the green pepper production the farmer earn additional Birr 1.56 after recapturing the cost of M. Awaze green pod production.

Table 4: Pooled pepper cultivars green pod mean yield as influenced by sub factors (Nitrogen and Phosphorus rates) and main factors (Cultivars) combined across locations (Dugda, Fentalle and Melkassa) and over years (2018-2020)

Varieties	M. Awaze (n=5)	M. Shotte (n=5)	Vigro (n=3)
N, P rate (kgha^{-1})	Mean Green PY ± SD (Mt ha^{-1})‡		
0N, 0P	7.34^{e}±3.83	9.92^{f}±4.23	15.90^{bc}±8.82
0N, 20P	9.06^{cde}±4.37	11.12^{ef}±3.93	18.51^{abc}±9.06
0N, 40P	8.51^{de}±3.32	12.76^{c-f}±4.90	12.81^{c}±6.84
0N, 60P	10.13^{b-e}±6.29	12.16^{def}±5.20	18.48^{abc}±7.79
46N, 0P	10.57^{a-e}±3.52	13.76^{b-e}±4.45	19.68^{abc}±9.16
46N, 20P	12.25^{abc}±6.12	16.23^{abc}±7.04	22.88^{abc}±7.29
46N, 40P	10.23^{b-e}±3.48	14.6^{b-e}±6.59	24.23^{abc}±7.65
46N, 60P	10.12^{b-e}±5.12	15.16^{bcd}±4.62	23.67^{abc}±11.94
92N, 0P	12.59^{ab}±3.17	15.14^{bcd}±3.98	24.97^{abc}±10.31
92N, 20P	11.6^{a-d}±4.41	16.99^{ab}±7.48	25.47^{abc}±9.03
92N, 40P	11.99^{abc}±4.40	16.43^{abc}±6.10	29.23^{ab}±5.64
92N, 60P	9.33^{b-e}±3.70	15.08^{bcd}±4.66	24.08^{abc}±13.11
138N, 0P	10.59^{a-e}±4.19	13.23^{b-f}±4.63	22.65^{abc}±5.91
138N, 20P	12.47^{ab}±5.76	15.95^{abc}±5.86	26.76^{ab}±6.95
138N, 40P	13.71^{a}±4.32	19.38^{a}±4.50	31.12^{a}±5.61
138N, 60P	13.55^{a}±4.51	16.17^{abc}±3.77	29.75^{a}±7.50
$LSD_{(<0.05)}$	3.28	3.78	7.98
$CV_{(\%)}$	41.00	35.90	36.98
Var	10.88^{c}±4.45	14.63^{b}±5.12	23.14^{a}±8.29
$LDS_{(<0.05)}$		1.97	
$CV_{(\%)}$		20.2	

? = Standard deviation

Table 5: Partial budget analysis of NP fertilizers rate on Green Pepper Production (Melka AwazeVariety)

N, P Rate	APY (Awa)	GFB	TC V	N Benefit	MRR	CB
kgha^{-1}		EtB ha^{-1}			%	Ratio
0, 0	6, 606	79272	0	79272.00		
46, 0	9, 513	114156	1800	112356.00	1, 838.00	62.42
46, 20	11, 025	132300	3272.3	129027.70	1, 132.36	39.43
92, 0	11, 331	135972	3300	132672.00	1, 315.32	40.20
138, 40	12, 339	148068	8022.3	140045.70	156.15	17.46

APY = Adjusted Pod yield, GFB= Growth Field benefit, TC T= Total cost that varies, N=net, MRR= Mergenal rate of return, CB= Cost benefit ratio

For this variety (M. Shotte) partial budget analysis four rewarding treatments were dominated other treatments in green pod production. The application of N alone or N with P at different rates showed a significant economic advantage for the production of M. Shotte in the experimental sites. These rewarding treatments for the green pod production divided in to three farmer's financial abilities.

The application of 46 kg N fertilizer alone provided a marginal rate of return (MRR) of 1, 820.0 % with a net benefit (122, 040 ETB ha^{-1}) (Table 6), suggesting for each Birr invested in the production of M. Shotte green pod, the farmers having low financial abilities (can invest up to Birr 3, 000.00) earn additional Birr 18.20 after recapturing their cost of production.

The application of 46kg N with 20kg P ha^{-1} and the application of 92kg N with 20kg provided higher net benefits 142, 797.7 and 148137.7 ETB ha^{-1} with MRR (1, 368.08 and 777.36 %) respectively. Thus, these suggesting that the farmers having medium financial ability (can invest up to 6000.00Et. Birr) for each birr invested in the production of M. Shotte green pod the farmer earns additional Birr 14.80 and 7.78 respectively after recovering their cost of green pod productions.

The application of 138kg N with 40kg P ha^{-1} gave the highest net benefit 166397.7 ETB ha^{-1} with MRR=457.85%. This indicated that the farmers having high financial ability, for each birr invested in the green pepper production the farmer earn additional Birr 4.58 after recovering the cost of M. Shotte green pod production.

In this partial budget analysis seven rewarding treatments were dominated other treatments for the green pod production in this study. The application of N alone or N with P at different rates exhibited a significant economic advantage for the production of Vigro in the experimental sites.

Table 6: Partial budget analysis of NP fertilizers rate on Green Pepper Production (Melka Shotte Variety)

N, P Rate	AGY	GFB	TC V	N Benefit	MRR	CB
---------- kgha^{-1} ----------		---------- EtB ha^{-1} ----------			%	Ratio
0, 0	8928	89280	0	89280		
46, 0	12384	123840	1800	122040	1820.00	67.8
46, 20	14607	146070	3272.3	142797.7	1368.08	43.64
92, 20	15291	152910	4772.3	148137.7	777.36	31.04
138, 40	17442	174420	8022.3	166397.7	457.85	20.74

Table 7: Partial budget analysis of NP fertilizers rate on Green Pepper Production (Vigro Hybrid Variety)

N, P Rate	AGY	GFB	TC V	N Benefit	MRR%	CB
---------- kgha^{-1} ----------		---------- EtBha^{-1} ----------			%	Ratio
0, 0	14310	143100	0.0	143, 100.0		
46, 0	17712	177120	1800.0	175, 320.0	1, 790.00	97.40
46, 20	20592	205920	3272.3	202, 647.7	1, 856.12	61.93
92, 0	22473	224730	3300.0	221, 430.0	6, 780.61	67.10
92, 20	22923	229230	4772.3	224, 457.7	205.64	47.03
138, 20	24084	240840	6272.3	234, 567.7	674.00	37.40
92, 40	26307	263070	6522.3	256, 547.7	8, 792.00	39.33
138, 40	28008	280080	8022.3	272, 057.7	1, 034.00	33.91

The application of 46 kg N fertilizer alone provided the highest marginal rate of return (MRR) of 1, 790.00 % with a net benefit (175, 320 ETB ha^{-1}) (Table 7), suggesting for each Birr invested in the production of Vigro green pod, the farmers having low financial abilities (can spent only Birr 3000.00) earn additional Birr 17.90 after recovering their cost of production.

The applications of 46kg N with 20kg P, 92kg N alone and 92kg N with 20kg P ha^{-1}gave higher net benefits 202647.70, 221430.00 and 224457.70ETB ha^{-1} with MRR (1, 856.12, 6, 780, 61 and 205.64 %) respectively. Thus, these suggesting that the farmers having medium financial ability (can invest up to 6, 000.00Et. Birr) for each birr invested in the production of Vigro green pod the farmer earn additional Birr 18.56, 67.80 and 2.06 respectively after recovering their cost of green pod productions.

The application of 138kg N with 20kg P, 92 kg N with 40kg P and 138kg N with 40kg P ha^{-1}gave high net benefit 234567.7, 256547.7 and 272057.7 ETB ha^{-1} with MRR = (674.00, 8, 792.00 and 1, 034.00 %) respectively. This implying that the farmers having high financial ability, for each birr invested in the green pepper production the farmer earn additional Birr 6.74, 87.92 and 10.34 after recapturing their cost of Vigro green pod production.

CONCLUSION AND RECOMMENDATIONS

Green pepper pod yields in all testing sites showed a significant yield effect over the zero control and to each other by the application of N or P alone and N with P under balanced fertilization.

All green pepper cultivars, green pod yields were significantly improved by the combined application of NP fertilizers at different rates, there were no a significant yield differences between smallest rates 46N 20P and the highest rate 138N 60P kg ha^{-1} at P<0.05 level. The main plot factors (Varieties) were also significantly difference between each other, Vigro (hybrid) was significantly higher than both M. shotte and M. Awaze, also M. Shotte significantly higher than M. awaze at 5 % probability. Thus, from the finding in this study the following recommendations are given based on the financial ability of the farmers.

Farmers having low financial ability (<3, 000 EtB), for the production of green pod 46kg N with20kg P ha^{-1} Melka Awaze, Melka Shotte and Vigro or 92kg N ha^{-1} alonerecommended for the production of Melka Awaze and Vigro. For farmers having medium financial ability (3000-6000EtB), for the production of green pepper 92 kg N with 20kg P ha^{-1} is recommended for the production of Melka Shotte and Vigro varieties. For the farmer having high financial ability (> 6, 000 EtB) farmers generally use high rate of fertilizers 92kg N with 40P or 138kg N with 20 kg P ha^{-1} for the production of Vigroonly and 138kg N with 40kg P ha^{-1} recommended for the production of M. Awaze, M. Shotte and Vigro varieties green pod production in the study areas and similar locations.

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