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Anchote Yield Response to Blended (NPSB) and Farmyard Manure Fertilization in Southwest Ethiopia

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Abstract

In order to assess how anchote (Desta 01) responded to different dosages of NPSB fertilizer and farmyard manure (FYM), a field experiment was carried out in Jimma, southwest Ethiopia. A randomized complete block design (RCBD) with three replicates and a 3×6 factorial layout was used in the experiment. Three levels of FYM (0, 5, and 10 t ha^{-1}) and six different rates of mixed NPSB fertilizer (0, 58, 116, 175, 233, and 291 kg ha^{-1}) made up the treatments.The findings showed that the application of FYM and NPSB fertilizer had a significant interaction impact ($P<0.05$). The combined application of 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM produced the highest results for physiological maturity (149.38 days), total storage root yield (29.78 t ha^{-1}), total root weight (0.45 kg), storage root diameter (81.94 mm), and harvest index (82.86%). Furthermore, the treatment with 233 kg ha^{-1} NPSB and 10 t ha^{-1} FYM produced the highest total biomass (26.30 kg).The control treatment, on the other hand, had the lowest values for emergence percentage (69.23%), physiological maturity (119.33 days), number of vines (2.87), vine length (1.67 m), number of leaves (35.04), internode length (9.89 cm), leaf area (90.65 m^2), total biomass (14.13 kg), total storage root yield (15.85 t ha^{-1}), total root weight (0.31 kg), storage root diameter (60.22 mm), and harvest index (52.0%).According to these results, anchote yield and yield-related characteristics in the research area can be considerably increased by using FYM and NPSB fertilizer together.

To validate these findings and improve fertilizer application rates for maximum output, more study should be done in a variety of seasons and environmental settings.

Keywords: Anchote; Blended fertilizer; Farmyard manure; Storage root diameter; Root crop

Introduction

Anchote [Coccinia abyssinica (Lam.) (Cogn.)] is an important native crop in Ethiopia,primarily grown for its edible tuberous root. Grown mostly in the country's south and southwest, it is especially well-known in the Wollega region, where it coexists with other root and tuber crops in a significant way [1]. Particularly among the Oromo, anchote is highly prized for its nutritional, cultural, and historical significance. Anchote can be either wild or domesticated, and different strains produce varying amounts of roots. According to research, the root production of several anchote cultivars varies from 42 to 76 tons per hectare [2]. In addition to being an essential food source, this crop is valued for having a higher calcium and protein content than many other widely grown root and tuber crops. According to indigenous wisdom, eating anchote may help people recover from bone fractures and dislocated joints more quickly [3]. In addition to its nutritional advantages, anchote is essential to everyday living in social, cultural, economic, and medical contexts. The harvest in Wollega is especially useful from September to November, greatly increasing food security and offering vital nutrition during times of food scarcity [4]. Additionally, according to Bekele [3], the Oromo people use anchote in a variety of customary foods, rituals, and feasts served to distinguished visitors. It is also utilized in the fattening of livestock.

According to Abera and Gudeta [5], anchotes have shown a favorable reaction to organic fertilizers. In addition to providing essential nutrients, applying organic manure enhances the physical composition, organic carbon content, and water-retention ability of the soil. Degradation of the soil and nutrient depletion are two of the main issues influencing Ethiopia's crop productivity. Fertilizer scarcity and ineffective use have been ongoing challenges in the production of anchotes. While anchote is primarily maintained by women, who frequently lack the financial means to purchase fertilizers, farmers typically give priority to applying fertilizer to grain crops.According to Rashid *et al.* [6], the majority of fertilizers used in Ethiopia are used for the production of cereals, including teff, maize, wheat, barley, and sorghum. The extensive use of fertilizers for anchote production is further hampered by elements including the high cost of fertilizers, the predominance of subsistence farming, and farmers' lack of knowledge about the advantages of fertilizers for root crops [4]. Anchote is still an underdeveloped crop because of a number of factors, despite its enormous nutritional, cultural, medicinal, and agronomic significance. Among these difficulties are the dearth of well-established cultivars with comprehensive morphological and nutritional traits, the lack of precise guidelines about the best times to plant in various zones of agro- ecology, the lack of enhanced high-yielding cultivars, and the lack of knowledge about the crop's fertilizer needs.

Anchote requires a sufficient supply of nutrients because it is a crop that grows quickly and has a large potential yield [7]. There is a dearth of published data on the crop as a result of insufficient research efforts to increase its yield and consumption [2]. It is advised to use an integrated nutrient management strategy that blends organic and inorganic fertilizers in order to improve anchote production and optimize its economic potential. Thus, the goal of this study is to evaluate how anchote responds to varying rates of NPSB (nitrogen, phosphorus, sulfur, and boron) fertilizer treatment in conjunction with farmyard manure in terms of growth, yield, and yield component responses.

Materials and Methods

Description of the Experimental Site: The Horticultural Garden at JUCAVM, Ethiopia, was the site of the experiment, which was carried out in 2022–2023 under irrigation. The site, which is 1710 meters above sea level and situated in the Jimma, Oromia area (06°36' N, 37°12' E), receives 1500 mm of rainfall annually and experiences temperatures between 11.4°C to 26.8°C. The range of relative humidity is 39.92% at the lowest and 91.4% at the highest [8].

Experimental Materials: Desta 01, an anchote variety published by DZARC/EIAR in 2018, was used in the study. With a potential yield of 32.5 t ha^{-1} and creamy-colored root flesh, this cultivar is appropriate for mid- and high-altitude areas.

Treatments and Experimental Design: There were 54 plots (2×2 m each) in the trial, which used a 6×3 factorial design in an RCBD with three replications. Three farmyard manure (FYM) levels (0, 5, and 10 t ha^{-1}) and six NPSB fertilizer levels (0, 58, 116, 175, 233, and 291 kg ha^{-1}) were used as treatments. One month after seeding, decomposed FYM that was sourced locally was administered.

Experimental Procedures: Oxen were used to plow the field and plots were leveled by hand. In five-row beds, two seeds were sown at a depth of 5 cm each hill. Cow manure from JUCAVM's farm that had sufficiently decomposed used as the organic fertilizer.

Data Collection and Analysis: Seed emergence was observed twenty days after seeding. Growth and yield data were collected from five randomly selected plants per plot. The plant was deemed ripe when 90% of its leaves turned yellow. The data was analyzed using SAS 9.3, and at a 5% significance level, ANOVA and LSD were utilized.

Results and Discussion

Emergence Percentage: The analysis of variance revealed that while farmyard manure (FYM) had a substantial impact on seed emergence ($P < 0.01$) and NPSB fertilizer had a significant impact ($P < 0.05$), their interaction was not significant ($P > 0.05$). Even though it was not very different from lower rates, the maximum emergence (82.08%) was at 291 kg ha^{-1} NPSB. The control had the lowest emergence rate (75.01%). There was a 9.43% improvement in emergence when NPSB was increased from 0 to 291 kg ha^{-1}. Similarly, emergence was greatly improved by 21.81% above the control, with 10 t ha^{-1} FYM producing the highest emergence (84.33%). FYM had a higher effect, which is consistent with earlier research by Lemma (2018) and is probably the result of better soil structure, aeration, and moisture retention.

Table 1: Effect of Blended (NPSB kg ha-1) and farmyard yard manure (t ha-1) fertilizer on days to emergence of Anchote

Treatments	
(NPSB Kg ha^{-1}	Emergence Percentage (%)
0	75.01[b]
58	78.36[ab]
116	75.024[ab]
175	80.091[ab]
233	81.18[a]
291	82.08[a]
LSD (0.05)	5.38
CV (%)	7.15
Treatments	
FYM tha^{-1}	Emergence Percentage (%)
0	69.23[b]
5	82.31[a]
10	84.33[a]
LSD (0.05)	3.81

CV (%)	7.15

Key: Means sharing common letter(s) are not significantly different at 5% level of significance

Days to physiological maturity:The study discovered that days to maturity were significantly impacted by both FYM and NPSB fertilizer (P<0.01), and that their interaction was also significantly impacted (P<0.05). Although it was statistically comparable to 233 kg ha^{-1} NPSB + 10 t ha^{-1} FYM (147.42 days) and 175 kg ha^{-1} NPSB + 10 t ha^{-1} FYM (146.17 days), the longest maturity duration (149.38 days) was obtained with 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM. The control showed the shortest maturity (119.33 days). Because the highest fertilizer treatment had improved nutrient availability, plants remained vegetative for longer, delaying maturity by 13.67%. Mohammed et al. (2018) discovered a similar pattern in potatoes, which is consistent with this.

Table 2: The interaction effects of farmyard manure (t ha^{-1}) and blended (NPSB (kg ha^{-1}) fertilizer on days of physiological maturity of anchote.

Treatments NPSB rates kg ha^{-1}	**Days of Physiological maturity.**		
	FYM rates t ha^{-1}		
	0	5	10
0	119.33^{j}	127.12^{ghi}	132.28^{fg}
58	121.38^{j}	128.82^{gh}	137.92^{de}
116	124.42^{hij}	124.42^{hij}	136.25^{ef}
175	123.17^{ij}	138.38^{de}	146.17^{abc}
233	129.38^{gh}	142.48^{bc}	147.42^{ab}
291	131.42^{fg}	141.25^{dce}	149.38^{a}
LSD(0.05)	5.39		
CV (%)	2.46		

Key. Means sharing common letter(s) are not significantly different at 5% level of significance

Vine Number: According to the study, the quantity of vines was significantly impacted (P < 0.05) by the interaction between farmyard manure (FYM) and NPSB fertilizer. 2.91 kg ha^{-1} NPSB and 10 t ha^{-1} FYM produced the most vines (5.07), followed by 233 kg ha^{-1} NPSB and 10 t ha^{-1} FYM, which produced 4.69 vines. The smallest vine number (2.87) was produced by the control. Compared to the control, the number of vines increased by 76.67% when 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM were applied together. This rise is explained by increased metabolic activity and better nutritional availability, which encourage the growth of lateral shoots.

Vine Length: Vine length was strongly impacted by the combined treatment of FYM and NPSB (P < 0.05). 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM produced the longest vine (3.01 m), whereas 175 kg ha^{-1} NPSB and 10 t ha^{-1} FYM produced the second--longest vine (2.97 m). The vine length of the control was the shortest (1.67 m). Compared to the control, vine length rose by 79.64% with the application of 10 t ha^{-1} FYM and 291 kg ha^{-1} NPSB. The higher vine growth is consistent with other research showing that both organic and inorganic fertilizers encourage vine growth.

Vine Internode Length: Vine internode length was significantly impacted by the interaction between FYM and NPSB (P <

0.05). With 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM, the longest internode measured was 15.92 cm, while with 233 kg ha^{-1} NPSB and 10 t ha^{-1} FYM, it was 14.92 cm. The internode length of the control was the shortest, measuring 9.89 cm. Compared to the control, the internode length increased by 60.79% with the 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM application. Increased nutrient availability is thought to be the cause of the improvement in internode length, which boosts vine and leaf development.

Number of Leaves: The number of leaves was dramatically increased by both FYM and NPSB (P < 0.01). 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM produced the maximum leaf count (64.92), which was statistically comparable to 233 kg ha^{-1} NPSB and 10 t ha^{-1} FYM (64.42). The control had the fewest leaves (35.04). Because nitrogen-rich fertilizers promote vegetative growth, the combined application of 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM increased the number of leaves by 85.27% compared to the control.

Leaf Area: Leaf area was considerably impacted by NPSB and FYM (P < 0.01). With 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM, the greatest leaf area (156.12 cm2) was recorded; this was followed by 140.28 cm² with 233 kg ha^{-1} NPSB and 10 t ha^{-1} FYM. The control's leaf area was the smallest, at 90.65 cm². Because nitrogen availability promotes leaf growth, the 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM application increased leaf area by 74.39% over the control.

Total Biomass: Total biomass was considerably raised by the combined application of FYM and NPSB (P < 0.01). 233 kg ha^{-1} NPSB and 10 t ha^{-1} FYM produced the most biomass (26.30 kg), followed by 291 kg ha^{-1} NPSB and 10 t ha^{-1} FYM, which produced 23.91 kg. The biomass of the control was the lowest at 14.13 kg. The application of 10 t ha^{-1} FYM and 233 kg ha^{-1} NPSB enhanced total biomass by 86.13% in comparison to the control. Nitrogen-based fertilizers that boost plant production and vegetative development are responsible for the rise in biomass.

Table 3: Interaction effect of farmyard manure (t ha^{-1}) and blended (NPSB kg ha^{-1}) on growth attributes of Anchote.

Treatment FYM	NPSB	VN	VL	VIL	LN	LA	TBM
	0	2.87^{m}	1.67^{i}	9.89^{j}	35.04^{k}	90.65^{j}	14.13^{i}
	58	2.92^{lm}	1.71^{hi}	11.15^{i}	35.19^{jk}	94.51^{ij}	17.76^{defgh}
0	116	3.23^{kl}	1.99^{gh}	11.28^{i}	36.38^{ijk}	108.93^{gh}	15.93^{ghi}
	175	3.44^{jk}	2.05^{g}	11.39^{i}	38.25^{hij}	128.12^{ef}	16.43^{fghi}
	233	3.59^{jl}	2.06^{g}	11.57^{hi}	39.39^{hi}	124.37^{f}	17.07^{efghi}
	291	3.77^{ghi}	2.07^{fg}	12.24^{gh}	40.19^{hj}	144.78^{bc}	19.83^{cde}
	0	3.91^{fi}	1.68^{i}	12.32^{gh}	40.19^{gh}	94.03^{ij}	18.10^{defgh}
5	58	3.98^{eh}	1.90^{ghi}	12.37^{fgh}	43.28^{g}	97.06^{ij}	15.80^{ih}
	116	3.69^{ghi}	2.47^{de}	12.68^{fg}	47.81^{h}	113.45^{g}	19.15^{cdefg}
	175	4.07^{dg}	2.38^{e}	12.53^{fg}	49.26^{f}	123.16^{f}	19.28^{cdef}
	233	4.10^{def}	2.53^{de}	12.83^{fg}	54.48^{e}	131.97^{def}	19.50^{cdef}
	291	4.19^{c-f}	2.7^{bcd}	13.67^{de}	52.63^{e}	153.40^{ab}	19.80^{dce}
	0	4.25^{cde}	2.34^{ef}	13.76^{cde}	53.34^{e}	89.52^{j}	19.28^{cdef}
	58	4.46^{bc}	2.61^{cde}	13.13^{ef}	55.53^{de}	98.26^{ij}	18.40^{defgh}

10	116	4.44^{bc}	2.51^{de}	13.98^{cd}	58.52^{cd}	101.02^{hi}	20.45^{cd}
	175	4.34^{cd}	2.97^{ab}	14.53^{bc}	61.15^{bc}	135.13^{de}	22.23^{bc}
	233	4.69^{b}	2.86^{abc}	14.92^{b}	62.42^{ab}	140.48^{bc}	26.30^{a}
	291	5.07^{a}	3.00^{a}	15.92^{a}	64.92^{a}	156.12^{a}	23.91^{ab}
$LSD_{0.05}$		0.33	0.28	0.80	3.13	9.59	3.30
$CV_{\%}$		5.10	7.24	3.78	3.87	5.01	10.39

Key. Means sharing common letter(s) are not significantly different at 5% level of significance

Storage Root Diameter: NPSB fertilizer and farmyard manure (FYM) had a strong interaction effect ($p < 0.05$) and a highly significant main effect ($p < 0.01$) on storage root diameter. Applying 10 t FYM ha^{-1} and 175 kilogram NPSB ha^{-1} produced the biggest diameter (81.94 mm), while using 233 kg NPSB and 10 t FYM ha^{-1} produced a comparable result (76.59 mm). The control group had the smallest diameter (60.22 mm). Improved soil fertility, better nutrient availability, and increased vegetative growth are the reasons for increased root diameter with higher FYM and fertilizer rates.

Total Root Weight: Both FYM and NPSB fertilizer significantly affected total root weight ($P < 0.01$). The maximum root weight (0.45 kg) was observed with 175 kg NPSB and 10 t FYM ha-1, followed by 0.41 kg with 233 kg NPSB and 10 t FYM ha-1. The control had the lowest value (0.31 kg). Fertilizer application was associated with increased root weight, which in turn was linked to longer photosynthesis, increased canopy area, and improved vegetative growth, all of which increased root growth and yield.

Total Root Yield: FYM and NPSB fertilizer had a substantial impact on total root yield ($P < 0.01$). The combined application of 175 kg NPSB and 10 t FYM ha^{-1} produced the maximum yield (29.78 t ha^{-1}), which was not statistically different from 27.42 t ha^{-1} with 233 kg NPSB and 10 t FYM ha^{-1}. The lowest yield (15.85 t ha^{-1}) was produced by the control group. The inorganic fertilizer's quick nutrient release, which balanced the organic fertilizer's longer nutrient release and encouraged better growth and output, was the cause of the highest yield.

Harvest Index: The result was altogether influenced by FYM and NPSB fertilizer ($P < 0.01$), with the interaction impact being noteworthy ($P < 0.05$). The most elevated collect file (82.86%) was accomplished with 175 kg NPSB and 10 t FYM ha^{-1}, taken after by 80.50% with 233 kg NPSB and 10 t FYM ha^{-1}. The least esteem (52%) was recorded within the control. The expanded gather list with higher fertilizer and fertilizer rates demonstrates superior supplement accessibility, progressing both root and above-ground development. Comparative advancements in gather record were detailed in potatoes with FYM and blended fertilizer application.In rundown, combining FYM with NPSB fertilizer altogether made strides capacity root distance across, add up to root weight, surrender, and harvest record, with the finest comes about from the combined application of 10 t FYM ha^{-1} and 175-233 kg NPSB ha^{-1}.

Table 4: The interaction effect of NPSB Kg ha^{-1} and FYM t ha^{-1} fertilizer on number of yield and yield components of Anchote

Treatments		SRD	TRW	TRY	HI
FYM	NPSB				
	0	60.22^{a}	0.31^{j}	15.85^{h}	52.00^{j}
	58	63.38^{ef}	0.33i^{h}	16.62^{h}	54.04^{ij}

0	116	64.24^{ef}	0.34^{ghi}	17.34^{h}	58.41^{hij}
	175	67.92^{cde}	0.33^{ih}	18.66^{gfh}	61.76^{ghi}
	233	72.25^{bc}	0.37^{de}	21.19^{def}	70.08^{efg}
	291	71.21^{bcd}	0.35^{fgh}	18.09^{gh}	63.18^{fgh}
	0	63.48^{ef}	0.32^{ij}	20.79^{efg}	62.11^{ghi}
	58	71.81^{bcd}	0.33^{igh}	21.32^{def}	70.67^{edf}
5	116	65.51^{ef}	0.34^{igh}	22.993^{cde}	71.19^{def}
	175	72.48^{bc}	0.35^{fg}	22.79^{de}	72.65^{bcde}
	233	73.87^{b}	0.36^{ef}	23.19^{cde}	73.37^{bcde}
	291	71.37^{bcd}	0.37^{de}	23.83^{cd}	61.38^{hi}
	0	66.42^{ed}	0.35^{fg}	23.82^{dc}	74.20^{bcde}
	58	71.15^{bcd}	0.36^{fe}	22.23^{de}	79.06^{abcd}
	116	74.78^{b}	0.38^{cd}	22.81^{de}	71.71^{cde}
10	175	81.94^{a}	0.45^{a}	29.78^{a}	82.86^{a}
	233	76.59^{ab}	0.41^{b}	27.42^{ab}	80.50^{ab}
	291	73.94^{b}	0.39^{c}	25.73^{bc}	79.91^{abc}
LSD (0.05)		5.48	0.02	2.81	8.42
CV (%)		4.52	3.18	7.54	7.17

Key. Means sharing common letter(s) are not significantly different at 5% level of significance.

Summary and Conclusion

The study assessed how various treatments affected the growth and yield of anchotes. For a number of growth characteristics, the control treatment, treatments with 291 kg NPSB ha^{-1}, and treatments with 10 t FYM ha^{-1} displayed the highest and lowest values, respectively. Vine length (3.00 m), leaf area (156.12 cm2), vine number (5.07), leaf number (64.92), and vine internode length (15.92 cm) were all highest in the control treatment. On the other hand, the 291 kg NPSB ha^{-1} and 10 t FYM ha^{-1} treatment produced the lowest values for these metrics.The control had the lowest biomass at 14.13 kg, while the highest total biomass was produced by combining 233 kg NPSB ha^{-1} with 10 t FYM ha^{-1}. 175 kg NPSB ha^{-1} and 10 t FYM ha^{-1} produced the best yield and yield component variables, whereas 233 kg NPSB ha^{-1} + 10 t FYM ha^{-1} produced the maximum root production (29.78 t ha^{-1}) and total root weight (0.45 kg). 175 kg NPSB ha^{-1} and 10 t FYM ha^{-1} produced the highest harvest index (82.86%), while the control produced the lowest (52.00%).The study concluded by showing that anchote growth, yield, and yield components were greatly enhanced by the combined application of FYM and NPSB mixed fertilizer. 10 t ha^{-1} of FYM and 175 kg ha^{-1} of NPSB mixed fertilizer produced the best root output results. For optimal anchote production, 175 kg ha^{-1} of NPSB mixed fertilizer and 10 t ha^{-1} of FYM are advised; however, more research is required to validate these results.

Data Availability

Upon reasonable request, the corresponding author will provide the raw data obtained and analyzed during this work.

Conflicts of Interest

No conflicts of interest are disclosed by the writers.

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