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Response of Blended Fertilizers on the Yield and Yield Components of some Horticultural and Field Crops in the Case of Ethiopia: A Review

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Abstract: *In Ethiopia Urea and DAP (di-ammonium phosphate) are the only fertilizer sources that have been in use for the past four decades in the country with blanket recommendation (100kg DAP and 100Kg urea ha-1). This blanket recommendation often fails to take into consideration differences in resource endowment (soil type, labor capacity, climate risk) or make allowances for dramatic changes in input/output price ratio, thereby discouraging farmers from fertilizer application.*

Since absence of one or more nutrients P, S, B and Zn besides N and P can depress yield significantly this could explain, in part, the modest crop yield improvements observed over the last few decades in contrast to significant increases in fertilizer use and investment made in the country. Today, in addition to N and P, S, B and Zn deficiencies are widespread in Ethiopian soils, while some soils are also deficient in K,

To overcome the constraint Balanced fertilizers containing N, P, K, S, B and Zn in blend form are recommended for ameliorating site specific nutrient deficiencies and thereby increasing productivity. This review part was mainly focused on the newly blended fertilizers response on the growth and crop yield of different horticultural and field crops that was produced in the country.

Keywords: *blended fertilizer, crop, grain yield, nutrient, soil*

1. INTRODUCTION

In Ethiopia, fertilizer use trend has been focused mainly on the use and application of nitrogen and phosphorous fertilizers in the form of Di-ammonium phosphate (DAP) (18-46-0) and Urea (46-0-0) or blanket recommendation for the major food crops. The previous result indicated In Ethiopia fertilizer recommendations is based on very general crop specific guidelines or more often, a single recommendation for all crops (100 kg DAP (18-46-0) and 100 kg Urea (46-0-0). Urea and DAP (di-ammonium phosphate) are the only fertilizer sources that have been in use for the past four decades in the country (IFDC, 2015). This blanket recommendation often fails to take into consideration differences in resource endowment (soil type, labor capacity, climate risk) or make allowances for dramatic changes in input/output price ratio, thereby discouraging farmers from fertilizer application. Moreover, the nutrients in the blanket recommendation are not well balanced agronomically and its continued use will gradually exhaust soil nutrient reserves. According to those sources, urea and DAP (diammonium phosphate) are the only fertilizers imported into the country since 1971. Urea is chemically composed of 46% of N, while DAP contains 18% of N and 46% of P (National Fertilizer Industry Agency, 2001).

Therefore, neither yields nor profits can be sustained using imbalanced application of fertilizers, as the practice results in accelerating deficiencies of other soil nutrients. Since absence of one or more nutrients besides N and P can depress yield significantly. This could explain, in part, the modest crop yield improvements observed over the last few decades in contrast to significant increases in fertilizer use and investment made in the country. Today, in addition to N and P, S, B and Zn deficiencies are widespread in Ethiopian soils, while some soils are also deficient in K, Cu, Mn and Fe (Laekemariam, 2016; Asgelil *et al.*, 2007).

Mineral fertilizers containing N, P, K and S not only increase crop yield but also improve nutritional quality of crop yields, such as protein, oil, starch, essential amino acids and vitamins in pulses, oil seeds, tubers, and vegetables respectively (Wang *et al.*, 2008).

To overcome the constraint Balanced fertilizers containing N, P, K, S, B and Zn in blend form are recommended ameliorating site specific nutrient deficiencies and thereby increasing productivity (ATA, 2014). Although there is general perception that the new fertilizer blends are better than the traditional fertilizer recommendation (urea and DAP), their comparative advantages are not explicitly examined and understood under various production environments.

This review part was mainly focused on the newly blended fertilizers and its response on yield and yield components of different field crop and horticultural crops that was conducted recently in some parts of the country.

2. Response of Blended Fertilizers on Tef (*Eragrostis Tef* (Zucc) Trotter)

There was a significant plant height, shoot length per plant, panicle length per plant, number of tillers per plant, number of spicks per panicle and weight of seeds per panicle at maturity stage than convectional fertilizer Dap and Urea and also control plots. Whereas, application of blended fertilizer and row planting method has brought a significant effect in the *Eragrostis tef* yield and yield components grown on vertisols (Lemlem *et al.*, 2015).

As the rates of N and blended fertilizers increased the number of total tillers, productive tillers, aboveground dry biomass yield, grain yield and nutrient uptake of N, S, Zn and B were increased. The economic analysis showed that combined application of 100 kg blended fertilizer ha^{-1} supplemented with 92 kg N ha^{-1} provided relatively high net benefit and hence these could be the best rate to apply. The treatment (92 kg N + 100 kg NPSZnB kg ha^{-1}) showed high marginal rate of return, high net benefit and relatively small total cost of production for tef production (Teshome, 2018). Similarly Tekle and Wassie (2018) reported that the blended fertilizer provide significantly higher yield components and yield of tef in Tembaro district as compared with conventional N and P fertilizers. The maximum economical return recorded from the blended fertilizes (127 NPSZnB + 90 Urea) kg^{-1}(Table 1).

Table1. *Partial budget analysis data of treatment effect on tef at Tembaro district*

	Treatments						
Variables	C	NP	NPKSZnB	NPS	NPKSB	NPSB	NPSZnB
Average yield ($kgha^{-1}$)	811	1632.2	2493.3	2500	2733.3	2933.3	3122.2
Adjusted yield ($kgha^{-1}$)	729.9	1469.0	2244.0	2250.0	2460.0	2640.0	2810.0
Gross benefit (ETB)	12773.3	25707.2	39269.5	39375.0	43049.5	46199.5	49174.7
Cost of Urea-N	0	1600	0	0	0	0	0
Cost of TSP-P	0	4000	0	0	0	0	0
Cost of Blended fertilizers	0	0	2816	2936	3488	3820	4100
Total Variable Cost	0	5600	2816	2936	3488	3820	4100
Net Benefit (Birr)	12773.3	20107.2	36453.5	36439.0	39561.5	42379.5	45074.7
MRR (%)	-	1.31	-	D	5.6	8.5	9.6

Source: *Tekle and Wassie (2018)*

3. Response of Blended Fertilizers on Maize (*Zea Mays* L.)

Dagne (2016) observed that the maximum mean grain yield (8399.7 kg ha^{-1}), stover yield (8553.1 kg ha^{-1}) and total biomass yield (16867.7 kg ha^{-1}) were recorded from blended fertilizers, whereas the lowest were recorded for the control (Table 2). Also yield per unit application of N of blended fertilizer with Cu and Zn was superior to all the treatments. Accordingly, the highest agronomic efficiency of N was obtained by the blended fertilizer with Cu and Zn and the least was recorded for control at both sites. Despite field experiment was conducted on maize with the treatments blended fertilizer and lime for three consecutive cropping seasons on acid Nitisols of Jimma Kersa woreda. Whereas the result revealed that blended fertilize and lime increase yield significantly in all seasons and yield difference observed compare to recommended fertilizer (Table 3) (Jafar, 2018).

Table2. *Mean of grain, Stover and total biomass yields of maize*

Treatments	Grain yield (kgha^{-1})		Stover yield (kgha^{-1})		Total biomass yield (kgha^{-1})	
	Kejo	Ongobo	Kejo	Ongobo	Kejo	Ongobo
Control	1750.3^{c}	1953.9^{c}	2875.2^{c}	2824.8^{c}	4625.5^{c}	4778.7^{c}
Rec. NP	7425.9^{b}	7858.9^{b}	7710.1^{b}	7630.5^{b}	15136.0^{b}	15489.4^{b}
Rec. NP + Cu + Zn	7532.2^{b}	7930.4^{b}	7825.2^{b}	7725.1^{b}	15357.4^{b}	15655.5^{b}
Ble. Fer	8000.9^{a}	8233.0^{a}	8411.0^{a}	8389.0^{a}	16411.9^{a}	16622.0^{a}
Ble. fer + Cu + Zn	8103.0^{a}	8399.7^{a}	8553.1^{a}	8468.0^{a}	16656.1^{a}	16867.7^{a}
LSD (0.05)	151.80	188.74	435.35	347.22	688.49	664.22
CV (%)	1.50	1.78	4.00	3.22	3.28	3.11
SE (±)	49.26	61.24	141.28	112.68	223.42	215.55

Source: Dagne (2016)

Table3. *Blended fertilizer and limed on Mean Grain Yield Kg Over years (2015-2017) and % mean Maize grain yield (kgha^{-1}) increment over Control and Recommended NP fertilizer*

Treatment	Mean G Yield Kg/ha			Over year mean G Yield Kg/ha	% G Yield increments over Recommended NP	% G Yield increments over Recommended NP
	2015	2016	2017			
Control	3129	1008	3972	2703	-	
Recommended NP	6162	4494	6636	5764	113	3
NPSB	6585	4522	6788	5965	121	3
NPSZnB	6697	4305	7248	6083	125	6
Modified NPSZnB	6549	5199	6565	6104	126	6
NPKSZnB	5888	5184	5857	5643	109	-2
Control+Lime	3483	1244	3294	2673	-	
Recommended NP	6723	5657	5990	6123	129	
NPSB+Lime	6798	6358	7000	6719	100	10
NPSZnB+Lime	7583	5411	6526	6507	143	6
Modified NPSZnB+Lime	6997	5279	6611	6296	135	3
NPKSZnB+Lime	7167	5648	7109	6641	148	8

Source: Jafar (2018)

4. Response of Blended Fertilizers on Sorghum (*Sorghum Bicolor* (L.) Moench)

The experiment was conducted at the experimental station of Shire-Mytsebri Agricultural Research Center (SMARC) at Sheraro sub-site. The result revealed that nitrogen, phosphorus and potassium uptake by grain and stalk were significant difference among fertilizers treatments. The maximum N uptake by grain (38.56 kg ha^{-1}) and stalk (37.28 kg ha^{-1}), P uptake by grain (26.50 Kg ha^{-1}) and stalk (23.02 Kg ha^{-1}) uptake of grain (28.84 Kg ha^{-1}) and stalk (40.00 Kg ha^{-1}) was recorded from plot treated by NPKSZn fertilizer. Similarly the maximum total (Grain + Stalk) nutrients uptake were recorded from the NPKSZn treated plots (Table 4). Finally the results conclude that NPKSZn blended fertilizer can be recommended for increased sorghum productivity particularly in the study area because it improved sorghum plant nutrient uptake and yield production (Redai *et al.*, 2018).

5. Response of Blended Fertilizers on Durum Wheat (*Triticum Aestivum* L.)

The responses of blended fertilizer on durum wheat (*Triticum aestivum* L.) were conducted on two varieties Wane and Kingbird. The numbers of productive tillers per plant were significantly affected by the interaction effect of varieties and fertilizer rates. The result showed that the maximum number of productive tiller (7.7) and (6) were recorded from 300 kg NPSB + 100 kg Urea ha Wane and Kingbird varieties respectively. The highest result of Wane and Kingbird verities were improved by 42.9% and 26.7% respectively as compared to the lowest number of productive tillers per plant at control (Rut-Duga *et al.*, 2019).

The activity conducted blended fertilizer with bread wheat variety Danda'a showed that the grain yield, straw yield and above ground dry biomass was highly significantly affected by the blended fertilizers. The maximum grain yield (5.77 t ha^{-1}), straw yield (8.52 t ha^{-1}) and above ground dry

biomass (14.29 t ha-^{1}) were recorded from the treatment NPSBZn (175N + 125P_2O_5 +11.1S + 3.3B and 0.15Zn) Kg ha-^{1} rate. This might be due to the combined effect of nutrients like N, P, S, Zn and B in blended fertilizer which might have boosted growth and development of crop compared as compared to the control plots (Abebual *et al.*, 2019).

(Abebaw and Hirpa, 2018) reported that, application of blended fertilizer 200 kg blended fertilizer + 63.91 kg of urea /ha gives the maximum grain yield as compared to control and NP recommended rates. Despite that blended and urea fertilizer application with row planting yield can increase by 38 % over the blanket fertilizer recommendation of DAP and urea.

6. Response of Blended Fertilizers on Chickpea (*Cicer Arientinum* L.)

Research reports indicate that productivity of chickpea is below potential due to low soil fertility and little use of soil amendment practices, especially low use of mineral fertilizers. Four levels of blended NPSZnB fertilizer (0, 64.4, 129 and 193 kg ha-1) with standard check (100 kg DAP ha^{-1}) and four chickpea varieties (Natoli, Dalota, Arerti and Dhera) the result revealed that blended NPSZnB fertilizer significantly affected most of the agronomic parameters (China, 2018).

Despite an application of 193 kg NPSZnB ha^{-1} shortened days to flowering (49.33) and physiological maturity (99.3) Similarly, chickpea responses were maximum at 193 kg NPSZnB ha^{-1} resulted in the highest number of primary branches (3.442 plant^{-1}), total number of nodules (32.81 plant^{-1}), aboveground biomass (6494 kg ha^{-1}), seed yield (3187 kg ha^{-1}) and straw yield (3308 kg ha^{-1}) Generally significantly increased and optimum growth, yield, and yield components were obtained already in response to the application of 193 kg NPSZnB ha^{-1}, which were statistically in parity with the standard fertilizer practice of applying 100 kg DAP ha^{-1} (China, 2018).

7. Response of Blended Fertilizers on Common Bean (*Phaseoluse Vulgaris* L.)

The research activity conducted at Hawassa dume in the Meskan districts of South Ethiopia showed there was significant response observed in growth, yield and yield components blended fertilizer application level of 100 kg/ha. The economic analysis shows the highest net benefit was obtained from 100 kg NPSZnB per hectare with highest marginal rate of return (12.78%) (Lake and Jemaludin, 2018).

8. Response of Blended Fertilizers on Sugarcane (*Saccharum Officinarum* L.)

Application of balanced fertilizers could be the basis to produce more crop output from existing land under cultivation and nutrient needs of crops according to their physiological requirements and expected yields (Ryan, 2008). This can be achieved by application of blended fertilizers, the mechanical mixture of two or more granular fertilizer materials containing N, P, K and other essential plant nutrients such as S, Zn, and B.

Dereje *et al.* (2018) reported that blended fertilizer treatment with the rate of (250kg ha^{-1} blended + 94kg N) ha^{-1} at one month after harvest resulted in higher ratoon cane weight per stalk, stalk girth, cane yield, sugar yield, node length, stalk population and node number on sugarcane plant.

Table4. *The effect of fertilizer treatments on nutrient uptake of sorghum*

Treatments	Nutrient uptake (kgha-^{1})								
	Nitrogen			Phosphorus			Potassium		
	Grain	Stalk	Total	Grain	Stalk	Total	Grain	Stalk	Total
N	15.14e	17.32 d	32.46 e	8.80 f	8.37 e	17.16 f	11.24 d	17.62 d	28.85 e
P	13.37e	14.75 d	28.13 f	10.68 e	10.03 d	20.71 e	12.04 d	20.88 cd	32.92 e
NP	27.42 d	25.53 c	52.95 d	16.48 d	15.29 c	31.76 d	21.20 bc	26.95 bc	48.14 d
NPK	34.78b	35.69 a	70.46 b	23.16 b	22.30 a	45.45 b	27.45 a	38.68 a	66.13 ab
NPS	28.51d	30.93 b	59.45 c	17.91 cd	17.10 b	35.01 c	19.96 c	33.73 ab	53.69 cd
NPKS	29.30cd	29.09 b	58.39 c	17.96 cd	17.59 b	35.55 c	21.71 bc	33.82 ab	55.53 cd
NPKSZn	38.56a	37.28 a	75.84 a	26.50 a	23.02 a	49.52 a	28.84 a	40.00 a	68.84 a
NPKSZnB	30.89c	29.07 b	59.95 c	19.05 c	18.12 b	37.17 c	24.04 b	33.44 ab	57.48 c
NPKSZnB(ATA)	28.35d	28.35 b	56.71 c	17.95 cd	17.77 b	35.71 c	22.51 bc	36.03 a	58.55 bc
Control	10.16f	15.28 d	25.45 f	6.01 g	7.31 e	13.32 g	8.26 e	16.68 d	24.94 e
SEM	0.756	0.982	1.265	0.554	0.557	0.743	0.917	2.500	2.683
LSD	2.165	2.813	3.621	1.587	1.595	2.127	2.627	7.15	7.682
Significance	***	***	***	***	***	***	***	***	***

Means sharing the same letter do not differ significantly at P ≤0.05 according to the LSD test Redai *et al.* (2018)

9. Response of Blended Fertilizers on Hot Pepper (*Capsicum annuum* L.)

Soil fertility decline and a resultant nutrient deficiency is the most yield limiting factor for vegetable production including hot pepper in different agro-ecologies of Ethiopia, of them the major limiting ones are N, P and other macro and micronutrients such as K S, B and Zn deficiencies (Alemu and Ermias, 2000). Application of blended fertilizer showed significant diference among the treatments. The maximum plant height 67.33 cm, number of primary branches 3.33 and secondary branches 6.93 was observed from application of blended fertilizers rate at 150 kg NPSB + 42 kg N ha^{-1} and 150 kg NPSBZn + 44 kg N ha^{-1} respectively as compared to the recommended NP fertilizers and the control (Table 3) (Nimona *et al.*,2018)

Nimona *et al.* (2018) reported that the marketable hot pepper pod yield was significantly affected by blended fertilizer rates. The results showed that the highest marketable pod yield (2.22 t ha^{-1}) was obtained from plots treated with blended fertilizer rate of 150 kg NPSBZn + 44 kg N ha-^{1}.

Table5. *Effect of blended fertilizers type and rates on plant height, number of primary and secondary branches of hot pepper at Assosa, western Ethiopia*

Treatment (kg ha^{-1})	PH	NPB	NSB
Control	49.47^{d}	2.47^{d}	4.27^{d}
Recommended NP	57.33^{c}	2.8^{c}	5.73^{c}
100 NPSB + 28 N	63.07^{ab}	3.07^{b}	5.87^{c}
150 NPSB + 42 N	66.4^{ab}	3.33^{a}	6.47^{ab}
200 NPSB + 56 N	62.13^{abc}	3.0^{bc}	5.93^{bc}
100 NPSBZn + 29N	61.07^{bc}	3.00^{bc}	5.87^{c}
150 NPSBZn + 44N	67.33^{a}	3.13^{ab}	6.93^{a}
200 NPSBZn + 58N	62.53^{abc}	3.07^{b}	6.07^{bc}
LSD (0.05)	5.591	0.204	0.5694
CV (%)	5.22	3.91	5.52

PH=Plant height; NPB=Number of primary branches; NSB=Number of secondary branches; NPSBZn are fertilizer that contains nitrogen, phosphorous, sulfur, boron and zinc; CV=Coefficient variance; LSD= List significance difference. Nimona *et al.* (2018)

10. Response of Blended Fertilizers on Sweet Potato (*Ipomoea Batatas* (L.) Lam) And Potato (*Solanum Tuberosum* L.)

Getachew (2018) reported that blended fertilizer responded to sweet potato verities. An application of 159 kg ha^{-1} NPSB fertilizer rate is economical and recommended for sweet potato varieties production under Jimma and its vicinity of Southwest Ethiopia. The dry matter increased from 24.23 to 33.48%; 25 to 35% as NPSB increased from 0 to159 kg ha^{-1} with Kulfo and Tulla, varities respectively and from 22.07 to 30.52% in Guntutie, as NPSB increased from 0 to 214 kg ha^{-1} which implies the same flow in Starch content. The analyzed partial budget for average of 15 treatments was resulted in highest MRR at Guntutie, Kulfo and Tulla X 159 kg ha $^{-1}$ blended fertilizer with 805.19%, 577.76% and 573.41, respectively.

Means of marketable fresh storage root yield ton per hectare and mean storage root girth with the same variety that received the same NPSB level were resulted in significant different. These tested varieties with 159 kg ha^{-1} blended fertilizer were resulted in high yield Kulfo scored 39.41%, Tulla scored 34.2 % and Guntutie scored 47.7% total yield advantage over the control (Getachew, 2018).

On the other hand Potato growth parameter and yield was significantly affected by NPS blended fertilizer (150 kg ha-^{1}) gave the maximum main stem number of 8.5 and dry matter content (23.5%) respectively (Fig 1) (Amin, 2018).

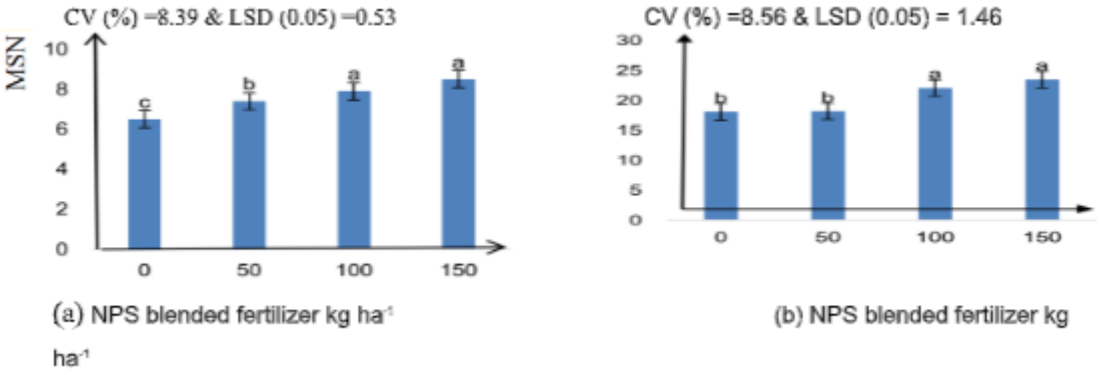

Fig1. *Effects of NPS blended fertilizer on (a) Main Stem Number of potatoes and (b) Dry Matter Content of potato tuber Amin (2018)*

11. CONCLUSION

Recent soil inventory by EthioSIS (Ethiopian Soil Information System) revealed that in addition to N and P, nutrients such as S, B, and Zn are deficient in different areas of the country. However, yields have not increased as expected even when recommendation rates of N and P fertilizers applied. This is mainly due to use of two types of fertilizers (DAP and urea) alone and this may cause unbalanced fertilizers use.

Different research activity was conducted on the response of blended fertilize on tef, maize, Sorghum, durum wheat, chickpea, common bean, sugarcane, hot pepper sweet potato and potato crops in different parts of the country. Whereas blended fertilizer improved the Yield related traits, yield and also economical acceptable as compared with the previous convectional fertilizers (DAP and urea). Generally soil test based recommended a blended fertilizer usage provides macro and micro nutrients that was needed by the crop to provide the maximum yield and which was economically feasible for the growers.

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