IJMPR 2018, 2(5), 111-116

International Journal of Modern Pharmaceutical Research
www.ijmpronline.com

ISSN: 2319-5878
IJMPR
Research Article
SJIF Impact Factor: 3.458

EFFECT OF RATE AND COMBINATION OF DAP AND UREA FERTILIZERS ON GERA POTATO (*SOLANUM TUBEROSUM L.)* VARIETY YIELD AT DEBRE BERHAN, NORTH SHEWA ZONE, AMHARA, ETHIOPIA

Wubshet Mamo*

Assistant Researcher, Ethiopian Biodiversity Institute, Crop and Horticulture Biodiversity Directorate.

Received on: 12/09/2018
Revised on: 03/10/2018
Accepted on: 24/10/2018

***Corresponding Author**
Wubshet Mamo*
Assistant Researcher, Ethiopian Biodiversity Institute, Crop and Horticulture Biodiversity Directorate.

ABSTRACT

Potato (Solanum tuberosum L.) is the major world food crop and worldwide the most important vegetable crop in terms of quantities produced and consumed. It ranks fourth after maize, rice and wheat. Potato was introduced to Ethiopia around 1858 by German botanist, Schimper. It is the second most important tuber crop next to 'Enset' in the country. Under Ethiopian condition the utilization of fertilizers (DAP, Urea) to improve potato yield is not common; attributed to lack of information regarding suitable fertilizers and their methods, rate and time of application for efficient use. Though there is recommended rate of nitrogen and phosphorous fertilizers, the work done so far is blanket recommendation, not updated and there is rise in fertilizer price that needs new study. This study was initiated to identify proper combination and rate of 'N and P' fertilizer application for potato crop. The research was carried out at Debre Berhan University campus demonstration site using irrigation. The experimental design was arranged in a randomized block design with three replications. Treatments were 100% DAP, 50% Urea; 100% DAP, 75% Urea; 50% DAP, 100% Urea;75% DAP, 100% Urea; 100% DAP, 100% Urea; and unfertilized control (0 DAP and 0 Urea). Data on uniformity, tuberization, quality of tubers in terms of shape and size were collected from central rows. Furthermore, number of tillers per plant, days to flowering, stem thickness, plant height, number of tubers per plant and yield (t/ha) were collected. Treatments that received 100% DAP, 50% Urea and 50% DAP, 100% Urea showed higher yield than other treatments. Yet the difference is not statistically significant except for the control. The difference needs further investigation in terms of cost and benefit analysis.

KEYWORDS: Potato, tuberization, fertilizer, rate, combination, Debre Berhan.

1. INTRODUCTION

1.1 Background of the Study

Potato (*Solanum tuberosum L.)* is the member of Solanaceae family (Beukema H., 1990). It is the major world food crop and by far the most important vegetable crop in terms of qualities produced and consumed worldwide ranking fourth (309 million metric tons per year) after maize, rice and wheat with the estimated production area of 18.5 million hectare and average yield of 16.7 tons per hectare (FAO, 2007). Potato is an important food and cash crop in Eastern and Central Africa playing a major role in national food security and nutrition, poverty alleviation and income generation and provides employment in the production, processing and marketing sub-sectors (Lung`aho, 2007).

Potato crop was introduced to Ethiopia around 1858 by German botanist, Schimper (Pankhurst, 1964). Unlike its long history of cultivation and the existence of suitable climate and edaphic conditions in the country, potato production is low (Horton Y., 1987). Potato is the second most important tuber crop grown in the country next to 'Enset' (*Ensete ventricosum L.)* in terms of area coverage (Girma, 2001).

The current area under potato production in Ethiopia is about 73095 hectares which is an average national yield of 9.86 tons per hectare for the main cropping season (CSA, 2007). It has now become an important food and cash crop in Ethiopia, especially in the highland mid altitude areas. It has also promising prospect in improving the quality of basic diet in both rural and urban areas for the country (Kullaya K., 1980). As a food crop, it has a great potential to supply a high-quality food with in a relatively short period and is one of cheapest source of energy. Potatoes produce 54% more protein per unit of land area than wheat, and 78% more than rice. Potato crop is very important for countries like Ethiopia where inadequate protein and supplies of calories are the apparent nutritional problems (Berga, 1994).

Under Ethiopian condition the utilization of fertilizers (DAP, Urea) to regulate potato yield is not common

which is attributed to lack of information regarding suitable fertilizers and their methods, rate and time of application for efficient use. However, the efficient use of application and optimum rate of fertilizers must be identified and its influence on the subsequent performance of the crop should be studied.

Many diverse and complex biotic and (abiotic and atmospheric) factors have contributed to the existing low productivity of potato in Ethiopia (Lommen W., 1995). Among others poor growing practices, lack of good quality planting materials, low use of inputs and poor control of diseases and pests, improper planting and harvesting, rigid traditional food habit of the people and poor soil management practices can be mentioned as major constraints (Berga, 1994).

Though there is recommended rate of nitrogen and phosphorous fertilizers the work is (a) blanket that is not specific to Debre Berhan area, (b) it is not updated, (c) The rise in fertilizer price needs new study.

The overall objective of this study was to identify proper combination and optimum rate of fertilizer application on potato yield and the specific objectives of this study were to identify proper combination of N and P fertilizers and to identify optimum rate of fertilizer application to increase potato yield. The best combination of Urea and DAP fertilizers were identified. Moreover, the right dose or rate was known to increase potato yield at Debre Berhan.

2. METHODS AND MATERIALS

2.1 Description of the Study Site

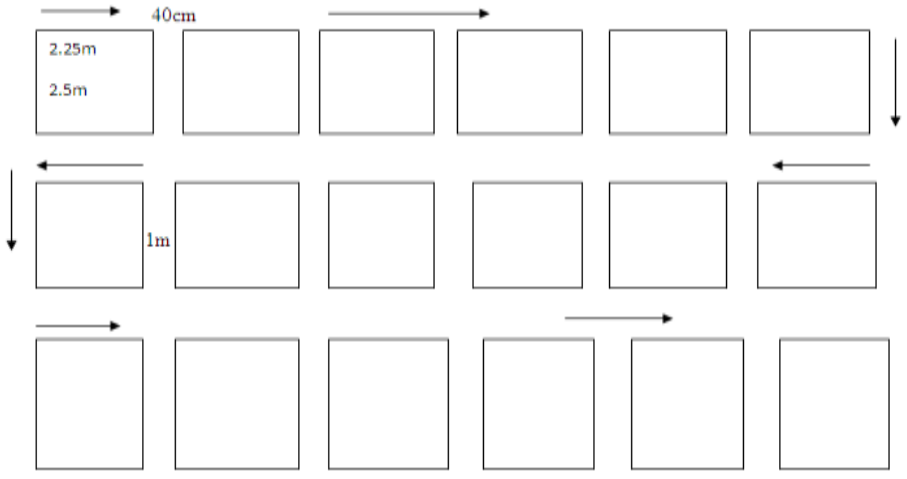
The study was carried out at Debre Birhan University campus at the demonstration site of the department of plant science (Fig.1) using irrigation. This site is situated at an altitude of 2750 meters above sea level; 39-degree North and 9 degree and 36-minute South longitude; it is located at 130 kilometers North East of Addis Ababa along Dessie road. The area is characterized by a mean annual rainfall of 940 millimeters. The average annual minimum and maximum temperature is 10 and 24 degree centigrade, respectively. The soil type is vertisol (DBAO, 2011, unpublished).

Fig. 1: Research site-DBU campus.

2.2 Experimental Design and Treatments

2.2.1 Experimental Design

The experimental plots were laid down in a randomized complete block design (RCBD) with three replications. The design had 18 plots. Each plot had 3-rows, where 7 potatoes planted per row; totally one plot contained 3 rows and 21 potatoes. Each replication had a length of 2.5 meter and 2.25-meter width. The area was 5.625 square meter. There was a path of 1 meter between the blocks (Fig 2).



Note: " → "shows direction to count plots starting from plot one.

Fig. 2: Illustration of the experimental design.

Medium sized (30-40 millimeters diameter) and well sprouted tubers of the variety 'Gera' were planted at recommended spacing. Phosphorous (P) fertilizer was applied in the form of Diammonium Phosphate (DAP) and Nitrogen (N) fertilizer in the form of Urea. The entire rate of 'P' for all fertilizer rates were applied during the planting time whereas half of the rates for each rate of N fertilizer was applied at the time of

planting and the remaining half rate was side dressed 35 days after planting. Other cultural practices such as earthing up, watering, cultivating etc. were carried out according to research recommendations.

The recommended rate of DAP and Urea is 195 kilogram per hectare and 165 kilogram per hectare respectively (John L., 2005). Different proportion of the recommended rates were used as the treatments. The combination (in percent, %) is shown as follows:

Table 1: Treatment combinations of DAP and Urea.

Treatment	DAP	UREA
1	100%	50%
2	100%	75%
3	50%	100%
4	75%	100%
5	100%	100%
6	0	0

Note: Treatment 5 is the recommended check, and treatment 6 is control (no fertilizer).

2.2.2 Data collection

Data were collected from the central rows (Fig 3). Parameters were taken randomly from all the 18 plots. Data on uniformity, tuberization, flowering, maturity, quality of tubers in terms of shape and size were taken from each plot.

Generally, all agronomic data were collected from the time of planting up to harvesting (Anex 1). Tuber weight yield per plant and total yield per hectare were measured using balances (Fig.4 [traders balance and digital balance for small quantities]).

Fig. 3: Data collection from central rows.

2.2.3 Data Analysis Approach

The collected data were analyzed using SPSS version 16 statistical software. Furthermore, data organization and pictorial representations were done using Excel application software.

Fig. 4: Weight measurement for potato yield.

3. RESULTS AND DISCUSSION

During this study different parameters were measured. Tiller number per plant, days to flowering, stem thickness (cm), plant height (cm), number of tubers per plant, tuber weight per plant (kg), yield per row (kg) and yield per hectare (tons/ha) were measured.

3.1 Tillers per Plant

Even though the analysis of variance (ANOVA) table shows ns for number of tillers per plant (Annex 2), Duncan mean separation shows significant difference between treatments receiving 100% DAP, 50% UREA (Treatment 1), and treatment 6 which did not receive any fertilizer; and 75% DAP, 100% Urea (treatment 4) and treatment 6 which did not receive any fertilizer. This could be due to the impact of DAP on the rooting system and that of Urea on vegetative growth of the plant (Table 2).

Table 2: Duncan's mean separation for groups in homogeneous subsets for number of tillers per plant.

	Treatment	N	Subset for alpha = 0.05	
			1	2
Duncan[1]	6	3	6.33a	
	5	3	7.67a	7.67ab
	2	3	8.33a	8.33ab
	3	3	8.33a	8.33ab
	4	3		8.67b
	1	3		9.00b
	Sig.		.067	.211

1. Uses Harmonic Mean Sample Size = 3.000.

Treatments followed by different letters differ significantly.

3.2. Days to Flowering

In days to flowering there is significant difference only between treatment 6 (control) and treatment 2; and between treatment 6 and treatment 5. Here both treatments 2 and 5 got 100% DAP so that there could happened quick protein synthesis to encourage earlier plant development (Table 3).

Table 3. Duncan's mean separation for groups in homogeneous subsets for days to flowering.

	Treatment	N	Subset for alpha = 0.05	
			1	2
Duncan[1]	5	3	41.00a	
	2	3	41.33a	
	1	3	42.67a	42.67ab
	3	3	42.67a	42.67ab
	4	3	42.67a	42.67ab
	6	3		44.33b
	Sig.		.079	.075

1. Uses Harmonic Mean Sample Size = 3.000.

Treatments followed by different letters differ significantly.

3.3 Plant Height

For plant height significant difference was observed between unfertilized treatment (treatment 6) and all other treatments (Table 4 and Fig. 5). This is expected result that fertilizer encourages plant growth and development. Nevertheless, there were no significant differences among other rates of fertilizer trials. It is obvious that plant height along with tiller number play significant role in light harvest; there by nutrient utilization and finally yield increment. However, in this case, the yield difference is not in line with the plant height analysis.

Table 4: Plant height (cm).

	Treatment	N	Subset for alpha=0.05	
			1	2
Duncan[1]	6	3	56.77a	
	4	3		72.20b
	5	3		73.63b
	3	3		75.30b
	1	3		75.87b
	2	3		76.07b
	Sig.		1.000	.427

1. Uses Harmonic Mean Sample Size = 3.000.
Treatments followed by different letters differ significantly.

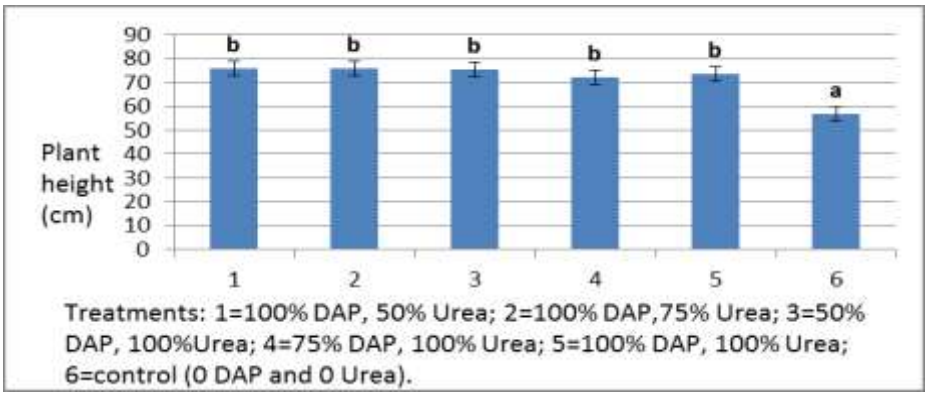


Fig. 5: Graph showing significant difference between the unfertilized check and other treatments but non-significant difference among other rates of fertilizer application.

3.4 Tuber Weight

Tuber weight per plant showed significant difference between treatment 2 (DAP 100%, Urea 75%) and treatment 6 (control) as well as treatment 3 (DAP 50%, Urea 100%) and treatment 6 (Table 5).

Table 5: Duncan's mean separation for groups in homogeneous subsets for tuber weight per plant (kg).

	Treatment	N	Subset for alpha = 0.05	
			1	2
Duncan[1]	6	3	.47a	
	5	3	.62a	.62ab
	1	3	.63a	.63ab
	4	3	.68a	.68ab
	3	3		.73b
	2	3		.83b
	Sig.		.066	.079

Means for groups in homogeneous subsets are displayed.
1. Uses Harmonic Mean Sample Size = 3.000.
Treatments followed by different letters differ significantly.

3.5 Total Yield

As it can be seen from Table 6 and Figure 6, there were significant differences in total yield (t/ha) between treatment 1 (100% DAP, 50% Urea) and treatments 6 (no fertilizer); and between treatment 3(50% DAP, 100% Urea) and treatment 6 (no fertilizer). In all measurements treatment 1 showed better records. This treatment received the recommended rate of DAP and half the recommended rate of Urea. Treatment 3 also received half the recommended rate of DAP and complete rate of the recommended Urea. The main function of P fertilizer is enabling the crop to form and grow roots earlier whereas that of Urea for its vegetative growth; which in combination result in fast and vigorous growth and development of the crop. This is a very good finding that farmers can reduce the amount of DAP or Urea by half. These days the cost of fertilizer is rising. If higher yield is obtained by applying half of the recommended rate at least for one of the fertilizers, costs can be reduced significantly.

Table 6: Duncan's mean separation for groups in homogeneous subsets for yield (t/ha).

Treatment	N	Subset for alpha = 0.05	
		1	2
6	3	17.49a	
5	3	20.52a	20.52ab
4	3	21.45a	21.45ab
2	3	22.54a	22.54ab
3	3		25.466b
1	3		26.06b
Sig.		.183	.154

Means for groups in homogeneous subsets are displayed.
1. Uses Harmonic Mean Sample Size = 3.000.
Treatments followed by different letters differ significantly.

Reductions in the rate of fertilizer also save the environment from pollution and salinity apart from the money incurred to buy the fertilizer. Therefore, the combination of DAP to Urea fertilizer for potato should be either 100% DAP and 50% Urea or 50% DAP and 100% Urea. Application of large amount of fertilizers did not add yield rather it showed yield reduction may be due to the toxic effect as fertilizes amount increased. This is clear by the treatments 2, 4 and 5 (Fig.6). In these treatments the rates were 75 up to 100% for DAP and Urea alternatively with both DAP and Urea 100% each for treatment 5, but the yield responses were not higher than treatments 1 and 3.

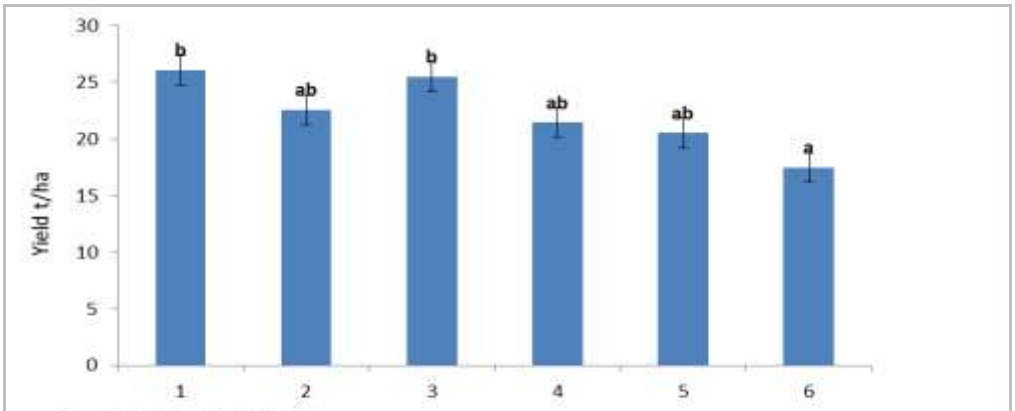


Fig. 6. Total yield (t/ha).
Treatments: 1=100% DAP, 50% Urea; 2=100% DAP,75% Urea; 3=50% DAP, 100%Urea; 4=75% DAP, 100% Urea; 5=100% DAP, 100% Urea; 6=control (0 DAP and 0 Urea).

4. CONCLUSION AND RECOMMENDATION

In addition to different management practices the use and proportion of fertilizers have a great impact on yield and yield components of potato. Under Ethiopian condition the utilization of fertilizers (DAP, Urea) to regulate potato yield is not common which is attributed to lack of information regarding the rate and methods, and time of application. Hence, my objectives were to show effects of rate and combinations of fertilizers for potatoes production.

The result of the current study showed that two distinct differences of potato yield based on the rate and combination of DAP and Urea fertilizers. 100% DAP and 50% Urea and 50% DAP and 100% Urea showed higher yield than other combinations. However statistical differences were observed between treatments those received either 100% and 50% or vice versa combination of the recommended rates of DAP and Urea and the unfertilized check. Higher rates showed lower yield. Hence, farmers can reduce the amount of fertilizer (DAP or Urea) at least one of them by half the recommended rate. These days the cost of fertilizer is rising. Therefore, it is very good news for the farmers to minimize their fertilizer cost and negative environmental impacts by applying lower dose of either DAP or Urea.

Though, the present study gives some information about rate and combination of fertilizer application on potato crop, further research should be carried out to update the previous studies and forward a clear recommendation for the potato farmers around Debre Berhan.

5. REFERENCES

1. Berga L., Potato Agronomy research. Addis Ababa, Ethiopia, 1994.
2. Beukema H., Introduction to potato production. Wageningen, Netherland, 1990.
3. CSA, Agricultural sample survey. Addis Ababa, Ethiopia, 2007.
4. DBAO, Environmental data survey, Debre Berhan, Ethiopia, 2001.
5. FAO, Agricultural production. Washington, America, 2007.
6. Girma A., Influence of Nitrogen and Phosphorus on yield, yield components and tuber quality of potato varieties on nitosols Bako area. Addis Ababa, Ethiopia, 2001.
7. Horton Y., Potato production, marketing and programs for developing countries. West view press, London, 1987.
8. John L., Soil fertility and fertilization: An introduction to nutrient management. New Delhi, India, 2005.
9. Kullaya K., production, marketing and consumption of potatoes in Ethiopian high lands. Addis Ababa, Ethiopia, 1980.
10. Lommen W., Basic studies on production and performance of mini tubers. Wageningen, Netherland, 1995.
11. Lung'aho C., Seed potato production in Eastern and central Africa. Nirobi, Kenya, 2007.
12. Pankhurst R., Notes for a history of Ethiopian Agriculture. Addis Ababa, Ethiopia, 1964.

ANNEXES

Annex 1: Variables measured.

Treatment	No. of tillers per plant	Days to flowering	Stem thickness (cm)	Plant height (cm)	Tuber number/ plant	Tuber weight/ plant (kg)	Single tuber weight (kg)	Total yield (kg/row)	Total yield (t/ha)
1	9	42.67	5.5	75.87	17	0.63	0.11	4.89	26.06
2	8	41.33	5.63	76.07	14	0.83	0.09	4.23	22.54
3	8	42.67	5.93	75.3	13	0.73	0.10	4.78	25.46
4	9	42.67	5.4	72.2	12	0.68	0.11	4.02	21.45
5	8	41	5.33	73.63	13	0.63	0.09	3.85	20.52
6	6	44.33	4.7	56.77	11	0.47	0.10	3.28	17.49
Treatments:1=100% DAP & 50%Urea; 2=100%DAP & 75%Urea; 3= 50%DAP & 100% Urea; 4=75%DAP & 100% Urea; 5=100%DAP & 100%Urea and 6=0%DAP & 0% Urea.									

Annex 2: ANOVA table.

		Sum of Squares	df	Mean Square	F	Sig.
Tiller number per plant	Between Groups	13.611	5	2.722	2.130	.131
	Within Groups	15.333	12	1.278		
	Total	28.944	17			
Days to flowering	Between Groups	21.111	5	4.222	4.471	.016
	Within Groups	11.333	12	.944		
	Total	32.444	17			
Stem thickness	Between Groups	2.525	5	.505	9.182	.001
	Within Groups	.660	12	.055		
	Total	3.185	17			
Plant height	Between Groups	829.076	5	165.815	5.968	.005
	Within Groups	333.387	12	27.782		
	Total	1162.463	17			
Tuber number per plant	Between Groups	56.500	5	11.300	1.304	.326
	Within Groups	104.000	12	8.667		
	Total	160.500	17			
Tuber weight per plant	Between Groups	.221	5	.044	2.991	.056
	Within Groups	.178	12	.015		
	Total	.399	17			
Single tuber weight	Between Groups	.002	5	.000	.985	.466
	Within Groups	.005	12	.000		
	Total	.008	17			
Yield per row	Between Groups	5.418	5	1.084	1.863	.175
	Within Groups	6.980	12	.582		
	Total	12.397	17			
Yield per hectare	Between Groups	153.751	5	30.750	1.858	.176
	Within Groups	198.639	12	16.553		
	Total	352.390	17			