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Growth and Yield Response of Hot Pepper (*Capsicum annum* L.) to Different Rate of NPS Blended Fertilizer and Cattle Manure at Bako, West Oromia, Ethiopia

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Abstract: Hot Pepper (*Capsicum annum* L.) is one of economically important horticultural crops in Ethiopia. However, the productivity of the crop is low at national as well as regional levels which, constrained mainly by low soil fertility. A new blended fertilizer (NPS) containing nitrogen (19% N), phosphorous (38% P_2O_5) and sulfur (7% S) is recently introduced aiming at substituting DAP in Ethiopian agriculture. There is a need to optimize the fertilizer under farmers' conditions particularly its use along with organic resources. The experiment was conducted at Bako Agricultural Research Center, Oromia, Ethiopia during main cropping season. The objective of this study was to determining the optimum rates of NPS blended fertilizer and cattle manure (CM) on growth, yield and yield response and to investigate the interaction effect of NPS blended fertilizer and cattle manure application and their economic feasibility on hot pepper variety (Bako local) production. The treatments consisted of four NPS blended fertilizer levels (0, 50, 100 and 150 kg ha^{-1}) and three Cattle Manure levels (0, 3.75, and 7.5 t ha^{-1}). The experiment was laid out as a Randomized Complete Block Design and replicated three times. The results showed that the interaction effects of NPS blended fertilizer and cattle manure rates significantly influenced hot pepper growth, yield, and yield component parameters. The maximum marketable dry pod yield (2.94 t ha^{-1}) was obtained from the combined application of 150 NPS Kg ha^{-1} and 3.75 t ha^{-1} CM. Therefore, it can be concluded that the combination of these treatments gives a better yield and yield components of hot pepper in the study area.

Keywords: Hot Pepper (*Capsicum annuum* L.), NPS Blended Fertilizer, Cattle Manure, Growth, Yield Response

1. Introduction

Hot Pepper (*Capsicum annum L.*) is one of the world's most important vegetables after tomato and used as fresh, dried or processed products, as vegetables and as spices or condiments [1]. The productivity of hot pepper is constrained by lack of proper nursery and field agronomic management practices, such as adequate nutrient supply, diseases, poor aeration, unbalanced nutrient supply and lack of high yielding cultivars. Among these, nutrient deficiency is the most yield limiting factor in vegetable crop production in Ethiopia [2]. The application of balanced fertilizer is the basis to produce more crop output from existing land under cultivation [4]. It enhances sustainable production and provides nutrient needs to crops according to their physiological requirements and expected yields [19]. Chemical fertilizers specifically DAP and Urea was used for major crops production including hot pepper over decades. Good productivity can be seen from the use of chemical fertilizers, but there might be problems such as biological activities and total soil health and environmental damage. In view of this gap, the Agricultural Transformation Agency (ATA) of Ethiopia suggested the general improvement of soil fertility management system by considering inclusion of more nutrients in the fertilizer program. The supply of nutrients from organic fertilizer improves the exchange capacity due to the increase of organic matter content, soil water retention, slow release of nutrients and contributes to the residual pool of organic nitrogen and phosphorus in the soil. However, the use of organic manure alone as a

substitute to inorganic fertilizer is not sufficient to maintain the present levels of crop productivity of high yielding varieties [7]. Crop nutrients such as nitrogen, phosphorus, sulphur, and others are depleted that may be amended by the application of organic matter and the production of pepper may be increased by the combined organic and inorganic fertilizers application. Thus, integrated nutrient management in which both organic and inorganic fertilizers are used simultaneously is the most effective method to maintain a healthy and sustainably productive soil [6]. Therefore, the present study was conducted to assess the effect of NPS blended fertilizers and cattle manure on growth and yield response of hot pepper and to determine optimum rate of NPS fertilizer and cattle manure for hot pepper production at Bako, west Oromia, Ethiopia.

2. Material and Methods

2.1. Description of the Study Area

The experiment was conducted at Bako Agricultural Research Center (BARC), Western Oromia in 2019 cropping season. The site is geographically located at 260 km west of Addis Ababa and lies at 09^0 06'N latitude and 37^0 09' E longitude. It has an altitude of 1650 meter above sea level and receives an average annual rainfall of 1067.1 mm per year. The mean minimum and maximum temperature of the area was 14.5°C and 26.92°C, respectively. The soil of the study site was loamy soil with a pH of 4.5-5.8 and relative humidity of 53.92.

2.2. Experimental Materials

Bako Local hot pepper variety, which adapted to the agro-ecology of the area, was used for the study. The cattle manure collected from Bako Agricultural Research Center animal farm was used as organic fertilizer and NPS blended fertilizer containing 19%N, 38%P and 7%S was used as inorganic fertilizer.

2.3. Experimental Treatments, Design and Procedures

The experiment was consisted 12 treatment combinations, four levels of blended NPS fertilizers rates (0, 50, 100 and 150 Kg ha^{-1}), and three levels of cattle manure (CM) rates (0, 3.75, 7.5 t ha^{-1}). The levels of NPS blended fertilizers rates were set based on the recommendation made by Meresa *et al.,* who stated that application of 200 NPS Kg ha^{-1} is good for production and productivity of hot pepper [13]. Similarly, the levels of cattle manure were set based on recommendation given by Bosland and Votava, who stated 10 t ha^{-1} organic manure is best to grow pepper [3]. The experiment was laid out as a randomized complete block design (RCBD) and replicated three times. A plot size used was 2.8m wide and 3m long ($8.4m^2$) with 1.5m space between blocks and 1m between plots within a blocks. A spacing of 30 and 70 cm between plants and rows respectively was maintained. There were four rows per plot and 10 plants per row with a total of 40 plants per plot. The net harvestable plot area was $4.2m^2$. Keeping the inside two rows aside for data collection to eliminate any border effects.

2.4. Soil Sampling and Analysis

Prior to field experiment, twelve representative soil samples (0 - 20cm depth) were collected and then, bulked as one composite soil sample to determine soil physico-chemical properties (pH, OM, N, P, S, CEC and texture). Cattle manure also analysed for selected chemical composition such as total nitrogen, available phosphorus soil pH, OM% using the appropriate laboratory procedures. Determination of particle size distribution was done by using hydrometer procedure method. Organic carbon was determined following wet digestion method [22]. Total nitrogen contents were analyzed by Micro-Kjeldhal method [12]. The pH of the soil was determined using 1:2.5 soil sample to water ratio using a digital pH meter [9]. Cation exchange capacity (CEC) was measured after saturating the soil with 1 N ammonium acetate (NH_4OAc) and displacing it with 1 N NaOAc [5]. Available phosphorous was determined by Olsen's method [15]. The available S in the soil samples was extracted with monocalcium phosphate extract.

2.5. Data Collection and Analysis

Data were collected from the two middle rows of plants. The collected growth, phonological, yield components, yield and physical pod quality parameters were subjected to analysis of variance using SAS software version 9.3. Significant treatment differences were separated using the Least Significant Difference (LSD) test at the alpha level of 5%.

3. Results and Discussion

3.1. Growth Parameters

3.1.1. Plant Height

Table 1. *Interaction effect of NPS blended fertilizer and cattle manure on plant height of hot pepper.*

NPS (Kg/ha	CM (t/ha)			
	0	**3.75**	**7.5**	**Means**
0	40.40^{f}	43.33^{f}	45.30^{ef}	43.02
50	44.00^{f}	49.20^{de}	49.20^{de}	48.29
100	52.40^{cd}	54.53^{bc}	57.90^{b}	54.95
150	54.13^{bcd}	63.80^{a}	53.70^{bcd}	57.27
Means	47.73	52.73	52.15	
LSD (0.05)		5.12		
CV (%)		5.94		

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

The interaction of blended NPS fertilizer and cattle manure (CM) rates significantly ($P<0.05$) affected plant height of pepper plants (Table 1). The tallest plant height obtained from the combined application of 150 NPS Kg ha^{-1} + 3.75 CM t ha^{-1}. This could be due to better nutrient supply from NPS and CM which might in turn better plant height. The

current study result is in line with the finding of Gonzalez *et al*., who reported that application of organic manure and inorganic fertilizer has increased growth variables including plant height [10]. Similarly, El-Tohamy *et al*., reported that the increase in plant height could be initiated due to the availability of soil nutrients in the growing areas, especially nitrogen and phosphorus, which have enhancing effect on the vegetative growth of plants by increasing cell division and elongation [8].

3.1.2. Number of Primary Branches Per Plant

The analysis of variance indicate that the interaction application of NPS blended fertilizer and cattle manure was highly significant (*P<0.01*) differences with regard to the number of primary branch (Table 2). The maximum and minimum number of primary branches (5.33) and (2.13) were observed from application of 150 NPS Kg ha^{-1} + 3.75 CM t ha^{-1} and control respectively. The increase in the number of branches in response to the increases in the rates of fertilizer up to optimum could be attributed to the positive effect of nitrogen and other nutrients on promotion of vegetative growth due to its simulative effect on protein synthesis and meristematic tissues through hormonal synthesis leading to more number of buds which may have resulted in the production of more number of branches per plant.

Table 2. *Interaction effect of NPS blended fertilizer and cattle manure on primary branches of hot pepper.*

NPS (Kg/ha)	CM (t/ha)			
	0	3.75	7.5	Means
0	2.13^{h}	2.53^{gh}	2.93^{fg}	2.53
50	2.6^{gh}	3.4^{ef}	3.93^{cde}	3.31
100	3.47^{ef}	4.4^{bc}	4.93^{ab}	4.27
150	4.27^{bcd}	5.33^{a}	3.67^{de}	4.42
Means	3.12	3.92	3.87	
LSD (0.05)		0.70		
CV (%)		11.35		

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

3.1.3. Number of Secondary Branches Per Plant

Table 3. *Interaction effect of NPS blended fertilizer and cattle manure on secondary branches of hot pepper.*

NPS (Kg/ha	CM (t/ha)			
	0	3.75	7.5	Means
0	3.00^{f}	3.27^{ef}	3.80^{de}	3.36
50	3.33^{ef}	3.47^{def}	4.20^{cd}	3.67
100	3.53^{ef}	4.47^{c}	5.13^{b}	4.38
150	4.40^{cd}	6.13^{a}	4.33^{cd}	4.95
Means	3.57	4.34	3.75	
LSD (0.05)		0.6181		
CV (%)		8.93		

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

The analysis of variance indicate that the interaction application of NPS blended fertilizer and cattle manure was highly significant (*P<0.01*) differences with regard to the number of secondary branches per plant (Table 3). The largest number of secondary branches (6.13) was measured from application of 150 NPS Kg ha^{-1} + 3.75 CM t ha^{-1} treatments, whereas the lowest number of secondary branches (3.00) was counted from control plots. This might be due to the combined application of both organic and inorganic fertilizer increases the vegetative parts of the crop in addition to branch numbers. The increase in the number of branches in response to the increases in the rates of fertilizer up to optimum could be attributed to the positive effect of nitrogen and other nutrients on promotion of vegetative growth due to its simulative effect on protein synthesis and meristematic tissues through hormonal synthesis leading to more number of buds which may have resulted in the production of more number of branches per plant.

3.1.4. Canopy Diameter

The interaction effect of NPS blended fertilizer and cattle manure rates were showed significant (P< 0.05) difference on canopy diameter (Table 4). The widest canopy diameter (63.50 cm) was recorded from the combined application of 150 NPS Kg ha^{-1} + 3.75 CM t ha^{-1} treatment, whereas the narrowest canopy diameter (35.00 cm) was observed from unfertilized plot. The optimum application of fertilizers could result better canopy diameter rather than excess or lower application of fertilizers. El-Tohamy *et al*., noted that nitrogen has positive effect on branching of pepper plants [8].

Table 4. *Interaction effects of NPS blended fertilizer and cattle manure on canopy diameter (cm) of hot pepper.*

NPS (Kg/ha	CM (t/ha)			
	0	3.75	7.5	Means
0	35.00^{h}	42.00^{g}	44.60^{fg}	40.53
50	45.00^{fg}	48.80^{def}	51.33^{cde}	48.38
100	47.70^{efg}	55.88^{bc}	58.43^{ab}	54.00
150	51.40^{cde}	63.50^{a}	54.40^{bcd}	56.43
Means	44.75	52.54	52.69	
LSD (0.05)		5.7809		
CV (%)		8.28		

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

3.1.5. Days to 50% Flowering

Table 5. *Interaction effect of NPS blended fertilizer and cattle manure on days to 50% flowering of hot pepper.*

NPS (Kg/ha)	CM (t/ha)			
	0	3.75	7.5	Means
0	61.00^{g}	64.33^{ef}	66.00^{de}	63.78
50	62.00^{fg}	63.67^{efg}	65.33^{de}	63.67
100	63.00^{efg}	67.67^{cd}	69.33^{c}	66.67
150	64.67^{def}	73.67^{b}	77.33^{a}	71.89
Means	62.67	67.34	69.5	
LSD (0.05)	3.02			
CV (%)	2.68			

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

The analysis of variance revealed that interaction effect of NPS blended fertilizer and cattle manure were shows highly significant (*P < 0.01*) to influence days to 50% flowering of

pepper (Table 5). The earliest days to 50% flowering (61.00 days) and the most delayed plants in flowering (77.33 days) were recorded with unfertilized plot and the combined application of 150 NPS Kg ha^{-1} + 7.5 CM t ha^{-1} respectively. Delayed flowering in response to the interaction effect of maximum amount of mineral and organic fertilizer could be due to extended vegetative phase of the plant owing to the availability of nutrients in cattle manure [14] could also be due to enhanced soil moisture holding capacity as a result of integrated mineral fertilizer and organic manure application [21].

3.1.6. Days to Physiological Maturity

The interaction effect of NPS blended fertilizer and Cattle manure showed significant ($P < 0.05$) difference on 90% days to physiological maturity of pepper. Plants grown in controlled plots were the earliest (117.00 days) to 90% physiological maturity while plants treated with 150 NPS Kg ha^{-1} + 7.5 CM t ha^{-1} fertilizers were the latest (134.67 days) to reach 90% physiological maturity (Table 6). The use of organic manure with inorganic fertilizer leads to increase the leaf area which increases the amount of solar radiation intercepted thereby increasing days to flowering, physiological maturity, plant height and dry matter accumulation.

Table 6. *Interaction effect of NPS blended fertilizer and cattle manure on 90% days to physiological maturity of hot pepper.*

NPS (Kg/ha)	CM (t/ha)			
	0	3.75	7.5	Means
0	117.00^{g}	118.67^{efg}	121.67^{de}	119.11
50	118.33^{fg}	121.67^{de}	124.00^{cd}	121.33
100	119.00^{efg}	126.33^{c}	129.67^{b}	125.0
150	120.33^{ef}	130.60^{b}	134.67^{a}	128.56
Means	118.67	124.34	127.5	
LSD (0.05)	3.0491			
CV (%)	1.46			

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

3.2. Yield and Yield Components

3.2.1. Number of Pods Per Plant

The analysis of variation revealed the interaction effect of NPS blended fertilizer and cattle manure showed significant ($p < 0.05$) difference on the number of pods per plant (Table 7). The maximum number of pods per plant (36.80) was obtained from the plot treated with 150 NPS Kg ha^{-1} + 3.75 CM t ha^{-1} while the minimum was counted from unfertilized plot. As a general trend, it was observed that number of pods per plant was maximum in plots that received the combinations of highest inorganic fertilizer rates (150 NPS Kg ha^{-1}) relatively lower rates of organic fertilizer (3.75 CM t ha^{-1}). It is reported that unless organic fertilizer is integrated with inorganic fertilizers, the use of cattle manure alone may not fully satisfy crop nutrient demand, especially in the year of application. Supporting this result, *Shuresh et al.,* who studied the productivity of sweet pepper using different nitrogen sources in subtropical climate and found that percentage of pods set was highest on application of 50% FYM+50 UREA [20]. The minimum number of pods obtained from the combined application of lower rate of inorganic and organic fertilizer might be due to insufficient nutrient supply. Bosland and Votava) indicated that if the assimilates from leaves is limited it affects the pods of pepper [3].

Table 7. *Interaction effect NPS blended fertilizer and cattle manure on the number of pods per plant of hot pepper.*

NPS (Kg/ha)	CM (t/ha)			
	0	3.75	7.5	Means
0	15.00^{g}	17.33^{fg}	20.53^{ef}	17.62
50	17.93^{fg}	21.20^{def}	23.27^{cde}	20.8
100	23.27^{cde}	25.60^{bcd}	29.87^{b}	26.25
150	27.07^{bc}	36.80^{a}	28.80^{b}	30.89
Means	20.82	25.23	25.62	
LSD (0.05)		4.9313		
CV (%)		12.09		

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

3.2.2. Number Seeds Per Pod

The analysis of variance result showed the number of seeds per pod was significantly ($P<0.05$) influenced by interaction effect of NPS blended fertilizer and cattle manure rates (Table 8). The applications 150 NPS Kg ha^{-1} + 3.75 CM tha^{-1} produced maximum number (139.07), whereas, the minimum number (76.53) of seeds per pod were obtained from the control. The results indicated that the application of fertilizers both inorganic and organic in balanced combination produced pods with highest number and weight of seeds and thereby high economic return for farmers. Most of the time number and weight of seeds per pods are directly related. Supporting this result, Bosland and Votava, indicated the seed of some pepper cultivars can contain up to 60% of the dry weight of the fruit that makes it an important economic part of the crop [3].

Table 8. *Interaction effect of NPS blended fertilizer and cattle manure on the number of seeds per pod of hot pepper.*

NPS (Kg/ha)	CM (t/ha)			
	0	3.75	7.5	Means
0	76.53^{g}	87.93^{g}	104.60^{f}	
50	108.73^{ef}	115.20^{cdef}	118.9^{bcde}	
100	113.27^{def}	125.80^{bc}	129.5^{ab}	
150	121.53^{bcd}	139.07^{a}	112.7^{def}	
Means	105.02	117	116.4	
LSD (0.05)		12.426		
CV (%)		6.50		

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

3.2.3. Dry Seed Weight Per Pod (g)

The analysis of variance result showed the dry seeds weight per pod was significantly ($P< 0.05$) influenced by interaction application of NPS blended fertilizer and cattle manure rates (Table 9). The applications 150 NPS Kg ha^{-1} + 3.75 CM tha^{-1} produced maximum dry seed weight per pod (0.85 g), whereas the minimum dry seed weight (0.45 g) per pod was obtained from the control. Supporting this result, [3]

indicated that the seed of some pepper cultivars can contain up to 60% of the dry weight of the fruit that makes it an important economic part of the crop.

Table 9. *Interaction effect of NPS blended fertilizer and cattle manure on dry seed weight per pod of hot pepper.*

NPS (Kg /ha)	CM (t/ha)			
	0	3.75	7.5	Means
0	0.45^{g}	0.57^{ef}	0.66^{de}	0.56
50	0.51^{fg}	0.71^{bcd}	0.73^{bcd}	0.65
100	0.68^{cd}	0.77^{abc}	0.79^{ab}	0.75
150	0.69^{cd}	0.85^{a}	0.72^{bcd}	0.75
Means	0.58	0.73	0.73	
LSD (0.05)		0.1028		
CV (%)		8.96		

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

3.2.4. Fruit Length (cm)

The analysis of variance revealed the interaction effect of NPS blended fertilizer and cattle manure was highly significant (*P<0.01*) difference on the average length of pods of hot pepper (Table 10). The highest length of marketable red pod (12.11cm) was obtained from plots that received 150 NPS Kg ha^{-1} + 3.75 CM t ha^{-1} combinations whereas, the shortest length of marketable pod (7.71cm) was recorded from unfertilized plots. *Shuresh et al.,* studied the productivity of sweet pepper using different nitrogen sources in subtropical climate and found that the highest fruit length, fruit diameter and fruit weight were obtained from application of 50% FYM+50% urea the recommended rates [20]. It is in conformity with Randle and Bussard who reported that Sulphur often ranked immediately behind nitrogen, phosphorus, and potassium in terms of importance to crop productivity [16].

Table 10. *Interaction effect of NPS blended fertilizer and cattle manure on pod length of hot pepper.*

NPS (Kg/ha)	CM (t/ha)			
	0	3.75	7.5	Means
0	7.71^{f}	9.49^{bcde}	9.28^{cde}	8.83
50	8.76^{def}	8.42^{ef}	10.16^{bc}	9.11
100	8.46^{ef}	10.46^{b}	10.22^{bc}	9.71
150	9.71^{bcd}	12.11^{a}	9.5^{bcde}	10.45
Means	8.66	10.12	9.79	
LSLD (0.05)		1.1798		
CV (%)		7.32		

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

3.2.5. Pod Width (cm)

The analysis of variance revealed the interaction effect of NPS blended fertilizer and CM showed highly significant (*P<0.01*) difference on pod width of hot pepper (Table 11). The widest width of marketable red pods (2.48cm) was obtained from plots that received 150 NPS Kg ha^{-1} + 3.75 CM t ha^{-1} combinations whereas, the narrowest width (1.58 cm) of marketable pod was recorded from unfertilized plot. The optimum amount of nitrogen from inorganic and organic fertilizer sources might be important to obtain large size of pods.

Table 11. *Interaction effect of NPS blended fertilizer and cattle manure application on pod width of hot pepper.*

NPS (Kg/ha)	CM (t/ha)			
	0	3.75	7.5	Means
0	1.58^{f}	1.73^{de}	1.79^{cd}	1.7
50	1.65^{ef}	1.71^{de}	1.87^{c}	1.74
100	1.75^{de}	2.11^{b}	2.19^{b}	2.02
150	1.78^{cd}	2.48^{a}	1.80^{cd}	2.02
Means	1.69	2.01	1.91	
LSD (0.05)		0.1245		
CV (%)		3.93		

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

3.2.6. Marketable Dry Pod Yield (t ha^{-1})

The marketable pod of pepper was significantly ($p < 0.05$) influenced by the interaction effect of NPS blended fertilizer and cattle manure rates (Table 12). The maximum marketable dry pod yield (2.94 t ha^{-1}) was obtained from plot that fertilized 150 Kg NPS ha^{-1} + 3.75 CM t ha^{-1} treatments and the minimum marketable yield (1.33) was recorded from unfertilized plot. The maximum marketable dry pod yield obtained might be attributed to the enhanced pod length, pod width, higher seed weight, seed number per pod obtained at these levels of fertilizer rates.

The application of essential nutrient increases vegetative growth and this in turn had resulted in development of pods which are relatively healthy, attractive and acceptable in markets. Production of lower marketable yield from higher rate combination of inorganic and organic fertilizers could be due to toxic effect of over fertilization. Harmful effects to the young plants leading to retarded growth or death have been observed when organic matter in the form of compost or FYM is added at high rates [11].

Table 12. *Interaction effect of NPS blended fertilizer and cattle manure on marketable dry pod yield (t ha^{-1}) of hot pepper.*

Marketable dry pod yield (t/ha)				
NPS (Kg/ha)	CM (t/ha)			
	0	3.75	7.5	Means
0	1.33^{g}	1.39^{fg}	1.66^{efg}	1.46
50	1.51^{efg}	1.72^{defg}	1.79^{cdef}	1.67
100	1.61^{efg}	1.89^{bcde}	2.30^{b}	1.93
150	2.15^{bc}	2.94^{a}	2.13^{bcd}	2.41
Means	1.65	1.79	1.97	
LSD (0.05)	0.436			
CV (%)	13.77			

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

3.2.7. Unmarketable Dry Pod Yield (t ha^{-1})

The interaction effect of analysis result indicated that there was significantly ($p < 0.05$) different on unmarketable dry pod yields (Table 13). The maximum unmarketable dry pod yield (0.30 t ha^{-1}) was obtained from unfertilized plots, whereas the minimum marketable dry pod yield was recorded from the combined application of 150 Kg NPS ha^{-1} + 3.75 CM t ha^{-1} treatment.

Table 13. *Interaction effect of NPS blended fertilizer and cattle manure on unmarketable dry pod yield (t ha^{-1}) of hot pepper.*

NPS (Kg/ha)	CM (t/ha)			
	0	**3.75**	**7.5**	**Means**
0	0.30^{a}	0.25^{b}	0.20^{bc}	0.25
50	0.18^{cd}	0.17^{cd}	0.17^{cd}	0.17
100	0.16^{cde}	0.16^{cde}	0.14^{de}	0.15
150	0.15^{de}	0.12^{e}	0.17^{cd}	0.15
Means	0.2	0.18	0.17	
LSD (0.05)		0.0445		
CV (%)		14.46		

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

3.2.8. Total Dry Pod Yield (t ha^{-1})

Total dry fruit yield was significantly ($P < 0.05$) affected by the combined applications of NPS blended fertilizer and cattle manure rates (Table 14). The combined applications of 150 Kg NPS ha^{-1} + 3.75 CM t ha^{-1} produced the highest total dry pod yield (3.06 t ha^{-1}) while the lowest total dry pod yield (1.63 t ha^{-1}) was recorded from the control. However, the applications of 3.75 CM t ha^{-1} and 50 kg NPS ha^{-1} were not significantly different from unfertilized plots. This might be due to the slow release of nutrients from cattle manure and too low supply of inorganic fertilizers to the soil. The highest total dry pod yield might be due to the higher mean pod length, width, weight, seed number and relatively larger number of marketable pod obtained at this level of fertilizer supply. However, there was a yield decline at the highest rate of fertilizers supply, implying that hot pepper yield increase occurs up to a certain optimum level of fertilizer supply and then decrease afterwards [17].

Table 14. *Interaction effect of NPS blended fertilizer and cattle manure on total dry pod yield (t ha^{-1}) of hot pepper.*

NPS (Kg/ha)	CM (t/ha)			
	0	**3.75**	**7.5**	**Means**
0	1.63^{d}	1.64^{d}	1.87^{d}	1.71
50	1.69^{d}	1.89^{cd}	1.97^{cd}	1.85
100	1.77^{d}	2.05^{bcd}	2.44^{b}	2.09
150	2.30^{bc}	3.06^{a}	2.30^{bc}	2.55
Means	1.85	2.16	2.15	
LSD (0.05)	0.4307			
CV (%)	12.40			

Where, LSD = Least significance difference, CV = Coefficient variance, CM = Cattle manure

4. Summary and Conclusions

The current study was initiated with the main objective of improving the productivity of hot pepper around Bako area through the integrated use of mineral NPS blended fertilizer and cattle manure in West Oromia, Ethiopia. It has been found that the combined application of NPS blended fertilizer and cattle manure is necessary to improve the production and productivity of hot pepper in rain fed farming system in the study area.

The results revealed that almost all growth and yield parameters of hot pepper were significantly affected by different rates of NPS blended fertilizer and cattle manure application. The combined application of NPS blended fertilizer and cattle manure at the rate of 150 NPS Kg ha-1 + 3.75 CM t ha-1 gave the highest marketable pod yield of hot pepper (2.94 t ha-1). The highest net benefit (312217.50 ETB ha-1) and marginal rate of return (4036) was obtained from the combined application of 150 NPS Kg ha-1 + 3.75 CM t ha-1 rates. Therefore, the combined application of NPS blended fertilizer and cattle manure at the rate of 150 NPS Kg ha-1 + 3.75 CM t ha^{-1} can be recommended for the production of hot pepper in the study area as well as in other areas with similar agro ecologies under rain fed production system. This recommendation is made based on total costs that vary, net benefits and marginal rate of return for alternative treatments. However, sound recommendation cannot be drawn from this study since the research work was conducted only for one season in a single location.

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