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Evaluation of Organic Fertilizer Products to Enhance Seed Cotton (*Gossypium* spp.) Yield in Alkaline Soil of Middle Awash Valley Ethiopia

Diriba Megersa Soboka[1*], Bethel Nekir[2] and Getinet Adugna[3]

[1]Ambo Agricultural Research Center, Ambo, Ethiopia
[2]Welkite Agricultural Research Center, Ethiopian Institute of Agricultural Research (EIAR) P.O.Box-2003, Welkite, Ethiopia
[3]Melkasa Agricultural Research Center, Ethiopian Institute of Agricultural Research (EIAR), P.O.Box- 436, Melkasa, Ethiopia

**Corresponding author*

Abstract

Melfert is the organic fertilizer that has been reported to supply a top quality organic matter and reclaim degraded soils. This study was carried out to evaluate the importance of the product for the seed cotton yield improvement. The experiment was conducted during 2018 main cropping season at Amibara District, Afar region, Ethiopia. The experiment comprised of seven treatments, and designed in randomized complete block design with four replications. Results showed that the mean seed cotton yield was significantly influenced by the application of Melfert organic fertilizer. Application of 1 t ha^{-1} Melfert organic fertilizer alone or in combination with full or one-third of the recommended rate of N (46 kg ha^{-1}) produced significantly higher seed cotton yield ($p<0.05$) compared to the recommended nitrogen fertilizer level (46 kg ha^{-1}). However, application of SeaMel^{pure} organic fertilizer alone or in combination with Melfert or recommended N did not show positive effect on seed cotton yield. Despite the yield increment with the application of Melfert organic fertilizer alone or combined with full (reduced) dose of nitrogen fertilizer, application of 46 kg ha^{-1} N, which is the existing recommendation, was still found economically feasible. Therefore, the new products could not be promoted as better management option for seed cotton production unless the cost is reduced and further investigation is advised.

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Keywords

Melfert, Middle Awash, organic fertilizer, SeaMelpure and seed cotton yield.

Introduction

In the Middle Awash Valley, where over 64% of the total cotton production of the country has been produced (EIA, 2012), fertilizer application for seed cotton production has been limited to nitrogen fertilizer only. Recently, following the development of floriculture and export-oriented large-scale commercial vegetables and fruits productions, various agricultural inputs in addition to chemical fertilizers have been imported and used. In response to such developments, importers of agrochemicals have been requesting the Ethiopian Institute of Agricultural Research (EIAR) to evaluate the efficacy of their new products. In line with this, Melspring International B.V Company requested EIAR to evaluate the efficacy of Melfert and SeaMel^{pure}

fertilizers for cotton production in the Middle Awash Valley of Ethiopia.

Melfert, an organic fertilizer product (Figure 1), has been reported to supply top quality organic matter as an excellent remedy to soils that lost their fertility. The regular use of this Melfert organic fertilizer is reported to enhance soil structure and microbial biodiversity, increasing the soil's nutrient buffer capacity (Melspring International B.V. PLC).

On the other hand, SeaMel^{Pure} has been reported as one of the purest refined seaweeds extract, where only natural processes and forces are used to refine these extracts. The product is shown to ensure strong root development and rapid absorption of macro- and micronutrients. Furthermore, the product is reported to enhance the efficacy of foliar and fertigation feeds and results in better crop quality and higher yield (Melspring International B.V. PLC). Moreover, it is believed that the product is easy to use, and safe for people and environment (Melspring International B.V. PLC). Hence, it is important to evaluate the importance of Melefrt and SeaMel^{pure} fertilizers for the seed cotton yield improvement under irrigated condition in middle Awash Valley of Ethiopia.

Materials and Methods

Description of the study area

The experiment was conducted at three farmers' field in Bedule Ale, Awash Sheleko and Koma Gidayo kebeles, and at Werer Agricultural Research Center on-station (Halay Somale kebele) during 2018 main cropping season in Amibara district, Afar Region, Ethiopia (Figure 1). The study areas are located between 8°58'20" and 9°45'0" N latitude and 40°06'40" and 40°30'0"E longitude with altitude of 740 m a.s.l at about 280 km east of Addis Ababa on the way to Djibouti main road. The average annual rainfall of the area is 593 mm, and the average maximum and minimum temperatures of the study area are 34°C and 19°C, respectively. The dominant soil type is Fluvisols that had been developed from alluvial deposition (IUSS working group WRB, 2014).

Experimental design and treatment setup

The experiment comprised of seven treatments, and arranged in randomized complete block design with four replications (Table 1). The chemical composition of the fertilizer products evaluated are indicated in Table 2. The experimental plot size was 4 m by 4.5 m with intra- and inter-row spacing of 0.20 m and 0.90 m, respectively. The net harvestable plot size was 8.1 m^2 (3 m by 2.7 m) comprising three harvestable rows, each row containing 20 plants. The common management practices such as soil and crop managements recommended for cotton production were uniformly applied to all plots. Cotton, werer-50 variety, was used in this experiment.

Treatments application methods

Nitrogen was supplied from urea, and was applied in two splits (half at planting and half at early flowering stage), while, Melfert organic fertilizer was applied along rows at planting. In accordance with the company's recommendation for SeaMel^{pure}, 2 liters of SeaMel^{pure} fertilizer dissolved in 200 liters of water per hectare, and sprayed in two splits to the soil root zone at vegetative and early flowering stages of the crop.

Data collection

Soil samples

Surface (0–30 cm) soil samples were collected from the experimental plot and composited in to one sample per each Kebele before planting, and for each treatment after harvest at 0–30 cm soil depth. The chemical compositions of the soil samples were analyzed at the Soils Laboratory of Werer Agricultural Research Center following standard procedures. Soil pH and electrical conductivity from 1:1 soil:water were measured in supernatant suspension of mixture by pH-meter (Peech, 1986) and conductivity meter, respectively. Organic matter was determined following the modified Walkley and Black wet oxidation method (Walkley and Black, 1934) and the total N by Kjeldahl procedure (Bremner, 1996). Available phosphorous was determined following the Olsen method (Olsen *et al.*, 1954) after extraction with sodium bicarbonate solution (pH 8.5).

Crop yield

Seed cotton was collected at first and second pickings from the net plots, and the total yield was determined by weighing all samples (gram $plot^{-1}$) and converted to ton per hectare for statistical analysis.

Statistical analysis

The seed cotton yield from the field experiment was subjected to analysis of variances using SAS software

version 9.0 (SAS Institute, 2002). Significant differences among treatment means were compared and separated using the least significant difference (LSD) test at 0.05 probability levels (Gomez and Gomez, 1984).

Economic analysis

Partial budget analysis technique as described by CIMMYT (1988) was conducted to test the economic returns from the use of these new fertilizers in cotton production. The analysis was done using the prevailing market prices for inputs at planting and for outputs at the time of crop harvest. The cost that varied during the conduct of this study were the prices for urea, Melfert, SeaMel^{pure}, and labor costs for transporting fertilizers to farm gate, application to soil and spray of the liquid fertilizer. All costs and benefits were calculated on hectare basis in Ethiopian Birr (ETB ha^{-1}). For a treatment to be considered as worthwhile option to farmers, the minimum acceptable rate of return (MRR) should be greater than or equal to 100% (CIMMYT, 1988).

Results and Discussion

Soil analysis results

The soil reactions of the study area in Werer ARC (7.78) and Awash Sheleko (7.99) were moderately alkaline, whereas in Koma Gidayo (8.11) and Bedulale (8.3) were strongly alkaline (Tekalign, 1991). The soils of the study area were low in available P (Olsen *et al.*, 1954), organic matter and nitrogen contents (Tekalign, 1991). The electrical conductivity of the soil samples collected before treatment application were slightly high but not to the level that could cause seed cotton yield reduction. Effects of the treatments on soil chemical properties were insignificant and showed no consistent trend (Table 2).

Seed-cotton yield

The mean seed cotton yield was significantly influenced by the application of Melfert organic fertilizer alone and integrated with recommended N (Table 3). Application of 1 t ha^{-1} Melfert organic fertilizer alone (2.86 t ha^{-1}) or combined with recommended N (46 kg N ha^{-1}) (2.91 t ha^{-1}) or with one-third of the recommended N (2.87 t ha^{-1}) produced significantly higher seed cotton yield (p<0.05) (Figure 3) as compared to the existing production practice that recommends 46 kg ha^{-1} N (2.64 t ha^{-1}; Table 3).

Application of 1 t ha^{-1} Melfert organic fertilizer alone gave 8.3% advantage of seed cotton yield over the existing recommended practice. When 1 t ha^{-1} Melfert organic fertilizer combined with recommended N or with one-third of the recommended N, the seed cotton yield advantages were 10.2 and 8.7%, respectively (Table 3).

The yield enhancement with Melfert organic fertilizer application could be due to its high organic matter content (Table 2) that can improve the soil condition for favorable plant growth. Enhancing soil organic matter content has been indicated to improve the water holding capacity of soil, beneficial microbial activity, nutrient use efficiency of crops and slow nutrient release (Emmanuel, 2015; Gete *et al.*, 2010; Oldfield *et al.*, 2018). This result was from a one-year data over multi location, while improvements in the physical, chemical and biological soil quality parameters are expected to be observed from long-term permanent-plot experiments.

Table.1 Treatment setup of the experiment

Treatments	Fertilizer combination
1	Control (no input)
2	Recommended N (46 kg ha^{-1} N)
3	1000 kg ha^{-1} Melfert
4	1000 kg ha^{-1} Melfert + 2 lit ha^{-1} SeaMel^{pure}
5	1000 kg ha^{-1} Melfert + recommended N
6	2 lit SeaMel^{pure} + recommended N
7	1000 kg ha^{-1} Melfert + 1/3 recommended N

Table.2 Compositions of fertilizer products

Fertilizer products	TN	DM	OM	P_2O_5	K_2O	CaO	SO_4	MgO
Urea	46	-	-	-	-	-	-	-
Melfert (%)	4.25	89.9	65.3	2.95	2.5	9	0.5	1.0
SeaMel^{pure}(%)	-	-	-	-	-	-	-	-
	Fe	Zn	Mn	B	Mo	Cu	Na_2O	Cl
Melfert (mg kg^{-1})	900	400	350	28	2	70	4	0.5
SeaMel^{pure} (%)	-	0.6	0.6	0.3	0	0.8	-	-

Note: *TN, DM and OM are total nitrogen, dry matter and organic matter, respectively*

Table.3 The soil chemical properties before planting and after harvest

Location	Sampling period	Trt.	pH	EC (dS m^{-1})	Avail. P (mg kg^{-1})	OM (%)	TN (%)
Werer ARC	Before planting	whole plot	7.78	1.01	5.57	1.52	0.08
	After harvest	1	7.92	0.42	22.08	1.59	0.08
		2	7.83	0.46	19.54	1.55	0.08
		3	7.95	0.46	15.4	1.66	0.08
		4	7.87	0.52	14.58	1.66	0.08
		5	7.81	0.49	16.23	1.62	0.08
		6	7.9	0.44	17.06	1.66	0.08
		7	7.91	0.52	15.4	1.62	0.08
Sheleko	Before planting	whole plot	7.99	1.07	3.46	1.66	0.08
	After harvest	1	7.86	0.37	13.75	1.28	0.06
		2	7.94	0.39	24.84	1.41	0.07
		3	7.89	0.45	12.93	1.66	0.08
		4	7.91	0.43	19.97	1.69	0.08
		5	8	0.45	28.32	1.69	0.08
		6	8.01	0.47	14.58	1.76	0.09
		7	7.95	0.62	16.23	1.45	0.07
Dirk Kebele	Before planting	whole plot	8.11	3.27	7.77	1.24	0.06
	After harvest	1	7.97	0.4	11.27	1.41	0.07
		2	7.81	0.4	10.45	1.45	0.07
		3	7.93	0.52	19.88	1.69	0.08
		4	7.91	0.49	14.47	1.79	0.09
		5	7.87	0.41	14.65	1.41	0.07
		6	7.86	0.53	15.4	1.59	0.08
		7	8	0.55	12.93	1.52	0.08
Bedulale	Before planting	whole plot	8.3	1.18	3.74	1.59	0.08
	After harvest	1	7.96	0.43	13.75	1.24	0.06
		2	7.88	0.47	14.58	1.59	0.08
		3	7.91	0.6	15.75	1.62	0.08
		4	7.9	0.49	12.93	1.83	0.09
		5	8.41	0.73	12.93	1.41	0.07
		6	7.8	0.43	14.58	1.38	0.07
		7	7.89	0.57	14.1	1.41	0.07

Note: *pH, EC, Avail. P, OM and TN are soil reaction, electrical conductivity, available phosphorous, organic matter and total nitrogen content of the soils, respectively*

Table.4 Effect of Melfert and Seamel pure fertilizers on mean seed cotton yield in the middle Awash Valley of Ethiopia

No	Treatments	Seed cotton yield (t ha^{-1})	Yield advantage over recommended N (%)
1	No fertilizer application (negative control)	2.54^{c}	-3.8
2	Recommended Nitrogen (46 kg ha^{-1} N)	2.64^{c}	-
3	1000 kg ha^{-1} Melfert	2.86^{ab}	8.3
4	1000 kg ha^{-1} Melfert + 2 lit ha^{-1} $Seamel^{pure}$	2.68^{bc}	1.5
5	1000 kg ha^{-1} Melfert + recommended N	2.91^{a}	10.2
6	2 lit ha^{-1} $Seamel^{pure}$ + recommended N	2.62^{c}	-0.8
7	1000 kg ha^{-1} Melfert + 1/3 recommended N	2.87^{ab}	8.7
	LSD	0.21	
	CV%	10.74	

Note: *Values with similar letter (s) in column are not significantly different at 5% probability level.*

Table.5 Mean seed cotton yield for each location

Study locations	Mean seed cotton yield (t ha^{-1})
Werer ARC	2.66^{a}
Sheleko	2.77^{a}
Dirk kebele	2.73^{a}
Bedulale	2.76^{a}
LSD	0.12
CV	10.74

Note: *Values with similar letter in column are not significantly different at 5% probability level.*

Table.6 Effects of Melfert and $SeaMel^{pure}$ fertilizer application on economic profitability of cotton production in Fluvisols of the middle Awash Valley of Ethiopia.

Treatment	Seed cotton yield (kg ha^{-1})	GFB (ETB ha^{-1})	TVC (ETB ha^{-1})	NB (ETB ha^{-1})	BCR	MRR (%)
No fertilizer (negative control)	2530.6	45550.8	0	45550.8		
Recommended N (RN) (46 kg ha^{-1} N)	2643.1	47575.8	1330	46245.8	34.8	52
1000 kg ha^{-1} Melfert	2853.1	51355.8	20600	30755.8	1.5	D
1000 kg ha^{-1} Melfert + 2 l ha^{-1} $Seamel^{pure}$	2678.1	48205.8	21900	26305.8	1.2	D
1000 kg ha^{-1} Melfert + RN	2898.1	52165.8	21930	30235.8	1.4	D
2 lit ha^{-1} $Seamel^{pure}$ + RN	2624.4	47239.2	2630	44609.2	17	D
1000 kg ha^{-1} Melfert + 1/3 RN	2880.6	51850.8	21042	30808.4	1.5	D

Note: *GFB, TVC, NB, BCR, MRR and ETB are gross field benefit, total variable costs, net benefit, benefit to cost ratio, marginal rate of return and Ethiopian birr, respectively*

Fig.1 Pictorial representation of Melfert product

Fig.2 Location map of the study kebeles in Amibara district

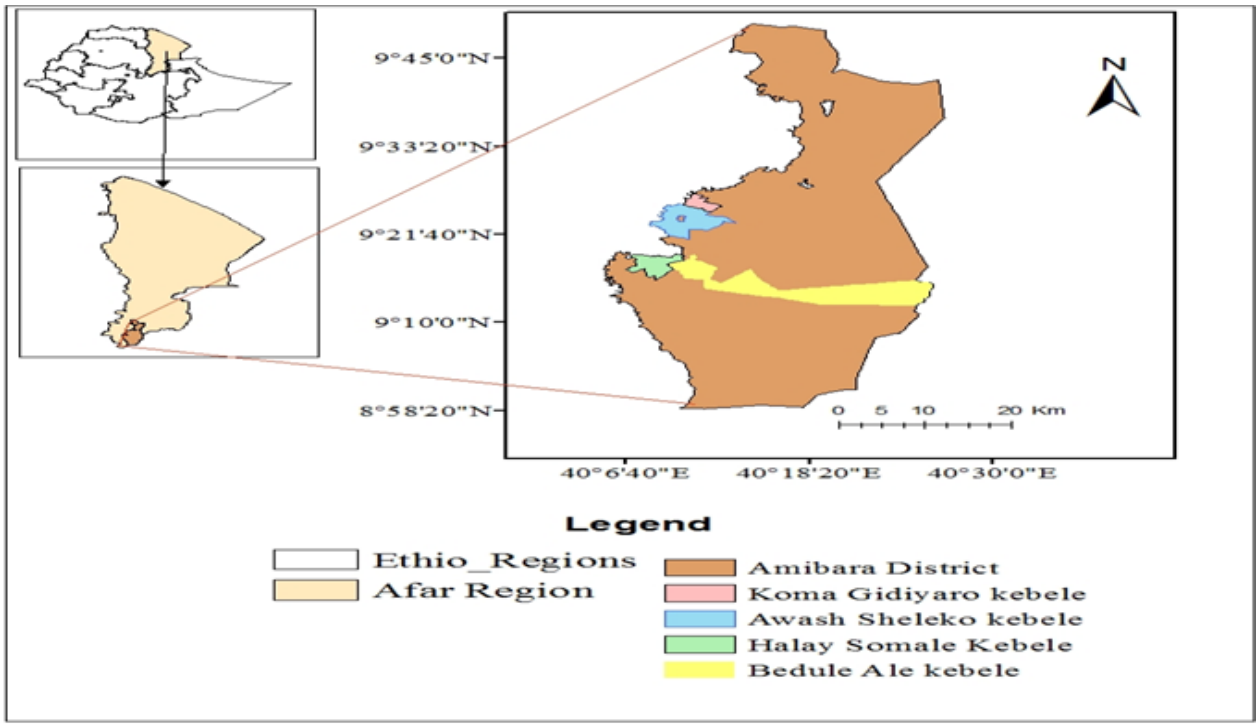

Fig.3 Field performance evaluation of Cotton crop

The low nutrient contents of the organic product coupled with its relatively high price could be attributable to unprofitability.

On the other hand, application of SeaMel^{pure} fertilizer either in combination with Melfert organic fertilizer or with recommended N did not show positive effect on the seed cotton yield. Despite the merits of SeaMel^{pure} on efficacy of nutrient uptake and hence yield increase reported in the Company's blog (Melspring International B.V. PLC), its application in this experiment showed rather a decrease in seed cotton yield. The antagonistic effect behind the decline in yield is not clear known from this experiment. Assessment of the micronutrients statuses of the soil and cotton tissue may be required before application of this product.

The analysis of variance further showed no significant difference (p>0.05) in seed cotton yield among the 4 study locations (Table 4).

Economic analysis

Application of recommended N (46 kg ha^{-1} N), the existing N fertilizer recommendation, gave the highest net benefits of EB 46,245.8 ha^{-1} with marginal rate of return (MRR) of 52%, which was less than 100% (Table 5). All other treatments were found dominated indicating that the marginal costs offset the marginal net benefits.

Hence, the result of this experiment suggest that either sole application of Melfert organic fertilizer or in combination with nitrogen fertilizer did not bring better economic return to the cotton growing farmers. It also showed no better economic return from application of SeaMel^{pure} as supplementary fertilizer.

Recommendation

Application of Melfert organic fertilizer alone or in combination with full or reduced rate of recommended rate of nitrogen (46 kg ha^{-1} N) had significantly enhanced seed cotton yield. However, the yield advantage with the use of Melfert organic fertilizer alone or as a supplement did not show appreciable economic return compared to the profit obtained from the exiting recommended practice due to the costly price of the new product. It is advised to further investigate the long-term possible positive effects of the products on soil biophysical and chemical characteristics, and yield improvements of cotton by conducting the experiment on fixed plot for at least three years.

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References

Bremner, J. M. 1996. Nitroegen-total. In: Spark, D.L. (ed.), Methods of Soil Analysis. Part 3. Chemical Methods. Soil Science Society of America, American Society of Agronomy, Madison WI, USA, pp. 1085–1121.

CIMMYT (International Maize and Wheat Improvement Center). 1988. From agronomic data to farmers' recommendations. Economics training manual. Completely revised edition. D.F. Mexico.

EIA (Ethiopian Investment Agency). 2012. Investment opportunity profile for cotton production and ginning in Ethiopia. Updated Report on Cotton Ginning. Addis Ababa, Ethiopia.

Emmanuel, I. M. 2015. Use of different organic fertilizers on soil fertility improvement, growth and head yield parameters of cabbage (*Brassica oleraceae* L). Int J Recycl Org Waste Agricult. 4:291–298.

Gete, Z., Getachew, A., Dejene, A., Shahid, R. 2010. Fertilizer and soil fertility potential in Ethiopia. Constraints and opportunities for enhancing the system. International Food Policy Research Institute, sustainable solution for ending hunger.

Gomez, K. A, Gomez, A. A. 1984. Statistical Procedures for Agricultural Research. Second Edition. John Wiley &Sons, Inc. USA

IUSS Working Group WRB. 2014. World reference base for soil resources 2014. International soil classification system for naming soils and creating legends for soil maps. World Soil Resources Reports No. 106. FAO, Rome, Italy.

Landon, J. R. 1991. Booker tropical soil manual Hand Book for soil survey and agricultural land evaluation in the tropical and sub tropics. Long man scientific and technical, ESSXEX, New York.474p.

Oldfield, E. E., Bradford, M. A., Wood, S. A. 2018. Global meta-analysis of the relationship between soil organic matter and crop yields. SOIL Discuss. Avaiable at https://doi.org/10.5194/soil-2018-21.

Olsen, S. R., Cole, C. V., Watanabe, F. S., Dean, L. A. 1954. Estimation of available phosphorus in soils by extraction with sodium bicarbonate. U.S. Dep. of Agric. Circ. 939.

Peech, M. 1986. Hydrogen ion activity. In:Methods of Soil Analysis. Part 2. Chemical and Microbiological Properties. Agronomy Monograph 9, pp. 914–925.

SAS, 2003. Statistical analysis system: version 9.0, SAS Institute Inc, Cary, North Carolina, USA.

Tekalign, T. 1991. Soil, plant, water, fertilizer, animal manure and compost analysis. Working Document No. 13. International Livestock Research Center for Africa, Addis Ababa.

Walkley, A., Black, I. A. 1934. An examination of the Degtjareff method for determining soil organic matter, and a proposed modification of the chromic soil titration method. Soil Sci. 37: 29–38.

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