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The Effect of Nano Fertilizer on Teff Yield and Yield Components in Ethiopia

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Abstract: Nano technology increases the nutrient use efficiency. The experiment to test nano fertilizers on tef was conducted at the teff crop producing areas of Adet, Meray, and Meshenti areas. A total of sixteen fertilizer combinations of urea, DAP (Di Amonium phosphate) and Nano fertilizers including without fertilizer and without nano checks were tested on 2m X 1.5m plot size. The materials were planted in RCBD (Randomized Complete Block Design) with three replications. Spacing between replications and plots were 1 meter and 0.5 meter respectively. The seed and fertilizer rates were used as per recommendation rate per hectare bases. The nano fertilizer was tested as early as seed dressing and field spray during tillering stage. The performances of nano fertilizer over all locations have shown consistence results at all locations. Analysis of variance showed that there is a significant difference between the treatments for all parameters including grain yield. The highest grain yield (38 Q/ha) was recorded at the treatment combination of 2gm/ha nano seed dressing, 39g DAP and 10.8g urea. And the least grain yield (2.5 Q/ha) was recorded at treatment combination of no nano and no fertilizer treatments. Here all nano treatment combinations without DAP and urea fertilizers gave grain yield less than 7Q/ha. Which implies that Nano fertilizers cannot act solely without DAP and Urea. The least maturity date (119 dates) and the highest plant height (132.4 cm) was also recorded at a treatment combination of 2gm/ha nano seed dressing, 39g DAP and 10.8g urea. This implies that the crop at these treatments was vigor and was able to mature early.

Keywords: Nano, Tef Seed Dressing, Spray, Tillering, Days to Maturity, Grain Yield

1. Introduction

Agriculture is always the backbone of many developing countries. It does not only fill the people abdomen but also it is the part of economy. In concern of providing food to continuously growing population there has to be a new technology giving more yields in short period. In agriculture the main reason to use fertilizer is to give full-fledged macro and micro nutrients which usually soil lacks. To overcome all these drawbacks a smarter way i.e., nanotechnology can be one of the source. Since fertilizers are the main concern, developing nano based fertilizer would be a new technology in this field. The inorganic fertilizers are supplied in order to provide three main components namely nitrogen, phosphorous and potassium [4]. Nanotechnology increases the Nutrient use efficiency (NUE) and it also provides stress tolerating ability. Irrespective of the type of crop it can be used, it will be the complete bio source increasing the eco friendly nature builds carbon uptake, improves soil aggregation. Nanotechnology is gathering information of atom in nano scale range, with considering the physical, catalytic, magnetic, optical properties [11]. However, the technology chronically exposes soil microbes and micro fauna, as well as the plants themselves, to level of chemical reactivity that may be toxic [15]. Nano fertilizer is used to improve soil fertility, plant productivity and quality of agricultural products [6]. Nano-fertilizers may be absorbed by plants rapidly and completely [10]. Nano fertilizer is the most important field of agriculture and has more attention due to its capability to increase yield, improve soil fertility, reduce pollution and make a favorable environment for microorganisms [7]. The Nano fertilizers provide more surface area for different metabolic reactions in the plant which increases the rate of photosynthesis and produce more dry matters and yield of the crops, it has a slower release with uniform quantities compared to the conventional

fertilizer application [13]. Nowadays farmers are striving to overcome nutrient deficiency by using more amounts of synthetic inorganic fertilizers [14]. There is more attention for nanotechnology in the agricultural sector and great potentials for it is higher reactivity, enhanced bioavailability and bioactivity, adherence effects and surface effects of nanoparticles [9]. Nanotechnology as a novel science has a good scenario for achieving sustainable agriculture, particularly in developing countries [2]. Nano-fertilizers are necessary to increase plant growth and crop productivity, and implement fruit quality through improvement nutrients efficiency and providing optimum usage of nutrients [1]. Heavy use of nitrogen (N) and phosphorus (P) fertilizers causes eutrophication problems in freshwater bodies and coastal ecosystems world-wide [3] and [5]. Heavy use of nitrogen (N) and phosphorus (P) fertilizers is responsible for serious environmental pollution [8]. Production of nano-fertilizers can be increased the value chain of the entire agriculture production system [12].

Objective

To test and recommend Nano fertilizer for teff production in Ethiopia.

2. Material and Methods

The experiment was conducted at the major teff crop producing areas of Adet, Meray and Meshenti areas.

Table 1. *Descriptions of Soil type, altitude, latitude and longitude of testing locations.*

Location	Altitude (m.a.s.l)	Soil type	Global positions	
			Latitude	Longitude
Adet	2240	Vertisol	11° 16` N	37° 29` E
Merawi	1901	Nitosol	11° 41` N	37° 15` E
Meshenti	1800	Nitosol	11° 47` N	37° 28` E

A total of sixteen fertilizer combinations of urea, DAP (Di Amonium phosphate) and Nano fertilizers including without fertilizer and without nano checks were tested on 2m X 1.5m plot size. The materials were planted in RCBD (Randomized Complete Block Design) with three replications. Spacing between replications and plots were 1 meter and 0.5 meter respectively. The seed and fertilizer rates were used as per recommendation rate per hectare bases. The nano fertilizer was tested as early as seed dressing and field spray during tillering stage. Any farmers' suggestions and feed backs were incorporated.

Table 2. *Treatment combinations.*

Plot №	Seed dressing	Field spray
1	0.5gm/ha Nano	5gm/ha Nano
2	0.5gm/ha Nano	10gm/ha Nano
3	0.5gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot
4	0.5gm/ha Nano	No nano/Fertilizer treatment (control)
5	1.0gm/ha Nano	5gm/ha Nano
6	1.0gm/ha Nano	10gm/ha Nano
7	1.0gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot
8	1.0gm/ha Nano	No nano/Fertilizer treatment (control)
9	2.0gm/ha Nano	5gm/ha Nano
10	2.0gm/ha Nano	10gm/ha Nano
11	2.0gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot
12	2.0gm/ha Nano	No nano/Fertilizer treatment (control)
13	No nano trt	5gm/ha Nano
14	No nano trt	10gm/ha Nano
15	No nano trt	39 gm DAP and 10.8 gm Urea per plot
16	No nano trt	No nano/Fertilizer treatment (control)

Data collection included

1) Days to maturity
2) Plant height
3) Grain yield

3. Results and Discussion

Adet: The performance analysis of variance at Adet (see table 3) showed that there is a significant difference between the treatments for all parameters including grain yield. The highest grain yield (37.6 Q/ha) was recorded at the treatment combination of 2gm/ha nano seed dressing, 39g DAP and 10.8g urea. And the least grain yield (2.4 Q/ha) was recorded at treatment combination of no nano and no fertilizer treatments. Here all nano treatment combinations without DAP and urea fertilizers gave grain yield less than 7Q/ha. Which implies that Nano fertilizers cannot act solely without DAP and Urea. This is because, if the nano fertilizers are to intensify the nitrogen use efficiency of the crop, then addition of nitrogen sources DAP and urea will be mandatory. The least maturity date (119 dates) and the highest plant height (132.2 cm) was also recorded at a treatment combination of 2gm/ha nano seed dressing, 39g DAP and 10.8g urea. Which implies that the crop at these treatments was vigor and matured early.

Table 3. *Mean grain yield and other important agronomic characters of teff on the nano fertilizer trial at Adet.*

Entries	Seed treatments	Field spray	Days to maturity	Plant height (cm)	Grain yield (Q/ha)
1	0.5gm/ha Nano	5gm/ha Nano	124	129.5	4.9
2	0.5gm/ha Nano	10gm/ha Nano	119	130.4	6.2

Entries	Seed treatments	Field spray	Days to maturity	Plant height (cm)	Grain yield (Q/ha)
3	0.5gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot	119	132.5	35.6
4	0.5gm/ha Nano	No nano/Fertilizer treatment (control)	123	130.6	4.2
5	1.0gm/ha Nano	5gm/ha Nano	121	131.6	5.5
6	1.0gm/ha Nano	10gm/ha Nano	120	129.5	5.4
7	1.0gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot	121	131.5	36.5
8	1.0gm/ha Nano	No nano/Fertilizer treatment (control)	121	129.8	5.4
9	2.0gm/ha Nano	5gm/ha Nano	123	130.7	5.5
10	2.0gm/ha Nano	10gm/ha Nano	125	129.5	5.8
11	2.0gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot	119	132.2	37.6
12	2.0gm/ha Nano	No nano/Fertilizer treatment (control)	122	129.4	5.02
13	No nano trt	5gm/ha Nano	123	131.2	5.12
14	No nano trt	10gm/ha Nano	120	130.2	5.45
15	No nano trt	39 gm DAP and 10.8 gm Urea per plot	121	131.8	36
16	No nano trt	No nano/Fertilizer treatment (control)	123	129	2.4
Mean			121.56	130.59	12.91
CV%			1.95	5.92	6.52
LSD (0.05)			2.50**	1.52**	0.96**

Meshenti: Analysis of variance at Meshenti (see table 4) showed that there is a significant difference between the treatments for all parameters including grain yield. The highest grain yield (37.9 Q/ha) was recorded at the treatment combination of 2gm/ha nano seed dressing, 39g DAP and 10.8g urea. And the least grain yield (2.6 Q/ha) was recorded at treatment combination of no nano and no fertilizer treatments. Here all nano treatment combinations without DAP and urea fertilizers gave grain yield less than 7Q/ha. Which again implies that Nano fertilizers cannot act solely without DAP and Urea at Meshenti too. The least maturity date (120 dates) and the highest plant height (133.1 cm) was also recorded at a treatment combination of 2gm/ha nano seed dressing, 39g DAP and 10.8g urea. This implies that the crop at these treatments was vigor and matures early like the other locations.

Table 4. *Mean grain yield and other important agronomic characters of teff on the nano fertilizer trial at Meshenti.*

Entries	Seed treatments	Field spray	Days to maturity	Plant height (cm)	Grain yield (Q/ha)
1	0.5gm/ha Nano	5gm/ha Nano	124	128.4	5.2
2	0.5gm/ha Nano	10gm/ha Nano	121	131.2	5.9
3	0.5gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot	120	132.3	35.8
4	0.5gm/ha Nano	No nano/Fertilizer treatment (control)	121	131.3	3.9
5	1.0gm/ha Nano	5gm/ha Nano	123	132.2	5.1
6	1.0gm/ha Nano	10gm/ha Nano	123	130.2	5.6
7	1.0gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot	120	132.1	37.0
8	1.0gm/ha Nano	No nano/Fertilizer treatment (control)	123	130.4	5.5
9	2.0gm/ha Nano	5gm/ha Nano	123	131.3	5.3
10	2.0gm/ha Nano	10gm/ha Nano	123	130.0	5.6
11	2.0gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot	124	133.1	37.9
12	2.0gm/ha Nano	No nano/Fertilizer treatment (control)	120	130.4	5.14
13	No nano trt	5gm/ha Nano	121	129.8	5.20
14	No nano trt	10gm/ha Nano	123	131.0	5.23
15	No nano trt	39 gm DAP and 10.8 gm Urea per plot	122	131.0	36.2
16	No nano trt	No nano/Fertilizer treatment (control)	121	130.2	2.6
Mean			122.0	130.9	12.9
CV%			2.14	5.7	8.4
LSD (0.05)			1.96**	2.04**	0.91**

Meray: Analysis of variance at Meray (see table 5) showed that there is a significant difference between the treatments for all parameters including grain yield. The highest grain yield (38.5 Q/ha) was recorded at the treatment combination of 2gm/ha nano seed dressing, 39g DAP and 10.8g urea. And the least grain yield (2.5 Q/ha) was recorded at treatment combination of no nano and no fertilizer treatments. Here all nano treatment combinations without DAP and urea fertilizers gave grain yield less yields than together with together with them. Which again implies that Nano fertilizers cannot act solely without DAP and Urea at Meray too. The least maturity date (118 dates) and the highest plant height (135.5 cm) was also recorded at a treatment combination of 2gm/ha nano seed dressing, 39g DAP and 10.8g urea. This implies that the crop at these treatments was vigor and matures early like Adet and Meshenti too.

Table 5. *Mean grain yield and other important agronomic characters of teff on the nano fertilizer trial at Meray.*

Entries	Seed treatments	Field spray	Days to maturity	Plant height (cm)	Grain yield (Q/ha)
1	0.5gm/ha Nano	5gm/ha Nano	126	133.3	5.2
2	0.5gm/ha Nano	10gm/ha Nano	121	124.5	6.2

Entries	Seed treatments	Field spray	Days to maturity	Plant height (cm)	Grain yield (Q/ha)
3	0.5gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot	120	133.1	39
4	0.5gm/ha Nano	No nano/Fertilizer treatment (control)	119	132.6	5.4
5	1.0gm/ha Nano	5gm/ha Nano	122	123.2	5.6
6	1.0gm/ha Nano	10gm/ha Nano	126	126.1	5.8
7	1.0gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot	120	133.6	37.5
8	1.0gm/ha Nano	No nano/Fertilizer treatment (control)	120	130.4	4.7
9	2.0gm/ha Nano	5gm/ha Nano	128	131.6	6
10	2.0gm/ha Nano	10gm/ha Nano	127	125.1	5.1
11	2.0gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot	118	135.5	38.5
12	2.0gm/ha Nano	No nano/Fertilizer treatment (control)	117	125.7	5.56
13	No nano trt	5gm/ha Nano	119	130.2	6.48
14	No nano trt	10gm/ha Nano	126	124.3	4.92
15	No nano trt	39 gm DAP and 10.8 gm Urea per plot	129	131	37.3
16	No nano trt	No nano/Fertilizer treatment (control)	116	125.4	2.5
Mean			122.12	129.1	13.5
CV%					
LSD (0.05)					

Combined: The performances of nano fertilizer over all locations have shown consistence results at all locations. Analysis of variance (see table 6) showed that there is a significant difference between the treatments for all parameters including grain yield. The highest grain yield (38 Q/ha) was recorded at the treatment combination of 2gm/ha nano seed dressing, 39g DAP and 10.8g urea. And the least grain yield (2.5 Q/ha) was recorded at treatment combination of no nano and no fertilizer treatments. Here all nano treatment combinations without DAP and urea fertilizers gave grain yield less than 7Q/ha. Which implies that Nano fertilizers cannot act solely without DAP and Urea. This is because, if the nano fertilizers are to intensify the nitrogen use efficiency of the crop, then addition of nitrogen sources DAP and urea will be mandatory. The least maturity date (119 dates) and the highest plant height (132.4 cm) was also recorded at a treatment combination of 2gm/ha nano seed dressing, 39g DAP and 10.8g urea. Which implies that the crop at these treatments were vigor so that it matures early.

Table 6. *Mean grain yield and other important agronomic characters of teff on the nano fertilizer trial combined over locations.*

Entries	Seed treatments	Field spray	Days to maturity	Plant height (cm)	Grain yield (Q/ha)
1	0.5gm/ha Nano	5gm/ha Nano	125	130.4	5.1
2	0.5gm/ha Nano	10gm/ha Nano	120	128.7	6.1
3	0.5gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot	119	133.7	36.8
4	0.5gm/ha Nano	No nano/Fertilizer treatment (control)	121	131.5	4.5
5	1.0gm/ha Nano	5gm/ha Nano	122	129.0	5.4
6	1.0gm/ha Nano	10gm/ha Nano	123	128.6	5.6
7	1.0gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot	120	132.4	37
8	1.0gm/ha Nano	No nano/Fertilizer treatment (control)	120	130.2	5.2
9	2.0gm/ha Nano	5gm/ha Nano	124	131.2	5.6
10	2.0gm/ha Nano	10gm/ha Nano	125	128.2	5.5
11	2.0gm/ha Nano	39 gm DAP and 10.8 gm Urea per plot	119	132.4	38.0
12	2.0gm/ha Nano	No nano/Fertilizer treatment (control)	121	128.5	5.24
13	No nano trt	5gm/ha Nano	121	130.4	5.6
14	No nano trt	10gm/ha Nano	123	128.5	5.2
15	No nano trt	39 gm DAP and 10.8 gm Urea per plot	124	131.4	36.5
16	No nano trt	No nano/Fertilizer treatment (control)	120	128.2	2.5
Mean			121.68	130.20	12.90
CV%			1.95	6.71	9.32
LSD (0.05)			2.50**	1.44**	0.85**

Market Analysis

The marginal rate of return which is gained from Nano over DAP and urea has to be greater than the initial cost of Nano fertilizer. Or in other words, the cost of the additional yield which is gained from application of Nano in addition to DAP and urea must be greater than the initial cost of the added nano. There is a 1.5Q/ha difference between the nano without DAP and urea (36.5Q/ha) and nano with DAP and urea (38Q/ha). The current price of teff is 1,500 Ethiopian Birr. For a hectare of land four packet of nano fertilizer is need. If we take the price of nano packet $11 US dollars, then $44 US dollars or 880 Ethiopian birr will be needed for a hectare of land. So, there is a difference of 700 Ethiopian birr or $35 US dollars. Hence the nano fertilizer is cost effective.

4. Conclusion and Recommendation

The nano fertilizer are latest relevant technologies. Even

though it seems difficult to get the market opportunity, I strongly recommend the nano fertilizers especially for large state and investment farms. Besides, as the technology is new and needs technical procedure, continues trainings for the farmers are important. Otherwise, miss use of it might cause toxicity of those small scale farms.

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